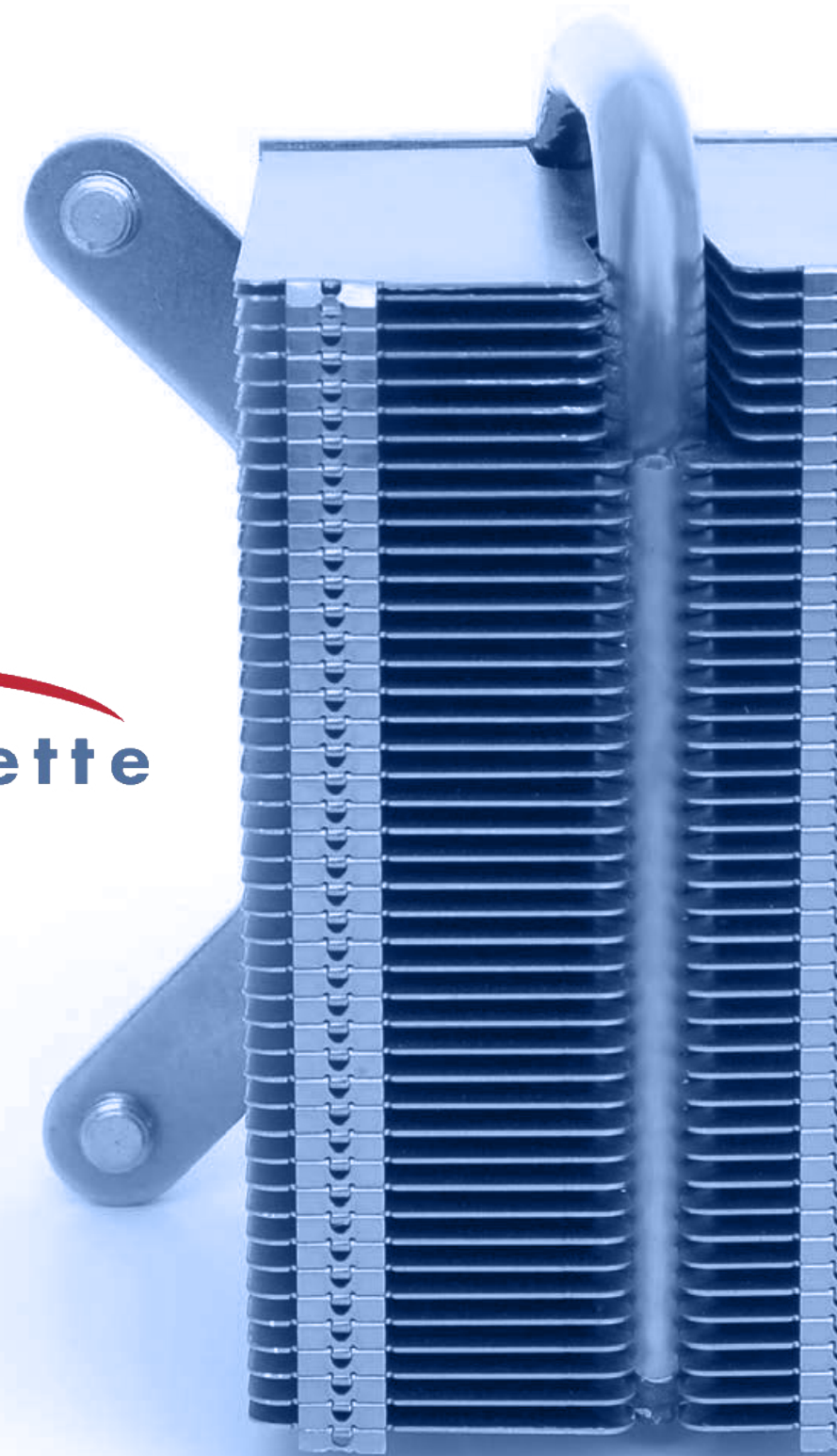




Corporate Headquarters:  
Wakefield Engineering Inc.\*  
33 Bridge Street, Pelham, NH 03076  
Tel: 603-635-2800 • Fax: 603-635-1900  
\* ISO 9001:2015 REGISTERED

**THERMAL MANAGEMENT**  
Standard Product Catalog

**2018**

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Heat sinks for microprocessors, ASICs, SRAM, BGAs, multichip modules, and other integrated circuits.

Board Level Power Semiconductor Heat Sinks ..... 44-85

A wide variety of heat dissipators with various attachment mechanisms for surface mount and thru-hole power semiconductors packaged in industry standard plastic, ceramic, and metal cases such as D²Pak, TO-220, TO-3 to TO-247, DO-4 to DO-11, multiwatt, hex-type, and stud mount devices.

Extruded Heat Sinks ..... 86-97

For cooling single and multiple high power devices packaged in industry standard semiconductor case styles: TO-3 to TO-247, DO-4 to DO-30, hex-type, and stud mount; press pack devices; power modules; SCRs, IGBTs; I/O devices; and other isolated flat base devices in both natural and forced convection.

Bonded Fin Heat Sinks ..... 98-105

A variety of Natural Convection, Forced Convection, and Custom Bonded Fin Assemblies.

Precision Compression Clamp Systems ..... 106-113

Mounting clamps for compression-type devices to 5,250 in. (133.4 mm) diameter and clamp force requirements ranging from 800 lbs. (262.9 kg) to 16,000 lbs. (7257.5 kg). A wide variety of Press Pack Heat Sinks are offered that are compatible with these mounting clamp series.

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For higher power applications where conventional cooling is no longer acceptable.

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Wakefield-Vette believes that information provided in this product catalog is accurate as of publication date. Product testing for proper performance in customer applications is recommended for all component designs and adhesives. Obtain mechanical samples of all assembly components and test to determine suitability. The physical properties reported herein are representative of performance values obtained by standard predictive and testing methods and exclude the interface resistance of any adhesive or other interface material in heat sink data. Wakefield-Vette is a manufacturer of heat dissipation products and reserves the right to make changes to its products without notice to improve the design or performance characteristics.

All trademarks and tradenames used in this publication are for identification purposes only and may be trademarks of their respective companies.



ABOUT WAKEFIELD-VETTE

SINCE 1952

**Wakefield-Vette** has been in continuous operations since 1952, providing thermal solutions across multiple industries, from international Fortune 50 companies to small and medium sized businesses. Industries served include *Power Conversion, Information Technology, Renewable Energy, Telecommunications, Transportation, Aerospace/Defense, LED Lighting, Factory Automation, Consumer, and Medical.*

The thermal solutions Wakefield-Vette manufactures comprise a wide array of products, including *thermal extrusions, LED heat sinks, heat frames and pipes, fans, heat exchangers, coolant distribution units, liquid cold plates, etc.*, making Wakefield-Vette unique in its ability to deliver the increasingly complex **thermal solutions** required to meet the thermal engineering challenges of today's ever-higher electronics packaging densities.

Wakefield-Vette is a **700-employee strong company** with 500,000 square feet of global manufacturing capacity with facilities located in New Hampshire, North Carolina, and Wisconsin.



PELHAM, NH

*US Headquarters Production – Thermal Management, Extrusions*

-   
Design Lab
-   
Design Eng.
-   
Application Eng.
-   
Aluminum Extrusions
-   
Heat Sinks
-   
Heat Frames
-   
Bonded Fin
-   
Thermal Accessories



**33 Bridge Street  
Pelham, NH 03076**  
**Phone:** (603) 635-2800  
**Fax:** (603) 635-1900

210 Employees  
240,000 ft²

LOCATION OVERVIEW

RALEIGH, NC

*Production – Ruggedized & Electronic Packaging, Hi-end Complex Mfg, Military*

-   
Design Lab
-   
Design Eng.
-   
Application Eng.
-   
Thermal – Military – Ruggedized
-   
Enclosures
-   
Front Panels
-   
Wedgelocks



**2910 Industrial Drive  
Raleigh, NC 27609**  
**Phone:** (919) 831-9950

65 Employees  
50,000 ft²

WITHEE, WI

*Production – Extrusions, Fabrications*

-   
Aluminum Extrusions
-   
Fabrication
-   
Industrial Applications

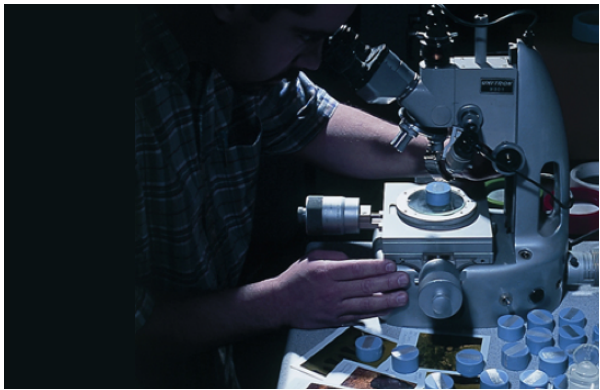
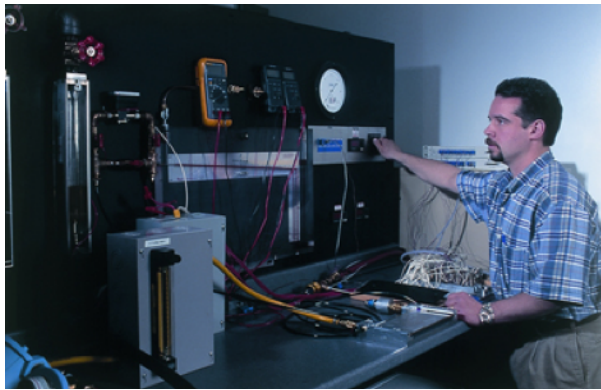
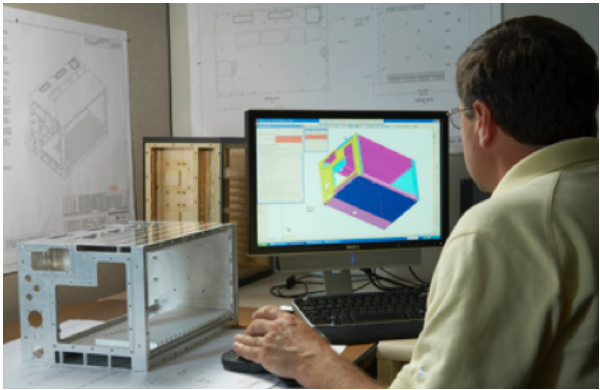
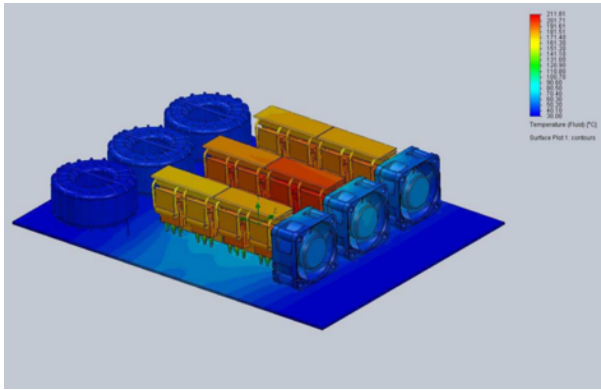


**511 Progress Street  
Withee, WI 54498**  
**Phone:** (715) 229-9200  
**Fax:** (715) 229-9202

60 Employees  
55,000 ft²

DESIGN SERVICES

THERMAL SOLUTIONS



Wakefield-Vette also offers a **wide range of engineering design services** along with our standard and custom products. In many cases, our customers need to make small changes to our standard products. Wakefield-Vette's application engineers are ready to modify drawings and give feedback on requested changes to support your efforts to make the product you purchase work as intended in your application. When even more design assistance is needed, Wakefield-Vette has a world class team of engineers to work with you. We excel at collaboration with **engineering teams** to share drawings, design ideas, analysis and manufacturing understanding. Wakefield-Vette uses SolidWorks solid models and drawings and Ansys IcePak for Computational Fluid Dynamics (CFD) analysis.

Even if you do not have a thermal solution in mind, bring your applications to us and we can support ground-up design efforts with options for **liquid, natural and forced air convection cooling solutions**. Wakefield-Vette can also give insight into the use of thermal products like heat pipes, vapor chambers, liquid cold plates and many other technologies to bring to bear on your application as well as accessory items such as thermal interface materials, fans and attach methods. Wakefield-Vette can truly be your one-stop-shop for thermal solutions from start to finish.

NOTES

Notes section with horizontal lines for writing.

# Thermal Management Solutions & Thermal Interface

Thermal Management Solutions for BGAs.....

7

Thermal Interface .....

8



## BGA Thermal Solutions Matrix

The following table represents Wakefield-Vette’s recommendations for a variety of standard BGA sizes. However, this is by no means a complete list of components that can be used with these heat sinks. To determine suitability for your particular component, request a BGA heat sink evaluation kit.

| BGA Sizes (mm) | Heat Sink Footprint (mm) | Heat Sink Height (inches) | Recommended Series # | Attachment Method |
|----------------|--------------------------|---------------------------|----------------------|-------------------|
| 17             | 17 x 17                  | .40                       | D10650               | Adhesive          |
| 19             | 19 x 19                  | 1.00                      | 602                  | Adhesive          |
| 21             | 21 x 21                  | .40                       | D10850               | Adhesive          |
| 21             | 21 x 21                  | .25 .35 .45 .60           | 624                  | Adhesive          |
| 23             | 22 x 22                  | .40 .60                   | 604                  | Adhesive          |
| 23             | 22 x 22                  | .75                       | 605                  | Adhesive          |
| 25             | 25 x 25                  | .25 .35 .45 .60           | 625                  | Adhesive          |
| 27             | 28 x 28                  | .25 .35 .45 .60           | 658                  | Adhesive          |
| 29             | 30 x 30                  | .77                       | 606                  | Adhesive          |
| 31             | 31 x 28                  | .65                       | 607                  | Adhesive          |
| 31             | 31 x 31                  | .80                       | 611                  | Adhesive          |
| 33             | 32 x 32                  | .35 .40                   | 610                  | Adhesive          |
| 35             | 35 x 35                  | .65                       | 612                  | Adhesive          |
| 35             | 35 x 35                  | .25 .35 .45 .60           | 642                  | Adhesive          |
| 35             | 35 x 35                  | .25 .35 .45 .60           | 630                  | Adhesive          |
| 37.5           | 37 x 37                  | .50                       | 613                  | Adhesive          |
| 37.5           | 37 x 37                  | .65                       | 659                  | Adhesive          |
| 45.7 x 35.5    | 37 x 47                  | .80                       | 617                  | Adhesive          |
| 40             | 38 x 38                  | .30 .50 1.00              | 614                  | Adhesive          |
| 37.5           | 38 x 38                  | .29                       | 660                  | Adhesive          |
| 40             | 40 x 28                  | .35                       | 643                  | Clip              |
| 40             | 40 x 40                  | .26 .53                   | 655                  | Adhesive          |
| 42.5           | 41 x 41                  | .41                       | 615                  | Adhesive          |
| 45             | 43 x 43                  | .20 .25 .35 .45 .60       | 628                  | Adhesive          |
| 45             | 43 x 43                  | .15                       | 662                  | Adhesive          |
| 47.5           | 47 x 47                  | .80                       | 616                  | Adhesive          |
| 50             | 50 x 50                  | .40 .65 .80 1.00          | 698                  | Adhesive          |
| 50             | 51 x 51                  | .20 1.00                  | 618                  | Adhesive          |
| 50             | 52 x 51                  | .80                       | 622                  | Adhesive          |
| 50             | 53 x 47                  | .40 .65 .80 1.00          | 798                  | Adhesive          |
| 50             | 64 x 51                  | .24                       | 620                  | Adhesive          |
| up to 45       | 73 x 50                  | .50 1.00                  | 609                  | Clip              |
| up to 45       | 73 x 50                  | .95                       | 619                  | Clip              |

### RoHS COMPLIANCE

Please note that Wakefield-Vette part numbers designated with an “E” in this catalog denote new parts in compliance with the RoHS initiative, with the exception of our Precision Clamps. Wakefield-Vette will still continue to offer non-RoHS compliant versions of these parts. Please be aware that many Wakefield-Vette Standard parts have always been compliant since their design inception and therefore will not carry the “E” designation.

Wakefield-Vette requests that you refer to the RoHS compliance tool on our website at [www.wakefield-vette.com](http://www.wakefield-vette.com) to verify RoHS compliance. If you require further clarification or information regarding RoHS, please contact the factory.



# THERMAL INTERFACE MATERIAL PART NUMBER GUIDE

All of the heat sinks shown in this catalog are available with any of the following thermal tape and interface materials, pre-applied at the factory. Use the “T” series, thermally enhanced, pressure sensitive adhesives to attach the heat sink to the electronic package and provide a good thermal link to the heat sink. Specify these materials in applications where the heat sink will be fixed to the electronic package by some mechanical means other than a tape. Please note that none of these materials are for use in applications requiring electrical isolation from the electronic device. All options other than -T1 and -T4 are RoHS compliant.

**Note:** To obtain the estimated thermal resistance of the interface material in your application, divide the thermal impedance value by the area of the pad in square inches. For example, a 2” x 2” piece of T4 has a resistance of 1.10 C-in^2/W ÷ 4 in^2=0.275 C/W

## “T” Series Thermally Enhanced Pressure Sensitive Adhesives

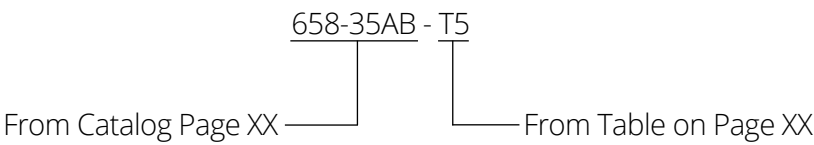
| Suffix | Manufacturer Product | Thermal Impedance C-in^2/W | Thickness, Inches | Package Surface, Comments                           |
|--------|----------------------|----------------------------|-------------------|-----------------------------------------------------|
| -T1    | Chomerics, T405      | 0.47                       | 0.006             | Metal/ceramic; aluminum carrier                     |
| -T1E   | Chomerics, T405R     | 0.47                       | 0.006             | RoHS-compliant version of -T1                       |
| -T3    | Chomerics, T412      | 0.25                       | 0.009             | Metal/ceramic; very good performance and conformity |
| -T4    | Chomerics, T410      | 1.10                       | 0.007             | Plastic                                             |
| -T4E   | Chomerics, T410R     | 1.10                       | 0.007             | RoHS-compliant version of -T4                       |
| -T5    | Chomerics, T411      | 1.00                       | 0.011             | Plastic; conforms to out-of-flat packages           |
| -T6    | 3M, 8810             | 0.88                       | 0.010             | Metal/ceramic; very good adhesion and conformity    |
| -T7    | Bergquist, BP 108    | 1.28                       | 0.008             | Metal/ceramic; electrically insulating              |

## ORDERING INFORMATION

Once you have chosen heat sink and thermal interface material that meets your thermal & mechanical requirements it is easy to designate the part number. Simply add the interface material suffix referenced on the chart above to the base part number for the heat sink. The base part number already includes information regarding its size and finish.

Example:

To order the 658 Series heat sink at .350” tall with the T5 thermal interface material, specify part number:





# INTEGRATED CIRCUIT COOLING HEAT SINKS

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| Wave Series Heat Sink With Integrated Clip Assembly ..... | 36-43 |

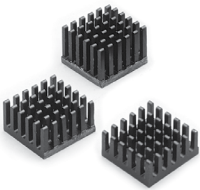


With the increase in heat dissipation from microelectronics devices and the reduction in overall form factors, thermal management becomes a more important element of electronic product design.

Both the performance reliability and life expectancy of electronic equipment are inversely related to the component temperature of the equipment. The relationship between the reliability and the operating temperature of a typical silicon semi-conductor device shows that a reduction in the temperature corresponds to an exponential increase in the reliability and life expectancy of the device. Therefore, long life and reliable performance of a component may be achieved by effectively controlling the device operating temperature within the limits set by the device design engineers.

Heat sinks are devices that enhance heat dissipation from a hot surface, usually the case of a heat generating component, to a cooler ambient, usually air. For the following discussions, air is assumed to be the cooling fluid. In most situations, heat transfer across the interface between the solid surface and the coolant air is the least efficient within the system, and the solid-air interface represents the greatest barrier for heat dissipation. A heat sink lowers this barrier mainly by increasing the surface area that is in direct contact with the coolant. This allows more heat to be dissipated and/or lowers the device operating temperature. The primary purpose of a heat sink is to maintain the device temperature below the maximum allowable temperature specified by the device manufacturers.

HEAT SINKS FOR BGAs, SUPER BGAs, PBGAs, & FPBGAs



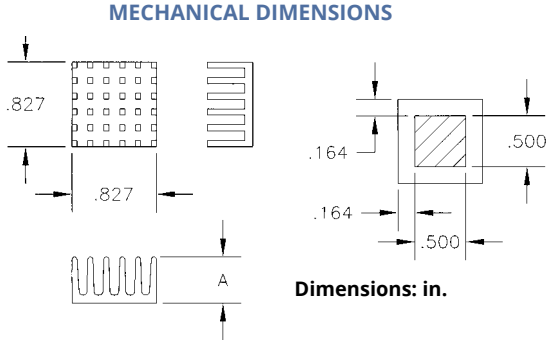
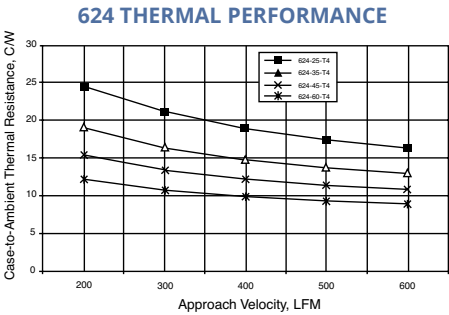
624 SERIES OMNIDIRECTIONAL PIN FIN HEAT SINK FOR BGAs

The **624 Series** is an omnidirectional pin fin heat sink for both natural and forced-convection applications. Applications include network routers and switches, high-resolution printers, digital cameras, consumer video games, digital video disks (DVD) and global positioning systems (GPS).

| Standard P/N | Base Dimensions in. Sq. | Fin Height "A" in. (mm) | Typical Applications | Weight lbs. (grams) |
|--------------|-------------------------|-------------------------|----------------------|---------------------|
| 624-25AB     | .827 (21)               | .250 (6.4)              | 21mm BGA             | .009 (4.09)         |
| 624-35AB     | .827 (21)               | .350 (8.9)              | 21mm BGA             | .011 (4.99)         |
| 624-45AB     | .827 (21)               | .450 (11.4)             | 21mm BGA             | .015 (6.81)         |
| 624-60AB     | .827 (21)               | .600 (15.2)             | 21mm BGA             | .026 (11.80)        |

**Material:** Aluminum, Black Anodized

- PRODUCT FEATURES
- Available in four standard heights, .25 inch, .35 inch, .45 inch, and .60 inch.
  - Available with pressure sensitive adhesives for quick and easy mounting. See Page 8.



OMNIDIRECTIONAL PIN FIN HEAT SINK FOR BGAs 625 SERIES

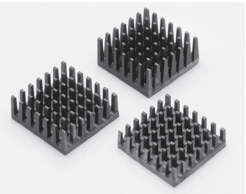
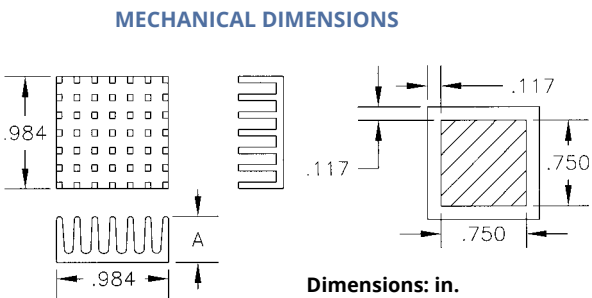
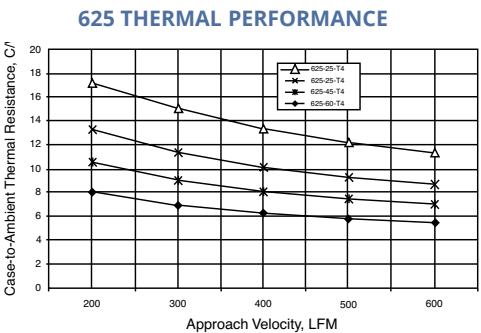
PRODUCT FEATURES

- Available in four standard heights, .25 inch, .35 inch, .45 inch, and .60 inch.
- Available with pressure sensitive adhesives for quick and easy mounting. See Page 8.

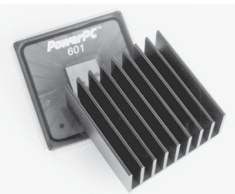
The **625 Series** is an omnidirectional pin fin heat sink for both natural and forced-convection applications. Applications include network routers and switches, high-resolution printers, digital cameras, consumer video games, digital video disks (DVD) and global positioning systems (GPS).

| Standard P/N | Base Dimensions in. Sq. | Fin Height "A" in. (mm) | Typical Applications | Weight lbs. (grams) |
|--------------|-------------------------|-------------------------|----------------------|---------------------|
| 625-25AB     | .984 (25)               | 0.250 (6.4)             | 25 mm BGA            | .012 (5.45)         |
| 625-35AB     | .984 (25)               | 0.350 (8.9)             | 25 mm BGA            | .014 (6.36)         |
| 625-45AB     | .984 (25)               | 0.450 (11.4)            | 25 mm BGA            | .018 (8.17)         |
| 625-60AB     | .984 (25)               | 0.600 (15.2)            | 25 mm BGA            | .030 (13.62)        |

**Material:** Aluminum, Black Anodized

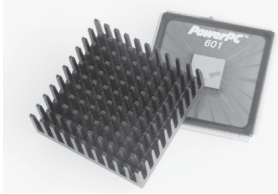
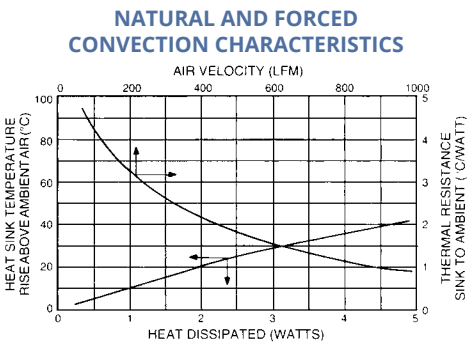
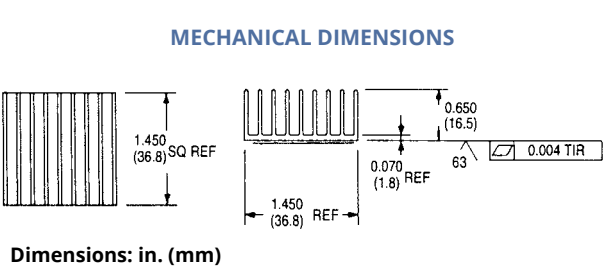


UNIDIRECTIONAL FIN HEAT SINK FOR BGAs 659 SERIES



| Standard P/N | Base Dimensions in. (mm) | Height in. (mm) | Typical Application | Heat Sink Finish | Weight lbs. (grams) |
|--------------|--------------------------|-----------------|---------------------|------------------|---------------------|
| 659-65AB     | 1.45 (36.8) sq           | .650 (16.5)     | 37mm BGA            | Black Anodized   | 0.050 (22.68)       |

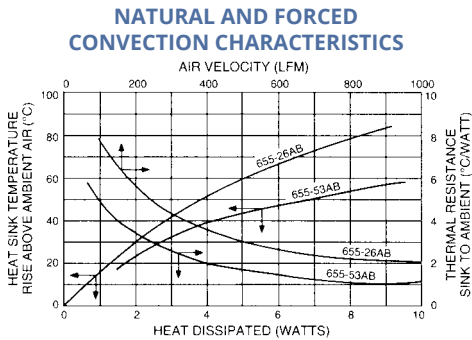
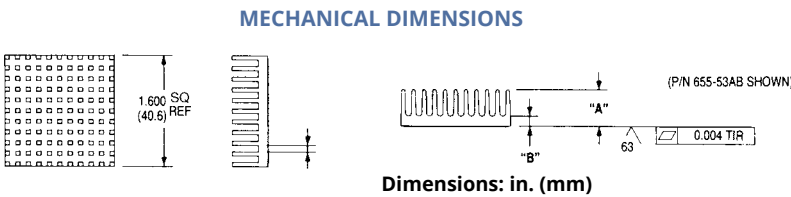
**Notes:** 1. Optional factory pre-applied pressure-sensitive adhesive. See Page 8.



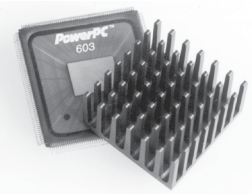
655 SERIES OMNIDIRECTIONAL PIN FIN HEAT SINK FOR BGAs AND POWERPC™

| Standard P/N | Base Dimensions in. (mm) | Dimension "A" in. (mm) | Dimension "B" in. (mm) | Typical Applications | Heat Sink Finish | Weight lbs. (grams) |
|--------------|--------------------------|------------------------|------------------------|----------------------|------------------|---------------------|
| 655-26AB     | 1.600 (40.6) sq          | 0.260 (6.6)            | 0.125 (3.2)            | 40mm BGA             | Black Anodized   | 0.038 (17.01)       |
| 655-53AB     | 1.600 (40.6) sq          | 0.525 (13.3)           | 0.145 (3.7)            | 40mm BGA             | Black Anodized   | 0.050 (22.68)       |

**Notes:** 1. Optional factory pre-applied pressure-sensitive adhesive. See Page 8.

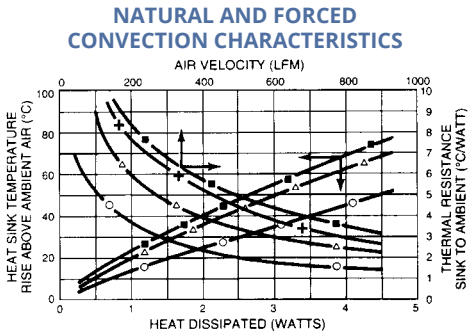
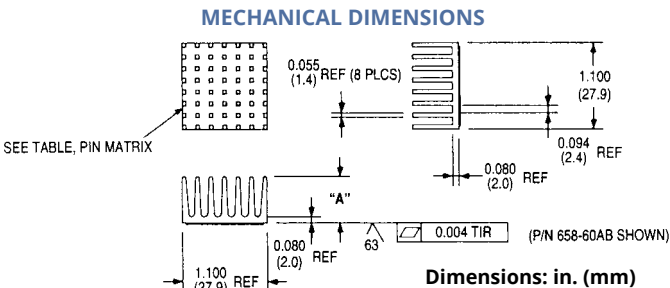


OMNIDIRECTIONAL PIN FIN HEAT SINK FOR BGAs AND POWERPC™ 658 SERIES



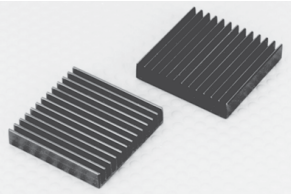
| Standard P/N | Base Dimensions in. (mm) | Dimension "A" in. (mm) | Typical Applications | Heat Sink Finish | Weight lbs. (grams) |
|--------------|--------------------------|------------------------|----------------------|------------------|---------------------|
| 658-25AB     | 1.100 (27.9) sq          | 0.250 (6.4)            | 27mm BGA             | Black Anodized   | 0.013 (5.67)        |
| 658-35AB     | 1.100 (27.9) sq          | 0.350 (8.9)            | 27mm BGA             | Black Anodized   | 0.015 (6.70)        |
| 658-45AB     | 1.100 (27.9) sq          | 0.450 (11.4)           | 27mm BGA             | Black Anodized   | 0.019 (8.50)        |
| 658-60AB     | 1.100 (27.9) sq          | 0.600 (15.2)           | 27mm BGA             | Black Anodized   | 0.031 (14.17)       |

**Notes:** 1. Optional factory pre-applied pressure-sensitive adhesive. See Page 8.



KEY:  
■ 658-25AB  
+ 658-35AB  
△ 658-45AB  
○ 658-60AB

HEAT SINKS FOR BGAs, SUPER BGAs, PBGAs, & FPBGAs



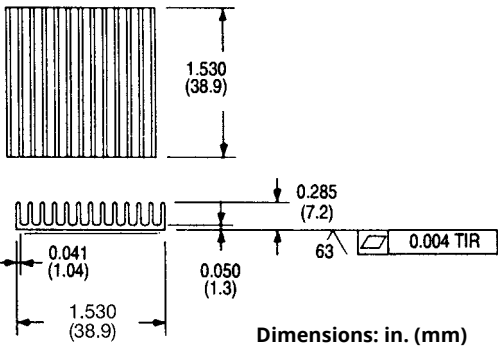
660 SERIES

UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

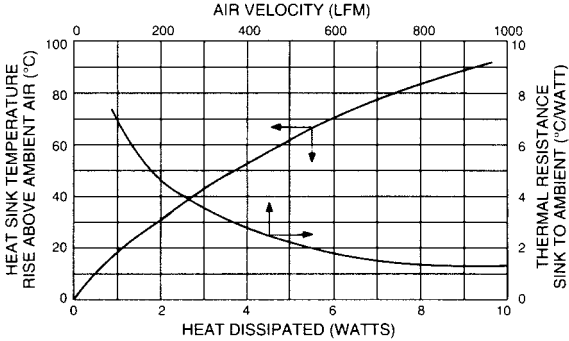
| Standard P/N | Base Dimensions in. (mm) | Height in. (mm) | Typical Application | Heat Sink Finish | Weight lbs. (grams) |
|--------------|--------------------------|-----------------|---------------------|------------------|---------------------|
| 660-29AB     | 1.530SQ. (38.9)SQ.       | 0.285 (7.2)     | 37mm BGA            | Black Anodized   | 0.031 (14.17)       |

Notes: 1. Optional factory pre-applied pressure-sensitive adhesive. See Page 8.

MECHANICAL DIMENSIONS

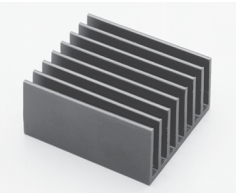


NATURAL AND FORCED CONVECTION CHARACTERISTICS



UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

642 SERIES



PRODUCT FEATURES

- Available in four standard heights, .25 inch, .35 inch, .45 inch, and .60 inch.
- Available with pressure sensitive adhesives for quick and easy mounting. See Page 8.

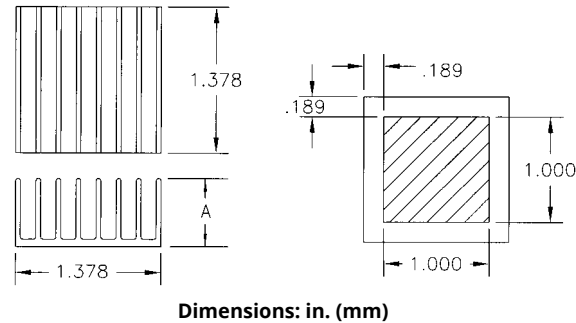
The **642 Series** is an unidirectional pin fin heat sink for both natural and forced-convection applications.

Applications include network routers and switches, high-resolution printers, digital cameras, consumer video games, digital video disks (DVD) and global positioning systems (GPS).

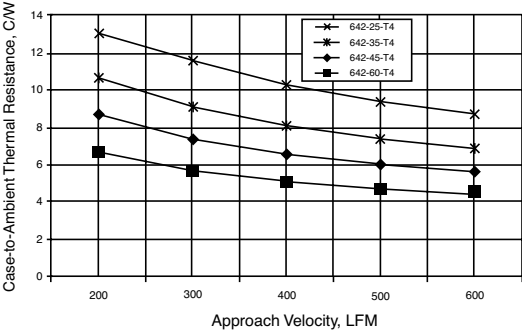
| Standard P/N | Base Dimensions in. Sq. | Fin Height "A" in. (mm) | Typical Applications | Weight lbs. (grams) |
|--------------|-------------------------|-------------------------|----------------------|---------------------|
| 642-25AB     | 1.378 (35)              | .250 (6.4)              | 35 mm BGA            | .022 (9.99)         |
| 642-35AB     | 1.378 (35)              | .350 (8.9)              | 35 mm BGA            | .027 (12.26)        |
| 642-45AB     | 1.378 (35)              | .450 (11.4)             | 35 mm BGA            | .031 (14.07)        |
| 642-60AB     | 1.378 (35)              | .600 (15.2)             | 35 mm BGA            | .039 (17.71)        |

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



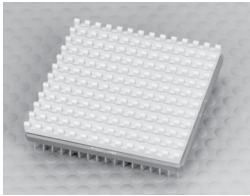
642 THERMAL PERFORMANCE



Performance shown is with T4 thermal adhesive applied.

OMNIDIRECTIONAL PIN FIN HEAT SINK FOR LIMITED HEIGHT BGAs

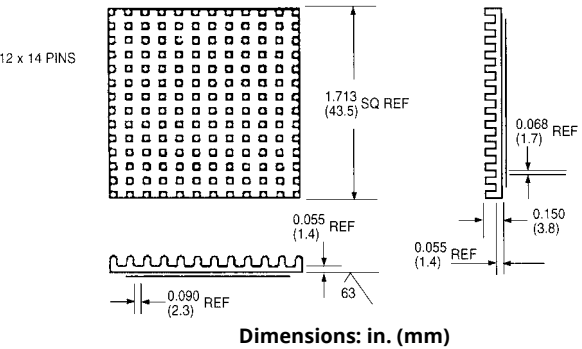
662 SERIES



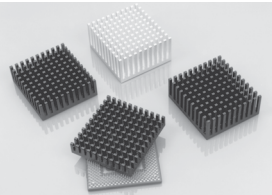
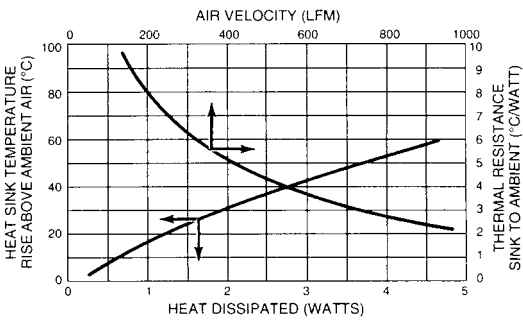
| Standard P/N | Base Dimensions in. (mm) | Height in. (mm) | Typical Applications | Heat Sink Finish | Weight lbs. (grams) |
|--------------|--------------------------|-----------------|----------------------|------------------|---------------------|
| 662-15AG     | 1.713 (43.5) sq          | 0.150 (3.8)     | 45mm BGA             | Gold Iridite     | 0.019 (8.50)        |
| 662-15AB     | 1.713 (43.5) sq          | 0.150 (3.8)     | 45mm BGA             | Black Anodized   | 0.019 (8.50)        |

Notes: 1. Optional factory pre-applied pressure-sensitive adhesive. See Page 8.

MECHANICAL DIMENSIONS



NATURAL AND FORCED CONVECTION CHARACTERISTICS



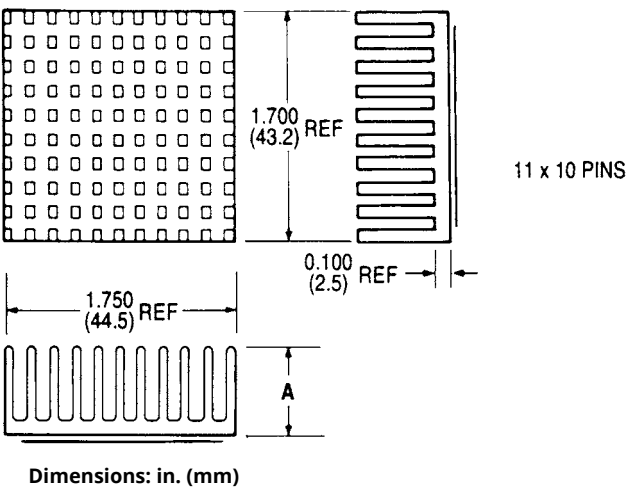
628 SERIES

OMNIDIRECTIONAL PIN FIN HEAT SINK FOR BGAs

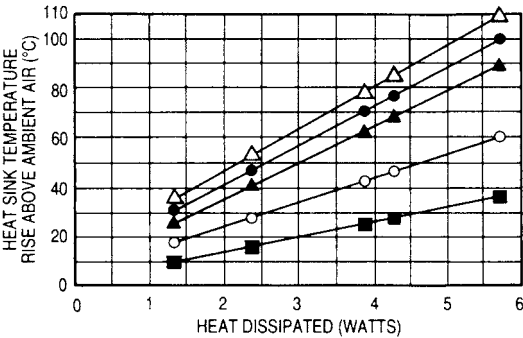
| Standard P/N | Base Dimensions in. (mm)    | Dimensions "A" in. (mm) | Typical Applications | Heat Sink Finish | Weight lbs. (grams) |
|--------------|-----------------------------|-------------------------|----------------------|------------------|---------------------|
| 628-20AB     | 1.750 (44.5) x 1.700 (43.2) | 0.200 (5.1)             | 45mm BGA             | Black Anodized   | 0.031 (14.17)       |
| 628-25AB     | 1.750 (44.5) x 1.700 (43.2) | 0.250 (6.4)             | 45mm BGA             | Black Anodized   | 0.038 (17.01)       |
| 628-35AB     | 1.750 (44.5) x 1.700 (43.2) | 0.350 (8.9)             | 45mm BGA             | Black Anodized   | 0.044 (19.84)       |
| 628-40AB     | 1.750 (44.5) x 1.700 (43.2) | 0.400 (10.2)            | 45mm BGA             | Black Anodized   | 0.050 (22.68)       |
| 628-65AB     | 1.750 (44.5) x 1.700 (43.2) | 0.650 (16.5)            | 45mm BGA             | Black Anodized   | 0.056 (25.51)       |

Notes: 1. Optional factory pre-applied pressure-sensitive adhesive. See Page 8.

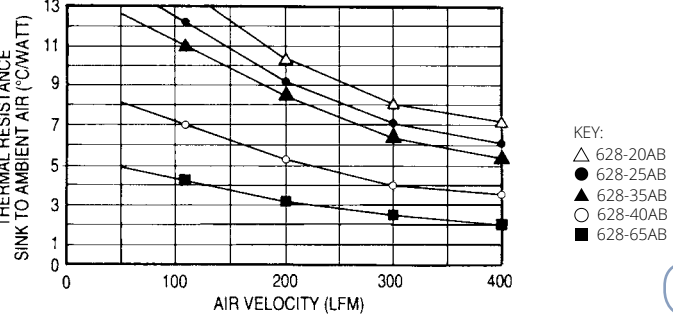
MECHANICAL DIMENSIONS



NATURAL CONVECTION CHARACTERISTICS



FORCED CONVECTION CHARACTERISTICS



KEY:  
△ 628-20AB  
● 628-25AB  
▲ 628-35AB  
○ 628-40AB  
■ 628-65AB



HEAT SINKS FOR BGAs, SUPER BGAs, PBGAs, & FPBGAs

630 SERIES OMNIDIRECTIONAL PIN FIN HEAT SINK FOR BGAs

The **630 Series** is an omnidirectional pin fin heat sink for both natural and forced-convection applications.

Applications include network routers and switches, high-resolution printers, digital cameras, consumer video games, digital video disks (DVD) and global positioning systems (GPS).

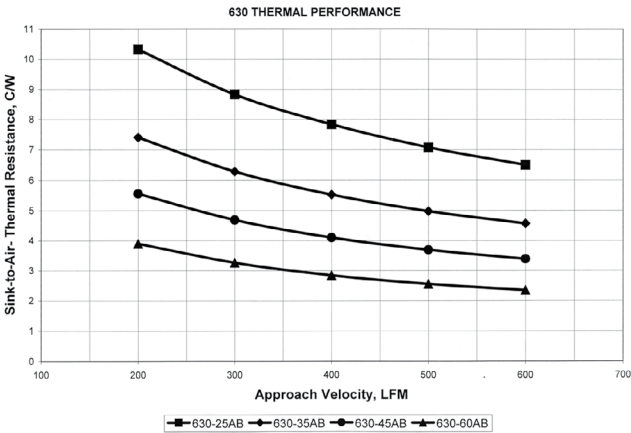
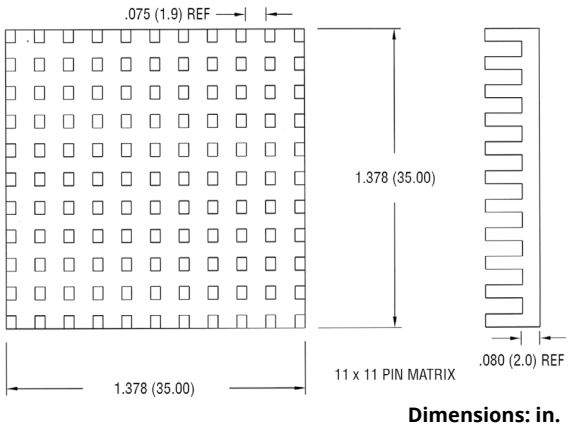
| Standard P/N | Base Dimensions in. Sq. | Fin Height "A" in. (mm) | Typical Applications | Weight lbs. (grams) |
|--------------|-------------------------|-------------------------|----------------------|---------------------|
| 630-25AB     | 1.378 (35)              | .250 (6.4)              | 35mm BGA             | .009 (4.09)         |
| 630-35AB     | 1.378 (35)              | .350 (8.9)              | 35mm BGA             | .011 (4.99)         |
| 630-45AB     | 1.378 (35)              | .450 (11.4)             | 35mm BGA             | .015 (6.81)         |
| 630-60AB     | 1.378 (35)              | .600 (15.2)             | 35mm BGA             | .026 (11.80)        |

**Material:** Aluminum, Black Anodized

PRODUCT FEATURES

- Available in four standard heights, .25 inch, .35 inch, .45 inch, and .60 inch.
- Available with pressure sensitive adhesives for quick and easy mounting. See Page 8.

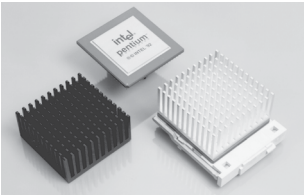
MECHANICAL DIMENSIONS



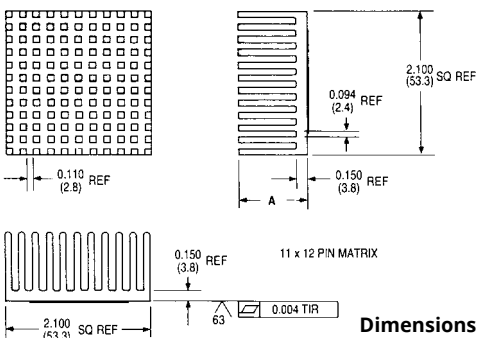
OMNIDIRECTIONAL PIN FIN HEAT SINK FOR BGAs 698 SERIES

| Standard P/N | Base Dimensions in. (mm) | Dimensions "A" in. (mm) | Typical Applications | Heat Sink Finish | Weight lbs. (grams) |
|--------------|--------------------------|-------------------------|----------------------|------------------|---------------------|
| 698-40AB     | 2.100 (53.3) sq.         | 0.400 (10.2) sq.        | 45mm BGA             | Black Anodized   | 0.075 (34.02)       |
| 698-65AB     | 2.100 (53.3) sq.         | 0.650 (16.5) sq.        | 45mm BGA             | Black Anodized   | 0.119 (53.86)       |
| 698-80AB     | 2.100 (53.3) sq.         | 0.800 (20.3) sq.        | 45mm BGA             | Black Anodized   | 0.125 (56.70)       |
| 698-100AB    | 2.100 (53.3) sq.         | 1.000 (25.4) sq.        | 45mm BGA             | Black Anodized   | 0.144 (65.20)       |

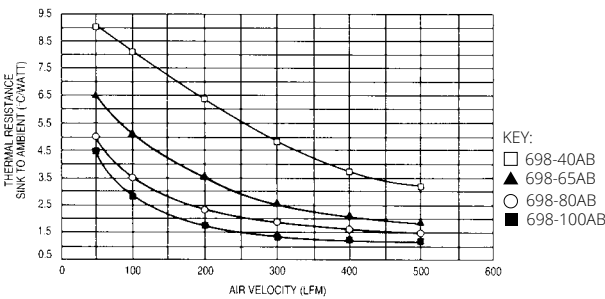
**Notes:** 1. Optional factory preapplied pressure-sensitive adhesive. See Page 8.



MECHANICAL DIMENSIONS

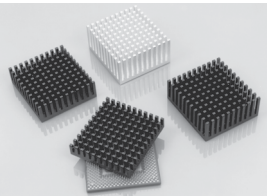


FORCED CONVECTION THERMAL PERFORMANCE DATA (FLOW PARALLEL TO EXTRUSION DIRECTION)

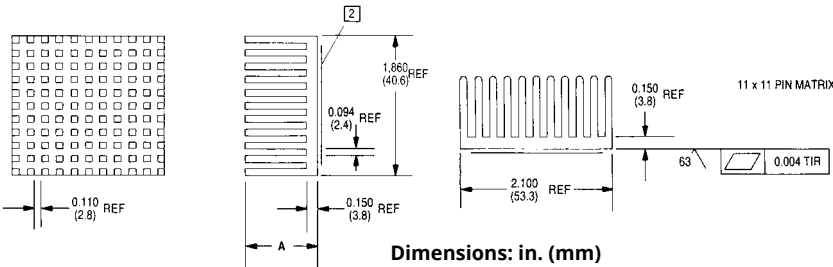


PIN FIN HEAT SINK FOR BGAs 798 SERIES

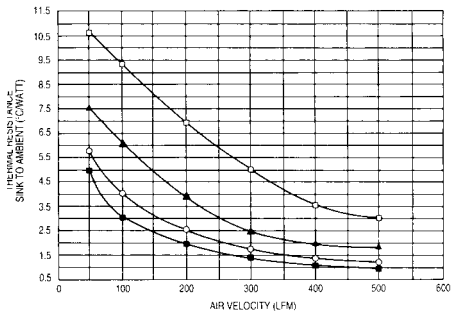
| Standard P/N | Base Dimensions in. (mm)    | Dimensions "A" in. (mm) | Typical Applications | Heat Sink Finish | Weight lbs. (grams) |
|--------------|-----------------------------|-------------------------|----------------------|------------------|---------------------|
| 798-40AB     | 2.100 (53.3) x 1.860 (47.2) | 0.400 (10.2)            | 45mm BGA             | Black Anodized   | 0.063 (28.35)       |
| 798-65AB     | 2.100 (53.3) x 1.860 (47.2) | 0.650 (16.5)            | 45mm BGA             | Black Anodized   | 0.106 (48.19)       |
| 798-80AB     | 2.100 (53.3) x 1.860 (47.2) | 0.800 (20.3)            | 45mm BGA             | Black Anodized   | 0.113 (51.03)       |
| 798-100AB    | 2.100 (53.3) x 1.860 (47.2) | 1.000 (25.4)            | 45mm BGA             | Black Anodized   | 0.131 (59.53)       |



MECHANICAL DIMENSIONS



FORCED CONVECTION THERMAL PERFORMANCE DATA (FLOW PARALLEL TO EXTRUSION DIRECTION)



NOTES:

- Heat sink mounting surface flatness: 0.004" TIR
- Optional factory pre-applied pressure-sensitive adhesive. See Page 8.

KEY:  
□ 798-40AB ▲ 798-65AB ○ 798-80AB ■ 798-100AB

643 SERIES OMNIDIRECTIONAL PIN FIN HEAT SINK FOR BGAs

The **Series 643-35AP** is an omnidirectional pin fin heat sink for both natural and forced-convection applications designed to fit a 40 mm BGA.

Applications include network routers and switches, high-resolution printers, digital cameras, consumer video games, digital video disks (DVD) and global positioning systems (GPS).

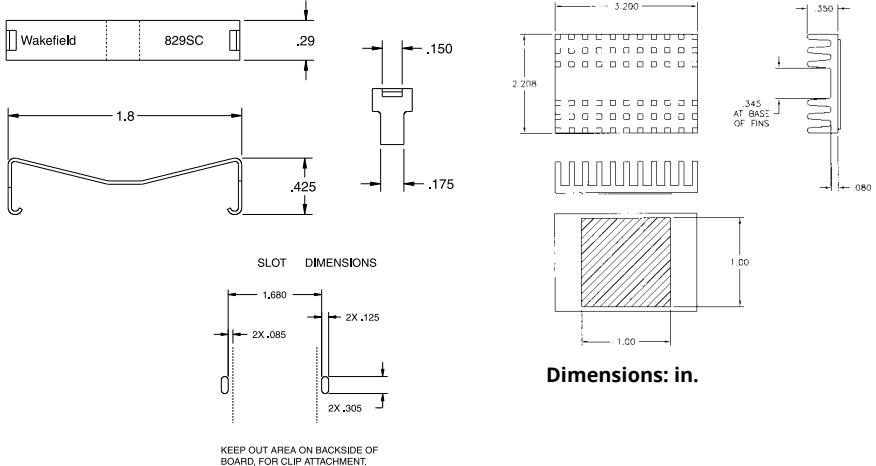
PRODUCT FEATURES

- Available with pressure sensitive adhesives to ensure good thermal performance. See page 8.
- Can be ordered with the **829SC clip**. Order clip separately. (Clip cannot be purchased without heat sink)

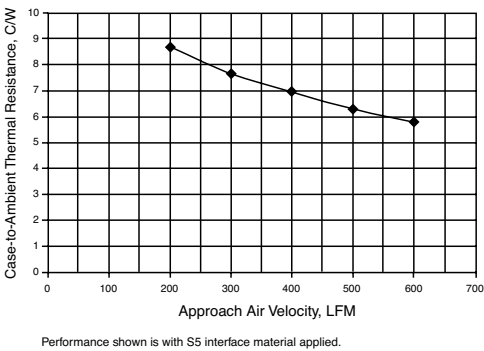
| Standard P/N | Base Dimensions in. (mm)    | Fin Height in. (mm) | Typical Applications | Weight lbs. (grams) |
|--------------|-----------------------------|---------------------|----------------------|---------------------|
| 643-35AP     | 1.60 (40.64) x 1.10 (27.94) | 0.350 (8.89)        | 40 mm BGA            | .070 (31.78)        |

**Material:** Aluminum, Plain Finish

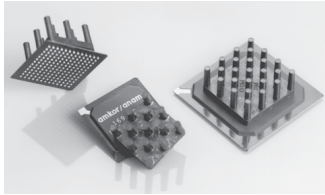
MECHANICAL DIMENSIONS



643 THERMAL PERFORMANCE



## DELTEM™ COMPOSITE HEAT SINKS FOR BGAs



# DELTEM™ D10650-40

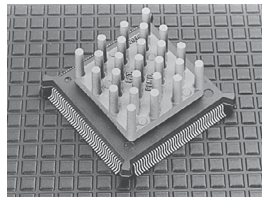
## PIN FIN HEAT SINK

| Standard P/N                                                                                       | Base Dimensions in. (mm) | Height in. (mm) | Weight lbs. (grams) |
|----------------------------------------------------------------------------------------------------|--------------------------|-----------------|---------------------|
| D10650-40                                                                                          | 0.650 (16.5) sq          | 0.400 (10.2)    | 0.004 (1.91)        |
| <b>Notes:</b> Available with pressure sensitive adhesives for quick and easy mounting. See Page 8. |                          |                 |                     |

**Notes:** Available with pressure sensitive adhesives for quick and easy mounting. See Page 8.

## PIN FIN HEAT SINK

# DELTEM™ D10850-40

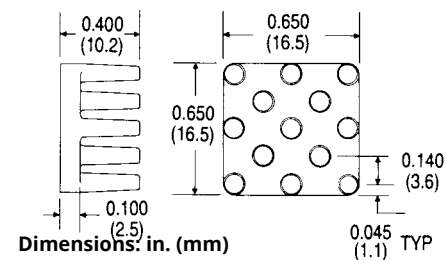


| Standard P/N                                                                                       | Base Dimensions in. (mm) | Height in. (mm) | Typical Applications | Weight lbs. (grams) |
|----------------------------------------------------------------------------------------------------|--------------------------|-----------------|----------------------|---------------------|
| D10850-40                                                                                          | 0.850 (21.6) sq          | 0.400 (10.2)    | 21mm BGA             | 0.006 (3.9)         |
| <b>Notes:</b> Available with pressure sensitive adhesives for quick and easy mounting. See Page 8. |                          |                 |                      |                     |

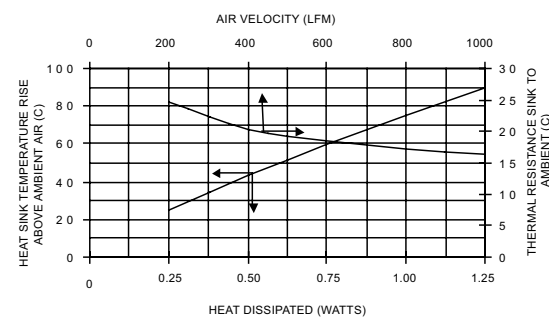
**Notes:** Available with pressure sensitive adhesives for quick and easy mounting. See Page 8.

## MECHANICAL DIMENSIONS

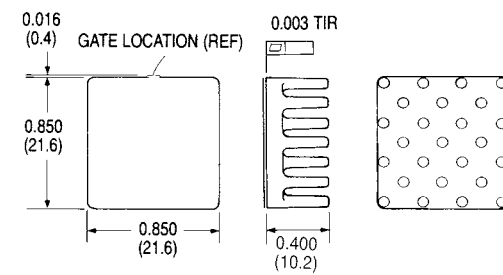
## DELTEM™ D10650-40 PIN FIN HEAT SINK



## NATURAL AND FORCED CONVECTION CHARACTERISTICS

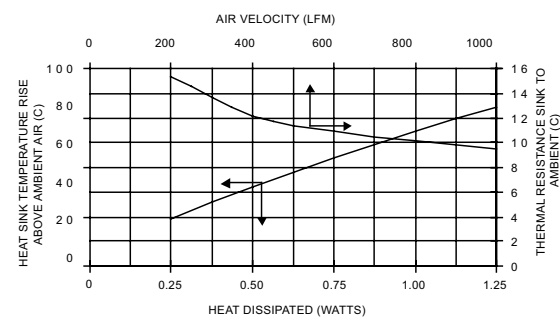


## DELTEM™ D10850-40 PIN FIN HEAT SINK



**Dimensions: in. (mm)**

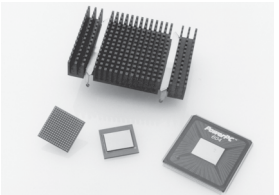
## NATURAL AND FORCED CONVECTION CHARACTERISTICS



## HEAT SINKS FOR BGAs, SUPER BGAs, PBGAs, & FPBGAs

PIN FIN HEAT SINK FOR BGAs HEAT SINK/CLIP  
ASSEMBLY FOR BGAs AND POWERPC™ PACKAGES

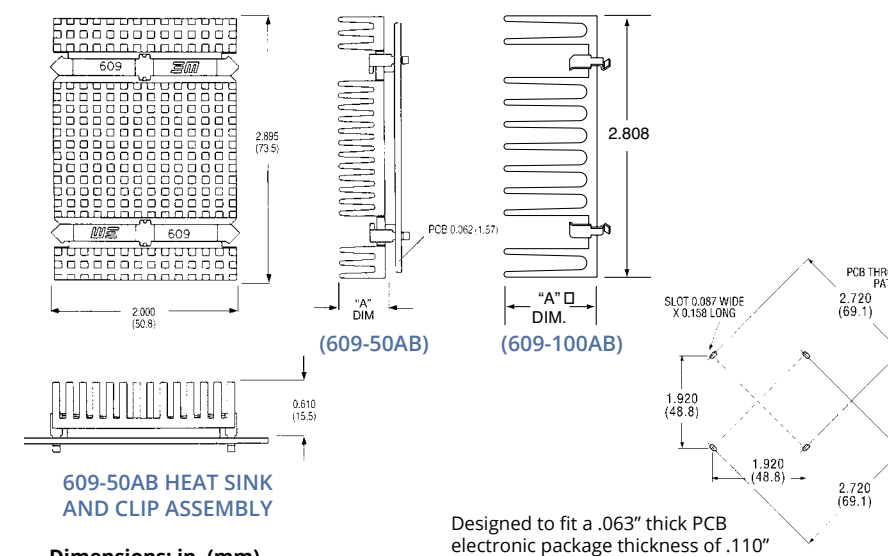
## 609 SERIES



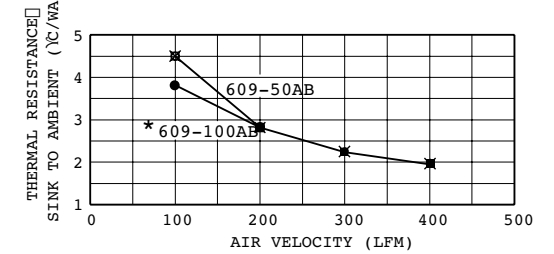
| Standard P/N | Base Dimensions<br>in. (mm)  | Dimensions "A"<br>in. (mm) | Typical Applications | Heat Sink Finish | Weight<br>lbs. (grams) |
|--------------|------------------------------|----------------------------|----------------------|------------------|------------------------|
| 609-50AB     | 2.895 (73.5) x 2.000 (50.8)  | 0.500 (12.7)               | 40&45mm BGA          | Black Anodized   | 0.094 (42.5)           |
| 609-100AB    | 2.808 (71.32) x 1.700 (43.2) | 1.00 (25.4)                | 40&45mm BGA          | Black Anodized   | 0.130 (59.0)           |

**Note:** Optional factory pre-applied thermal interface material.  
S3 (Bergquist Q-Pad 3, 0.14 °C in2/w)  
S4 (Bergquist Softface, 0.07 °C in2/w)

## MECHANICAL DIMENSIONS



**FORCED CONVECTION THERMAL PERFORMANCE DATA  
(FLOW PARALLEL TO EXTRUSION DIRECTION)**



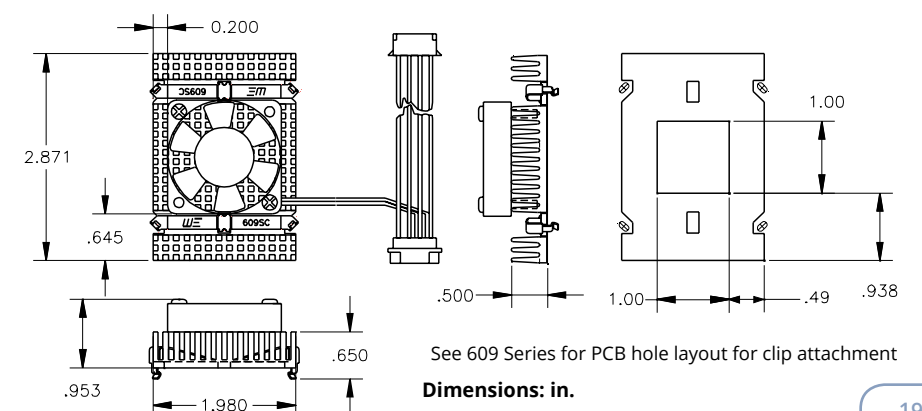
\*Performance is for shrouded conditions.  
609-100 will perform better than 609-50 in  
cases with bypass.

**619 SERIES** FAN HEAT SINK FOR BGA AND POWERPC™ PACKAGES

| Standard P/N | Base Dimensions in. (mm)     | Height in. (mm) | Typical Applications | Heat Sink Finish | Thermal Performance | Weight lbs.(grams) |
|--------------|------------------------------|-----------------|----------------------|------------------|---------------------|--------------------|
| 61995AB124D1 | 2.871 (72.92) x 1.98 (50.29) | 0.953 (24.21)   | 40&45mm BGA          | Black Anodized   | 1.2° C/W            | .150 (68.10)       |
| 61995AB054D1 | 2.871 (72.92) x 1.98 (50.29) | 0.953 (24.21)   | 40&45mm BGA          | Black Anodized   | 1.2° C/W            | .150 (68.10)       |

**Note:** Optional factory pre-applied thermal interface material. See 609 series.

## MECHANICAL DIMENSIONS



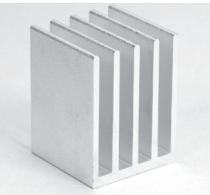
## FEATURES AND BENEFITS

- Captivated clips for ease of assembly.
- Low acoustic noise.
- Impingement air flow.
- Accommodates BGA packages up to 45 mm in size.

See 609 Series for PCB hole layout for clip attachment

**Dimensions: in.**

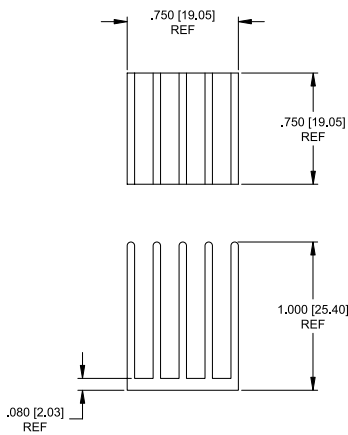
HEAT SINKS FOR BGAs, SUPER BGAs, PBGAs, & FPBGAs



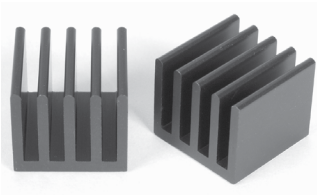
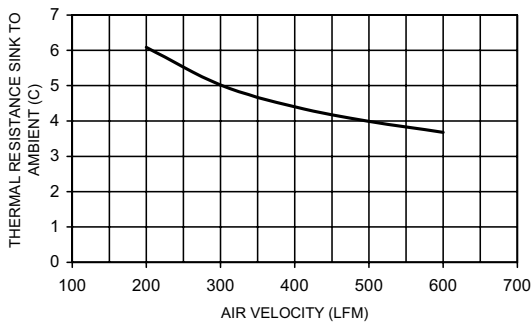
602 SERIES UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

| Standard P/N                     | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|----------------------------------|--------------------------|-----------------|------------------|---------------------|
| 602-100AP                        | .750 (19.1) sq           | 1.000 (25.4)    | Plain            | .021 (9.59)         |
| Material: Aluminum, Plain Finish |                          |                 |                  |                     |

MECHANICAL DIMENSIONS



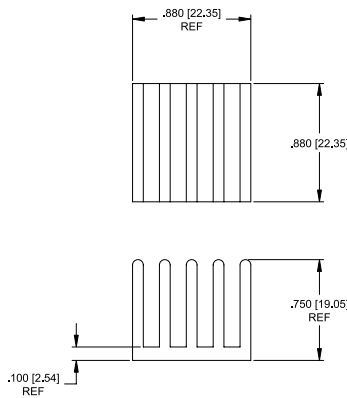
602 THERMAL PERFORMANCE



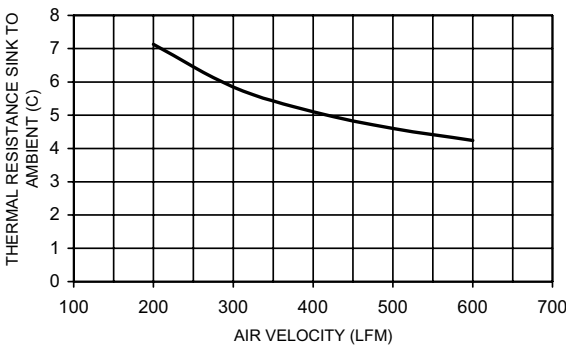
UNIDIRECTIONAL FIN HEAT SINK FOR BGAs 605 SERIES

| Standard P/N                       | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 605-75AB                           | .880 (22.4) sq           | .750 (19.1)     | Black Anodized   | .030 (13.5)         |
| Material: Aluminum, Black Anodized |                          |                 |                  |                     |

MECHANICAL DIMENSIONS

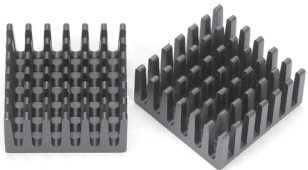


605 THERMAL PERFORMANCE



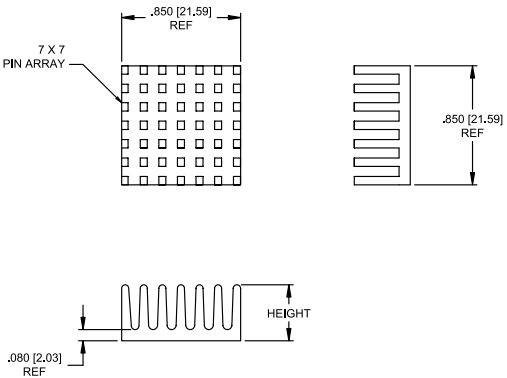
OMNIDIRECTIONAL PIN FIN HEAT SINK FOR BGAs

604 SERIES

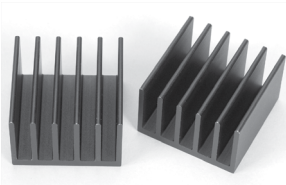
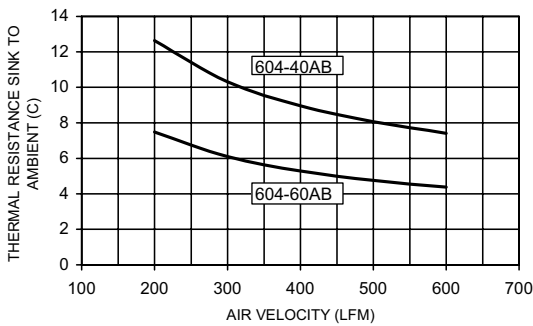


| Standard P/N                       | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 604-40AB                           | .850 (21.6) sq           | .400 (10.2)     | Black Anodized   | .012 (5.60)         |
| 604-60AB                           | .850 (21.6) sq           | .600 (15.2)     | Black Anodized   | .016 (7.47)         |
| Material: Aluminum, Black Anodized |                          |                 |                  |                     |

MECHANICAL DIMENSIONS



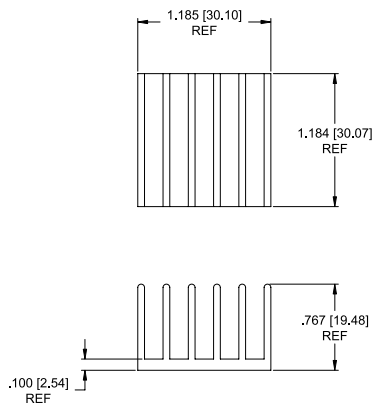
604 THERMAL PERFORMANCE



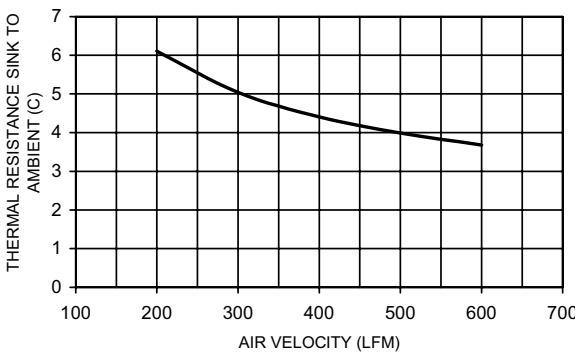
606 SERIES UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

| Standard P/N                       | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 606-77AB                           | 1.185 (30.1) sq          | .767 (19.5)     | Black Anodized   | .041 (18.7)         |
| Material: Aluminum, Black Anodized |                          |                 |                  |                     |

MECHANICAL DIMENSIONS

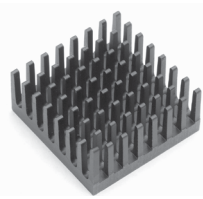


606 THERMAL PERFORMANCE





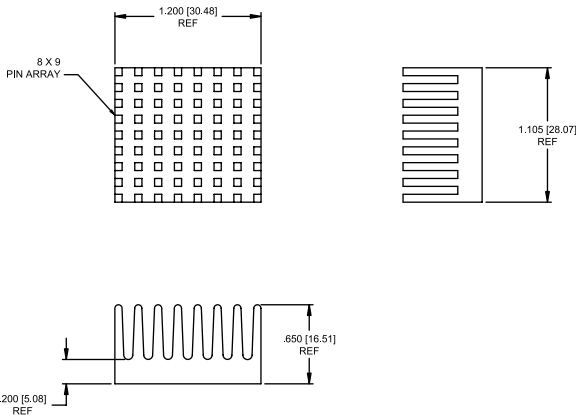
HEAT SINKS FOR BGAs, SUPER BGAs, PBGAs, & FPBGAs



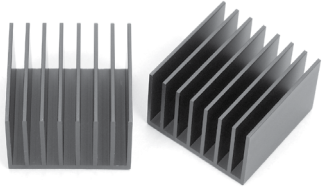
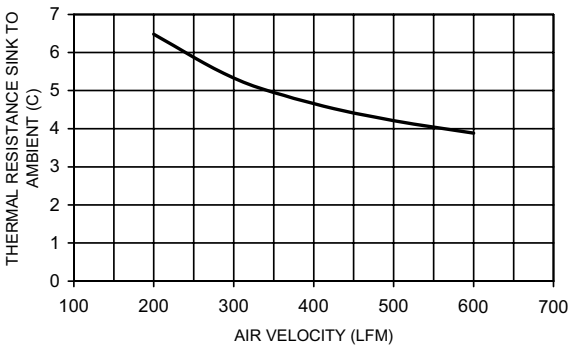
607 SERIES UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

| Standard P/N                       | Base Dimensions in. (mm)    | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|-----------------------------|-----------------|------------------|---------------------|
| 607-65AB                           | 1.200 (30.5) x 1.105 (28.1) | .650 (16.5)     | Black Anodized   | .041 (18.7)         |
| Material: Aluminum, Black Anodized |                             |                 |                  |                     |

MECHANICAL DIMENSIONS



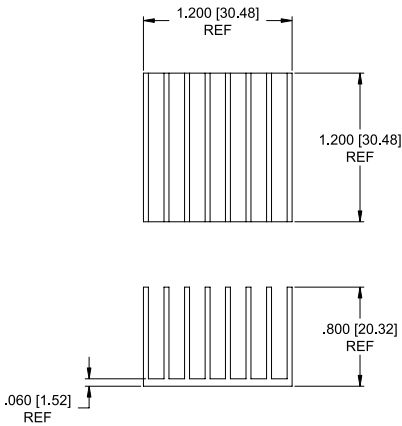
607 THERMAL PERFORMANCE



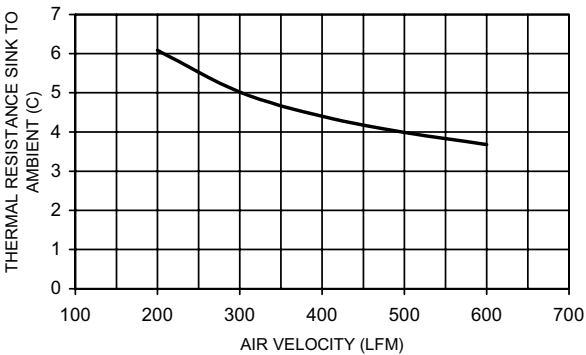
UNIDIRECTIONAL FIN HEAT SINK FOR BGAs 611 SERIES

| Standard P/N                       | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 611-80AB                           | 1.200 (30.5) sq          | .800 (20.3)     | Black Anodized   | .036 (16.3)         |
| Material: Aluminum, Black Anodized |                          |                 |                  |                     |

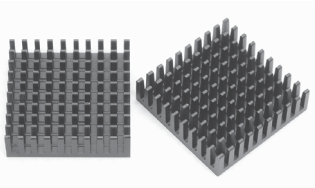
MECHANICAL DIMENSIONS



611 THERMAL PERFORMANCE

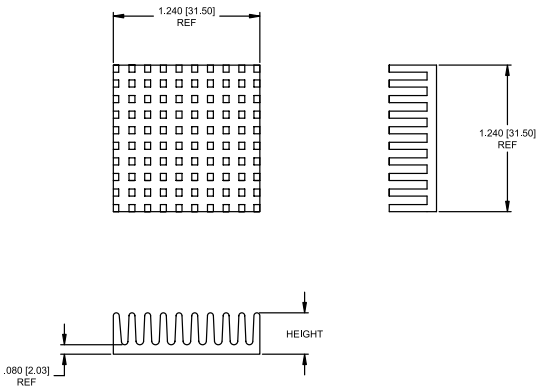


OMNIDIRECTIONAL PIN FIN HEAT SINK FOR BGAs 610 SERIES

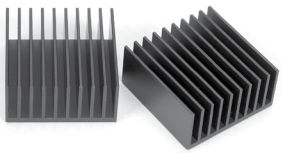
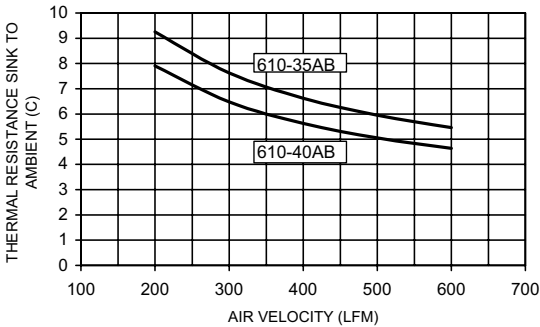


| Standard P/N                       | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 610-35AB                           | 1.240 (31.5) sq          | .350 (8.9)      | Black Anodized   | .022 (10.0)         |
| 610-40AB                           | 1.240 (31.5) sq          | .400 (10.2)     | Black Anodized   | .024 (10.8)         |
| Material: Aluminum, Black Anodized |                          |                 |                  |                     |

MECHANICAL DIMENSIONS



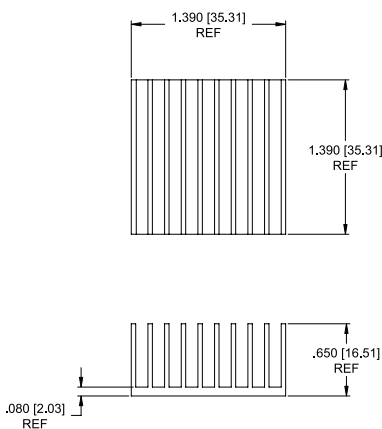
610 THERMAL PERFORMANCE



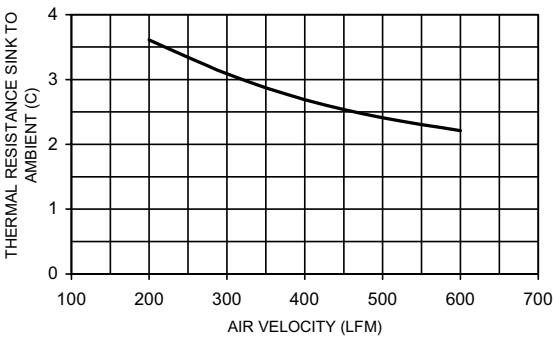
612 SERIES UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

| Standard P/N                       | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 612-65AB                           | 1.390 (35.3) sq          | .650 (16.5)     | Black Anodized   | .054 (24.5)         |
| Material: Aluminum, Black Anodized |                          |                 |                  |                     |

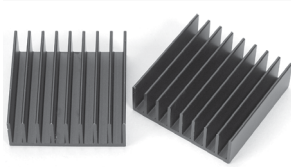
MECHANICAL DIMENSIONS



612 THERMAL PERFORMANCE



HEAT SINKS FOR BGAs, SUPER BGAs, PBGAs, & FPBGAs

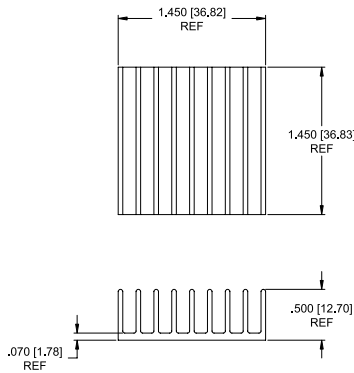


613 SERIES

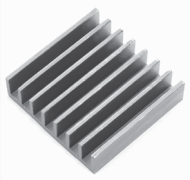
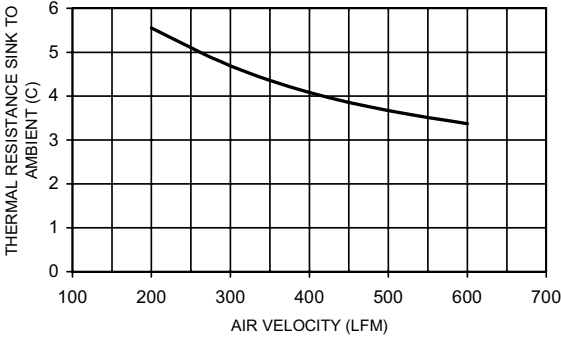
UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

| Standard P/N                       | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 613-50AB                           | 1.450 (36.8) sq          | .500 (12.7)     | Black Anodized   | .046 (20.8)         |
| Material: Aluminum, Black Anodized |                          |                 |                  |                     |

MECHANICAL DIMENSIONS



613 THERMAL PERFORMANCE

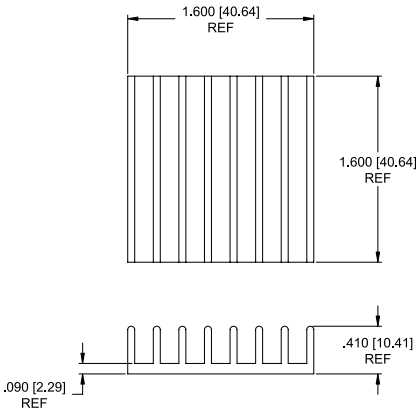


UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

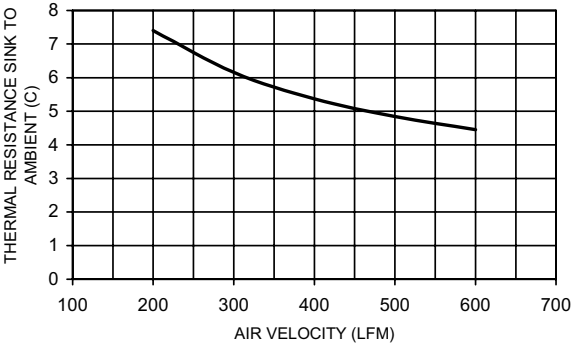
615 SERIES

| Standard P/N                       | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 615-41AB                           | 1.600 (40.6) sq          | .410 (10.4)     | Black Anodized   | .046 (21.0)         |
| Material: Aluminum, Black Anodized |                          |                 |                  |                     |

MECHANICAL DIMENSIONS

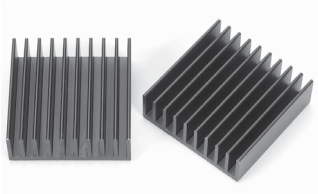


615 THERMAL PERFORMANCE



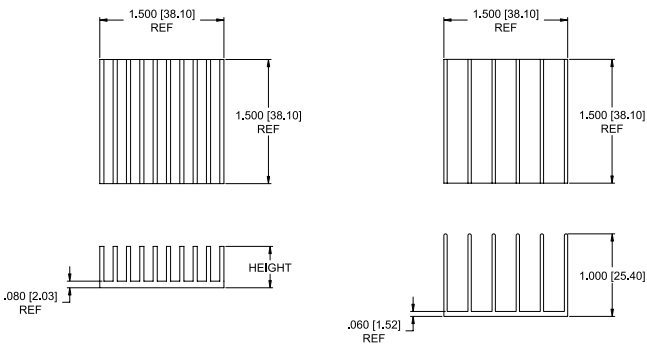
UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

614 SERIES

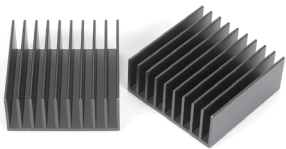
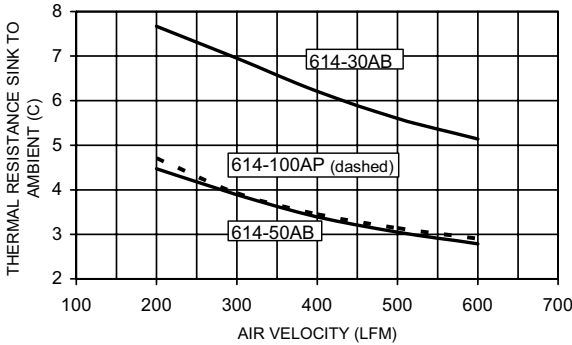


| Standard P/N                                | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|---------------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 614-30AB                                    | 1.500 (38.1) sq          | .300 (7.6)      | Black Anodized   | .030 (13.8)         |
| 614-50AB                                    | 1.500 (38.1) sq          | .500 (12.7)     | Black Anodized   | .048 (21.8)         |
| 614-100AP                                   | 1.500 (38.1) sq          | 1.000 (25.4)    | Plain            | .046 (20.9)         |
| Material: Aluminum, Black Anodized or Plain |                          |                 |                  |                     |

MECHANICAL DIMENSIONS



614 THERMAL PERFORMANCE

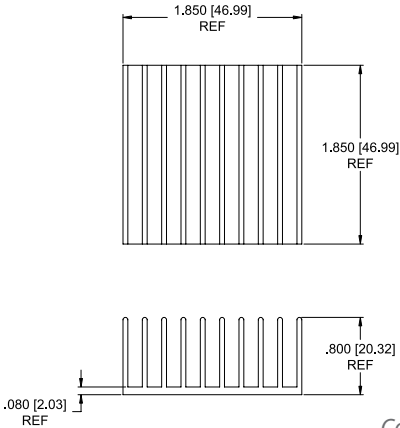


616 SERIES

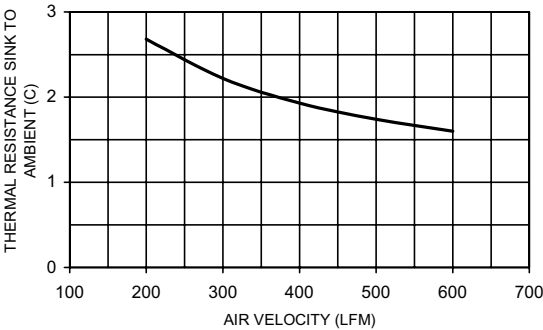
UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

| Standard P/N                       | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 616-80AB                           | 1.85 (47.0) sq           | .800 (20.3)     | Black Anodized   | .054 (24.5)         |
| Material: Aluminum, Black Anodized |                          |                 |                  |                     |

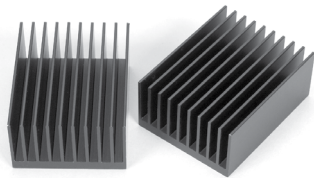
MECHANICAL DIMENSIONS



616 THERMAL PERFORMANCE



HEAT SINKS FOR BGAs, SUPER BGAs, PBGAs, & FPBGAs

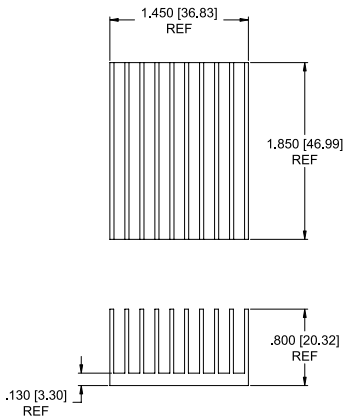


617 SERIES

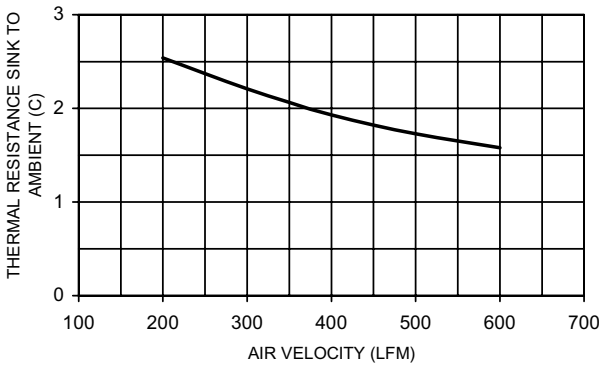
UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

| Standard P/N                       | Base Dimensions in. (mm)    | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|-----------------------------|-----------------|------------------|---------------------|
| 617-80AB                           | 1.450 (36.8) x 1.850 (47.0) | .800 (20.3)     | Black Anodized   | .082 (37.2)         |
| Material: Aluminum, Black Anodized |                             |                 |                  |                     |

MECHANICAL DIMENSIONS

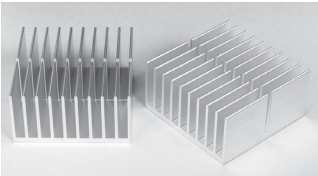


617 THERMAL PERFORMANCE



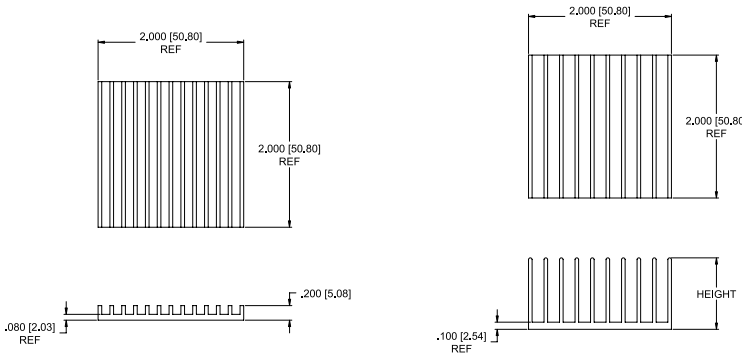
UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

618 SERIES

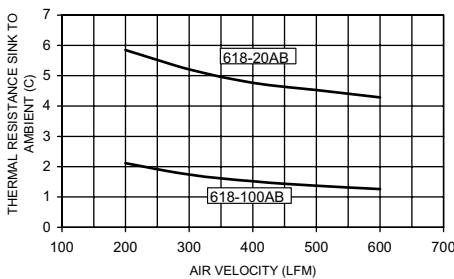


| Standard P/N                                | Base Dimensions in. (mm) | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|---------------------------------------------|--------------------------|-----------------|------------------|---------------------|
| 618-20AB                                    | 2.00 (50.8) sq           | .200 (5.1)      | Black Anodized   | .046 (21.0)         |
| 618-100AP                                   | 2.00 (80.8) sq           | 1.000 (25.4)    | Plain            | .122 (55.5)         |
| Material: Aluminum, Black Anodized or Plain |                          |                 |                  |                     |

MECHANICAL DIMENSIONS

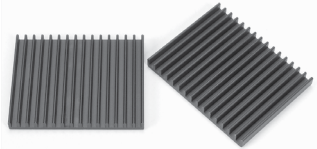


618 THERMAL PERFORMANCE



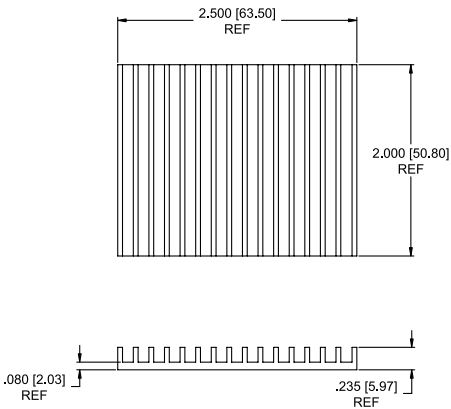
UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

620 SERIES

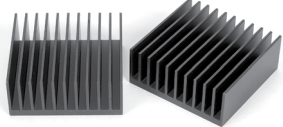
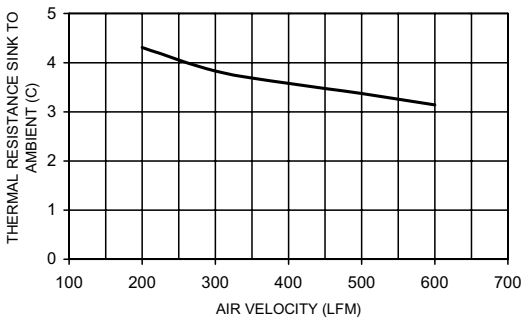


| Standard P/N                       | Base Dimensions in. (mm)    | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|-----------------------------|-----------------|------------------|---------------------|
| 620-24AB                           | 2.500 (63.5) x 2.000 (50.8) | .235 (6.0)      | Black Anodized   | .063 (28.6)         |
| Material: Aluminum, Black Anodized |                             |                 |                  |                     |

MECHANICAL DIMENSIONS



620 THERMAL PERFORMANCE

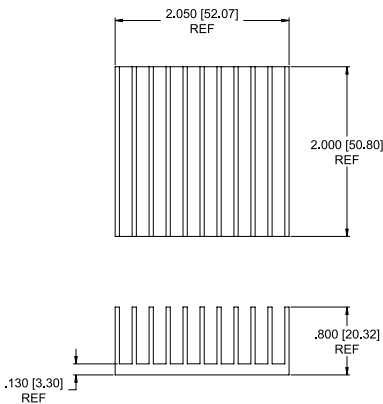


622 SERIES

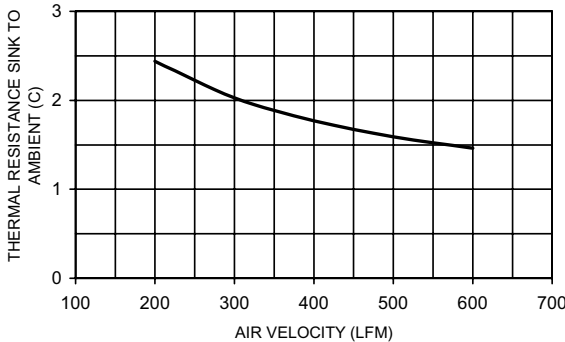
UNIDIRECTIONAL FIN HEAT SINK FOR BGAs

| Standard P/N                       | Base Dimensions in. (mm)    | Height in. (mm) | Heat Sink Finish | Weight lbs. (grams) |
|------------------------------------|-----------------------------|-----------------|------------------|---------------------|
| 622-80AB                           | 2.050 (52.1) x 2.000 (50.8) | .800 (20.3)     | Black Anodized   | .123 (56.0)         |
| Material: Aluminum, Black Anodized |                             |                 |                  |                     |

MECHANICAL DIMENSIONS



622 THERMAL PERFORMANCE



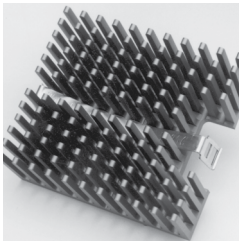


HEAT SINKS FOR MICROPROCESSORS & ASICs

569, 579, 589,  
599 SERIES

HEAT SINKS & CLIP FOR INTEL'S PENTIUM, PENTIUM MMX, AMD'S K6 & K62,  
CYRIX'S 6X86 & MEDIA GX, CENTAUR/IDT'S WINCHIP C6

- PRODUCT FEATURES**
- Compact design heat sinks can comfortably fit a variety of Robust Socket 7-based PC boxes.
  - Robust clip attachments.
  - Clips are not captive to sink.
  - To order heat sink with optional interface material pre-applied at the factory, add S4 or S5 suffix to the part number. (See Product Designation)

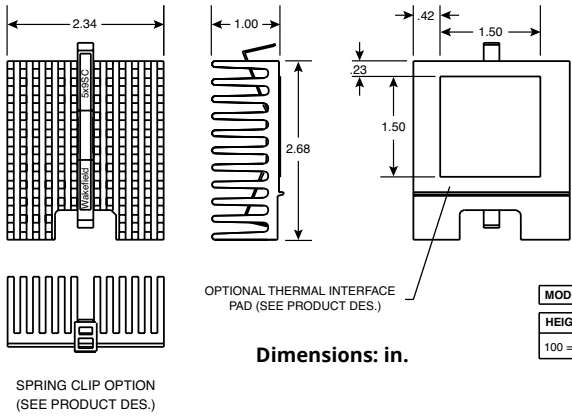


569-100AK SERIES

| Standard P/N | Base Dimensions in. (mm)    | Fin Height in. (mm) | Thermal Resistance at 200 LFM (°C/W) | Interface Material Options |
|--------------|-----------------------------|---------------------|--------------------------------------|----------------------------|
| 569-100AK    | 2.34 (59.44) x 2.68 (67.95) | 1.00 (25.4)         | 1.7                                  | Pages 74-76                |
| 579-150AK    | 2.15 (54.71) x 1.95 (49.53) | 1.50 (38.10)        | 1.6                                  | Pages 74-76                |
| 589-150AK    | 2.15 (54.71) x 3.10 (78.74) | 1.50 (38.10)        | 1.5                                  | Pages 74-76                |
| 599X-100AB   | 1.96 (49.78) x 2.67 (67.95) | 1.00 (25.4)         | 1.9                                  | Pages 74-76                |

**Material:** Aluminum, Black Anodized

MECHANICAL DIMENSIONS



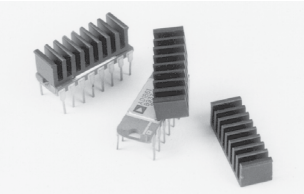
PRODUCT DESIGNATION

|                   |                                             |
|-------------------|---------------------------------------------|
| MODEL NUMBER      | 569 - 100 XX - XX                           |
| HEIGHT            | 100 = 1.00"                                 |
| THERMAL INTERFACE | S4 = DELTALINK IV<br>BLANK = NO THERMAL PAD |
| CLIP              | AK = SPRING CLIP                            |

LOW-COST HEAT SINKS  
FOR DIPs AND SRAMs

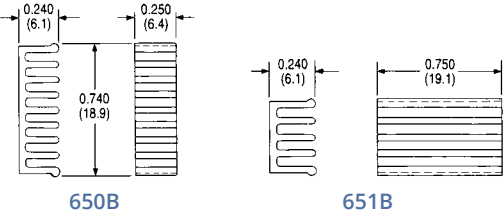
650 & 651 SERIES

These extruded heat sinks serve as low-cost heat dissipation solutions for DIPs with pin counts from 14 to 16. Use an epoxy such as Wakefield-Vette Engineering DeltaBond™ 152 or 155, or use Wakefield-Vette 2-part DeltaBond™ 156 modified acrylic adhesive. The 650 and 651 are also available in natural aluminum finish. They can be ordered as 650P or 651P.



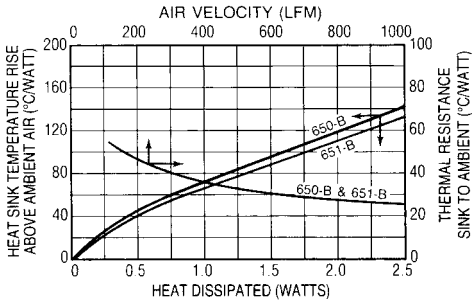
| Standard P/N | Length in. (mm) | Width in. (mm) | Height in. (mm) | Typical Applications | Weight lbs. (grams) |
|--------------|-----------------|----------------|-----------------|----------------------|---------------------|
| 650B         | 0.250 (6.4)     | 0.740 (18.9)   | 0.240 (6.1)     | 14-Pin, 16-Pin DIP   | 0.003 (1.36)        |
| 651B         | 0.750 (19.1)    | 0.415 (10.5)   | 0.240 (6.1)     | 14-Pin, 16-Pin DIP   | 0.005 (2.27)        |

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS

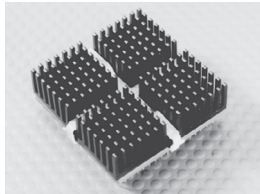


NOTES:

1. Finish: black anodize
2. TIR: Total Indicator Reading. This is a measure of flatness across the greatest dimension of a surface.

SPIDERCLIP™ HEAT SINK ASSEMBLY  
FOR MOTOROLA MC68040™, MC68060

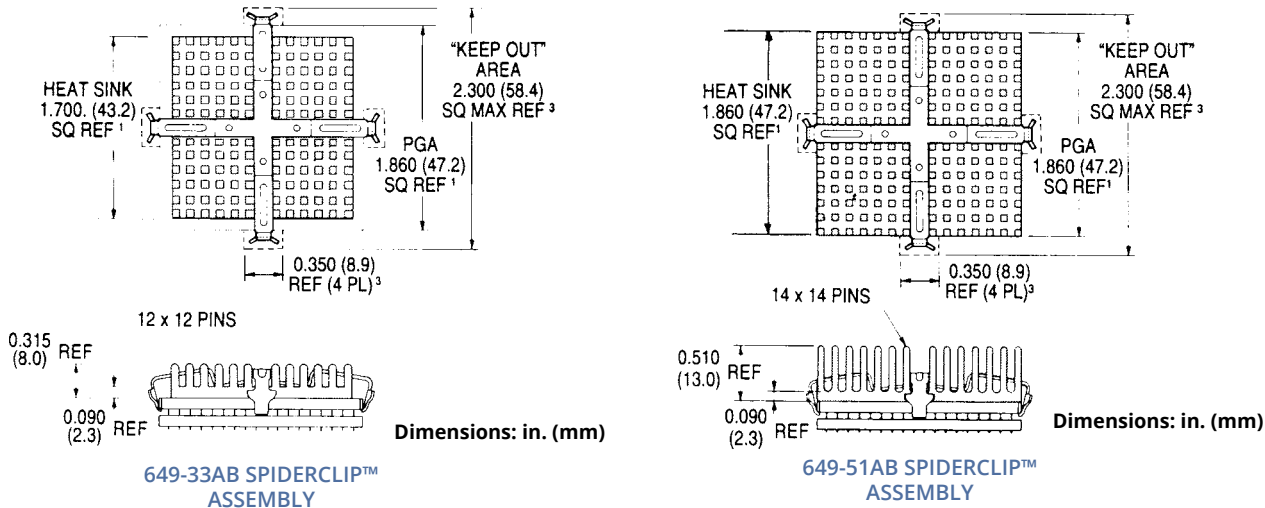
649 SERIES



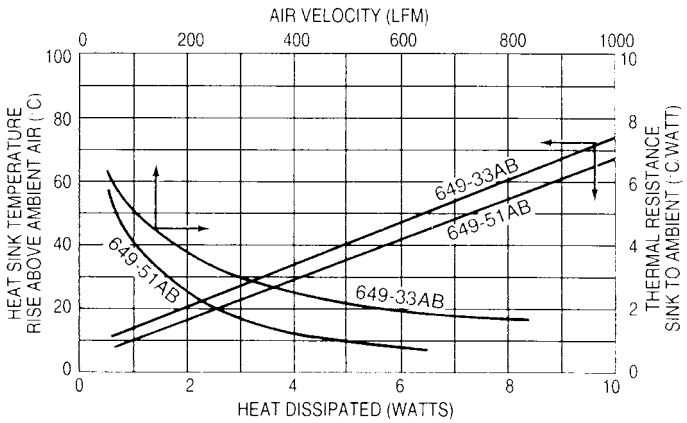
18 x 18 PGA

| Standard P/N | Base Dimensions in. (mm) | Height in. (mm) | Base Thickness in. (mm) | Clip Color | Heat Sink Finish | Weight lbs. (grams) |
|--------------|--------------------------|-----------------|-------------------------|------------|------------------|---------------------|
| 649-33AB     | 1.70 (43.2) sq           | 0.315 (8.0)     | 0.090 (2.3)             | Gray       | Black Anodized   | 0.044 (19.84)       |
| 649-51AB     | 1.86 (47.2) sq           | 0.510 (13.0)    | 0.090 (2.3)             | Gray       | Black Anodized   | 0.056 (25.51)       |

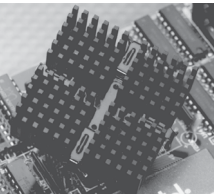
MECHANICAL DIMENSIONS



NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



HEAT SINKS FOR MICROPROCESSORS & ASICs



669 SERIES

SPIDERCLIP™ HEAT SINK ASSEMBLY FOR INTELDX4™,  
AMD AM486DX2, AND AM486DX4

17 x 17 SPGA

661 SERIES

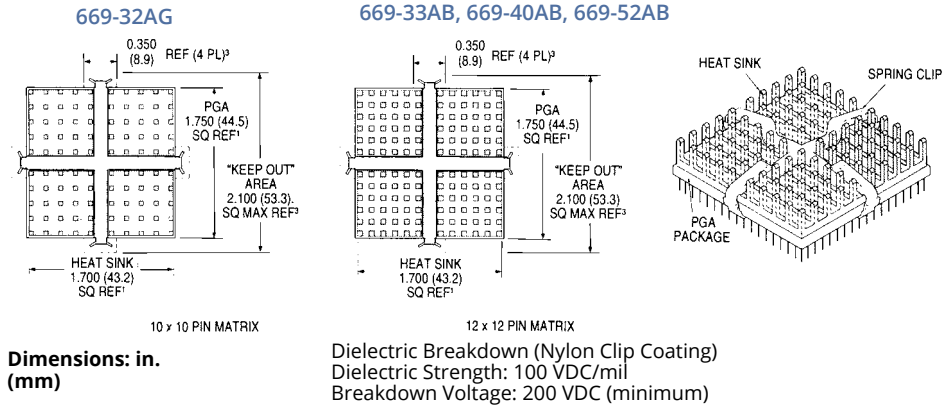
HEAT SINK WITHOUT CLIP

669 Series SpiderClip™ Heat Sink Assemblies may be applied to the following:

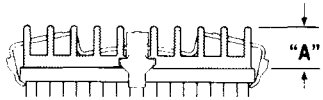
- Intel 80486DX and 80486DX2™ (168 PGA)
- Intel DX4™ (168 PGA)
- Intel 80486SX (168 PGA) and I860XR (208 PGA)
- AMD Am 486 Microprocessors AM486DX2, AM486DX4
- Intel 82495 Cache Controller
- AMD Am 29000 Microcontrollers
- Intel I960CA, I960CF Embedded Controllers

| Standard P/N | Base Dimensions in. (mm) | Dimensions "A" Height in. (mm) | Base Thickness in. (mm) | Clip Color | Standard Finish | Weight lbs. (grams) |
|--------------|--------------------------|--------------------------------|-------------------------|------------|-----------------|---------------------|
| 669-32AG     | 1.70 (43.2) sq           | 0.315 (8.0)                    | 0.090 (2.3)             | Black      | Gold Iridite    | 0.044 (19.84)       |
| 669-33AB     | 1.70 (43.2) sq           | 0.315 (8.0)                    | 0.090 (2.3)             | Black      | Black Anodized  | 0.044 (19.84)       |
| 669-40AB     | 1.70 (43.2) sq           | 0.400 (10.2)                   | 0.090 (2.3)             | Black      | Black Anodized  | 0.044 (19.84)       |
| 669-52AB     | 1.70 (43.2) sq           | 0.520 (13.2)                   | 0.090 (2.3)             | Black      | Black Anodized  | 0.050 (22.68)       |
| 661-32AG     | 1.70 (43.2) sq           | 0.315 (8.0)                    | 0.090 (2.3)             | N/A        | Gold Iridite    | 0.044 (19.84)       |
| 661-33AB     | 1.70 (43.2) sq           | 0.315 (8.0)                    | 0.090 (2.3)             | N/A        | Black Anodized  | 0.044 (19.84)       |
| 661-40AB     | 1.70 (43.2) sq           | 0.400 (10.2)                   | 0.090 (2.3)             | N/A        | Black Anodized  | 0.044 (19.84)       |
| 661-52AB     | 1.70 (43.2) sq           | 0.520 (13.2)                   | 0.090 (2.3)             | N/A        | Black Anodized  | 0.050 (22.68)       |

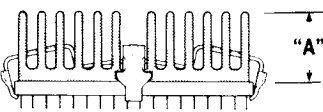
MECHANICAL DIMENSIONS



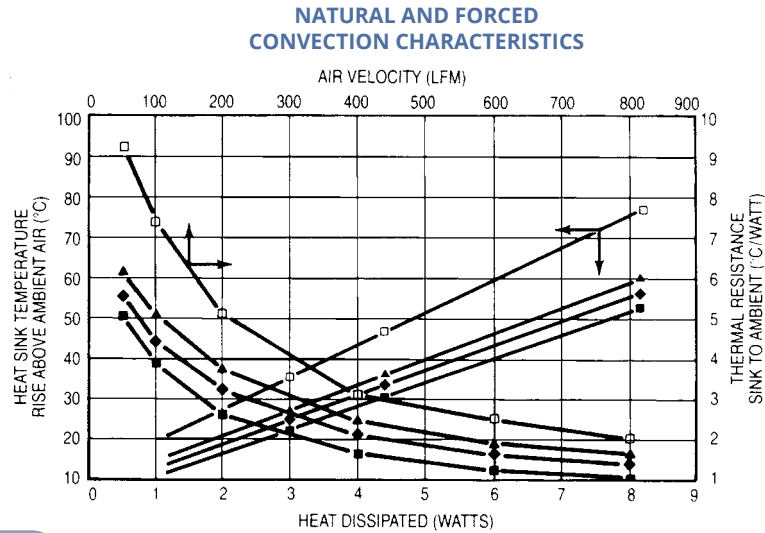
669-32AG SPIDERCLIP™ ASSEMBLY



669-52AB SPIDERCLIP™ ASSEMBLY



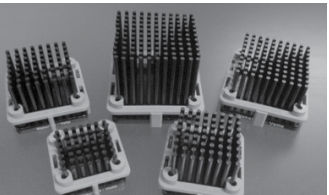
Dimensions: in. (mm)  
Dielectric Breakdown (Nylon Clip Coating)  
Dielectric Strength: 100 VDC/mil  
Breakdown Voltage: 200 VDC (minimum)



PIN FIN HEAT SINK



900 SERIES



Wakefield-Vette's **900 Series** Heat Sinks for Chipset can match up to devices from Intel, Xilinx, TI, Motorola, ATI, AMD, Nvidia, Vishay, Powerex, Infineon, Microsemi, and many more.

These heat sinks are designed for air flow applications in the Telecom, Data Center, Networking, Cloud Computing, and many more Industries.

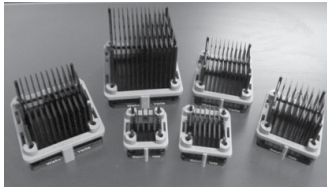
| Series | Height | Chip Size | Natural Convection | Forced Convection |          |          | Series | Height | Chip Size | Natural Convection | Forced Convection |          |          |
|--------|--------|-----------|--------------------|-------------------|----------|----------|--------|--------|-----------|--------------------|-------------------|----------|----------|
|        |        |           |                    | 200 LFM           | 400 LFM  | 600 LFM  |        |        |           |                    | 200 LFM           | 400 LFM  | 600 LFM  |
| 901    | 12     | 19mm      | 12.74 C/W          | 6.6 C/W           | 4.79 C/W | 4.16 C/W | 906    | 12     | 31mm      | 10.71 C/W          | 3.49 C/W          | 2.28 C/W | 1.69 C/W |
|        | 15     | 19mm      | 12.05 C/W          | 6.3 C/W           | 4.51 C/W | 3.86 C/W |        | 15     | 31mm      | 10.14 C/W          | 3.18 C/W          | 2.03 C/W | 1.5 C/W  |
|        | 18     | 19mm      | 11.35 C/W          | 5.97 C/W          | 4.16 C/W | 3.47 C/W |        | 18     | 31mm      | 9.57 C/W           | 2.93 C/W          | 1.86 C/W | 1.33 C/W |
|        | 21     | 19mm      | 10.66 C/W          | 5.66 C/W          | 3.89 C/W | 3.21 C/W |        | 21     | 31mm      | 9.01 C/W           | 2.72 C/W          | 1.69 C/W | 1.2 C/W  |
|        | 23     | 19mm      | 10.55 C/W          | 5.36 C/W          | 3.64 C/W | 2.99 C/W |        | 23     | 31mm      | 8.88 C/W           | 2.5 C/W           | 1.54 C/W | 1.07 C/W |
|        | 28     | 19mm      | 10.27 C/W          | 4.91 C/W          | 3.36 C/W | 2.71 C/W |        | 28     | 31mm      | 8.56 C/W           | 2.26 C/W          | 1.38 C/W | .96 C/W  |
| 902    | 33     | 19mm      | 9.99 C/W           | 4.52 C/W          | 3.07 C/W | 2.49 C/W | 907    | 33     | 31mm      | 8.24 C/W           | 2.09 C/W          | 1.27 C/W | .88 C/W  |
|        | 12     | 21mm      | 12.4 C/W           | 6.61 C/W          | 4.37 C/W | 3.7 C/W  |        | 12     | 33mm      | 10.37 C/W          | 3.32 C/W          | 2.18 C/W | 1.62 C/W |
|        | 15     | 21mm      | 11.73 C/W          | 5.84 C/W          | 4.09 C/W | 3.42 C/W |        | 15     | 33mm      | 9.82 C/W           | 3.14 C/W          | 1.99 C/W | 1.45 C/W |
|        | 18     | 21mm      | 11.06 C/W          | 5.51 C/W          | 3.76 C/W | 3.07 C/W |        | 18     | 33mm      | 9.28 C/W           | 2.89 C/W          | 1.78 C/W | 1.3 C/W  |
|        | 21     | 21mm      | 10.38 C/W          | 5.20 C/W          | 3.49 C/W | 2.84 C/W |        | 21     | 33mm      | 8.73 C/W           | 2.67 C/W          | 1.60 C/W | 1.13 C/W |
|        | 23     | 21mm      | 10.27 C/W          | 4.9 C/W           | 3.26 C/W | 2.62 C/W |        | 23     | 33mm      | 8.60 C/W           | 2.45 C/W          | 1.43 C/W | .99 C/W  |
| 903    | 28     | 21mm      | 9.98 C/W           | 4.55 C/W          | 2.98 C/W | 2.42 C/W | 908    | 28     | 33mm      | 8.27 C/W           | 2.24 C/W          | 1.28 C/W | .87 C/W  |
|        | 33     | 21mm      | 9.7 C/W            | 4.18 C/W          | 2.73 C/W | 2.21 C/W |        | 33     | 33mm      | 7.94 C/W           | 2.03 C/W          | 1.15 C/W | .77 C/W  |
|        | 12     | 23mm      | 12.06 C/W          | 5.72 C/W          | 3.95 C/W | 3.24 C/W |        | 12     | 35mm      | 10.03 C/W          | 3.06 C/W          | 1.97 C/W | 1.49 C/W |
|        | 15     | 23mm      | 11.41 C/W          | 5.39 C/W          | 3.67 C/W | 2.99 C/W |        | 15     | 35mm      | 9.5 C/W            | 2.85 C/W          | 1.81 C/W | 1.34 C/W |
|        | 18     | 23mm      | 10.76 C/W          | 5.05 C/W          | 3.35 C/W | 2.67 C/W |        | 18     | 35mm      | 8.98 C/W           | 2.6 C/W           | 1.64 C/W | 1.19 C/W |
|        | 21     | 23mm      | 10.11 C/W          | 4.74 C/W          | 3.1 C/W  | 2.46 C/W |        | 21     | 35mm      | 8.46 C/W           | 2.4 C/W           | 1.5 C/W  | 1.07 C/W |
| 904    | 23     | 23mm      | 9.99 C/W           | 4.44 C/W          | 2.87 C/W | 2.31 C/W | 909    | 23     | 35mm      | 8.32 C/W           | 2.19 C/W          | 1.34 C/W | .97 C/W  |
|        | 28     | 23mm      | 9.70 C/W           | 4.09 C/W          | 2.62 C/W | 2.12 C/W |        | 28     | 35mm      | 7.99 C/W           | 1.97 C/W          | 1.19 C/W | .83 C/W  |
|        | 33     | 23mm      | 9.41 C/W           | 3.83 C/W          | 2.43 C/W | 1.96 C/W |        | 33     | 35mm      | 7.65 C/W           | 1.82 C/W          | 1.06 C/W | .7 C/W   |
|        | 12     | 27mm      | 11.38 C/W          | 4.84 C/W          | 3.11 C/W | 2.32 C/W |        | 12     | 37.5mm    | 9.60 C/W           | 2.93 C/W          | 1.90 C/W | 1.36 C/W |
|        | 15     | 27mm      | 10.78 C/W          | 4.48 C/W          | 2.84 C/W | 2.12 C/W |        | 15     | 37.5mm    | 9.11 C/W           | 2.71 C/W          | 1.72 C/W | 1.19 C/W |
|        | 18     | 27mm      | 10.17 C/W          | 4.13 C/W          | 2.56 C/W | 1.88 C/W |        | 18     | 37.5mm    | 8.61 C/W           | 2.52 C/W          | 1.53 C/W | 1.05 C/W |
| 905    | 21     | 27mm      | 9.56 C/W           | 3.82 C/W          | 2.32 C/W | 1.72 C/W | 910    | 21     | 37.5mm    | 8.11 C/W           | 2.25 C/W          | 1.36 C/W | .88 C/W  |
|        | 23     | 27mm      | 9.44 C/W           | 3.51 C/W          | 2.11 C/W | 1.6 C/W  |        | 23     | 37.5mm    | 7.98 C/W           | 2.04 C/W          | 1.2 C/W  | .75 C/W  |
|        | 28     | 27mm      | 9.13 C/W           | 3.26 C/W          | 1.97 C/W | 1.49 C/W |        | 28     | 37.5mm    | 7.63 C/W           | 1.82 C/W          | 1.01 C/W | .63 C/W  |
|        | 33     | 27mm      | 8.82 C/W           | 3.07 C/W          | 1.82 C/W | 1.39 C/W |        | 33     | 37.5mm    | 7.29 C/W           | 1.6 C/W           | .87 C/W  | .52 C/W  |
|        | 12     | 29mm      | 11.04 C/W          | 4.08 C/W          | 2.55 C/W | 1.98 C/W |        | 12     | 40mm      | 9.18 C/W           | 2.84 C/W          | 1.86 C/W | 1.36 C/W |
|        | 15     | 29mm      | 10.46 C/W          | 3.82 C/W          | 2.32 C/W | 1.78 C/W |        | 15     | 40mm      | 8.71 C/W           | 2.64 C/W          | 1.65 C/W | 1.18 C/W |

Material: AL 6063  
Finish: Black Anodize

| Series | Chip Size | Construction | Height    | Chip Height               | Finish      | Interface            |
|--------|-----------|--------------|-----------|---------------------------|-------------|----------------------|
|        | 19-       | 2-           | 12-       | 1-                        | B-          | 1                    |
| 901    | 19        | 2= Pin Fin   | 12 = 11.6 | 1 = .9-2.1<br>2 = 2.2-3.4 | B = BLK ANO | 0 = None<br>1 = T725 |
|        | 21        |              | 15 = 14.6 |                           |             |                      |
|        | 23        |              | 18 = 17.6 |                           |             |                      |
|        | 27        |              | 21 = 20.6 |                           |             |                      |
|        | 29        |              | 23 = 22.6 |                           |             |                      |
|        | 31        |              | 28 = 27.6 |                           |             |                      |
|        | 33        |              | 33 = 32.6 |                           |             |                      |
|        | 35        |              |           |                           |             |                      |
|        | 37.5      |              |           |                           |             |                      |
|        |           |              |           |                           |             |                      |

Refer to Page 33 for  
Installation Instructions

ELLIPTICAL FIN HEAT SINK



900 SERIES



Wakefield-Vette's **900 Series** Heat Sinks for Chipset can match up to devices from Intel, Xilinx, TI, Motorola, ATI, AMD, Nvidia, Vishay, Powerex, Infineon, Microsemi, and many more.

These heat sinks are designed for air flow applications in the Telecom, Data Center, Networking, Cloud Computing, and many more Industries.

| Series | Height | Chip Size | Natural Convection | Forced Convection |          |          | Series | Height | Chip Size | Natural Convection | Forced Convection |          |          |
|--------|--------|-----------|--------------------|-------------------|----------|----------|--------|--------|-----------|--------------------|-------------------|----------|----------|
|        |        |           |                    | 200 LFM           | 400 LFM  | 600 LFM  |        |        |           |                    | 200 LFM           | 400 LFM  | 600 LFM  |
| 901    | 12     | 19mm      | 12.74 C/W          | 6.6 C/W           | 4.79 C/W | 4.16 C/W | 906    | 12     | 31mm      | 10.71 C/W          | 3.49 C/W          | 2.28 C/W | 1.69 C/W |
|        | 15     | 19mm      | 12.05 C/W          | 6.3 C/W           | 4.51 C/W | 3.86 C/W |        | 15     | 31mm      | 10.14 C/W          | 3.18 C/W          | 2.03 C/W | 1.5 C/W  |
|        | 18     | 19mm      | 11.35 C/W          | 5.97 C/W          | 4.16 C/W | 3.47 C/W |        | 18     | 31mm      | 9.57 C/W           | 2.93 C/W          | 1.86 C/W | 1.33 C/W |
|        | 21     | 19mm      | 10.66 C/W          | 5.66 C/W          | 3.89 C/W | 3.21 C/W |        | 21     | 31mm      | 9.01 C/W           | 2.72 C/W          | 1.69 C/W | 1.2 C/W  |
|        | 23     | 19mm      | 10.55 C/W          | 5.36 C/W          | 3.64 C/W | 2.99 C/W |        | 23     | 31mm      | 8.88 C/W           | 2.5 C/W           | 1.54 C/W | 1.07 C/W |
|        | 28     | 19mm      | 10.27 C/W          | 4.91 C/W          | 3.36 C/W | 2.71 C/W |        | 28     | 31mm      | 8.56 C/W           | 2.26 C/W          | 1.38 C/W | .96 C/W  |
| 902    | 33     | 19mm      | 9.99 C/W           | 4.52 C/W          | 3.07 C/W | 2.49 C/W | 907    | 33     | 31mm      | 8.24 C/W           | 2.09 C/W          | 1.27 C/W | .88 C/W  |
|        | 12     | 21mm      | 12.4 C/W           | 6.61 C/W          | 4.37 C/W | 3.7 C/W  |        | 12     | 33mm      | 10.37 C/W          | 3.32 C/W          | 2.18 C/W | 1.62 C/W |
|        | 15     | 21mm      | 11.73 C/W          | 5.84 C/W          | 4.09 C/W | 3.42 C/W |        | 15     | 33mm      | 9.82 C/W           | 3.14 C/W          | 1.99 C/W | 1.45 C/W |
|        | 18     | 21mm      | 11.06 C/W          | 5.51 C/W          | 3.76 C/W | 3.07 C/W |        | 18     | 33mm      | 9.28 C/W           | 2.89 C/W          | 1.78 C/W | 1.3 C/W  |
|        | 21     | 21mm      | 10.38 C/W          | 5.20 C/W          | 3.49 C/W | 2.84 C/W |        | 21     | 33mm      | 8.73 C/W           | 2.67 C/W          | 1.60 C/W | 1.13 C/W |
|        | 23     | 21mm      | 10.27 C/W          | 4.9 C/W           | 3.26 C/W | 2.62 C/W |        | 23     | 33mm      | 8.60 C/W           | 2.45 C/W          | 1.43 C/W | .99 C/W  |
| 903    | 28     | 21mm      | 9.98 C/W           | 4.55 C/W          | 2.98 C/W | 2.42 C/W | 908    | 28     | 33mm      | 8.27 C/W           | 2.24 C/W          | 1.28 C/W | .87 C/W  |
|        | 33     | 21mm      | 9.7 C/W            | 4.18 C/W          | 2.73 C/W | 2.21 C/W |        | 33     | 33mm      | 7.94 C/W           | 2.03 C/W          | 1.15 C/W | .77 C/W  |
|        | 12     | 23mm      | 12.06 C/W          | 5.72 C/W          | 3.95 C/W | 3.24 C/W |        | 12     | 35mm      | 10.03 C/W          | 3.06 C/W          | 1.97 C/W | 1.49 C/W |
|        | 15     | 23mm      | 11.41 C/W          | 5.39 C/W          | 3.67 C/W | 2.99 C/W |        | 15     | 35mm      | 9.5 C/W            | 2.85 C/W          | 1.81 C/W | 1.34 C/W |
|        | 18     | 23mm      | 10.76 C/W          | 5.05 C/W          | 3.35 C/W | 2.67 C/W |        | 18     | 35mm      | 8.98 C/W           | 2.6 C/W           | 1.64 C/W | 1.19 C/W |
|        | 21     | 23mm      | 10.11 C/W          | 4.74 C/W          | 3.1 C/W  | 2.46 C/W |        | 21     | 35mm      | 8.46 C/W           | 2.4 C/W           | 1.5 C/W  | 1.07 C/W |
| 904    | 23     | 23mm      | 9.99 C/W           | 4.44 C/W          | 2.87 C/W | 2.31 C/W | 909    | 23     | 35mm      | 8.32 C/W           | 2.19 C/W          | 1.34 C/W | .97 C/W  |
|        | 28     | 23mm      | 9.70 C/W           | 4.09 C/W          | 2.62 C/W | 2.12 C/W |        | 28     | 35mm      | 7.99 C/W           | 1.97 C/W          | 1.19 C/W | .83 C/W  |
|        | 33     | 23mm      | 9.41 C/W           | 3.83 C/W          | 2.43 C/W | 1.96 C/W |        | 33     | 35mm      | 7.65 C/W           | 1.82 C/W          | 1.06 C/W | .7 C/W   |
|        | 12     | 27mm      | 11.38 C/W          | 4.84 C/W          | 3.11 C/W | 2.32 C/W |        | 12     | 37.5mm    | 9.60 C/W           | 2.93 C/W          | 1.90 C/W | 1.36 C/W |
|        | 15     | 27mm      | 10.78 C/W          | 4.48 C/W          | 2.84 C/W | 2.12 C/W |        | 15     | 37.5mm    | 9.11 C/W           | 2.71 C/W          | 1.72 C/W | 1.19 C/W |
|        | 18     | 27mm      | 10.17 C/W          | 4.13 C/W          | 2.56 C/W | 1.88 C/W |        | 18     | 37.5mm    | 8.61 C/W           | 2.52 C/W          | 1.53 C/W | 1.05 C/W |
| 905    | 21     | 27mm      | 9.56 C/W           | 3.82 C/W          | 2.32 C/W | 1.72 C/W | 910    | 21     | 37.5mm    | 8.11 C/W           | 2.25 C/W          | 1.36 C/W | .88 C/W  |
|        | 23     | 27mm      | 9.44 C/W           | 3.51 C/W          | 2.11 C/W | 1.6 C/W  |        | 23     | 37.5mm    | 7.98 C/W           | 2.04 C/W          | 1.2 C/W  | .75 C/W  |
|        | 28     | 27mm      | 9.13 C/W           | 3.26 C/W          | 1.97 C/W | 1.49 C/W |        | 28     | 37.5mm    | 7.63 C/W           | 1.82 C/W          | 1.01 C/W | .63 C/W  |
|        | 33     | 27mm      | 8.82 C/W           | 3.07 C/W          | 1.82 C/W | 1.39 C/W |        | 33     | 37.5mm    | 7.29 C/W           | 1.6 C/W           | .87 C/W  | .52 C/W  |
|        | 12     | 29mm      | 11.04 C/W          | 4.08 C/W          | 2.55 C/W | 1.98 C/W |        | 12     | 40mm      | 9.18 C/W           | 2.84 C/W          | 1.86 C/W | 1.36 C/W |
|        | 15     | 29mm      | 10.46 C/W          | 3.82 C/W          | 2.32 C/W | 1.78 C/W |        | 15     | 40mm      | 8.71 C/W           | 2.64 C/W          | 1.65 C/W | 1.18 C/W |
| 906    | 18     | 29mm      | 9.87 C/W           | 3.58 C/W          | 2.14 C/W | 1.58 C/W | 911    | 18     | 40mm      | 8.24 C/W           | 2.4 C/W           | 1.44 C/W | .98 C/W  |
|        | 21     | 29mm      | 9.28 C/W           | 3.33 C/W          | 1.96 C/W | 1.44 C/W |        | 21     | 40mm      | 7.77 C/W           | 2.21 C/W          | 1.27 C/W | .86 C/W  |
|        | 23     | 29mm      | 9.16 C/W           | 3.13 C/W          | 1.82 C/W | 1.34 C/W |        | 23     | 40mm      | 7.63 C/W           | 2 C/W             | 1.15 C/W | .73 C/W  |
|        | 28     | 29mm      | 8.84 C/W           | 2.82 C/W          | 1.64 C/W | 1.2 C/W  |        | 28     | 40mm      | 7.27 C/W           | 1.77 C/W          | .99 C/W  | .62 C/W  |
|        | 33     | 29mm      | 8.53 C/W           | 2.59 C/W          | 1.47 C/W | 1.07 C/W |        | 33     | 40mm      | 6.92 C/W           | 1.58 C/W          | .85 C/W  | .51 C/W  |

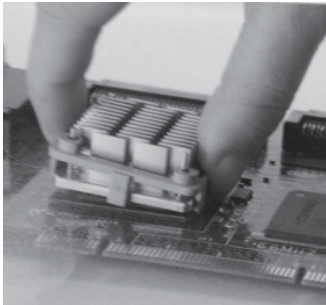
Material: AL 6063  
Finish: Black Anodize

| Series | Chip Size | Construction                    | Height    | Chip Height               | Finish      | Interface            |
|--------|-----------|---------------------------------|-----------|---------------------------|-------------|----------------------|
| 901-   | 19-       | 1-                              | 12-       | 1-                        | B-          | 1                    |
| XXX    | XX        | X                               | XX        | X                         | X           | X                    |
| 901    | 19        | 1= Elliptical Fin<br>2= Pin Fin | 12 = 11.6 | 1 = .9-2.1<br>2 = 2.2-3.4 | B = BLK ANO | 0 = None<br>1 = T725 |
| 902    | 21        |                                 | 15 = 14.6 |                           |             |                      |
| 903    | 23        |                                 | 18 = 17.6 |                           |             |                      |
| 904    | 27        |                                 | 21 = 20.6 |                           |             |                      |
| 905    | 29        |                                 | 23 = 22.6 |                           |             |                      |
| 906    | 31        |                                 | 28 = 27.6 |                           |             |                      |
| 907    | 33        |                                 | 33 = 32.6 |                           |             |                      |
| 908    | 35        |                                 |           |                           |             |                      |
| 909    | 37.5      |                                 |           |                           |             |                      |
| 910    | 40        |                                 |           |                           |             |                      |

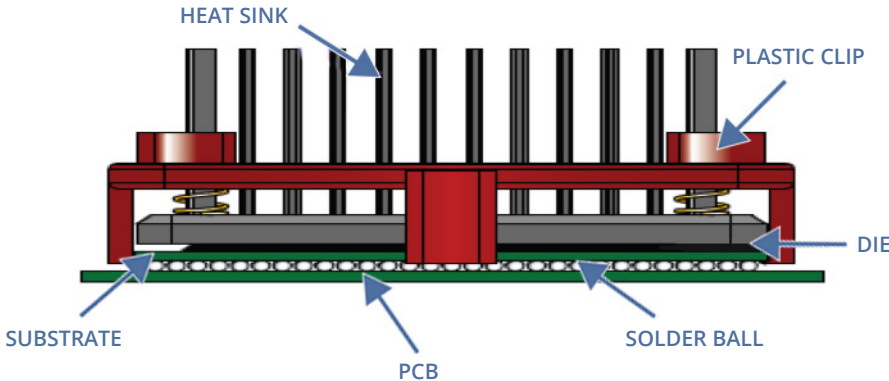
Refer to Page 33 for  
Installation Instructions

PIN FIN & ELLIPTICAL FIN HEAT SINK

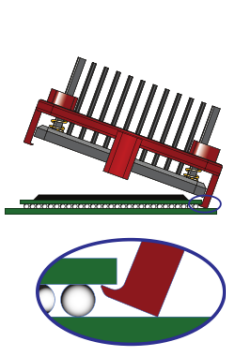
900 SERIES



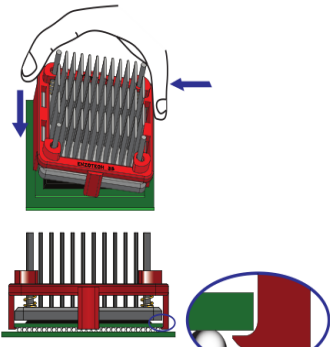
Wakefield-Vette's heat sink assemblies onto chip set using the space that is between the PCB and the substrate of the solder balls. The solder balls provide a minimal gap of .5mm to .7mm. Attachment feature is below a .4mm thickness. The clipping system will not interfere or damage chip. Contact area is the edge of chip.



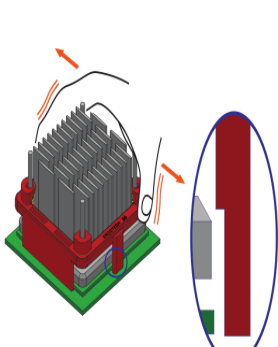
ASSEMBLY INSTRUCTIONS:



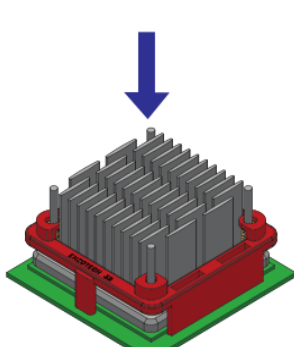
**Step 1**  
Hook the clip under one side of the BGA chip set.



**Step 2**  
Rotate assembly down until opposite side clip engages substrate edge of BGA chip set.



**Step 3**  
Make sure the sop rods are clearing from edges of BGA chip set.



**Step 4**  
Press firmly down to make sure clips fully engage edges of chip set. Heat Sink should not move around easily.

RANDOM VIBRATION TEST

Frequency: 5 Hz to 500 Hz  
Acceleration: 3.13 grms  
P.S.D: 0.01 g2/HZ (5 Hz)  
0.02 g2/HZ (20 Hz to 500 Hz)  
Test Axis: X, Y, Z axis  
Test Time: 10 mins (Each axis)  
Total Test Time: 30 mins

SHOCK TEST SPECIFICATION:

Wave Form: Half sine wave  
Acceleration: 50 g  
Duration Time: 11 ms  
No. of Shock: Each axis 3 times  
Shock Direction: ±X, ±Y, ±Z axis  
Reliability & Communication Testing Instruments



CERAMIC HEAT SINK FOR TO DEVICES W/ omniKlip



omniKlip™

CE-OMNI-38

HEAT SINK



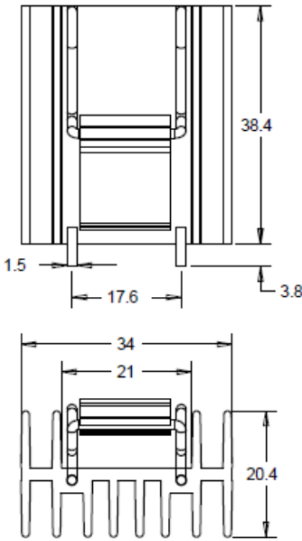
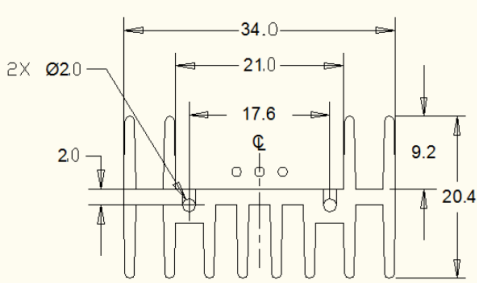
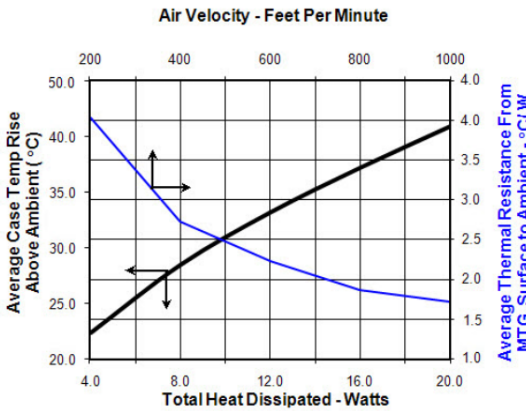
Wakefield-Vette introduces heat sinks made from alumina and aluminum nitride for thermal management of high-power/ voltage electronics, photovoltaic, LED, power resistors and other applications. While electrically insulating and thermally conducting, the ceramic heat sink is an effective combination for the circuit board and heat sink reliability of cooling thermally sensitive components and circuits. The power chip dies can be directly bonded onto ceramic heat sink as a module substrate to eliminate the thermal barriers to quickly dissipate the generated heat. These heat sinks extend component life and enhance performance.

FEATURES

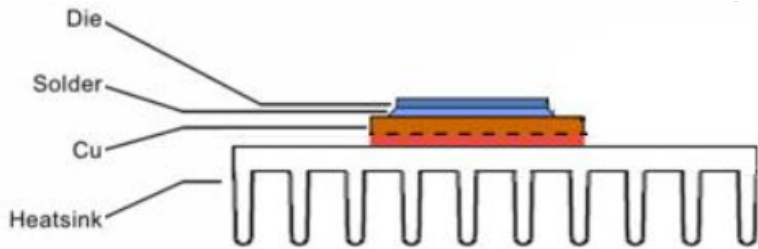
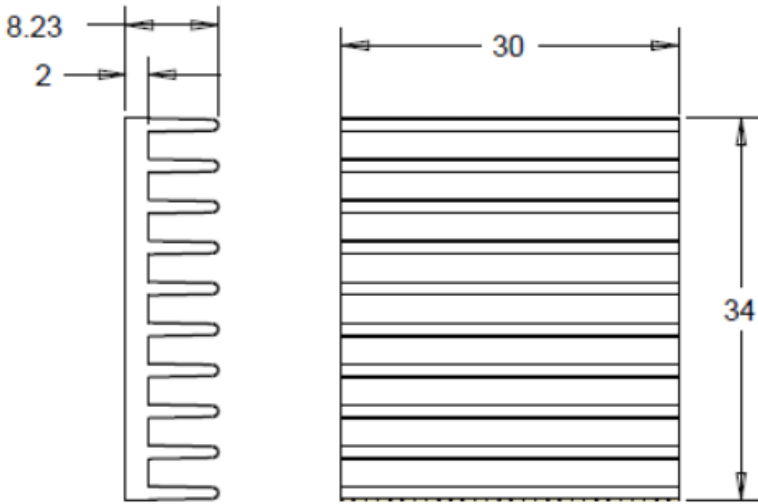
- An innovative ceramic (Patent Pending) heat sink with unique design combines the tin plated solderable integral omniKlip spring with a molded aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) or aluminum nitride (AlN) heat sink body to be mountable onto the PCB directly with no other fasteners needed. Unlike any others, this type of heat sink provides ease of assembly and an all-in-one solution (one part does all). It can be used with different package devices, such as TO-220, TO-247, TO-264 and TO-218 package, etc. series power devices with either natural or forced convection cooling.

| WkV Part Number | Description                                 | Package Cooled | Attachment Method | Length | Width | Height Off Base (Fin Height) | Thermal Resistance @ Forced Air Flow | Thermal Resistance @ Natural |
|-----------------|---------------------------------------------|----------------|-------------------|--------|-------|------------------------------|--------------------------------------|------------------------------|
| CE-OMNI-38      | Ceramic Heat Sink for TO Devices w/omniKlip | TO-220, TO-247 | Solderable Feet   | 38.4mm | 34mm  | 9.2mm                        | 3.8°C/W @ 200 LFM                    | 7.0°C/W @ 200 LFM            |

**Material:** 95% Al<sub>2</sub>O<sub>3</sub>, Surface Area: 11,408mm<sup>2</sup>, Weight: 22 g  
**RoHS Compliant**



Common Ceramic Heat sinks are a rectangular or square shape ceramic as commonly seen in an extrusion heat sink that provides the most common use in cooling. It can be used as Chip-on-heat-sink (on the metalized surface) and makes it possible to achieve an extremely compact design for the entire cooling system. Using ceramic as the material for a heat sink ensures outstanding thermal conductivity and electrical insulation; the closer it is used to a source of heat, the greater the cooling advantage it offers.



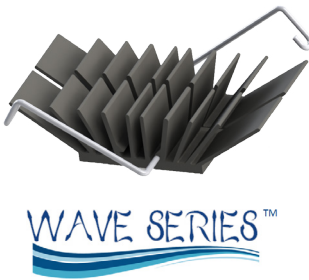
**Material:** 95% Al<sub>2</sub>O<sub>3</sub>, Surface Area: 5,979mm<sup>2</sup>, Weight: 15 g

Additional Configurations & Custom Ceramic Heat Sinks

Contact Wakefield-Vette for more information or visit [www.wakefield-vette.com](http://www.wakefield-vette.com)



WAVE SERIES HEAT SINK WITH INTEGRATED CLIP ASSEMBLY



WAVE SERIES BGA HEAT SINKS



The Wakefield-Vette **Wave Series Heat Sink Series** are a superior choice for cooling BGA applications in which limited height/footprint while achieving maximum surface area. The Wave Series Heat Sinks include a unique clipping mechanism that allows for superior heat transfer while securing the heat sink to the BGA itself. The clipping mechanism allows for easy installation in high production assembly.

FEATURES AND BENEFITS

- Approximately 12% better thermal performance than traditional footprint heat sinks.
- Height- A low profile design allows for more surface area in a height restricted application.
- Clipping mechanism included with heat sink.
- Surface Area - Fin array allows for more surface area for forced convection.
- Easily customizable.
- Easily compatible with major BGA device manufacturers components such as: Motorola, Freescale, TI, Intel, etc.

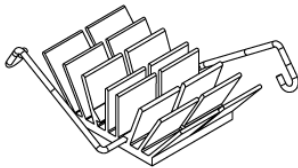
| WkV Part Number | Description                                   | Attachment Method | Mechanical Dimensions (mm) |       |           |        |                      |                              | Thermal Resistance - Forced Conv. @ 200 LFM |
|-----------------|-----------------------------------------------|-------------------|----------------------------|-------|-----------|--------|----------------------|------------------------------|---------------------------------------------|
|                 |                                               |                   | Length                     | Width | Fin Width | Height | Surface Area (sq mm) | Height Off Base (Fin Height) |                                             |
| WAVE-23-125     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 23                         | 23    | 40        | 12.5   | 6055.1               | 10.5                         | 6.76                                        |
| WAVE-23-165     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 23                         | 23    | 46.5      | 16.5   | 7634.6               | 14.5                         | 5.08                                        |
| WAVE-26-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 26                         | 26    | 52.9      | 12     | 8305.2               | 10                           | 5.21                                        |
| WAVE-29-127     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 29                         | 29    | 61.4      | 12.7   | 11810.5              | 10.7                         | 4.08                                        |
| WAVE-32-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 32                         | 32    | 50.2      | 12     | 10957.5              | 10                           | 4.64                                        |
| WAVE-34-21      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 34                         | 34    | 70        | 21     | 21268.4              | 19                           | 2.19                                        |
| WAVE-35-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 35                         | 35    | 62        | 12     | 15180.8              | 10                           | 3.83                                        |
| WAVE-35-125     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 35                         | 35    | 63.3      | 12.5   | 15792.6              | 10.5                         | 3.63                                        |
| WAVE-35-15      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 35                         | 35    | 58.1      | 15     | 15612.7              | 13                           | 3.15                                        |
| WAVE-35-21      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 35                         | 35    | 74.6      | 21     | 21721.8              | 19                           | 2.11                                        |
| WAVE-366-175    | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 36.6                       | 36.6  | 63.6      | 17.5   | 18637.8              | 15.5                         | 2.55                                        |
| WAVE-40-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 40                         | 40    | 66.9      | 12     | 17689.4              | 10                           | 3.36                                        |
| WAVE-40-125     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 40                         | 40    | 68.3      | 12.5   | 18410.1              | 10.5                         | 3.16                                        |
| WAVE-425-117    | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 42.5                       | 42.5  | 67.4      | 11.7   | 21668.3              | 9.3                          | 3.40                                        |
| WAVE-45-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 45                         | 45    | 72        | 12     | 22303.7              | 10                           | 2.96                                        |

**Material Specifications:** Heat Sink: Aluminum Alloy 6063-T5 with black anodized finish. Spring Clip: 304 Stainless Steel, 1.2mm [0.47"] DIA  
RoHS Compliant

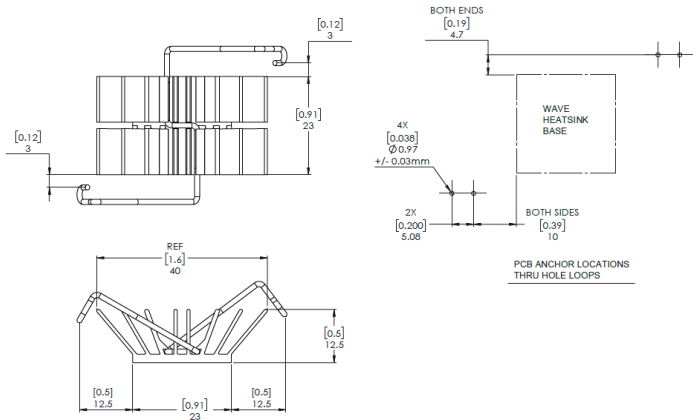
BGA HEAT SINKS WAVE 2X SERIES

| WkV Part Number | Description                                   | Attachment Method | Mechanical Dimensions (mm) |       |           |        |                      |                              | Thermal Resistance - Forced Conv. @ 200 LFM |
|-----------------|-----------------------------------------------|-------------------|----------------------------|-------|-----------|--------|----------------------|------------------------------|---------------------------------------------|
|                 |                                               |                   | Length                     | Width | Fin Width | Height | Surface Area (sq mm) | Height Off Base (Fin Height) |                                             |
| WAVE-23-125     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 23                         | 23    | 40        | 12.5   | 6055.1               | 10.5                         | 6.76                                        |
| WAVE-23-165     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 23                         | 23    | 46.5      | 16.5   | 7634.6               | 14.5                         | 5.08                                        |

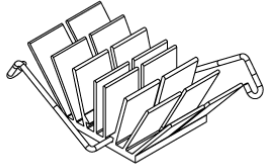
WAVE-23-125



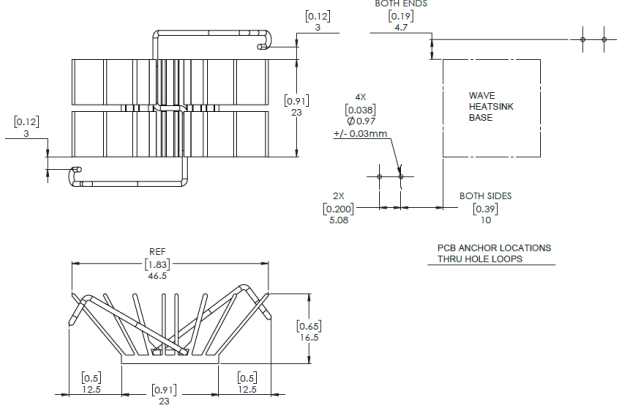
MECHANICAL DIMENSIONS



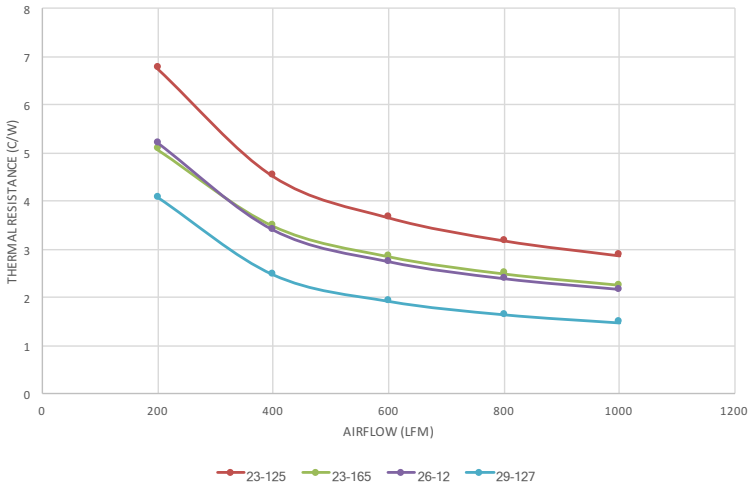
WAVE-23-165



MECHANICAL DIMENSIONS



Wave 2X



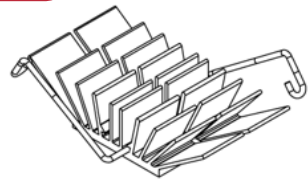
## WAVE SERIES HEAT SINK WITH INTEGRATED CLIP ASSEMBLY

## WAVE 2X SERIES

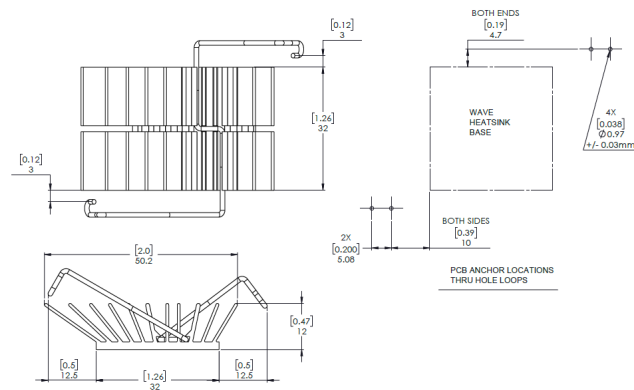
## BGA HEAT SINKS

|                 |                                               |                   | Mechanical Dimensions (mm) |       |           |        |                      |                              |                                             |
|-----------------|-----------------------------------------------|-------------------|----------------------------|-------|-----------|--------|----------------------|------------------------------|---------------------------------------------|
| WkV Part Number | Description                                   | Attachment Method | Length                     | Width | Fin Width | Height | Surface Area (sq mm) | Height Off Base (Fin Height) | Thermal Resistance - Forced Conv. @ 200 LFM |
| WAVE-26-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 26                         | 26    | 52.9      | 12     | 8305.2               | 10                           | 5.21                                        |
| WAVE-29-127     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 29                         | 29    | 61.4      | 12.7   | 11810.5              | 10.7                         | 4.08                                        |

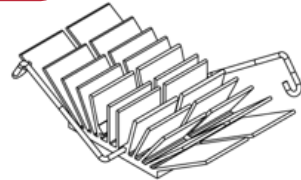
**WAVE-26-12**



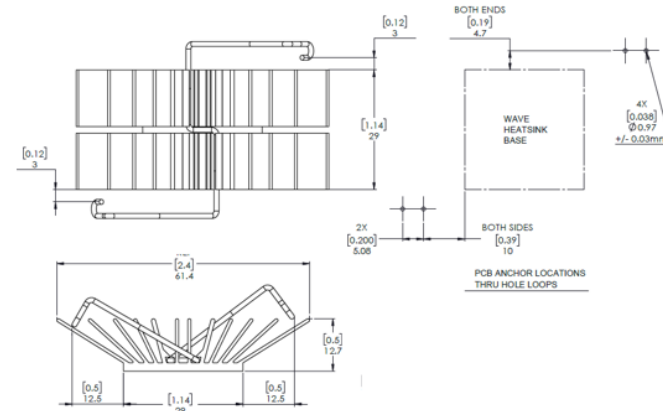
## MECHANICAL DIMENSIONS



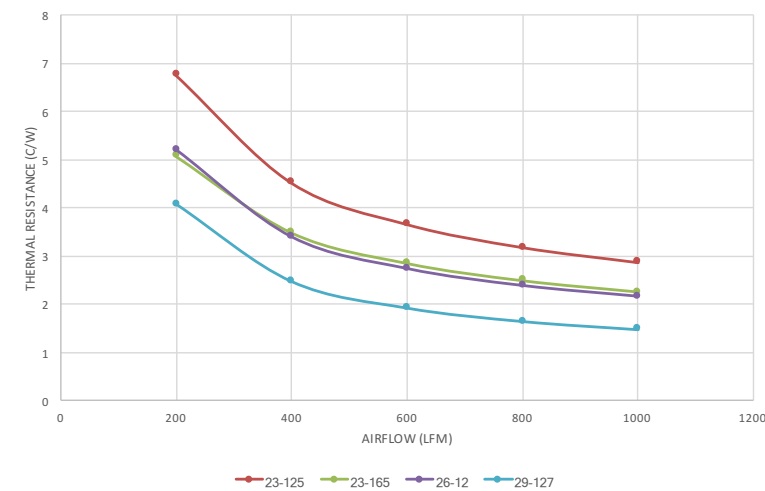
**WAVE-29-127**



## MECHANICAL DIMENSIONS



Wave 2X

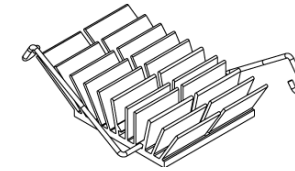


## BGA HEAT SINKS

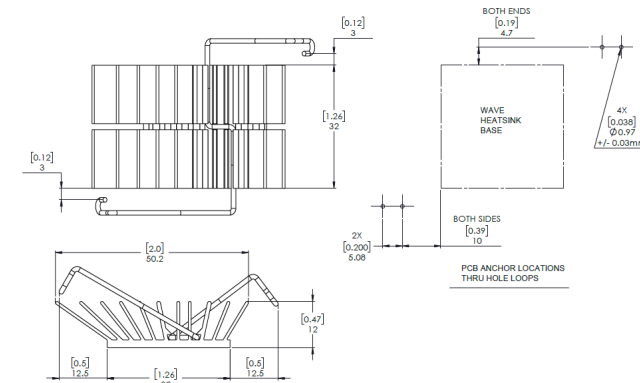
## WAVE 3X SERIES

|                 |                                               |                   | Mechanical Dimensions (mm) |       |           |        |                      |                              |                                             |
|-----------------|-----------------------------------------------|-------------------|----------------------------|-------|-----------|--------|----------------------|------------------------------|---------------------------------------------|
| WkV Part Number | Description                                   | Attachment Method | Length                     | Width | Fin Width | Height | Surface Area (sq mm) | Height Off Base (Fin Height) | Thermal Resistance - Forced Conv. @ 200 LFM |
| WAVE-32-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 32                         | 32    | 50.2      | 12     | 10957.5              | 10                           | 4.64                                        |
| WAVE-34-21      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 34                         | 34    | 70        | 21     | 21268.4              | 19                           | 2.19                                        |

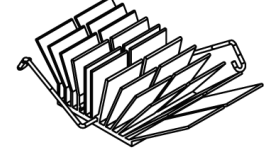
( WAVE-32-12



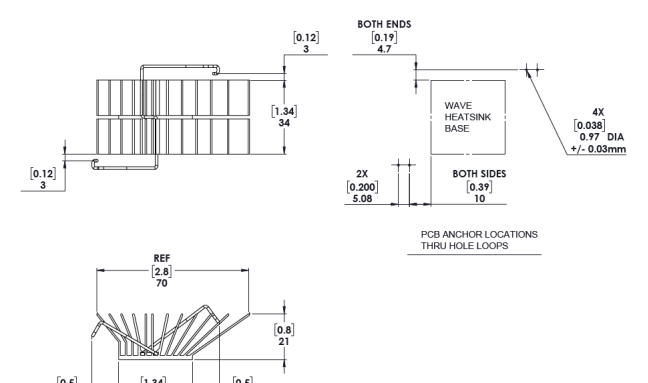
## MECHANICAL DIMENSIONS



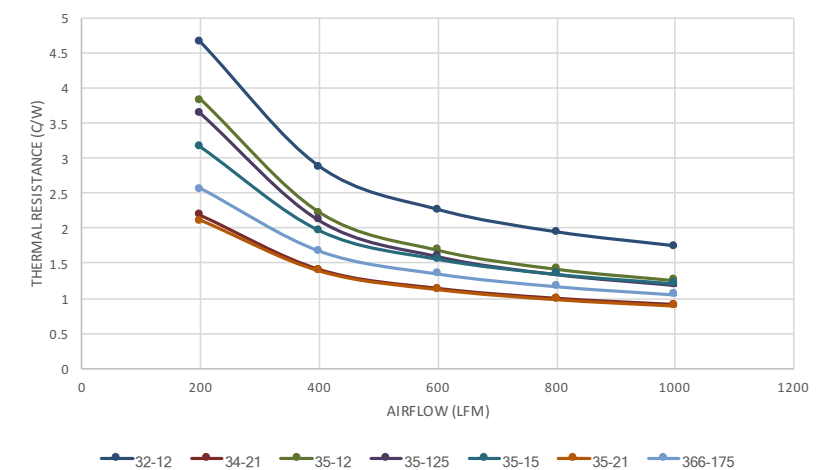
( WAVE-34-21



## MECHANICAL DIMENSIONS



Wave 3X



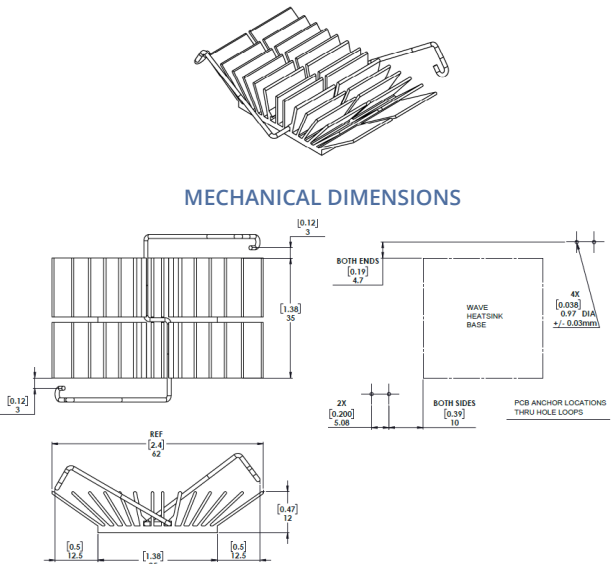
WAVE SERIES HEAT SINK WITH INTEGRATED CLIP ASSEMBLY

WAVE 3X SERIES

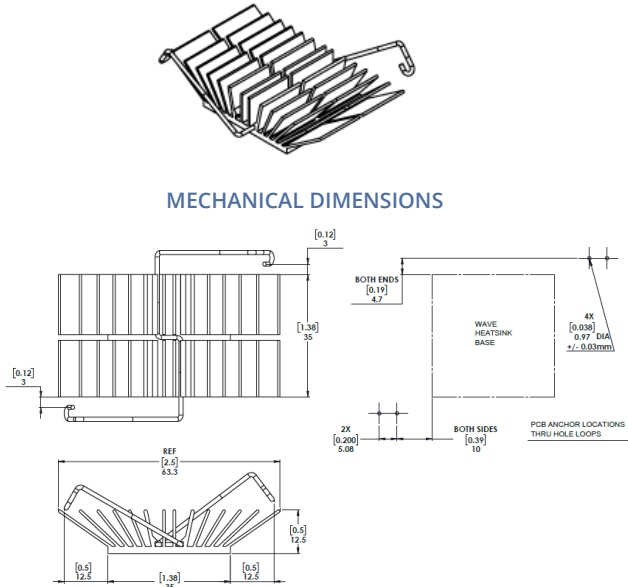
BGA HEAT SINKS

| WkV Part Number | Description                                   | Attachment Method | Mechanical Dimensions (mm) |       |           |        |                      |                              | Thermal Resistance - Forced Conv. @ 200 LFM |
|-----------------|-----------------------------------------------|-------------------|----------------------------|-------|-----------|--------|----------------------|------------------------------|---------------------------------------------|
|                 |                                               |                   | Length                     | Width | Fin Width | Height | Surface Area (sq mm) | Height Off Base (Fin Height) |                                             |
| WAVE-35-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 35                         | 35    | 62        | 12     | 15180.8              | 10                           | 3.83                                        |
| WAVE-35-125     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 35                         | 35    | 63.3      | 12.5   | 15792.6              | 10.5                         | 3.63                                        |

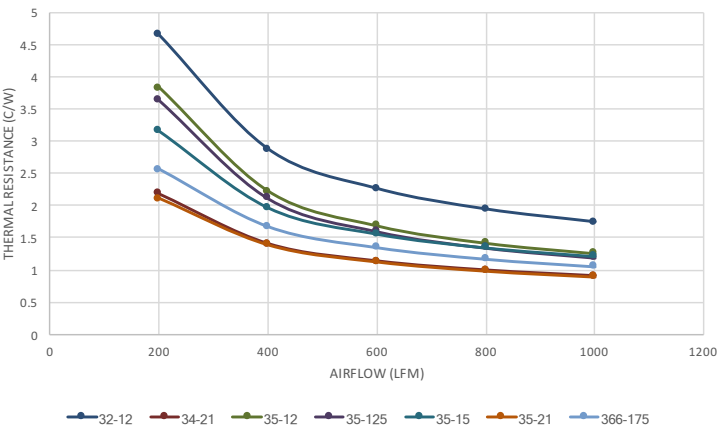
WAVE-35-12



WAVE-35-125



Wave 3X

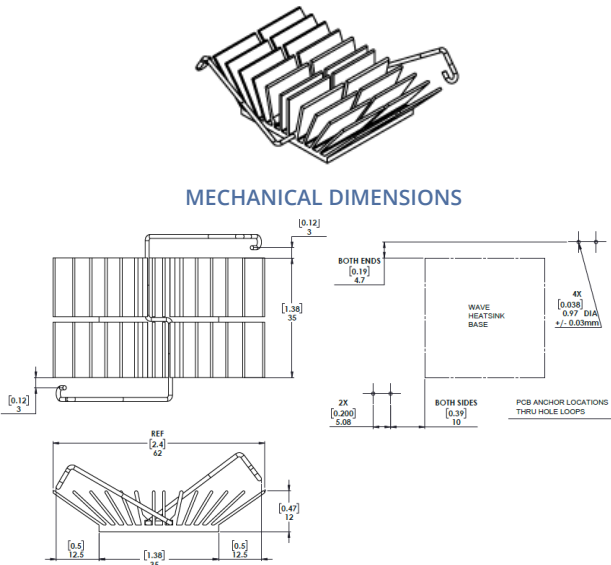


BGA HEAT SINKS

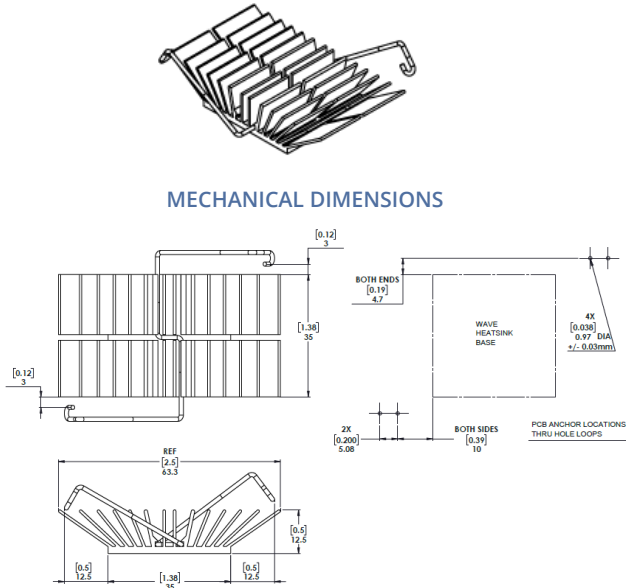
WAVE 3X SERIES

| WkV Part Number | Description                                   | Attachment Method | Mechanical Dimensions (mm) |       |           |        |                      |                              | Thermal Resistance - Forced Conv. @ 200 LFM |
|-----------------|-----------------------------------------------|-------------------|----------------------------|-------|-----------|--------|----------------------|------------------------------|---------------------------------------------|
|                 |                                               |                   | Length                     | Width | Fin Width | Height | Surface Area (sq mm) | Height Off Base (Fin Height) |                                             |
| WAVE-35-15      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 35                         | 35    | 58.1      | 15     | 15612.7              | 13                           | 3.15                                        |
| WAVE-35-21      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 35                         | 35    | 74.6      | 21     | 21721.8              | 19                           | 2.11                                        |
| WAVE-366-175    | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 36.6                       | 36.6  | 63.6      | 17.5   | 18637.8              | 15.5                         | 2.55                                        |

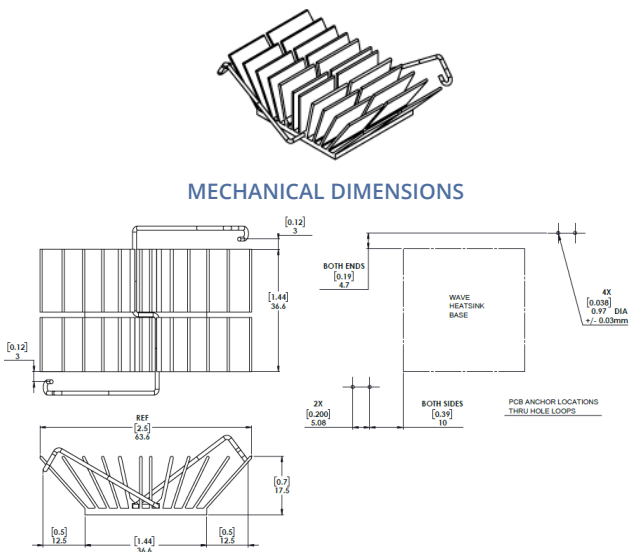
WAVE-35-15



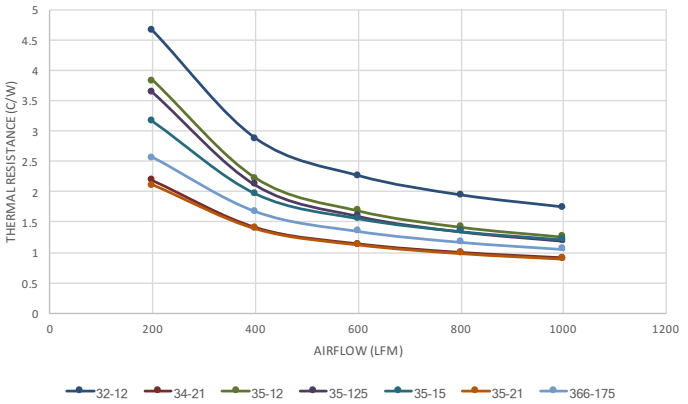
WAVE-35-21



WAVE-366-175



Wave 3X





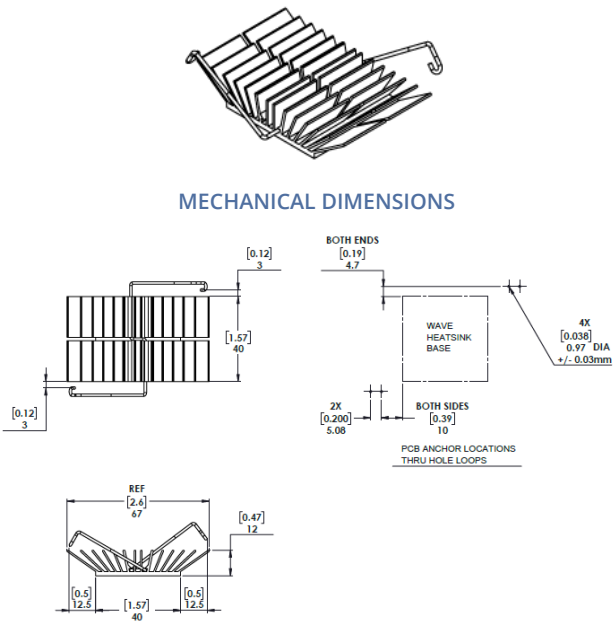
WAVE SERIES HEAT SINK WITH INTEGRATED CLIP ASSEMBLY

WAVE 4X SERIES

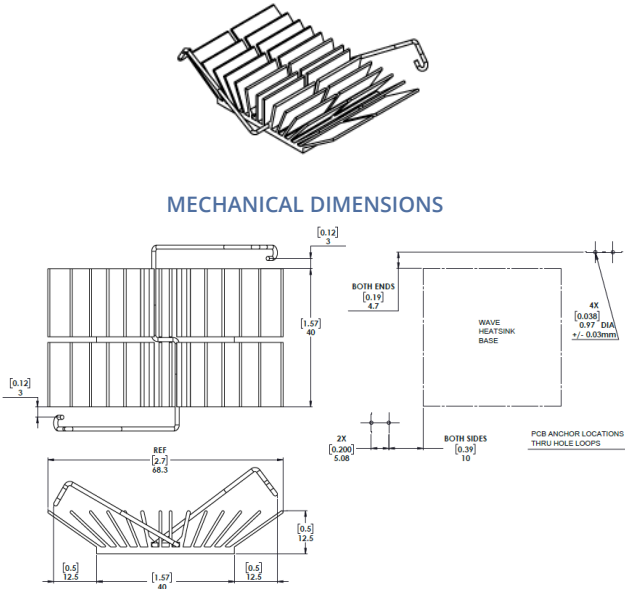
BGA HEAT SINKS

| WkV Part Number | Description                                   | Attachment Method | Mechanical Dimensions (mm) |       |           |        |                      |                              | Thermal Resistance - Forced Conv. @ 200 LFM |
|-----------------|-----------------------------------------------|-------------------|----------------------------|-------|-----------|--------|----------------------|------------------------------|---------------------------------------------|
|                 |                                               |                   | Length                     | Width | Fin Width | Height | Surface Area (sq mm) | Height Off Base (Fin Height) |                                             |
| WAVE-40-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 40                         | 40    | 66.9      | 12     | 17689.4              | 10                           | 3.36                                        |
| WAVE-40-125     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 40                         | 40    | 68.3      | 12.5   | 18410.1              | 10.5                         | 3.16                                        |
| WAVE-425-117    | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 42.5                       | 42.5  | 67.4      | 11.7   | 21668.3              | 9.3                          | 3.40                                        |
| WAVE-45-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 45                         | 45    | 72        | 12     | 22303.7              | 10                           | 2.96                                        |

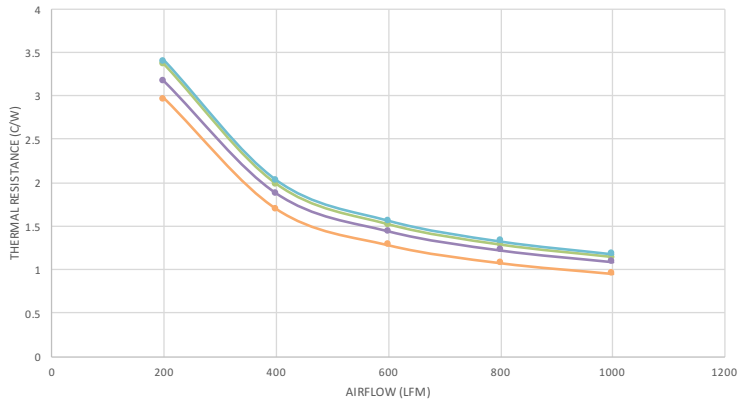
WAVE-40-12



WAVE-40-125



Wave 4X



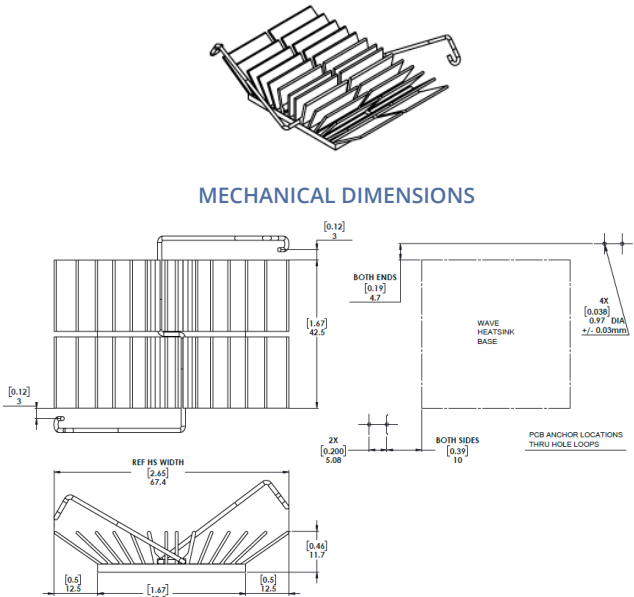
40-12 40-125 425-117 45-12

BGA HEAT SINKS

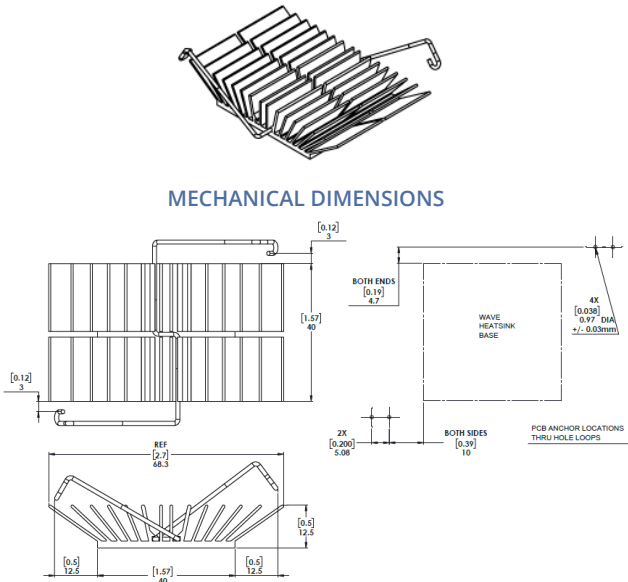
WAVE 4X SERIES

| WkV Part Number | Description                                   | Attachment Method | Mechanical Dimensions (mm) |       |           |        |                      |                              | Thermal Resistance - Forced Conv. @ 200 LFM |
|-----------------|-----------------------------------------------|-------------------|----------------------------|-------|-----------|--------|----------------------|------------------------------|---------------------------------------------|
|                 |                                               |                   | Length                     | Width | Fin Width | Height | Surface Area (sq mm) | Height Off Base (Fin Height) |                                             |
| WAVE-40-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 40                         | 40    | 66.9      | 12     | 17689.4              | 10                           | 3.36                                        |
| WAVE-40-125     | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 40                         | 40    | 68.3      | 12.5   | 18410.1              | 10.5                         | 3.16                                        |
| WAVE-425-117    | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 42.5                       | 42.5  | 67.4      | 11.7   | 21668.3              | 9.3                          | 3.40                                        |
| WAVE-45-12      | Wave Heat Sink BGA Chipset Aluminum Top Mount | Spring-Anchor     | 45                         | 45    | 72        | 12     | 22303.7              | 10                           | 2.96                                        |

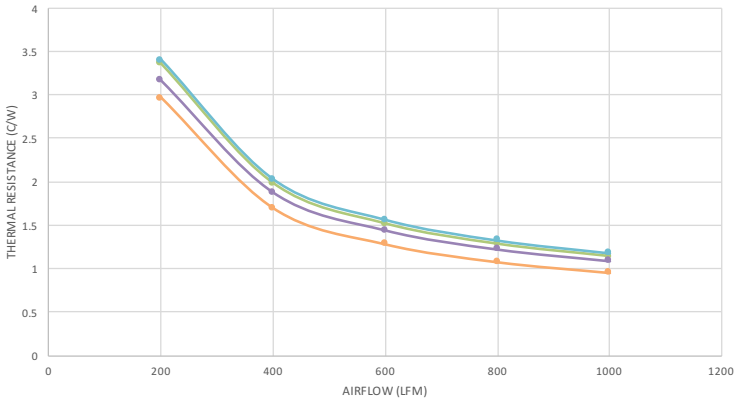
WAVE-425-117



WAVE-45-12



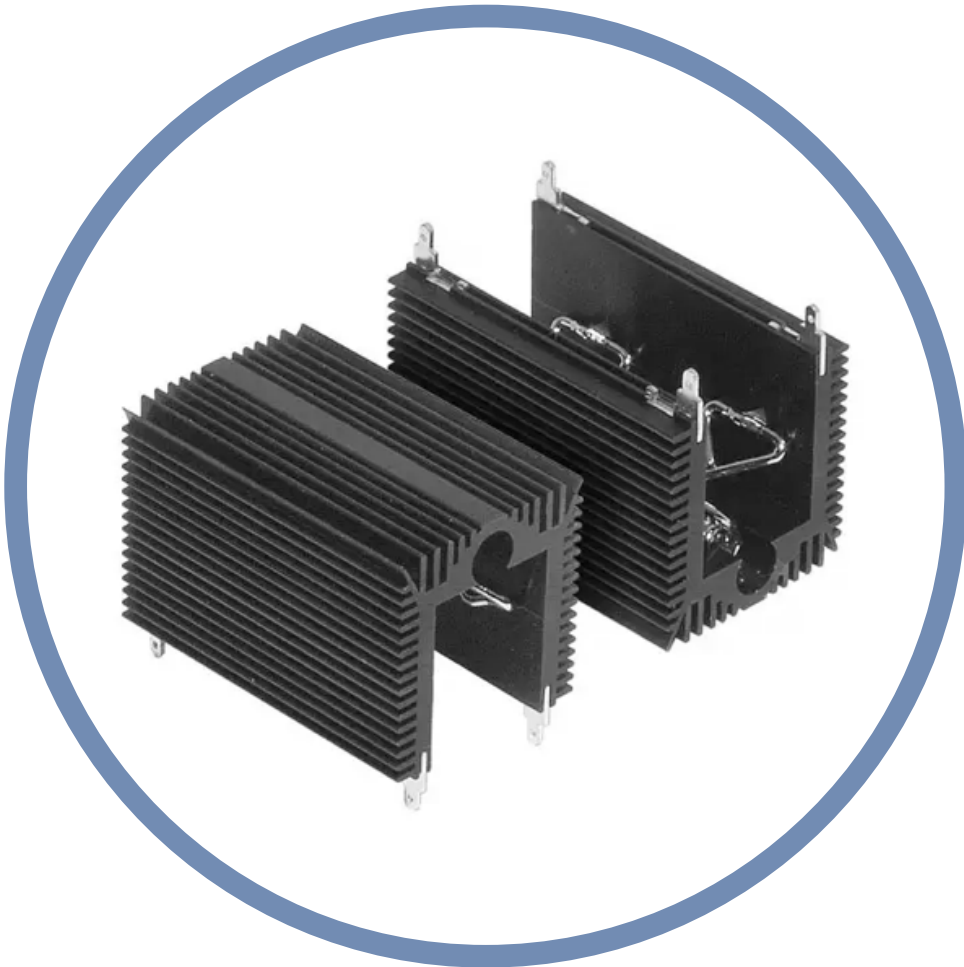
Wave 4X



40-12 40-125 425-117 45-12

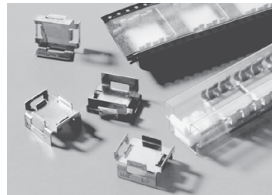
# BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS

|                                                                                    |              |
|------------------------------------------------------------------------------------|--------------|
| <i>Board Level Power Semiconductor Heat Sinks .....</i>                            | <i>46-76</i> |
| <i>219 Series Heat Sinks for TO-263 Devices .....</i>                              | <i>48-49</i> |
| <i>Board Level Heat Sinks for TO-220, TO-218 &amp; Multiwatt™ Components .....</i> | <i>59-61</i> |
| <i>Universal 678 Series Vertical Heat Sink for Power Devices .....</i>             | <i>77</i>    |
| <i>One Heat Sink for all Packages .....</i>                                        | <i>78</i>    |
| <i>Mountain Series Heat Sinks for TO-264, TO-247 Devices.....</i>                  | <i>79-80</i> |
| <i>omniKlip™ Series Heat Sink w/ Clip(s) for TO-Devices.....</i>                   | <i>81-83</i> |
| <i>Additional Configurations.....</i>                                              | <i>84</i>    |



A wide variety of heat dissipators with various attachment mechanisms for surface mount and thru-hole power semiconductors packaged in industry standard plastic, ceramic, and metal cases such as D2Pak, TO-220, TO-3 to TO-247, DO-4 to DO-11, multiwatt, hex-type, and stud mount devices.

BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



217 SERIES

SURFACE MOUNT HEAT SINKS

D2PAK; TO-220; SOT-223; SOL-20

Compatible with surface mount technology (SMT) automated production techniques for ease of assembly and a variety of soldering methods, these heat sinks allow greater packaging densities and reduction in PC-board area, increasing the power dissipation of surface mount devices (SMDs) while maintaining and improving manufacturers' component thermal specifications.

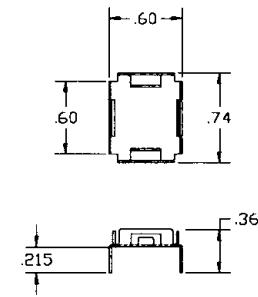
FEATURES AND BENEFITS

- No interface material is needed
- Copper with matte tin plating for improved solderability and assembly
- Both the component and the heat sink are installed on the PC-board utilizing standard SMT assembly equipment for "Tape & Reel" and "Tube" formats
- EIA standards and ESD protection are specified
- Can be used with water soluble or no clean SMT solder creams or other pastes

| Footprint Standard P/N | Height Above PC Board in. (mm) | Dimensions in. (mm)       | Package Format | Package Quantity | Thermal Performance at Typical Load |                    |
|------------------------|--------------------------------|---------------------------|----------------|------------------|-------------------------------------|--------------------|
|                        |                                |                           |                |                  | Natural Convection                  | Forced Convection  |
| 217-36CTE6             | .360 (9.1)                     | .600 (15.2) x .740 (18.8) | Bulk           | 1                | 55°C @ 1W                           | 16.0°C/W @ 200 LFM |
| 217-36CTTE6            | .360 (9.1)                     | .600 (15.2) x .740 (18.8) | Tube           | 20               | 55°C @ 1W                           | 16.0°C/W @ 200 LFM |
| 217-36CTRE6            | .360 (9.1)                     | .600 (15.2) x .740 (18.8) | Tape & Reel    | 250              | 55°C @ 1W                           | 16.0°C/W @ 200 LFM |

Material: Copper, Matte Tin Plated

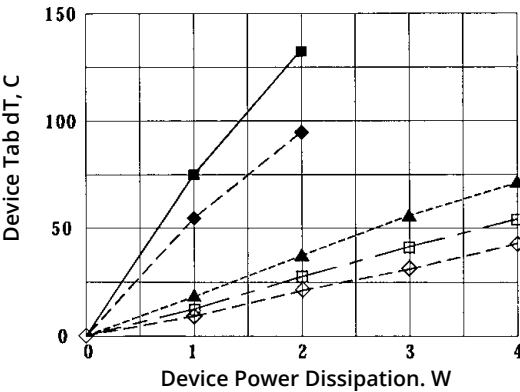
MECHANICAL DIMENSIONS



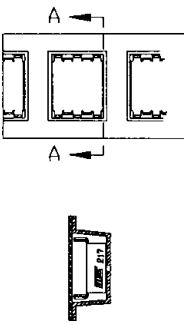
217-36CT6

Dimensions: in.

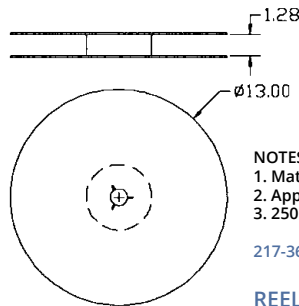
THERMAL PERFORMANCE  
6 LAYER BOARD, D' PAK  
125°C LEAD, 40°C AMBIENT



KEY: ■ Device only, NC ◆ Device + HS, NC ▲ Device + HS, 100 lfm  
□ Device + HS, 200 lfm ◇ Device + HS, 300 lfm



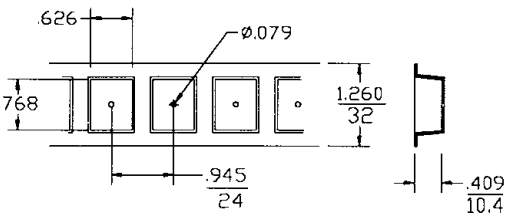
SECTION A-A



NOTES  
1. Material to be "ESD"  
2. Approximately 6 Meters per Reel  
3. 250 Pieces per Reel.

217-36CTRE6

REEL DETAILS



TAPE DETAILS

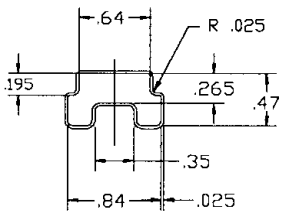
D2PAK; TO-220; SOL-20

SURFACE MOUNT HEAT SINKS

217 SERIES

MECHANICAL DIMENSIONS

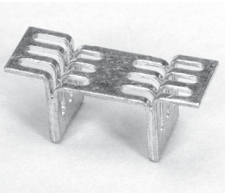
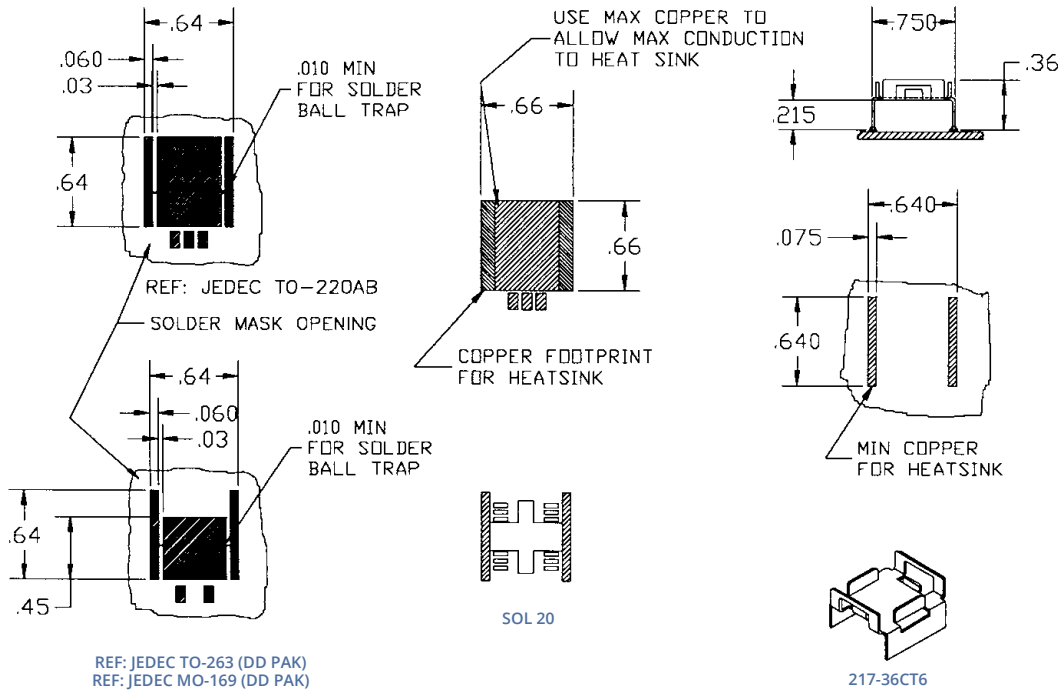
TUBE DETAILS



Tube: 16.25 Inches Long,  
Min. esd Material with  
Nail Stops  
20 Pieces per Tube

217-36CTT6

Dimensions: in.



218 SERIES

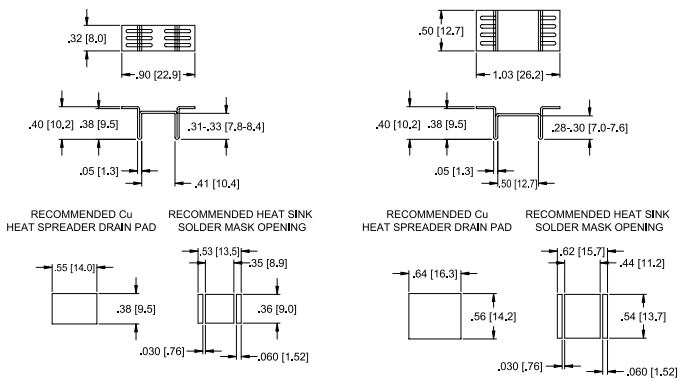
SURFACE MOUNT HEAT SINK

SMT Devices

| Standard P/N | Height Above PC Board in. (mm) | Maximum Footprint in. (mm) | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|----------------------------|-------------------------------------|-------------------|
|              |                                |                            | Natural Convection                  | Forced Convection |
| 218-40CTE3   | .40 (10.2)                     | .90 (22.9) x .315 (8.0)    | 62°C rise @ 2W                      | 21°C/W @ 200LFM   |
| 218-40CTE5   | .40 (10.2)                     | 1.03 (26.2) x .50 (12.7)   | 62°C rise @ 2W                      | 21°C/W @ 200LFM   |

Material: Copper, Matte Tin Plated

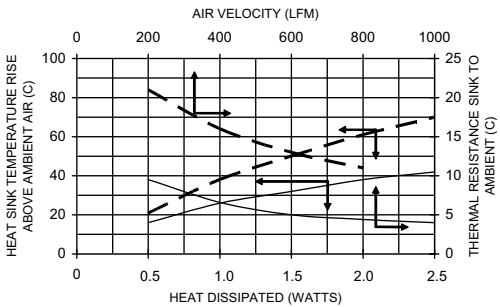
MECHANICAL DIMENSIONS



218-40CT3

218-40CT5

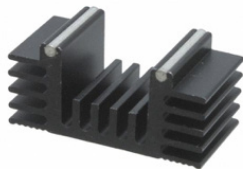
NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



Solid line = 218-40CT5 Dashed Line = 218-40CT3



219 SERIES HEAT SINKS FOR TO-263 DEVICES



219-263A HEAT SINK FOR TO-263 DEVICES



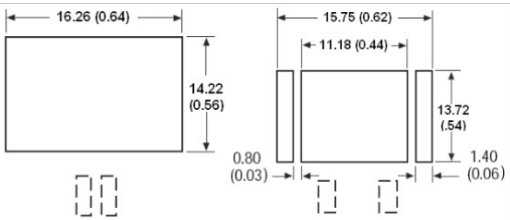
Innovation in SMT compatible heat sinks to meet the needs of newer higher power SMT semiconductors. The 219 Series heat sinks unique design (Patent Pending) combines the technology of automatically assembling the tin plated solderable wires/rods with that of extruded aluminum anodized heat sink body to configure these SMT heat sinks. Rods/wires named "Rollers" are mated mechanically to the heat sink body by forging to reduce the interface thermal resistance between the drains & heat dissipation body.

FEATURES AND BENEFITS

- Increased thermal performance up to 30% over bright copper heat sinks from improved radiation of the black finish.
- Increased surface areas by 3 times therefore thermal performance up to 300% over the aluminum stamped heat sinks on markets.
- Light weight aluminum construction allows faster pick and place assembly reducing the manufacturing cycle time.
- Radius mounted "Rollers" are designed for maximizing heat transfer from component and to avoid "bottle neck" heat transfer like the Aluminum stamped heat sinks.
- Available in bulk packaging or Tape & Reel.

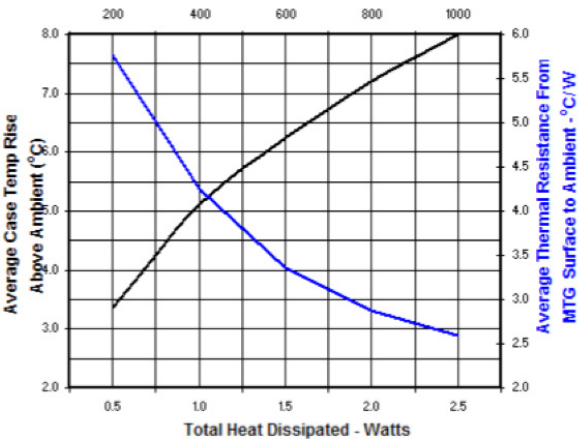
| Part Number | Description                       | Attachment         | Length              | Width               | Height Off Base<br>(Height Of Fin) | Power Dissipation @<br>Temperature Rise | Thermal Resistance<br>@ Forced Air Flow | Package<br>Type |
|-------------|-----------------------------------|--------------------|---------------------|---------------------|------------------------------------|-----------------------------------------|-----------------------------------------|-----------------|
| 219-263A    | TO-263 SMD<br>HEAT SINK<br>ANODZD | Solderable<br>Feet | 0.500"<br>(12.70mm) | 1.020"<br>(25.91mm) | 0.480"<br>(12.19mm)                | 2W @ 30°C                               | 8°C/W @ 500 LFM                         | Bulk            |

MECHANICAL DIMENSIONS



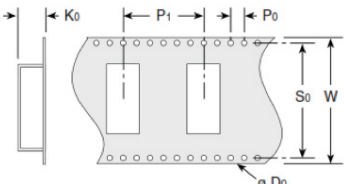
THERMAL RESISTANCE

Air Velocity - Feet Per Minute



TAPE AND REEL INFORMATION

Reel diameter: 13.00" (330.00mm)  
250 pcs. per



|    | Style 10 | Style 20 | Style 30 |
|----|----------|----------|----------|
| Do | 1.55mm   | 1.5mm    | 1.5mm    |
| K0 | 10.5mm   | 12.20mm  | 11.50mm  |
| P0 | 4mm      | 4.0mm    | 4.0mm    |
| P1 | 24mm     | 24mm     | 24.0mm   |
| S0 | 40.4mm   | 40.4mm   | 52.4mm   |
| W  | 44mm     | 44mm     | 56mm     |

TAPE DETAILS



HEAT SINK FOR TO-263 DEVICES

219-263A-TR



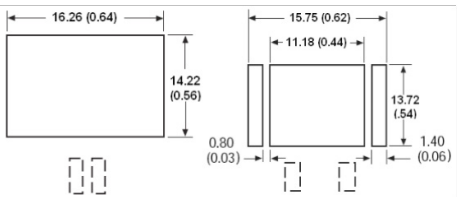
Innovation in SMT compatible heat sinks to meet the needs of newer higher power SMT semiconductors. The 219 Series heat sinks unique design (Patent Pending) combines the technology of automatically assembling the tin plated solderable wires/rods with that of extruded aluminum anodized heat sink body to configure these SMT heat sinks. Rods/wires named "Rollers" are mated mechanically to the heat sink body by forging to reduce the interface thermal resistance between the drains & heat dissipation body.

FEATURES AND BENEFITS

- Increased thermal performance up to 30% over bright copper heat sinks from improved radiation of the black finish.
- Increased surface areas by 3 times therefore thermal performance up to 300% over the aluminum stamped heat sinks on markets.
- Light weight aluminum construction allows faster pick and place assembly reducing the manufacturing cycle time.
- Radius mounted "Rollers" are designed for maximizing heat transfer from component and to avoid "bottle neck" heat transfer like the Aluminum stamped heat sinks.
- Available in bulk packaging or Tape & Reel.

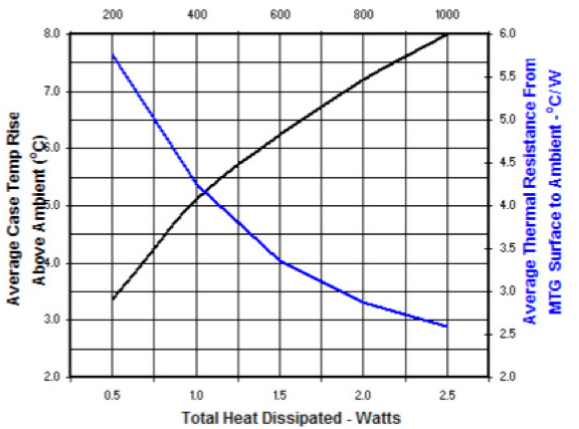
| Part Number | Description                       | Attachment         | Length              | Width               | Height Off Base<br>(Height Of Fin) | Power Dissipation @<br>Temperature Rise | Thermal Resistance<br>@ Forced Air Flow | Package<br>Type |
|-------------|-----------------------------------|--------------------|---------------------|---------------------|------------------------------------|-----------------------------------------|-----------------------------------------|-----------------|
| 219-263A-TR | TO-263 SMD<br>HEAT SINK<br>ANODZD | Solderable<br>Feet | 0.500"<br>(12.70mm) | 1.020"<br>(25.91mm) | 0.480"<br>(12.19mm)                | 2W @ 30°C                               | 8°C/W @ 500 LFM                         | Tape & Reel     |

MECHANICAL DIMENSIONS



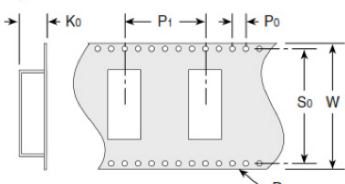
THERMAL RESISTANCE

Air Velocity - Feet Per Minute



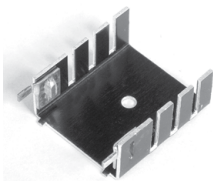
TAPE AND REEL INFORMATION

Reel diameter: 13.00" (330.00mm)  
250 pcs. per



|    | Style 10 | Style 20 | Style 30 |
|----|----------|----------|----------|
| Do | 1.55mm   | 1.5mm    | 1.5mm    |
| K0 | 10.5mm   | 12.20mm  | 11.50mm  |
| P0 | 4mm      | 4.0mm    | 4.0mm    |
| P1 | 24mm     | 24mm     | 24.0mm   |
| S0 | 40.4mm   | 40.4mm   | 52.4mm   |
| W  | 44mm     | 44mm     | 56mm     |

BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



206 SERIES

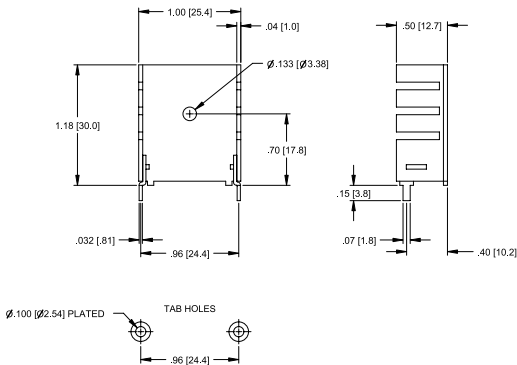
VERTICAL MOUNT HEAT SINK

TO-220

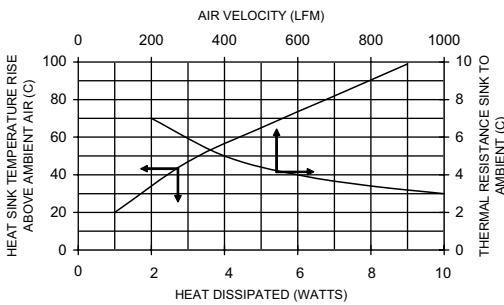
| Standard P/N | Height Above PC Board in. (mm) | Maximum Footprint in. (mm) | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|----------------------------|-------------------------------------|-------------------|
|              |                                |                            | Natural Convection                  | Forced Convection |
| 206-1PABEH   | 1.18 (30.0)                    | 1.00 (25.4) x .50 (12.7)   | 56°C rise @ 4W                      | 7.3°C/W @ 200LFM  |

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



NATURAL AND FORCED CONVECTION CHARACTERISTICS



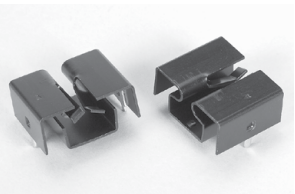
TO-220

HORIZONTAL MOUNT HEAT SINK

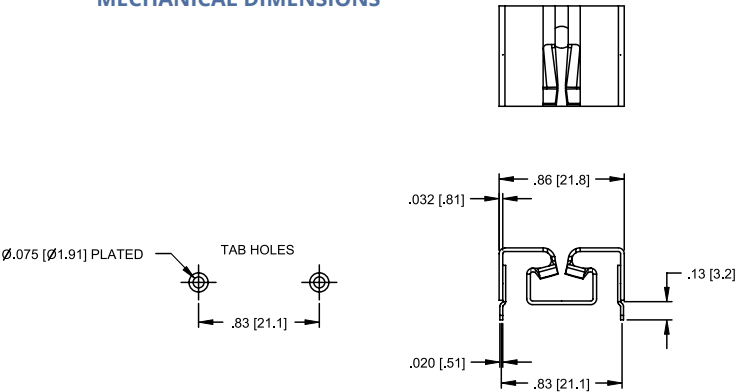
241 SERIES

| Standard P/N | Height Above PC Board in. (mm) | Maximum Footprint in. (mm) | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|----------------------------|-------------------------------------|-------------------|
|              |                                |                            | Natural Convection                  | Forced Convection |
| 241-69ABE-03 | .39 (9.9)                      | .86 (21.8) x .69 (17.5)    | 77°C rise @ 4W                      | 12°C/W @ 200LFM   |

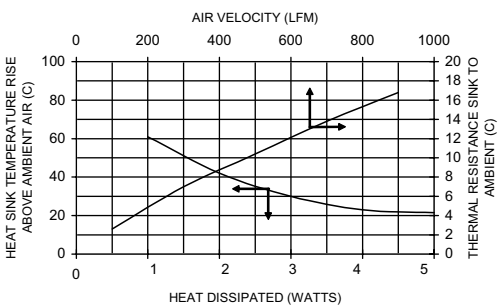
Material: Aluminum, Black Anodized



MECHANICAL DIMENSIONS



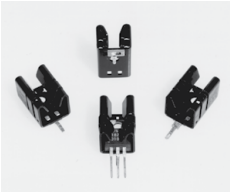
NATURAL AND FORCED CONVECTION CHARACTERISTICS



COMPACT, WAVE-SOLDERABLE LOW-PROFILE  
SELF-LOCKING HEAT SINKS

TO-220

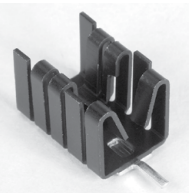
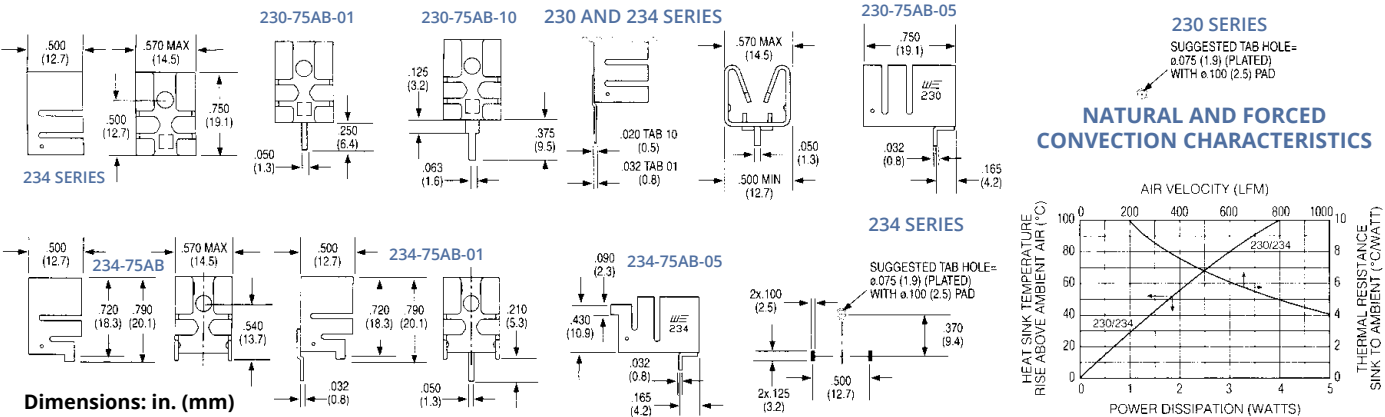
230 & 234 SERIES



| Standard P/N | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Option | Mounting Style | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|-------------------------------|------------------------|-----------------------|----------------|-------------------------------------|-------------------|
|              |                                |                               |                        |                       |                | Natural Convection                  | Forced Convection |
| 230-75AB     | .750 (19.1)                    | .570 (14.5) x .500 (12.7)     | Vert./Horiz.           | No Tab                | Clip/Mtg Hole  | 57°C @ 2W                           | 7.5°C/W @ 400 LFM |
| 230-75ABE-01 | .750 (19.1)                    | .570 (14.5) x .500 (12.7)     | Vertical               | 01                    | Clip/Mtg Hole  | 57°C @ 2W                           | 7.5°C/W @ 400 LFM |
| 230-75ABE-05 | .500 (12.7)                    | .750 (19.1) x .570 (14.5)     | Horizontal             | 05                    | Clip/Mtg Hole  | 57°C @ 2W                           | 7.5°C/W @ 400 LFM |
| 230-75ABE-10 | .875 (22.2)                    | .570 (14.5) x .500 (12.7)     | Vertical               | 10                    | Clip/Mtg Hole  | 57°C @ 2W                           | 7.5°C/W @ 400 LFM |
| 234-75AB     | .790 (20.0)                    | .570 (14.5) x .500 (12.7)     | Vert./Horiz            | No Tab                | Clip/Mtg Hole  | 57°C @ 2W                           | 7.5°C/W @ 400 LFM |
| 234-75ABE-01 | .790 (20.0)                    | .570 (14.5) x .500 (12.7)     | Vertical               | 01                    | Clip/Mtg Hole  | 57°C @ 2W                           | 7.5°C/W @ 400 LFM |
| 234-75ABE-05 | .500 (12.7)                    | .790 (20.0) x .570 (14.5)     | Horizontal             | 05                    | Clip/Mtg Hole  | 57°C @ 2W                           | 7.5°C/W @ 400 LFM |

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



262 SERIES

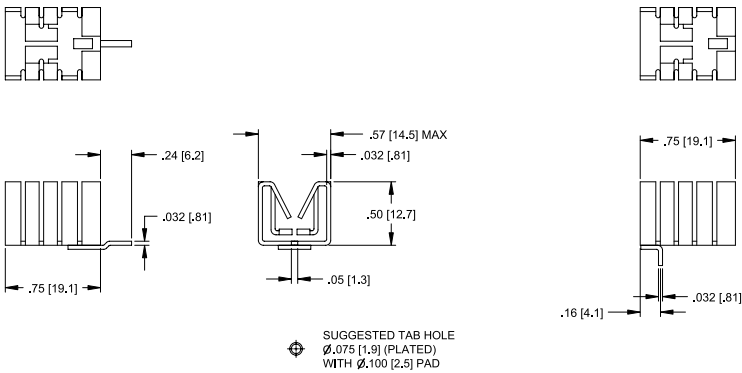
HORIZONTAL AND VERTICAL MOUNT HEAT SINK

TO-220

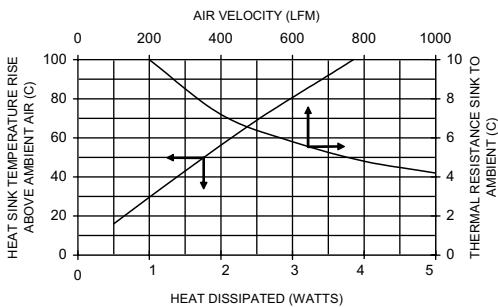
| Standard P/N | Height Above PC Board in. (mm) | Maximum Footprint in. (mm) | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|----------------------------|-------------------------------------|-------------------|
|              |                                |                            | Natural Convection                  | Forced Convection |
| 262-75ABE-05 | .53 (13.4)                     | .75 (19.1) x .50 (12.78)   | 80°C rise @ 2W                      | 10°C/W @ 200LFM   |
| 262-75ABE-01 | .75 (19.1)                     | .53 (13.4) x .50 (12.7)    | 80°C rise @ 2W                      | 10°C/W @ 200LFM   |

Material: Aluminum, Black Anodized

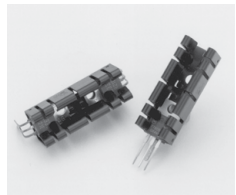
MECHANICAL DIMENSIONS



NATURAL AND FORCED CONVECTION CHARACTERISTICS



BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



233 & 236 SERIES

SELF-LOCKING WAVE-SOLDERABLE HEAT SINKS

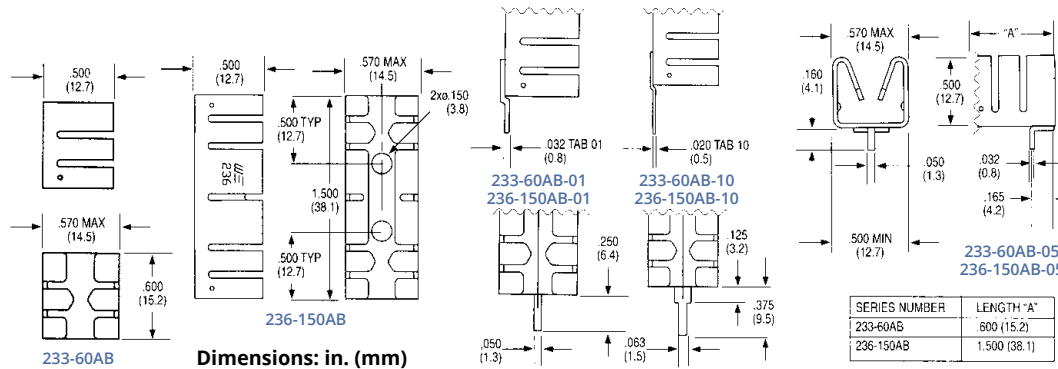
TO-220

PATENT  
PENDING

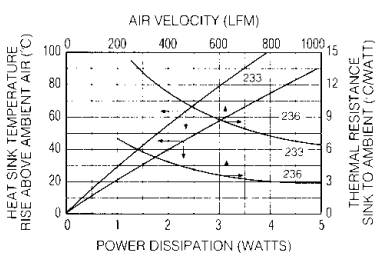
| Standard P/N  | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                    |
|---------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|--------------------|
|               |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection  |
| 233-60AB      | .600(15.2)                     | .570 (14.5) x .500 (12.7)     | Vert./Horiz.           | No Tab                 | Clip/Mtg Hole  | 58°C @ 2W                           | 11.0°C/W @ 400 LFM |
| 233-60ABE-01  | .600(15.2)                     | .570 (14.5) x .500 (12.7)     | Vertical               | 01                     | Clip/Mtg Hole  | 58°C @ 2W                           | 11.0°C/W @ 400 LFM |
| 233-60ABE-05  | .500(12.7)                     | .600 (15.2) x .570 (14.5)     | Horizontal             | 05                     | Clip/Mtg Hole  | 58°C @ 2W                           | 11.0°C/W @ 400 LFM |
| 233-60ABE-10  | .725(18.4)                     | .570 (14.5) x .500 (12.7)     | Vertical               | 10                     | Clip/Mtg Hole  | 58°C @ 2W                           | 11.0°C/W @ 400 LFM |
| 236-150AB     | 1.500(38.1)                    | .570 (14.5) x .500 (12.7)     | Vert./Horiz.           | No Tab                 | Clip/Mtg Hole  | 40°C @ 2W                           | 4.80°C/W @ 400 LFM |
| 236-150ABE-01 | 1.500(38.1)                    | .570 (14.5) x .500 (12.7)     | Vertical               | 01                     | Clip/Mtg Hole  | 40°C @ 2W                           | 4.80°C/W @ 400 LFM |
| 236-150ABE-05 | .500(12.7)                     | 1.500 (38.1) x .570 (14.5)    | Horizontal             | 05                     | Clip/Mtg Hole  | 40°C @ 2W                           | 4.80°C/W @ 400 LFM |
| 236-150ABE-10 | 1.625(41.3)                    | .570 (14.5) x .570 (12.7)     | Vertical               | 10                     | Clip/Mtg Hole  | 40°C @ 2W                           | 4.80°C/W @ 400 LFM |

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



NATURAL AND FORCED CONVECTION CHARACTERISTICS



| SERIES NUMBER | LENGTH "A"   |
|---------------|--------------|
| 233-60AB      | .600 (15.2)  |
| 236-150AB     | 1.500 (38.1) |

SUGGESTED TAB HOLE =  
Ø.075 (1.9) (PLATED)  
WITH Ø.100 (2.5) PAD

COMPACT, STRESS-FREE LABOR-SAVING  
LOCKING-TAB HEAT SINKS

275 & 231 SERIES



PATENT  
5381041

| Standard P/N    | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|-----------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|                 |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 275-75AB        | .750 (19.1)                    | .835 (21.2) x .400 (12.7)     | Vert./Horiz.           | No Tab                 | Clip/Mtg Hole  | 44°C @ 2W                           | 7.9°C/W @ 400 LFM |
| 275-75ABE-01    | .750 (19.1)                    | .835 (21.2) x .400 (12.7)     | Vertical               | 01                     | Clip/Mtg Hole  | 44°C @ 2W                           | 7.9°C/W @ 400 LFM |
| 275-75ABE-10    | .875 (12.7)                    | .835 (21.2) x .400 (14.5)     | Vertical               | 10                     | Clip/Mtg Hole  | 44°C @ 2W                           | 7.9°C/W @ 400 LFM |
| 231-69PAB       | .690 (18.4)                    | .835 (21.2) x .400 (12.7)     | Vert./Horiz.           | No Tab                 | Clip/Mtg Hole  | 45°C @ 2W                           | 8°C/W @ 400 LFM   |
| 231-69PABE      | .400 (10.1)                    | .690 (17.5) x .835 (12.7)     | Horizontal             | 13H                    | Clip/Mtg Hole  | 45°C @ 2W                           | 8°C/W @ 400 LFM   |
| 231-69PABE-XXX  | .690 (17.5)                    | .835 (21.2) x .400 (12.7)     | Vertical               | 13V, 14V, 15V          | Clip/Mtg Hole  | 45°C @ 2W                           | 8°C/W @ 400 LFM   |
| 231-75PAB       | .750 (19.1)                    | .835 (21.2) x .400 (14.5)     | Vert./Horiz.           | No Tab                 | Clip/Mtg Hole  | 43°C @ 2W                           | 7.9°C/W @ 400 LFM |
| 231-75PABE      | .400 (10.1)                    | .750 (19.1) x .835 (12.7)     | Horizontal             | 13H                    | Clip/Mtg Hole  | 43°C @ 2W                           | 7.9°C/W @ 400 LFM |
| 231-75PABE-XXX  | .750 (19.1)                    | .835 (21.2) x .400 (12.7)     | Vertical               | 13V, 14V, 15V          | Clip/Mtg Hole  | 43°C @ 2W                           | 7.9°C/W @ 400 LFM |
| 231-137PAB      | 1.375 (35)                     | .835 (21.2) x .400 (12.7)     | Vert./Horiz.           | No Tab                 | Clip/Mtg Hole  | 32°C @ 2W                           | 5.9°C/W @ 400 LFM |
| 231-137PABE     | .400 (10.2)                    | 1.375 (34.9) x .835 (12.7)    | Horizontal             | 13H                    | Clip/Mtg Hole  | 32°C @ 2W                           | 5.9°C/W @ 400 LFM |
| 231-137PABE-XXX | 1.375 (35)                     | .835 (21.2) x .400 (12.7)     | Vertical               | 13V, 14V, 15V          | Clip/Mtg Hole  | 32°C @ 2W                           | 5.9°C/W @ 400 LFM |

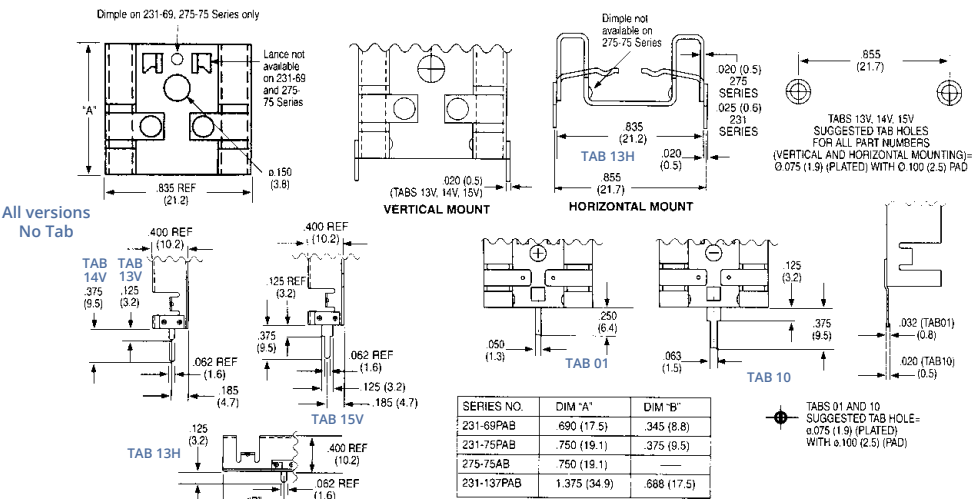
Material: Aluminum, Pre-anodized Black (PAB), Anodized Black (AB)

COMPACT, STRESS-FREE LABOR-SAVING  
LOCKING-TAB HEAT SINKS

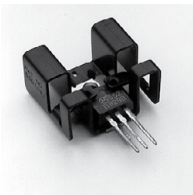
275 & 231 SERIES

TO-220

MECHANICAL DIMENSIONS



Dimensions: in. (mm)



235 SERIES

COMPACT, STRESS-FREE LABOR-SAVING  
LOCKING-TAB HEAT SINKS

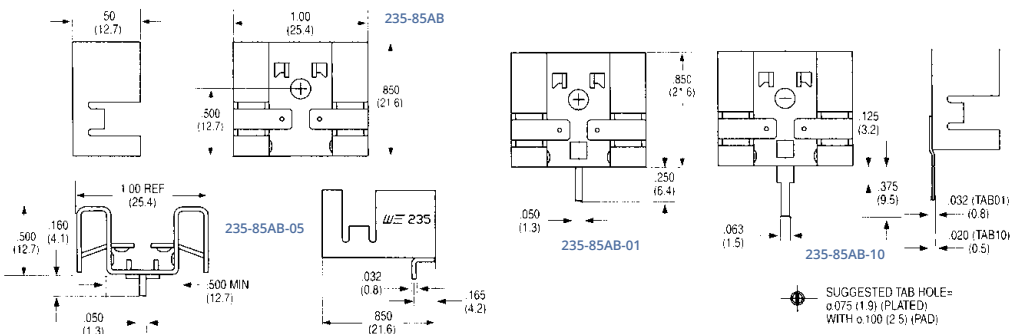
TO-220

PATENT  
5381041

| Standard P/N | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|              |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 235-85AB     | .850 (21.6)                    | 1.000 (25.4) x .500 (12.7)    | Vert./Horiz.           | No Tab                 | Clip/Mtg Hole  | 40°C @ 2W                           | 6.8°C/W @ 400 LFM |
| 235-85ABE-01 | .850 (21.6)                    | 1.000 (25.4) x .500 (12.7)    | Vertical               | 01                     | Clip/Mtg Hole  | 40°C @ 2W                           | 6.8°C/W @ 400 LFM |
| 235-85ABE-05 | .500 (12.7)                    | .850 (21.6) x 1.000 (25.4)    | Horizontal             | 05                     | Clip/Mtg Hole  | 40°C @ 2W                           | 6.8°C/W @ 400 LFM |
| 235-85ABE-10 | .975 (24.8)                    | 1.000 (25.4) x .500 (12.7)    | Vertical               | 10                     | Clip/Mtg Hole  | 40°C @ 2W                           | 6.8°C/W @ 400 LFM |

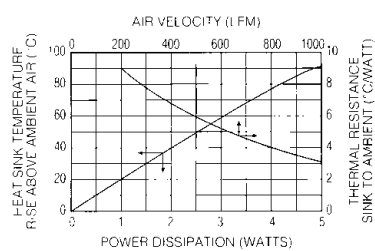
Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



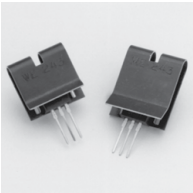
Dimensions: in. (mm)

NATURAL AND FORCED CONVECTION CHARACTERISTICS





BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



243 SERIES

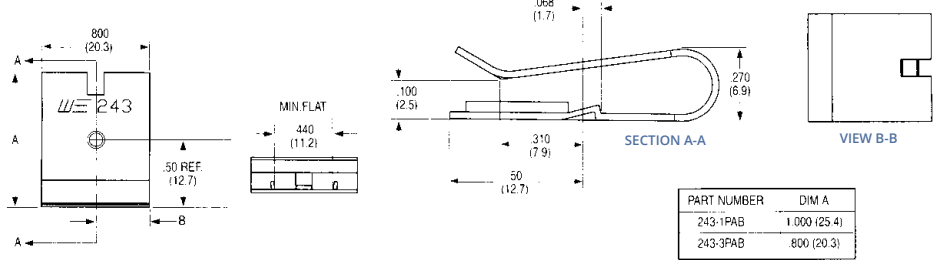
LABOR-SAVING CLIP-ON HEAT SINKS

TO-220

| Standard P/N | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|              |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 243-1PAB     | 1.000 (25.4)                   | .800 (20.3) x .270 (6.9)      | Vert./Horiz.           | No Tab                 | Clip           | 50°C@ 2W                            | 4.5°C/W @ 400 LFM |
| 243-3PAB     | .800 (20.3)                    | .800 (20.3) x .270 (6.9)      | Verl./Horiz.           | No Tab                 | Clip           | 78°C@ 2W                            | 8.2°C/W @ 400 LFM |

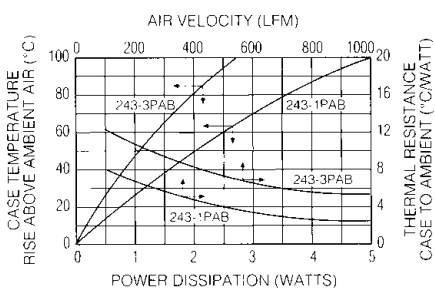
**Material:** Aluminum, Pre-anodized Black

MECHANICAL DIMENSIONS

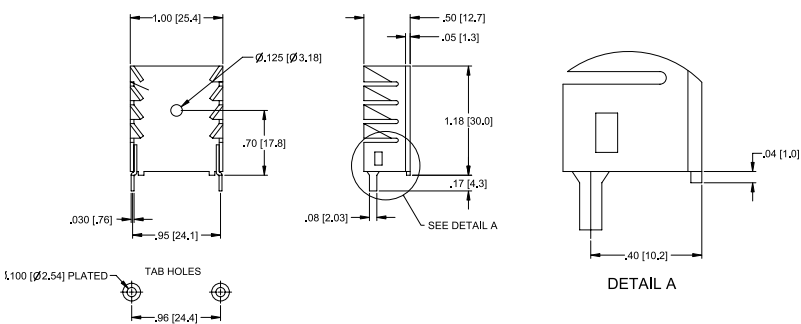


Dimensions: in. (mm)

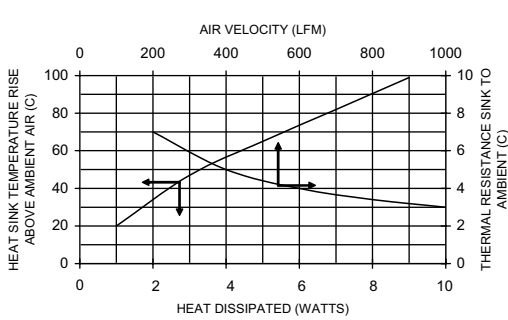
NATURAL AND FORCED CONVECTION CHARACTERISTICS



MECHANICAL DIMENSIONS



NATURAL AND FORCED CONVECTION CHARACTERISTICS



TO-220

SNAP-DOWN SELF-LOCKING HEAT SINKS

239 SERIES

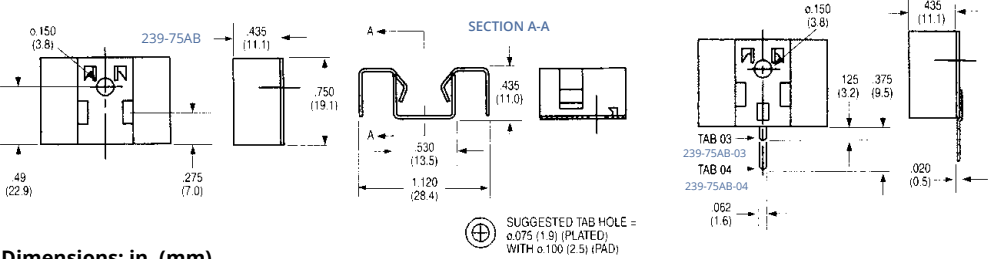


PATENT PENDING

| Standard P/N | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|              |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 239-75AB     | .750 (19.1)                    | 1.120 (28.4) x .435 (11.0)    | Vert./Horiz.           | No Tab                 | Clip/Mtg Hole  | 38°C @ 2W                           | 6°C/W @ 400 LFM   |
| 239-75ABE-03 | .750 (19.1)                    | 1.120 (28.4) x .435 (11.0)    | Vertical               | 03                     | Clip/Mtg Hole  | 38°C @ 2W                           | 6°C/W @ 400 LFM   |
| 239-75ABE-04 | .750 (19.1)                    | 1.120 (28.4) x .435 (11.0)    | Vertical               | 04                     | Clip/Mtg Hole  | 38°C @ 2W                           | 6°C/W @ 400 LFM   |

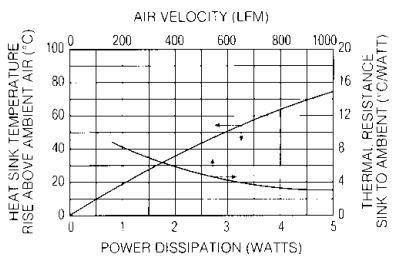
**Material:** Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

NATURAL AND FORCED CONVECTION CHARACTERISTICS



286DB SERIES

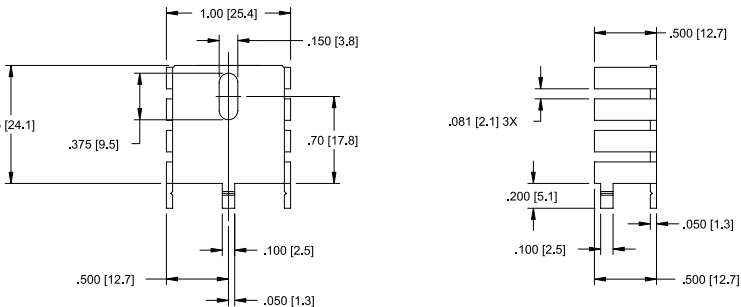
VERTICAL MOUNT HEAT SINK

TO-220

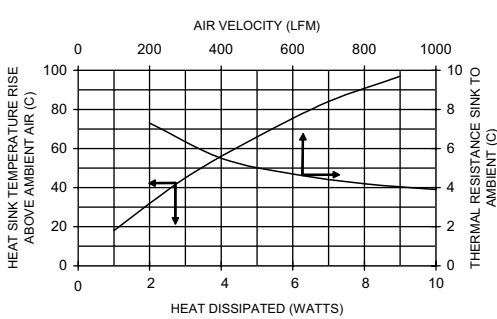
| Standard P/N | Height Above PC Board in. (mm) | Maximum Footprint in. (mm) | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|----------------------------|-------------------------------------|-------------------|
|              |                                |                            | Natural Convection                  | Forced Convection |
| 286DBE       | .95 (24.1)                     | 1.00 (25.4) x .50 (12.7)   | 65°C rise @ 4W                      | 9.0°C/W @ 200LFM  |

**Material:** Aluminum, Black Anodized

MECHANICAL DIMENSIONS

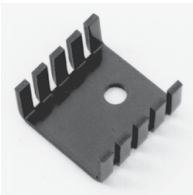


NATURAL AND FORCED CONVECTION CHARACTERISTICS





BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



273 SERIES

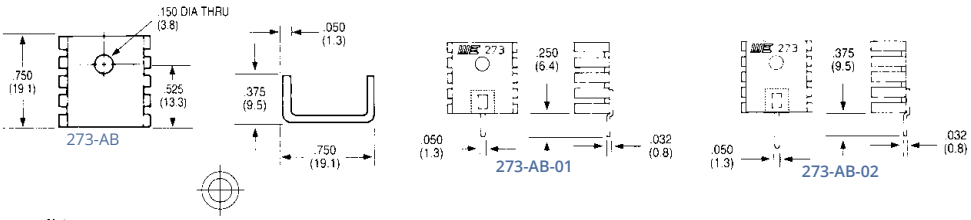
LOW-COST, LOW-HEIGHT WAVE-SOLDERABLE  
HEAT SINKS

TO-220 and TO-218

| Standard P/N | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|              |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 273-AB       | .375 (9.5)                     | .750 (19.1) x .750 (19.1)     | Vert./Horiz.           | No Tab                 | Mtg Hole       | 49°C @ 2W                           | 7.2°C/W @ 400 LFM |
| 273-ABE-01   | .375 (9.5)                     | .750 (19.1) x .750 (19.1)     | Vertical               | 01                     | Mtg Hole       | 49°C @ 2W                           | 7.2°C/W @ 400 LFM |
| 273-ABE-02   | .375 (9.5)                     | .750 (19.1) x .750 (19.1)     | Vertical               | 02                     | Mtg Hole       | 49°C @ 2W                           | 7.2°C/W @ 400 LFM |

Material: Aluminum, Black Anodized

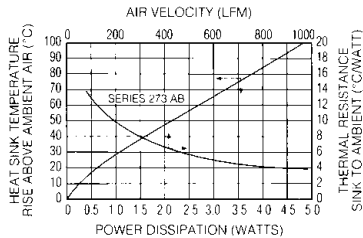
MECHANICAL DIMENSIONS



Note:  
1. Suggested Tab Hole =  $\phi$ .075 (1.9) (Plated) with  $\phi$ .100 (2.5) pad

Dimensions: in. (mm)

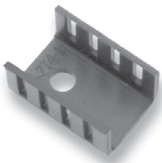
NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



LOW-COST, LOW-HEIGHT WAVE-SOLDERABLE  
HEAT SINKS

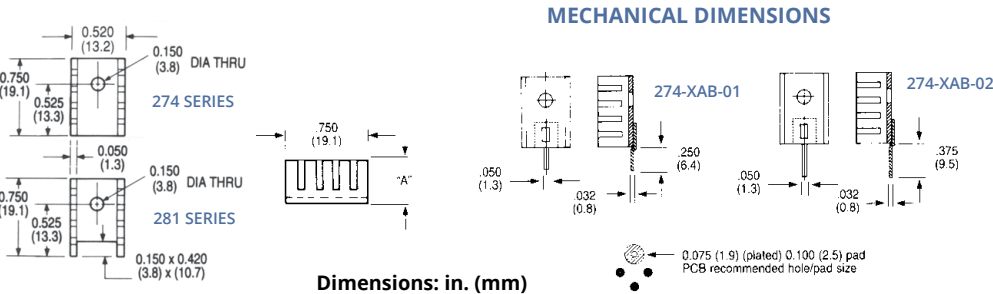
274 & 281 SERIES

TO-220



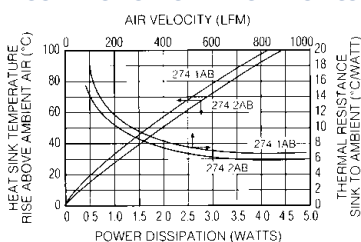
| Standard P/N | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|              |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 274-1AB      | .375 (9.5)                     | .520 (13.2) x .750 (19.1)     | Vert./Horiz.           | No Tab                 | Mtg Hole       | 56°C @ 2W                           | 8.0°C/W @ 400 LFM |
| 274-1ABE-01  | .375 (9.5)                     | .520 (13.2) x .750 (19.1)     | Vertical               | 01                     | Mtg Hole       | 56°C @ 2W                           | 8.0°C/W @ 400 LFM |
| 274-1ABE-02  | .375 (9.5)                     | .520 (13.2) x .750 (19.1)     | Vertical               | 02                     | Mtg Hole       | 56°C @ 2W                           | 8.0°C/W @ 400 LFM |
| 274-2AB      | .500 (12.7)                    | .520 (13.2) x .750 (19.1)     | Vert./Horiz.           | No Tab                 | Mtg Hole       | 50°C @ 2W                           | 7.0°C/W @ 400 LFM |
| 274-2ABE-01  | .500 (12.7)                    | .520 (13.2) x .750 (19.1)     | Vertical               | 01                     | Mtg Hole       | 50°C @ 2W                           | 7.0°C/W @ 400 LFM |
| 274-2ABE-02  | .500 (12.7)                    | .520 (13.2) x .750 (19.1)     | Vertical               | 02                     | Mtg Hole       | 50°C @ 2W                           | 7.0°C/W @ 400 LFM |
| 274-3AB      | .250 (6.4)                     | .520 (13.2) x .750 (19.1)     | Vert./Horiz.           | No Tab                 | Mtg Hole       | 62°C @ 2W                           | 9.0°C/W @ 400 LFM |
| 274-3ABE-01  | .250 (6.4)                     | .520 (13.2) x .750 (19.1)     | Vertical               | 01                     | Mtg Hole       | 62°C @ 2W                           | 9.0°C/W @ 400 LFM |
| 274-3ABE-02  | .250 (6.4)                     | .520 (13.2) x .750 (19.1)     | Vertical               | 02                     | Mtg Hole       | 62°C @ 2W                           | 9.0°C/W @ 400 LFM |
| 281-1AB      | .375 (9.5)                     | .520 (13.2) x .750 (19.1)     | Vertical               | No Tab                 | Mtg Hole       | 56°C @ 2W                           | 8.0°C/W @ 400 LFM |
| 281-2AB      | .500 (12.7)                    | .520 (13.2) x .750 (19.1)     | Vertical               | No Tab                 | Mtg Hole       | 50°C @ 2W                           | 7.0°C/W @ 400 LFM |

Material: Aluminum, Black Anodized



Dimensions: in. (mm)

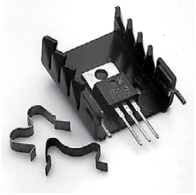
NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



TO-220

LABOR-SAVING TWISTED FIN HEAT SINKS

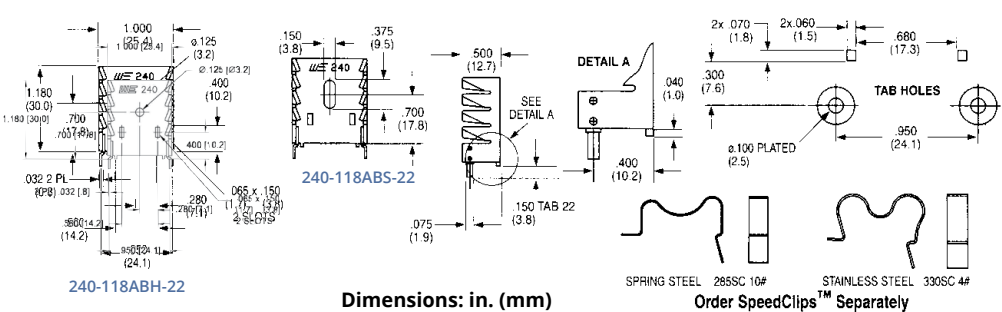
240 SERIES



| Standard P/N   | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|----------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|                |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 240-118ABEH-22 | 1.180 (30.0)                   | 1.000 (25.4) x .500 (12.7)    | Vertical               | 22                     | Clip/Mtg Hole  | 55°C @ 4W                           | 5.3°C/W @ 400 LFM |
| 240-118ABES-22 | 1.180 (30.0)                   | 1.000 (25.4) x .500 (12.7)    | Vertical               | 22                     | Clip/Mtg Slot  | 55°C @ 4W                           | 5.3°C/W @ 400 LFM |

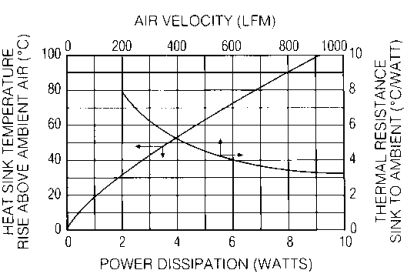
Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

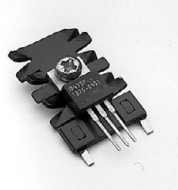
NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



242 SERIES

LOW-COST, LOW-HEIGHT WAVE-SOLDERABLE HEAT SINKS

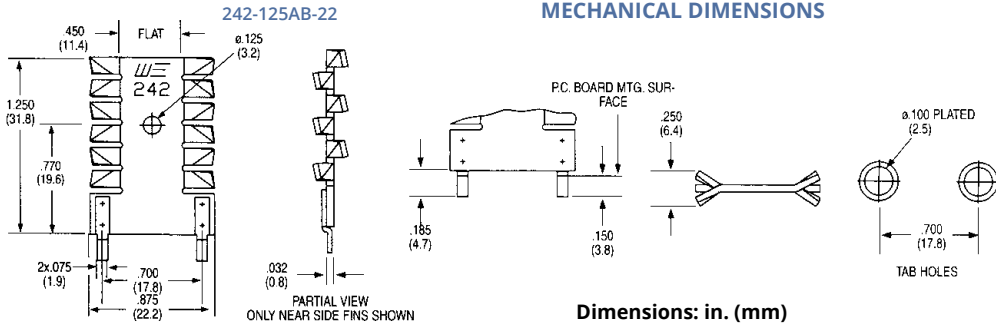
TO-220



| Standard P/N  | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|---------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|               |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 242-125ABE-22 | 1.285 (32.6)                   | .875 (22.2) x .250 (6.4)      | Vertical               | 22                     | Mtg Hole       | 48°C @ 2W                           | 6.2°C/W @ 400 LFM |

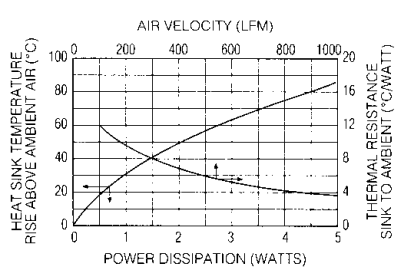
Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



232 & 238 SERIES

STAGGERED FIN HEAT SINKS FOR  
VERTICAL MOUNTING

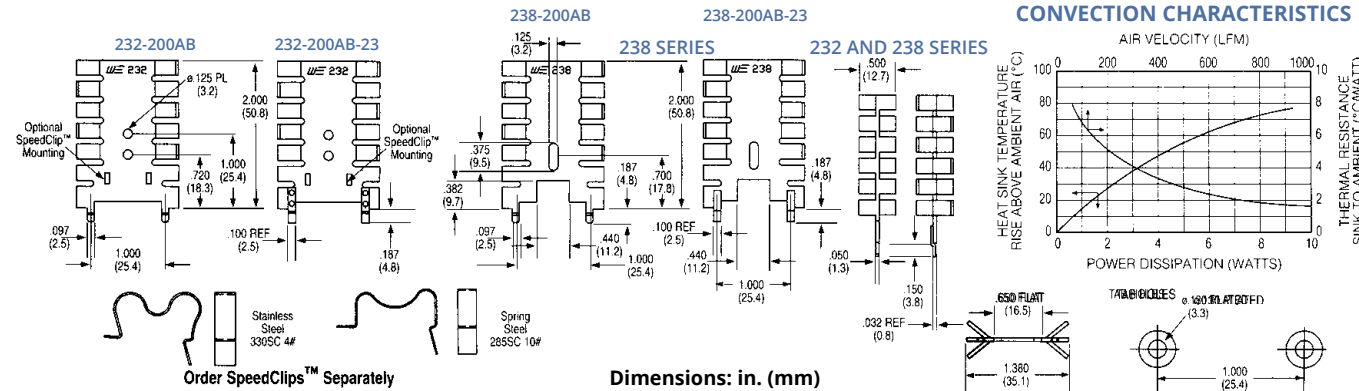
TO-220 and TO-202

| Standard P/N  | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|---------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|               |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 232-200AB     | 2.000 (50.8)                   | 1.380 (35.1) x .500 (12.7)    | Vertical               | 2, Twisted             | Clip/Mtg Hole  | 48°C @ 4W                           | 3.3°C/W @ 400 LFM |
| 232-200ABE-23 | 2.000 (50.8)                   | 1.380 (35.1) x .500 (12.7)    | Vertical               | 2, Solderable          | Clip/Mtg Hole  | 48°C @ 4W                           | 3.3°C/W @ 400 LFM |
| 238-200AB     | 2.000 (50.8)                   | 1.380 (35.1) x .500 (12.7)    | Vertical               | 2, Twisted             | Mtg Slot       | 48°C @ 4W                           | 3.3°C/W @ 400 LFM |
| 238-200ABE-23 | 2.000 (50.8)                   | 1.380 (35.1) x .500 (12.7)    | Vertical               | 2, Solderable          | Mtg Slot       | 48°C @ 4W                           | 3.3°C/W @ 400 LFM |

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



15 Lead Multiwatt

SLIM-PROFILE HEAT SINKS WITH INTEGRAL CLIPS

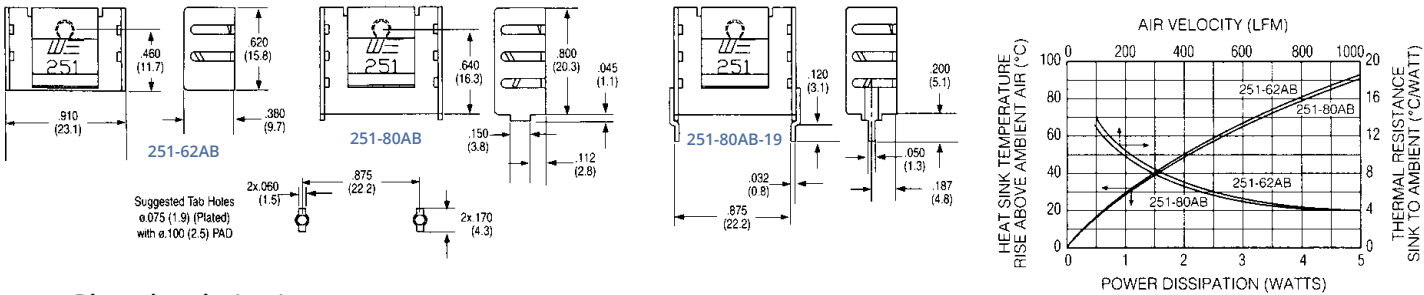
251 SERIES

| Standard P/N | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|--------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|              |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 251-62AB     | .620 (15.7)                    | .910 (23.1) x .380 (9.7)      | Vert./Horiz.           | No Tab                 | Clip           | 66°C @ 3W                           | 66°C/W @ 400 LFM  |
| 251-80AB     | .845 (21.5)                    | .910 (23.1) x .380 (9.7)      | Vert./Horiz.           | No Tab                 | Clip           | 64°C @ 3W                           | 66°C/W @ 400 LFM  |
| 251-80ABE-19 | .875 (22.2)                    | .910 (23.1) x .380 (9.7)      | Vertical               | 19                     | Clip           | 64°C @ 3W                           | 66°C/W @ 400 LFM  |

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



Dimensions: in. (mm)

BOARD LEVEL HEAT SINKS FOR TO-220, TO-218 &  
MULTIWATT™ COMPONENTS

Multiwatt

LOW HEIGHT, SLIM PROFILE WAVE-SOLDERABLE  
FOLDED FIN HEAT SINKS

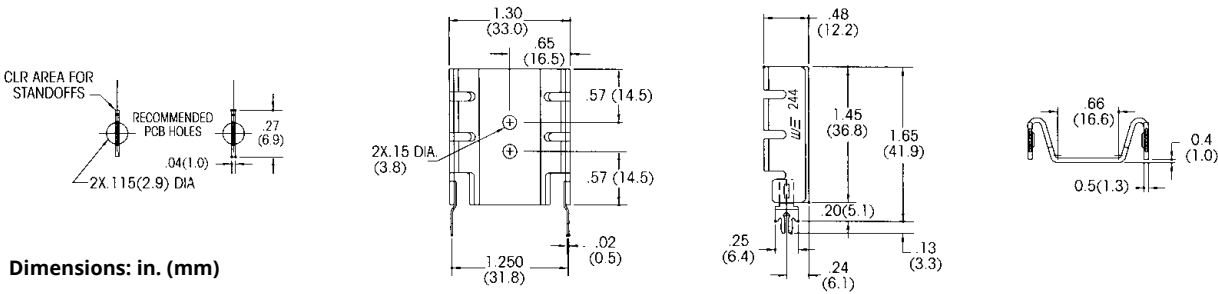
244 SERIES



| Standard P/N  | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|---------------|--------------------------------|-------------------------------|------------------------|------------------------|-------------------------------------|-------------------|---------------------|
|               |                                |                               |                        |                        | Natural Convection                  | Force Convection  |                     |
| 244-145AB     | 1.450 (36.8)                   | 1.300 (33.0) x .480 (12.1)    | Vert/Horiz, Vertical   | No Tab 50              | 44°C @ 4W                           | 4.4°C/W @ 400 LFM | .0160 (7.25)        |
| 244-145ABE-50 | 1.650 (41.9)                   | 1.300 (33.0) x .480 (12.1)    | Vertical               | 50                     | 44°C @ 4W                           | 4.4°C/W @ 400 LFM | .0170 (7.20)        |

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)



245 SERIES

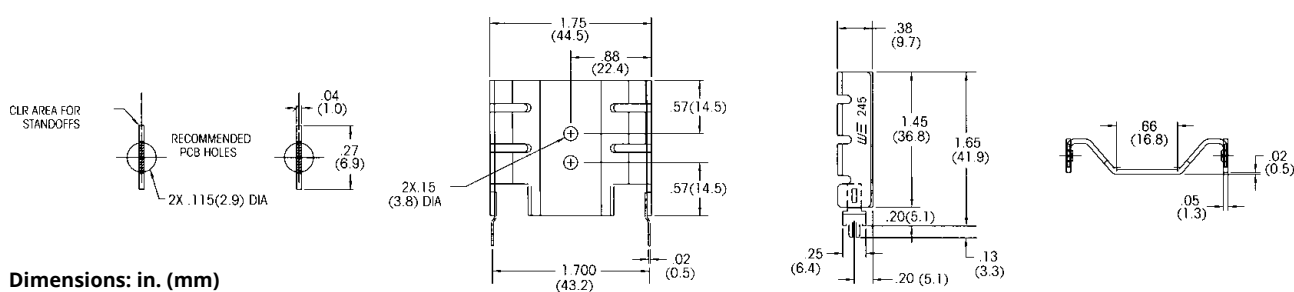
LOW HEIGHT, SLIM PROFILE WAVE-SOLDERABLE  
FOLDED FIN HEAT SINKS

Multiwatt

| Standard P/N  | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|---------------|--------------------------------|-------------------------------|------------------------|------------------------|-------------------------------------|-------------------|---------------------|
|               |                                |                               |                        |                        | Natural Convection                  | Forced Convection |                     |
| 245-145AB     | 1.450 (36.8)                   | 1.750 (44.5) x .380 (9.7)     | Ver.t/Horiz. Vertical  | No Tab 50              | 38°C @ 4W                           | 3.2°C/W @ 400 LFM | .0160 (7.25)        |
| 245-145ABE-50 | 1.650 (41.9)                   | 1.750 (44.5) x .380 (9.7)     | Vertical               | 50                     | 38°C @ 4W                           | 3.2°C/W @ 400 LFM | .0170 (7.20)        |

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

BOARD LEVEL HEAT SINKS FOR TO-220, TO-218 & MULTIWATT™ COMPONENTS



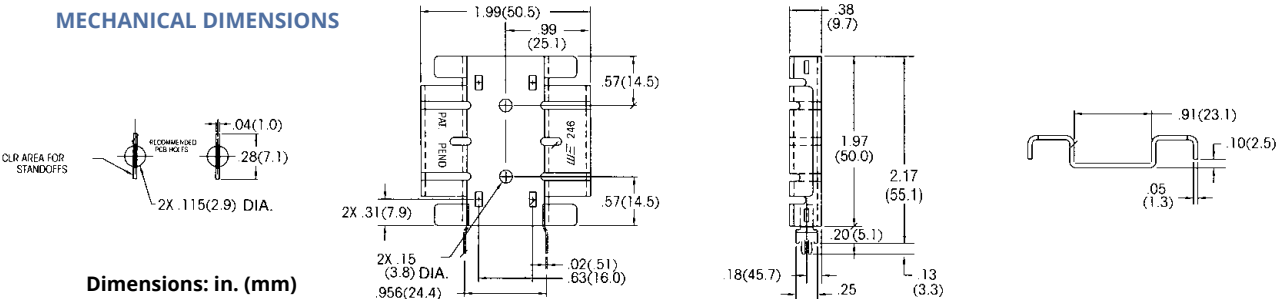
246 SERIES

MEDIUM HEIGHT, SLIM PROFILE WAVE-SOLDERABLE FOLDED FIN HEAT SINKS

Multiwatt

| Standard P/N                                                          | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|-----------------------------------------------------------------------|--------------------------------|-------------------------------|------------------------|------------------------|-------------------------------------|-------------------|---------------------|
|                                                                       |                                |                               |                        |                        | Natural Convection                  | Forced Convection |                     |
| 246-197AB                                                             | 1.968 (50.0)                   | 1.986 (50.4) x 3.75 (9.5)     | Vert./Horiz.           | No Tab                 | 35°C @ 4W                           | 2.8°C/W @ 400 LFM | .0240 (10.90)       |
| 246-197ABE-50                                                         | 2.168 (55.1)                   | 1.986 (50.4) x 3.75 (9.5)     | Vertical               | 50                     | 35°C @ 4W                           | 2.8°C/W @ 400 LFM | .0250 (11.40)       |
| Order SpeedClip™ 285SC or 330SC separately. (See 248 Series section). |                                |                               |                        |                        |                                     |                   |                     |
| Material: Aluminum, Black Anodized                                    |                                |                               |                        |                        |                                     |                   |                     |

MECHANICAL DIMENSIONS



LOW HEIGHT, MEDIUM PROFILE WAVE-SOLDERABLE FOLDED FIN HEAT SINKS

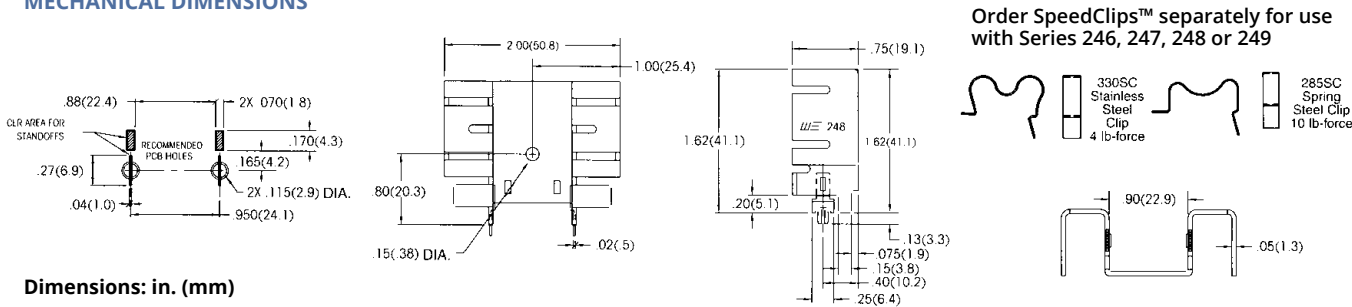
Multiwatt

248 SERIES



| Standard P/N                                | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|---------------------------------------------|--------------------------------|-------------------------------|------------------------|------------------------|-------------------------------------|-------------------|---------------------|
|                                             |                                |                               |                        |                        | Natural Convection                  | Forced Convection |                     |
| 248-162AB                                   | 1.620 (41.1)                   | 2.000 (50.8) x .750 (19.1)    | Vert./Horiz.           | No Tab                 | 35°C @ 4W                           | 2.5°C/W @ 400 LFM | .026 (11.60)        |
| 248-162ABE-50                               | 1.620 (41.1)                   | 2.000 (50.8) x .750 (19.1)    | Vertical               | 50                     | 35°C @ 4W                           | 2.5°C/W @ 400 LFM | .027 (12.20)        |
| Order SpeedClip™ 285SC or 330SC separately. |                                |                               |                        |                        |                                     |                   |                     |
| Material: Aluminum, Black Anodized          |                                |                               |                        |                        |                                     |                   |                     |

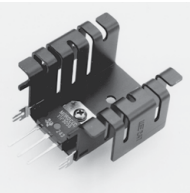
MECHANICAL DIMENSIONS



MEDIUM HEIGHT, DEEP PROFILE WAVE-SOLDERABLE FOLDED FIN HEAT SINKS

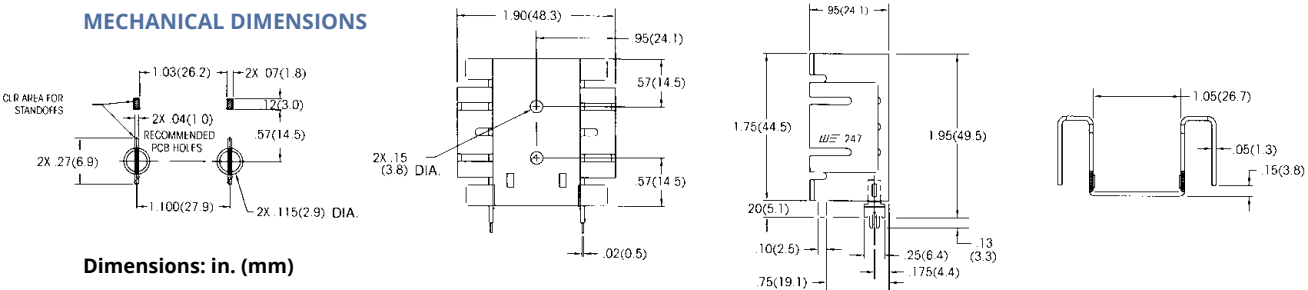
Multiwatt

247 SERIES



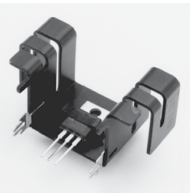
| Standard P/N                                                          | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|-----------------------------------------------------------------------|--------------------------------|-------------------------------|------------------------|------------------------|-------------------------------------|-------------------|---------------------|
|                                                                       |                                |                               |                        |                        | Natural Convection                  | Forced Convection |                     |
| 247-195AB                                                             | 1.950 (49.5)                   | 1.900 (48.3) x .950 (24.1)    | Vert./Horiz.           | No Tab                 | 25°C@ 4W                            | 2.4°C/W @ 400 LFM | .0330 (15.10)       |
| 247-195ABE-50                                                         | 1.950 (49.5)                   | 1.900 (48.3) x .950 (24.1)    | Vertical               | 50                     | 25°C@ 4W                            | 2.4°C/W @ 400 LFM | .0340 (15.60)       |
| Order SpeedClip™ 285SC or 330SC separately. (See 248 Series section). |                                |                               |                        |                        |                                     |                   |                     |
| Material: Aluminum, Black Anodized                                    |                                |                               |                        |                        |                                     |                   |                     |

MECHANICAL DIMENSIONS



MEDIUM HEIGHT, DEEP PROFILE WAVE-SOLDERABLE FOLDED FIN HEAT SINKS

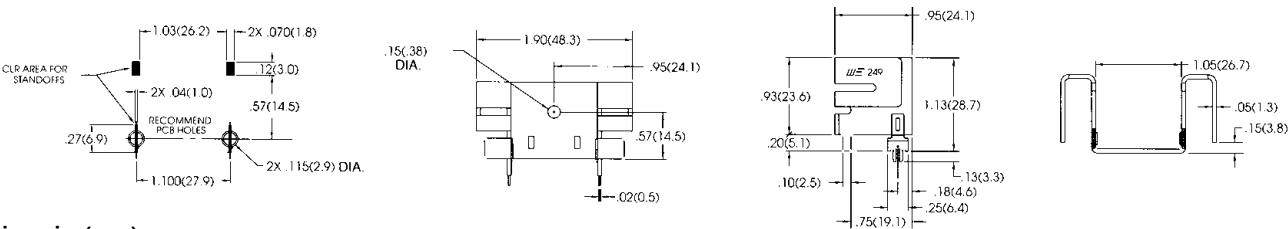
249 SERIES



Multiwatt

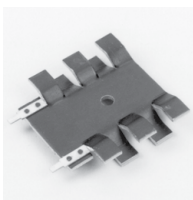
| Standard P/N                                                          | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Thermal Performance at Typical Load |                    | Weight lbs. (grams) |
|-----------------------------------------------------------------------|--------------------------------|-------------------------------|------------------------|------------------------|-------------------------------------|--------------------|---------------------|
|                                                                       |                                |                               |                        |                        | Natural Convection                  | Forced Convection  |                     |
| 249-113AB                                                             | 1.130 (28.7)                   | 1.900 (48.3) x .950 (24.1)    | Vert./Horiz.           | No Tab                 | 35°C@ 4W                            | 3.29°C/W @ 400 LFM | .020 (8.90)         |
| 249-113ABE-50                                                         | 1.130 (28.7)                   | 1.900 (48.3) x .950 (24.1)    | Vertical               | 50                     | 35°C@ 4W                            | 3.29°C/W @ 400 LFM | .021 (9.40)         |
| Order SpeedClip™ 285SC or 330SC separately. (See 248 Series section). |                                |                               |                        |                        |                                     |                    |                     |
| Material: Aluminum, Black Anodized                                    |                                |                               |                        |                        |                                     |                    |                     |

MECHANICAL DIMENSIONS





BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



288 SERIES

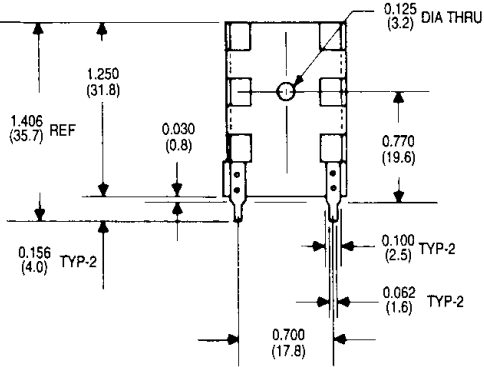
COMPACT WAVE-SOLDERABLE LOW-COST  
HEAT SINKS

TO-220 and TO-202

Mounting tabs are pre-tinned to ensure excellent wave-solder bond and good electrical connections for vertical mounting of TO-220 and TO-202 semiconductor packages. These heat sinks are designed for use where minimum PC board space is available. The 288-1AB is a stamped aluminum heat sink, black anodized, designed for applications requiring good heat dissipation from a heat sink occupying minimum space, available at minimum cost.

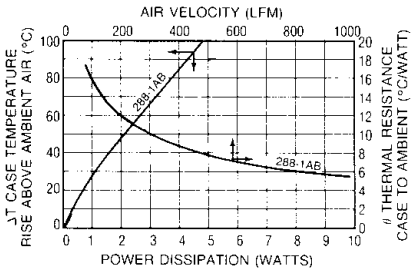
| Standard P/N | Height Above PC Board in. (mm) | Maximum Footprint in. (mm) | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|--------------------------------|----------------------------|-------------------------------------|-------------------|---------------------|
|              |                                |                            | Natural Convection                  | Forced Convection |                     |
| 288-1ABE     | 1.250 (31.8)                   | 0.875 (22.2) x 0.215 (5.5) | 85°C @ 4W                           | 12°C/W @ 200 LFM  | 0.0057 (2.59)       |

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



TOP-MOUNT BOOSTER HEAT SINKS FOR USE WITH  
270/272/280 SERIES

271 SERIES

TO-220

This top-hat style booster heat sink can be added to any of the 270, 272, or 280 Series for improved performance. NOTE A: Thermal resistance with one 271-AB. NOTE B: Thermal resistance (total) as shown with (2) 271-AB types added to (1) 272-AB type.



| Standard P/N | Height Above Semiconductor Case in. (mm) | Horizontal Mounting Footprint Dimensions in. (mm) | Thermal Performance at Typical Load       |                                               | Weight lbs. (grams) |
|--------------|------------------------------------------|---------------------------------------------------|-------------------------------------------|-----------------------------------------------|---------------------|
|              |                                          |                                                   | Natural Convection                        | Forced Convection                             |                     |
| 271-AB       | 0.500 (12.7)                             | 1.750 (44.5) x 0.700 (17.8)                       | 62°C @ 4W (NOTE A)<br>31 °C @ 4W (NOTE B) | 5.1°C/W @ 400 LFM<br>1.8°C/W 400 LFM (NOTE B) | 0.0052 (2.36)       |

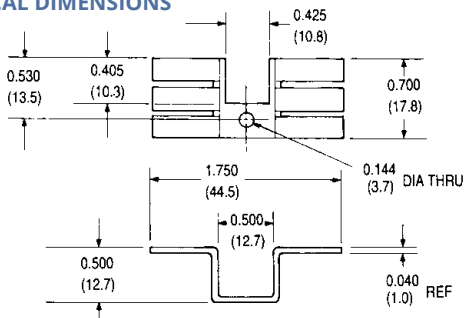
Material: Aluminum, Black Anodized

TO-220

TOP-MOUNT BOOSTER HEAT SINKS FOR USE WITH  
270/272/280 SERIES

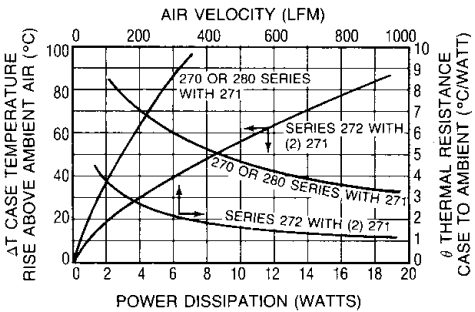
271 SERIES

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



270, 272, &  
280 SERIES

SMALL FOOTPRINT LOW-COST HEAT SINKS

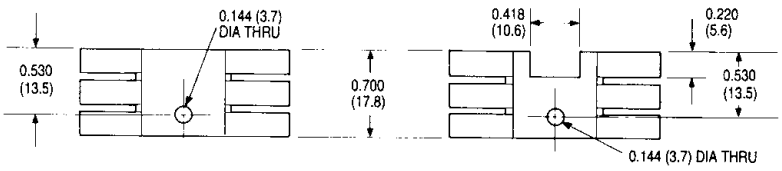
TO-220 and TO-202

These exceptionally low-cost heat sinks can be mounted horizontally under a TO-220 or TO-202 case style with a maximum height of only 0.375 in. (9.4). For added performance, a 271 Series heat sink can also be used for double-sided heat dissipation. The 270-AB and 280-AB accept one power semiconductor; the 272-AB is designed for two power semiconductors. Specify solderable tab options for the **272 Series** by the addition of suffix "01" or "02" to the standard part number (i.e. 272-AB01 or 272-AB02).

| Standard P/N | Height Above PC Board in. (mm) | Horizontal Mounting Maximum Footing in. (mm) | Solderable Tab Options | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|--------------------------------|----------------------------------------------|------------------------|-------------------------------------|-------------------|---------------------|
|              |                                |                                              |                        | Natural Convection                  | Forced Convection |                     |
| 270-AB       | 0.375 (9.4)                    | 1.750 (44.5) x 0.700 (17.8)                  | —                      | 70°C @ 4W                           | 6.0°C/W @ 400 LFM | 0.0052 (2.36)       |
| 272-AB       | 0.375 (9.4)                    | 1.750 (44.5) x 1.450 (36.8)                  | 01,02                  | 42°C @ 4W                           | 3.6°C/W @ 400 LFM | 0.0105 (5.72)       |
| 280-AB       | 0.375 (9.4)                    | 1.750 (44.5) x 0.700 (17.8)                  | —                      | 70°C @ 4W                           | 6.0°C/W @ 400 LFM | 0.0048 (2.18)       |

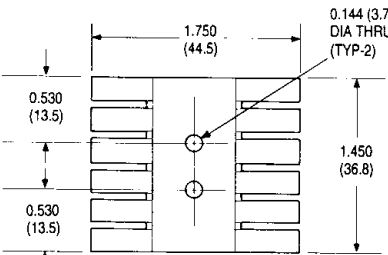
Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS

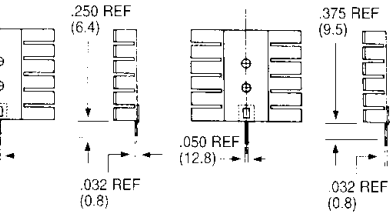
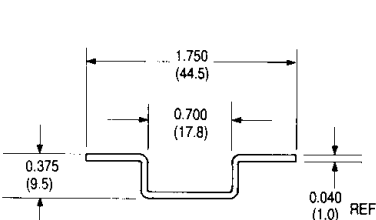


270 SERIES

280 SERIES



272 SERIES



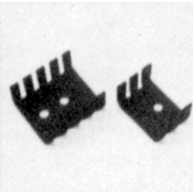
272AB01

272AB02

Dimensions: in. (mm)

Note:  
1. Suggested Tab Hole = 0.075 ±0.03 plated with 0.100 pad

BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



289 & 290 SERIES

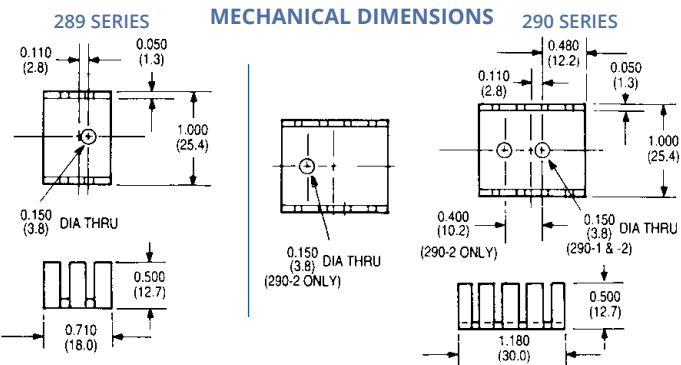
LOW-COST SINGLE OR DUAL PACKAGE  
HEAT SINKS

TO-218; TO-202; TO-220

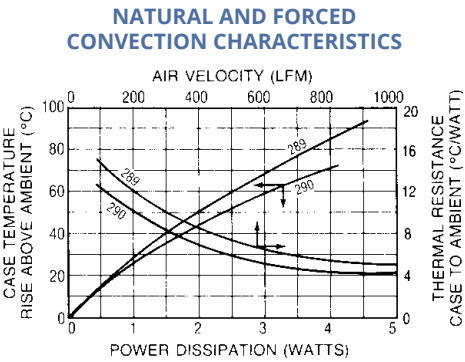
Low in cost and compact in overall dimensions, one **289 Series** heat sink can accommodate one semiconductor; the **289 Series** is available with a black anodized finish (289-AB) or with no finish (289-AP). Two semiconductors can be mounted to the 290-2AB style.

| Standard P/N | Height Above PC Board in. (mm) | Horizontal Mounting Maximum Footing in. (mm) | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|--------------------------------|----------------------------------------------|-------------------------------------|-------------------|---------------------|
|              |                                |                                              | Natural Convection                  | Forced Convection |                     |
| 289-AB       | 0.500 (12.7)                   | 1.000 (25.4) x 0.710 (18.1)                  | 50°C @ 2W                           | 9.0 C/W @ 400 LFM | 0.0055 (2.49)       |
| 289-AP       | 0.500 (12.7)                   | 1.000 (25.4) x 0.710 (18.1)                  | 50°C @ 2W                           | 9.0 C/W @ 400 LFM | 0.0055 (2.49)       |
| 290-1AB      | 0.500 (12.7)                   | 1.000 (25.4) x 1.180 (30.0)                  | 44°C @ 2W                           | 7.0 C/W @ 400 LFM | 0.0082 (3.72)       |
| 290-2AB      | 0.500 (12.7)                   | 1.000 (25.4) x 1.180 (30.0)                  | 44°C @ 2W                           | 7.0 C/W @ 400 LFM | 0.0081 (3.67)       |

Material: Aluminum, Black Anodized



Dimensions: in. (mm)



HIGH-PERFORMANCE SLIM PROFILE HEAT SINKS  
WITH INTEGRAL CLIPS

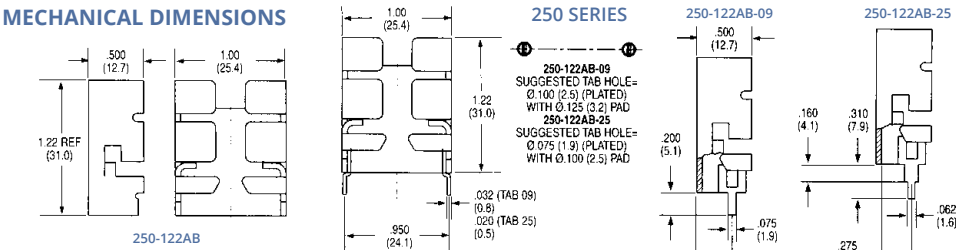
Multiwatt

250 SERIES

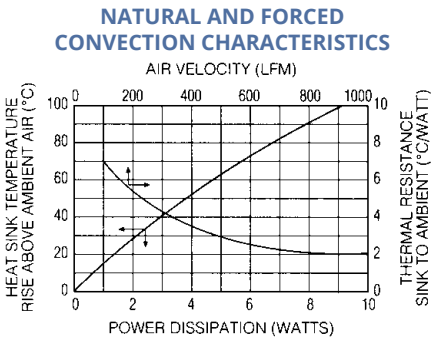


| Standard P/N  | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|---------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|               |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 250-122AB     | 1.220 (31.0)                   | 1.000 (25.4) x .500 (12.7)    | Vert./Horiz.           | No Tab                 | Clip           | 50°C @ 4W                           | 3.7°C/W @ 400 LFM |
| 250-122ABE-09 | 1.220 (31.0)                   | 1.000 (25.4) x .500 (12.7)    | Vertical               | 09                     | Clip           | 50°C @ 4W                           | 3.7°C/W @ 400 LFM |
| 250-122ABE-25 | 1.380 (35.1)                   | 1.000 (25.4) x .500 (12.7)    | Vertical               | 25                     | Clip           | 50°C @ 4W                           | 3.7°C/W @ 400 LFM |

Material: Aluminum, Black Anodized



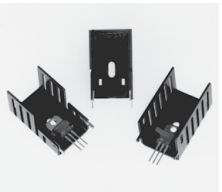
Dimensions: in. (mm)



HIGH-PERFORMANCE, HIGH-POWER VERTICAL  
MOUNT HEAT SINKS

TO-220

237 & 252 SERIES

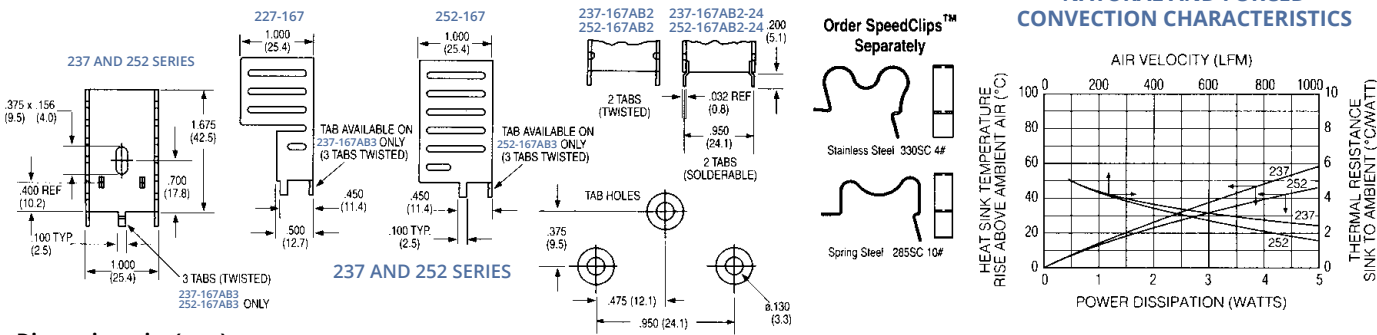


| Standard P/N   | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Mounting Configuration | Solderable Tab Options | Mounting Style | Thermal Performance at Typical Load |                   |
|----------------|--------------------------------|-------------------------------|------------------------|------------------------|----------------|-------------------------------------|-------------------|
|                |                                |                               |                        |                        |                | Natural Convection                  | Forced Convection |
| 237-167AB2     | 1.675 (42.5)                   | 1.000 (25.4) x 1.000 (25.4)   | Vertical               | 2, Twisted             | Clip/Mtg       | Slot46°C @ 4W                       | 4.5°C/W @ 200 LFM |
| 237-167AB3     | 1.675 (42.5)                   | 1.000 (25.4) x 1.000 (25.4)   | Vertical               | 3, Twisted             | Clip/Mtg       | Slot46°C @ 4W                       | 4.5°C/W @ 200 LFM |
| 237-167ABE2-24 | 1.675 (42.5)                   | 1.000 (25.4) x 1.000 (25.4)   | Vertical               | 2, Solderable          | Clip/Mtg       | Slot46°C @ 4W                       | 4.5°C/W @ 200 LFM |
| 252-167AB2     | 1.675 (42.5)                   | 1.000 (25.4) x 1.000 (25.4)   | Vertical               | 2, Twisted             | Clip/Mtg       | Slot40°C @ 4W                       | 4.5°C/W @ 200 LFM |
| 252-167AB3     | 1.675 (42.5)                   | 1.000 (25.4) x 1.000 (25.4)   | Vertical               | 3, Twisted             | Clip/Mtg       | Slot40°C @ 4W                       | 4.5°C/W @ 200 LFM |
| 252-167ABE2-24 | 1.675 (42.5)                   | 1.000 (25.4) x 1.000 (25.4)   | Vertical               | 2, Solderable          | Clip/Mtg       | Slot40°C @ 4W                       | 4.5°C/W @ 200 LFM |

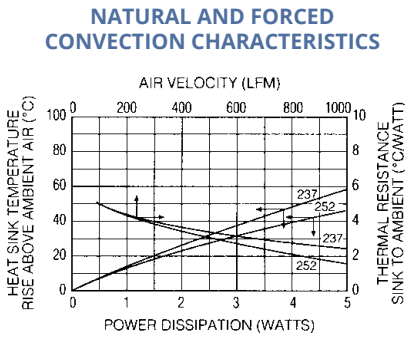
Order SpeedClips™ 285SC or 330SC separately for rapid component installation, lowering manufacturing costs.

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)



291 SERIES

LABOR-SAVING CLIP-ON HEAT SINKS

TO-220

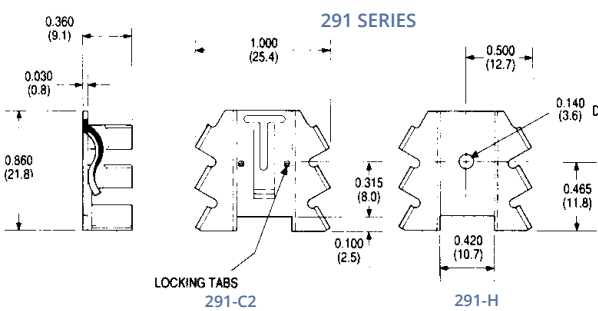


Designed for mounting horizontally or vertically on a circuit board, **291 Series** heat sinks employ a unique clip for attachment of TO-220 case styles. One type is available with a locking clip and one with a 0.140 in. (3.6) diameter mounting hole only.

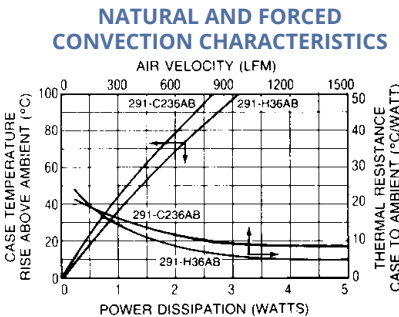
| Standard P/N | Vertical Height Above PC Board in. (mm) | Mounting Footprint Dimensions in. (mm) | Mounting Style     | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|-----------------------------------------|----------------------------------------|--------------------|-------------------------------------|-------------------|---------------------|
|              |                                         |                                        |                    | Natural Convection                  | Forced Convection |                     |
| 291-C236AB   | 0.860 (21.9)                            | 1.100 (27.0) x 0.360 (9.1)             | TO-220 (Clip)      | 80°C @ 2W                           | 24°C/W @ 600 LFM  | 0.0026 (1.18)       |
| 291-H36AB    | 0.860 (21.9)                            | 1.100 (27.0) x 0.360 (9.1)             | TO-220 (Mtg. Hole) | 68°C @ 2W                           | 16°C/W @ 600 LFM  | 0.0026 (1.18))      |

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)



BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



286 SERIES

ALUMINUM AND COPPER LOW-COST WAVE-SOLDERABLE  
HEAT SINKS

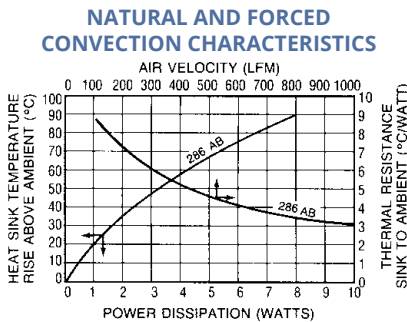
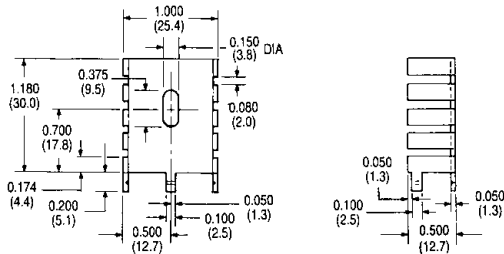
TO-220

Efficient heat removal at low cost can be achieved by inserting the **286 Series** directly into pre-drilled circuit boards; scored mounting tabs may be bent after insertion to provide added stability. The **286 Series** can be wave-soldered directly to the board. See also 286DB Series on page 55.

| Standard P/N | Height Above PC Board in. (mm) | Maximum Footprint in. (mm)  | Material           | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|--------------------------------|-----------------------------|--------------------|-------------------------------------|-------------------|---------------------|
|              |                                |                             |                    | Natural Convection                  | Forced Convection |                     |
| 286-AB       | 1.190 (30.2)                   | 1.000 (25.4) x 0.500 (12.7) | Aluminum, Anodized | 58°C @ 4W                           | 7.4°C/W @ 200 LFM | 0.0085 (3.86)       |
| 286-CBTE     | 1.190 (30.2)                   | 1.000 (25.4) x 0.500 (12.7) | Copper, Black      | 58°C @ 4W                           | 7.4°C/W @ 200 LFM | 0.0250 (11.34)      |
| 286-CTE      | 1.190 (30.2)                   | 1.000 (25.4) x 0.500 (12.7) | Copper, Tinned     | 58°C @ 4W                           | 7.4°C/W @ 200 LFM | 0.0250 (11.34)      |

**Material:** 286-AB style (aluminum, black anodized), 286-CBT style (copper, black paint tin tabs), and 286-CT style (copper, tinned).

MECHANICAL DIMENSIONS

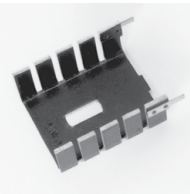


Dimensions: in. (mm)

TO-220

WAVE-SOLDERABLE LOW-COST HEAT SINKS

287 SERIES

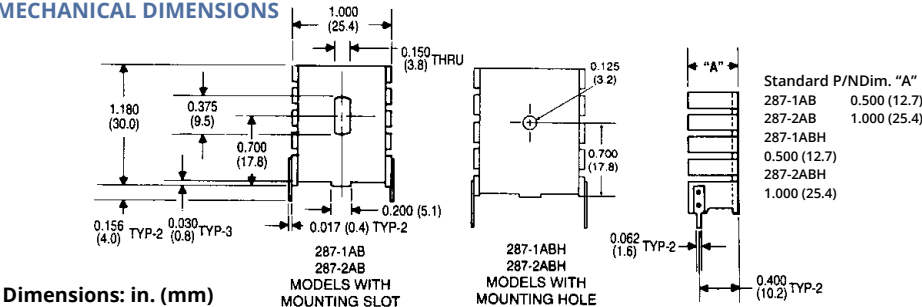


Mount these cost-effective TO-220 heat sinks vertically into pre-drilled printed circuit boards. Soldered, pre-tinned tabs can be wavesoldered directly to the board. A 0.375 in. (9.5 mm) mounting slot allows for correct positioning of TO-220 and similar semiconductor packages.

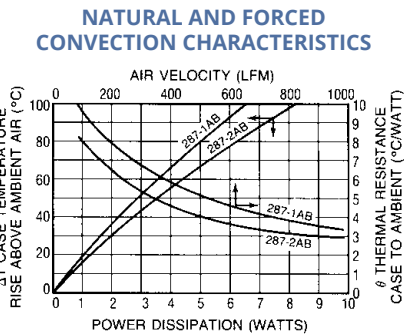
| Standard P/N  |               | Height Above PC Board in. (mm) | Maximum Footprint "A" in. (mm) | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|---------------|---------------|--------------------------------|--------------------------------|-------------------------------------|-------------------|---------------------|
| Mounting Slot | Mounting Hole |                                |                                | Natural Convection                  | Forced Convection |                     |
| 287-1ABE      | 287-1ABH      | 1.180 (30.0)                   | 1.000 (25.4) x 0.500 (12.7)    | 65°C @ 4W                           | 7.8°C/W @ 200 LFM | 0.0090 (4.08)       |
| 287-2ABE      | 287-2ABH      | 1.180 (30.0)                   | 1.000 (25.4) x 1.000 (25.4)    | 55°C @ 4W                           | 6.4°C/W @ 200 LFM | 0.0140 (6.35)       |

**Material:** Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)



285 SC AND 330 SC SPEEDCLIPS™

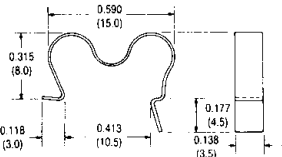
285 & 330 SERIES



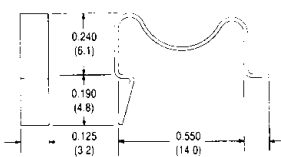
SpeedClips™ employ a locking safety tab for mounting. Must be ordered separately for these heat sink series. Use these SpeedClips™ with our 237, 240, and 252 Series heat sinks for the lowest production assembly time and cost. Order one SpeedClip™ for each heat sink purchased. Must be purchased with heat sinks.

| Standard P/N | Nominal Installed Loading Force | For Use With Series     | Material        | Weight lbs. (grams) |
|--------------|---------------------------------|-------------------------|-----------------|---------------------|
| 285 SC       | 10 lbs                          | 232, 237, 240, 252, 667 | Carbon Steel    | 0.00053 (0.24)      |
| 330 SC       | 4 lbs                           | 232, 237, 240, 252, 667 | Stainless Steel | 0.00074 (0.34)      |

MECHANICAL DIMENSIONS



Speed Clip  
330 SC  
4 lb (17.8N)  
Nominal Force Installed



Speed Clip  
285 SC  
10 lb (44.5N)  
Nominal Force Installed

Dimensions: in. (mm)



695 SERIES

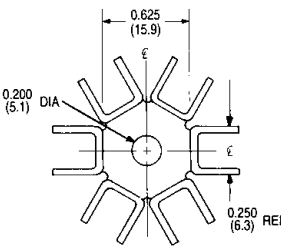
SPACE-SAVING HEAT SINKS FOR SMALL  
STUD-MOUNTED DIODES

Stud-Mount

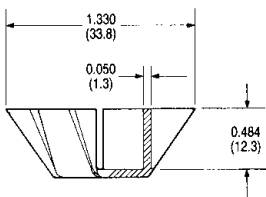
Mount and effectively heat sink small stud-mounted diodes with the **695 Series** space-saving heat sink type. Each unit is black anodized aluminum with an 0.200 in. (5.1) dia. mounting hole centered in the base. The folded fin design provides good heat dissipation for use where height is limited above the printed circuit board or base plate.

| Standard P/N | Maximum Width in. (mm) | Height in. (mm) | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|------------------------|-----------------|-------------------------------------|-------------------|---------------------|
|              |                        |                 | Natural Convection                  | Forced Convection |                     |
| 695-1B       | 1.330 (33.8)           | 0.530 (13.7)    | 72°C @ 4.0W                         | 5.2°C/W @ 400 LFM | 0.008 (4.0)         |

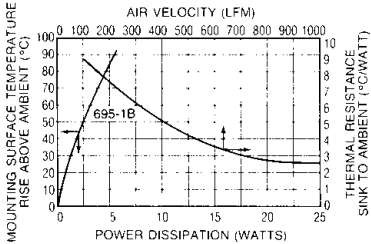
MECHANICAL DIMENSIONS



Dimensions: in. (mm)



NATURAL AND FORCED CONVECTION CHARACTERISTICS





BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



260 SERIES

CUP CLIPS FOR TO-5 CASE STYLE SEMICONDUCTORS

TO-5

| Characteristics                             | TO-5     |
|---------------------------------------------|----------|
| Thermal Resistance – Epoxy Insulated        | 14° C/W  |
| Breakdown Voltage – Epoxy Type (VAC), 60 Hz | 500      |
| Recommended Operating Voltage, AC or DC     |          |
| Clean Conditions: % Hipot Rating            | 50       |
| Dusty Conditions: % Hipot Rating            | 30       |
| Dirty Conditions: % Hipot Rating            | 10 to 20 |
| Temperature Range — Continuous (C°)         | -73/+149 |

| Model     | Depth of Tapped Base |
|-----------|----------------------|
| 260-4T5E  | 0.093 (2.36)         |
| 260-4TH5E | 0.125 (3.18)         |

|                        |                                     |                                                                         |
|------------------------|-------------------------------------|-------------------------------------------------------------------------|
| <b>Thread Size:</b>    | 4 = #4-40 UNC<br>6 = #6-32 UNC      | <b>Base Style:</b> H = hex<br><b>Semiconductor Case Style:</b> 5 = TO-5 |
| <b>Mounting Style:</b> | T = tapped<br>S = stud<br>P = plain | <b>Insulation</b> E = epoxy                                             |

TO-5 CASE STYLE CUP CLIPS — ORDERING GUIDE

| Standard P/N | Outline Dimension Insulation Type | L x W x I.D. in. (mm)                         | Weight lbs. (grams) | Case Style |
|--------------|-----------------------------------|-----------------------------------------------|---------------------|------------|
| 260-4T5E     | Epoxy Insulated                   | 0.370 (9.4) x 0.380 (9.7) dia. x 0.290 (7.4)  | 0.0024 (1.09)       | TO-5       |
| 260-4TH5E    | Epoxy Insulated                   | 0.400 (10.2) x 0.370 (9.4) hex. x 0.290 (7.4) | 0.0031 (1.41)       | TO-5       |
| 260-6SH5E    | Epoxy Insulated                   | 0.557 (14.1) x 0.370 (9.4) hex. x 0.290 (7.4) | 0.0037 (1.68)       | TO-5       |

Materials and Finish: Cups – beryllium copper, black ebonol “C”; Bases – brass, black ebonol “C”

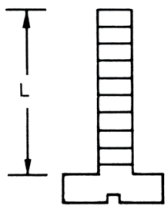
Base Mounting Configurations — TO-5

**Plain Type** — Epoxy bonded, or used with #4 pan head screws.

**Tapped Base** — #4-40 UNC screw (not supplied) fits tapped hole. Care should be taken not to use too long a screw, which could short against the semiconductor case. For correct screw lengths:

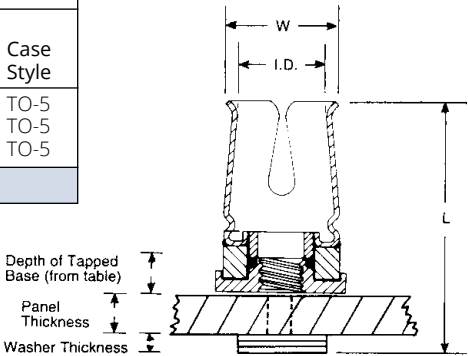
Correct Screw Length (L) =  $\frac{\text{Depth of Base}}{\text{Panel Thickness}} + \frac{\text{Washer Thickness}}$

**Stud Mounting Base.** #6-32 UNC. Nuts and washers not supplied. Stud hole must be slightly countersunk to ensure flat mounting.



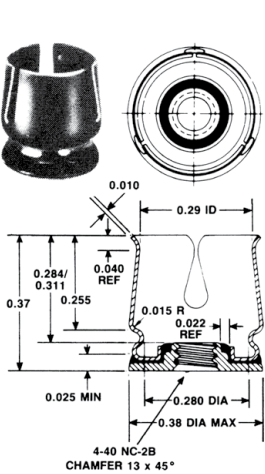
To determine the correct mounting screw lengths, add dimensions as follows:

Correct Screw Length (L) =  $\frac{\text{Depth of Base}}{\text{Panel Thickness}} + \frac{\text{Washer Thickness}}$

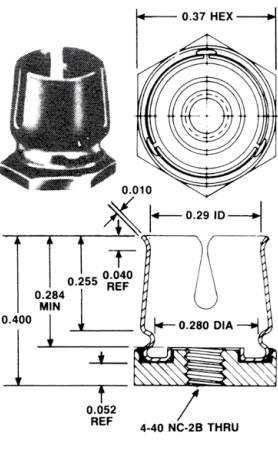


EPOXY INSULATED FOR TO-5

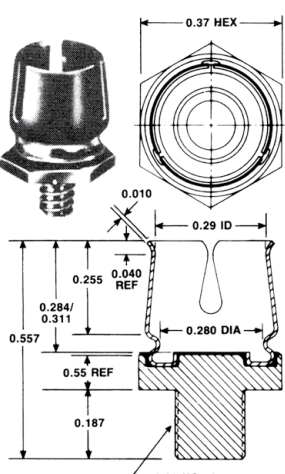
260 SERIES



260-4T5E



260-4TH5E

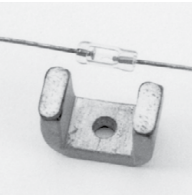


260-6SH5E

Diodes

THERMAL LINKS FOR FUSED GLASS DIODES

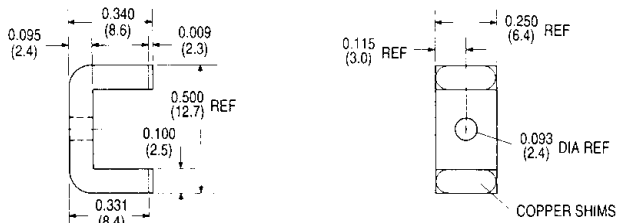
258 SERIES



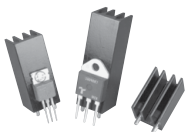
The thermal resistance from diode leads to chassis or heat sink is 12°C/watt, when unit is mounted with TYPE 120 Joint Compound. If a 10°C/watt chassis or sink to ambient impedance is available, the thermal resistance from the diode leads to ambient is reduced from about 150°C/watt to 22°C/watt.

| Standard P/N | Dimensions in. (mm)                      | Material | Finish                                                      | Weight lbs. (grams) |
|--------------|------------------------------------------|----------|-------------------------------------------------------------|---------------------|
| 258          | 0.500 (12.7) x 0.250 (6.4) x 0.340 (8.6) | Aluminum | DeltaCoate™ 151 on all surfaces except solder pads and base | 0.0018 (0.82)       |

MECHANICAL DIMENSIONS



Dimensions: in. (mm)



634 SERIES

SLIM PROFILE UNIDIRECTIONAL FIN VERTICAL MOUNT HEAT SINK

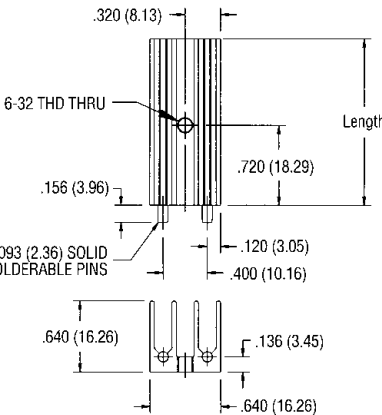
TO-220 and TO-218

These slim profile unidirectional fin heat sinks offer users two assembly alternatives for vertically mounting TO-220 and TO-218 components. Models are available with or without wave-solderable pins on 0.40 in. (10.2) centers, making them ideal for a variety of applications where quick assembly is needed and space is at a premium.

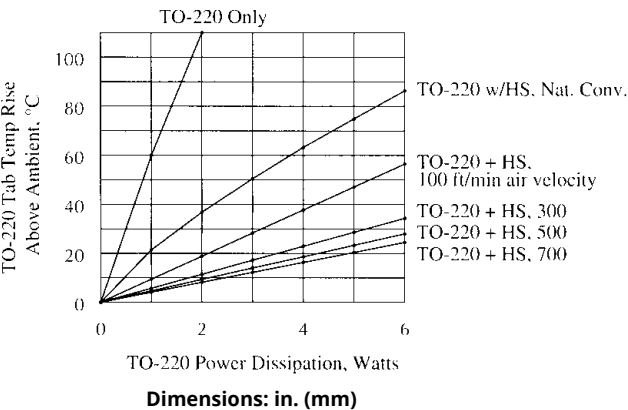
| Standard P/N |             | Height Above PC Board in. (mm) | Footprint Dimensions in. (mm) | Weight lbs. (grams) |
|--------------|-------------|--------------------------------|-------------------------------|---------------------|
| Plain Pin    | Without Pin |                                |                               |                     |
| 634-10ABEP   | 634-10AB    | 1.000 (25.4)                   | 0.640 (16.26) x 0.640 (16.26) | 0.016 (7.48)        |
| 634-15ABEP   | 634-15AB    | 1.500 (38.1)                   | 0.640 (16.26) x 0.640 (16.26) | 0.025 (11.21)       |
| 634-20ABEP   | 634-20AB    | 2.000 (50.8)                   | 0.640 (16.26) x 0.640 (16.26) | 0.033 (14.95)       |

Material: Aluminum, Black Anodized.

MECHANICAL DIMENSIONS



TYPICAL THERMAL PERFORMANCE FOR 634-15ABP



NOTES:

1. Thermal compound is assumed between device and heat sink.
2. Tab temp with longer heat sink (634-20ABP) will typically be about 15% cooler. Tab temp with shorter heat sink (634-10ABP) will typically be about 25% higher.

BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



292 SERIES HEAT SINK FOR SINGLE TO-92

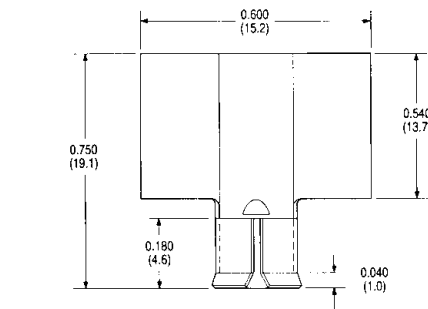
TO-92

Power semiconductors packaged in a TO-92 style plastic case can be cooled effectively at little additional cost with the addition of the 292-AB heat sink. The 292-AB is effective over the typical power range of such devices.

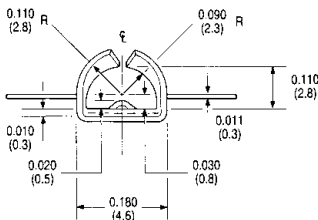
| Standard P/N | Height Above PC Board in. (mm) | Overall Fin Width in. (mm) | Thermal Performance Natural Convection | Finish         | Weight lbs. (grams) |
|--------------|--------------------------------|----------------------------|----------------------------------------|----------------|---------------------|
| 292-AB       | 0.750 (19.1)                   | 0.600 (15.3)               | 0.225°C/W @ 0.250 W                    | Black Anodized | 0.00049 (0.22)      |

Material: Aluminum, Black Anodized

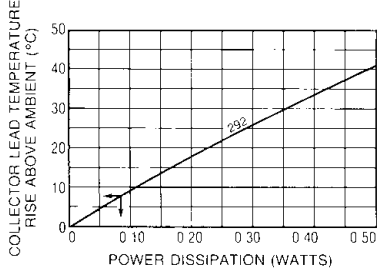
MECHANICAL DIMENSIONS



Dimensions: in. (mm)



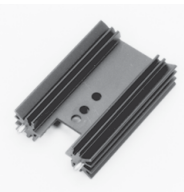
NATURAL AND FORCED CONVECTION CHARACTERISTICS



HIGH-EFFICIENCY HEAT SINKS FOR VERTICAL BOARD MOUNTING

TO-220

637 SERIES

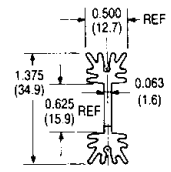


Wave-solderable pins on 1 in. centers for vertical mounting on printed circuit boards. Maximum semiconductor package width 0.625 in. (15.9). Use this heat sink where weight and board space occupied must be minimized. Refer to the Accessory products section for thermal interface materials, thermal compounds, and other accessories products.

| Standard P/N | Height Above PC Board "A" in. (mm) | Maximum Footprint in. (mm)  | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|------------------------------------|-----------------------------|-------------------------------------|-------------------|---------------------|
|              |                                    |                             | Natural Convection                  | Forced Convection |                     |
| 637-10ABEP   | 1.000 (25.4)                       | 1.375 (34.9) x 0.500 (12.7) | 76°C @ 6W                           | 5.8°C/W @ 200 LFM | 0.023 (10.43)       |
| 637-15ABEP   | 1.500 (38.1)                       | 1.375 (34.9) x 0.500 (12.7) | 65°C @ 6W                           | 5.5°C/W @ 200 LFM | 0.035 (15.88)       |
| 637-20ABEP   | 2.000 (50.8)                       | 1.375 (34.9) x 0.500 (12.7) | 55°C @ 6W                           | 4.7°C/W @ 200 LFM | 0.050 (22.68)       |
| 637-25ABEP   | 2.500 (63.5)                       | 1.375 (34.9) x 0.500 (12.7) | 48°C @ 6W                           | 4.2°C/W @ 200 LFM | 0.062 (28.12)       |

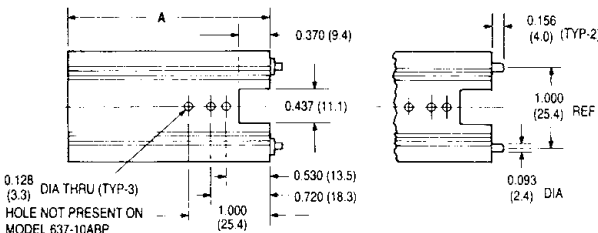
Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS

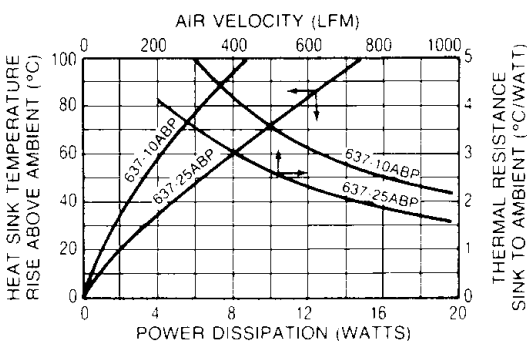


Dimensions: in. (mm)

637 SERIES (EXTRUSION PROFILE 5183)



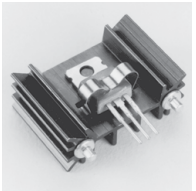
NATURAL AND FORCED CONVECTION CHARACTERISTICS



LABOR-SAVING SPEEDCLIP™ HEAT SINKS FOR VERTICAL BOARD MOUNTING

TO-220

667 SERIES



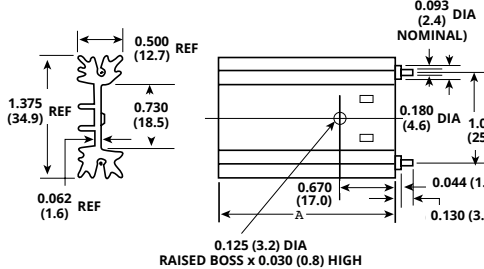
Excellent performance, choice of wave-solderable plain pins (PP-Type) or wave-solderable hex-shaped standoff pins (SP-Type), and reduced assembly cost.

| Standard P/N Standoff Pin | P/N Plain Pin | Height Above PC Board "A" in. (mm) | Maximum Footprint in. (mm)  | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|---------------------------|---------------|------------------------------------|-----------------------------|-------------------------------------|-------------------|---------------------|
|                           |               |                                    |                             | Natural Convection                  | Forced Convection |                     |
| 667-10ABESP               | 667-10ABPP    | 1.000 (25.4)                       | 1.375 (34.9) x 0.500 (12.7) | 76°C @ 6W                           | 5.8°C/W @ 200 LFM | 0.0240 (11.0)       |
| 667-15ABESP               | 667-15ABPP    | 1.500 (38.1)                       | 1.375 (34.9) x 0.500 (12.7) | 66°C @ 6W                           | 5.5°C/W @ 200 LFM | 0.0340 (15.6)       |
| 667-20ABESP               | 667-20ABPP    | 2.000 (50.8)                       | 1.375 (34.9) x 0.500 (12.7) | 58°C @ 6W                           | 4.7°C/W @ 200 LFM | 0.0460 (21.0)       |
| 667-25ABESP               | 667-25ABPP    | 2.500 (63.5)                       | 1.375 (34.9) x 0.500 (12.7) | 48°C @ 6W                           | 4.2°C/W @ 200 LFM | 0.0580 (26.2)       |

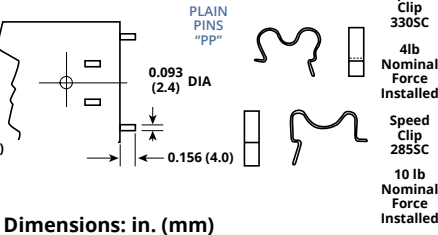
Order 330 SC or 285 SC SpeedClip™ separately.

Wave-solderable pins. Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS

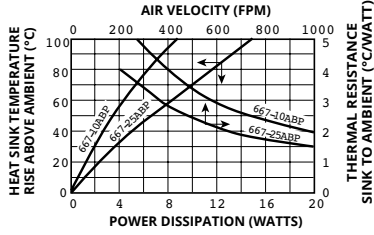


667 SERIES (EXTRUSION PROFILE 8073)



Dimensions: in. (mm)

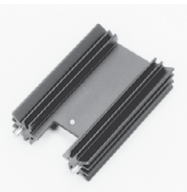
NATURAL AND FORCED CONVECTION CHARACTERISTICS



626 & 627 SERIES

HIGH-EFFICIENCY HEAT SINKS FOR VERTICAL BOARD MOUNTING

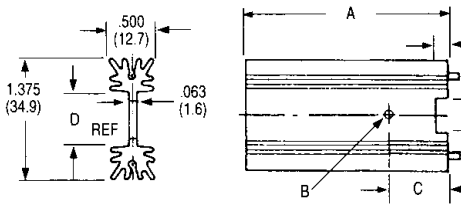
TO-220 and TO-218



| Standard P/N | Standard P/N | Height Above PC Board "A" in. (mm) | Maximum Footprint in. (mm) | Thermal Performance at Typical Load |                   |
|--------------|--------------|------------------------------------|----------------------------|-------------------------------------|-------------------|
|              |              |                                    |                            | Natural Convection                  | Forced Convection |
| 626-10ABEP   | 627-10ABP    | 1.000 (25.4)                       | 1.375 (34.9) x .500 (12.7) | 76°C @ 6W                           | 5.8°C/W @ 200 LFM |
| 626-15ABEP   | 627-15ABP    | 1.500 (38.1)                       | 1.375 (34.9) x .500 (12.7) | 65°C @ 6W                           | 5.5°C/W @ 200 LFM |
| 626-20ABEP   | 627-20ABP    | 2.000 (50.8)                       | 1.375 (34.9) x .500 (12.7) | 55°C @ 6W                           | 4.7°C/W @ 200 LFM |
| 626-25ABEP   | 627-25ABP    | 2.500 (63.5)                       | 1.375 (34.9) x .500 (12.7) | 48°C @ 6W                           | 4.2°C/M @ 200 LFM |

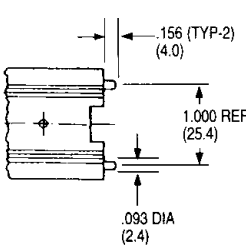
Wave-solderable pins. Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS

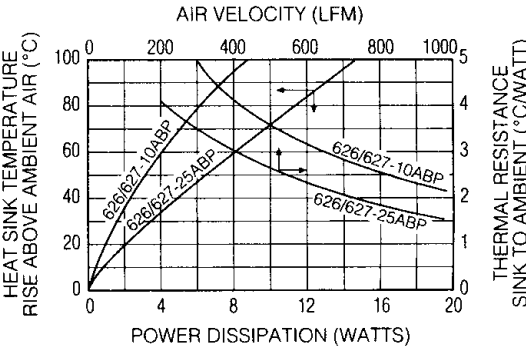


Dimensions: in. (mm)

626 AND 627 SERIES

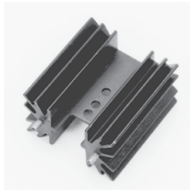


NATURAL AND FORCED CONVECTION CHARACTERISTICS



| Series | Type Device | Hole Diameter "B" | Hole Height "C" | Webb Width "D" | Notch Width "E" | Extrusion Profile |
|--------|-------------|-------------------|-----------------|----------------|-----------------|-------------------|
| 626    | TO-218      | .144 (3.7)        | .850 (21.6)     | .660 (16.8)    | .540 (13.7)     | 8420              |
| 627    | TO-220      | .128 (3.3)        | .720 (18.3)     | .625 (15.9)    | .437 (11.1)     | 5183              |

BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



647 SERIES

HIGH-PERFORMANCE HEAT SINKS FOR VERTICAL  
BOARD MOUNTING

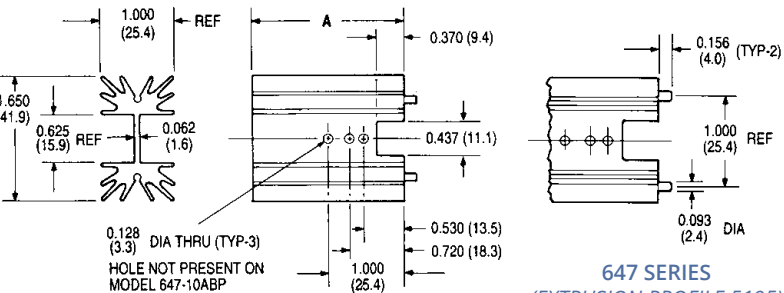
TO-220

Wave-solderable pins on 1 in. centers for vertical mounting of larger devices on printed circuit boards. Maximum semiconductor package width: 0.625 (15.9). Refer to the Accessory Products section for thermal interface materials, 126 Series silicone-free thermal compounds, and other accessories products.

| Standard P/N | Height Above PC Board "A" in. (mm) | Maximum Footprint in. (mm)  | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|------------------------------------|-----------------------------|-------------------------------------|-------------------|---------------------|
|              |                                    |                             | Natural Convection                  | Forced Convection |                     |
| 647-10ABEP   | 1.000 (25.4)                       | 1.650 (41.9) x 1.000 (25.4) | 42°C @ 6W                           | 3.8°C/W @ 200 LFM | 0.055 (24.95)       |
| 647-15ABEP   | 1.500 (38.1)                       | 1.650 (41.9) x 1.000 (25.4) | 37°C @ 6W                           | 3.5°C/W @ 200 LFM | 0.075 (34.02)       |
| 647-175ABEP  | 1.750 (44.5)                       | 1.650 (41.9) x 1.000 (25.4) | 34°C @ 6W                           | 3.3°C/W @ 200 LFM | 0.090 (40.82)       |
| 647-20ABEP   | 2.000 (50.8)                       | 1.650 (41.9) x 1.000 (25.4) | 31°C @ 6W                           | 3.1°C/W @ 200 LFM | 0.104 (47.17)       |
| 647-25ABEP   | 2.500 (63.5)                       | 1.650 (41.9) x 1.000 (25.4) | 25°C @ 6W                           | 2.8°C/W @ 200 LFM | 0.125 (56.70)       |

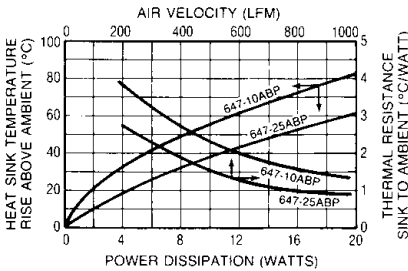
Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS

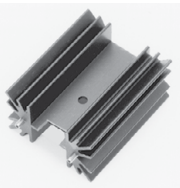


647 SERIES  
(EXTRUSION PROFILE 5195)

HIGH-PERFORMANCE HEAT SINKS FOR VERTICAL  
BOARD MOUNTING

TO-218; TO-247; TO-220

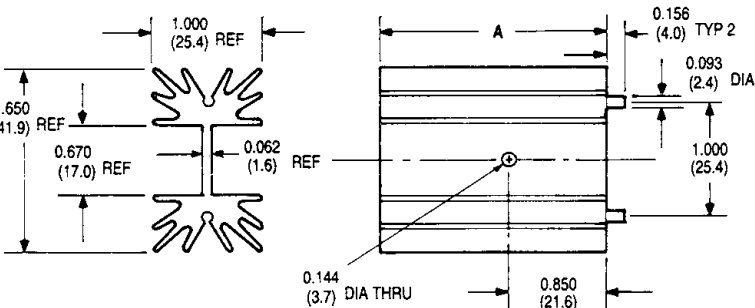
657 SERIES



| Standard P/N | Height Above PC Board "A" in. (mm) | Maximum Footprint in. (mm)  | Thermal Performance at Typical Load |                   | Weight lbs (grams) |
|--------------|------------------------------------|-----------------------------|-------------------------------------|-------------------|--------------------|
|              |                                    |                             | Natural Convection                  | Forced Convection |                    |
| 657-10ABEP   | 1.000 (25.4)                       | 1.650 (41.9) x 1.000 (25.4) | 41°C @ 6W                           | 3.7°C/W @ 200 LFM | 0.0515 (23.36)     |
| 657-15ABEP   | 1.500 (38.1)                       | 1.650 (41.9) x 1.000 (25.4) | 38°C @ 6W                           | 3.3°C/W @ 200 LFM | 0.0760 (34.60)     |
| 657-20ABEP   | 2.000 (50.8)                       | 1.650 (41.9) x 1.000 (25.4) | 32°C @ 6W                           | 2.9°C/W @ 200 LFM | 0.1030 (47.00)     |
| 657-25ABEP   | 2.500 (63.5)                       | 1.650 (41.9) x 1.000 (25.4) | 25°C @ 6W                           | 2.7°C/W @ 200 LFM | 0.1250 (57.00)     |

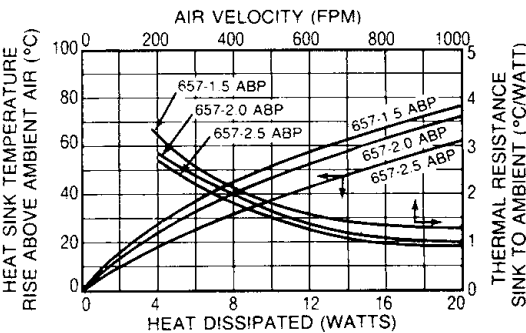
Wave-solderable pins. Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS

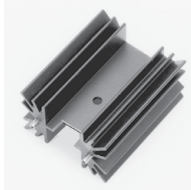


657 SERIES  
(EXTRUSION PROFILE 6533)

HIGH-PERFORMANCE NOTCHED HEAT SINKS  
FOR VERTICAL BOARD MOUNTING

TO-218; TO-247; TO-220

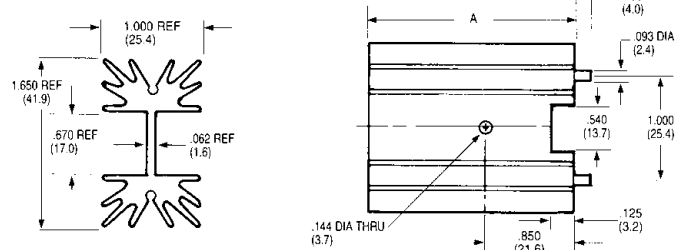
657 SERIES



| Standard P/N | Height Above PC Board "A" in. (mm) | Maximum Footprint in. (mm)  | Thermal Performance at Typical Load |                   |
|--------------|------------------------------------|-----------------------------|-------------------------------------|-------------------|
|              |                                    |                             | Natural Convection                  | Forced Convection |
| 657-10ABEPN  | 1.000 (25.4)                       | 1.650 (41.9) x 1.000 (25.4) | 41°C @ 6W                           | 3.7°C/W @ 200 LFM |
| 657-15ABEPN  | 1.500 (38.1)                       | 1.650 (41.9) x 1.000 (25.4) | 38°C @ 6W                           | 3.3°C/W @ 200 LFM |
| 657-20ABEPN  | 2.000 (50.8)                       | 1.650 (41.9) x 1.000 (25.4) | 32°C @ 6W                           | 2.9°C/W @ 200 LFM |
| 657-25ABEPN  | 2.500 (63.5)                       | 1.650 (41.9) x 1.000 (25.4) | 25°C @ 6W                           | 2.7°C/W @ 200 LFM |

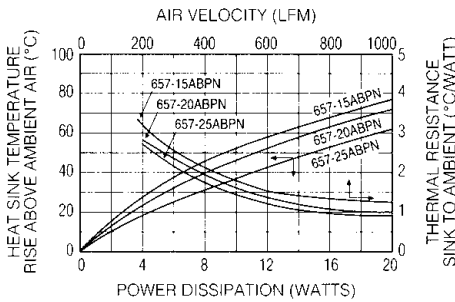
Wave-solderable pins. Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

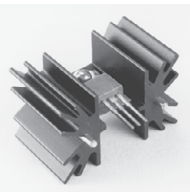
NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



657 SERIES  
(EXTRUSION PROFILE 6533)

HIGH-PERFORMANCE HEAT SINKS WITH SPEEDCLIPS™  
FOR VERTICAL BOARD MOUNTING

TO-218; TO-247; TO-220

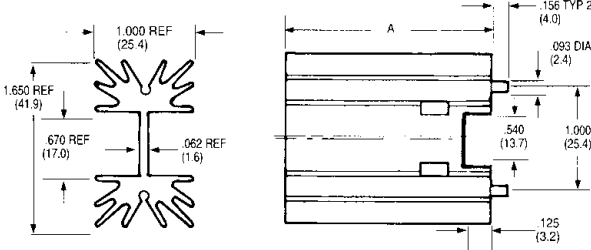


657 SERIES

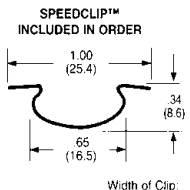
| Standard P/N | Height Above PC Board "A" in. (mm) | Maximum Footprint in. (mm)  | Thermal Performance at Typical Load |                   |
|--------------|------------------------------------|-----------------------------|-------------------------------------|-------------------|
|              |                                    |                             | Natural Convection                  | Forced Convection |
| 657-10ABEPSC | 1.000 (25.4)                       | 1.650 (41.9) x 1.000 (25.4) | 41°C @ 6W                           | 3.7°C/W @ 200 LFM |
| 657-15ABEPSC | 1.500 (38.1)                       | 1.650 (41.9) x 1.000 (25.4) | 38°C @ 6W                           | 3.3°C/W @ 200 LFM |
| 657-20ABEPSC | 2.000 (50.8)                       | 1.650 (41.9) x 1.000 (25.4) | 32°C @ 6W                           | 2.9°C/W @ 200 LFM |
| 657-25ABEPSC | 2.500 (63.5)                       | 1.650 (41.9) x 1.000 (25.4) | 25°C @ 6W                           | 2.7°C/W @ 200 LFM |

Wave-solderable pins. Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS

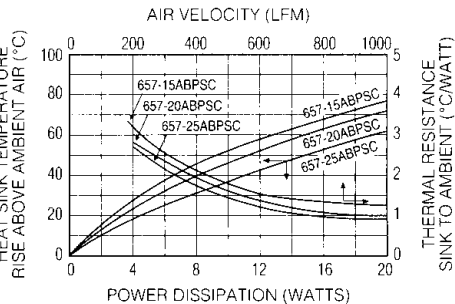


Dimensions: in. (mm)



657 SERIES  
(EXTRUSION PROFILE 6533)

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS





BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS



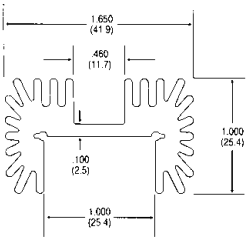
677 SERIES

HIGH-PERFORMANCE, HIGH-POWER HEAT  
SINKS FOR VERTICAL BOARD MOUNTING

TO-218; TO-220; TO-247;  
15-Lead Multiwatt

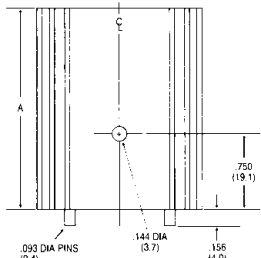
| Standard P/N                                             | Height Above PC Board "A" in. (mm) | Maximum Footprint in. (mm)  | Thermal Performance at Typical Load |                   |
|----------------------------------------------------------|------------------------------------|-----------------------------|-------------------------------------|-------------------|
|                                                          |                                    |                             | Natural Convection                  | Forced Convection |
| 677-10ABEP                                               | 1.000 (25.4)                       | 1.650 (41.9) x 1.000 (25.4) | 52°C @ 6W                           | 3.1°C/W @ 200 LFM |
| 677-15ABEP                                               | 1.500 (38.1)                       | 1.650 (41.9) x 1.000 (25.4) | 46°C @ 6W                           | 2.8°C/W @ 200 LFM |
| 677-20ABEP                                               | 2.000 (50.8)                       | 1.650 (41.9) x 1.000 (25.4) | 40°C @ 6W                           | 2.5°C/W @ 200 LFM |
| 677-25ABEP                                               | 2.500 (63.5)                       | 1.650 (41.9) x 1.000 (25.4) | 35°C @ 6W                           | 2.2°C/W @ 200 LFM |
| Wave-solderable pins. Material: Aluminum, Black Anodized |                                    |                             |                                     |                   |

MECHANICAL DIMENSIONS

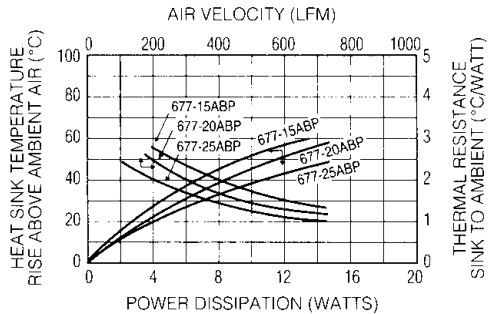


Dimensions: in. (mm)

677 SERIES  
(EXTRUSION  
PROFILE 8719)



NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



HIGHEST EFFICIENCY/LOWEST UNIT COST  
HEAT SINKS

TO-3; TO-66; TO-220

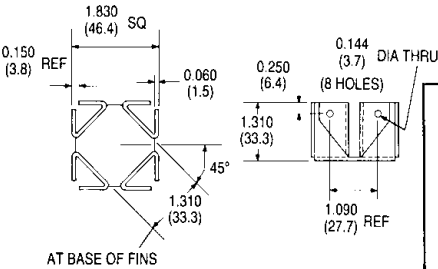
690 SERIES



These low-cost heat sinks provide the most power dissipation at the lowest unit cost and are available in three standard types to mount and cool one TO-3 or TO-66 metal power semiconductor type or two plastic package TO-220 power semiconductor types. For higher power semiconductors, the **690 Series** can dissipate up to 20 watts while maintaining a mounting surface temperature rise above ambient air temperature of no more than 91°C.

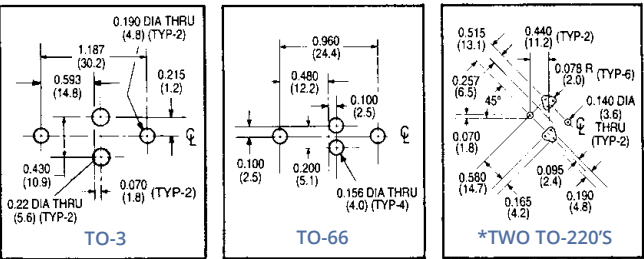
| Standard P/N                       | Height Above PC Board in. (mm) | Outline Dimensions in. (mm) | Thermal Performance at Typical Load |                   | Semiconductor Mounting Hole Pattern | Weight lbs. (grams) |
|------------------------------------|--------------------------------|-----------------------------|-------------------------------------|-------------------|-------------------------------------|---------------------|
|                                    |                                |                             | Natural Convection                  | Forced Convection |                                     |                     |
| 690-3B                             | 1.310 (33.3)                   | 1.860 (47.2)-sq             | 44°C @ 7.5W                         | 2.0°C/W @ 400 LFM | (1) TO-3                            | 0.0700 (31.75)      |
| 690-66B                            | 1.310 (33.3)                   | 1.860 (47.2)-sq             | 44°C @ 7.5W                         | 2.0°C/W @ 400 LFM | (1) TO-66                           | 0.0700 (31.75)      |
| 690-220B                           | 1.310 (33.3)                   | 1.860 (47.2)-sq             | 44°C @ 7.5W                         | 2.0°C/W @ 400 LFM | (2) TO-220                          | 0.0700 (31.75)      |
| Material: Aluminum, Black Anodized |                                |                             |                                     |                   |                                     |                     |

MECHANICAL DIMENSIONS

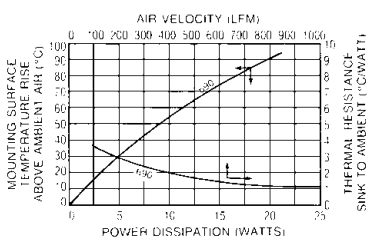


Dimensions: in. (mm)

SEMICONDUCTOR MOUNTING HOLES



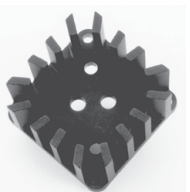
NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



MAXIMUM EFFICIENCY OMNIDIRECTIONAL  
HEAT SINKS

TO-3; TO-220

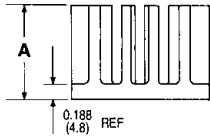
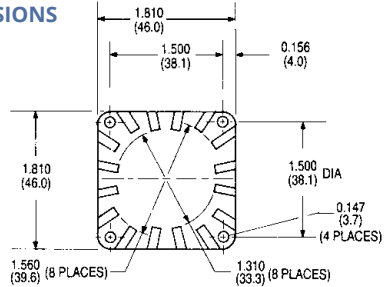
680 SERIES



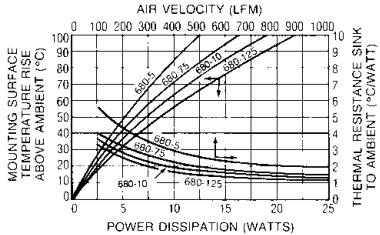
Achieve optimum natural convection cooling per unit volume occupied above the printed circuit board for TO-3 (one semiconductor package per heat sink) or for two TO-220 style cases, when this low-cost heat sink is used. Any mounting attitude will provide free circulation of air in natural convection applications. These **680 Series** heat sinks can also be specified without any semiconductor mounting hole pattern by specifying suffix "K" (Example: 680-5K).

| Standard P/N                       | Height Above PC Board "A" in. (mm) | Horizontal Mounting Footprint Dimensions in. (mm) | Thermal Performance at Typical Load |                   | Semiconductor Mounting Hole Pattern | Weight lbs. (grams) |
|------------------------------------|------------------------------------|---------------------------------------------------|-------------------------------------|-------------------|-------------------------------------|---------------------|
|                                    |                                    |                                                   | Natural Convection                  | Forced Convection |                                     |                     |
| 680-5A                             | 0.500 (12.7)                       | 1.810 (46.0)-sq                                   | 70°C @ 7.5W                         | 3.0°C/W @ 400 LFM | (1) TO-3                            | 0.0700 (31.75)      |
| 680-75A                            | 0.750 (19.1)                       | 1.810 (46.0)-sq                                   | 58°C @ 7.5W                         | 2.4°C/W @ 400 LFM | (1) TO-3                            | 0.0900 (40.82)      |
| 680-10A                            | 1.000 (25.4)                       | 1.810 (46.0)-sq                                   | 52°C @ 7.5W                         | 2.0°C/W @ 400 LFM | (1) TO-3                            | 0.0980 (44.45)      |
| 680-125A                           | 1.250 (31.8)                       | 1.810 (46.0)-sq                                   | 45°C @ 7.5W                         | 1.5°C/W @ 400 LFM | (1) TO-3                            | 0.1100 (49.90)      |
| 680-5220                           | 0.500 (12.7)                       | 1.810 (46.0)-sq                                   | 70°C @ 7.5W                         | 3.0°C/W @ 400 LFM | (2) TO-220                          | 0.0700 (31.75)      |
| 680-75220                          | 0.750 (19.1)                       | 1.810 (46.0)-sq                                   | 58°C @ 7.5W                         | 2.4°C/W @ 400 LFM | (2) TO-220                          | 0.0900 (40.82)      |
| 680-10220                          | 1.000 (25.4)                       | 1.810 (46.0)-sq                                   | 52°C @ 7.5W                         | 2.0°C/W @ 400 LFM | (2) TO-220                          | 0.0980 (44.45)      |
| 680-125220                         | 1.250 (31.8)                       | 1.810 (46.0)-sq                                   | 45°C @ 7.5W                         | 1.5°C/W @ 400 LFM | (2) TO-220                          | 0.1100 (49.90)      |
| Material: Aluminum, Black Anodized |                                    |                                                   |                                     |                   |                                     |                     |

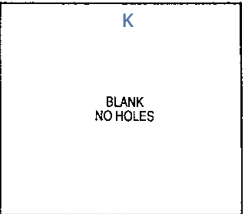
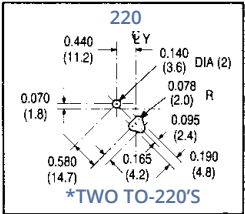
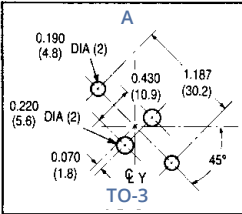
MECHANICAL DIMENSIONS



NATURAL AND FORCED  
CONVECTION CHARACTERISTICS

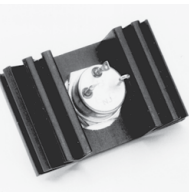


SEMICONDUCTOR MOUNTING HOLES



Dimensions: in. (mm)

\*Only one hole pattern of two is shown. Hole patterns are symmetrical about the center lines.



601 & 603 SERIES

LOW-HEIGHT HEAT SINKS

DO-4/DO-5 Diodes

Use these low-height heat sinks on printed circuit board applications for TO-66 power semiconductors and DO-4 and DO-5 diodes, where close board-to-board spacing and efficient heat dissipation are required. The **601 and 603 Series** may also be attached to enclosure panels or brackets using isolation hardware where necessary.

| Standard P/N                             | Footprint Dimensions in. (mm) | Height in. (mm) | Mounting Hole Dia. in. (mm) | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|------------------------------------------|-------------------------------|-----------------|-----------------------------|-------------------------------------|-------------------|---------------------|
|                                          |                               |                 |                             | Natural Convection                  | Forced Convection |                     |
| 601E                                     | 2.000 (50.8) x 1.250 (31.8)   | 0.562 (14.3)    | 0.200 (5.1)                 | 52°C @ 5.0W                         | 4.5°C/W @ 175 LFM | 0.0500 (22.68)      |
| 601F                                     | 2.000 (50.8) x 1.250 (31.8)   | 0.562 (14.3)    | 0.270 (6.9)                 | 52°C @ 5.0W                         | 4.5°C/W @ 175 LFM | 0.0500 (22.68)      |
| 601K                                     | 2.000 (50.8) x 1.250 (31.8)   | 0.562 (14.3)    | None                        | 52°C @ 5.0W                         | 4.5°C/W @ 175 LFM | 0.0500 (22.68)      |
| 603K                                     | 2.000 (50.8) x 2.000 (50.8)   | 0.562 (14.3)    | None                        | 41°C @ 5.0W                         | 4.0°C/W @ 175 LFM | 0.0810 (36.74)      |
| Material: Aluminum Alloy, Black Anodized |                               |                 |                             |                                     |                   |                     |

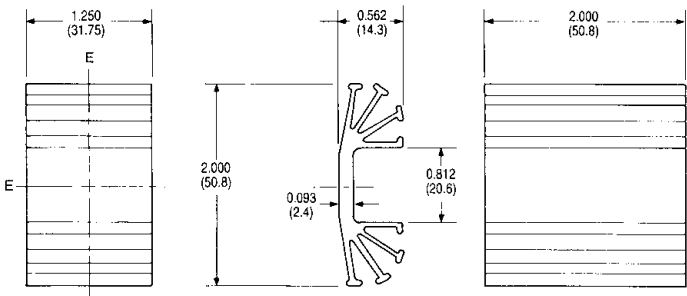
BOARD LEVEL POWER SEMICONDUCTOR HEAT SINKS

601 & 603 SERIES

LOW-HEIGHT HEAT SINKS

DO-4/DO-5 Diodes

MECHANICAL DIMENSIONS



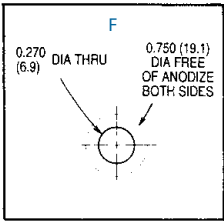
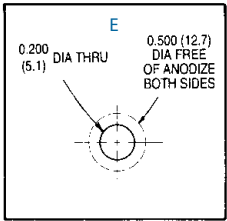
601 SERIES  
(EXTRUSION PROFILE 1284)

603 SERIES  
(EXTRUSION PROFILE 1284)

SEMICONDUCTOR MOUNTING HOLES

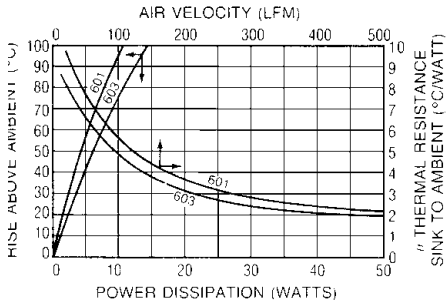


E&F available on 601 Series only as a standard product.



Dimensions: in. (mm)

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



MAXIMUM PERFORMANCE NATURAL CONVECTION HEAT  
SINK FOR ALL METAL-CASE SEMICONDUCTORS

641 SERIES

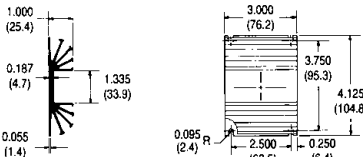
Available with a standard TO-3 mounting hole pattern predrilled for cost-effective mounting in limited-height applications, the **641 Series** provides maximum performance in natural convection with an optimized heat sink surface area. The 641K type with an open channel area of 1.300 in. (33.0) and no predrilled mounting holes can be adapted to meet mounting requirements for most metal case power semiconductor types.

| Standard P/N | Outline Dimensions in. (mm)  | Height in. (mm) | Mounting Hole Pattern | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|------------------------------|-----------------|-----------------------|-------------------------------------|-------------------|---------------------|
|              |                              |                 |                       | Natural Convection                  | Forced Convection |                     |
| 641A         | 4.125 (104.8) x 3.000 (76.2) | 1.000 (25.4)    | (1) TO-3              | 36°C @ 15W                          | 0.9°C/W @ 250 LFM | 0.2900 (131.54)     |
| 641K         | 4.125 (104.8) x 3.000 (76.2) | 1.000 (25.4)    | None                  | 36°C @ 15W                          | 0.9°C/W @ 250 LFM | 0.2900 (131.54)     |

**Material:** Aluminum Alloy, Black Anodized.

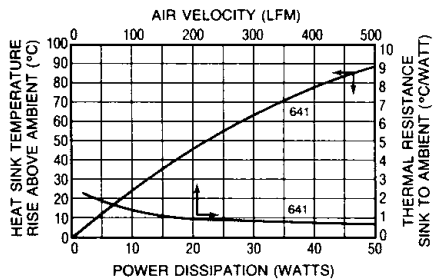
MECHANICAL DIMENSIONS

641 SERIES  
(EXTRUSION PROFILE 1371)

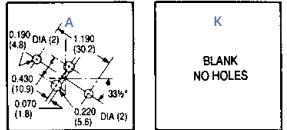


Dimensions: in. (mm)

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



SEMICONDUCTOR MOUNTING HOLES



UNIVERSAL 678 SERIES VERTICAL HEAT SINK FOR POWER DEVICES

678-39-S & 678-39-C

Wakefield-Vette introduces **Universal 678 series**, high performance, low cost and versatile heat sink with screw or clip for all kinds of standard packages. This type of heat sink provides both vertical and horizontal mounting options on PCB to accommodate natural and forced convection cooling method.



SPECIFICATIONS

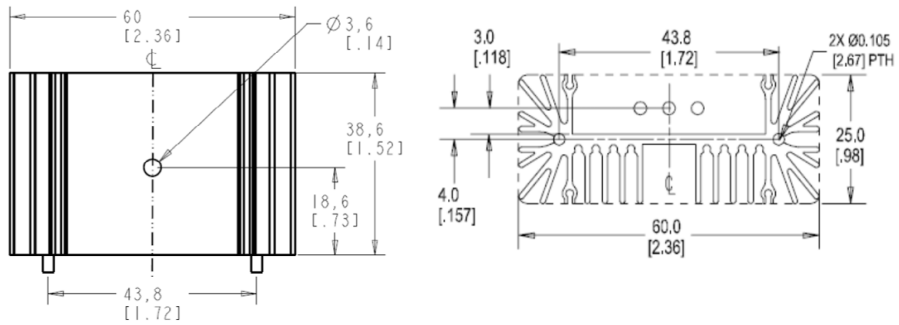
- Heat Sink:** Aluminum Alloy 6063-T5 or Equivalent with either degreased or black anodized finish
- Spring Clip:** Music Wire, Per ASTM A228 with bright nickel plating
- Solder Foot:** Cold-rolled Steel, Per ASTM A-366 with pure tin over copper strike. RoHS compliant.
- Insulator (Optional):** t-Global H48-1, L37-3F and H48-6S. The thickness of the insulating material not to exceed 10 mil (0.01").

FEATURES AND BENEFITS

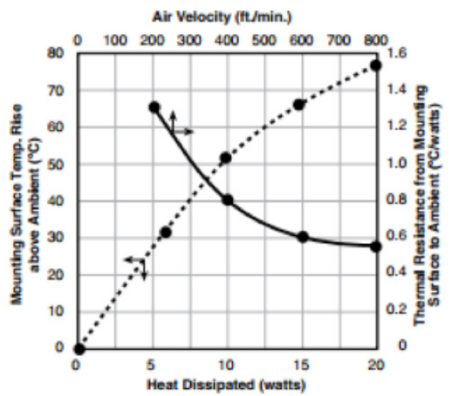
- Minimum assembly cost and labor** - Spring Clips make the mounting holes and fasteners obsolete in assembly operations & reduce costs.
- Design Flexibility** - Universal mountable and "one fits all" give designers total freedom to fit their packaging designs with ideal device pack style and to orient the heat sink to meet their power dissipations with optimized cooling method. (see page 7 of data sheet).

| Part Number | Description                                                    | Length           | Width            | Thermal Resistance @ Forced Air Flow |
|-------------|----------------------------------------------------------------|------------------|------------------|--------------------------------------|
| 678-39-S    | Universal Heat Sink for TO Devices w/Screw Hole, Black Anodize | 1.520" (38.61mm) | 2.362" (60.00mm) | 0.6°C/W @ 600 LFM                    |
| 678-39-C    | Universal Heat Sink for TO Devices w/ Clip, Black Anodize      | 1.520" (38.61mm) | 2.362" (60.00mm) | 0.6°C/W @ 600 LFM                    |

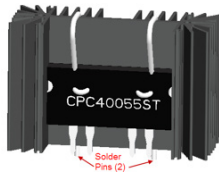
MECHANICAL DIMENSIONS



THERMAL PERFORMANCE

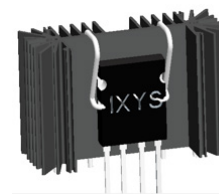


## ONE HEAT SINK FOR ALL PACKAGES



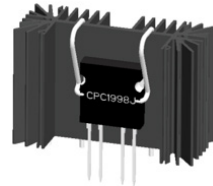
## CPC40055ST PACKAGE

Board level – 2 solder pins    Natural convection – Vertical    Spring Clip



## CPC1998J PACKAGE

Board level – 2 solder pins    Natural convection – Vertical    Spring Clip

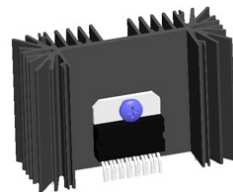


## CPC1968 AND TO-264 PACKAGE

Board level – 2 solder pins    Natural convection – Vertical    Spring Clip

## L4970A PACKAGE

Board level – 2 solder pins    Natural convection – Vertical    Screw attachment

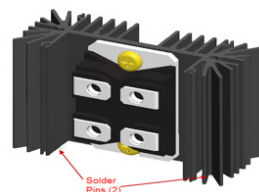


## KBU PACKAGE

Board level – 2 solder pins    Natural convection – Vertical    Spring Clip

## TO-247 AND TO-220 PACKAGE

Board level – 2 solder pins    Natural convection – Vertical    Screw attachment or Spring Clip



## SOT-227 PACKAGE

System level – 2 screws    Natural convection – Vertical

## MOUNTAIN SERIES HEAT SINKS FOR TO-264, TO-247 DEVICES

## MTN-264-27



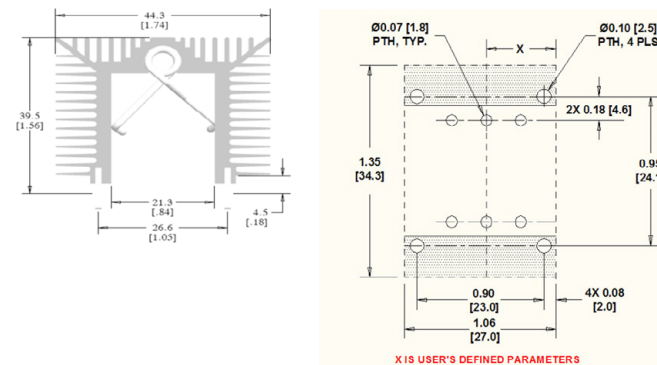
Wakefield-Vette's **Mountain Series Heat Sinks** are high performance, low cost, configurable, scalable and compact with a matrix clip system for TO220, TO-247, TO-264 and other standard packages. This type powerful heat sink provides easiest assembly, largest surface areas, smallest space occupation and all-in-one solution. The power dissipations can be easily increased simply by extending the fin height on each side of the heat sink, while keeping the heat sink height and PCB layout the same. It is the ideal type of heat sink for high power density and small size (1U or 2U) electronic packaging with forced convention cooling.

## FEATURES AND BENEFITS

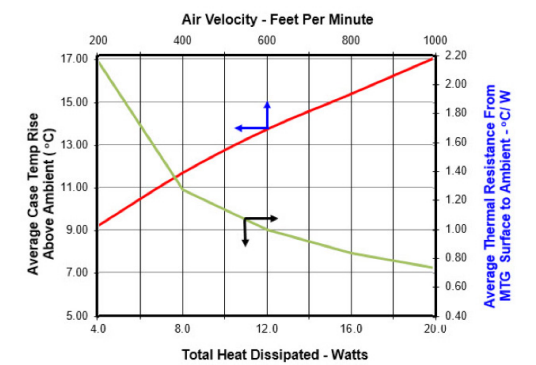
- **Minimum assembly cost and labor** - Spring Clips make the mounting holes and fasteners obsolete in assembly operations and reduce costs.
- **Maximum Thermal Transfer** - Maximum surface area per unit volume, efficient cooling fins & consistent mounting force reduces thermal resistance.
- **Maximum Repeatability** - Constant spring force over repeated assembly/disassembly.
- **Maximum Reliability** - Resilient spring action locks electronic component in place. Fewer parts in assembly and no fasteners and washers required. Prevent short circuit by eliminating metal particles generated from hardware or thread tapping.

| Part Number | Description                              | Type      | Package Cooled    | Attachment Method | Length       | Width           | Height Off Base (Height of Fin) | Thermal Resistance @ Forced Air Flow | Material | Material Finish |
|-------------|------------------------------------------|-----------|-------------------|-------------------|--------------|-----------------|---------------------------------|--------------------------------------|----------|-----------------|
| MTN-264-27  | Heat Sink w/ Two Clips for TO-247 TO-264 | Top Mount | TO-247 and TO-264 | Clip and PC Pin   | 1.06" (27mm) | 1.740" (44.3mm) | 1.56" (39.5mm)                  | 5.5°C/W @ 18 Watts                   | Aluminum | Black Anodized  |

## MECHANICAL DIMENSIONS



## THERMAL RESISTANCE





MOUNTAIN SERIES HEAT SINKS FOR TO-264, TO-247 DEVICES



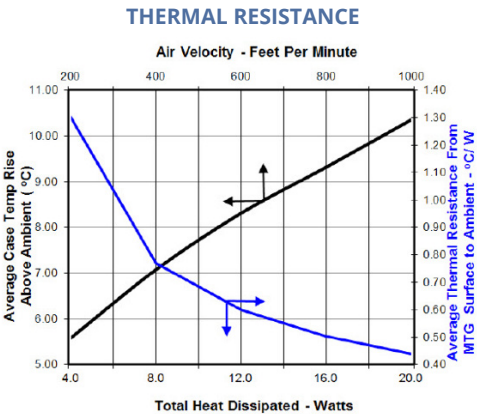
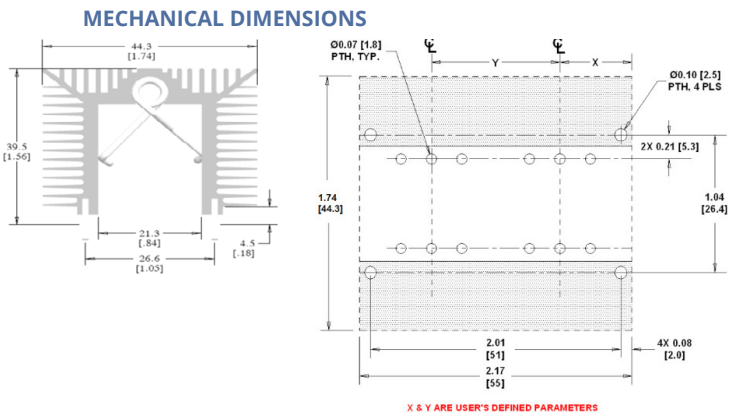
MTN-264-55

Wakefield-Vette's **Mountain Series Heat Sinks** are high performance, low cost, configurable, scalable and compact with a matrix clip system for TO220, TO-247, TO-264 and other standard packages. This type powerful heat sink provides easiest assembly, largest surface areas, smallest space occupation and all-in-one solution. The power dissipations can be easily increased simply by extending the fin height on each side of the heat sink, while keeping the heat sink height and PCB layout the same. It is the ideal type of heat sink for high power density and small size (1U or 2U) electronic packaging with forced convection cooling.

FEATURES AND BENEFITS

- Minimum assembly cost and labor** - Spring Clips make the mounting holes and fasteners obsolete in assembly operations and reduce costs.
- Maximum Thermal Transfer** - Maximum surface area per unit volume, efficient cooling fins & consistent mounting force reduces thermal resistance.
- Maximum Repeatability** - Constant spring force over repeated assembly/disassembly.
- Maximum Reliability** - Resilient spring action locks electronic component in place. Fewer parts in assembly and no fasteners and washers required. Prevent short circuit by eliminating metal particles generated from hardware or thread tapping.

| Part Number | Description                              | Type      | Package Cooled    | Attachment Method | Length         | Width           | Height Off Base (Height of Fin) | Thermal Resistance @ Forced Air Flow | Material | Material Finish |
|-------------|------------------------------------------|-----------|-------------------|-------------------|----------------|-----------------|---------------------------------|--------------------------------------|----------|-----------------|
| MTN-264-55  | Heat Sink w/ Two Clips for TO-247 TO-264 | Top Mount | TO-247 and TO-264 | Clip and PC Pin   | 2.17" (55.1mm) | 1.740" (44.3mm) | 1.56" (39.5mm)                  | 3.7°C/W @ 18 Watts                   | Aluminum | Black Anodized  |

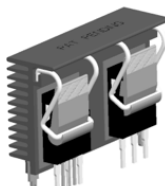


omniKLIP™ SERIES HEAT SINK W/ CLIP(s) FOR TO-DEVICES



HEAT SINKS

OMNI-CLIP-18-L SERIES



omniKlip™

The Wakefield- Vette **omniKlip Heat Sink Series** are a configurable and patented (Pat. Pending) high performance, low cost and compact solutions for TO-220, TO-247 and TO-264 , or similar packages. This powerful heat sink provides tool and fixture free assembly operation, largest surface areas and smallest space occupation. It is the ideal type of heat sink for high power density and small size (1U or 2U) electronic packaging with forced convection cooling.

SPECIFICATIONS

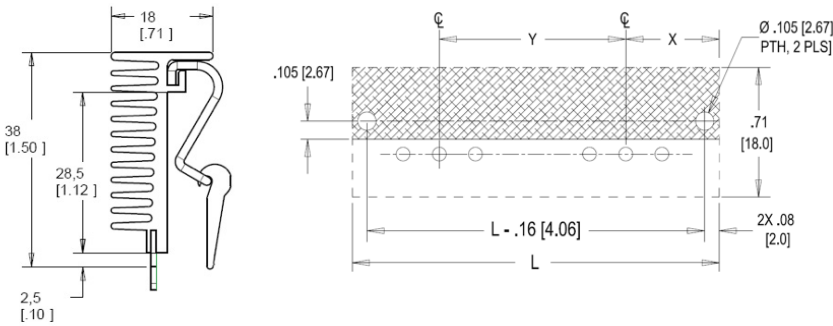
- Heat Sink:** Aluminum Alloy 6063-T5 or Equivalent with black anodized finish.
- Spring Clip:** Music Wire, Per ASTM A228 with bright nickel plating
- Solder Foot:** Cold-rolled Steel, Per ASTM A-366 with pure tin over copper strike. RoHS compliant.

FEATURES AND BENEFITS

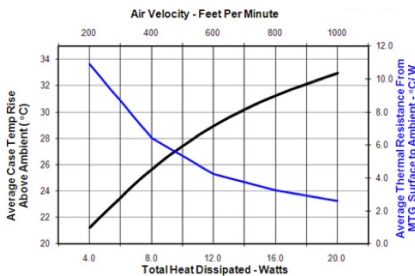
- Minimum assembly cost and labor** - Spring Clips make the mounting holes, fasteners, tools and fixtures obsolete in assembly operations & reduce costs.
- Maximum Repeatability** - Constant spring force over repeated assembly/disassembly
- Maximum Reliability** - Resilient spring action locks electronic component in place. Fewer parts in assembly and no fasteners and washers required. Prevent short circuit by eliminating metal particles generated from hardware or thread tapping
- Design Flexibility** - Maximum flexibility for dynamic device locations and power up grading. **"Configure-to-Fit"** gives designers total freedom to configure heat sink needed to fit their dynamic design environments.

| WkV Part Number   | Description                                                                   | Related Clip | Package Cooled | Length           | Width            | Height Off Base (Height of Fin) |
|-------------------|-------------------------------------------------------------------------------|--------------|----------------|------------------|------------------|---------------------------------|
| OMNI-UNI-18-25    | OmniKlip Heat Sink, 18mm wide, 25mm long, black anodized for TO-247 & TO-264  | OMNI-UC      | TO-247, TO-264 | 0.984" (25.00mm) | 1.500" (38.10mm) | 0.710" (18.03mm)                |
| OMNI-UNI-18-50    | OmniKlip Heat Sink, 18mm wide, 50mm long, black anodized for TO-247 & TO-264  | OMNI-UC      | TO-247, TO-264 | 1.969" (50.00mm) | 1.500" (38.10mm) | 0.710" (18.03mm)                |
| OMNI-UNI-18-75    | OmniKlip Heat Sink, 18mm wide, 75mm long, black anodized for TO-247 & TO-264  | OMNI-UC      | TO-247, TO-264 | 2.95" (75.00mm)  | 1.500" (38.10mm) | 0.710" (18.03mm)                |
| OMNI-220-18-25-1C | OmniKlip Heat Sink w/1 clip, 18mm wide, 25mm long, black anodized for TO-220  |              | TO-220         | 0.984" (25.00mm) | 1.500" (38.10mm) | 0.710" (18.03mm)                |
| OMNI-220-18-50-2C | OmniKlip Heat Sink w/2 clips, 18mm wide, 50mm long, black anodized for TO-220 |              | TO-220         | 1.969" (50.00mm) | 1.500" (38.10mm) | 0.710" (18.03mm)                |
| OMNI-220-18-75-3C | OmniKlip Heat Sink w/3 clips, 18mm wide, 75mm long, black anodized for TO-220 |              | TO-220         | 2.95" (75.00mm)  | 1.500" (38.10mm) | 0.710" (18.03mm)                |

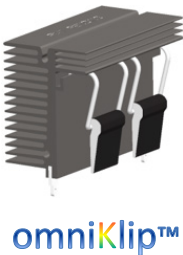
MECHANICAL DIMENSIONS



THERMAL PERFORMANCE (OMNI-UNI-18)  
TWO TO-247 DEVICES WITH SIL-PAD 900s  
L = 500mm[2.0"]



OmniKLIP™ SERIES HEAT SINK W/ CLIP(s) FOR TO-DEVICES



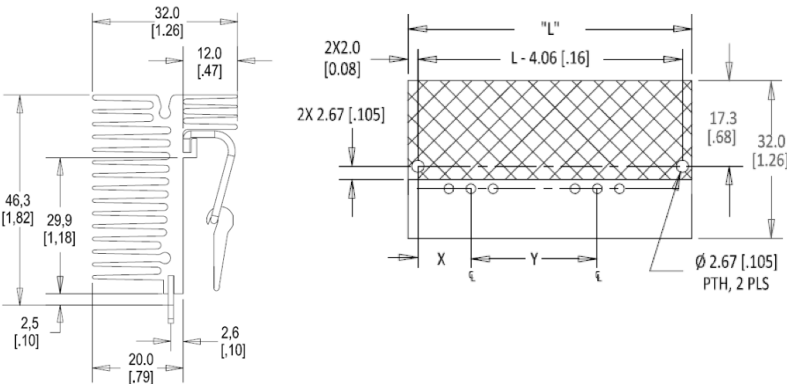
OMNI-UNI-32-L SERIES

HEAT SINKS

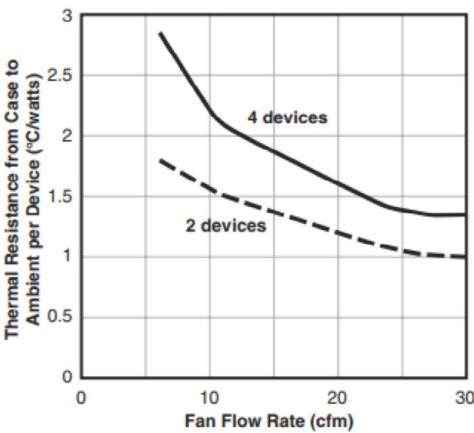


| WkV Part Number | Description                                                                                               | Related Cross Sell Part | Package Cooled | Shape             | Length       | Width        | Height Off Base (Height of Fin) |
|-----------------|-----------------------------------------------------------------------------------------------------------|-------------------------|----------------|-------------------|--------------|--------------|---------------------------------|
| OMNI-UNI-32-58  | OmniKlip Heat Sink for 2 universal 2 clips, 32mm wide, 58mm long, black anodized for any TO except TO-220 | OMNI-UC, OMNI-220C      | TO-247, TO-264 | Rectangular, Fins | 2.28" (58mm) | 1.25" (32mm) | 1.62" (46.3mm)                  |

MECHANICAL DIMENSIONS

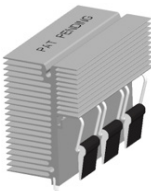


THERMAL PERFORMANCE



HEAT SINKS

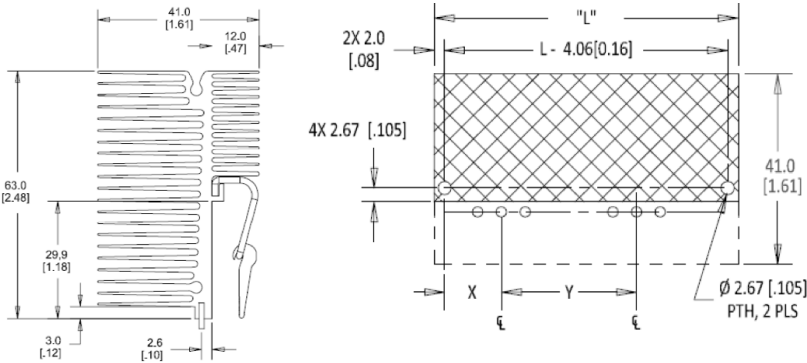
OMNI-UNI-41-L SERIES



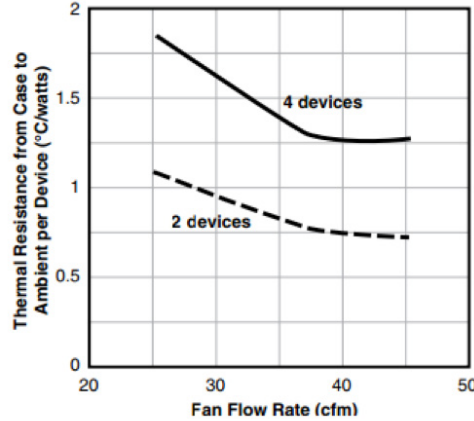
omniKlip™

| WkV Part Number | Description                                                                                               | Related Cross Sell Part | Package Cooled | Shape             | Length       | Width        | Height Off Base (Height of Fin) |
|-----------------|-----------------------------------------------------------------------------------------------------------|-------------------------|----------------|-------------------|--------------|--------------|---------------------------------|
| OMNI-UNI-41-75  | OmniKlip Heat Sink for 2 universal 2 clips, 41mm wide, 75mm long, black anodized for any TO except TO-220 | OMNI-UC, OMNI-220C      | TO-247, TO-264 | Rectangular, Fins | 2.95" (75mm) | 1.61" (41mm) | 1.62" (46.3mm)                  |

MECHANICAL DIMENSIONS



THERMAL PERFORMANCE

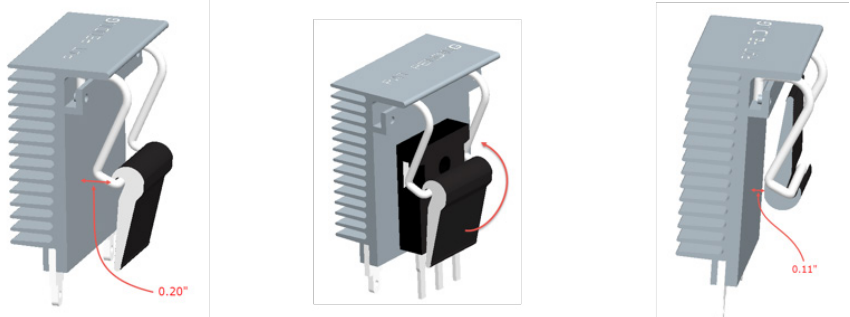


OMNIKLIPS™

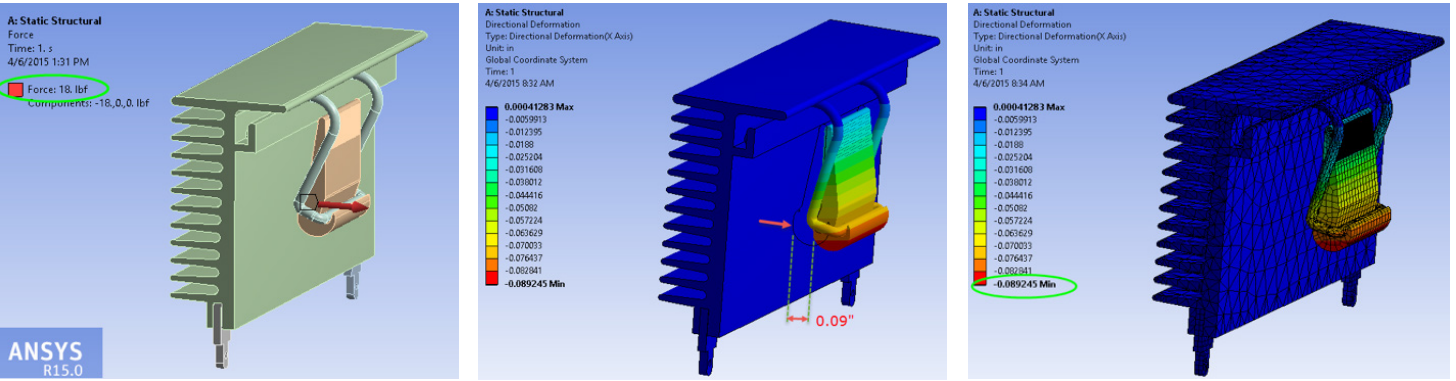


omniKlip™

| Part Number | Description                                                   |
|-------------|---------------------------------------------------------------|
| OMNI-UC     | Universal Clip for omniKlip Heat Sink for any TO except TO220 |
| OMNI-220C   | Clip for omniKlip Heat Sink for TO 220                        |



Universal Clip mechanism is rotating the bar by 180°. The eccentric circle will raise 0.09". This deformation will exert the force on the components.



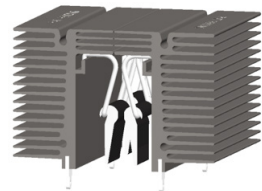
omniKlip assembly model in ANSYS, with 18 lbf load applied to the clip

Under the 18 lbf, the clip deformed 0.09" from its original position to the final

Directional deformation plot as shown.

With the FEA analysis and simulation, the force applied to the TO-series components will be at least 18 lbs.

ADDITIONAL CONFIGURATIONS

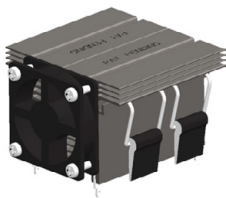


**OMNI-UNI-32-L SERIES** FACE TO FACE MOUNTING (SPACE SAVER)

omniKlip™

BACK TO BACK MOUNTING WITH 40MM FAN

**OMNI-UNI-32-L SERIES**



omniKlip™

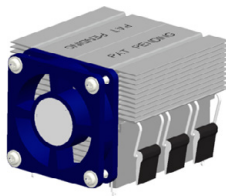


**OMNI-UNI-41-L SERIES** FACE TO FACE MOUNTING (SPACE SAVER)

omniKlip™

BACK TO BACK MOUNTING WITH 60MM FAN

**OMNI-UNI-41-L SERIES**



omniKlip™



# EXTRUDED SERIES HEAT SINKS

- Extruded Heat Sinks For Power Semiconductors* ..... 88-92
- Performance, Low Profile Heat Sinks For Power Modules & IGBT's* ..... 93
- Extruded Heat Sinks For DC/DC Converters*..... 94-96
- Mounting Hardware For Extruded Heat Sinks*..... 95



*For cooling single and multiple high power devices packaged in industry standard semiconductor case styles: TO-3 to TO-247, DO-4 to DO-30, hex-type, and stud mount; press pack devices; power modules; SCRs, IGBTs; I/O devices; and other isolated flat base devices in both natural and forced convection.*

EXTRUDED HEAT SINKS FOR POWER SEMICONDUCTORS

621 & 623 SERIES

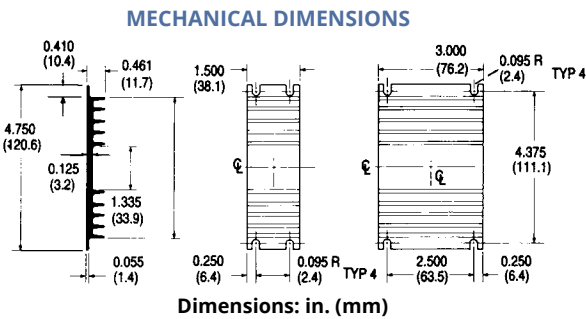
LOW-PROFILE HEAT SINKS FOR ALL METAL-CASE  
POWER SEMICONDUCTORS

TO-3

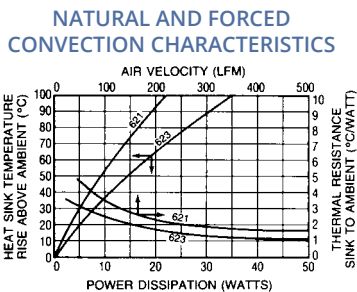
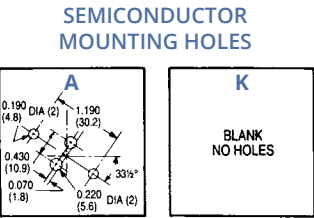
A general purpose yet efficient heat dissipator for TO-3 and virtually all other styles of metal case power semiconductor package types, the **621 and 623 Series** low-profile flat back heat sinks find a wide variety of applications. The central channel between fins measures 1.300 in. (33.0) (min.) in width, accommodating many types of packages. Mounting hole pattern "A" is pre-drilled for the standard TO-3 package.

| Standard P/N | Footprint Dimensions in. (mm) | Height in. (mm) | Mounting Hole Pattern | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|-------------------------------|-----------------|-----------------------|-------------------------------------|-------------------|---------------------|
|              |                               |                 |                       | Natural Convection                  | Forced Convection |                     |
| 621A         | 4.750 (120.6) x 1.500 (38.1)  | 0.461 (11.7)    | (1) TO-3              | 75°C @ 15W                          | 2.0°C/W @ 250 LFM | 0.1000 (45.36)      |
| 621K         | 4.750 (120.6) x 1.500 (38.1)  | 0.461 (11.7)    | None                  | 75°C @ 15W                          | 2.0°C/W @ 250 LFM | 0.1000 (45.36)      |
| 623A         | 4.750 (120.6) x 3.000 (76.2)  | 0.461 (11.7)    | (1) TO-3              | 52°C @ 15W                          | 1.5°C/W @ 250 LFM | 0.2100 (95.26)      |
| 623K         | 4.750 (120.6) x 3.000 (76.2)  | 0.461 (11.7)    | None                  | 52°C @ 15W                          | 1.5°C/W @ 250 LFM | 0.2100 (95.26)      |

Material: Aluminum Alloy, Black Anodized.



(EXTRUSION PROFILE 1327)



COMPACT HEAT SINKS FOR DUAL  
STUD-MOUNTED SEMICONDUCTOR CASES

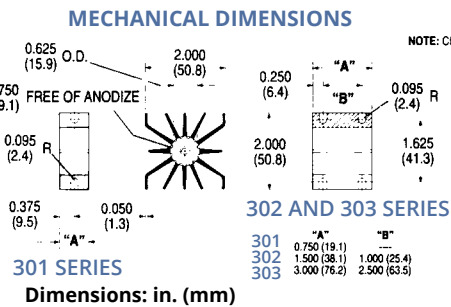
301, 302, &  
303 SERIES

Stud-Mount

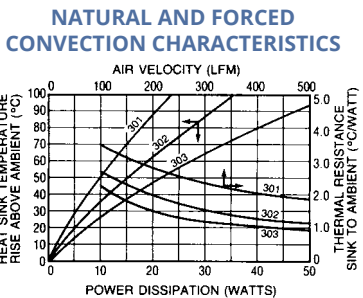
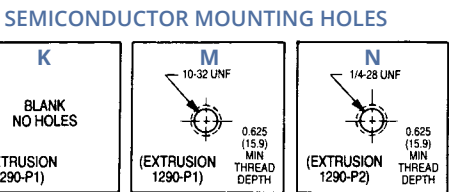
The large fin area in minimum total volume provided by the radial design of the **301/302/303 Series** offers maximum heat transfer efficiency in natural convection. All types are available with one tapped mounting hole for rectifiers and other stud-mounting semiconductors; the 302 and 303 Series offer maximum cost savings with dual mounting locations ("MM" and "NN" mounting hole patterns) for two stud-mount devices.

| Standard P/N | Outline Dimensions in. (mm) | Length "A" in. (mm) | Mounting Hole(s) Pattern and Number    | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|-----------------------------|---------------------|----------------------------------------|-------------------------------------|-------------------|---------------------|
|              |                             |                     |                                        | Natural Convection                  | Forced Convection |                     |
| 301K         | 2.000 (50.8) x 2.000 (50.8) | 0.750 (19.1)        | None                                   | 70°C @ 15W                          | 2.5°C/W @ 250 LFM | 0.0580 (26.31)      |
| 301M         | 2.000 (50.8) x 2.000 (50.8) | 0.750 (19.1)        | (1) 10-32UNF, 0.625 in. thread depth   | 70°C @ 15W                          | 2.5°C/W @ 250 LFM | 0.0580 (26.31)      |
| 301N         | 2.000 (50.8) x 2.000 (50.8) | 0.750 (19.1)        | (1) 1/4 -28UNF, 0.625 in. thread depth | 70°C @ 15W                          | 2.5°C/W @ 250 LFM | 0.0580 (26.31)      |
| 302M         | 2.000 (50.8) x 2.000 (50.8) | 1.500 (38.1)        | (1) 10-32UNF, 0.625 in. thread depth   | 50°C @ 15W                          | 1.8°C/W @ 250 LFM | 0.1330 (60.33)      |
| 302MM        | 2.000 (50.8) x 2.000 (50.8) | 1.500 (38.1)        | (2) 10-32UNF, 0.625 in. thread depth   | 50°C @ 15W                          | 1.8°C/W @ 250 LFM | 0.1330 (60.33)      |
| 302N         | 2.000 (50.8) x 2.000 (50.8) | 1.500 (38.1)        | (1) 1/4 -28UNF, 0.625 in. thread depth | 50°C @ 15W                          | 1.8°C/W @ 250 LFM | 0.1330 (60.33)      |
| 302NN        | 2.000 (50.8) x 2.000 (50.8) | 1.500 (38.1)        | (2) 1/4 -28UNF, 0.625 in. thread depth | 50°C @ 15W                          | 1.8°C/W @ 250 LFM | 0.1330 (60.33)      |
| 303M         | 2.000 (50.8) x 2.000 (50.8) | 3.000 (76.2)        | (1) 10-32UNF, 0.625 in. thread depth   | 37°C @ 15W                          | 1.3°C/W @ 250 LFM | 0.2680 (121.56)     |
| 303MM        | 2.000 (50.8) x 2.000 (50.8) | 3.000 (76.2)        | (2) 10-32UNF, 0.625 in. thread depth   | 37°C @ 15W                          | 1.3°C/W @ 250 LFM | 0.2680 (121.56)     |
| 303N         | 2.000 (50.8) x 2.000 (50.8) | 3.000 (76.2)        | (1) 1/4 -28UNF, 0.625 in. thread depth | 37°C @ 15W                          | 1.3°C/W @ 250 LFM | 0.2680 (121.56)     |
| 303NN        | 2.000 (50.8) x 2.000 (50.8) | 3.000 (76.2)        | (2) 1/4 -28UNF, 0.625 in. thread depth | 37°C @ 15W                          | 1.3°C/W @ 250 LFM | 0.2680 (121.56)     |

Material: Aluminum Alloy, Black Anodized.



NOTE: CROSS-HATCHED AREAS FREE OF ANODIZE



DOUBLE-SURFACE HEAT SINKS  
FOR TO-3 CASE STYLES

401 & 403 SERIES

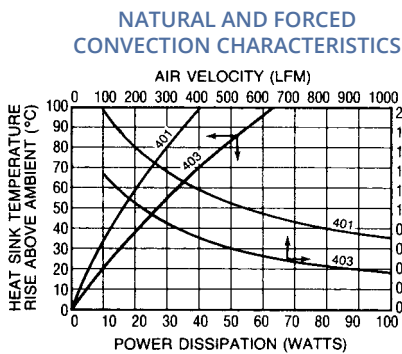
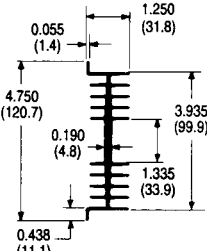
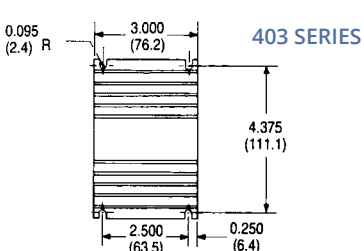
TO-3; Stud-Mount

With fins oriented vertically in cabinet sidewall applications, **401 and 403 Series** heat sinks are recommended for critical space applications where maximum heat dissipation is required for high-power TO-3 case styles. Forced convection performance is also exemplary with these double surface fin types. Semiconductor mounting hole style "F" offers a single centered 0.270 in. (6.9)-diameter mounting hole (with a 0.750 in. (19.1)-diameter area free of anodize) for mounting stud-type diodes and rectifiers. Hole pattern "V" available upon request.

| Standard P/N | Width in. (mm) | Overall Dimensions in. (mm) | Height in. (mm) | Semiconductor Mounting Hole Pattern | Thermal Performance at Typical Load |                   | Weight lbs. (grams) |
|--------------|----------------|-----------------------------|-----------------|-------------------------------------|-------------------------------------|-------------------|---------------------|
|              |                |                             |                 |                                     | Natural Convection                  | Forced Convection |                     |
| 401A         | 4.750 (120.7)  | 1.500 (38.1)                | 1.250 (31.8)    | (1) TO-3                            | 80°C @ 30W                          | 1.5°C/W @ 250 LFM | 0.1500 (68.04)      |
| 401F         | 4.750 (120.7)  | 1.500 (38.1)                | 1.250 (31.8)    | 0.270 in. (6.9)-Dia Hole            | 80°C @ 30W                          | 1.5°C/W @ 250 LFM | 0.1500 (68.04)      |
| 401K         | 4.750 (120.7)  | 1.500 (38.1)                | 1.250 (31.8)    | None                                | 80°C @ 30W                          | 1.5°C/W @ 250 LFM | 0.1500 (68.04)      |
| 403A         | 4.750 (120.7)  | 3.000 (76.2)                | 1.250 (31.8)    | (1) TO-3                            | 55°C @ 30W                          | 0.9°C/W @ 250 LFM | 0.3500 (158.76)     |
| 403F         | 4.750 (120.7)  | 3.000 (76.2)                | 1.250 (31.8)    | 0.270 in. (6.9)-Dia Hole            | 55°C @ 30W                          | 0.9°C/W @ 250 LFM | 0.3500 (158.76)     |
| 403K         | 4.750 (120.7)  | 3.000 (76.2)                | 1.250 (31.8)    | None                                | 55°C @ 30W                          | 0.9°C/W @ 250 LFM | 0.3500 (158.76)     |

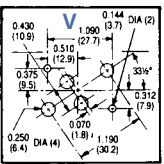
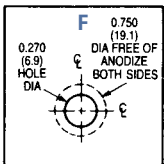
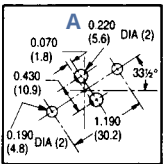
Material: Aluminum Alloy, Black Anodized.

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

SEMICONDUCTOR MOUNTING HOLES



(EXTRUSION PROFILE 1024)

441 SERIES

HIGH-PERFORMANCE NATURAL CONVECTION HEAT  
SINKS FOR RECTIFIERS AND DIODES

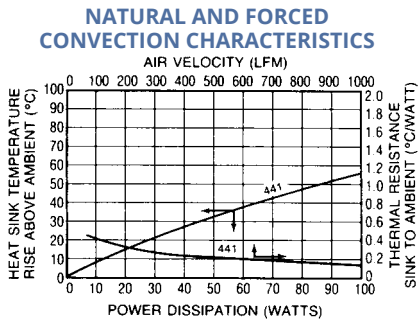
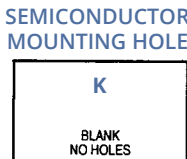
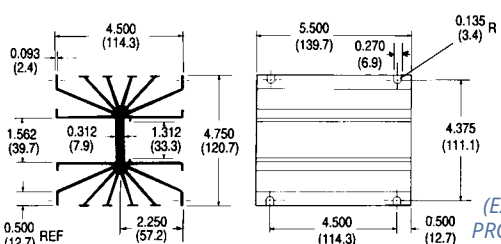
Stud-Mount

Designed for vertical mounting within a power supply enclosure or equipment cabinet without forced airflow available. This Wakefield-Vette **441 Series** heat sink will dissipate up to 100 watts efficiently in natural convection with a maximum 55°C heat sink temperature rise above ambient. When applied in a forced convection environment, the 441K Type will achieve thermal resistance of 0.18°C/W (sink to ambient) at 1000 LFM. Supplied with no pre-drilled device mounting hole pattern.

| Standard P/N | Nominal Dimensions |                 |                 | Semiconductor Mounting Hole Pattern | Thermal Performance at Typical Load |                                          | Weight lbs. (grams) |
|--------------|--------------------|-----------------|-----------------|-------------------------------------|-------------------------------------|------------------------------------------|---------------------|
|              | Width in. (mm)     | Length in. (mm) | Height in. (mm) |                                     | Natural Convection                  | Forced Convection                        |                     |
| 441K         | 4.750 (120.7)      | 5.500 (139.7)   | 4.500 (114.3)   | None                                | 34°C @ SOW<br>47°C @ 80W            | 0.30°C/W @ 250 LFM<br>0.19°C/W @ 600 LFM | 1.9700 (893.59)     |

Material: Aluminum Alloy, Black Anodized.

MECHANICAL DIMENSIONS



Dimensions: in. (mm)



EXTRUDED HEAT SINKS FOR POWER SEMICONDUCTORS

413, 421, & 423 SERIES

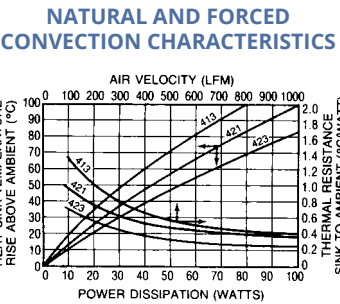
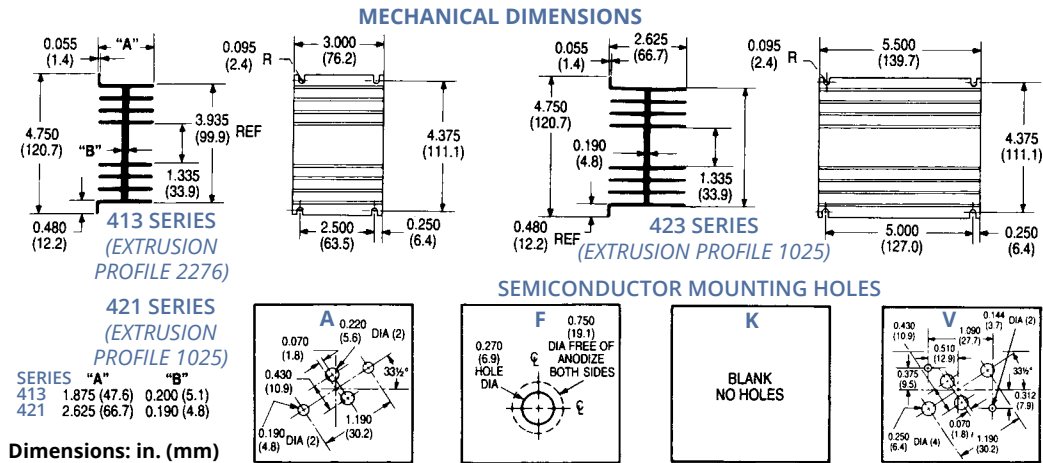
LOW-HEIGHT DOUBLE-SURFACE HEAT SINKS FOR TO-3 CASE STYLES AND DIODES

TO-3; DO-5; Stud-Mount

Space-saving double surface **413, 421, and 423 Series** utilize finned surface area on both sides of the power semiconductor mounting surface to provide maximum heat dissipation in a compact profile. Ready to install on popular power components in natural and forced convection applications. Apply Wakefield-Vette Type 126 silicone-free thermal compound or Wakefield-Vette DeltaPad™ interface materials for maximum performance.

| Standard P/N | Nominal Dimensions |                 |                     | Semiconductor Mounting Hole Pattern | Thermal Performance at Typical Load |                    | Weight lbs. (grams) |
|--------------|--------------------|-----------------|---------------------|-------------------------------------|-------------------------------------|--------------------|---------------------|
|              | Width in. (mm)     | Length in. (mm) | Height "A" in. (mm) |                                     | Natural Convection                  | Forced Convection  |                     |
| 413A         | 4.750 (120.7)      | 3.000 (76.2)    | 1.875 (47.6)        | (1) TO-3                            | 72°C @ 50W                          | 0.85°C/W @ 250 LFM | 0.6300 (285.77)     |
| 413F         | 4.750 (120.7)      | 3.000 (76.2)    | 1.875 (47.6)        | 0.270 in. (6.9)-Dia Hole            | 72°C @ 50W                          | 0.85°C/W @ 250 LFM | 0.6300 (285.77)     |
| 413K         | 4.750 (120.7)      | 3.000 (76.2)    | 1.875 (47.6)        | None                                | 72°C @ 50W                          | 0.85°C/W @ 250 LFM | 0.6300 (285.77)     |
| 421A         | 4.750 (120.7)      | 3.000 (76.2)    | 2.625 (66.7)        | (1) TO-3                            | 58°C @ 50W                          | 0.7°C/W @ 250 LFM  | 0.6300 (285.77)     |
| 421F         | 4.750 (120.7)      | 3.000 (76.2)    | 2.625 (66.7)        | 0.270 in. (6.9)-Dia Hole            | 58°C @ 50W                          | 0.7°C/W @ 250 LFM  | 0.6300 (285.77)     |
| 421K         | 4.750 (120.7)      | 3.000 (76.2)    | 2.625 (66.7)        | None                                | 58°C @ 50W                          | 0.7°C/W @ 250 LFM  | 0.6300 (285.77)     |
| 423A         | 4.750 (120.7)      | 5.500 (140.2)   | 2.625 (66.7)        | (1) TO-3                            | 47°C @ 50W                          | 0.5°C/W @ 250 LFM  | 1.1700 (530.71)     |
| 423K         | 4.750 (120.7)      | 5.500 (140.2)   | 2.625 (66.7)        | None                                | 47°C @ 50W                          | 0.5°C/W @ 250 LFM  | 1.1700 (530.71)     |

Material: Aluminum Alloy, Black Anodized.

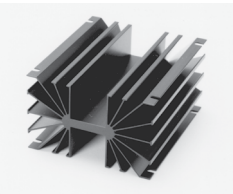


HIGH-PERFORMANCE HEAT SINKS FOR 30-100W METAL POWER SEMICONDUCTORS

431 & 433 SERIES

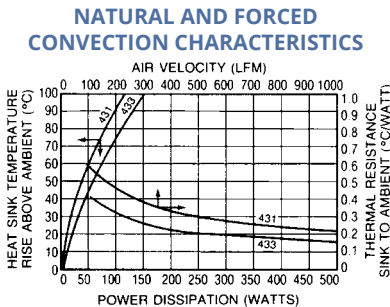
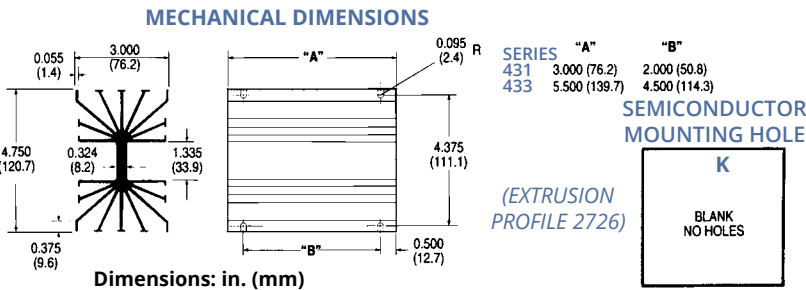
TO-3; Stud-Mount

Need maximum heat dissipation from a TO-3 rectifier heat sink in minimum space? The Wakefield-Vette **431 and 433 Series** center channel double-surface heat sinks offer the highest performance-to-weight ratio for minimum volume occupied for TO-3, diode, and stud-mount metal power semiconductors in the 30- to 100-watt operating range. Additional interface resistance reduction for maximized overall performance can be achieved with proper application of Wakefield-Vette Type 126 silicone-free thermal compound.



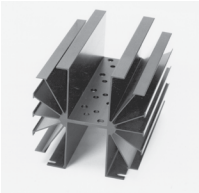
| Standard P/N | Nominal Dimensions |                     |                 | Semiconductor Mounting Hole Pattern | Thermal Performance at Typical Load |                    | Weight lbs. (grams) |
|--------------|--------------------|---------------------|-----------------|-------------------------------------|-------------------------------------|--------------------|---------------------|
|              | Width in. (mm)     | Length "A" in. (mm) | Height in. (mm) |                                     | Natural Convection                  | Forced Convection  |                     |
| 431K         | 4.750 (120.7)      | 3.000 (76.2)        | 3.000 (76.2)    | None                                | 55°C @ 50W                          | 0.40°C/W @ 250 LFM | 0.7800 (353.81)     |
| 433K         | 4.750 (120.7)      | 5.500 (139.7)       | 3.000 (76.2)    | None                                | 42°C @ 50W                          | 0.28°C/W @ 250 LFM | 1.4900 (675.86)     |

Material: Aluminum Alloy, Black Anodized.



LIGHTWEIGHT QUADRUPLE MOUNT HEAT SINK FOR TO-3 CASE STYLES

435 SERIES

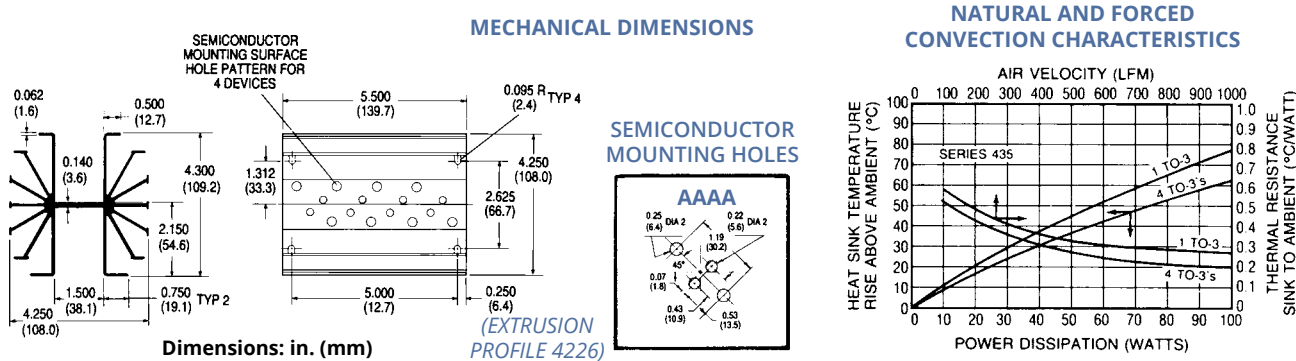


TO-3

This lightweight high-performance heat sink is designed to mount and cool efficiently one to four TO-3 style metal case power semiconductors. The Type 435AAAA is the standard configuration available from stock, pre-drilled for mounting four TO-3 style devices. Increased performance can be achieved with the proper selection and installation of a Wakefield-Vette Type 175 DeltaPad Kapton™ interface material for each power semiconductor or, for maximum reduction of case-to-sink interface loss, the application of Wakefield-Vette Type 126 silicone-free thermal compound.

| Standard P/N | Nominal Dimensions |                 |                 | Semiconductor Mounting Hole Pattern | Thermal Performance at Typical Load |                                          | Weight lbs. (grams) |
|--------------|--------------------|-----------------|-----------------|-------------------------------------|-------------------------------------|------------------------------------------|---------------------|
|              | Width in. (mm)     | Length in. (mm) | Height in. (mm) |                                     | Natural Convection                  | Forced Convection                        |                     |
| 435AAAA      | 4.250 (108.0)      | 5.500 (139.7)   | 4.300 (109.2)   | (4) TO-3                            | 37°C @ 50W<br>54°C @ 80W            | 0.38°C/W @ 250 LFM<br>0.24°C/W @ 600 LFM | 1.1500 (521.64)     |

Material: Aluminum Alloy, Black Anodized.



486 & 489 SERIES

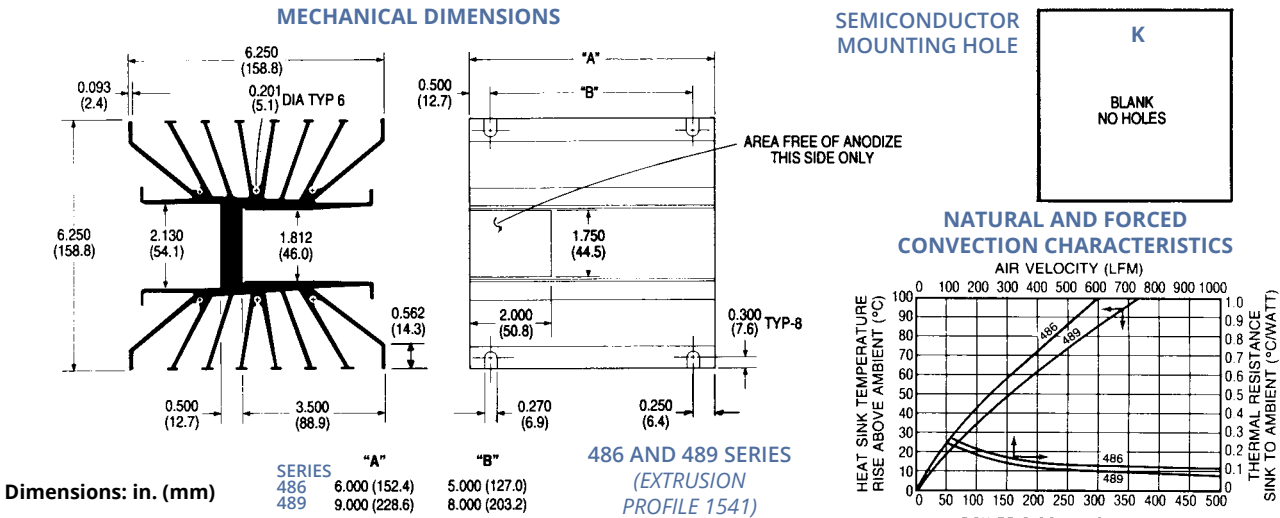
HEAT SINKS FOR HIGH-POWER HEX-TYPE RECTIFIERS AND DIODES

Stud-Mount

These two heat sink types accept industry standard 1.750 in. (44.5) hex-type devices for mounting and efficient heat dissipation. Each type is provided with a 1.750 in. (44.5) x 2.000 in. (50.8) area on the semiconductor base mounting surface which is free of anodize.

| Standard P/N | Nominal Dimensions |                 |                 | Hex Style Type | Mounting Hole Pattern | Thermal Performance at Typical Load |                                          | Weight lbs. (grams) |
|--------------|--------------------|-----------------|-----------------|----------------|-----------------------|-------------------------------------|------------------------------------------|---------------------|
|              | Width in. (mm)     | Length in. (mm) | Height in. (mm) |                |                       | Natural Convection                  | Forced Convection                        |                     |
| 486K         | 6.250 (158.8)      | 6.000 (152.4)   | 6.250 (158.8)   | 1.750 in. Hex  | None                  | 24°C @ 50W<br>86°C @ 250W           | 0.20°C/W @ 250 LFM<br>0.13°C/W @ 500 LFM | 4.2100 (1909.66)    |
| 489K         | 6.250 (158.8)      | 9.000 (228.6)   | 6.250 (158.8)   | 1.750 in. Hex  | None                  | 19°C @ 50W<br>75°C @ 250W           | 0.15°C/W @ 250 LFM<br>0.10°C/W @ 500 LFM | 6.1400 (2785.10)    |

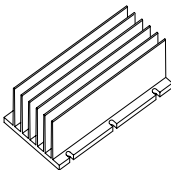
Material: Aluminum Alloy, Black Anodized.







EXTRUDED HEAT SINKS FOR DC/DC CONVERTERS



557, 558, & 559 SERIES

HEAT SINKS FOR “FULL-BRICK”  
DC/DC CONVERTERS

TO-220 and TO-218

FEATURES AND BENEFITS

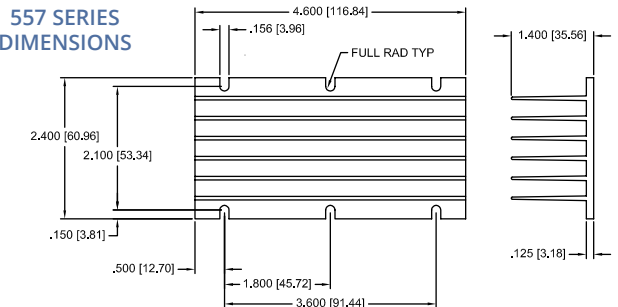
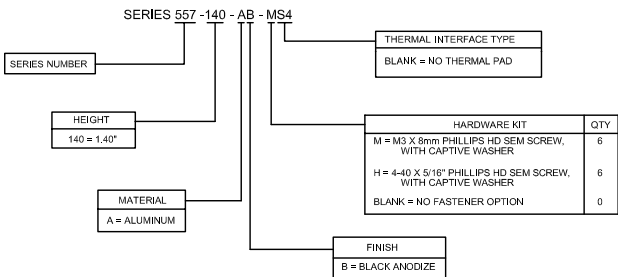
- Standard mounting hole pattern mates with Vicor DC/DC converters.
- Aluminum extruded fin construction keeps DC/DC converter modules cool in both forced and natural convection applications.
- Three fin heights, two flow direction options.
- Black anodized finish standard.
- Integral thermal interface pad option eliminates need to order and install pad separately.
- Ordering a single part number with the hardware kit option provides everything necessary to keep your converter cool.

| Standard P/N | Footprint Dimensions in. (mm) | Height in. (mm) | Fin Orientation | Number of Fins | Forced Convection Thermal Resistance at 300 ft/min (C/W) | Natural Convection Power Dissipation (Watts) 40°C Rise Heat Sink to Ambient |
|--------------|-------------------------------|-----------------|-----------------|----------------|----------------------------------------------------------|-----------------------------------------------------------------------------|
| 557-140AB    | 4.60 (116.8) x 2.40 (61.0)    | 1.40 (35.6)     | Horizontal      | 6              | 1.3                                                      | 14                                                                          |
| 558-75AB     | 2.40 (61.0) x 4.60 (116.8)    | 0.75 (19.1)     | Vertical        | 16             | 1.8                                                      | 12                                                                          |
| 559-50AB     | 2.40 (61.0) x 4.60 (116.8)    | 0.50 (12.7)     | Vertical        | 27             | 2.2                                                      | 10                                                                          |

Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS

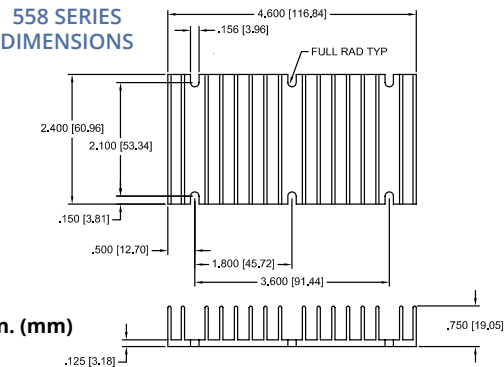
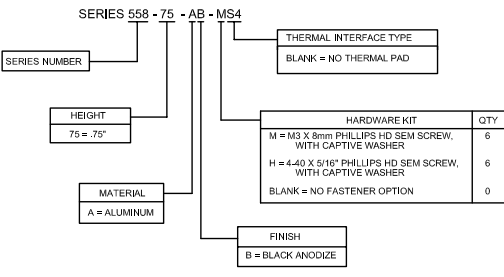
PRODUCT DESIGNATION



Dimensions: in. (mm)

MECHANICAL DIMENSIONS

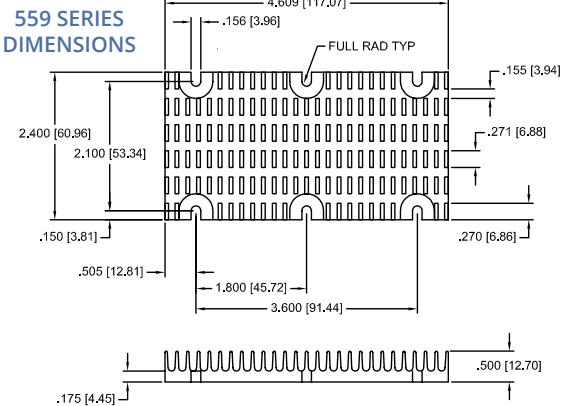
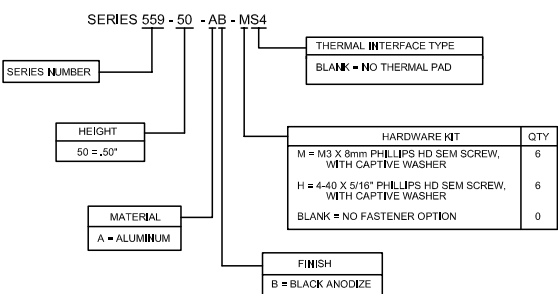
PRODUCT DESIGNATION



Dimensions: in. (mm)

MECHANICAL DIMENSIONS

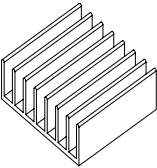
PRODUCT DESIGNATION



Dimensions: in. (mm)

HEAT SINKS FOR “HALF-BRICK”  
DC/DC CONVERTERS

517, 527, 518, & 528 SERIES



FEATURES AND BENEFITS

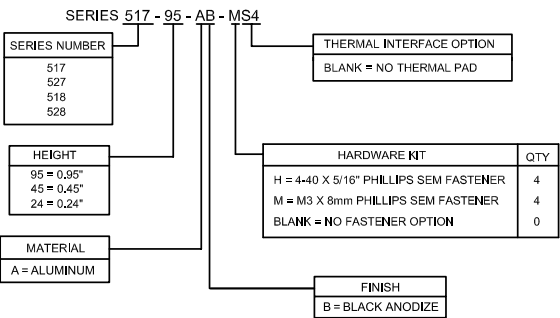
- Standard mounting hole patterns mate with the majority of “half-brick” DC/DC converters on the market.
- Aluminum extruded fin construction keeps DC/DC converter modules cool in both forced and natural convection applications.
- Vertical and horizontal fin configurations available in a variety of heights.
- Black anodized finish standard.
- Integral thermal interface pad option eliminates need to order and install pad separately.
- Ordering a single part number with the hardware kit option provides everything necessary to keep your converter cool.

| Standard P/N | Footprint Dimensions in. (mm) | Height in. (mm) | Fin Orientation | Number of Fins | Thermal Performance                                                         |                                                          |
|--------------|-------------------------------|-----------------|-----------------|----------------|-----------------------------------------------------------------------------|----------------------------------------------------------|
|              |                               |                 |                 |                | Natural Convection Power Dissipation (Watts) 60°C Rise Heat Sink to Ambient | Forced Convection Thermal Resistance at 300 ft/min (C/W) |
| 517-95AB     | 2.28 (57.9) x 2.40 (61.0)     | 0.95 (24.1)     | Horizontal      | 8              | 11W                                                                         | 2.0                                                      |
| 527-45AB     | 2.28 (57.9) x 2.40 (61.0)     | 0.45 (11.4)     | Horizontal      | 11             | 7W                                                                          | 3.2                                                      |
| 527-24AB     | 2.28 (57.9) x 2.40 (61.0)     | 0.24 (6.1)      | Horizontal      | 11             | 5W                                                                          | 5.8                                                      |
| 518-95AB     | 2.40 (61.0) x 2.28 (57.9)     | 0.95 (24.1)     | Horizontal      | 8              | 11W                                                                         | 2.0                                                      |
| 528-45AB     | 2.40 (61.0) x 2.28 (57.9)     | 0.45 (11.4)     | Vertical        | 11             | 7W                                                                          | 3.2                                                      |
| 528-24AB     | 2.40 (61.0) x 2.28 (57.9)     | 0.24 (6.1)      | Vertical        | 11             | 5W                                                                          | 5.8                                                      |

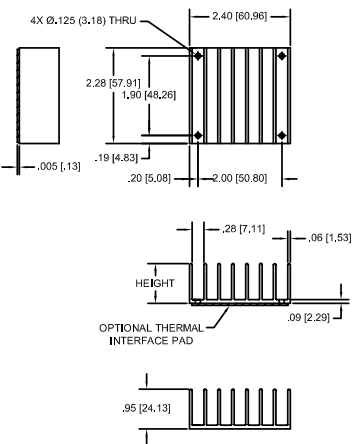
Material: Aluminum, Black Anodized

MECHANICAL DIMENSIONS

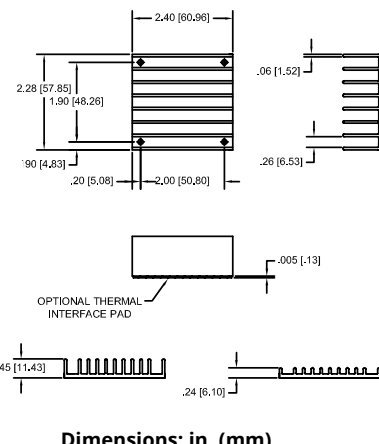
PRODUCT DESIGNATION



517/527 SERIES DIMENSIONS



518/528 SERIES DIMENSIONS



Dimensions: in. (mm)

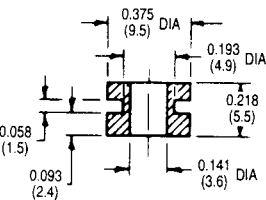
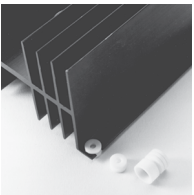
MOUNTING HARDWARE FOR EXTRUDED HEAT SINKS

100 SERIES

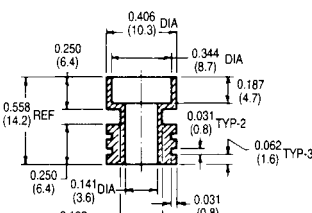
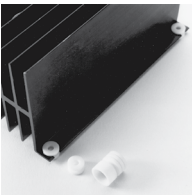
TEFLON MOUNTING INSULATORS

| Standard P/N | Description            | For Use with Series     | Mounting Hardware | Material | Hipot Rating (VAC) | Weight lbs. (grams) |
|--------------|------------------------|-------------------------|-------------------|----------|--------------------|---------------------|
| 103          | Spool-shaped insulator | 300, 400, 600, 111, 113 | #6-32 screw       | Teflon   | 1500               | 0.00012 (0.05)      |
| 107          | Spool-shaped insulator | 300, 400, 600, 111, 113 | #6-32 screw, nut  | Teflon   | 5000               | 0.0034 (1.54)       |

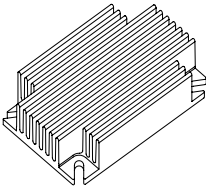
103 SERIES



107 SERIES



EXTRUDED HEAT SINKS FOR DC/DC CONVERTERS



537 & 547 SERIES

HEAT SINKS FOR “QUARTER-BRICK”  
DC/DC CONVERTERS

TO-220 and TO-218

FEATURES AND BENEFITS

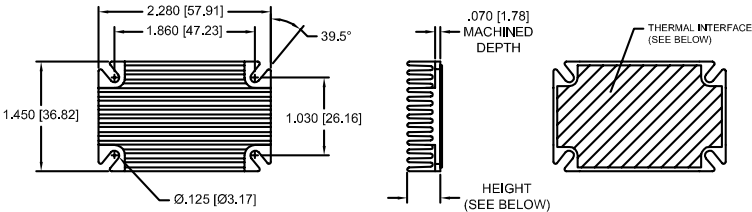
- Mounting slots accommodate two hole patterns: 1.86” x 1.03” and 2.00” x 1.20”, fitting the vast majority of quarter-brick converters on the market.
  - Designed for optimum use in forced convection applications.
  - Vertical and horizontal fin configurations available in a variety of heights.
- Black anodized finish standard.
  - Integral thermal interface pad option eliminates need to order and install pad separately.
  - Ordering a single part number with the hardware kit option provides everything necessary to keep your converter cool.

| Standard P/N | Footprint Dimensions in. (mm) | Height in. (mm) | Fin Orientation | Number of Fins | Forced Convection Thermal Resistance at 300 ft/min (C/W) |
|--------------|-------------------------------|-----------------|-----------------|----------------|----------------------------------------------------------|
| 537-95AB     | 2.28 (57.9) x 1.45 (36.8)     | 0.95 (24.1)     | Horizontal      | 8              | 2.1                                                      |
| 537-45AB     | 2.28 (57.9) x 1.45 (36.8)     | 0.45 (11.4)     | Horizontal      | 13             | 2.3                                                      |
| 537-24AB     | 2.28 (57.9) x 1.45 (36.8)     | 0.24 (6.1)      | Horizontal      | 14             | 4.2                                                      |
| 547-95AB     | 1.45 (36.8) x 2.28 (57.9)     | 0.95 (24.1)     | Vertical        | 11             | 2.2                                                      |
| 547-45AB     | 1.45 (36.8) x 2.28 (57.9)     | 0.45 (11.4)     | Vertical        | 20             | 2.1                                                      |
| 547-24AB     | 1.45 (36.8) x 2.28 (57.9)     | 0.24 (6.1)      | Vertical        | 22             | 3.5                                                      |

Material: Aluminum, Black Anodized

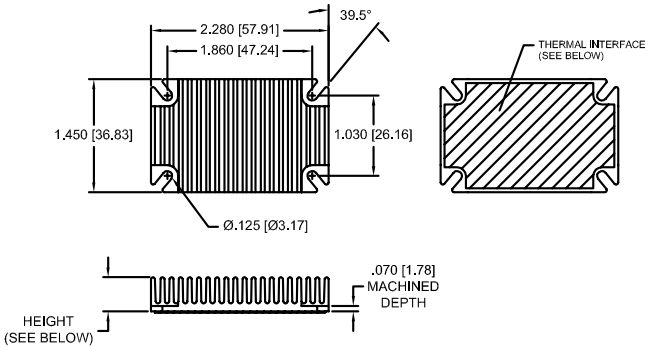
MECHANICAL DIMENSIONS

537 SERIES DIMENSIONS

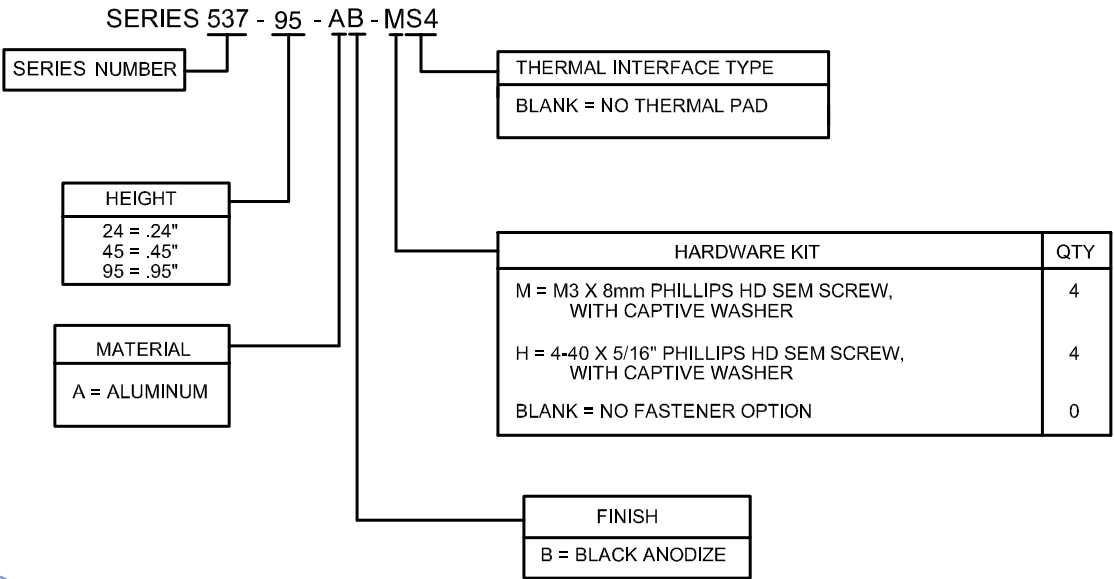


Dimensions: in. (mm)

547 SERIES DIMENSIONS



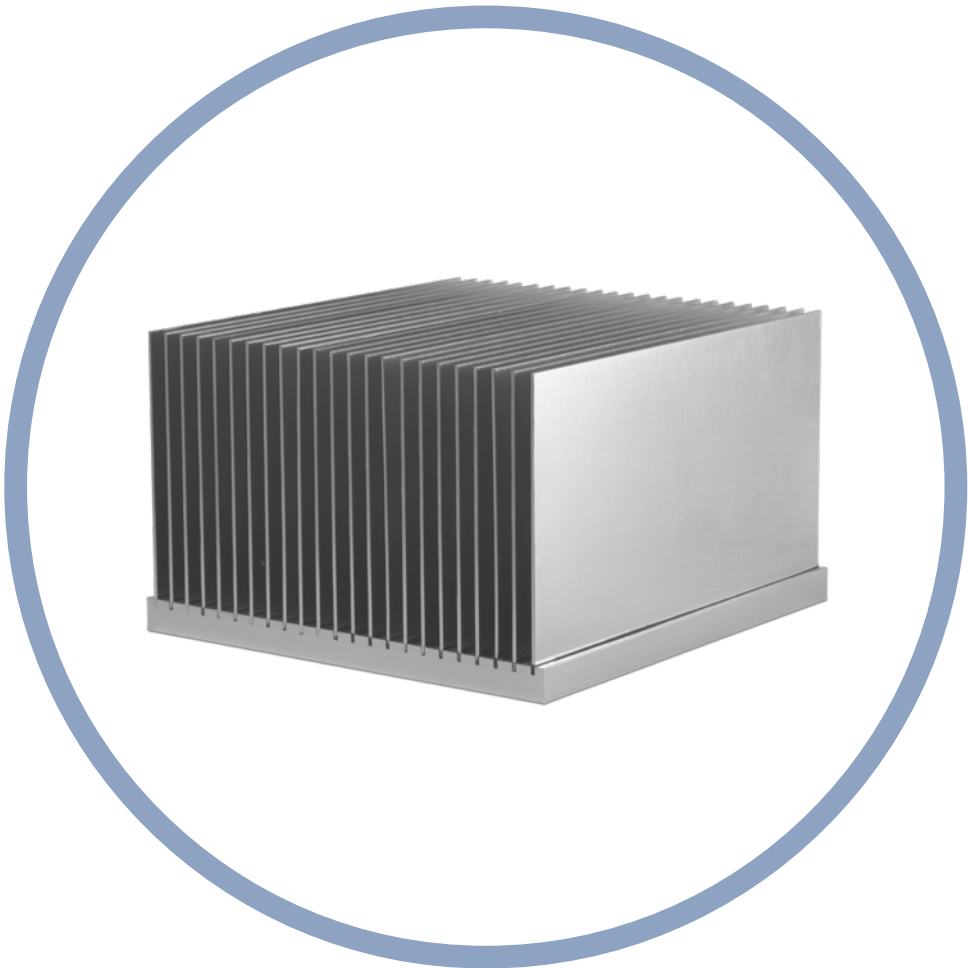
PRODUCT DESIGNATION





# BONDED FIN HEAT SINKS

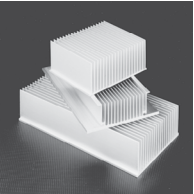
|                                                                         |         |
|-------------------------------------------------------------------------|---------|
| <i>High Fin Density Heat Sinks for Power Modules, IGBTs, Relays</i>     | 100–101 |
| <i>Custom Bonded Fin Heat Sinks &amp; Assemblies</i>                    | 102     |
| <i>maxiTHERM-HD<sup>3</sup>™ Bonded Fin Forced Convection Series #1</i> | 103     |
| <i>maxiTHERM-HD<sup>3</sup>™ Bonded Fin Forced Convection Series #2</i> | 104     |



Wakefield-Vette offers a variety of natural and forced convection bonded fin heat sink assemblies. Configurable in a variety of ways, they are reliable, cost effective, and highly efficient thermal management solutions for high power and densely packaged applications, even in demanding shock and vibration environments. Bonded fin heat sinks are used when the required combination of large heat sink size, tall fins and high fin density make simple extrusions impractical.

We offer these products in our standard catalog and also custom fabricated to meet a customer's needs.

HIGH FIN DENSITY HEAT SINKS FOR POWER MODULES, IGBTs, RELAYS



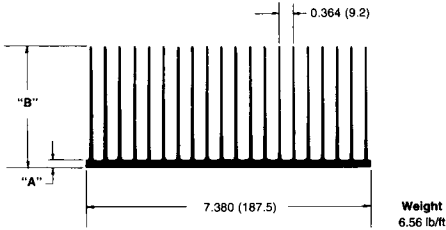
510, 511 & 512 SERIES

| Standard Catalog P/N <sup>(5)</sup><br>Milled Base <sup>(1)</sup> | Nonmilled<br>Base <sup>(2)</sup> | Base Width<br>in. (mm) | Length<br>in. (mm) | Height                                                 |                                                           | Thermal Resistance <sup>(5)</sup><br>( $\theta_{sa}$ ) at Typical Load |                                                         |
|-------------------------------------------------------------------|----------------------------------|------------------------|--------------------|--------------------------------------------------------|-----------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------------------------|
|                                                                   |                                  |                        |                    | Milled Base <sup>(1)</sup><br>("M Series")<br>in. (mm) | Nonmilled Base <sup>(2)</sup><br>("U" Series)<br>in. (mm) | Natural<br>Convection <sup>(3)</sup><br>(°C/W)                         | Forced<br>Convection <sup>(4)</sup><br>(°C/W @ 100 CFM) |
| 510-3M                                                            | 510-3U                           | 7.380 (187.452)        | 3.000 (76.2)       | 3.106 (78.9)                                           | 3.136 (79.7)                                              | 0.56                                                                   | 0.088                                                   |
| 510-6M                                                            | 510-6U                           | 7.380 (187.452)        | 6.000 (152.4)      | 3.106 (78.9)                                           | 3.136 (79.7)                                              | 0.38                                                                   | 0.070                                                   |
| 510-9M                                                            | 510-9U                           | 7.380 (187.452)        | 9.000 (228.6)      | 3.106 (78.9)                                           | 3.136 (79.7)                                              | 0.29                                                                   | 0.066                                                   |
| 510-12M                                                           | 510-12U                          | 7.380 (187.452)        | 12.000 (304.8)     | 3.106 (78.9)                                           | 3.136 (79.7)                                              | 0.24                                                                   | 0.062                                                   |
| 510-14M                                                           | 510-14U                          | 7.380 (187.452)        | 14.000 (355.6)     | 3.106 (78.9)                                           | 3.136 (79.7)                                              | 0.21                                                                   | 0.059                                                   |
| 511-3M                                                            | 511-3U                           | 5.210 (132.33)         | 3.000 (76.2)       | 2.350 (59.7)                                           | 2.410 (61.2)                                              | 0.90                                                                   | 0.120                                                   |
| 511-6M                                                            | 511-6U                           | 5.210 (132.33)         | 6.000 (152.4)      | 2.350 (59.7)                                           | 2.410 (61.2)                                              | 0.65                                                                   | 0.068                                                   |
| 511-9M                                                            | 511-9U                           | 5.210 (132.33)         | 9.000 (228.6)      | 2.350 (59.7)                                           | 2.410 (61.2)                                              | 0.56                                                                   | 0.060                                                   |
| 511-12M                                                           | 511-12U                          | 5.210 (132.33)         | 12.000 (304.8)     | 2.350 (59.7)                                           | 2.410 (61.2)                                              | 0.45                                                                   | 0.045                                                   |
| 512-3M                                                            | 512-3U                           | 7.200 (182.88)         | 3.000 (76.2)       | 2.350 (59.7)                                           | 2.410 (61.2)                                              | 0.90                                                                   | 0.120                                                   |
| 512-6M                                                            | 512-6U                           | 7.200 (182.88)         | 6.000 (152.4)      | 2.350 (59.7)                                           | 2.410 (61.2)                                              | 0.65                                                                   | 0.068                                                   |
| 512-9M                                                            | 512-9U                           | 7.200 (182.88)         | 9.000 (228.6)      | 2.350 (59.7)                                           | 2.410 (61.2)                                              | 0.56                                                                   | 0.060                                                   |
| 512-12M                                                           | 512-12U                          | 7.200 (182.88)         | 12.000 (304.8)     | 2.350 (59.7)                                           | 2.410 (61.2)                                              | 0.45                                                                   | 0.045                                                   |

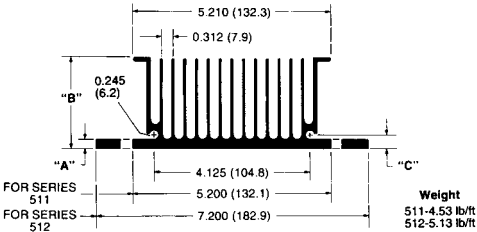
| 510 SERIES |             | 510 Series (Extrusion Profile 5113) |                            |  |
|------------|-------------|-------------------------------------|----------------------------|--|
| Series     | A           | B                                   | Flatness                   |  |
| 510-U      | 0.216 (5.5) | 3.136 (79.7)                        | 0.006 in./in. (0.15 mm/mm) |  |
| 510-M      | 0.165 (4.2) | 3.106 (78.9)                        | 0.002 in./in. (0.05 mm/mm) |  |

| 511 AND 512 SERIES |             |              | 511 Series (Extrusion Profile 6438-1) |                            | 512 Series (Extrusion Profile 6438-2) |  |
|--------------------|-------------|--------------|---------------------------------------|----------------------------|---------------------------------------|--|
| Series             | A           | B            | C                                     | Flatness                   |                                       |  |
| 511-U 512-U        | 0.250 (6.4) | 2.410 (61.2) | 0.372 (9.4)                           | 0.006 in./in. (0.15 mm/mm) |                                       |  |
| 511-M 512-M        | 0.220 (5.6) | 2.350 (59.7) | 0.342 (8.7)                           | 0.002 in./in. (0.05 mm/mm) |                                       |  |

MECHANICAL DIMENSIONS

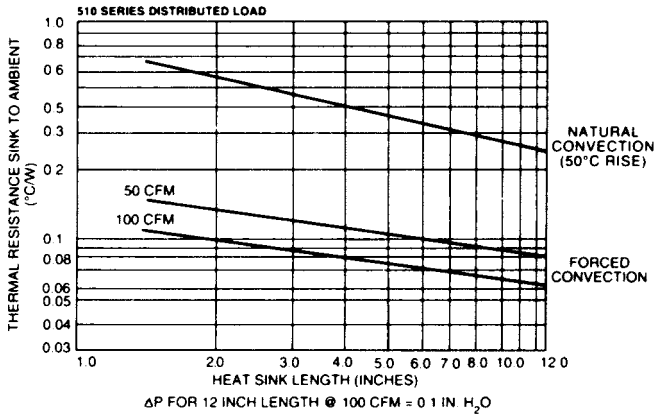


Dimensions: in. (mm)



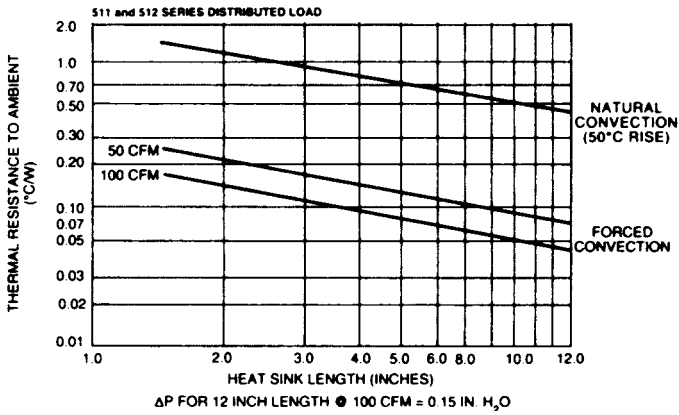
Weight  
511-4.53 lb/ft  
512-5.13 lb/ft

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



$\Delta P$  FOR 12 INCH LENGTH @ 100 CFM = 0.1 IN.  $H_2O$

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



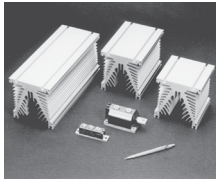
$\Delta P$  FOR 12 INCH LENGTH @ 100 CFM = 0.15 IN.  $H_2O$

NOTES:

1. Precision-milled base for maximum heat transfer performance (flatness 0.002 in./in.)
2. Nonmilled base flatness: 0.006 in./in.
3. Natural convection heat dissipation for distributed heat sources at 50°C rise.
4. Forced convection heat dissipation for distributed heat sources at 100 cubic feet per minute, shrouded condition.
5. Standard models are provided without finish.

HIGH PERFORMANCE HEAT SINKS FOR POWER MODULES,  
IGBTs AND SOLID STATE RELAYS

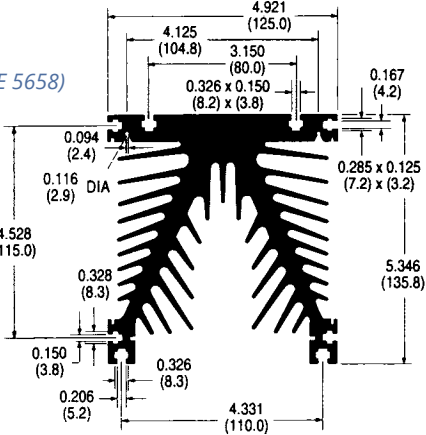
392 SERIES



| Standard P/N, Finish |                 | Length<br>in. (mm) | Thermal Resistance at Typical Load            |                                              | Weight<br>lbs. (grams) |
|----------------------|-----------------|--------------------|-----------------------------------------------|----------------------------------------------|------------------------|
| Black<br>Anodized    | Gold<br>Iridite |                    | Natural Convection ( $\theta_{sa}$ )<br>(°CW) | Forced Convection ( $\theta_{sa}$ )<br>(°CW) |                        |
| 392-120AB            | 392-120AG       | 4.725 (120.0)      | 0.50                                          | 0.16 @ 100 CFM                               | 4.452 (2019.43)        |
| 392-180AB            | 392-180AG       | 7.087 (180.0)      | 0.43                                          | 0.11 @ 100 CFM                               | 6.636 (3010.09)        |
| 392-300AB            | 392-300AG       | 11.811 (300.0)     | 0.33                                          | 0.08 @ 100 CFM                               | 10.420 (4726.51)       |

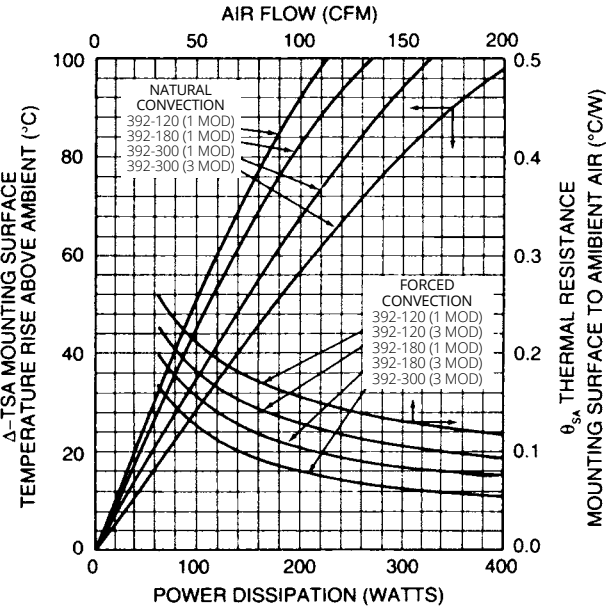
MECHANICAL DIMENSIONS

392 SERIES  
(EXTRUSION PROFILE 5658)

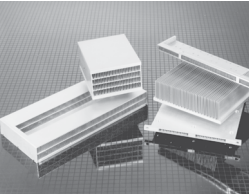


Dimensions: in. (mm)

NATURAL AND FORCED  
CONVECTION CHARACTERISTICS

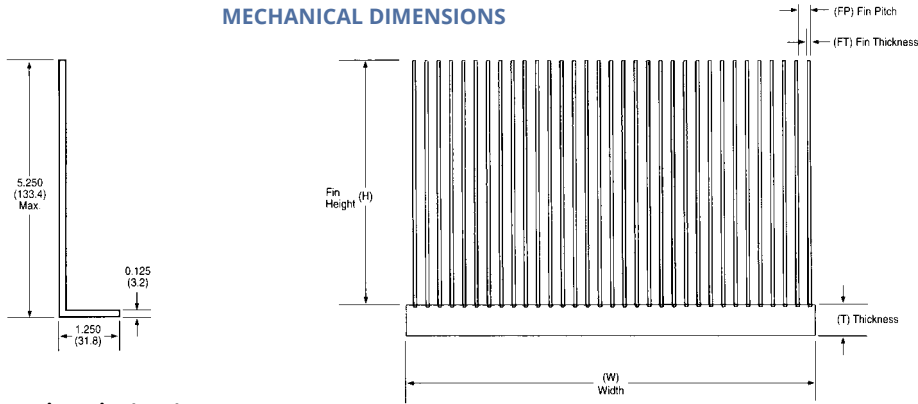


CUSTOM BONDED FIN HEAT SINKS & ASSEMBLIES



Wakefield-Vette offers an extensive line of natural convection and forced convection custom bonded fin heat sinks assemblies. Configurable in a variety of ways, they are reliable, cost effective, and highly efficient thermal management solutions for high power and densely packaged applications, even in demanding shock and vibration environments.

**MOUNTING LEG**  
(EXTRUSION PROFILE 8930)  
(EXTRUSION PROFILE 8120)



Dimensions: in. (mm)

| BONDED FIN BASES           |               |              |            |              |            | Thermal Resistance °C/W                |       |                                       |       |
|----------------------------|---------------|--------------|------------|--------------|------------|----------------------------------------|-------|---------------------------------------|-------|
| Base Extrusion Profile No. | W             | T            | FT         | FP           | Max # Fins | Natural Convection<br>H = 2"    H = 4" |       | Forced Convection<br>H = 2"    H = 4" |       |
| 8711                       | 2.800 (71.1)  | 0.520 (13.2) | .050 (1.3) | 0.275 (5.4)  | 10         | 1.360                                  | 0.830 | 0.459                                 | 0.277 |
| 8731                       | 3.615 (91.8)  | 0.575 (14.6) | .050 (1.3) | 0.239 (6.1)  | 15         | 1.110                                  | 0.685 | 0.281                                 | 0.168 |
| 8546                       | 4.000 (101.6) | 0.500 (12.7) | .050 (1.3) | 0.200 (5.1)  | 20         | 1.330                                  | 0.823 | 0.215                                 | 0.144 |
| 8737                       | 4.425 (112.4) | 0.650 (16.5) | .050 (1.3) | 0.238 (6.0)  | 18         | 0.937                                  | 0.580 | 0.233                                 | 0.140 |
| 8119                       | 4.750 (120.7) | 0.500 (12.7) | .050 (1.3) | 0.288 (7.3)  | 16         | 0.880                                  | 0.539 | 0.222                                 | 0.157 |
| 8712                       | 5.000 (127.0) | 0.530 (13.5) | .050 (1.3) | 0.198 (5.0)  | 25         | 1.122                                  | 0.692 | 0.170                                 | 0.101 |
| 8732                       | 5.650 (143.5) | 0.500 (12.7) | .050 (1.3) | 0.200 (5.1)  | 28         | 1.011                                  | 0.625 | 0.152                                 | 0.090 |
| 8556                       | 6.000 (152.4) | 0.500 (12.7) | .050 (1.3) | 0.250 (6.4)  | 24         | 0.751                                  | 0.438 | 0.153                                 | 0.107 |
| 8542                       | 6.620 (168.1) | 0.500 (12.7) | .050 (1.3) | 0.200 (5.1)  | 33         | 0.880                                  | 0.519 | 0.122                                 | 0.082 |
| 8671                       | 7.230 (183.6) | 0.550 (14.0) | .050 (1.3) | 0.239 (6.1)  | 30         | 0.655                                  | 0.399 | 0.123                                 | 0.086 |
| 8823                       | 7.440 (189.0) | 0.525 (13.3) | .050 (1.3) | 0.200 (5.1)  | 37         | 0.820                                  | 0.500 | 0.118                                 | 0.070 |
| 8734                       | 7.500 (190.5) | 0.560 (14.2) | .050 (1.3) | 0.400 (10.2) | 19         | 0.550                                  | 0.310 | 0.213                                 | 0.130 |
| 8545                       | 8.000 (203.2) | 0.500 (12.7) | .050 (1.3) | 0.200 (5.1)  | 40         | 0.591                                  | 0.353 | 0.095                                 | 0.053 |
| 8709                       | 8.327 (211.5) | 0.400 (10.2) | .050 (1.3) | 0.215 (5.5)  | 37         | 0.507                                  | 0.310 | 0.081                                 | 0.048 |
| 8715                       | 8.780 (223.0) | 0.600 (15.2) | .050 (1.3) | 0.270 (6.9)  | 28         | 0.384                                  | 0.231 | 0.106                                 | 0.063 |
| 8707                       | 10.00 (254.0) | 0.550 (14.0) | .050 (1.3) | 0.238 (6.0)  | 42         | 0.361                                  | 0.220 | 0.071                                 | 0.042 |
| 8121                       | 10.78 (273.8) | 0.560 (14.2) | .050 (1.3) | 0.238 (6.0)  | 45         | 0.348                                  | 0.209 | 0.065                                 | 0.040 |
| 8733                       | 12.60 (320.0) | 0.600 (15.2) | .050 (1.3) | 0.207 (5.3)  | 60         | 0.383                                  | 0.235 | 0.075                                 | 0.030 |
| 8714                       | 14.00 (355.6) | 0.525 (13.3) | .050 (1.3) | 0.250 (6.4)  | 56         | 0.275                                  | 0.168 | 0.053                                 | 0.032 |
| 8735                       | 15.00 (381.0) | 0.625 (15.9) | .050 (1.3) | 0.250 (6.4)  | 60         | 0.264                                  | 0.161 | 0.049                                 | 0.030 |

NOTES:

1. Natural and forced convection thermal resistances based on 6.000 in. length for profiles less than 8.000" wide.
2. Natural and forced convection thermal resistances based on 12.000 in. length for profiles 8.000" wide and greater
3. Forced convection thermal resistance based on 500 LFM, shrouded, horizontal. distributed heat load.
4. Forced convection bonded fin assemblies use standard "muffin" fans.
5. Dimensions shown are as extruded. To improve flatness across the width, bases can be machined. Machined base thickness will be reduced.

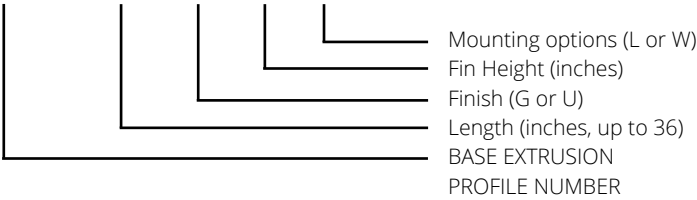
Order Guide - Example

Example Part Number - BE8546-1200-U4W

- BE8546 = Bonded fin base extrusion profile identifier
- Length (inches; 12.00 shown, two decimal point assumed)
- Finish (G = Gold Chromate, U = Unfinished)
- Fin Height (4 inches shown)
- Mounting Options (L = Mounting Legs, W = No Mounting Legs)

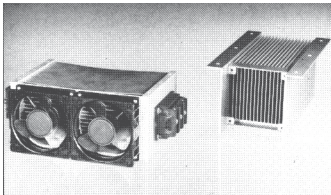
Part Numbering Order Guide\*

BEXXXX - XX - X X X



maxiTHERM-HD<sup>3™</sup> BONDED FIN FORCED CONVECTION SERIES #1

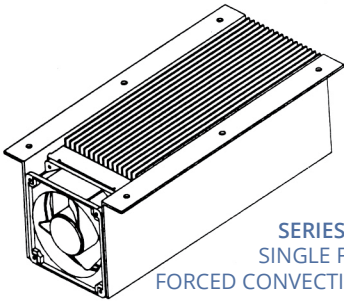
SERIES #1



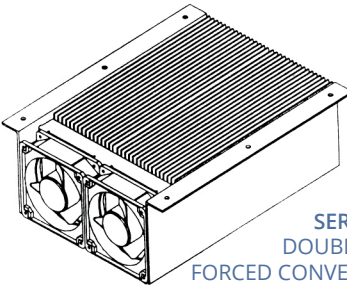
maxiTHERM-HD<sup>3™</sup> Bonded Fin Forced Convection Series #1 heat sinks provide more effective cooling per cubic inch of space compared to extruded heat sinks. Exceptionally low thermal resistance values in forced convection applications are achieved with "Series #1" models, as low as 0.024°C/W for a double unit employing 2 fans. Mounting hole pattern is 4.125 in. sq. for standard 120 mm axial ("box") fans. These heat sinks are ideal for a variety of high power applications, even in the most demanding shock and vibration environments.

| SERIES #1 (5.25" TALL ASSEMBLY)              |                                     |                       |               |                |                       |                         |
|----------------------------------------------|-------------------------------------|-----------------------|---------------|----------------|-----------------------|-------------------------|
| maxiTHERM-HD <sup>3™</sup> Package Series #1 | Standard Muffin Fan (S)             | Dimension (in inches) |               |                | Perimeter (in inches) | Thermal Resistance °C/W |
|                                              |                                     | "A"                   | "B"           | "C"            |                       |                         |
| 1A                                           | 1                                   | 7.000 (177.8)         | 2.500 (63.5)  | 4.500 (114.3)  | 742.5 (18859.5)       | 0.10                    |
| 1B                                           | 1                                   | 9.500 (241.3)         | 3.750 (95.3)  | 7.000 (114.3)  | 1515.0 (38481.0)      | 0.09                    |
| 1C                                           | 1                                   | 12.000 (304.8)        | 5.000 (127.0) | 9.500 (114.3)  | 1567.5 (39814.5)      | 0.07                    |
| 1D                                           | 1                                   | 14.500 (368.3)        | 6.250 (158.8) | 12.000 (114.3) | 1980.5 (50304.7)      | 0.05                    |
| 1E                                           | 2                                   | 14.590 (370.6)        | 6.000 (152.4) | 12.000 (114.3) | 4536.0 (115214.4)     | 0.028                   |
| 1F                                           | 2                                   | 16.590 (429.0)        | 7.000 (177.8) | 14.000 (114.3) | 5292.0 (134416.8)     | 0.025                   |
| 1G                                           | 2                                   | 18.590 (472.2)        | 8.000 (203.2) | 16.000 (114.3) | 6048.0 (153619.2)     | 0.024                   |
| 1Z                                           | NON-STANDARD LENGTH                 |                       |               |                |                       |                         |
| ZZ                                           | NON-STANDARD CONFIGURATION & LENGTH |                       |               |                |                       |                         |

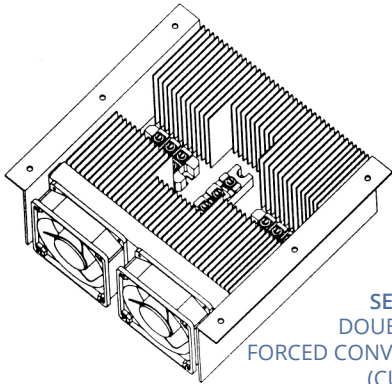
Refer to the following page for ordering information.



SERIES #1  
SINGLE FAN  
FORCED CONVECTION



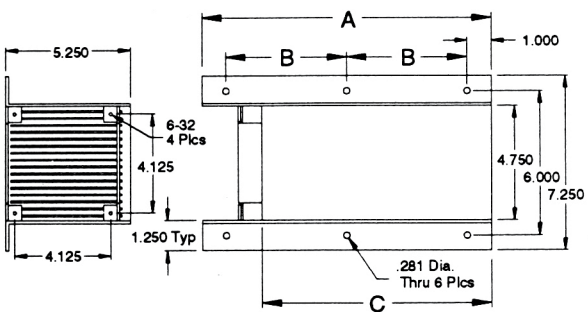
SERIES #1  
DOUBLE FAN  
FORCED CONVECTION



SERIES #1  
DOUBLE FAN  
FORCED CONVECTION  
(CUSTOM)

MECHANICAL DIMENSIONS

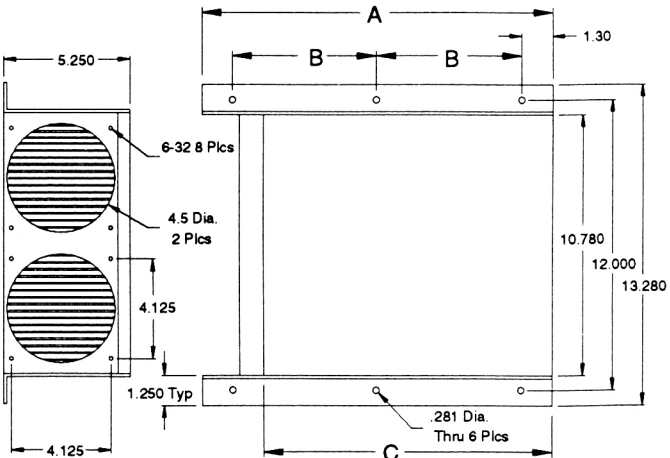
SERIES #1  
SINGLE FAN FORCED CONVECTION



NOTES:

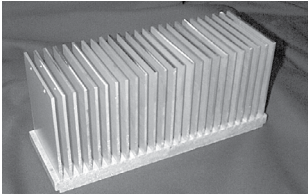
1. Standard muffin fans not included, order separately.

SERIES #1  
DOUBLE FAN FORCED CONVECTION





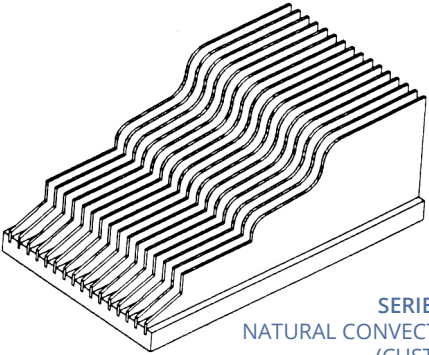
maxiTHERM-HD<sup>3</sup>™ BONDED FIN FORCED CONVECTION SERIES #2



SERIES #2

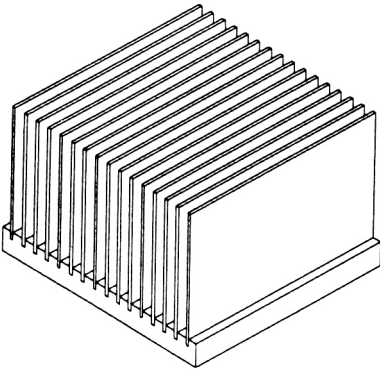
maxiTHERM-HD<sup>3</sup>™ Bonded Fin Natural Convection Series #2 heat sinks are designed for a variety of high power applications. These heat sinks are ideal even in the most demanding shock and vibration environments. Standard heat sink lengths range from 7.000 in. (177.8 mm) to 18.590 in. (472.2 mm) and the overall height is 3.130 in. (79.5 mm). Custom lengths, mounting options, and other configurations can be accommodated.

| SERIES #2 (3.13" TALL ASSEMBLY)                  |                       |               |                          |                               |
|--------------------------------------------------|-----------------------|---------------|--------------------------|-------------------------------|
| maxiTHERM-HD <sup>3</sup> ™<br>Package Series #2 | Dimension (in inches) |               | Perimeter<br>(in inches) | Thermal<br>Resistance<br>°C/W |
|                                                  | "A"                   | "B"           |                          |                               |
| 2A                                               | 4.500 (114.3)         | 1.250 (31.8)  | 427.5 (10858.5)          | 0.41**                        |
| 2B                                               | 9.500 (177.8)         | 2.500 (63.5)  | 665.0 (16891.0)          | 0.38**                        |
| 2C                                               | 9.500 (241.3)         | 3.750 (95.3)  | 902.0 (22910.8)          | 0.35**                        |
| 2D                                               | 12.000 (304.8)        | 5.000 (127.0) | 1140.0 (28956.0)         | 0.33**                        |
| ZZ NON-STANDARD LENGTH                           |                       |               |                          |                               |
| ZZ NON-STANDARD CONFIGURATION & LENGTH           |                       |               |                          |                               |

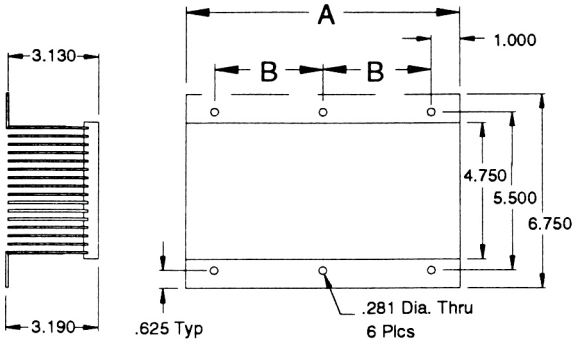


SERIES #2  
NATURAL CONVECTION  
(CUSTOM)

SERIES #2 NATURAL CONVECTION



MECHANICAL DIMENSIONS



NOTES:

- 1. All non-standard parts must have a modifier.
- 2. 1Z and 2Z denoting non-standard lengths should only be used for non-standard "A" dimensions. Part # must contain a modifier.
- \*3. When 105 CFM fan (s) used – fan mounting hole pattern for standard axial ("muffin") fan.
- \*\*4. Natural convection based on 50°C heat sink temperature rise above ambient.

ORDERING INFORMATION

|      |   |   |   |   |                                                                                             |
|------|---|---|---|---|---------------------------------------------------------------------------------------------|
| BE8- | - | - | - | - | MODIFIER                                                                                    |
|      |   |   |   |   | NNNN Factory issued number for modification to customer requirements.                       |
|      |   |   |   |   | PLATING OPTIONS                                                                             |
|      |   |   |   |   | GI Gold Iridite<br>CI Clear Iridite<br>N No Plating (Wash & Etch)                           |
|      |   |   |   |   | MOUNTING OPTIONS                                                                            |
|      |   |   |   |   | L Mounting Legs<br>F Fan Brackets & Mounting Legs (series #1 only)<br>W No Brackets or Legs |
|      |   |   |   |   | PACKAGE LENGTH ("A" Dimension)                                                              |
|      |   |   |   |   | SERIES #1 (5.25" tall assembly)                                                             |
|      |   |   |   |   | PN LENGTH                                                                                   |
|      |   |   |   |   | 1A 7.000"                                                                                   |
|      |   |   |   |   | 1B 9.500"                                                                                   |
|      |   |   |   |   | 1C 12.000"                                                                                  |
|      |   |   |   |   | 1D 14.500"                                                                                  |
|      |   |   |   |   | 1E 14.590"                                                                                  |
|      |   |   |   |   | 1F 16.590"                                                                                  |
|      |   |   |   |   | 1G 18.590"                                                                                  |
|      |   |   |   |   | 1Z non-standard lengths (Note 2)                                                            |
|      |   |   |   |   | ZZ non-standard configuration & length                                                      |
|      |   |   |   |   | PACKAGE LENGTH ("A" Dimension)                                                              |
|      |   |   |   |   | SERIES #2 (3.13" tall assembly)                                                             |
|      |   |   |   |   | PN LENGTH                                                                                   |
|      |   |   |   |   | 2A 4.500"                                                                                   |
|      |   |   |   |   | 2B 7.000"                                                                                   |
|      |   |   |   |   | 2C 9.500"                                                                                   |
|      |   |   |   |   | 2D 12.000"                                                                                  |
|      |   |   |   |   | 2Z non-standard length (Note 2)                                                             |
|      |   |   |   |   | ZZ non-standard configuration & length                                                      |
|      |   |   |   |   | BASE EXTRUSION NUMBER                                                                       |
|      |   |   |   |   | BE8119 Base profile identifier (SINGLE)                                                     |
|      |   |   |   |   | BE8121 Base profile identifier (DOUBLE)                                                     |
|      |   |   |   |   |                                                                                             |

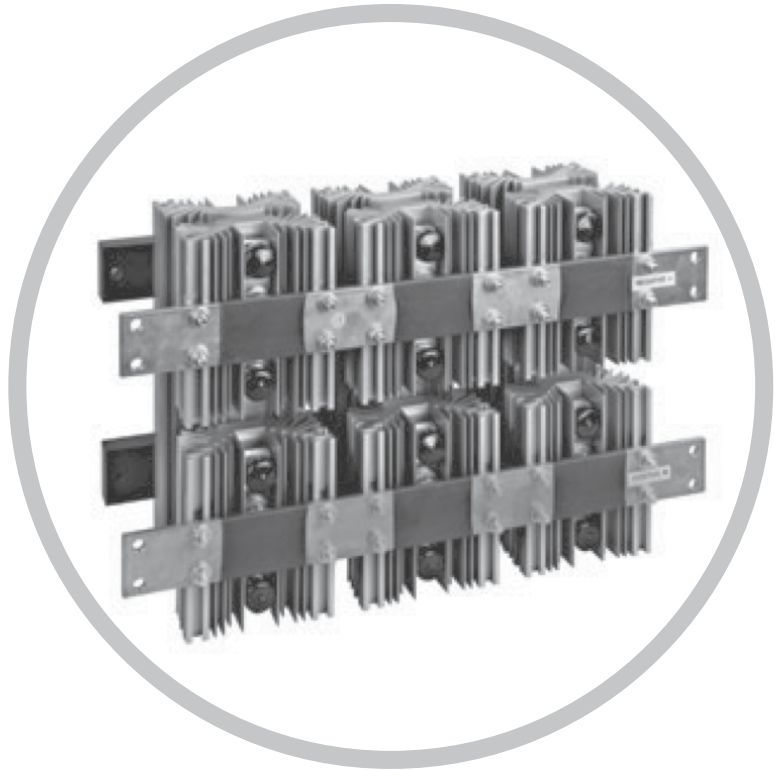
# PRECISION CLAMP HEAT SINKS

Precision Compression Mounting Clamp Systems .....

132/133 Series High-performance Heat Sinks For  
Compression Type Devices .....

108-112

112-113



Wakefield-Vette compression pack heat sink and clamp systems provide customers with the complete system solution for proper installation and heat dissipation for high-power compression pack semiconductors. These high-quality mounting clamp assemblies are the industry standard for mounting, compressing, and clamping press-pack SCR, thyristors, rectifiers, and other high power disc packaged devices. Devices of these styles are most commonly found in power distribution equipment, industrial controls, transportation systems, and power supply and conversion systems.

A clamp system consists of a crossbar and a spring assembly. The crossbar is a steel bar with two threaded rods installed in it. The rods are generally knurled and cold rolled into the bar to ensure proper fit. The cross bar assembly is covered in an epoxy coating which acts as an electrical insulator to ensure the devices are properly grounded. The crossbar is installed through the center web of the heat sink and sits in a channel surrounded by fins needed for thermal performance.

On the back of the heat sink, a puck style device is installed and then the spring assembly is installed in the threaded rods of the crossbar. By tightening the nuts on the spring assembly, a compression force is applied to the center of the puck. Each spring assembly has a force gauge integrated into it to ensure ease of assembly and consistency of force applied to the many devices used in a system.

The cross bar assembly is available in various lengths to meet the various needs of the industry. All components for device mounting are available separately for all standard compression requirements from 800 lbs. to 16,000 lbs.

PRECISION COMPRESSION MOUNTING CLAMP SYSTEMS

Wakefield-Vette compression pack heat sinks and clamp systems provide electrical and industrial equipment manufacturers with complete system solutions for proper installation and heat dissipation for high-power compression pack semiconductor. All components for device mounting and cooling are available separately for all standard compression requirements from 800 lbs (362.9 kg) to 16,000 lbs (7,257.5 kg) force in both natural and forced convection applications.

| Clamp Assembly Series | Maximum Clamping Force Force Range                | Maximum Diameter (Ref) Power Disc Device | Crossbar Stud Centerline to Centerline Dimension |
|-----------------------|---------------------------------------------------|------------------------------------------|--------------------------------------------------|
| 130 Series            | 800 lbs (362.9 kg) - 2,000 lbs (907.2 kg)         | 2.25 in. (57.2 mm)                       | 2.750 in. (69.9 mm) Ref                          |
| 139 Series            | 3,000 lbs (1,360.8 kg) and 5,000 lbs (2,268.0 kg) | 3.50 in. (88.9 mm)                       | 4.000 in. (101.6 mm) Ref                         |
| 143 Series            | 1,000 lbs (453.6 kg) - 6,000 lbs (2,721.6 kg)     | 3.50 in. (88.9 mm)                       | 4.000 in. (101.6 mm) Ref                         |
| 144 Series            | 1,000 lbs (453.6 kg) - 6,000 lbs (2,721.6 kg)     | 4.00 in. (101.6 mm)                      | 4.625 in. (117.5 mm) Ref                         |
| 145 Series            | 2,000 lbs (907.2 kg) - 10,000 lbs (4,535.9 kg)    | 4.50 in. (114.3 mm)                      | 5.500 in. (139.7 mm) Ref                         |
| 146 Series            | 8,000 lbs (3,628.8 kg) - 16,000 lbs (7,257.5 kg)  | 5.25 in. (133.4 mm)                      | 6.000 in. (152.4 mm) Ref                         |
| 131/132/133 Series    | High-Performance Press Pack Heat Sinks            |                                          |                                                  |

These high-quality mounting clamp assemblies are the worldwide standard for mounting, compression, and clamping press-pack SCR, thyristor, and other high power disc packaged devices utilized in power distribution equipment, industrial controls, transportation systems, and power supply and conversion systems.

Clamp assemblies will accommodate devices with overall case diameters to 5.25 in. (133.4 mm) maximum. Vertical device mounting space available for assemblies is determined by selecting an appropriate series crossbar by length which, when a series spring assembly is selected (based on maximum clamping force required), will provide the necessary vertical clearance space. For the 130 and 139 Series, this determination is made by subtracting the chosen spring assembly "Z" dimension (refer to dimensional tables) from the crossbar assembly "X" dimension minimum and maximum values, to calculate the available device mounting space clearance for the particular assembly combination. Spring assembly "Z" dimension is the dimension measured from the spring assembly device mounting surface to the spring assembly top surface. Some series have fixed dimensions for alpha characters. All spring assemblies are designed with a force indicator gauge.

| Max SCR DIA | Clamp Series | Force Range     | Extrusion Profile |
|-------------|--------------|-----------------|-------------------|
| 101.6 mm    | ALL          | 800 - 16000 LBS | XX7151            |
| 84 mm       | ALL          | 800 - 16000 LBS | XX6351            |
| 63 mm       | ALL          | 800 - 16000 LBS | XX5735            |
|             | 144          | 800 - 6000 LBS  | XX5360            |
|             | 143          | 800 - 6000 LBS  | XX10239           |
|             | 144          | 800 - 6000 LBS  | O16235            |
|             | 144          | 800 - 6000 LBS  | O14442            |
|             | 143          | 800 - 6000 LBS  | XX3529            |
|             | 143          | 800 - 6000 LBS  | XX5730            |
|             | 143          | 800 - 6000 LBS  | O14191            |
| 50 mm       | 143          | 800 - 6000 LBS  | XX5733            |
|             | 143          | 800 - 6000 LBS  | XX3559-2          |
|             | 143          | 800 - 6000 LBS  | XX5736            |
|             | 143          | 800 - 6000 LBS  | XX3561-2          |
|             | 143          | 800 - 6000 LBS  | XX5732            |
|             | 143          | 800 - 6000 LBS  | XX5731            |
|             | 143          | 800 - 6000 LBS  | XX3560-2          |
|             | 143          | 800 - 6000 LBS  | O13450            |
|             | 143          | 800 - 6000 LBS  | XX4554            |
|             | 143          | 800 - 6000 LBS  | XX5331            |
|             | 143          | 800 - 6000 LBS  | OO3537            |
|             | 143          | 800 - 6000 LBS  | XX5306            |
|             | 143          | 800 - 6000 LBS  |                   |
|             | 143          | 800 - 6000 LBS  |                   |
| 40 mm       | 143          | 800 - 6000 LBS  | O14779            |

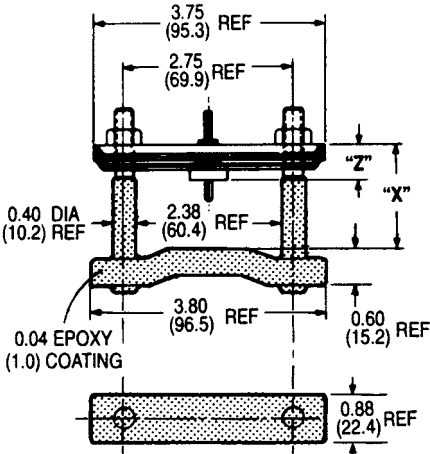


130 SERIES

COMPRESSION MOUNTING CLAMP ASSEMBLIES FOR SEMICONDUCTORS TO 2.25 IN. (57.2 MM) DIAMETER

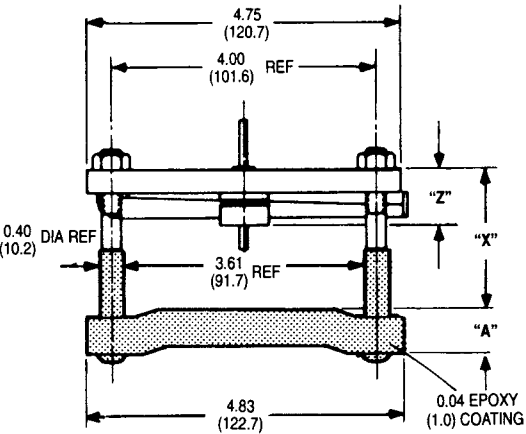
| 130 SERIES CROSSBAR<br>800 lb - 2,000 lb (362.8 kg - 907.2 kg)             |               |               |                     |
|----------------------------------------------------------------------------|---------------|---------------|---------------------|
| Crossbar Device Mounting, Surface to Spring Assembly Top Surface Dimension |               |               |                     |
| Model No.                                                                  | "X" Dimension |               | Weight lbs. (grams) |
|                                                                            | Min. in. (mm) | Max. in. (mm) |                     |
| 130-A                                                                      | 1.74 (44.2)   | 2.12 (53.8)   | 0.4 (181.44)        |
| 130-B                                                                      | 2.05 (52.1)   | 2.43 (61.7)   | 0.418 (189.60)      |
| 130-C                                                                      | 2.36 (59.9)   | 2.74 (69.6)   | 0.427 (193.68)      |
| 130-D                                                                      | 2.67 (67.8)   | 3.05 (77.5)   | 0.437 (198.22)      |
| 130-E                                                                      | 2.98 (75.7)   | 3.36 (85.3)   | 0.447 (202.76)      |
| 130-F                                                                      | 3.29 (83.6)   | 3.67 (93.2)   | 0.461 (209.11)      |
| 130-G                                                                      | 3.60 (91.4)   | 3.98 (101.1)  | 0.476 (215.91)      |
| 130-H                                                                      | 3.91 (99.3)   | 4.29 (109.0)  | 0.486 (220.45)      |
| 130-J                                                                      | 4.22 (107.2)  | 4.60 (116.8)  | 0.497 (225.44)      |
| 130-K                                                                      | 4.53 (115.1)  | 4.91 (124.7)  | 0.51 (231.33)       |
| 130-L                                                                      | 4.34 (122.9)  | 5.22 (132.6)  | 0.52 (235.87)       |
| 130-M                                                                      | 5.15 (130.8)  | 5.53 (140.5)  | 0.534 (242.22)      |
| 130-N                                                                      | 5.46 (138.7)  | 5.84 (147.3)  | 0.544 (246.75)      |
| 130-P                                                                      | 5.77 (146.6)  | 6.15 (156.2)  | 0.559 (253.56)      |

MECHANICAL DIMENSIONS

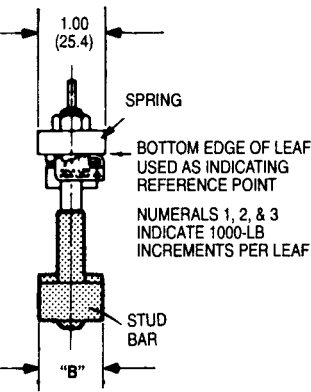


Dimensions: in. (mm)

MECHANICAL DIMENSIONS



Dimensions: in. (mm)



**Order Guide:**  
Order Crossbar and Spring Assembly separately by type number from table.

**Dimensions:**  
in. (mm)  
lb. (kg)

COMPRESSION MOUNTING CLAMP ASSEMBLIES FOR SEMICONDUCTORS TO 2.25 IN. (57.2 MM) DIAMETER

130 SERIES

| 130 SERIES SPRING ASSEMBLY |               |                   |                    |                   |
|----------------------------|---------------|-------------------|--------------------|-------------------|
| Model No.                  | No. of Leaves | "Z" Dim. in. (mm) | Max Force lb. (kg) | Weight lbs. (gms) |
| 130-1                      | 2             | 0.90 (22.9)       | 2,000 (907.2)      | 0.331 (150.14)    |
| 130-2                      | 2             | 0.50 (12.7)       | 800 (362.8)        | 0.19 (86.18)      |
| 130-3                      | 3             | 0.61 (15.5)       | 1,200 (544.3)      | 0.219 (99.34)     |
| 130-4                      | 4             | 0.72 (18.3)       | 1,600 (727.8)      | 0.333 (151.05)    |
| 130-5                      | 5             | 0.83 (21.1)       | 2,000 (907.2)      | 0.408 (185.07)    |

NOTES:

1. Spring assemblies are stainless steel leaves with a force indicator gauge, except the lowest cost Type 130-1 spring assembly manufactured from automotive grade stainless steel.

**Order Guide:**  
Order Crossbar and Spring Assembly separately by type number from table.

**Dimensions:**  
in. (mm)  
lb. (kg)



139 SERIES

COMPRESSION MOUNTING CLAMP ASSEMBLIES FOR SEMICONDUCTORS TO 3.50 IN. (88.9 MM) DIAMETER

| 139 SERIES CROSSBAR<br>3,000 lb - 5,000 lb, (1,360.8 kg - 2,268.0 kg), Crossbar Device Mounting, Surface to Spring Assembly, Top Surface Dimension |               |              |                     |                                            |               |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------|---------------------|--------------------------------------------|---------------|--------------|
| 139-3 SERIES CROSSBAR - 3,000 LB (1,360.8)                                                                                                         |               |              |                     | 139-5 SERIES CROSSBAR - 5,000 LB (2,268.0) |               |              |
| Model No.                                                                                                                                          | "X" Dimension |              | Weight lbs. (grams) | Model No.                                  | "X" Dimension |              |
|                                                                                                                                                    | Min in. (mm)  | Max in. (mm) |                     |                                            | Min in. (mm)  | Max in. (mm) |
| 139-3A                                                                                                                                             | 1.52 (38.6)   | 1.89 (48.0)  | 0.689 (312.52)      | 139-5A                                     | 1.52 (38.6)   | 1.89 (48.0)  |
| 139-3B                                                                                                                                             | 1.83 (46.5)   | 2.21 (56.1)  | 0.7 (317.51)        | 139-5B                                     | 1.83 (46.5)   | 2.21 (56.1)  |
| 139-3C                                                                                                                                             | 2.14 (54.4)   | 2.52 (64.0)  | 0.706 (320.24)      | 139-5C                                     | 2.14 (54.4)   | 2.52 (64.0)  |
| 139-3D                                                                                                                                             | 2.45 (62.2)   | 2.83 (71.9)  | 0.721 (327.04)      | 139-5D                                     | 2.45 (62.2)   | 2.83 (71.9)  |
| 139-3E                                                                                                                                             | 2.77 (70.4)   | 3.14 (79.8)  | 0.732 (332.03)      | 139-5E                                     | 2.77 (70.4)   | 3.14 (79.8)  |
| 139-3F                                                                                                                                             | 3.08 (78.2)   | 3.45 (87.6)  | 0.741 (336.11)      | 139-5F                                     | 3.08 (78.2)   | 3.45 (87.6)  |
| 139-3G                                                                                                                                             | 3.39 (86.1)   | 3.77 (95.8)  | 0.762 (345.64)      | 139-5G                                     | 3.39 (86.1)   | 3.77 (95.8)  |
| 139-3H                                                                                                                                             | 3.70 (94.0)   | 4.08 (103.6) | 0.773 (350.63)      | 139-5H                                     | 3.70 (94.0)   | 4.08 (103.6) |
| 130-3J                                                                                                                                             | 4.01 (101.9)  | 4.39 (111.5) | 0.784 (355.62)      | 139-5J                                     | 4.33 (101.9)  | 4.39 (111.5) |
| 139-3K                                                                                                                                             | 4.33 (110.0)  | 4.70 (119.4) | 0.79 (358.34)       | 139-5K                                     | 4.33 (110.0)  | 4.70 (119.4) |
| 139-3L                                                                                                                                             | 4.64 (117.9)  | 5.01 (127.3) | 0.793 (359.70)      | 139-5L                                     | 4.64 (117.9)  | 5.01 (127.3) |
| 139-3M                                                                                                                                             | 4.95 (125.7)  | 5.33 (135.4) | 0.796 (361.06)      | 139-5M                                     | 4.95 (125.7)  | 5.33 (135.4) |
| 139-3N                                                                                                                                             | 5.26 (133.6)  | 5.64 (143.3) | 0.832 (377.39)      | 139-5N                                     | 5.26 (133.6)  | 5.64 (143.3) |
| 139-3P                                                                                                                                             | 5.57 (141.5)  | 5.95 (151.1) | 0.838 (380.11)      | 139-5P                                     | 5.57 (141.5)  | 5.95 (151.1) |

| CROSSBAR HEIGHT AND WIDTH |                               |                              |
|---------------------------|-------------------------------|------------------------------|
| Series Number             | Height "A" Reference in. (mm) | Width "B" Reference in. (mm) |
| 139-3                     | 0.72 (18.3)                   | 0.95 (24.1)                  |
| 139-5                     | 1.02 (25.9)                   | 0.83 (21.1)                  |

| 139 SERIES SPRING ASSEMBLY |                  |                        |                        |
|----------------------------|------------------|------------------------|------------------------|
| Model Number               | Number of Leaves | "Z" Dimension in. (mm) | Maximum Force lb. (kg) |
| 139-1                      | 1                | 0.87(22.1)             | 3,000 (1,360.8)        |
| 139-2                      | 2                | 1.25(31.8)             | 5,000 (2,268.0)        |



PRECISION COMPRESSION MOUNTING CLAMP SYSTEMS



143 SERIES

COMPRESSION MOUNTING CLAMP ASSEMBLIES FOR SEMICONDUCTORS TO 3.50 IN. (88.9 MM) DIAMETER

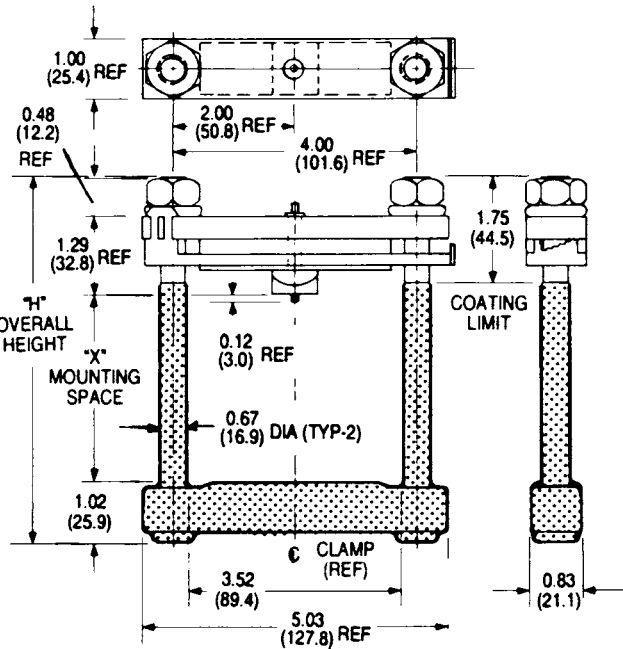
| 143 SERIES CROSSBAR<br>2,000 lb - 6,000 lb (907.2 kg - 2,721.6 kg)          |               |              |                             |                     |
|-----------------------------------------------------------------------------|---------------|--------------|-----------------------------|---------------------|
| Crossbar Device Mounting, Surface to Spring Assembly, Top Surface Dimension |               |              |                             |                     |
| Model No.                                                                   | "X" Dimension |              | Overall Height "H" in. (mm) | Weight lbs. (grams) |
|                                                                             | Min in. (mm)  | Max in. (mm) |                             |                     |
| 143-A                                                                       | 1.30 (33.0)   | 1.80 (45.7)  | 4.68 (118.9)                | 1.100 (498.95)      |
| 143-B                                                                       | 1.86 (45.7)   | 2.30 (58.4)  | 5.18 (131.6)                | 1.125 (510.29)      |
| 143-C                                                                       | 2.30 (58.4)   | 2.80 (71.1)  | 5.68 (144.3)                | 1.150 (521.63)      |
| 143-D                                                                       | 2.80 (71.1)   | 3.30 (83.8)  | 6.18 (157.0)                | 1.175 (532.97)      |
| 143-E                                                                       | 3.30 (83.8)   | 3.80 (96.5)  | 6.68 (169.7)                | 1.200 (544.31)      |
| 143-F                                                                       | 3.80 (96.5)   | 4.30 (109.2) | 7.18 (182.4)                | 1.225 (555.65)      |
| 143-G                                                                       | 4.30 (109.2)  | 4.80 (121.9) | 1.68 (195.1)                | 1.250 (566.99)      |
| 143-H                                                                       | 4.80 (121.9)  | 5.30 (134.6) | 8.18 (207.8)                | 1.275 (578.33)      |
| 143-J                                                                       | 5.30 (134.6)  | 5.80 (147.3) | 8.68 (220.5)                | 1.300 (589.67)      |
| 143-K                                                                       | 5.80 (147.3)  | 6.30 (160.0) | 9.18 (233.2)                | 1.325 (601.00)      |
| 143-L                                                                       | 6.30 (160.0)  | 6.80 (172.7) | 9.68 (245.9)                | 1.350 (612.35)      |

| 143 SERIES SPRING ASSEMBLY |                  |                              |                    |
|----------------------------|------------------|------------------------------|--------------------|
| Model Number               | Number of Leaves | Max. Clamping Force lb. (kg) | Weight lb. (grams) |
| 143-2                      | 2                | 6,000 (2,721.6)              | 0.813 (368.77)     |

**Order Guide:**  
Order Crossbar and Spring Assembly separately by type number from table.

**Dimensions:**  
in. (mm)  
lb. (kg)

MECHANICAL DIMENSIONS



Dimensions: in. (mm)



144 SERIES

COMPRESSION MOUNTING CLAMP ASSEMBLIES FOR SEMICONDUCTORS TO 4.00 IN. (101.6 MM) DIAMETER

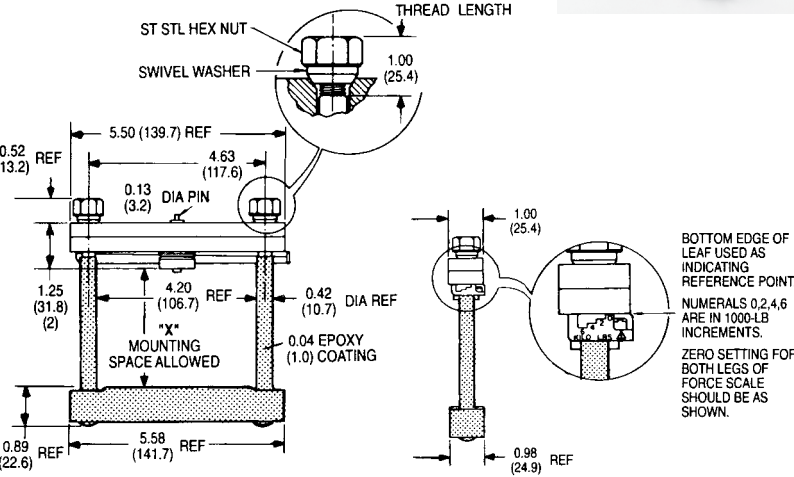
| 144 SERIES CROSSBAR<br>1,000 lb - 6,000 lb (453.6 kg - 2,721.6 kg)          |               |              |                     |
|-----------------------------------------------------------------------------|---------------|--------------|---------------------|
| Crossbar Device Mounting, Surface to Spring Assembly, Top Surface Dimension |               |              |                     |
| Model No.                                                                   | "X" Dimension |              | Weight lbs. (grams) |
|                                                                             | Min in. (mm)  | Max in. (mm) |                     |
| 144-A                                                                       | 1.50 (38.1)   | 2.00 (50.8)  | 1.231 (558.37)      |
| 144-B                                                                       | 2.00 (50.8)   | 2.50 (63.5)  | 1.262 (572.43)      |
| 144-C                                                                       | 2.50 (63.5)   | 3.00 (76.2)  | 1.285 (582.87)      |
| 144-D                                                                       | 3.00 (76.2)   | 3.50 (88.9)  | 1.310 (594.21)      |
| 144-E                                                                       | 3.50 (88.9)   | 4.00 (101.6) | 1.352 (613.26)      |

| 144 SERIES SPRING ASSEMBLY |                               |                     |
|----------------------------|-------------------------------|---------------------|
| Model No.                  | Clamping Force Range lb. (kg) | Weight lbs. (grams) |
| 144-2                      | 1,000 (453.6) - 6,000 (2,721) | 1.772 (803.77)      |

**Order Guide:**  
Order Crossbar and Spring Assembly separately by type number from table.

**Dimensions:**  
in. (mm)  
lb. (kg)

MECHANICAL DIMENSIONS



Dimensions: in. (mm)



145 SERIES

COMPRESSION MOUNTING CLAMP ASSEMBLIES FOR SEMICONDUCTORS TO 4.50 IN. (114.3 MM) DIAMETER

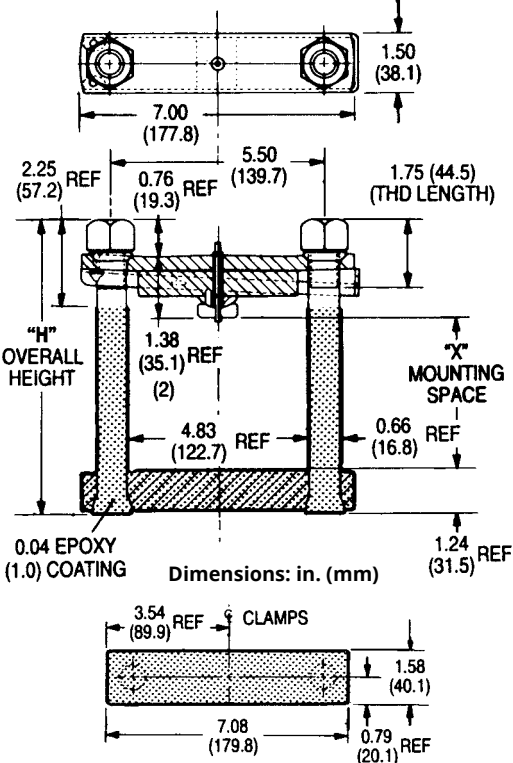
| 145 SERIES CROSSBAR<br>2,000 lb - 10,000 lb (907.2 kg - 4,535.9 kg)         |               |              |                             |                     |
|-----------------------------------------------------------------------------|---------------|--------------|-----------------------------|---------------------|
| Crossbar Device Mounting, Surface to Spring Assembly, Top Surface Dimension |               |              |                             |                     |
| Model No.                                                                   | "X" Dimension |              | Overall Height "H" in. (mm) | Weight lbs. (grams) |
|                                                                             | Min in. (mm)  | Max in. (mm) |                             |                     |
| 145-A                                                                       | 1.75 (44.5)   | 2.50 (63.5)  | 6.00 (152.4)                | 3.845 (1744.06)     |
| 145-B                                                                       | 2.50 (63.5)   | 3.25 (82.6)  | 6.75 (171.5)                | 3.987 (1808.47)     |
| 145-C                                                                       | 3.25 (82.6)   | 4.00 (101.6) | 7.50 (190.5)                | 4.06 (1841.58)      |
| 145-D                                                                       | 4.00 (101.6)  | 4.75 (120.7) | 8.25 (209.6)                | 4.187 (1899.19)     |
| 145-E                                                                       | 4.75 (120.7)  | 5.50 (139.7) | 9.00 (228.6)                | 4.37 (1982.20)      |
| 145-F                                                                       | 5.50 (139.7)  | 6.25 (158.8) | 9.75 (247.7)                | 4.459 (2022.57)     |

| 145 SERIES SPRING ASSEMBLY |                                  |                     |
|----------------------------|----------------------------------|---------------------|
| Model No.                  | Clamping Force Range lb. (kg)    | Weight lbs. (grams) |
| 145-2                      | 2,000 (907.2) - 10,000 (4,535.9) | 2.01 (911.72)       |

**Order Guide:**  
Order Crossbar and Spring Assembly separately by type number from table.

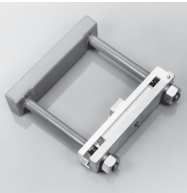
**Dimensions:**  
in. (mm)  
lb. (kg)

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

PRECISION COMPRESSION MOUNTING CLAMP SYSTEMS



146 SERIES

COMPRESSION MOUNTING CLAMP ASSEMBLIES FOR SEMICONDUCTORS TO 5.25 IN. (133.5 MM) DIAMETER

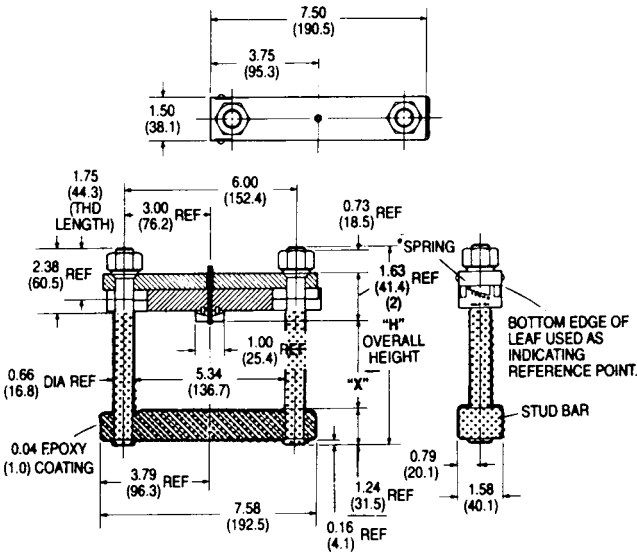
| 146 SERIES CROSSBAR                                                         |               |              |                             |                     |
|-----------------------------------------------------------------------------|---------------|--------------|-----------------------------|---------------------|
| 8,000 lb-16,000 lb (3,628.7 kg - 7,257.4 kg)                                |               |              |                             |                     |
| Crossbar Device Mounting, Surface to Spring Assembly, Top Surface Dimension |               |              |                             |                     |
| Model No.                                                                   | "X" Dimension |              | Overall Height "H" in. (mm) | Weight lbs. (grams) |
|                                                                             | Min in. (mm)  | Max in. (mm) |                             |                     |
| 146-A                                                                       | 1.54 (39.1)   | 2.29 (58.2)  | 5.92 (150.4)                | 3.813 (1729.55)     |
| 146-B                                                                       | 2.29 (58.2)   | 3.04 (77.2)  | 6.67 (169.4)                | 3.938 (1786.25)     |
| 146-C                                                                       | 3.04 (77.2)   | 3.79 (96.3)  | 7.42 (188.5)                | 4.063 (1842.95)     |
| 146-D                                                                       | 3.79 (96.3)   | 4.54 (115.3) | 8.17 (207.5)                | 4.188 (1899.64)     |
| 146-E                                                                       | 4.54 (115.3)  | 5.29 (134.4) | 8.92 (226.6)                | 4.313 (1956.34)     |
| 146-F                                                                       | 5.29 (134.4)  | 6.04 (153.4) | 9.67 (245.6)                | 4.438 (2013.04)     |
| 146-G                                                                       | 6.04 (153.4)  | 6.79 (172.5) | 10.42 (264.7)               | 4.563 (2069.74)     |

| 146 SERIES SPRING ASSEMBLY |                  |                                    |                           |
|----------------------------|------------------|------------------------------------|---------------------------|
| Model Number               | Number of Leaves | Clamping Force Range lb. (kg)      | Maximum Force lb. (grams) |
| 146-2                      | 2                | 8,000 (3,628.7) - 16,000 (7,257.5) | 2,688 (1,219.26)          |

Order Guide:  
Order Crossbar and Spring Assembly separately by type number from table.

Dimensions:  
in. (mm)  
lb. (kg)

MECHANICAL DIMENSIONS



Dimensions: in. (mm)

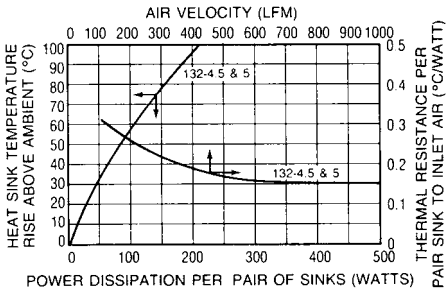
132/133 SERIES HIGH-PERFORMANCE HEAT SINKS FOR COMPRESSION TYPE DEVICES

132 & 133 SERIES

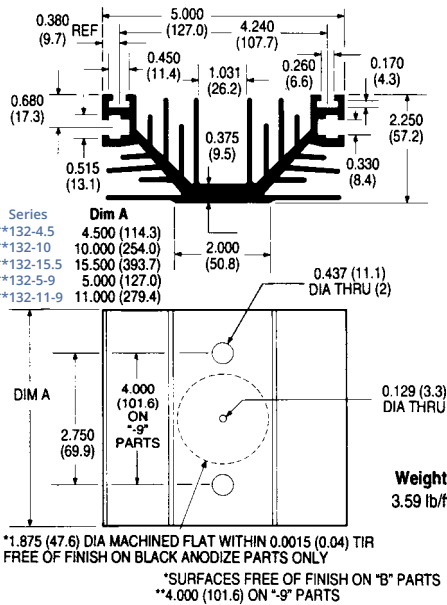
| Standard P/N                                 |              | Width in. (mm) | Nominal Dimensions: <sup>(1)</sup> Length "A" in. (mm) | Height in. (mm) | Clamp System Series <sup>(5)</sup> | Thermal Performance at Typical Load <sup>(2)</sup> |                             |
|----------------------------------------------|--------------|----------------|--------------------------------------------------------|-----------------|------------------------------------|----------------------------------------------------|-----------------------------|
| Black Anodize <sup>(4,5)</sup>               | Gold Iridite |                |                                                        |                 |                                    | Natural Convection (°C/W) <sup>(3)</sup>           | Convection (°C/W) @ 500 LFM |
| 132-4.5B                                     | 132-4.5G     | 5.000 (127.0)  | 4.500 (114.3)                                          | 2.250 (57.2)    | 130                                | 0.61                                               | 0.170                       |
| 132-10B                                      | 132-10G      | 5.000 (127.0)  | 10.000 (254.0)                                         | 2.250 (57.2)    | 130                                | 0.38                                               | 0.130                       |
| 132-15.5B                                    | 132-15.5G    | 5.000 (127.0)  | 15.500 (393.7)                                         | 2.250 (57.2)    | 130                                | 0.28                                               | 0.100                       |
| 132-5-B9                                     | 132-5-G9     | 5.000 (127.0)  | 5.000 (127.0)                                          | 2.250 (57.2)    | 139                                | 0.61                                               | 0.170                       |
| 132-11-B9                                    | 132-11-G9    | 5.000 (127.0)  | 11.000 (279.4)                                         | 2.250 (57.2)    | 139                                | 0.37                                               | 0.120                       |
| 133-4.5B                                     | 133-4.5G     | 7.000 (177.8)  | 4.500 (114.3)                                          | 3.125 (79.4)    | 130                                | 0.37                                               | 0.110                       |
| 133-7.5B                                     | 133-7.5G     | 7.000 (177.8)  | 7.500 (190.5)                                          | 3.125 (79.4)    | 130                                | 0.28                                               | 0.085                       |
| 133-10B                                      | 133-10G      | 7.000 (177.8)  | 10.000 (254.0)                                         | 3.125 (79.4)    | 130                                | 0.26                                               | 0.082                       |
| 133-5-B9                                     | 133-5-G9     | 7.000 (177.8)  | 5.000 (127.0)                                          | 3.125 (79.4)    | 139                                | 0.37                                               | 0.110                       |
| 133-7.5-B9                                   | 133-7.5-G9   | 7.000 (177.8)  | 7.500 (190.5)                                          | 3.125 (79.4)    | 139                                | 0.28                                               | 0.085                       |
| 133-11-B9                                    | 133-11-G9    | 7.000 (177.8)  | 11.000 (279.4)                                         | 3.125 (79.4)    | 139                                | 0.24                                               | 0.076                       |
| Material: Aluminum, Black Anodized           |              |                |                                                        |                 |                                    |                                                    |                             |
| Finish: B = Black Anodized, G = Gold Iridite |              |                |                                                        |                 |                                    |                                                    |                             |

132 & 133 SERIES

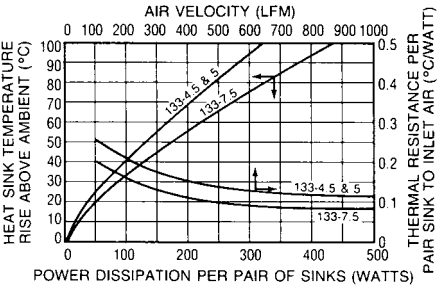
132 SERIES  
NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



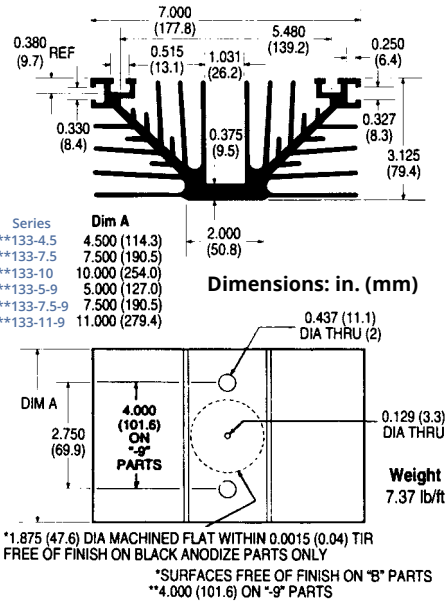
MECHANICAL DIMENSIONS  
132 SERIES  
(EXTRUSION PROFILE 3560-2)



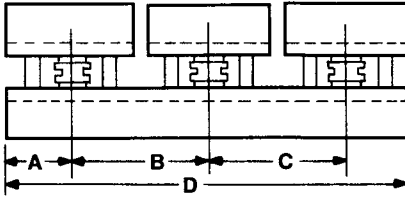
133 SERIES  
NATURAL AND FORCED  
CONVECTION CHARACTERISTICS



MECHANICAL DIMENSIONS  
133 SERIES  
(EXTRUSION PROFILE 3559-2)



MULTIPLE ASSEMBLY CONFIGURATION



| Type        | Use with     | A    | B    | C           | D     |
|-------------|--------------|------|------|-------------|-------|
| 132-4.5     | -            | -    | -    | See Fig.132 | -     |
| 132-10      | 2 ea 132-4.5 | 2.25 | 5.50 | -           | 10.0  |
| 132-15.5    | 3 ea 132-4.5 | 2.25 | 5.50 | 5.50        | 15.5  |
| 133-4.5     | -            | -    | -    | See Fig.133 | -     |
| 133-7.5     | -            | -    | -    | See Fig.133 | -     |
| 133-10      | 2 ea 133-4.5 | 2.25 | 5.50 | -           | 10.0  |
| 132-5-9**   | -            | -    | -    | See Fig.132 | -     |
| 132-11-9**  | 2 ea 132-5-9 | 2.50 | 6.00 | -           | -     |
| 133-5-9**   | -            | -    | -    | See Fig.133 | -     |
| 133-7.5-9** | -            | -    | -    | See Fig.133 | -     |
| 133-11-9**  | 2 ea 133-5-9 | 2.50 | 6.00 | -           | 11.00 |

\*\* -9 indicates heat sinks drilled for 139 clamp.

NOTES:

- Nominal dimensions for one heat sink of this type.
- Thermal performance values shown are per pair of heat sinks.
- Natural convection performance at 50°C heat sink rise above ambient.
- Black anodize finish [1.875 in. (47.6 mm) diameter spot face. Device mounting surface area free of finish].
- Predrilled heat sinks accept 130 and 139 Series clamp systems.

# LIQUID COOLING

Liquid Cold Plates For High-Performance Components & Systems

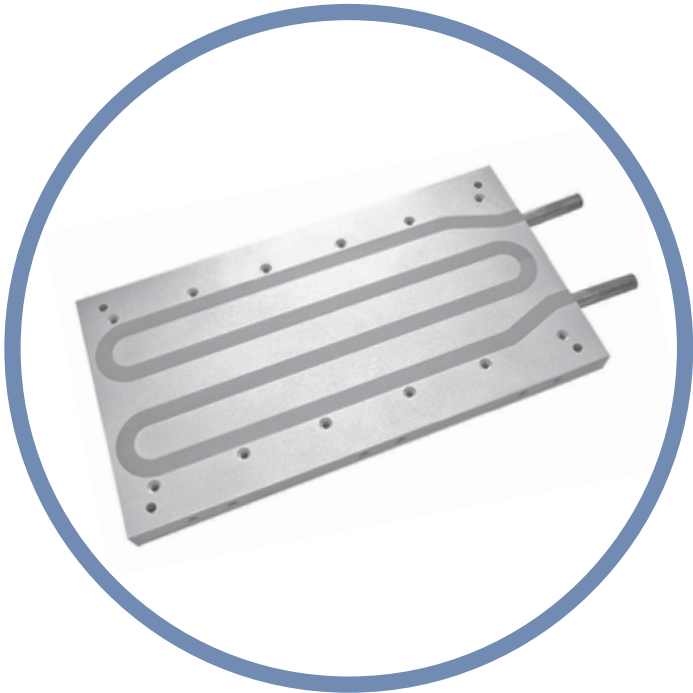
Exposed Tube Liquid Cold Plates

Full Buried Tube Liquid Cold Plates

116–117

118–119

120–122



Liquid cooling is a natural evolution beyond air cooling where either due to thermal requirements or footprint requirements, the desired performance can no longer be economically met by air cooling.

There are many ways to accomplish liquid cooling, but the most common method is to have a plate with a flow path that moves liquid under the devices. After the heat is absorbed into the liquid, it is taken out of the plate and into the larger system. While water or water/glycol are the most common fluids used in liquid cooling, gasoline, oil, and refrigerant are other fluids that can be utilized.

There are lots of ways to construct a cold plate and the methods can be driven by the level of performance needed, the materials needed or the environmental requirements.

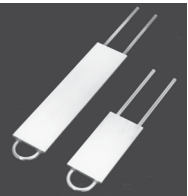
One construction method is to use a series of cross drilled holes in a plate. The holes intersect in the plate to determine the flow pattern and unneeded patterns are plugged. This construction method can be cost effective, but the pattern is limited to straight lines.

Another method is to embed a tube in a plate by machining a groove in the plate. The tube can either be placed toward the top surface of the plate to provide better cooling to devices mounted on that surface, or it can be embedded further into the plate so that it cools devices mounted on both sides of the plate. This option provides greater flexibility, but the thermal performance is limited because of the surface area of the tube perimeter.

To get more performance, extended surface area in contact with the fluid is required and this leads to machined cold plates. The cold plate is constructed of a plate that has been machined to form some flow passages and then a cover is assembled to capture the flow. The extended surface area can be machined in place or installed by use of a piece of folded fin. The cover can be flat or be another machined plate. The method of assembly of the two parts can be done by gasket/screw, glue/screw, brazing, or welding and is dependent on the required performance and the requirements of the environment.



LIQUID COLD PLATES FOR  
HIGH-PERFORMANCE COMPONENTS & SYSTEMS



180-10 & 180-11 SERIES

LIQUID COLD PLATES FOR RECTIFIERS  
AND POWER DIODES

General Purpose

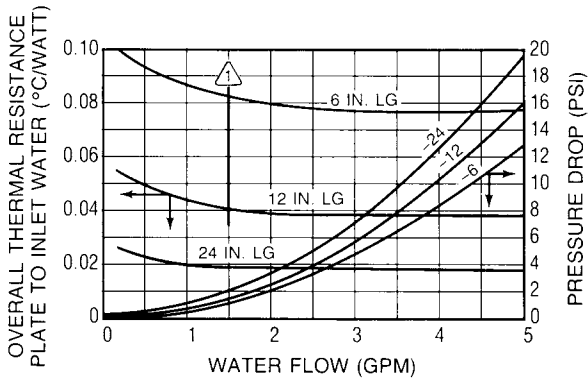
| Standard P/N | Cold Plate Body Nominal Dimensions |                |                    |                        | Overall Length in. (mm) | Overall Thermal Resistance (Plate to Inlet Water) | Weight lbs. (grams) |
|--------------|------------------------------------|----------------|--------------------|------------------------|-------------------------|---------------------------------------------------|---------------------|
|              | Length "A" in. (mm)                | Width in. (mm) | Thickness in. (mm) | Channel Width in. (mm) |                         |                                                   |                     |
| 180-10-6C    | 6.000 (152.4)                      | 3.000 (76.2)   | 0.625 (15.9)       | 1.250 (31.8)           | 13.406 (340.5)          | 0.084°C/W @ 1.5 GPM                               | 0.850 (385.56)      |
| 180-10-12C   | 12.000 (304.8)                     | 3.000 (76.2)   | 0.625 (15.9)       | 1.250 (31.8)           | 19.406 (429.9)          | 0.041°C/W @ 1.5 GPM                               | 1.700 (771.12)      |
| 180-10-24C   | 24.000 (609.6)                     | 3.000 (76.2)   | 0.625 (15.9)       | 1.250 (31.8)           | 31.406 (797.7)          | 0.020°C/W @ 1.5 GPM                               | 2.900 (1315.4)      |
| 180-11-6C    | 6.000 (152.4)                      | 5.000 (127.2)  | 0.688 (17.5)       | 1.813 (46.1)           | 13.688 (347.7)          | 0.084°C/W @ 1.5 GPM                               | 1.500 (680.40)      |
| 180-11-12C   | 12.000 (304.8)                     | 5.000 (127.2)  | 0.688 (17.5)       | 1.813 (46.1)           | 19.688 (500.1)          | 0.041°C/W @ 1.5 GPM                               | 2.867 (1300.47)     |
| 180-11-24C   | 24.000 (609.6)                     | 5.000 (127.2)  | 0.688 (17.5)       | 1.813 (46.1)           | 31.688 (804.9)          | 0.020°C/W @ 1.5 GPM                               | 5.730 (2599.13)     |

Material: Aluminum, no finish. Tubing: Copper (stainless steel tubing available on special order).

LOCAL THERMAL RESISTANCE PER DEVICE  
PLATE TO INLET WATER (°C/WATT)

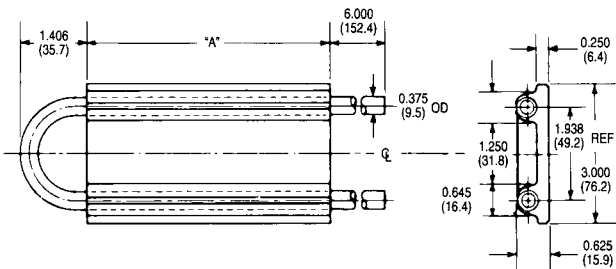
| ℄ to ℄ Device Spacing Inches | Flow - GPM |      |      |      |      |
|------------------------------|------------|------|------|------|------|
|                              | ½          | 1    | 2    | 3    | 4    |
| 1.0 (25.4)                   | 0.59       | 0.52 | 0.48 | 0.47 | 0.46 |
| 2.0 (50.8)                   | 0.40       | 0.36 | 0.33 | 0.32 | 0.31 |
| 3.0 (76.2)                   | 0.29       | 0.26 | 0.24 | 0.23 | 0.22 |

PERFORMANCE CHARACTERISTICS



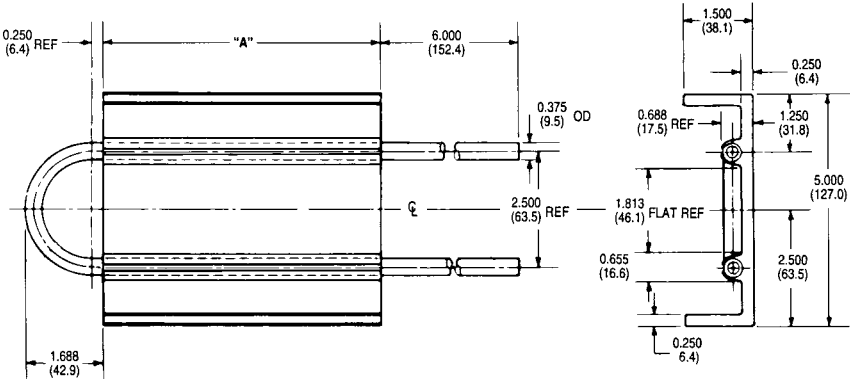
MECHANICAL DIMENSIONS

180-10 SERIES



| Standard P/N | Length "A" in. (mm) |
|--------------|---------------------|
| 180-10-6C    | 6.000 in. (152.4)   |
| 180-10-12C   | 12.000 in. (304.8)  |
| 180-10-24C   | 24.000 in. (609.6)  |
| 180-11-6C    | 6.000 in. (152.4)   |
| 180-11-12C   | 12.000 in. (304.8)  |
| 180-11-24C   | 24.000 in. (609.6)  |

180-11 SERIES



Dimensions: in. (mm)

wakefield-vette.com

LIQUID COLD PLATES FOR RECTIFIERS,  
DIODES, AND POWER MODULES

General Purpose

180-12 & 180-20 SERIES

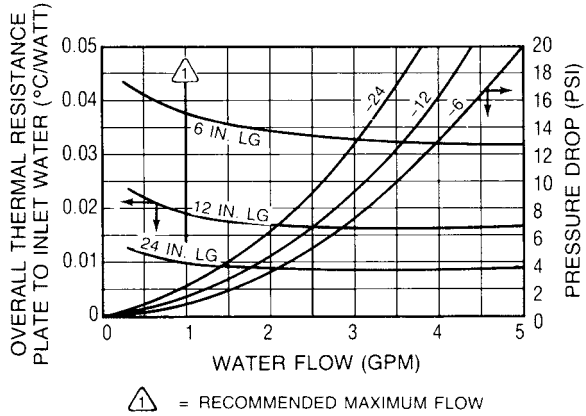


| Standard P/N | Cold Plate Body Nominal Dimensions |                |                    | Mounting Surfaces | Overall Length in. (mm) | Overall Thermal Resistance (Plate to Inlet Water) | Weight lbs. (grams) |
|--------------|------------------------------------|----------------|--------------------|-------------------|-------------------------|---------------------------------------------------|---------------------|
|              | Length "A" in. (mm)                | Width in. (mm) | Thickness in. (mm) |                   |                         |                                                   |                     |
| 180-12-6C    | 6.000 (152.4)                      | 7.750 (196.9)  | 0.658 (16.7)       | Single            | 13.406 (340.5)          | 0.038°C/W @ 1.0 GPM                               | 2.270 (1029.67)     |
| 180-12-12C   | 12.000 (304.8)                     | 7.750 (196.9)  | 0.658 (16.7)       | Single            | 19.406 (429.9)          | 0.018°C/W @ 1.0 GPM                               | 4.300 (1950.48)     |
| 180-12-24C   | 24.000 (609.6)                     | 7.750 (196.9)  | 0.658 (16.7)       | Single            | 31.406 (797.7)          | 0.009°C/W @ 1.0 GPM                               | 8.600 (3900.96)     |
| 180-20-6C    | 6.000 (152.4)                      | 5.500 (139.7)  | 0.690 (17.5)       | Double            | 13.125 (333.4)          | 0.038°C/W @ 1.0 GPM                               | 1.090 (494.42)      |

LOCAL THERMAL RESISTANCE PER DEVICE  
PLATE TO INLET WATER (°C/WATT)

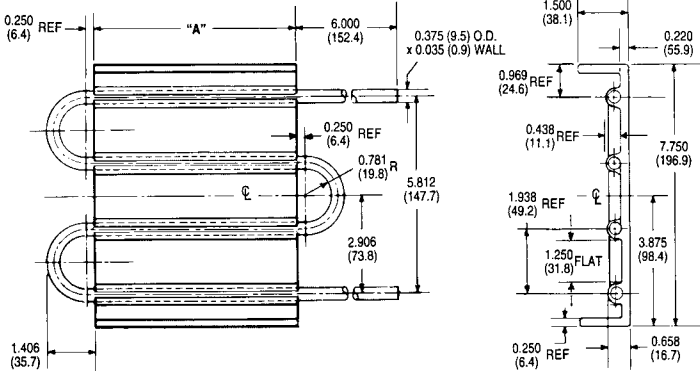
| ℄ to ℄ Device Spacing Inches | Flow - GPM |      |      |      |      |
|------------------------------|------------|------|------|------|------|
|                              | ½          | 1    | 2    | 3    | 4    |
| 1.0 (25.4)                   | 0.76       | 0.67 | 0.62 | 0.59 | 0.57 |
| 2.0 (50.8)                   | 0.58       | 0.49 | 0.43 | 0.40 | 0.39 |
| 3.0 (76.2)                   | 0.42       | 0.34 | 0.30 | 0.28 | 0.27 |

PERFORMANCE CHARACTERISTICS

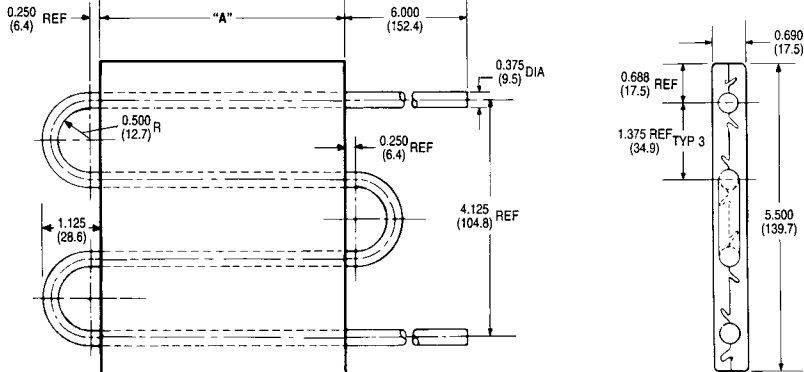


MECHANICAL DIMENSIONS

180-12 SERIES



180-20 SERIES



Dimensions: in. (mm)

| Standard P/N | Length "A" in. (mm) |
|--------------|---------------------|
| 180-12-6C    | 6.000 in. (152.4)   |
| 180-12-12C   | 12.000 in. (304.8)  |
| 180-12-24C   | 24.000 in. (609.6)  |
| 180-20-6C    | 6.000 in. (152.4)   |

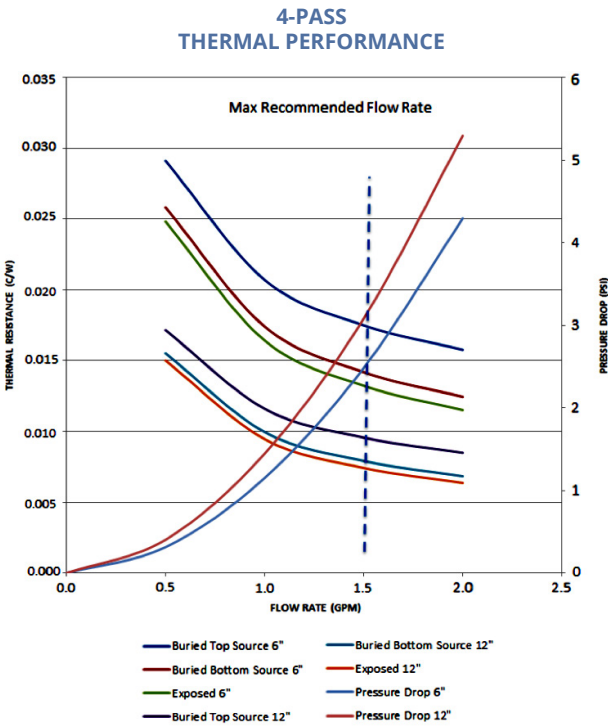
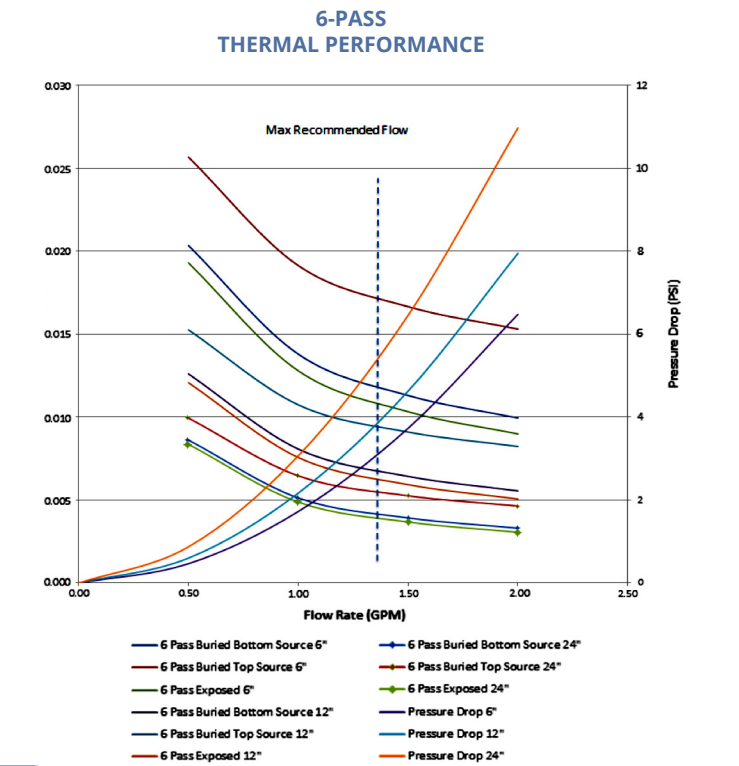
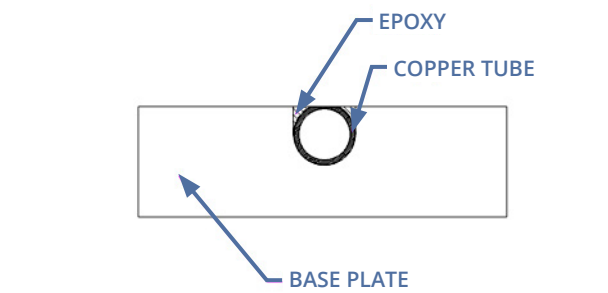
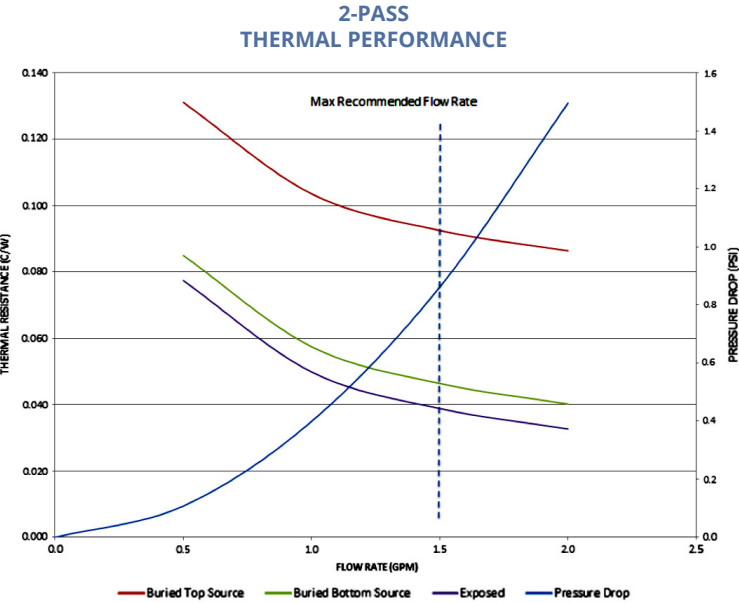
Contact us: (603) 635-2800

EXPOSED TUBE LIQUID COLD PLATES

Wakefield-Vette's exposed tube liquid cold plates ensure minimum thermal resistance between the power device and the cold plate by placing the coolant tube in direct contact with the power device's base. Direct contact reduces the number of thermal interfaces between device and fluid thus increasing performance for the application.

| Part Number | Description                     | "X" Dimension Inches | Passes | Figure |
|-------------|---------------------------------|----------------------|--------|--------|
| 120455      | Exposed Tube 2- Pass Cold plate | N/A                  | 2      | 1      |
| 120456      | Exposed Tube 4- Pass Cold plate | 6.00                 | 4      | 2      |
| 120457      | Exposed Tube 4- Pass Cold plate | 12.00                | 4      | 2      |
| 120458      | Exposed Tube 6- Pass Cold plate | 6.00                 | 6      | 3      |
| 120459      | Exposed Tube 6- Pass Cold plate | 12.00                | 6      | 3      |
| 120460      | Exposed Tube 6- Pass Cold plate | 24.00                | 6      | 3      |

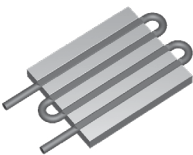
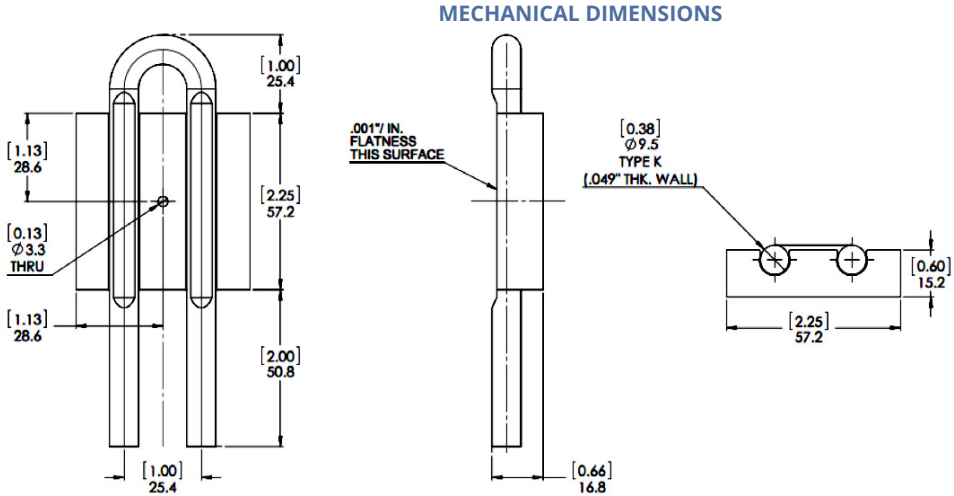
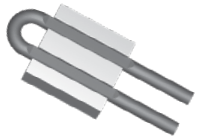
- KEY SPECIFICATIONS
- Base Plate: Extruded Aluminum.
  - Copper Tube Material: .0375" OD x .049" wall.
  - Thermal Epoxy fill with high thermal conductivity.



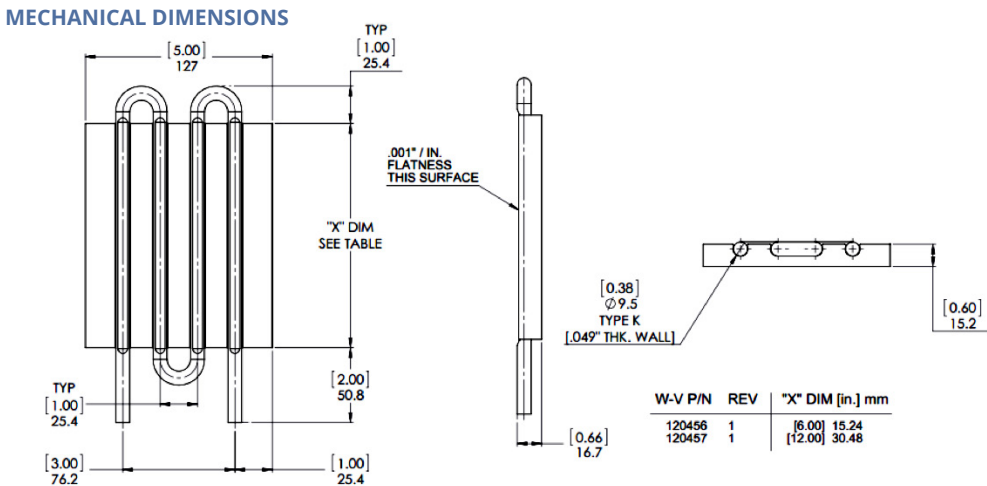
Custom Exposed Tube  
Liquid Cold Plates Available  
Contact Wakefield-Vette for more information  
or visit [www.wakefield-vette.com](http://www.wakefield-vette.com)



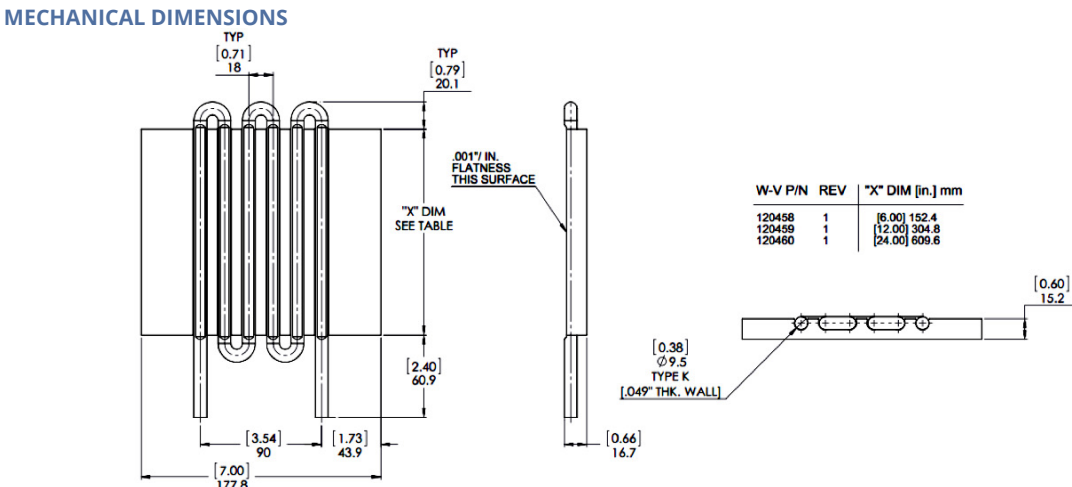
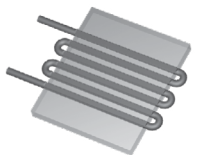
PART NUMBER 120455



PART NUMBER 120456 & 120457



PART NUMBER 120458, 120459, & 120460

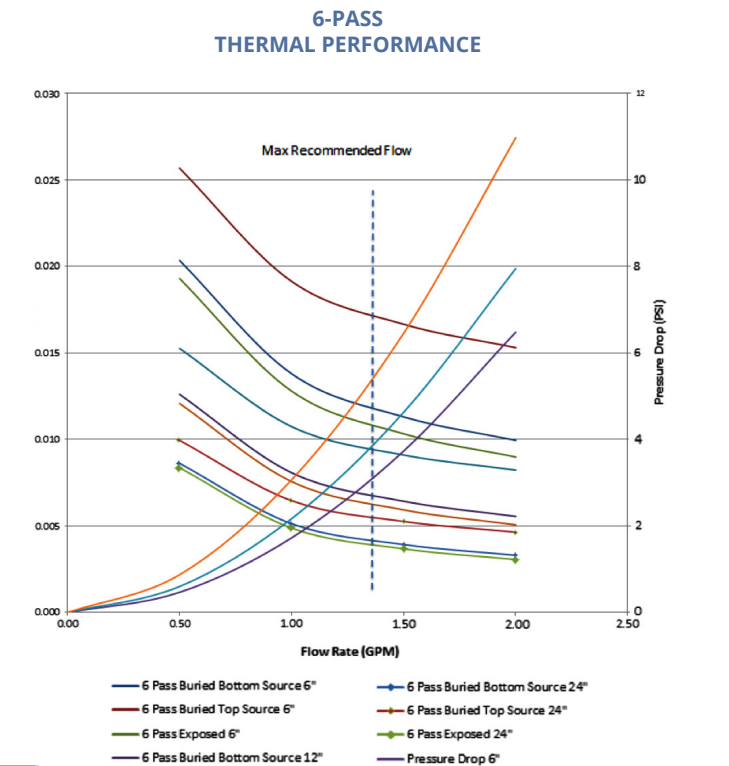
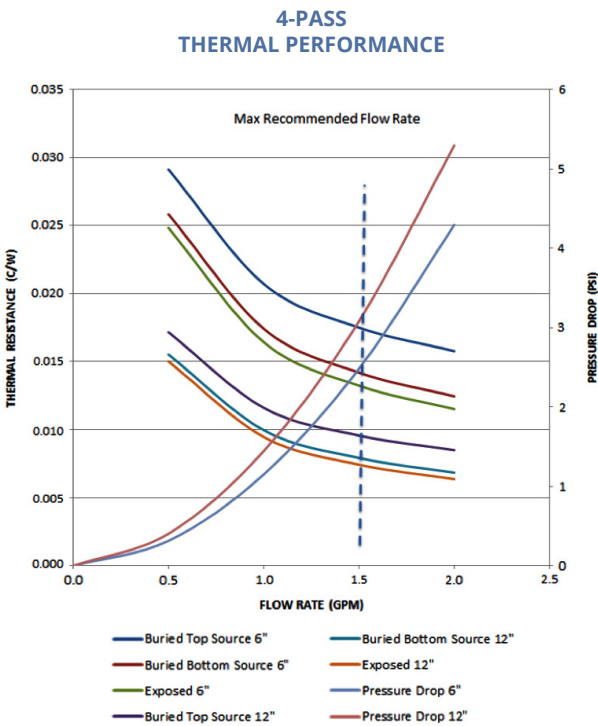
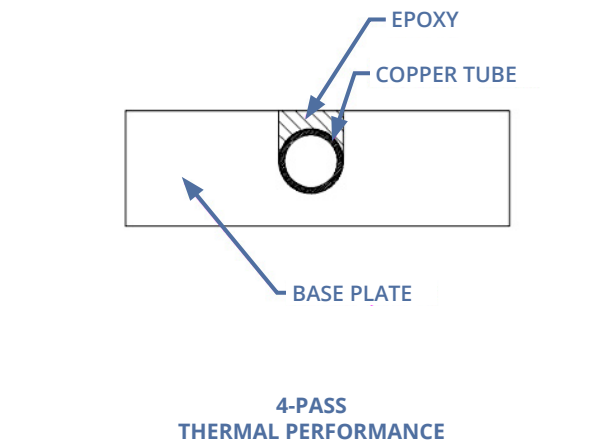
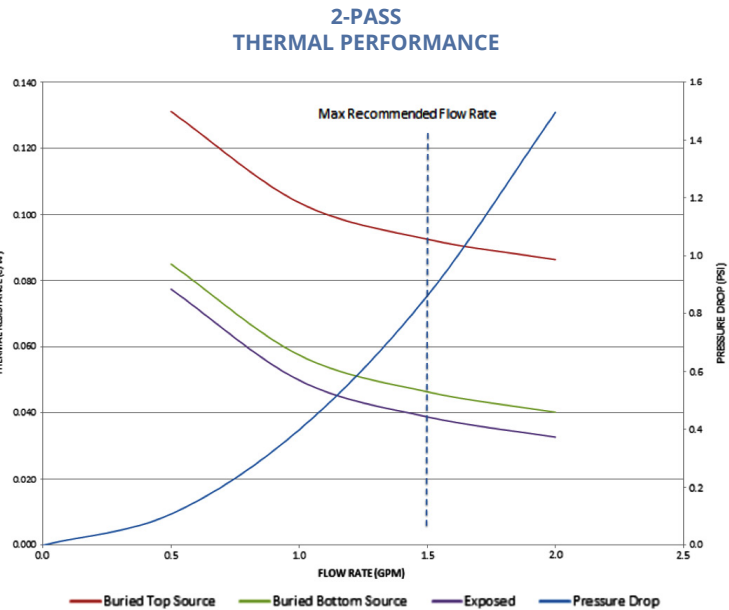


FULL BURIED TUBE LIQUID COLD PLATES

Wakefield-Vette's fully buried tube liquid cold plates have the ability to cool both sides of the cold plate because of it's positioning within the base plate. Another key feature of the fully buried tube is that it is not exposed to the outside environment. Some engineers prefer the epoxy layer above the tube to protect the tube from leakage.

| Part Number | Description                          | "X" Dimension Inches | Passes | Figure |
|-------------|--------------------------------------|----------------------|--------|--------|
| 120959      | Fully Buried Tube 2- Pass Cold plate | N/A                  | 2      | 1      |
| 120960      | Fully Buried Tube 4- Pass Cold plate | 6.00                 | 4      | 2      |
| 120961      | Fully Buried Tube 4- Pass Cold plate | 12.00                | 4      | 2      |
| 120962      | Fully Buried Tube 6- Pass Cold plate | 6.00                 | 6      | 3      |
| 120963      | Fully Buried Tube 6- Pass Cold plate | 12.00                | 6      | 4      |
| 120964      | Fully Buried Tube 6- Pass Cold plate | 24.00                | 6      | 5      |

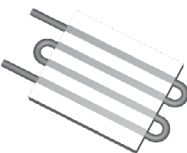
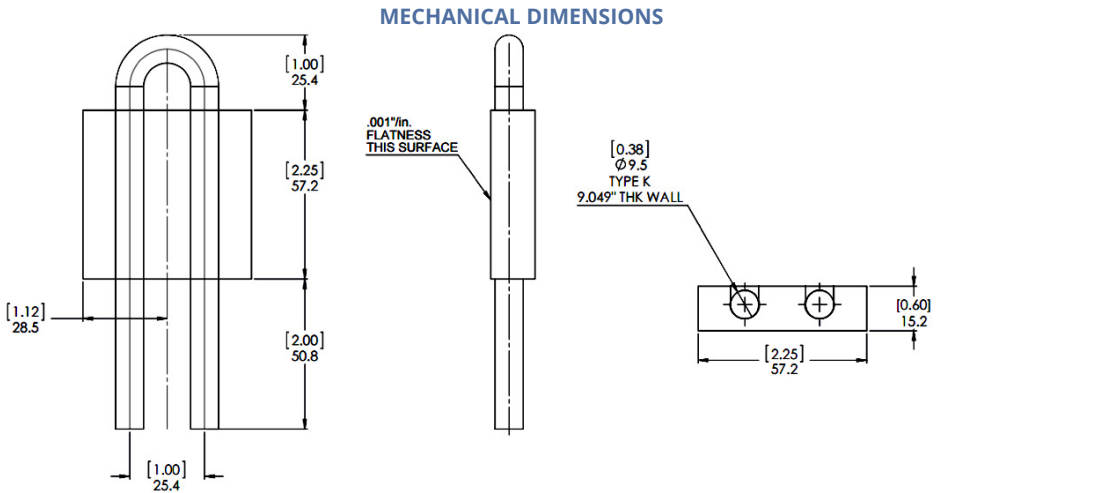
- KEY SPECIFICATIONS
- Base Plate: Extruded Aluminum.
  - Copper Tube Material: .0375" OD x .049" wall.
  - Thermal Epoxy fill with high thermal conductivity.



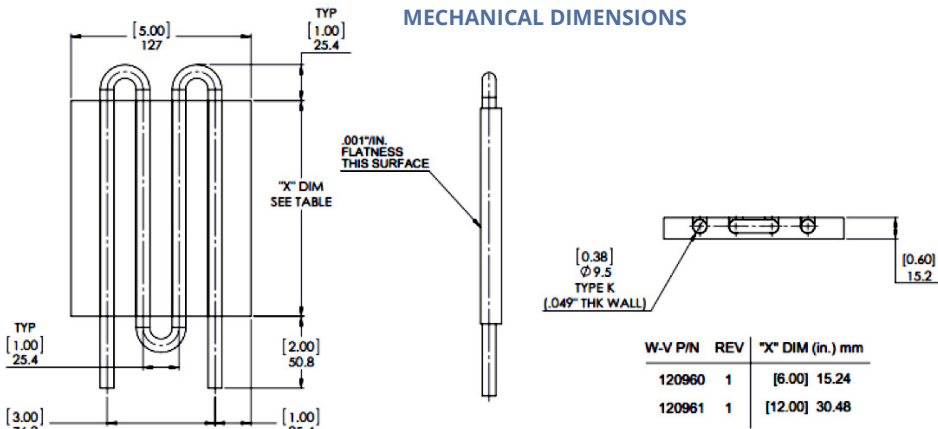
Custom Full Buried Tube  
Liquid Cold Plates Available  
Contact Wakefield-Vette for more information  
or visit [www.wakefield-vette.com](http://www.wakefield-vette.com)



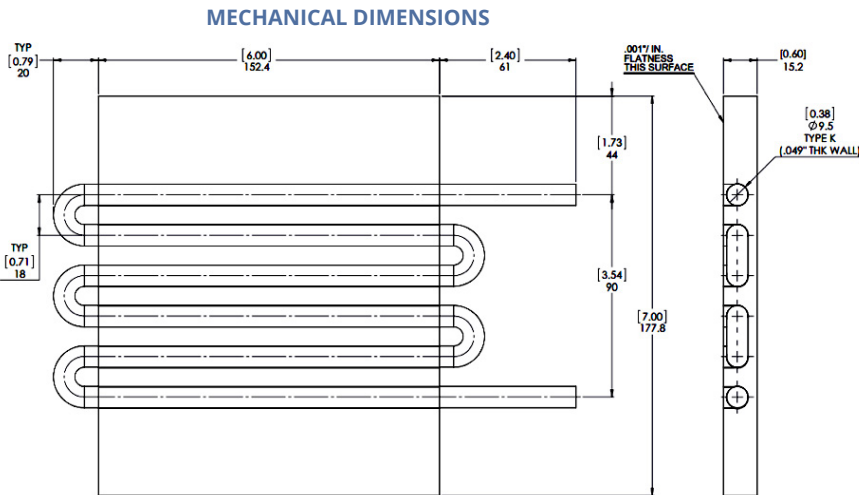
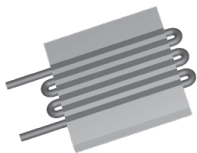
PART NUMBER 120959



PART NUMBER 120960 & 120961

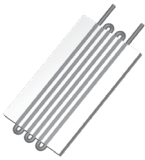


PART NUMBER 12062





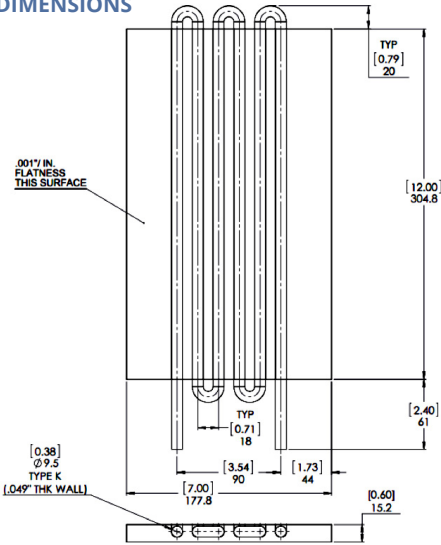
FULL BURIED TUBE LIQUID COLD PLATES



PART NUMBER 120963



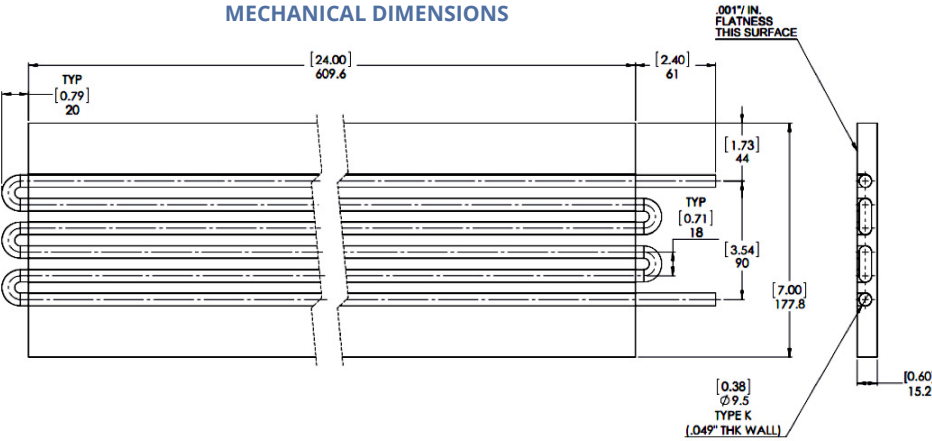
MECHANICAL DIMENSIONS



PART NUMBER 120964



MECHANICAL DIMENSIONS



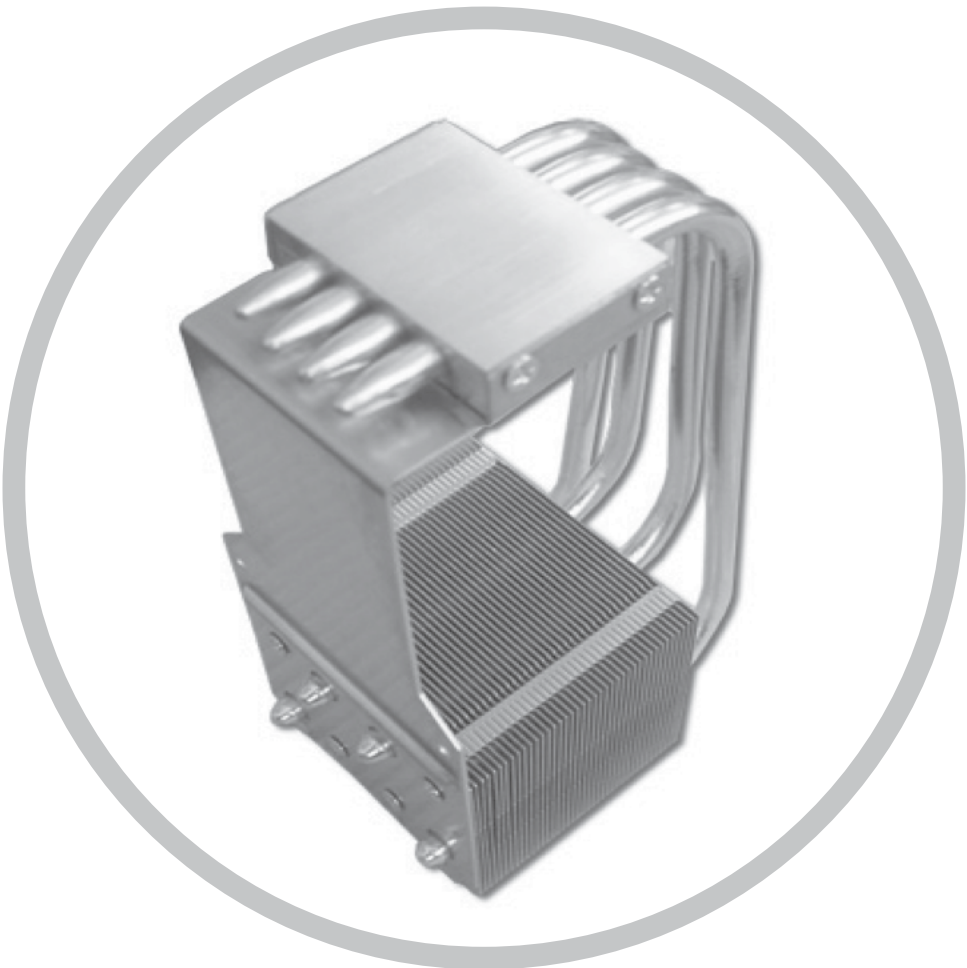
# PHASE CHANGE

Heat Pipe Selection Guide .....

Vapor Chamber Design Guide .....

126-131

132-137

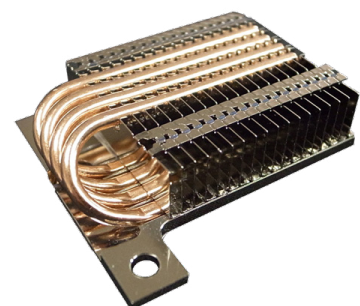


*Fluid Phase Change applications, often referred to as “re-circulating,” use closed loop heat pipes to transfer heat quickly through evaporation and condensation within the heat pipe. Because of their high thermal efficiency, heat pipes are often designed into advanced heat sink technologies when increased thermal density or physical size restrictions exist. This similar process is utilized in vapor chamber technology as well.*

## HEAT PIPE SELECTION GUIDE

### HEAT PIPE INTRODUCTION

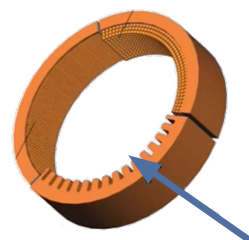
Heat pipes are used to transport heat over a distance with very low thermal resistance. This is very helpful when small or distant heat sources need to be dissipated over a larger area or moved to a remote heat exchanger. Heat pipes are a **Fluid Phase Change application**, often referred to as “re-circulating,” because they use a closed loop to transfer heat quickly through evaporation and condensation within the heat pipe.



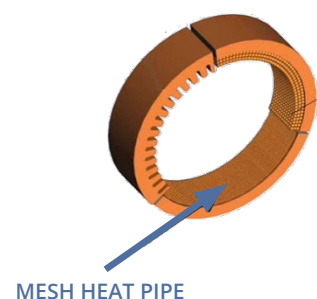
Heat pipes do not actually dissipate the heat to the environment, but serve to move heat efficiently within a thermal system. A heat pipe is a copper tube with an internal wick structure that is sealed on both ends with a small amount of water inside. As heat is applied to the pipe, the water will boil and turn to a gas, which then travels to the colder section of the heat pipe where it condenses back to a liquid. It is the evaporating and condensing of the water that form a pumping action to move the water (and thus the heat) from end to end of the pipe. There are many types of wick structure that can be used within the heat pipe and they are generally classified into grooved, mesh, powder and hybrid.



A **grooved heat pipe** is a copper tube with a series of shallow grooves around the internal perimeter of the heat pipe. While the water is a liquid, it travels in the grooves and while it is a vapor it travels in the open space of the pipe. Grooved pipes can be used in horizontal orientations, but are very limited in performance if used above 15° out of horizontal.



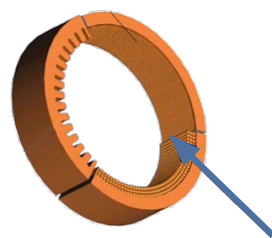
GROOVED HEAT PIPE



MESH HEAT PIPE

A **mesh heat pipe** is a smooth wall copper tube with a woven copper mesh installed along the interior of the pipe. The mesh is designed to remain in contact with the walls of the pipe in areas where the pipe may be bent or flattened. Mesh pipes can be used in horizontal and orientations up to 30° out of horizontal.

A **powder wick heat pipe** can also be known as a **sintered heat pipe**. During the manufacturing process a mandrel is installed in the center of the pipe and copper powder is poured into the pipe around the mandrel. After the powder is sufficiently packed, the parts are placed into a sintering oven. Once at temperature, the copper powder will stick to the pipe and to itself, forming numerous internal pockets like a sponge. Because of the small pocket sizes, sintered pipes can efficiently move the water and can be used horizontally, vertically and all points in between including upside down.



POWDER WICK HEAT PIPE

Wakefield-Vette primarily sells sintered, or powder, style heat pipes due to their higher performance and the best heat pipe for your application.

### WHY USE HEAT PIPES?

Heat pipes have proven to be robust and reliable over many years in these types of applications. The next section will give more technical detail on the performance of heat pipes depending on diameter, length, and angle of use. Many thermal systems benefit from the addition of heat pipes, especially when heat sources are dense and/or remote to the final heat exchanger. Computer applications, such as processors, graphics cards and other chip-sets, have high thermally dissipated power in a small area. Fan heat sink combinations used in these applications can offer high-performance dissipation to the ambient, but much of the battle is to bring the heat to the heat exchanger with as little temperature change as possible. Heat pipes excel at this and can transport large heat loads from small areas with very little temperature difference.

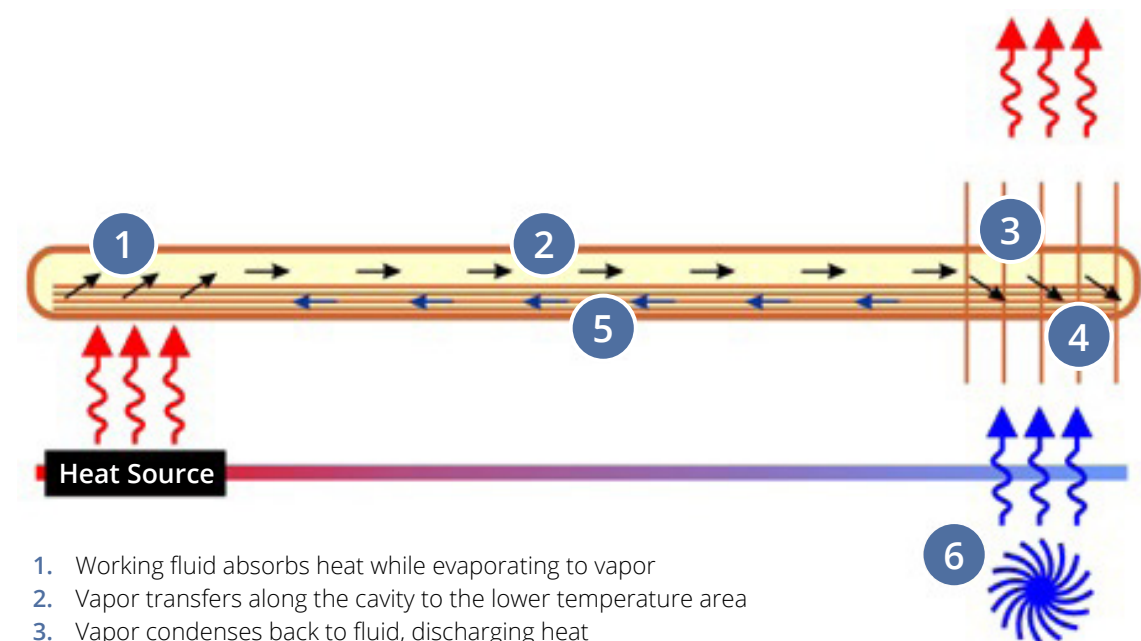
Heat pipes are used in many harsh environments such as:

- Telecommunications
- Aerospace
- Transportation
- Computers and Data Centers

#### KEY FEATURES

- Material: Copper
- Wick Structure: Powder Sintered Copper
- Light Weight
- Versatile with high thermal performance

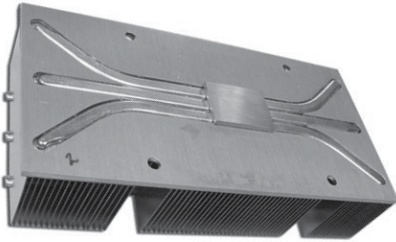
### HOW HEAT PIPES OPERATE



1. Working fluid absorbs heat while evaporating to vapor
2. Vapor transfers along the cavity to the lower temperature area
3. Vapor condenses back to fluid, discharging heat
4. Fluid is absorbed by the sintered/powdered wick structure
5. Fluid returns to high temperature end via capillary force in the wick structure
6. Natural or forced convection air flow dissipates excess heat to ambient



# HEAT PIPE SELECTION GUIDE



## HEAT PIPE BASICS

- Picking the correct pipe
- Transport
- General parameters
- Bending
- Flattening

## HEAT PIPE BASICS

When selecting the diameter and length of heat pipe it is important to consider the orientation with respect to gravity and overall heat load for the thermal system. The transport of vapor within the heat pipe is responsible for the thermal conduction from one end to the other. A larger diameter heat pipe can transport more vapor, translating into a larger heat carrying capacity. Also, the orientation of the pipe with respect to gravity plays a role in the thermal capacity of a heat pipe.

When selecting the diameter and length of heat pipe it is important to consider the orientation with respect to The thermal capacity is increased when the heat source is lower than the condenser (or ambient heat exchanger) because gravity assists the return of condensed water back to the heat source. The opposite is also true as the thermal capacity is reduced when the condensed water must move by capillary forces back to the heat source against gravity. This effect is exaggerated with longer heat pipes and testing has shown that the gravity effect can nearly the double the thermal capacity in the advantageous direction and cut the capacity in half in the deleterious direction from the heat pipe in the horizontal orientation. In the short heat pipe extreme (3"-4" length), this effect is nearly zero, so please consult with Wakefield-Vette engineers to find the right solution for your application.

| MAXIMUM HEAT TRANSFER TABLE<br>(POWDER TYPE) |                      |                      |                      |                      |                      |
|----------------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| HEAT PIPE LENGTH = 150MM                     |                      |                      |                      |                      |                      |
| Qmax<br>Type                                 | Out Diameter<br>Φ3mm | Out Diameter<br>Φ4mm | Out Diameter<br>Φ5mm | Out Diameter<br>Φ6mm | Out Diameter<br>Φ8mm |
| Flatten<br>t=2.0mm                           | 13.2 W               | 16.6 W               | 20.5 W               |                      |                      |
| Flatten<br>t=2.5mm                           | 13.2 W               | 19.8 W               | 23.6 W               | 34.0 W               | 51.5 W               |
| Flatten<br>t=3.0mm                           | 13.1 W               | 19.8 W               | 28.4 W               | 39.2 W               | 67.5 W               |
| Round Pipe                                   | 13.2 W               | 19.8 W               | 30.1 W               | 48.1 W               | 74.2 W               |



| MAXIMUM HEAT TRANSFER TABLE<br>(POWDER TYPE) |                      |                      |                      |                      |                      |
|----------------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| HEAT PIPE LENGTH = 250MM                     |                      |                      |                      |                      |                      |
| Qmax<br>Type                                 | Out Diameter<br>Φ3mm | Out Diameter<br>Φ4mm | Out Diameter<br>Φ5mm | Out Diameter<br>Φ6mm | Out Diameter<br>Φ8mm |
| Flatten<br>t=2.0mm                           | 7.2 W                | 10.1 W               | 12.2 W               |                      |                      |
| Flatten<br>t=2.5mm                           | 8.1 W                | 11.2 W               | 13.1 W               | 16.5 W               | 23.0 W               |
| Flatten<br>t=3.0mm                           | 8.2 W                | 12.1 W               | 14.1 W               | 22.0 W               | 37.0 W               |
| Round Pipe                                   | 9.0 W                | 12.3 W               | 15.6 W               | 29.3 W               | 45.0 W               |



## FLATTENING HEAT PIPES

Flattening is another aspect of heat pipes that effect their performance. Often it is necessary to flatten a heat pipe to fit into a desired shape or gap or to increase the contact area of the pipe with the heat. Since flattening reduces the effective cross-sectional area of the round pipe, the thermal capacity is reduced, just as if a smaller diameter pipe was being used. The larger diameter of the starting heat pipe, the larger reduction of thermal capacity is seen when flattening. Also, the larger diameter pipes cannot be flattened to the same ultimate dimension as the smaller pipes without disrupting heat flow altogether. This is also true for bending of pipes. The radius of bending is usually 3-5x the diameter of the heat pipe depending on the pipe diameter and the process of bending the pipe. The potential danger is to collapse the pipe, effectively cutting off vapor and thermal transport.



| SIZE OF FLATTED HEAT PIPES |                   |               |                   |
|----------------------------|-------------------|---------------|-------------------|
| Diameter<br>(mm)           | Thickness<br>(mm) | Width<br>(mm) | Tolerance<br>(mm) |
| 4mm                        | 3                 | 4.65          | +/- 0.15          |
|                            | 2.5               | 5             | +/- 0.15          |
|                            | 2                 | 5.23          | +/- 0.15          |
| 5mm                        | 3.5               | 5.97          | +/- 0.15          |
|                            | 3                 | 6.25          | +/- 0.15          |
|                            | 2                 | 6.83          | +/- 0.15          |
| 6mm                        | 4                 | 7.3           | +/- 0.15          |
|                            | 3.5               | 7.58          | +/- 0.15          |
| 8mm                        | 6                 | 9.35          | +/- 0.15          |
|                            | 5                 | 9.95          | +/- 0.15          |
|                            | 4                 | 10.5          | +/- 0.15          |
|                            | 3                 | 10.99         | +/- 0.15          |

*Bending radius for heat pipes of different diameters depending on the method of bending.*

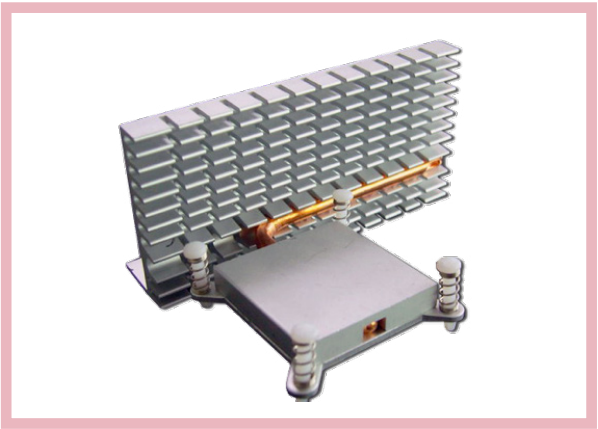
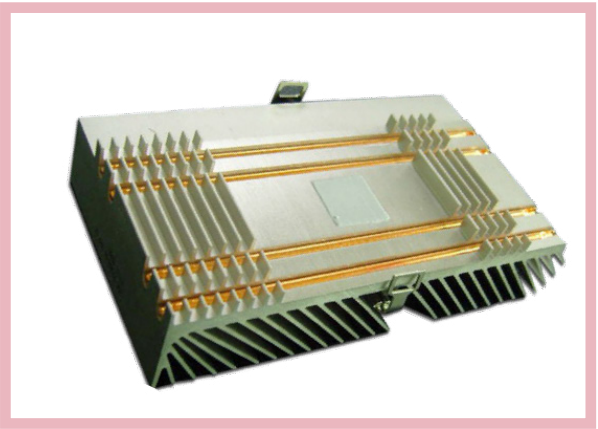
## BENDING

### By Hand:

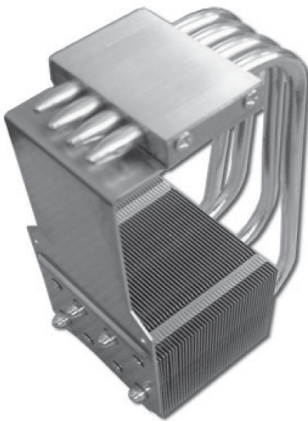
- 4mm: 4 x diameter
- 6mm: 4 x diameter
- 8mm: 5 x diameter

### Tooling:

- 4mm: 3 x diameter
- 6mm: 3 x diameter
- 8mm: 4 x diameter



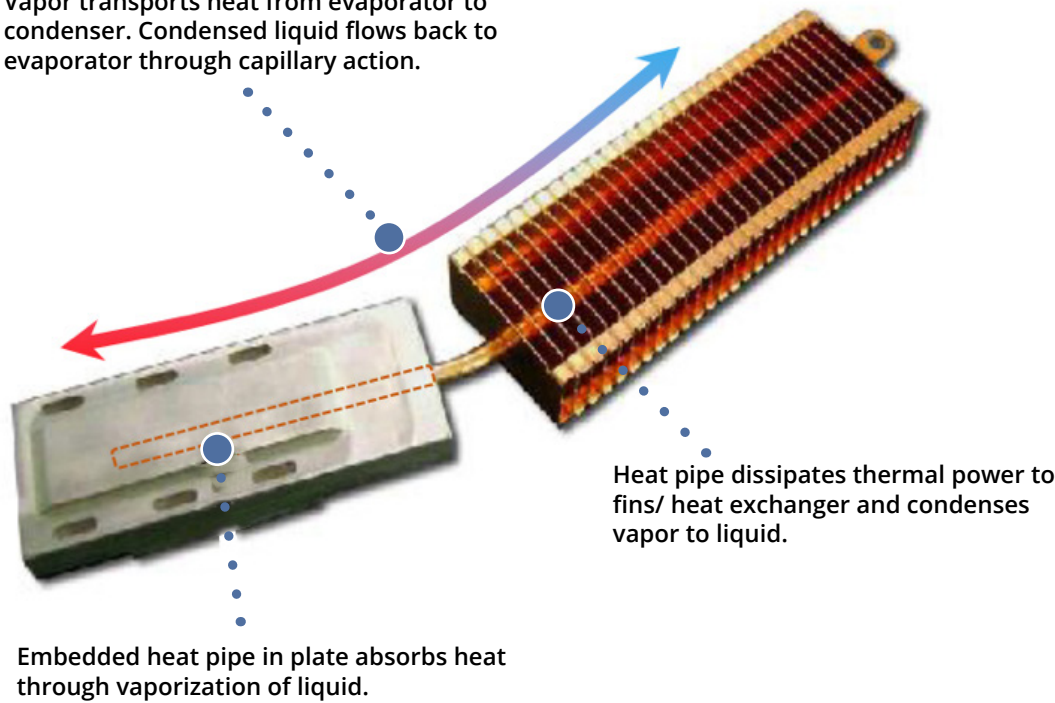
HEAT PIPE SELECTION GUIDE



HEAT PIPE ASSEMBLIES

Interfacing heat pipes with plates and heat exchangers is predominately about maximizing contact area while adhering to the flattening and bending guidelines mentioned above. In most cases, the heat pipes are slotted into channels/grooves in the plate to maximize contact. The heat pipe can be secured into the groove using solder or thermal epoxy, which also augments the contact area of the heat pipe. The heat pipe can also be clamped between two plates with matching channels/grooves which are fastened together. In the clamped configuration, thermal grease can be used to increase the contact of the heat pipe to the plates to reduce the thermal resistance of the contact interface, just as the thermal epoxy and solder did in the prior example.

Vapor transports heat from evaporator to condenser. Condensed liquid flows back to evaporator through capillary action.



Embedded heat pipe in plate absorbs heat through vaporization of liquid.

WAKEFIELD-VETTE STANDARD HEAT PIPES

Wakefield-Vette offers individual Heat Pipes through distribution. These most common offerings are a great option for testing, sampling, and validating your heat pipe solution into eventual production.

When building or testing your heat sink assembly please feel free to contact one of Wakefield Vette's authorized distributors to purchase. Always remember to contact us for free consultation on assembly design or parameter questions.

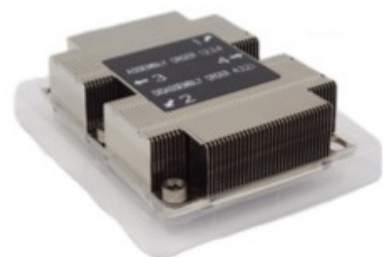
| Wakefield-Vette Part Number | Description                 |
|-----------------------------|-----------------------------|
| 121686                      | Round Heat Pipe 4 x 70mm    |
| 121687                      | Round Heat Pipe 4 x 100mm   |
| 121688                      | Round Heat Pipe 4 x 150mm   |
| 110578                      | Round Heat Pipe 6 x 100mm   |
| 110579                      | Round Heat Pipe 6 x 150mm   |
| 110580                      | Round Heat Pipe 6 x 200mm   |
| 110581                      | Round Heat Pipe 6 x 250mm   |
| 110582                      | Round Heat Pipe 6 x 300mm   |
| 121968                      | Round Heat Pipe 8 x 100mm   |
| 110583                      | Round Heat Pipe 8 x 200mm   |
| 110584                      | Round Heat Pipe 8 x 250mm   |
| 110585                      | Round Heat Pipe 8 x 300mm   |
| 121689                      | Round Heat Pipe 10 x 100mm  |
| 121690                      | Round Heat Pipe 10 x 200mm  |
| 121691                      | Round Heat Pipe 10 x 250mm  |
| 121692                      | Round Heat Pipe 10 x 300mm  |
| 121716                      | Flat Heat Pipe 2.5 x 100mm  |
| 121717                      | Flat Heat Pipe 2.5 x 150mm  |
| 121718                      | Flat Heat Pipe 2.5 x 200mm  |
| 121719                      | Flat Heat Pipe 2.5 x 250mm  |
| 121720                      | Flat Heat Pipe 3 x 100 mm   |
| 121721                      | Flat Heat Pipe 3 x 150 mm   |
| 121722                      | Flat Heat Pipe 3 x 200 mm   |
| 121723                      | Flat Heat Pipe 3 x 250 mm   |
| 121724                      | Flat Heat Pipe 3 x 300 mm   |
| 121725                      | Flat Heat Pipe 4.5 x 100mm  |
| 121726                      | Flat Heat Pipe 4.5 x 150 mm |
| 121727                      | Flat Heat Pipe 4.5 x 200 mm |
| 121728                      | Flat Heat Pipe 4.5 x 250 mm |
| 121729                      | Flat Heat Pipe 4.5 x 300 mm |
| 120231                      | Ultra Thin 6MM DIA X 1.50MM |
| 120229                      | Ultra Thin 5MM DIA X 1.00MM |

## VAPOR CHAMBER DESIGN GUIDE

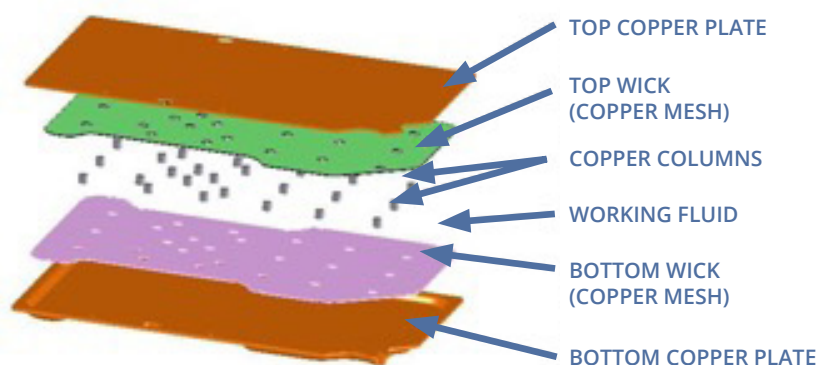
### VAPOR CHAMBER INTRODUCTION

**Vapor Chambers** are used to transport heat over a distance with very low thermal resistance. This is very helpful when small heat sources need to be dissipated over a larger area. Vapor chambers are a **Fluid Phase Change application** because they use a closed loop to transfer heat quickly through evaporation and condensation within the chamber. The particular aspect useful in designs is that vapor chambers transport heat in a plane, more effectively “spreading heat” compared to a heat pipe which transports heat over a distance in a straight line.

Vapor chambers, like heat pipes, do not actually dissipate the heat to the environment, but serve to move heat efficiently within a thermal system. A vapor chamber is made from copper plates (top and bottom) with an internal wick structure that is sealed around the perimeter with a small amount of water inside. As heat is applied to the chamber, the water will boil and turn to a gas, which then travels to the colder section of the vapor chamber, where heat is dissipated through an external heat exchanger, where it condenses back to a liquid. It is the evaporating and condensing of the water that form a pumping action to move the water (and thus the heat) from the area of the heat source to all other areas of the vapor chamber.



There are a few types of wick structure that can be used within the vapor chamber, but most commercial chambers are classified as mesh or powder. In both cases, the powder or mesh lines the copper plate surfaces to allow water flow to/from all directions within the area of the vapor chamber. Often, when mesh is used as the wick structure, different sized meshes are used together to promote condensation or transport of liquid depending on the void size. Vapor chambers are best used in horizontal orientations. The effects of gravity may vary depending on application and orientation, but one must consider lower performance if used above 15° out of horizontal.



During the manufacturing process copper columns are used throughout the vapor chamber to support the plates that act as the lids and contain the liquid and vapor. The copper mesh is oriented within the chamber pressed against the copper plates. The plates are sealed around the perimeter via diffusion bonding. In some cases, soldering or welding are used, but diffusion bonding allows for the strongest and highest temperature compatible seal for the vapor chamber. The diffusion bonding process also allows the mesh to bond to the copper plates as well.

### WHY USE VAPOR CHAMBERS?

Vapor chambers have proven to be robust and reliable over many years in these types of applications. The next section will give more technical detail on the performance of vapor chambers depending on thickness and area. Many thermal systems benefit from the addition of vapor chambers, especially when heat sources are dense and the final heat exchanger is much larger and the heat from the source must be spread to a larger area effectively to efficiently use the heat exchanger. Computer applications, such as processors, graphics cards and other chip-sets, have high thermally dissipated power in a small area. Fan heat sink combinations used in these applications can offer high-performance dissipation to the ambient, but much of the battle is to spread the heat to the heat exchanger with as little temperature change as possible. Vapor chambers excel at this and can transport large heat loads from small areas with very little temperature difference.

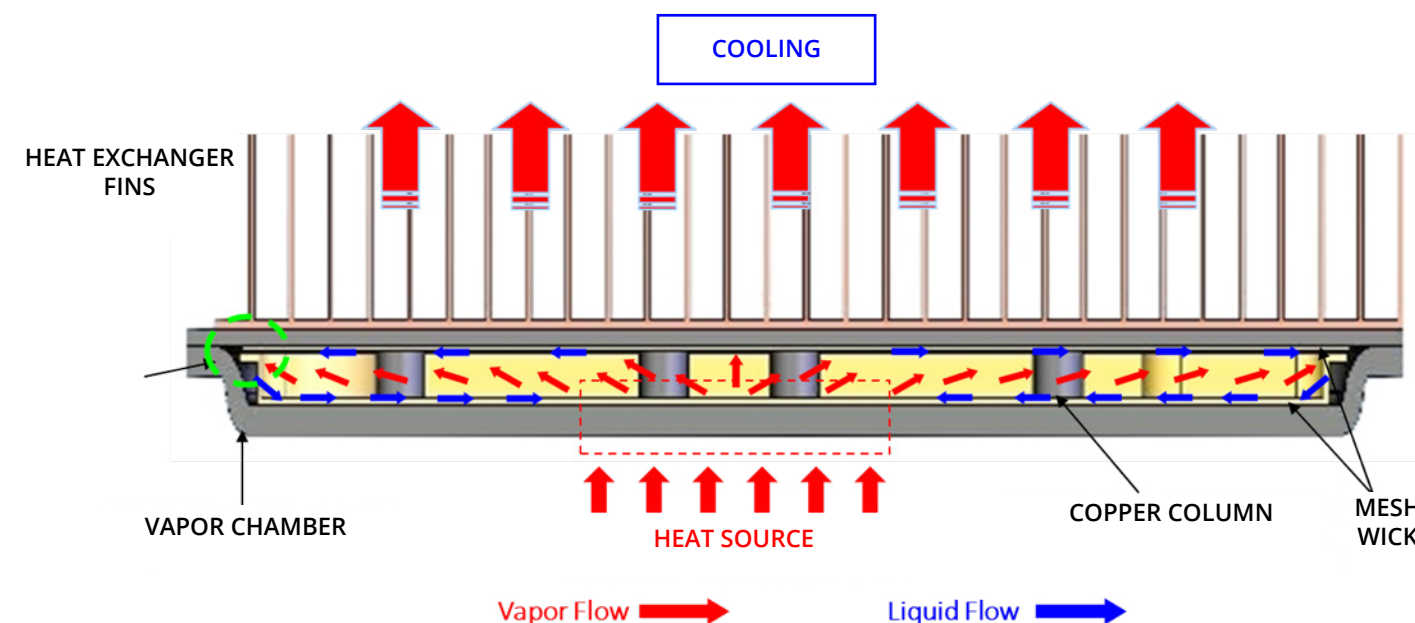
**Vapor chambers are used in many harsh environments such as:**

- Computers and Data Centers
- Telecommunications
- Aerospace
- Transportation

#### KEY FEATURES

- Material: Copper
- Wick Structure: Copper Mesh
- Light Weight
- Versatile with high thermal performance

### HOW VAPOR CHAMBERS OPERATE





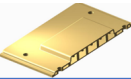
VAPOR CHAMBER DESIGN GUIDE

VAPOR CHAMBER BASICS

When considering the use of a vapor chamber in your application, it is important to consider the orientation with respect to gravity and overall heat load for the thermal system. The transport of vapor within the vapor chamber is responsible for the thermal conduction from one area to the other. A thicker vapor chamber can transport more vapor, translating into a larger heat carrying capacity. Although vapor chambers can have complex shapes and mounting features, they are not typically bent and integration can be more direct with the heat source than with heat pipes.

VAPOR CHAMBER BASICS

- Comparison to Heat Pipes
- Transport
- General parameters



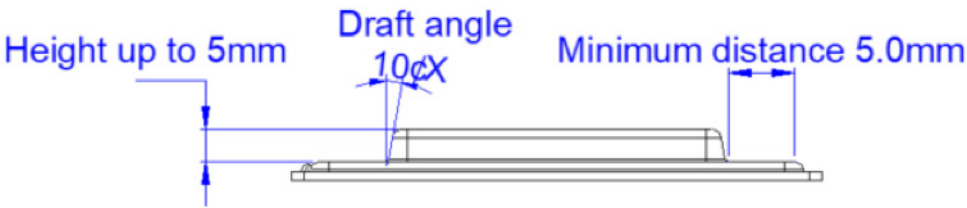
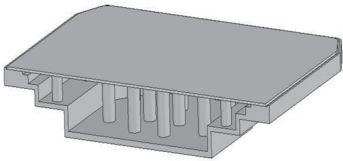
| VAPOR CHAMBER                                                                                                                                                                                           |                     | HEAT PIPE                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| 2-Phase heat transfer                                                                                                                                                                                   | Theory              | 2-Phase heat Transfer                                                                                                                  |
| 2-D heat distribution. Spreading heat by a single vapor chamber. Suitable for large heat flux and high power.                                                                                           | Application         | 1-D heat distribution. Using one or more heat pipes to spread heat. Suitable for long distance between heat source and heat exchanger. |
| Complex shape in X and Y direction with pedestal.                                                                                                                                                       | Shape               | Round, flattened or bent in any direction.                                                                                             |
| Mounted with through-holes in vapor chamber                                                                                                                                                             | Fixtures            | Additional fixure plates needed to mount heat pipes.                                                                                   |
| Direct contact. Mounting pressure to 90PSI                                                                                                                                                              | Heat Source Contact | A base plate required to contact the heat source unless flattened/machined.                                                            |
| T=5mm > 400W; T=3mm > 200W; T=1mm > 60W                                                                                                                                                                 | Qmax                | Ø5 > 20W; Ø6 > 40W; Ø8 > 60W                                                                                                           |
| Vapor chamber has larger tooling cost so high volume applications can lower cost to ~2X heat pipe. However, solution may need only 1 vapor chamber compared to many heat pipes and fixture/base plates. | Cost                | Lower cost for a single heat pipe, but may also need tooling cost for bending/flattening.                                              |

In many applications, the decision to use a vapor chamber is frequently compared to a thermal solution using heat pipes. In both cases, 2-phase transport is used as a vapor moves heat within the chamber or pipe and the liquid is condensed at the heat exchanger and transported back to the heat source. However, the main aspects of applications that differentiate vapor chambers from heat pipes are:

- **High power density:** when the heat source is small but heat generation is large, vapor chambers can more easily transport the heat to a larger area. A heat pipe solution would require multiple pipes, which may be difficult to integrate within the footprint of the heat source.
- **High power:** when the application must dissipate large wattage, a vapor chamber spreads the heat to a large area efficiently with similar temperatures of the chamber surface. This allows more efficient use of the final heat exchanger since hot spots are minimized. Heat pipes can also spread the heat, but unless many are ganged together, the hot spots may still persist.

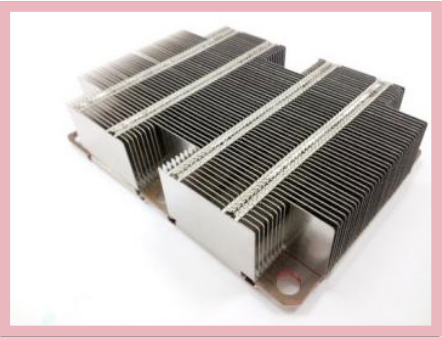
VAPOR CHAMBERS THERMAL CAPACITY

Much like heat pipes, the ultimate dimension in determining heat carrying capacity of a vapor chamber is the volume of the vapor space. This is determined by the thickness and area of the vapor chamber. For most applications, the thickness of the vapor chamber does not exceed 3mm, however pedestals and other surface features can be used to contact specific heat sources while leaving clearance for other board mounted objects. These pedestals can be extended 5mm from the vapor chamber lid plate. Mounting holes can also be integrated within the area of the vapor chamber for better integration with the heat source and locating the heat source a the center of the vapor chamber with good pressure application.

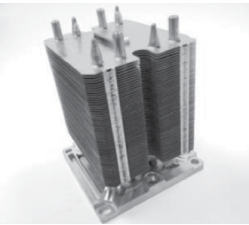


|         | HEAT CARRYING CAPACITY (Q-MAX) BY VAPOR CHAMBER THICKNESS |       |       |       |       |       |       |        |
|---------|-----------------------------------------------------------|-------|-------|-------|-------|-------|-------|--------|
|         | 1.0mm                                                     | 1.2mm | 1.5mm | 2.0mm | 2.3mm | 2.5mm | 3.0mm | >3.0mm |
| 45*45   | 10W                                                       | 15W   | 20W   | 25W   | 60W   | 80W   | 100W  | >100W  |
| 90*90   | 40W                                                       | 50W   | 80W   | 100W  | 150W  | 180W  | 250W  | >300W  |
| 120*120 | 40W                                                       | 50W   | 80W   | 100W  | 160W  | 200W  | 275W  | >300W  |
| 150*150 |                                                           |       | 80W   | 100W  | 170W  | 220W  | 300W  | >300W  |
| 200*200 |                                                           |       |       | 100W  | 175W  | 225W  | >300W | >300W  |
| 250*250 |                                                           |       |       |       | 180W  | 240W  | >300W | >300W  |
| 300*300 |                                                           |       |       |       |       |       |       | >300W  |

**Note:** Heat source = 30\*30mm  
This table is for reference. Q-max is related to heat source power density and effectiveness of final heat exchanger.

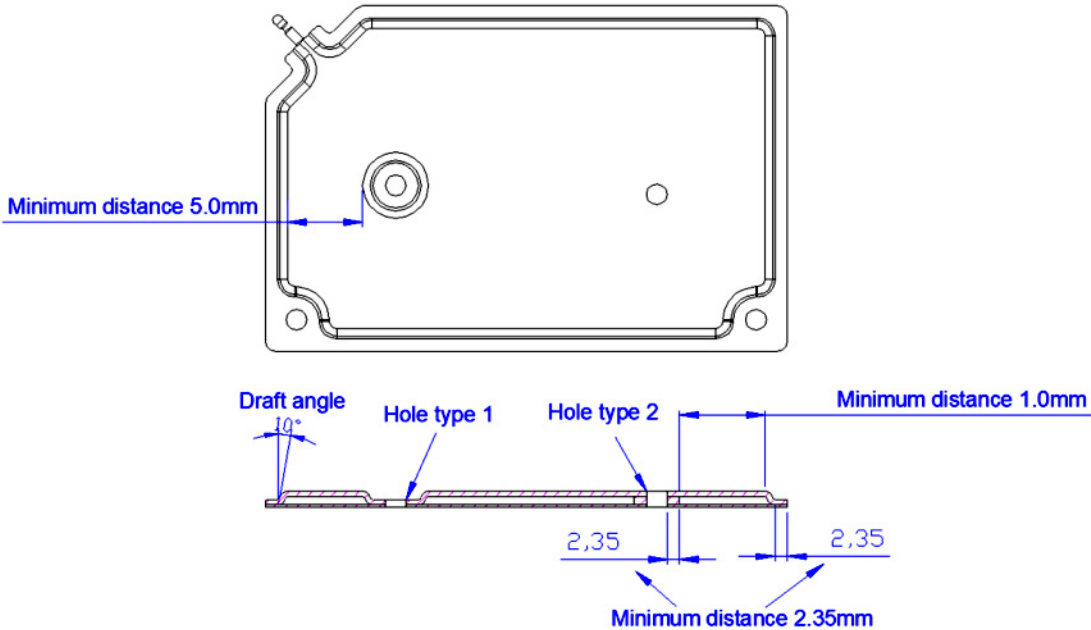


VAPOR CHAMBER DESIGN GUIDE

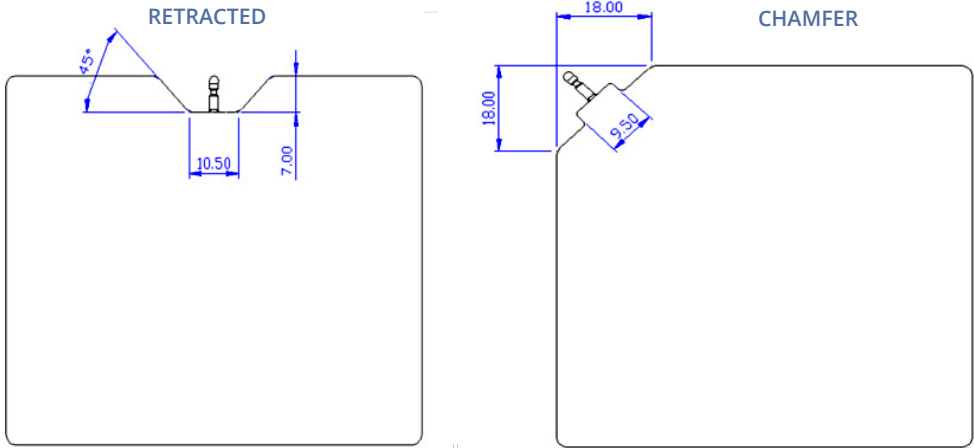


VAPOR CHAMBER ASSEMBLIES

Interfacing vapor chambers with plates and heat exchangers is predominately about maximizing contact area. In most cases, the vapor chambers are soldered to heat exchanger fins for air cooled applications. The vapor chambers can also be soldered to liquid cold plates to take advantage of spreading the heat before final heat exchange with the liquid. In many cases, the vapor chambers are also integrated with heat pipes to take the heat that has spread in the plane of the vapor chamber and extend it in the vertical dimension to more efficiently interact with cooling fins. Integrating with the heat source is most commonly done with pressure, up to 90 psi, and the use of a thermal grease or other interface material to maximize surface area contact to the source.



2 TYPES OF FILLING PORTS  
(7MM MAXIMUM):



WAKEFIELD-VETTE STANDARD VAPOR CHAMBERS

Wakefield-Vette offers individual vapor chambers through distribution. These most common offerings are a great option for testing, sampling, and validating your vapor chamber solution into eventual production. When building or testing your heat sink assembly please feel free to contact one of Wakefield-Vette's authorized distributors to purchase. Always remember to contact us for free consultation on assembly design or parameter questions.

| WKV Part #       | Product Description                               | Thermal Resistance | Length | Width | Thickness | qMax  |
|------------------|---------------------------------------------------|--------------------|--------|-------|-----------|-------|
| VC-1131-8175-517 | Standard Vapor Chamber 113.1mm x 81.75mm X 5.17mm | 0.145              | 113.1  | 81.75 | 5.7       | 180W~ |
| VC-90-90-3       | Standard Vapor Chamber 90mm x 90mm x 3.00mm       | 0.143              | 90     | 90    | 3         | 150W~ |
| VC-106-70-3      | Standard Vapor Chamber 106mm x70mm x 3mm          | 0.150              | 106    | 70    | 3         | 150W~ |
| VC-106-82-3      | Standard Vapor Chamber 106mm x 82mm x 3mm         | 0.140              | 106    | 82    | 3         | 150W~ |



PART NUMBER VC-1131-8175-517

Product Info Description

Dimension(mm): L: 113mm / W: 81.8mm / T: 5.7mm  
Operation Power: 180W~

Product Info Details

Thermal Resistance: 0.145°C/W  
Operation Temp: 40~130°C  
Platform : VGA

PART NUMBER VC-90-90-3

Product Info Description

Dimension(mm): L: 90mm / W: 90mm / T: 3mm  
Operation Power: 150W~

Product Info Details

Thermal Resistance: 0.143°C/W  
Operation Temp: 40~140°C  
Platform : Intel 2011 Square



PART NUMBER VC-106-70-3

Product Info Description

Dimension(mm): L: 106mm / W: 70mm / T: 3mm  
Operation Power: 150W~

Product Info Details

Thermal Resistance: 0.150°C/W  
Operation Temp: 40~140°C  
Platform : Intel 2011 Narrow

PART NUMBER VC-106-82-3

Product Info Description

Dimension(mm): L: 106mm / W: 82mm / T: 3mm  
Operation Power: 150W~

Product Info Details

Thermal Resistance: 0.140°C/W  
Operation Temp: 40~140°C  
Platform : Intel 2011 Narrow



# THERMAL INTERFACE PRODUCTS

Thermal Compounds, Adhesives & Interface Materials .....

High Performance Thermal Compound .....

General & Thermal High Performance Epoxy .....

140-145

140

146-155



Cost-effective accessory products that facilitate installation and improve the thermal performance of both standard and custom heat dissipation components. Included are thermal joint compounds; filled epoxy systems; adhesives; thermally conductive insulating wafers, washers, pads and mounting hardware.



THERMAL COMPOUNDS, ADHESIVES & INTERFACE MATERIALS



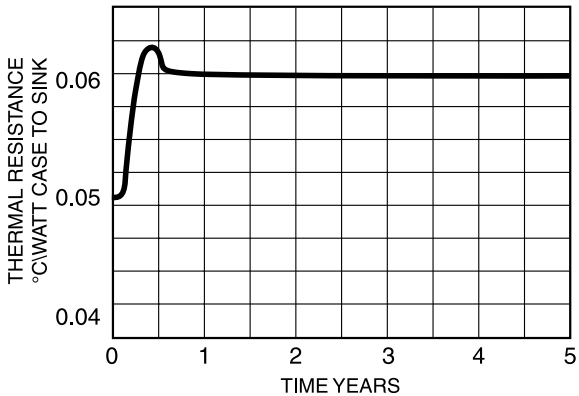
120 SERIES

The **120 Series** Silicone Oil-Based Thermal Joint Compound fills the minute air gap between mating surfaces with a grease-like material containing zinc oxide in a silicone oil carrier. It possesses an excellent thermal resistance of only 0.05°C/W for a 0.001 in. film with an area of one square inch. There is no measurable increase in case temperature of a mounted semiconductor on a heat sink after the 6-month stabilization period (Time versus Thermal Resistivity graph below).

| TYPICAL VALUES FOR THERMAL RESISTANCE, CASE TO SINK (Øcs) WHEN THERMAL JOINT COMPOUNDS ARE USED |                                              |                                      |
|-------------------------------------------------------------------------------------------------|----------------------------------------------|--------------------------------------|
| Case Style Characteristics                                                                      | Mounting Torque<br>in inch • pounds<br>(N•M) | Typical Thermal Resistance<br>(°C/W) |
| TO-3                                                                                            | 8 (0.9)                                      | 0.09                                 |
| TO-66                                                                                           | 9 (0.9)                                      | 0.14                                 |
| TO-220                                                                                          | 8 (0.9)                                      | 0.50                                 |
| 0.19 (4.8) stud x 0.44 (11.2) hex                                                               | 15 (1.7)                                     | 0.16                                 |
| 0.25 (6.4) stud x 0.69 (17.5) hex                                                               | 30 (3.39)                                    | 0.10                                 |
| 0.38 (9.7) stud x 1.06 (26.9) hex                                                               | 75 (8.47)                                    | 0.07                                 |
| 0.50 (12.7) stud x 1.06 (26.9) hex                                                              | 125 (14.12)                                  | 0.07                                 |
| 0.75 (19.1) stud x 1.25 (31.8) hex                                                              | 600 (67.79)                                  | 0.052                                |

| 120 SERIES - ORDER GUIDE |                     |
|--------------------------|---------------------|
| Series - P/N             | Container Size      |
| 120-SA                   | 4 gram plastic pak  |
| 120-2                    | 2 oz (0.06 kg) jar  |
| 120-5                    | 5 oz (0.14 kg) tube |
| 120-8                    | 8 oz (0.23 kg) jar  |
| 120-80                   | 5 lb (2.27 kg) can  |
| 120-320                  | 20 lb (9.08 kg) can |

| 120 SERIES - THERMAL JOINT COMPOUND |                              |
|-------------------------------------|------------------------------|
| Characteristic                      | Description                  |
| Volume Resistivity                  | 5 X 10 <sup>14</sup> ohm-cm  |
| Dielectric Strength                 | 225 volts/mil                |
| Specific Gravity                    | 2.1 min.                     |
| Thermal Conductivity @ 36°C         | 0.735 W/(m)(K)               |
|                                     | 5.1(Btu) (in.)/(hr)(ft²)(°F) |
| Thermal Resistivity (P)             | 56 (°C)(in.)/watt            |
| Bleed, % after 24 hrs @ 200°C       | 0.5                          |
| Evaporation, % after 24 hrs @ 200°C | 0.5                          |
| Color                               | opaque white                 |
| Shelf life                          | 5 years                      |
| Operating Temperature Range (°C)    | -40/+200                     |



HIGH PERFORMANCE THERMAL  
COMPOUND

122 SERIES



**122 Series Thermal Joint Compound** is a stable, silicone based, thixotropic paste developed to provide premium performance at an affordable price. It is formulated to significantly reduce contact thermal resistance where power densities are concentrated in devices such as flip chip, reduced die size, and 'overclock' microprocessors. When applied as a thin film between a Wakefield-Vette heat sink and device it possesses superior thermal conductivity compared to traditional 'grease'. It is compatible with automated or manual dispensing methods and is fully RoHS compliant.

| 122 SERIES THERMAL JOINT COMPOUND |                                                   |
|-----------------------------------|---------------------------------------------------|
| Typical Characteristics           | Description                                       |
| Appearance                        | Smooth Gray paste                                 |
| Thermal Conductivity              | 2.5 W / m °K,<br>17.3 (Btu) (in.)/(hr) (ft²) (°F) |
| Thermal Resistance                | 0.02 °C in 2 / W                                  |
| Bleed                             | 0.015 wt%, 24 hrs at 200°C                        |
| Evaporation                       | 0.150 wt%, 24 hrs at 200°C                        |
| Volume Resistivity                | 1.4 x 10 <sup>10</sup> ohm-cm                     |
| Dielectric Strength               | 225 volts/mil                                     |
| Specific Gravity                  | 2.23 (gm/cc) at 25°C                              |
| Operating Range                   | -40°C to 205°C                                    |
| Shelf Life                        | 5 years                                           |

| 122 SERIES - ORDER GUIDE |                    |
|--------------------------|--------------------|
| Series - P/N             | Container Size     |
| 122-10CC                 | 10cc syringe       |
| 122-2                    | 2 oz (0.06 kg) jar |
| 122-30CC                 | 30cc syringe       |

THERMAL COMPOUNDS, ADHESIVES & INTERFACE MATERIALS



126 SERIES

The **126 Series** is a nontoxic, synthetic, ester-based (nonsilicone) Thermal Joint Compound with metal oxide fillers designed to enhance thermal performance characteristics of plastic and metal package devices exceeding that of silicone-based compounds. Solved are problems associated with contamination of wave solder baths and migration of silicone-based products. Shelf life: 5 years.

| 126 SERIES THERMAL JOINT COMPOUND |                                              |
|-----------------------------------|----------------------------------------------|
| Characteristics                   | Description                                  |
| Appearance                        | Smooth, white homogeneous paste              |
| Solids Content, wt %              | 65% min                                      |
| Thermal Conductivity at 36°C      | .69 W / m °K, 4.8 (Btu)(in.)/(hr) (ft²) (°F) |
| Interface Thermal Resistance      | 0.043°C/W TO-3 at 0.0008 thick film          |
| Bleed, 24 hrs at 200°C, wt%       | 0.09% max                                    |
| Evaporation, 24 hrs at 200°C, wt% | 0.6 max                                      |
| Volume Resistivity                | 2.3 x 10 <sup>12</sup> ohms-cm               |
| Dielectric Strength               | 200 volts/mil                                |
| Specific Gravity @ 60°F           | 2.93 (gm/cc)                                 |
| Penetration                       | 280 to 320                                   |
| Operating Range                   | -40°C to 200°C                               |

| 126 SERIES - ORDER GUIDE |                        |
|--------------------------|------------------------|
| Series - P/N             | Container Size         |
| 126-2                    | 2 oz (0.6 kg) jar      |
| 126-4                    | 4 oz (0.11 kg) tube    |
| 126-4S                   | 4 oz (0.11 kg) syringe |
| 126-5LB                  | 5 lb (2.27 kg) can     |



DELTABOND™ 152

**DeltaBond™ 152** adhesive is ideal for general cementing; thermally bonding semiconductors and components to chassis or heat sinks, while electrically isolating one from the other; fabricating heat sinks or thermal links; and for all permanent bonding of assemblies which require high thermally conductive interfaces. It produces a rigid, high strength bond to most materials when cured. **DeltaBond™ 152** is available in bi-packs, kits, and quarts. Order one bottle of hardener A-4 or B-4 per one quart of **DeltaBond™ 152** separately. Shelf life: 152KA 1 year, all others 2 years.

| DELTABOND™ 152                                       |               |       |
|------------------------------------------------------|---------------|-------|
| Characteristics                                      | Hardener Type |       |
| Typical Properties Fully Cured                       | A4            | B4    |
| Thermal conductivity - W/(m) (°K)                    | 0.836         | 0.908 |
| (Btu) (in.)/(hr) (ft²) (°F)                          | 5.8           | 6.3   |
| Thermal resistivity - (°C) (in.) watt                | 47            | 42    |
| Bond shear strength 77°F                             | 2,900         | 2,300 |
| 1 in. overlap - psi 125°F                            | 2,200         | 2,000 |
| etched aluminum to etched aluminum 212°F             | 400           | 800   |
| Heat distortion point - °F                           | 130           | 225   |
| Minimum dielectric strength, v/mil, 0.125 in. sample | 400           | 400   |
| Max operation Continuous                             | 65            | 150   |
| temp - °C Intermittent                               | 100           | 190   |

| DELTABOND™152                                      |                |               |
|----------------------------------------------------|----------------|---------------|
| Mixing Proportions and Working Properties          |                |               |
| Characteristics                                    | A4             | B4            |
| Parts of hardener per 100 parts of resin by weight | 7.5            | 3.5           |
| *Working Time - at 77°F                            | 45 min         | 30 min        |
| †Initial cure time 77°F                            | 8 hrs          | 6 hrs         |
| 150°F                                              | 45 min         | 30 min        |
| 250°F                                              | 20 min         | 15 min        |
| ‡Post-cure time at a temp in °F                    | 4 hrs @200°F   | 4 hrs @ 200°F |
| ‡Alternate room temp. aging time at 77°F           | 4 days         | 4 days        |
| Working consistency (77°F)                         | viscous liquid | paste         |
| Working viscosity (77°F) cps                       | 25,000         | —             |

NOTES:

\* Since the hardener/resin reaction is exothermic, it is important that batch size be matched to hardener speed. Working times given are for approximate batch sizes: A—200 gms, B—200 gms. Larger batch sizes will greatly reduce working time.

\*\* For optimum electrical properties, dry parts for 15 minutes at 150°F (65°C) or 30 minutes at 75°F (24°C) to slowly evaporate the thinner and then final cure for 4 hours at 275°F (135°C).

† After initial cure, material may be handled, removed from fixture, etc., but has not yet achieved full properties and should be room temperature aged or post-cured as shown to achieve full physical and electrical properties.

‡ After initial cure, material may be brought to full physical and electrical properties during post-cure or may be room temperature aged for charted length of time to achieve same full properties.

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| DELTABOND™152                       |          |                                   |                                               |
|-------------------------------------|----------|-----------------------------------|-----------------------------------------------|
| Ordering Guide - Resin and Hardener |          |                                   |                                               |
| Model Number                        | Resin    |                                   | Hardener                                      |
|                                     | Part No. | Container                         | Part Number                                   |
| DeltaBond™ 152                      | 152-1A   | Bi-Pack (1 oz)                    | Included in PIN 152-1 A ("A-4") Type          |
|                                     | 152-1B   | Bi-Pack (1 oz)                    | Included in P/N 152-1 B ("B-4") Type          |
|                                     | 152-KA   | Kit (7 oz Resin, 0.5 oz Hardener) | Included in P/N 152-KA                        |
|                                     | 152-Q    | 1 quart (4 lbs)                   | A-4 (0.316 lb), B-4 (0.14 lb), (order 1 only) |
| All hardener part numbers: A-4, B-4 |          |                                   |                                               |

THERMAL COMPOUNDS, ADHESIVES & INTERFACE MATERIALS



DELTABOND™ 153

**DeltaCast™ 153** is a pourable casting resin having thermal expansion characteristics similar to aluminum and copper allowing assemblies to operate over a very wide temperature range. Ideal for encapsulating components and assemblies, this series’ major advantages and uses include potted systems (virtually indestructible), protecting components and systems from moisture and contaminants, securing proprietary circuitry, mechanical support of devices, removal of heat from hot components and the assembly equalizing temperatures, and high voltage isolation. **DeltaCast™ 153** is available in quarts and gallons. Order one bottle of hardener A4 or B4 per one quart of **DeltaCast™ 153** separately. Shelf life: 2 years.

| DELTACAST™153                                        |               |       |
|------------------------------------------------------|---------------|-------|
| Characteristics                                      | Hardener Type |       |
| Typical Properties Fully Cured                       | A4            | B4    |
| Thermal conductivity - W/(m) (°K)                    | 0.836         | 0.908 |
| (Btu) (in.)/(hr) (ft²) (°F)                          | 5.8           | 6.3   |
| Thermal resistivity - (°C) (in.) watt                | 47            | 42    |
| Bond shear strength 77°F                             | 2,500         | 1,900 |
| 1 in. overlap - psi 125°F                            | —             | —     |
| etched aluminum to etched aluminum 212°F             | —             | —     |
| Heat distortion point - °F                           | 130           | 225   |
| Minimum dielectric strength, v/mil, 0.125 in. sample | 400           | 400   |
| Max operation Continuous temp - °C                   | 65            | 150   |
| Intermittent                                         | 100           | 190   |

| DELTACAST™153                                      |              |                |
|----------------------------------------------------|--------------|----------------|
| Mixing Proportions and Working Properties          |              |                |
| Characteristics                                    | A4           | B4             |
| Parts of hardener per 100 parts of resin by weight | 7.5          | 3.5            |
| *Working Time - at 77°F                            | 45 min       | 30 min         |
| † Initial cure time 77°F                           | 8 hrs        | 6 hrs          |
| 150°F                                              | 45 min       | 30 min         |
| 250°F                                              | 20 min       | 15 min         |
| ‡Post-cure time at a temp in °F                    | 4 hrs @200°F | 4 hrs @ 200°F  |
| ‡Alternate room temp. aging time at 77°F           | 4 days       | 4 days         |
| Working consistency (77°F)                         | heavy liquid | viscous liquid |
| Working viscosity (77°F) cps                       | 10,000       | 30,000         |

| DELTACAST™153                       |          |                 |                                               |
|-------------------------------------|----------|-----------------|-----------------------------------------------|
| Ordering Guide - Resin and Hardener |          |                 |                                               |
| Model Number                        | Resin    |                 | Hardener                                      |
|                                     | Part No. | Container       | Part Number                                   |
| DeltaCast™ 153                      | 153-Q    | 1 quart (4 lbs) | A-4 (0.316 lb), B-4 (0.14 lb), (order 1 only) |
| All hardener part numbers: A-4, B-4 |          |                 |                                               |

DELTABOND™ 154



**DeltaBond™ 154** is a medium viscosity, aluminum-filled resin with the best thermal conductivity of this series.It is, however, neither a good electrical insulator nor conductor. Its principal application is that of a good thermal mechanical adhesive for applications such as bonding fins to base plates or structural mounting blocks or brackets to heat sinks. Order one bottle of hardener A4 or B4 per one quart of **DeltaBond™ 154** separately. Shelf life: 2 years.

| DELTABOND™ 154                                     |                |               |
|----------------------------------------------------|----------------|---------------|
| Mixing Proportions and Working Properties          |                |               |
| Characteristics                                    | A4             | B4            |
| Parts of hardener per 100 parts of resin by weight | 11.0           | 4.5           |
| *Working Time - at 77°F                            | 45 min         | 30 min        |
| † Initial cure time 77°F                           | 8 hrs          | 6 hrs         |
| 150°F                                              | 45 min         | 30 min        |
| 250°F                                              | 20 min         | 15 min        |
| ‡Post-cure time at a temp in °F                    | 4 hrs @200°F   | 4 hrs @ 200°F |
| ‡Alternate room temp. aging time at 77°F           | 4 days         | 4 days        |
| Working consistency (77°F)                         | viscous liquid | paste         |
| Working viscosity (77°F) cps                       | 25,000         | —             |

| DELTABOND™ 154                                       |               |       |
|------------------------------------------------------|---------------|-------|
| Characteristics                                      | Hardener Type |       |
| Typical Properties Fully Cured                       | A4            | B4    |
| Thermal conductivity - W/(m) (°K)                    | 1.053         | 1.154 |
| (Btu) (in.)/(hr) (ft²) (°F)                          | 7.3           | 8.0   |
| Thermal resistivity - (°C) (in.) watt                | 37            | 34    |
| Bond shear strength 77°F                             | 3,000         | 2,400 |
| 1 in. overlap - psi 125°F                            | 2,300         | 2,100 |
| etched aluminum to etched aluminum 212°F             | 500           | 800   |
| Heat distortion point - °F                           | 130           | 225   |
| Minimum dielectric strength, v/mil, 0.125 in. sample | NA*           | NA*   |
| Max operation Continuous temp - °C                   | 65            | 150   |
| Intermittent                                         | 100           | 190   |

DELTABOND™ 154

| DELTABOND™154                       |          |                 |                                               |
|-------------------------------------|----------|-----------------|-----------------------------------------------|
| Ordering Guide - Resin and Hardener |          |                 |                                               |
| Model Number                        | Resin    |                 | Hardener                                      |
|                                     | Part No. | Container       | Part Number                                   |
| DeltaBond™                          | 154-Q1   | quart (2.5 lbs) | A-4 (0.316 lb), B-4 (0.14 lb), (order 1 only) |
| All hardener part numbers: A-4, B-4 |          |                 |                                               |



DELTABOND™ 155

**DeltaBond™ 155** is an epoxy adhesive formulated for use within the semiconductor industry. An easy to mix spread thixotropic paste, it offers high heat transfer, low shrinkage, and a coefficient of thermal expansion comparable to that of copper and aluminum. This adhesive is principally used to form thermally conductive joints in fabricated heat sinks and between heat sinks and power devices. When used to bond semiconductors to heat sinks, it also serves as an electrical insulator. Its strong bond to a wide variety of substrates resists severe temperature cycling. **DeltaBond™ 155** is only available in kit size. Simply squeeze out equal lengths and mix to uniform color. Shelf life: 1 year.

| DELTABOND™ 155                                       |               |
|------------------------------------------------------|---------------|
| Characteristics                                      | Hardener Type |
| Typical Properties Fully Cured                       | DeltaBond™155 |
| Thermal conductivity - W/(m) (°K)                    | 0.836         |
| (Btu) (in.)/(hr) (ft²) (°F)                          | 5.8           |
| Thermal resistivity - (°C) (in.) watt                | 47            |
| Bond shear strength 77°F                             | 2,600         |
| 1 in. overlap - psi 125°F                            | —             |
| etched aluminum to etched aluminum 212°F             | —             |
| Heat distortion point - °F                           | 130           |
| Minimum dielectric strength, v/mil, 0.125 in. sample | 400           |
| Max operation Continuous temp - °C                   | 65            |
| Intermittent                                         | 100           |

| DELTABOND™ 155                            |               |  |
|-------------------------------------------|---------------|--|
| Mixing Proportions and Working Properties |               |  |
| Parts of hardener per 100 parts of resin  | by volume 100 |  |
| *Working Time - at 77°F                   | 90 min        |  |
| †Initial cure time 77°F                   | 8 hrs         |  |
| 150°F                                     | 45 min        |  |
| 250°F                                     | 20 min        |  |
| ‡Post-cure time at a temp in °F           | 4 hrs @ 200°F |  |
| ‡Alternate room temp. aging time at 77°F  | 4 days        |  |
| Working consistency (77°F)                | paste         |  |
| Working viscosity (77°F) cps              | paste         |  |

| DELTABOND™ 155                      |          |                             |                     |
|-------------------------------------|----------|-----------------------------|---------------------|
| Ordering Guide - Resin and Hardener |          |                             |                     |
| Model Number                        | Resin    | Hardener                    |                     |
|                                     | Part No. | Container                   | Part Number         |
| DeltaBond™ 155                      | 155 Kit  | (3 oz resin, 3 oz hardener) | Included in P/N 155 |

NOTES:

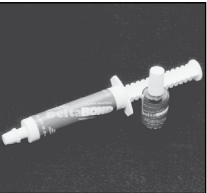
\* Since the hardener/resin reaction is exothermic, it is important that batch size be matched to hardener speed. Working times given are for approximate batch sizes: A—200 gms, B—200 gms. Larger batch sizes will greatly reduce working time.

† After initial cure, material may be handled, removed from fixture, etc., but has not yet achieved full properties and should be room temperature aged or post-cured as shown to achieve full physical and electrical properties.

‡ After initial cure, material may be brought to full physical and electrical properties during post-cure or may be room temperature aged for charted length of time to achieve same full properties.

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THERMAL COMPOUNDS, ADHESIVES & INTERFACE MATERIALS



DELTABOND™ 156

**DeltaBond™ 156** Thermally Conductive Adhesive is a modified acrylic adhesive designed for permanent mounting on components where heat must be effectively transmitted. Recommended for electromechanical assemblies to bond components and dissipate heat, it replaces mechanical fasteners and compressible pads, silicone grease, and epoxies; eliminates air entrapment, and other variables related to epoxy mixing. This soft paste requires no mixing and flows easily to allow thin bond lines. Primer activated, cure begins upon assembly. DeltaBond™ Activator fixtures at room temperature in less than 5 minutes. Full strength is developed in 4 to 12 hours and fillets become dry to the touch in 24 hours. It is not recommended to use this durable adhesive without the use of DeltaBond™ Activator. **DeltaBond™ 156** is available in kit size; order 156-K (25 ml Syringe and Activator Kit). Shelf life: 1 year.

| DELTABOND™ 156                                                                                                                        |                                                                 |       |
|---------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-------|
| Characteristics                                                                                                                       |                                                                 |       |
| Typical Properties Fully Cured                                                                                                        | Description                                                     |       |
| Test                                                                                                                                  | Results                                                         | ASTM  |
| Temperature Range                                                                                                                     | -65 to 300°F (-54 to 149°C)<br>300°F to (177°C)<br>Intermittent |       |
| Tensile Strength, at break                                                                                                            | 2360 psi                                                        | D638  |
| Modulus                                                                                                                               | 233,000 psi                                                     | D638  |
| Elongation, at break                                                                                                                  | 7.75%                                                           | D638  |
| Outgassing                                                                                                                            | 2.5% TLM                                                        | E595  |
| Coefficient of Thermal Expansion                                                                                                      | 0.05% CVCm                                                      |       |
| Tensile Shear                                                                                                                         | 7.1 x 10 <sup>-4</sup> (cm/cm°C)                                | D1002 |
| Thermal Conductivity, K (absolute at 86°F (30°C))                                                                                     | 2500psi<br>3.47 Btu x in./hr ft² °F (0.50 W/m °C)               |       |
| Note: The absolute thermal conductivity test was developed specifically for measuring thermal properties of thin film adhesive bonds. |                                                                 |       |

| DELTABOND™ 156                                                                                                                                                                                                                                                         |                                |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|------|
| Typical Electrical Properties                                                                                                                                                                                                                                          |                                |      |
| Test                                                                                                                                                                                                                                                                   | Results                        | ASTM |
| Dielectric Strength                                                                                                                                                                                                                                                    | 220 volts/mil                  | D149 |
| Dielectric Constant, 77°F (25°C)                                                                                                                                                                                                                                       |                                | D150 |
| 100 Hz                                                                                                                                                                                                                                                                 | 14.92                          |      |
| 1000 Hz                                                                                                                                                                                                                                                                | 14.26                          |      |
| 1MM Hz                                                                                                                                                                                                                                                                 | 12.34                          |      |
| Dissipation Factor, 77°F (25°C)                                                                                                                                                                                                                                        |                                | D150 |
| 100 Hz                                                                                                                                                                                                                                                                 | 0.05                           |      |
| 1000 Hz                                                                                                                                                                                                                                                                | 0.03                           |      |
| 1MM Hz                                                                                                                                                                                                                                                                 | 0.06                           |      |
| Volume Resistivity                                                                                                                                                                                                                                                     | 5.2x10 <sup>11</sup> (ohms-cm) | D257 |
| Surface Resistivity                                                                                                                                                                                                                                                    | 8.6 x 10 <sup>13</sup> (ohms)  | D257 |
| Note: DeltaBond™ Thermally Conductive Adhesive-High Strength contains a metallic filler which, in certain applications, may have an effect on electrical properties. Therefore, test each particular application to ensure that electrical properties are as required. |                                |      |

| DELTABOND™ 156                      |          |                                                                                             |                                                                     |
|-------------------------------------|----------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Ordering Guide - Resin and Hardener |          |                                                                                             |                                                                     |
| Model Number                        | Resin    |                                                                                             | Hardener                                                            |
|                                     | Part No. | Container                                                                                   | Part Number                                                         |
| DeltaBond™ 156                      | 156-K    | Resin Kit Hardener Syringe - 0.85 fl oz - 25 ml - 2 oz net/0.44 oz fl contents bottle -12ml | Included in kit hardener with brush applicator - 4.2 oz total wt/kt |

NOTES:

- \* Since the hardener/resin reaction is exothermic, it is important that batch size be matched to hardener speed. Working times given are for approximate batch sizes: A—200 gms, B—200 gms. Larger batch sizes will greatly reduce working time.
- † After initial cure, material may be handled, removed from fixture, etc., but has not yet achieved full properties and should be room temperature aged or post-cured as shown to achieve full physical and electrical properties.
- ‡ After initial cure, material may be brought to full physical and electrical properties during post-cure or may be room temperature aged for charted length of time to achieve same full properties.

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DELTAPADS™ THERMALLY  
CONDUCTIVE INSULATORS

173 & 174 SERIES

GREASELESS THERMALLY CONDUCTIVE  
KAPTON® REINFORCED INSULATORS

175 SERIES



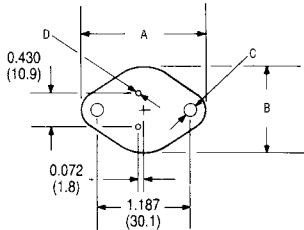
The **173, 174, and 175 Series** are highly efficient thermally conductive insulators designed for semiconductor interface to heat sinks. Their properties eliminate messy concerns associated with thermal greases.

| Characteristics                                    | DeltaPads™ 173-7 Series | DeltaPads™ 173-9 Series | DeltaPads™ 174-9 Series | Kapton® 175-6 Series   | Test Method |
|----------------------------------------------------|-------------------------|-------------------------|-------------------------|------------------------|-------------|
| Material Thickness                                 | 0.007 in.               | 0.009 in.               | 0.009 in.               | 0.006 in.              | Micrometer  |
| Color                                              | Gray                    | Gray                    | Tan                     | Gray                   | Visual      |
| Tear Strength, lb/in. Typical100                   | 100                     | 100                     | 100                     | ASTM 0624              |             |
| Volume Resistivity, megohm-cm, Minimum Normal      | 1.0 x 10 <sup>9</sup>   | 1.0 x 10 <sup>9</sup>   | 1.0 x 10 <sup>13</sup>  | 1 x 10 <sup>13</sup>   | ASTM D257   |
| Breakdown Voltage, Minimum                         | 4,000                   | 5,000                   | 5,000                   | 6,000                  | ASTM 0149   |
| Dielectric Constant at 60 Hz and 100 V Maximum     | 2.70                    | 2.40                    | 2.50                    | 5.5 @ 1,000 Hz         | ASTM D 150  |
| Continuous Use Temperature, °C                     | -60/+200                | -60/+200                | -60/+200                | -60/+200               | -           |
| Thermal Conductivity, cal/cm sec. °C, Minimum      | 3 x 10 <sup>-3</sup>    | 3 x 10 <sup>-3</sup>    | 1 x 10 <sup>-2</sup>    | 1.2 x 10 <sup>-3</sup> | -           |
| Thermal Resistance (TO-3), 1 in. <sup>2</sup> °C/W | 0.33                    | 0.50                    | 0.25                    | 0.40                   | -           |
| Recommended Mounting Pressure, lb/in. <sup>2</sup> | 350/550                 | 350/550                 | 350/550                 | 350/550                | Formula*    |

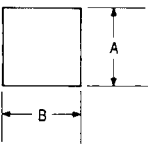
\*P (pressure in psi) =  $\frac{T \text{ (torque [in.-lb] x N (number of fasteners))}}{0.2 \times D \text{ (Thread Dia) x A (contact surface area square inches)}}$

| 173-7 Series |                  | 173-9 Series | 174-9 Series | 175-6 Series |
|--------------|------------------|--------------|--------------|--------------|
| No Adhesive  | Adhesive Backing | No Adhesive  | No Adhesive  | Greaseless   |
| -            | -                | 173-9-210P   | -            | 175-6-210P   |
| 173-7-220P   | -                | -            | -            | 175-6-220P   |
| 173-7-230P   | -                | 173-9-230P   | -            | 175-6-230P   |
| 173-7-240P   | 173-7-240A       | 173-9-240P   | -            | 175-6-240P   |
| -            | -                | -            | -            | 175-6-250P   |
| -            | -                | -            | -            | 175-6-280P   |
| -            | -                | -            | 174-9-310P   | 175-6-310P   |
| -            | -                | -            | -            | 175-6-320P   |
| -            | -                | -            | -            | 175-6-330P   |
| -            | -                | -            | -            | 175-6-410P   |
| -            | -                | -            | -            | 175-6-610P   |
| 173-7-1212P  | -                | 173-9-1212P  | 174-9-1212P  | -            |

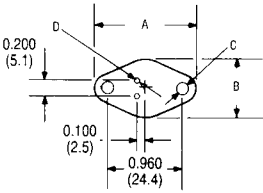
MECHANICAL DIMENSIONS



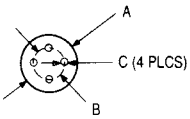
TO-3



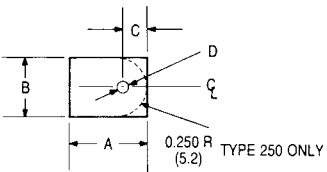
SHEET



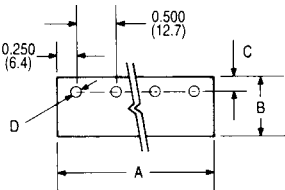
TO-66



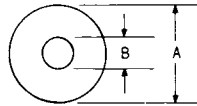
TO-5



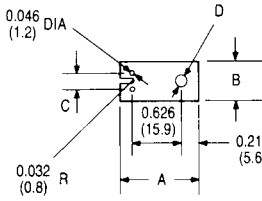
TO-220



DUAL TO-220



D04/05



TO-66 (RECTANGLE)



GENERAL & THERMAL HIGH PERFORMANCE EPOXY



BONDATHERM™



KEY FEATURES OF THE BONDATHERM  
EQUALIZER KITS:

- Eliminates improper ratios and mixing errors
- Reduces material waste
- Eliminates employee contact with resins
- Eliminates messy hand mixing and transferring
- Increases productivity
- Resins are protected from moisture contamination

BondaTherm™

| Wakefield-Vette Part Number                                           | Description                                                                                                                                                                                                                                                                                                                                 | Packaging                                                                                 |
|-----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| BT-101-50M<br>BT-102-50M<br>BT-301-50M<br>BT-301-200M                 | Non-Sag 5 Minute BondaTherm Epoxy Adhesive<br>Toughened, Flexible Adhesive System<br>Fast Curing Thermally Conductive Adhesive<br>Fast Curing Thermally Conductive Adhesive                                                                                                                                                                 | 50ml Dual Catridges<br>50ml Dual Catridges<br>50ml Dual Catridges<br>200ml Dual Catridges |
| BT-01-50M<br>BT-01-200M<br>BT-02-50M<br>BT-02-200M                    | BondaTherm Equalizer Dispense Gun (50ml)<br>BondaTherm Equalizer Dispense Gun (200ml)<br>BondaTherm Equalizer Static Mixer (50ml)<br>BondaTherm Equalizer Static Mixer (200ml)                                                                                                                                                              | -<br>-<br>-<br>-                                                                          |
| BT-101-50M-EQZ<br>BT-102-50M-EQZ<br>BT-301-50M-EQZ<br>BT-301-200M-EQZ | Two Dual Cartridges (BT-101-50M), One Gun (BT-01-50M), Three Mixers (BT-02-50M)<br>Two Dual Cartridges (BT-102-50M), One Gun (BT-01-50M), Three Mixers (BT-02-50M)<br>Two Dual Cartridges (BT-301-50M), One Gun (BT-01-50M), Three Mixers (BT-02-50M)<br>Two Dual Cartridges (BT-301-200M), One Gun (BT-01-200M), Three Mixers (BT-02-200M) | Kit<br>Kit<br>Kit<br>Kit                                                                  |
| BT-103-50M<br>BT-302-50M                                              | 5 Minute Clear Bondatherm Epoxy Adhesive<br>Fast Curing Aluminum Filled Bondatherm Epoxy Adhesive                                                                                                                                                                                                                                           | 50ml Dual Catridges<br>50ml Dual Catridges                                                |
| BT-401-H<br>BT-402-H<br>BT-403-H                                      | Silver Filled Bondatherm 2 gram Epoxy Hinge Packs<br>Thermally Conductive Epoxy Potting UL Listed 100 gram Bondatherm Hinge Pack<br>Aluminum Filled Bondatherm Epoxy Adhesive for Heat Sinks 100 gram Hinge Pack                                                                                                                            | 2 gram hinge pack<br>100 gram hinge pack<br>100 gram hinge pack                           |

BONDATHERM™ CARTRIDGES

BT-101-50M



These high bond strength adhesives are clear 100% solids, two component, non-sag adhesives with a quick setting time of 5–46 minutes at room temperature. They are excellent for bonding plated metals, pewter, glass, wood, ceramic, felt, cement, gem stones, most plastics and rubbers. These adhesives were tested in our laboratory for flame retardancy properties. According to our test results they meet the requirements of UL94HB.

APPLICATIONS:

These unique adhesives are ideally suited for a wide range of electronic, electrical, industrial, structural, and jewelry applications. These adhesives are also an excellent choice for field repairs. They are offered in the popular BondaTherm Equalizer Kit dual barrel cartridge dispensing system and bulk packaging.

BONDATHERM™ CARTRIDGES

BT-101-50M

FEATURES

- Non-sag consistency
- High bond strength
- Fast room temperature cure – three speeds to choose from
- Water & chemical resistance
- Outstanding thermal shock resistance
- 1:1 mix ratio
- Impact resistance

INSTRUCTIONS FOR USE:

1. Thoroughly mix equal parts of resin to catalyst by weight or volume.
2. Apply evenly to both surface(s) to be bonded.
3. Application to the substrates should be made within five minutes. Larger quantities and/or higher temperatures will reduce the working time. Avoid mixing large quantities and/or at high temperature due to the possibility of creating a high exothermic temperature.
4. Join the coated surfaces. Allow to cure at 60°F (16°C) or higher until adhesive is set. Heat may be added up to 200°F (93°C) to accelerate the cure.
5. Avoid moving parts during cure. Pressure to the substrates is recommended. Maximum shear strength is obtained with a 3-5 mil bond line.

Specifications

|                                                                                      |                                       |
|--------------------------------------------------------------------------------------|---------------------------------------|
| Color                                                                                | Semi-transparent (available in black) |
| Mix ratio by volume                                                                  | 1:01                                  |
| Mixed viscosity, 25°C cps*                                                           | Non-Sag                               |
| Solids content, %                                                                    | 100                                   |
| Specific gravity, 25°C                                                               | 1.15                                  |
| Shore D hardness                                                                     |                                       |
| 10-3005NS                                                                            | 86                                    |
| 10-3020NS                                                                            | 72                                    |
| 10-3046NS                                                                            | 65                                    |
| Work Life, 25°C, minutes                                                             |                                       |
| 10-3005NS                                                                            | 3-5                                   |
| 10-3020NS                                                                            | 10-15                                 |
| 10-3046NS                                                                            | 25-30                                 |
| Handling time, 25°C, minutes                                                         |                                       |
| 10-3005NS                                                                            | 15-20                                 |
| 10-3020NS                                                                            | 30-35                                 |
| 10-3046NS                                                                            | 55-60                                 |
| Cure time, 25°C, hours                                                               | 24-48                                 |
| Coefficient of thermal expansion (in/in/°C)                                          | 60x10 <sup>-6</sup>                   |
| Operating temperature range, °C                                                      | -50 to *130                           |
| Dielectric strength,V/mil                                                            | 420                                   |
| Izod Impact ft-lb/in                                                                 | 2.7                                   |
| Dielectric constant, 1KHz at 25°C                                                    | 4                                     |
| Dissipation factor, 1KHz at 25°C                                                     | 0.017                                 |
| Volume resistivity, ohm-cm at 25°C                                                   | 2.0 x 10 <sup>14</sup>                |
| Shear strength, psi                                                                  |                                       |
| Aluminum (etched)                                                                    | 1,500                                 |
| Cold rolled steel                                                                    | 1,000                                 |
| Copper                                                                               | 960                                   |
| Brass                                                                                | 725                                   |
| Stainless Steel                                                                      | 750                                   |
| Galvanized Steel                                                                     | 900                                   |
| ABS                                                                                  | 500                                   |
| PVC                                                                                  | 335                                   |
| Polycarbonate                                                                        | 250                                   |
| Compression strength, psi                                                            | 8,500                                 |
| Adhesive coverage: a .005-inch bond line will yield approximately 320 sq. ft./gallon |                                       |

GENERAL & THERMAL HIGH PERFORMANCE EPOXY



BT-102-50M BONDATHERM™ CARTRIDGES

A two component system that forms strong structural bonds at room temperature. This unique adhesive system provides high peel and shear strengths. This is excellent for bonding many metals and woods, most plastics and rubbers and masonry products.

**BT-102-50M** is a toughened, flexible, and impact resistant epoxy adhesive. **BT-102-50M** is a two component system that forms strong structural bonds at room temperature. This unique adhesive system provides high peel and shear strengths. **BT-102-50M** is excellent for bonding many metals and woods, most plastics and rubbers and masonry products. This system is designed for electronic, aerospace and other demanding industrial applications. This product is available in the popular BondaTherm Equalizer dual barrel cartridge system.

| FEATURES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------|--|----------------------------|---------|----------------------------------------------|-------------|---------------------------|------------|-----------------------------|-------|--------------------|----|----------------------------|-----|----------------------------|-----|---------------------------|------|----------------------------|------------------------|-----------------------------------------------------|---|------------------------------------------|-----------------------|
| <ul style="list-style-type: none"><li>• Impact resistant</li><li>• Excellent electrical insulator</li><li>• High peel and shear</li><li>• Outstanding structural bonds</li><li>• Convenient 1:1 Ratio</li><li>• Retention of strength after environmental aging</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| <table><tr><th colspan="2">Typical Specifications</th></tr><tr><td>Mixed viscosity, 25°C, cps</td><td>150,000</td></tr><tr><td>Specific gravity, 25°C,<br/>Resin<br/>Catalyst</td><td>1.32<br/>1.2</td></tr><tr><td>Gel time, 100 grams, 25°C</td><td>70 minutes</td></tr><tr><td>Tensile shear strength, psi</td><td>2,600</td></tr><tr><td>Durometer, shore D</td><td>70</td></tr><tr><td>Dielectric strength, V/mil</td><td>410</td></tr><tr><td>Dielectric constant, 60 Hz</td><td>4.4</td></tr><tr><td>Dissipation factor, 60 Hz</td><td>0.02</td></tr><tr><td>Volume resistivity, ohm-cm</td><td>1.1 x 10<sup>15</sup></td></tr><tr><td>Thermal conductivity, btu-in/hr-ft<sup>2</sup>-°F</td><td>4</td></tr><tr><td>Coefficient of thermal expansion, per °C</td><td>10 x 10<sup>-5</sup></td></tr></table> |                        | Typical Specifications |  | Mixed viscosity, 25°C, cps | 150,000 | Specific gravity, 25°C,<br>Resin<br>Catalyst | 1.32<br>1.2 | Gel time, 100 grams, 25°C | 70 minutes | Tensile shear strength, psi | 2,600 | Durometer, shore D | 70 | Dielectric strength, V/mil | 410 | Dielectric constant, 60 Hz | 4.4 | Dissipation factor, 60 Hz | 0.02 | Volume resistivity, ohm-cm | 1.1 x 10 <sup>15</sup> | Thermal conductivity, btu-in/hr-ft <sup>2</sup> -°F | 4 | Coefficient of thermal expansion, per °C | 10 x 10 <sup>-5</sup> |
| Typical Specifications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                        |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Mixed viscosity, 25°C, cps                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 150,000                |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Specific gravity, 25°C,<br>Resin<br>Catalyst                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1.32<br>1.2            |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Gel time, 100 grams, 25°C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 70 minutes             |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Tensile shear strength, psi                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2,600                  |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Durometer, shore D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 70                     |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Dielectric strength, V/mil                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 410                    |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Dielectric constant, 60 Hz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 4.4                    |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Dissipation factor, 60 Hz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0.02                   |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Volume resistivity, ohm-cm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1.1 x 10 <sup>15</sup> |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Thermal conductivity, btu-in/hr-ft <sup>2</sup> -°F                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 4                      |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| Coefficient of thermal expansion, per °C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 10 x 10 <sup>-5</sup>  |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |
| <b>Adhesive coverage:</b> a .005-inch bond line will yield approximately 320 sq. ft./gallon                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                        |                        |  |                            |         |                                              |             |                           |            |                             |       |                    |    |                            |     |                            |     |                           |      |                            |                        |                                                     |   |                                          |                       |

- INSTRUCTIONS FOR USE:**
1. Surfaces must be clean and grease free. Use an oil free solvent such as acetone to wipe surfaces. Adhesion can be substantially increased by abrading the surfaces to be bonded with emery cloth, sand paper, carbide grinding tools, and sand blasting. A roughened, porous surface will produce the best results. Any oxidized metal films should be removed just prior to application of the epoxy adhesive mixture.
  2. Thoroughly mix equal parts of resin and catalyst by volume.
  3. Apply mixed product evenly to both surfaces.
  4. Join the adhesive coated surfaces within 60 minutes of mixing resin and catalyst.
  5. Cure according to one of the following schedules:  
77°F        24-48 hours  
150°F      2 hours  
180°F      1 hour  
200°F      30 minutes
- STORAGE, HANDLING, AND AVAILABILITY:**
- Store in a cool, dry place in original containers.
  - Keep containers closed and stir well before using.

BONDATHERM™ CARTRIDGES BT-301-50M & BT-301-200M



The **BT-301-50M** and **BT-301-200M** have simple 1:1 mix ratios and develop a 1,400 psi Lap Shear strength (aluminum to aluminum) in four hours at room temperature. After just twenty four hours the strength is over 2,200 psi. This is perfect for any thermally conductive applications. Both cartridges are a two component fast curing thermally conductive epoxy adhesive.

These products are specifically formulated for use in the convenient BondaTherm Equalizer dual barrel cartridge system. The **BT-301-50M** and **BT-301-200M** offer fast heat dissipation for a wide range of electronic applications. The black resin and white hardener provide an excellent visual indication of a complete mix.

| FEATURES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                              |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|--------------------|--|-------------------------------------|-----------------------------|--------------------------------------------|------------------|----------------------------------------------|------------|--------------------------|------------|--------------------------------------|----------|----------------------------------------------------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|------------------------------------------------------------------|-----------|---------------------------|-------------|
| <ul style="list-style-type: none"><li>• Fast room temperature cure</li><li>• Thermally conductive</li><li>• Forms strong bonds to a variety of substrates</li><li>• Electrically insulating</li><li>• Vibration and impact resistant</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                              |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
| <table><tr><th colspan="2">Typical Properties</th></tr><tr><td>Color<br/>Resin<br/>Hardener<br/>Mixed</td><td>Black<br/>White<br/>Dark Gray</td></tr><tr><td>Viscosity, @25°C, cps<br/>Resin<br/>Hardener</td><td>70,000<br/>70,000</td></tr><tr><td>Specific Gravity, @25°C<br/>Resin<br/>Hardener</td><td>1.5<br/>1.5</td></tr><tr><td>Gel Time, 25°C, 15 grams</td><td>15 minutes</td></tr><tr><td>Durometer, Shore D<br/>@25°C<br/>@70°C</td><td>80<br/>50</td></tr><tr><td>Lapshear Strength (Al to Al), psi<br/>After 4 hours<br/>After 24 hours</td><td>1,413<br/>2,231</td></tr><tr><td>Thermal Conductivity, W/m - °K<br/>Dielectric Strength, V/mil<br/>Dielectric Constant, 25°C, 100Hz<br/>Volume Resistivity, ohm-cm, 25°C</td><td>1.04<br/>440<br/>5.3<br/>2.4 x 10<sup>12</sup></td></tr><tr><td>Coefficient of Thermal Expansion, ppm/°C<br/>Below Tg<br/>Above Tg</td><td>45<br/>175</td></tr><tr><td>Operating Temperature, °C</td><td>-40 to +120</td></tr></table> |                                              | Typical Properties |  | Color<br>Resin<br>Hardener<br>Mixed | Black<br>White<br>Dark Gray | Viscosity, @25°C, cps<br>Resin<br>Hardener | 70,000<br>70,000 | Specific Gravity, @25°C<br>Resin<br>Hardener | 1.5<br>1.5 | Gel Time, 25°C, 15 grams | 15 minutes | Durometer, Shore D<br>@25°C<br>@70°C | 80<br>50 | Lapshear Strength (Al to Al), psi<br>After 4 hours<br>After 24 hours | 1,413<br>2,231 | Thermal Conductivity, W/m - °K<br>Dielectric Strength, V/mil<br>Dielectric Constant, 25°C, 100Hz<br>Volume Resistivity, ohm-cm, 25°C | 1.04<br>440<br>5.3<br>2.4 x 10 <sup>12</sup> | Coefficient of Thermal Expansion, ppm/°C<br>Below Tg<br>Above Tg | 45<br>175 | Operating Temperature, °C | -40 to +120 |
| Typical Properties                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
| Color<br>Resin<br>Hardener<br>Mixed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Black<br>White<br>Dark Gray                  |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
| Viscosity, @25°C, cps<br>Resin<br>Hardener                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 70,000<br>70,000                             |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
| Specific Gravity, @25°C<br>Resin<br>Hardener                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1.5<br>1.5                                   |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
| Gel Time, 25°C, 15 grams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 15 minutes                                   |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
| Durometer, Shore D<br>@25°C<br>@70°C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 80<br>50                                     |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
| Lapshear Strength (Al to Al), psi<br>After 4 hours<br>After 24 hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1,413<br>2,231                               |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
| Thermal Conductivity, W/m - °K<br>Dielectric Strength, V/mil<br>Dielectric Constant, 25°C, 100Hz<br>Volume Resistivity, ohm-cm, 25°C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1.04<br>440<br>5.3<br>2.4 x 10 <sup>12</sup> |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
| Coefficient of Thermal Expansion, ppm/°C<br>Below Tg<br>Above Tg                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 45<br>175                                    |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |
| Operating Temperature, °C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | -40 to +120                                  |                    |  |                                     |                             |                                            |                  |                                              |            |                          |            |                                      |          |                                                                      |                |                                                                                                                                      |                                              |                                                                  |           |                           |             |

- INSTRUCTIONS FOR USE:**
1. Surfaces must be clean and grease free. Use an oil free solvent such as acetone to wipe surfaces. Adhesion can be substantially increased by abrading the surfaces to be bonded with emery cloth, sand paper, carbide grinding tools, and sand blasting. A roughened, porous surface will produce the best results. Any oxidized metal films should be removed just prior to application of the epoxy adhesive mixture.
  2. Dispense material from BondaTherm Equalizer. Apply mixed product to substrate to be bonded.
  3. Join substrates within 3-5 minutes.
  4. Cure according to one of the following schedules:
  5. 25°C 2-4 hours  
65°C < 10 minutes
- STORAGE, HANDLING AND AVAILABILITY:**
- Store in a cool, dry place in original containers.
  - Please read and understand the Safety Data Sheet (SDS) before using this product.

- NOTES:**
1. At room temperature, the BT-301-50M and BT-301-200M will reach handle cure within 1-2 hours. The lap shear strength is 1,413 psi after 4 hours.
  2. This product is an adhesive and is not designed for potting and encapsulating applications. The BT-301-50M and BT-301-200M are fast reacting epoxy systems and they will create a high exothermic temperature in large mass sizes (avoid mass sizes greater than 25 grams).

GENERAL & THERMAL HIGH PERFORMANCE EPOXY



BT-103-50M BONDATHERM™ CARTRIDGES

These high bond strength adhesives are clear 100% solids, two component, low viscosity adhesives with a quick setting time of 5-46 minutes at room temperature. They are excellent for bonding plated metals, pewter, glass, wood, ceramic, felt, cement, gem stones, most plastics, and rubbers. These adhesives were tested in our laboratory for flame retardancy properties. According to our test results they meet the requirements of UL94HB.

These unique adhesives are ideally suited for a wide range of electronic, electrical, industrial, structural, and jewelry applications. These adhesives are also an excellent choice for field repairs. They are offered in the popular TriggerBond® dual barrel cartridge dispensing system and bulk packaging.

FEATURES

- High bond strength
- Outstanding thermal shock resistance
- Water and chemical resistance
- Impact resistance
- 1:1 mix ratio
- Fast room temperature cure – three speeds to choose from

INSTRUCTIONS FOR USE:

1. Thoroughly mix equal parts of resin to catalyst by weight or volume.
2. Apply evenly to both surface(s) to be bonded.
3. Application to the substrates should be made within five minutes. Larger quantities and/or higher temperatures will reduce the working time.
4. Avoid mixing large quantities and/or at high temperature due to the possibility of creating a high exothermic temperature.
5. Join the coated surfaces. Allow to cure at 60°F (16°C) or higher until adhesive is set. Heat may be added up to 200°F (93°C) to accelerate the cure.
6. Avoid moving parts during cure. Pressure to the substrates is recommended. Maximum shear strength is obtained with a 3-5 mil bond line.

| Typical Specifications (10-3005)                                                        |                                |
|-----------------------------------------------------------------------------------------|--------------------------------|
| Color                                                                                   | Clear (available in black)     |
| Mix ratio by volume                                                                     | 1:01                           |
| Mixed viscosity, 25°C cps * Solids Content, %                                           | 12,000<br>100                  |
| Specific gravity, 25°C Shore D hardness                                                 | 1.15<br>86<br>72<br>65         |
| Work Life, 25°C, minutes                                                                | 3-5<br>10-15<br>25-30          |
| Handling time, 25°C, minutes                                                            | 15-20<br>30-35<br>55-60        |
| Cure time, 25°C, hours                                                                  | 24-48                          |
| Coefficient of thermal expansion (in/in/°C)                                             | 60x10 <sup>-6</sup>            |
| Operating temperature range, °C Dielectric strength V/mil                               | 50 to +130<br>420              |
| Izod Impact, ft-lb/in. Dielectric constant, 1KHz at 25°C                                | 2.7<br>4.00                    |
| Dissipation factor, 1KHZ at 25°C Volume resistivity, ohm-cm at 25°C Shear strength, psi | .017<br>2.0 x 10 <sup>14</sup> |
| Aluminum (etched) Cold rolled                                                           | 1,500                          |
| Steel Copper                                                                            | 1,000                          |
| Brass                                                                                   | 960                            |
| Stainless Steel                                                                         | 725                            |
| Galvanized Steel                                                                        | 750                            |
| ABS                                                                                     | 900                            |
| PVC                                                                                     | 500                            |
| Polycarbonate                                                                           | 335                            |
| Compression strength, psi                                                               | 250                            |
| Adhesive coverage: a .005-inch bond line will yield approximately 320 sq. ft./gallon    |                                |

BONDATHERM HARDWARE

| Wakefield-Vette Part Number | Description                               |
|-----------------------------|-------------------------------------------|
| BT-01-50M                   | BondaTherm Equalizer Dispense Gun (50ml)  |
| BT-01-200M                  | BondaTherm Equalizer Dispense Gun (200ml) |
| BT-02-50M                   | BondaTherm Equalizer Static Mixer (50ml)  |
| BT-02-200M                  | BondaTherm Equalizer Static Mixer (200ml) |

BONDATHERM EQUALIZER GUN



BT-01-50M BONDATHERM™ CARTRIDGES

FOR USE W/ 200ML CARTRIDGES

BT-01-200M



BONDATHERM EQUALIZER STATIC MIXERS



BT-02-50M FOR USE W/ 50ML CARTRIDGES

FOR USE W/ 200ML CARTRIDGES

BT-01-200M





GENERAL & THERMAL HIGH PERFORMANCE EPOXY

BONDATHERM EQUALIZER KIT™

| Wakefield-Vette Part Number | Description                                                                        | Packaging |
|-----------------------------|------------------------------------------------------------------------------------|-----------|
| BT-101-50M-EQZ              | Two Dual Cartridges (BT-101-50M), One Gun (BT-01-50M), Three Mixers (BT-02-50M)    | Kit       |
| BT-102-50M-EQZ              | Two Dual Cartridges (BT-102-50M), One Gun (BT-01-50M), Three Mixers (BT-02-50M)    | Kit       |
| BT-301-50M-EQZ              | Two Dual Cartridges (BT-301-50M), One Gun (BT-01-50M), Three Mixers (BT-02-50M)    | Kit       |
| BT-301-200M-EQZ             | Two Dual Cartridges (BT-301-200M), One Gun (BT-01-200M), Three Mixers (BT-02-200M) | Kit       |

(2) Dual Cartridges, (1) Dispense Gun, (3) Static Mixers



BONDATHERM HINGE PACKS

BT-401-H



**BT-401-H** is a two component epoxy adhesive filled with silver. This electrically conductive epoxy resin formulation offers continuity of conductivity with an electrical resistivity value of less than 1x10<sup>-4</sup> ohm-cm. 40-3900 is also well known for its wide operating temperature range, -50 to + 170°C.

**BT-401-H** is specifically designed for adhesive bonding in microelectronic and optoelectronic applications. Due to its excellent continuity, it has also been used extensively in applications such as micro-wave EMI and RFI shielding, in the assembly or repair of printed circuit boards, wave guides, electronic modules, flat cable, high frequency shields, connectors, circuitry, and as a cold solder. **BT-401-H** is formulated with pure silver (no alloys) and is designed in a convenient 1:1 mix ratio. Both the resin and hardener have silver powder dispersed.

FEATURES

- Electrically conductive
- Thermally conductive
- Room temperature cure
- Easy 1:1 mix ratio
- Good bond strength

STORAGE, HANDLING, AND AVAILABILITY:

- BT-401-H Resin and hardener should be stored at 25°C in original tightly sealed containers. Expected shelf life is twelve months in original unopened containers.
- Filler settling is common with these products. Gently stir resin and hardener before using to make sure fillers are evenly dispersed.

| Typical Specifications           |                                                                |
|----------------------------------|----------------------------------------------------------------|
| Mix Ratio, by Weight             | 1:1                                                            |
| Color                            | Silver                                                         |
| Mixed Viscosity                  | Creamy Paste                                                   |
| Pot Life, 100 gram mass @ 25°C   | 1 Hour                                                         |
| Specific Gravity, 25°C           |                                                                |
| Resin                            | 2.98                                                           |
| Hardener                         | 1.8                                                            |
| Hardness, Shore D                | 70                                                             |
| Thermal Conductivity, W/m- °K    | 7.93                                                           |
| Tensile Lapshear, psi (Al to Al) | 700                                                            |
| Flexural Strength, psi           | 10,200                                                         |
| Volume Resistivity, ohm-cm       | 0.0001                                                         |
| Operating Temp. Range, °C        | -50 to +170                                                    |
| Cure Schedule                    | a) 24 hours @ 25°C<br>b) 1 hour @ 65°C<br>c) 15 minutes @ 90°C |

GENERAL & THERMAL HIGH PERFORMANCE EPOXY



BT-402-H

BONDATHERM HINGE PACKS

This system has been formulated to meet the stringent non-burning requirements of UL94 V-0. **BT-402-H** Black Epoxy is used with Catalyst 190 and are listed with Underwriter's Laboratory for passing UL94 V-0. This system offers excellent heat transfer, low shrinkage, and outstanding insulation properties. **BT-402-H** Black with Catalyst 190 passes NASA's outgassing requirements per ASTM E595-07. Other Catalyst's are available as well (30, 150.).

Typical applications for **BT-402-H** include encapsulating power supplies, transformers, coils, insulators, and sensors. This system is an excellent choice for applications requiring high thermal conductivity and flame retardancy.

| Typical Specifications             |                        |
|------------------------------------|------------------------|
| Viscosity @ 25°C cps, Resin        | 60,000                 |
| Mixed with Cat. 190                | 28,000                 |
| Mixed with Cat. 30                 | 17,000                 |
| Mixed with Cat. 150                | 1,500                  |
| Specific Gravity, 25°C             | 1.6                    |
| Hardness, Shore D                  | 90                     |
| Color                              | Black                  |
| Tensile Strength, psi              | 9,850                  |
| Linear Shrinkage, in/in            | 0.002                  |
| Operating Temp. Range, °C          | -60 to +200            |
| Dielectric Strength, V/mil         | 485                    |
| Dielectric Constant at 60 Hz       | 5.6                    |
| Volume Resistivity, ohm-cm, 25°C   | 1.5 x 10 <sup>15</sup> |
| Dissipation Factor, 60 Hz          | 0.015                  |
| Thermal Conductivity, W/m- °K      | 2.16                   |
| Compressive Strength, psi          | 15,000                 |
| Coefficient of Expansion, in/in °F | 1.4 x 10 <sup>-5</sup> |
| Heat Distortion, °C Outgassing     |                        |
| (with Cat. 190)                    | 155                    |
| %TML                               | 0.5                    |
| %CVCM                              | 0.01                   |

INSTRUCTIONS FOR USE:

- A. With Catalyst 190 listed with UL 94 V-0 (room temperature curing):
- By weight, thoroughly mix 5 parts Catalyst 190 to 100 parts BT-402-H resin.
  - Degas and pour. Cure at room temperature for 12-24 hours at 25°C ambient.
- B. With Catalyst 30 listed with UL 94 V-0 and RTI Rating of 130°C (Heat curing - Recommended for higher operating temperature and physical property applications):
- By weight, thoroughly mix 10 parts Catalyst 30 to 100 parts BT-402-H resin.
  - Pour and cure according to one of the following recommended cure schedules:  
a) 85°C (185°F) 3-4 hours  
b) 100°C (212°F) 2-3 hours  
For optimum performance, an additional 2 hours @ 365°F (185°C) is recommended.
- C. With Catalyst 150 (room temperature/heat curing):
- By weight, thoroughly mix 17 parts Catalyst 150 to 100 parts BT-402-H resin.
  - Degas and pour. Cure at room temperature for 24 hours or for 2-3 hours at 35-40°C.

BONDATHERM HINGE PACKS

BT-403-H



**BT-403-H** is a two component, aluminum filled epoxy system. This system is used for making heat resistant tools, parts, or bonds that require the highest thermal conductivity and heat resistance. We have developed this extremely conductive epoxy by formulating it with a unique combination of fillers, particle sizes and dispersion techniques.

**BT-403-H** has good heat dissipation making this a popular choice for a variety of heat sink applications. Its viscosity is particularly suited for Fin bonding. **BT-403-H** passes NASA's outgassing requirements per ASTM E-595-07.

| FEATURES                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>Excellent Thermal Conductivity</li><li>Superior Adhesion</li><li>Low Viscosity allows quick self leveling</li></ul> |

| Typical Specifications                                      |                       |
|-------------------------------------------------------------|-----------------------|
| Color                                                       | Grey                  |
| Viscosity, 25°C, Resin                                      | 130,000               |
| Mixed                                                       | 8,000                 |
| Specific Gravity, 25°C                                      | 1.81                  |
| Working time, 100 grams, 25°C                               | 5 Hours               |
| Durometer, Shore D                                          |                       |
| 25°C                                                        | 90                    |
| 100°C                                                       | 65                    |
| Tensile Strength, psi, 25°C Aluminum to Aluminum 1" overlap | 9,000                 |
|                                                             | 2,500                 |
| Compressive Strength, PSI, 25°C Mix Ratio, by weight        | 18,500                |
| Operating temperature, °C                                   | 100:10                |
| Coefficient of Thermal Expansion, °C                        | -55 to 155            |
| Thermal Conductivity, W/m- °K                               | 28 x 10 <sup>-6</sup> |
|                                                             | 4.5                   |
| Outgassing                                                  |                       |
| % TML                                                       | 0.91                  |
| % CVCM                                                      | 0.07                  |

STORAGE, HANDLING, AND AVAILABILITY:

- BT-401-H Resin and hardener should be stored at 25°C in original tightly sealed containers. Expected shelf life is twelve months in original unopened containers.
- Filler settling is common with these products. Gently stir resin and hardener before using to make sure fillers are evenly dispersed.

# MIL EMBEDDED

Front Panels .....

Wedgelocks .....

Wavelock™ Data Sheet .....

Heat Frames .....

ATR Boxes / Enclosures .....

Complex RF Shield Enclosures.....

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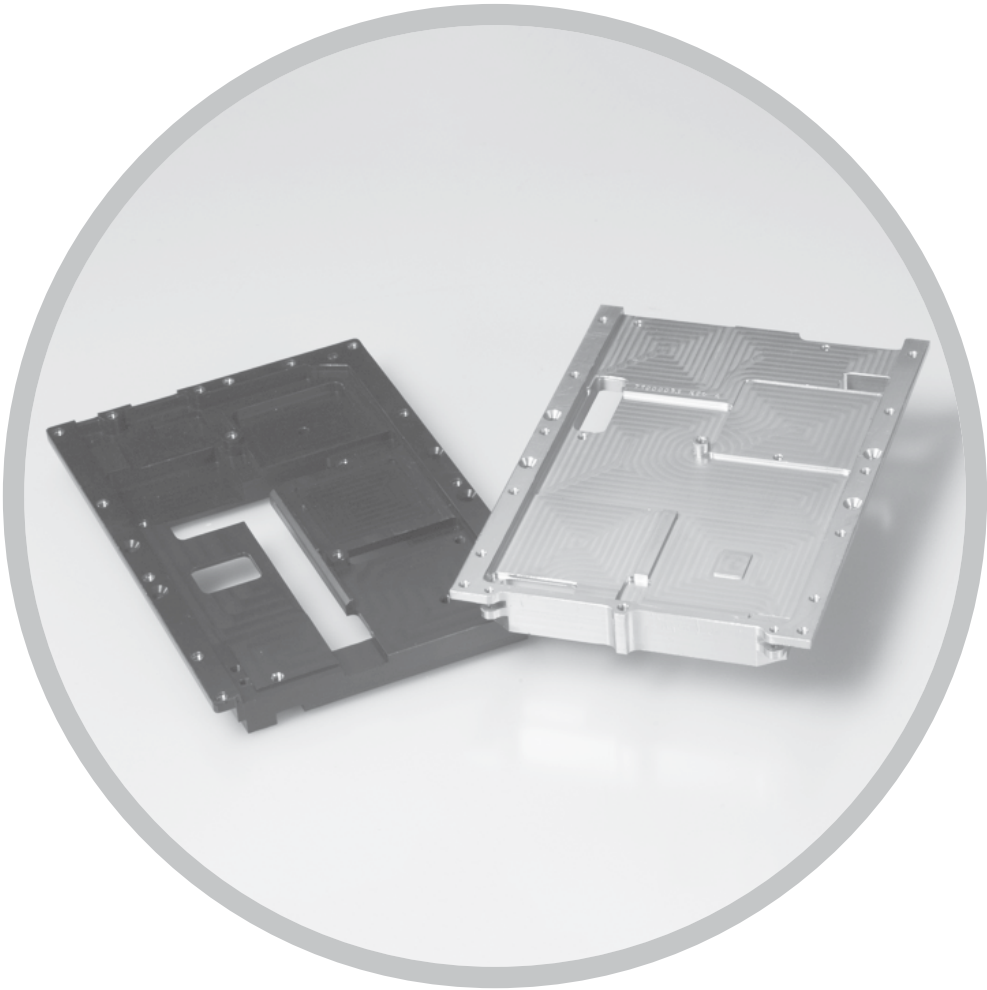
159-160

160

161

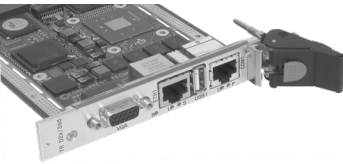
161

161





FRONT PANELS



Standard & custom front panels that are silk-screened, fully assembled, and ready to mount.

Parts are made from extrusion and manufactured on high-speed CNC machines , providing a superior finish and precision fit to a specific application.

- FEATURES AND OPTIONS
- Panel cutouts
  - Multi-color silk-screened
  - Choice of EMC gaskets
  - Choice of surface finish
  - Optional hot swap microswitch installation
  - Assembly and kitting

- APPLICATIONS
- VME Flat Panel
  - Compact PCI
  - 1101.10 compliant
  - Electrical/Electronic instrumentation, controls, and devices.
  - Electronic communication equipment.
  - Computer system front and rear back panels.
  - 19 inch panel plates - 1U, 2U and 3U make for many different applications.
  - Audio devices, vacuum tube amplifiers, and signal processing equipment.
  - PMC
  - XMC
  - FMC

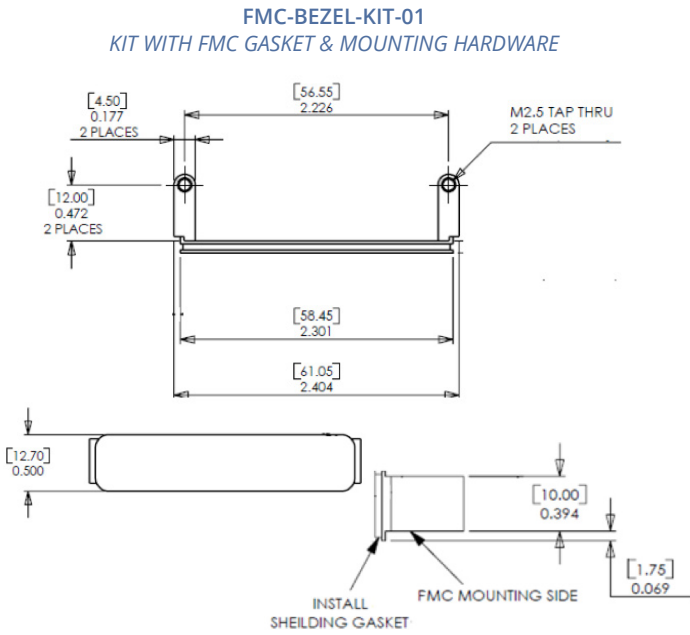
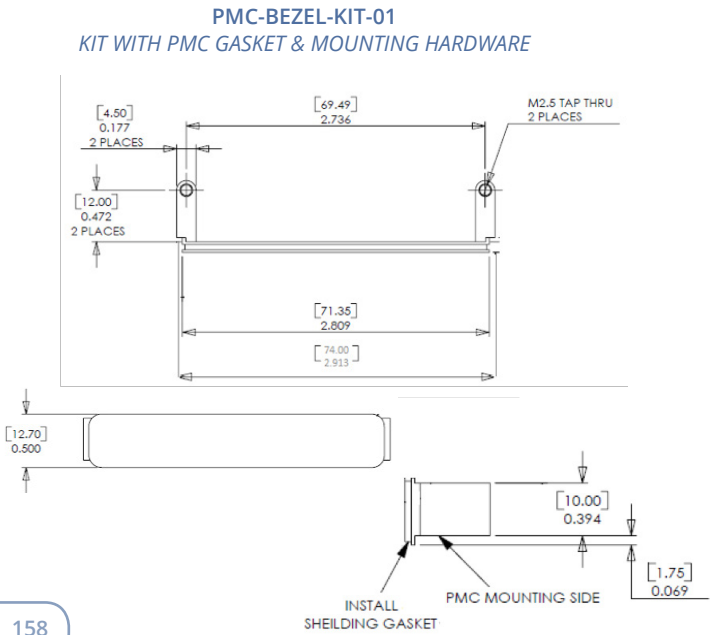


FMC & PMC BEZEL KITS DATA SHEETS

**FMC & PMC Mezzanine Cards** describes a specification of I/O mezzanine modules in conjunction with FPGA or another device with configurable I/O capability. The design allows use on any industry standard slot card with form factors such as VME, VPX, CompactPCI, AdvancedTCA, MicroTCA, PCI, PXI, and many others.. Wakefield-Vette can customize your specific application needs for custom FMC & PMC Bezels.

- FEATURES
- Material: Aluminum
  - Kit:
    - Bezel
    - Elastomer Gasket
    - Two M2.5 x 6mm PH Stainless Steel Screws
  - Custom cutouts, silkscreen or overlays available

| WV Part Number   | Description                         | Kit Description                                         | Size                                                         |
|------------------|-------------------------------------|---------------------------------------------------------|--------------------------------------------------------------|
| PMC-BEZEL-KIT-01 | Aluminum PMC Bezel Kit (1050056-00) | PMC Bezel, Elastomer Gasket, Qty. Two M2.5 x 6mm Screws | 0.659" L x 0.500" W x 2.913" H (16.75mm x 12.70mm x 74.00mm) |
| FMC-BEZEL-KIT-01 | Aluminum FMC Bezel Kit (1050117-00) | FMC Bezel, Elastomer Gasket, Qty. Two M2.5 x 6mm Screws | 0.659" L x 0.500" W x 2.404" H (16.75mm x 12.70mm x 61.00mm) |
| PMC-GASKET-01    | PMC EMC GASKET O RING (1070010-00)  | Spare, Replacement Component                            |                                                              |
| FMC-GASKET-01    | FMC EMC GASKET O RING (1070036-00)  | Spare, Replacement Component                            |                                                              |



WEDGELOCKS

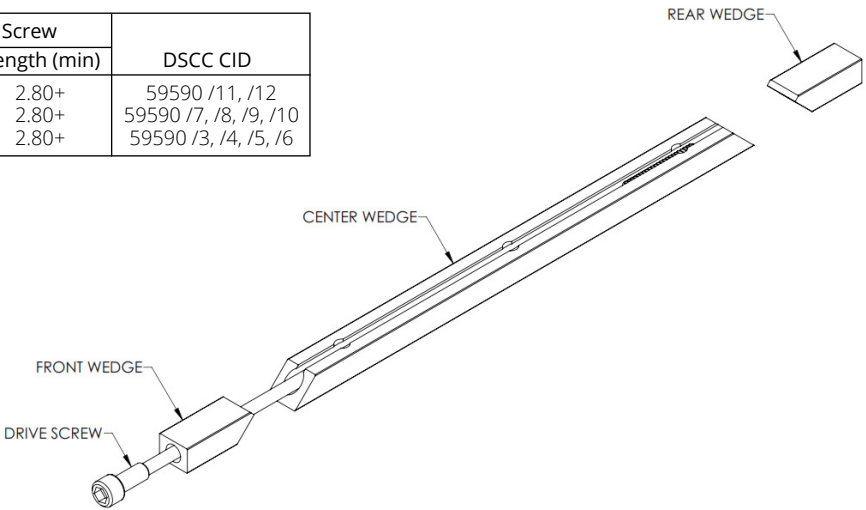


- Rugged fastener or retainer used to clamp a PCB within a cold wall slot.
- Provides clamping force to resist shock and vibration in rugged environments
  - Provides a thermally conductive path from the heat frame to the cold wall
  - Flexible mounting options to meet customer requirements
  - Available separately or integrated into Heat Frame
  - Ability to cross competitors Part Numbers

Wedgelocks are available in various profiles and allow for configurable length, mounting and plating selections. For configurations not shown within the data sheets, please contact the factory to review.

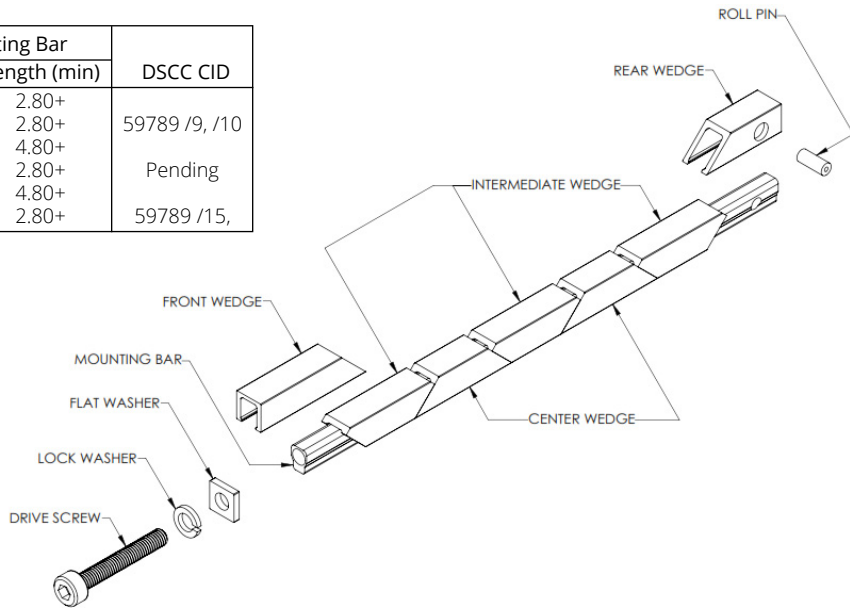
“B” STYLE WEDGELOCK

| “B” Style | # of Wedges | Assembly with Long Screw |       |              | DSCC CID              |
|-----------|-------------|--------------------------|-------|--------------|-----------------------|
|           |             | Height                   | Width | Length (min) |                       |
| 418B      | 3           | 0.180                    | 0.240 | 2.80+        | 59590 /11, /12        |
| 422B      | 3           | 0.220                    | 0.220 | 2.80+        | 59590 /7, /8, /9, /10 |
| 426B      | 3           | 0.260                    | 0.225 | 2.80+        | 59590 /3, /4, /5, /6  |



“C” STYLE WEDGELOCK

| “C” Style | # of Wedges | Assembly with Mounting Bar |       |              | DSCC CID      |
|-----------|-------------|----------------------------|-------|--------------|---------------|
|           |             | Height                     | Width | Length (min) |               |
| 419C      | 5           | 0.192                      | 0.25  | 2.80+        | 59789 /9, /10 |
| 422C      | 5           | 0.225                      | 0.225 | 2.80+        |               |
| 422C7     | 7           | 0.225                      | 0.225 | 4.80+        |               |
| 426C      | 5           | 0.260                      | 0.250 | 2.80+        | Pending       |
| 426C7     | 7           | 0.260                      | 0.250 | 4.80+        |               |
| 438C      | 5           | 0.375                      | 0.365 | 2.80+        | 59789 /15,    |

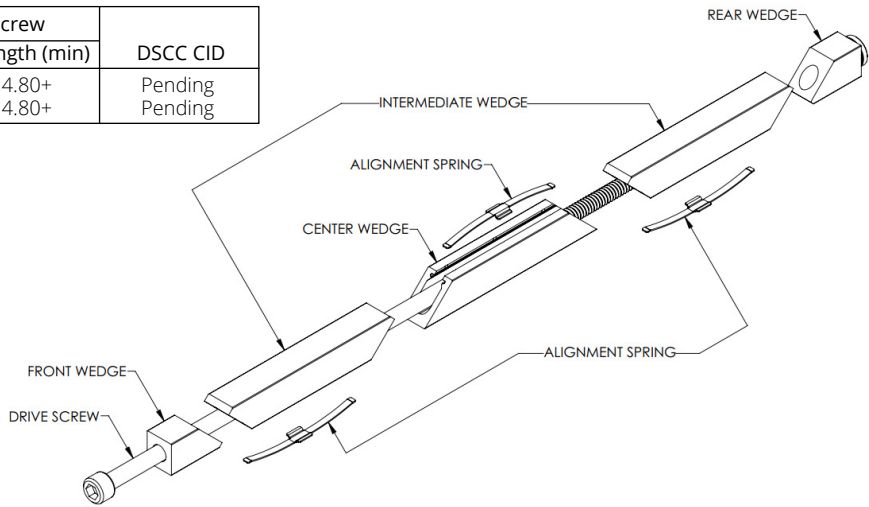


\* All dimension provided in Inches  
\*\* Standard profiles and lengths listed, inquire for other sizes

WEDGELOCKS

"D" STYLE WEDGELOCK

| "D" Style | # of Wedges | Assembly with Long Screw |       |              | DSCC CID |
|-----------|-------------|--------------------------|-------|--------------|----------|
|           |             | Height                   | Width | Length (min) |          |
| 422D      | 5           | 0.220                    | 0.220 | 4.80+        | Pending  |
| 426D      | 5           | 0.260                    | 0.225 | 4.80+        | Pending  |



\* All dimension provided in Inches  
\*\* Standard profiles and lengths listed, inquire for other sizes

WAVELOCK™ DATA SHEET

**Wavelock™** is a patent-pending, low-cost, high-performing, form fit, and function alternative to wedgelocks for some applications. A Wavelock assembly consists of only two discrete parts and represents the simplest form of a card retainer within a wedgelock envelope. The discrete parts are a wave spring and an injection molded carrier. Additional benefits include easy tool-free installation and visual indication of correct installation.

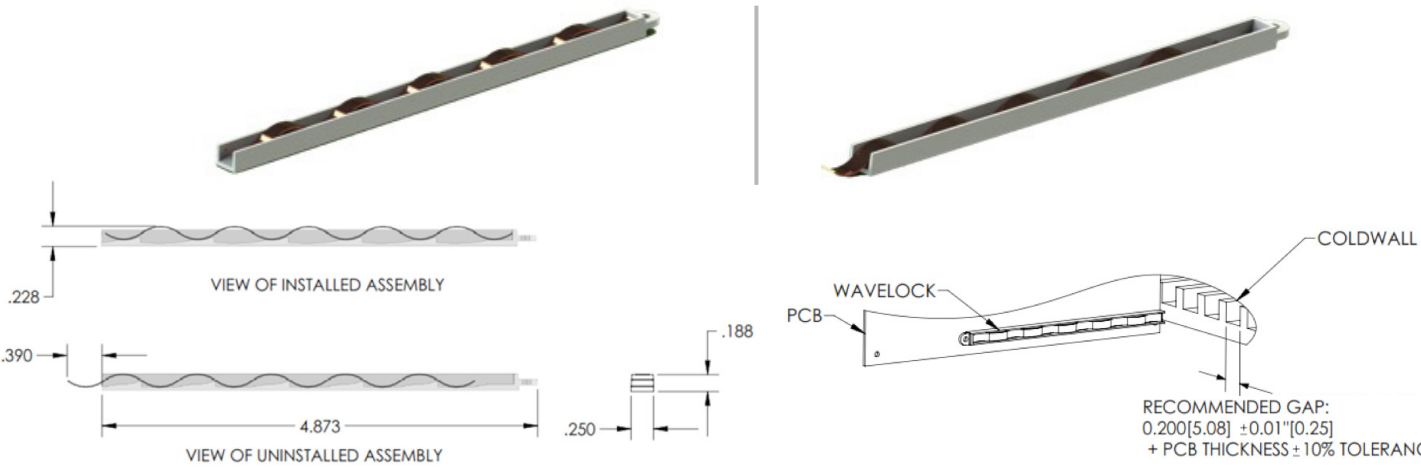
| FEATURES AND BENEFITS                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Low cost for light shock and vibration applications.</li><li>• Light weight assembly with uniform clamping force.</li><li>• Narrow width for maximum PCB component area.</li><li>• Low profile design allows for decreased slot pitch.</li><li>• Special lengths, finish, and other design options available.</li></ul> |

| MATERIAL                                                                                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Carrier: Polysulfone (PSU)</li><li>• Wave Spring: 17-7 PH Stainless Condition C to CH900</li></ul> |



ENGAGED STATE

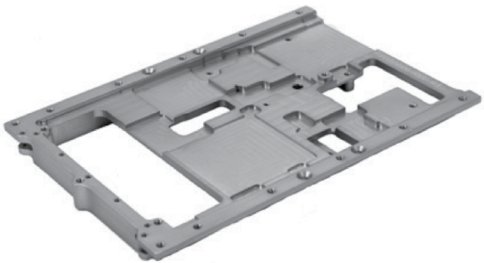
RELAXED STATE



HEAT FRAMES

Milled aluminum heat frames are used with electronics design to meet or exceed rugged specification requirements.

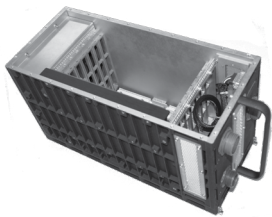
Heat frames are CNC precision-machined out of solid aluminum (or copper) and precisely match the topography or skyline of an electronic printed circuit board being ruggedized.



| FEATURES AND OPTIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Plating options include Chromate, Black Anodize, and Electroless Nickel.</li><li>• Integrated Heatpipes when needed</li><li>• When combined with thermal-interface material or "gap pads," conduction-cooled heat frames increase a board's operating temperature range, as well as its resistance to shock and vibration.</li><li>• Designs can integrate Front or Rear I/O and can also include Top and Bottom Covers for compliance with Two-Level Maintenance.</li><li>• When integrated with wedgelocks and ejectors, this product allows VME, cPCI and other boards to fit within conduction cooled chassis slot dimensions with zero insertion force.</li></ul> |

| APPLICATIONS                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• IEEE 1101.2</li><li>• VITA 30.1</li><li>• VITA 48 (both 0.8" and 1.0" slot pitch)</li><li>• Mezzanine cards</li><li>• Ruggedized Enviroments</li></ul> |

ATR BOXES / ENCLOSURES



Typically the rugged housings for multiple VME, CompactPCI or VPX computers boards. Enclosures can be bolted, brazed or epoxied together.

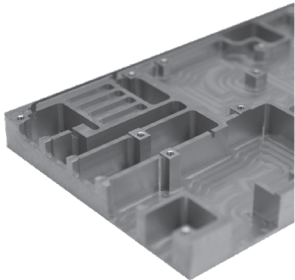
- Standard configuration COTS and Custom ATR enclosures
- Power supply and Backplane available when required
- Brazed or Epoxied and bolted Solutions
- Complete Custom Design capabilities to meet specific customer constraints
- Finishes Anodize :
- Chem Film
- Dual Plating
- Painting

COMPLEX RF SHIELD ENCLOSURES

Complex machined parts can be executed through Wakefield-Vette's North Carolina facility. One major product line it supports intricate machined parts for the RF industry.

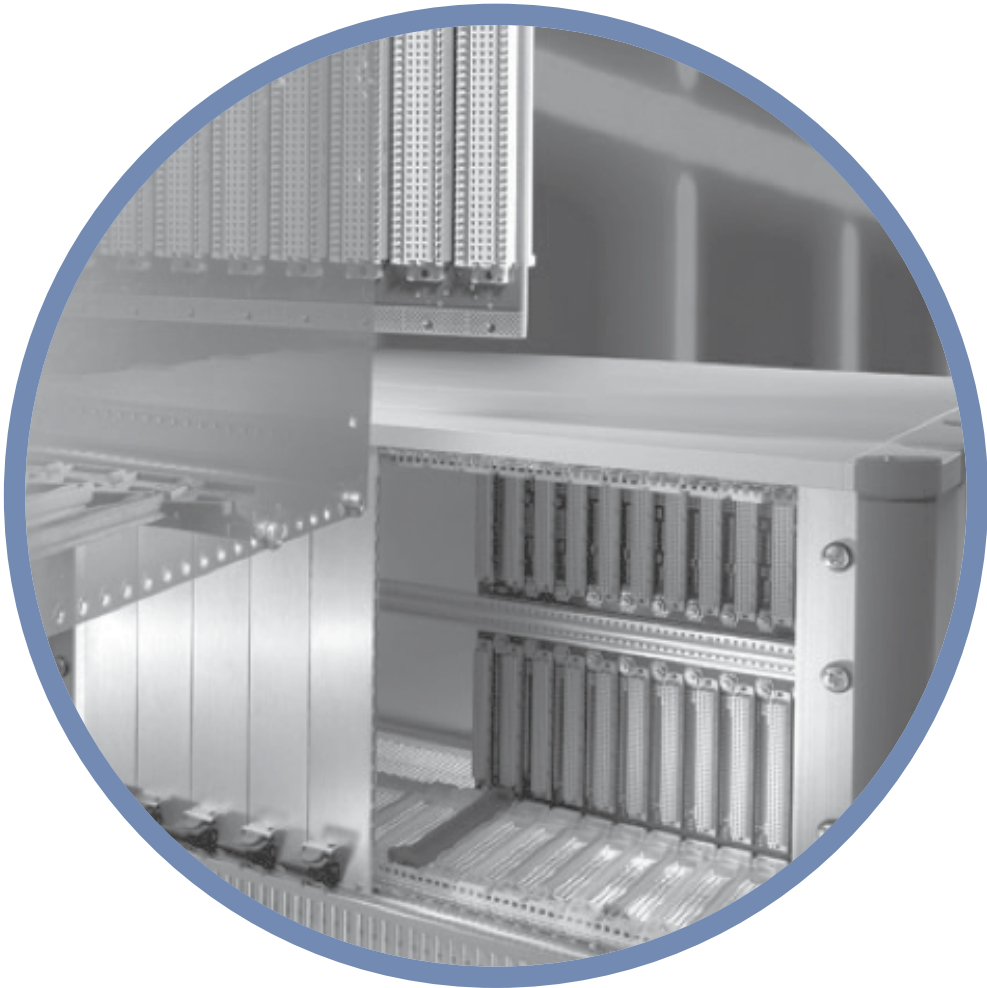
RF shielded enclosures refers to any box, chassis, or other packaging that prevents the passing of electromagnetic interference or radio frequency.

| APPLICATIONS                                                                                                                                                                          |                                                                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Desktop Shielded Enclosure</li><li>• Software-defined Radios</li><li>• Rugged/Embedded Computing</li><li>• TEMPEST/Secure Computing</li></ul> | <ul style="list-style-type: none"><li>• Sensor Equipment</li><li>• Surveillance Equipment</li><li>• Tactical Devices</li><li>• EMI Shielded Enclosure for Communications Equipment</li></ul> |



# ELECTRONICS PACKAGING SYSTEMS

|                                           |         |
|-------------------------------------------|---------|
| <i>Electronic Packaging Systems</i> ..... | 164-165 |
| <i>System Level Packaging</i> .....       | 166-167 |



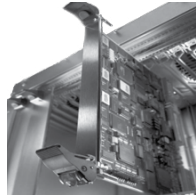
Wakefield-Vette manufactures both custom and standard electronic packaging solutions. In June of 2015, Wakefield-Vette announced an exclusive strategic partnership with Heitec AG, a recognized leader in electronic packaging systems (EPS), to sell, customize, and service the Heitec product line (formerly Rittal) to the North American marketplace.

Wakefield-Vette has the ability to modify a customer's unique specification within a quick turnaround time which separates it broad product line from the rest in North America.

Wakefield-Vette has achieved a leading position in the Rugged COTS packaging marketplace, providing for VME/VME64x, VXS/VPX, VXI,PXI, AdvancedTCA, and MicroTCA, and CompactPCI/2.16 architectures.

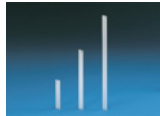


## ELECTRONIC PACKAGING SYSTEMS



## FRONT PANELS &amp; EJECTOR HANDLES

Wakefield-Vette manufactures custom front panels that are silk-screened, fully assembled, and ready to mount to your PCB. Parts are made from extrusion and manufactured on high-speed CNC machines to mill your custom cut outs and features, providing a superior finish and precision fit to your board. We also have the ability to stamp front panel cutouts to meet your specifications or high volume requirements.



## STANDARD FRONT PANELS

Subrack system for direct mounting in a cabinet. Mounting either on top hat rails or on mounting plate. Suitable for installation of standardized PCBs or plug-in units.



## INJECTORS &amp; EJECTORS

We offer all VME and compactPCI related front panel accessories, including gaskets and handles to meet Vita 41, 46, 48, 57, and IEEE 1101.10 requirements.



## CUSTOM FRONT PANELS

In addition to a variety of standard finishes and options, Wakefield-Vette offers custom front panel production along with our in-house silk-screening process. We offer build to order ATCA and PCI panels, as well as customized AMC, PMC, and FMC bezels.



## MEZZANINE FRONT PANELS

Extruded aluminum and Zinc Die Cast for PCI mezzanine cards and conforms to IEEE 1386.

## ELECTRONIC PACKAGING SYSTEMS COMPONENTS

Besides complete subrack and system solutions Wakefield-Vette offers a wide range of individual components and accessories for setup, mounting and upgrade. Our inside and outside sales staff will gladly help you to find the right selection of components and support you in compiling the optimum package to fulfill your individual preferences and requirements.



## CARD GUIDES

Keyable Guide rails to IEEE 1101.10. Prepared to accommodate a ground contact for assembly of a plug-type connection. Available in different form factors and material including plastic.



## COVERS

Covers are slid into the front and rear horizontal rails for mounting backplanes/connectors. There are several styles of this product line.



## HORIZONTAL RAILS

The adaptor rails accommodate the guide rails when fastened to the center horizontal rail. Front and rear horizontal rails available to meet the very simple to the very complex subrack configurations including rails to meet the IEEE 11001.10/1101.11 specifications.

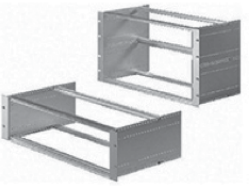


## BACKPLANES

Wakefield-Vette offers various backplanes. Our engineering team can help assist in any backplane design with your PICMG, VITA-based, VME, VME 64X, cPCI, uTCA, or custom architecture design.



## SUBRACKS



The modular concept of Ripac subracks facilitates a wide range of application options with a minimum of components. All Ripac subracks are based on the same horizontal rails and system components. The difference lies in the design of the side panels and installation options. The subracks are shock and vibration-tested and comply with IEC 60 297-3-101, -102, -103.



## RIPAC COMPACT

Subrack system for direct mounting in a cabinet. Mounting either on Din rails or on mounting plate. Suitable for installation of standardized PCBs or plug-in units.



## RIPAC ECO

Subrack system for standard applications. Suitable for installation of standardized PCBs or plug-in units of 160 and 220 mm depth.



## RIPAC VARIO EMC

Subrack system for EMC applications or complex installations. Suitable for installation of standardized PCBs or plug-in units up to 400 mm depth.



## RIPAC EASY

Subrack system for standard applications or high mechanical loads. In cases that require easy handling and fast assembly.



## RIPAC VARIO

Subrack system for standard applications or complex installations. Suitable for installation of standardized PCBs or plug-in units up to 400 mm depth.



## RIPAC VARIO MOBILE

Subrack system for applications in rail vehicles. Suitable for installation of standardized PCBs or plug-in units.



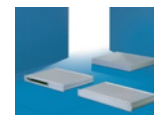
## ELECTRONIC CASES

The RiCase instrument case impresses with its modern design and high functionality. Particular features include the numerous color variants and the all-metal enclosure construction. The Ripac Vario-Module system enclosure (desktop or rack-mount enclosure) is fully compatible with the latest Ripac subrack range, making it ideal for individual configuration and assembly as a microcomputer system. At just 1 U, the HeiBox system enclosure offers a high packaging density in the smallest space.



## HEIBOX ECO

Cost optimized 1 U system housing for use as rack-mount enclosure or instrument case.



## RIBOX

Optionally for use as an instrument case or rack-mount enclosure. Accommodates Eurocards/Double Eurocards (horizontal), bridges, hubs, routers or modems.



## RICASE

Instrument case for installation of 19" slide-in assemblies and elements. For mobile and stationary applications.



## RIPAC VARIO MODULE

Optionally for use as an instrument case or rack-mount enclosure. External dimensions according to IEC 60 297-1 for installation in enclosures.

## SYSTEM LEVEL PACKAGING



## CPCI / CPCI SERIAL

Wakefield-Vette offers a wide selection of CompactPCI systems that conform to IEC 60 297-3 and IEEE 1101.1/10/11, as well as PICMG 2.0. Systems include backplane and power supply, excellent cooling, fully assembled, pre-wired and tested.



## RACK MOUNT SYSTEMS

Configuration of 19" industrial computer systems according to CompactPCI specification for Telecommunication and Industrial Automation.



## CPCI SERIAL PLATFORM SYSTEMS

Configuration of 19" industrial computer systems according to CompactPCI Serial specification.

## MicroTCA



MicroTCA offers standardized modularity, compact design and high scalability and bandwidth. Additionally, the consistent platform strategy reduces the time to market. Whenever ultra fast data transmission or data storage is required, MicroTCA systems are the first choice. This is true not only for telecom applications but also for industrial control systems or medical engineering.



## CubeTCA

Based on the MTCA specification the compact CubeTCA offers a wide range of application fields in the industrial sector. The CubeTCA can either be assembled directly on the mounting plate or integrated within the target system.



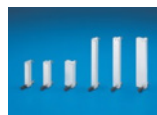
## AIR MANAGEMENT PANELS

Filler sheets are mounted on the AMC face plates and are used to route the airflow in ATCA carriers and MicroTCA systems.



## MicroTCA DEVELOPMENT SYSTEM

Instrument MicroTCA development systems are suited for design of hard and software or for testing AMC modules.



## FACE PLATES

These face plates are used for AMC cards and ATCA carriers, or as filler panels in MicroTCA systems.



## MicroTCA RACK MOUNT SYSTEMS

MicroTCA specification is designed as an amendment to the ATCA standard as a lower-cost compact version for the low-end sector. The main features are a compact design, high scalability, modularity and considerably reduced system costs.



## PicoTCA

Based on the MTCA specification, PicoTCA is a modular ready-to-run system, which carries up to 12 AMCs and 1 MCH. Due to the robust construction, the 19" rack can be used both in the telecommunication and in the industrial sector.

## VME



Wakefield-Vette supplies complete plug & play solutions for VME applications. Systems are based on standard components which may be configured to your specification. VME systems are complete with power supply, backplane, measures for EMC and ESD protection, climate control, fully assembled, pre-wired, and tested.



## BACKPLANES

The VME64 is a new addition to the VME family to ANSI/VITA 1-1994 and supports 64-bit data traffic. The VME64x extends the VME family to ANSI/VITA 1.1-1997 and is available with the optional 133-pole 2 mm connector J0. 160-pole connectors are used with VME64x.



## MPS MONITORING

The monitoring electronics for microcomputer packaging systems (MPS) offers a highly flexible, scalable security concept for key parameters such as temperature, voltage and fan speed.



## RACK MOUNT SYSTEMS

Ripac systems available in many different variations. Prepared to accommodate VMEbus boards and drives while having MPS Monitoring feature.



## SLIM BOX VARIO

Configuration of 19" industrial computer systems according to VME specification.

## NOTES

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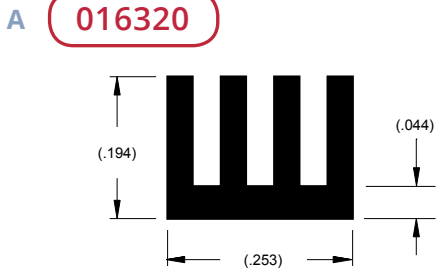
# THERMAL EXTRUSION PROFILES

|                                            |         |
|--------------------------------------------|---------|
| Flatback Extrusions .....                  | 172-234 |
| L-style Extrusions .....                   | 235-239 |
| Center Channel Extrusions .....            | 239-245 |
| Multi Channel Extrusions .....             | 245-247 |
| Flatback with Integral Mounting Feet ..... | 248-252 |
| T-style Extrusions .....                   | 252-256 |
| H-style Extrusions .....                   | 256-262 |
| Double-Side Extrusions .....               | 262-263 |
| Mounting Shelf Extrusions .....            | 263-265 |
| Press Pack Extrusions .....                | 265-268 |
| Power Module Extrusions .....              | 268-269 |
| Forced Convection Extrusions .....         | 269-271 |
| Modular Extrusions / Enclosures .....      | 271-272 |
| Hollow Extrusions .....                    | 272-273 |
| Miscellaneous Extrusions .....             | 273-276 |

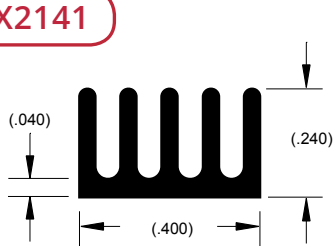


Extruded heat sinks are the most common heat sink used for thermal management today. They are manufactured by pushing hot aluminum billets through a steel die to produce the final shape. The most common aluminum alloy is 6063-T5, but other 6XXX alloys can also be examined as needed. When the material is extruded, the initial sticks are 30-40 feet and length and are very soft. The material is stretched by grabbing both ends to produce a straight stick. After stretching, the material can be either air or over aged depending upon the required final hardness of the material. After the aging process, the material is cut to the final length and any final fabrication (holes, pockets, or other secondary machining) can be done. Extruded heat sinks are usually supplied with a “finish” such as anodizing which can enhance its thermal performance. The heat sinks can also be supplied with a chromate finish which provides some corrosion protection or can be used as a primer before a final paint or powder coating is applied.

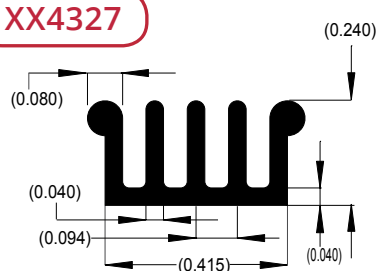
While each extruded shape is unique to the requirements that it was designed for, extruded heat sinks are the most cost-effective cooling solution. Each shape is engineered to achieve the optimal thermal and structural performance. Wakefield-Vette partners with a large list of vendors which insures that you have the best thermal solution based on your system structure and thermal requirements.



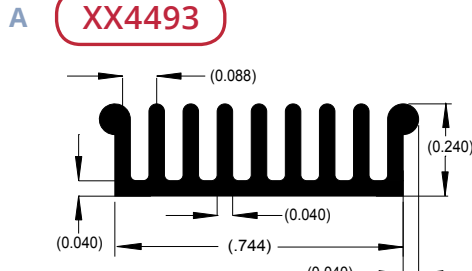
|      |       |         |
|------|-------|---------|
| Per. | 1.79  | in.     |
| WT.  | 0.04  | lb/ft   |
| θsa  | 42.00 | °C/w/3" |



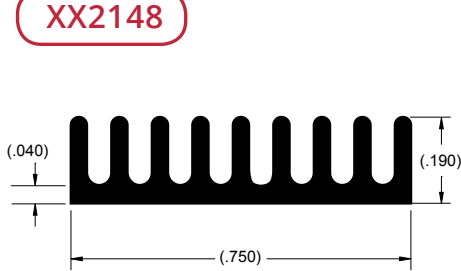
|      |       |         |
|------|-------|---------|
| Per. | 2.71  | in.     |
| WT.  | 0.06  | lb/ft   |
| θsa  | 20.30 | °C/w/3" |



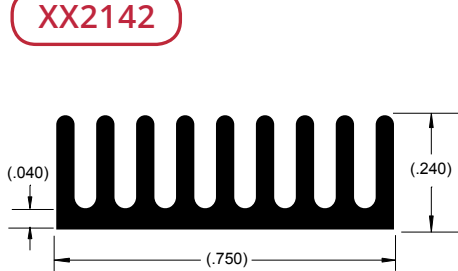
|      |       |         |
|------|-------|---------|
| Per. | 2.83  | in.     |
| WT.  | 0.07  | lb/ft   |
| θsa  | 26.00 | °C/w/3" |



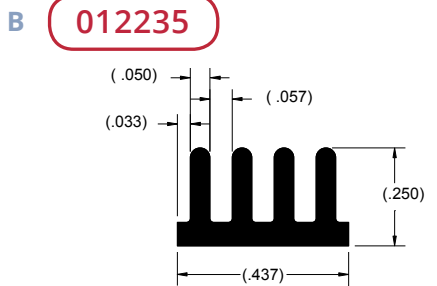
|      |       |         |
|------|-------|---------|
| Per. | 5.01  | in.     |
| WT.  | 0.13  | lb/ft   |
| θsa  | 18.00 | °C/w/3" |



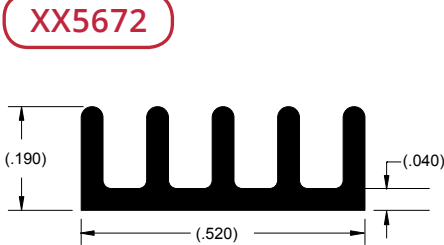
|      |      |         |
|------|------|---------|
| Per. | 3.96 | in.     |
| WT.  | 0.09 | lb/ft   |
| θsa  | 7.00 | °C/w/3" |



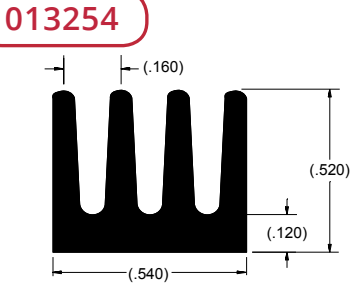
|      |      |         |
|------|------|---------|
| Per. | 4.86 | in.     |
| WT.  | 0.11 | lb/ft   |
| θsa  | 8.20 | °C/w/3" |



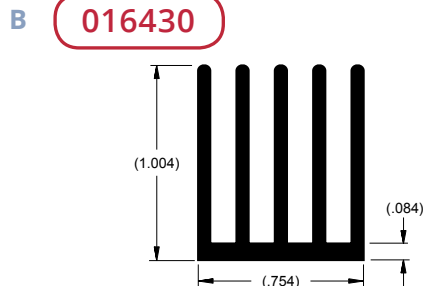
|      |       |         |
|------|-------|---------|
| Per. | 2.39  | in.     |
| WT.  | 0.07  | lb/ft   |
| θsa  | 29.16 | °C/w/3" |



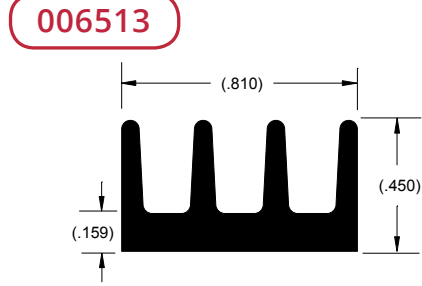
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|------|-------|---------|
| Per. | 2.48  | in.     |
| WT.  | 0.06  | lb/ft   |
| θsa  | 28.50 | °C/w/3" |



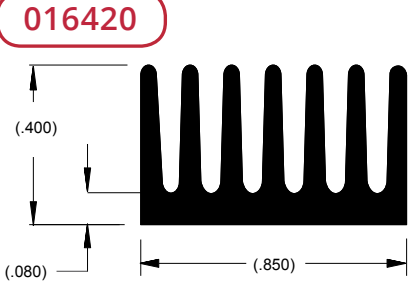
|      |       |         |
|------|-------|---------|
| Per. | 4.24  | in.     |
| WT.  | 0.21  | lb/ft   |
| θsa  | 14.00 | °C/w/3" |



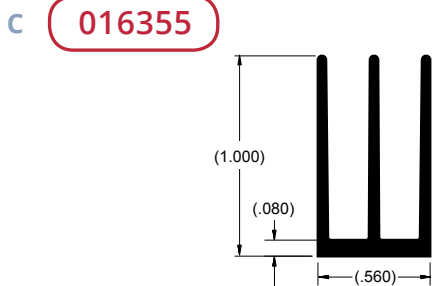
|      |       |         |
|------|-------|---------|
| Per. | 10.76 | in.     |
| WT.  | 0.37  | lb/ft   |
| θsa  | 7.90  | °C/w/3" |



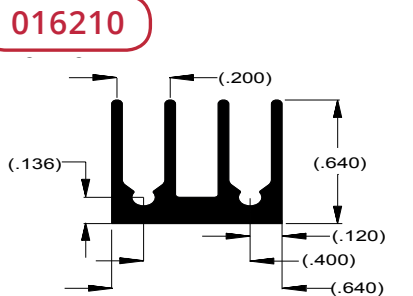
|      |       |         |
|------|-------|---------|
| Per. | 4.63  | in.     |
| WT.  | 0.24  | lb/ft   |
| θsa  | 15.10 | °C/w/3" |



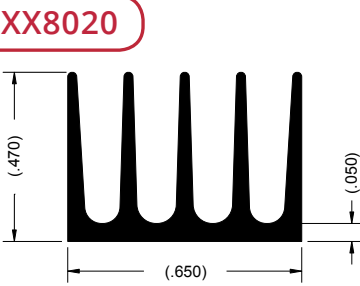
|      |       |         |
|------|-------|---------|
| Per. | 5.91  | in.     |
| WT.  | 0.24  | lb/ft   |
| θsa  | 12.50 | °C/w/3" |



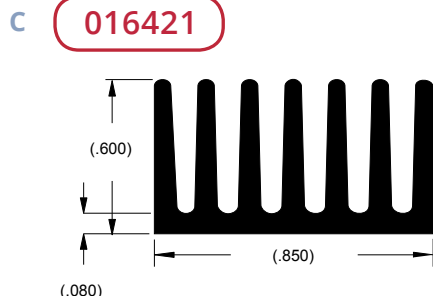
|      |      |         |
|------|------|---------|
| Per. | 6.69 | in.     |
| WT.  | 0.20 | lb/ft   |
| θsa  | 9.50 | °C/w/3" |



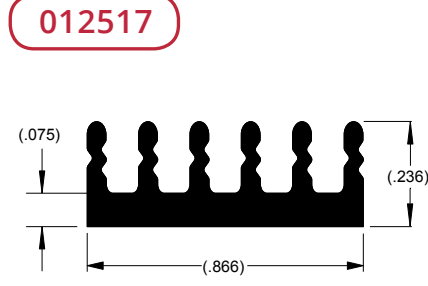
|      |       |         |
|------|-------|---------|
| Per. | 5.53  | in.     |
| WT.  | 0.20  | lb/ft   |
| θsa  | 11.10 | °C/w/3" |



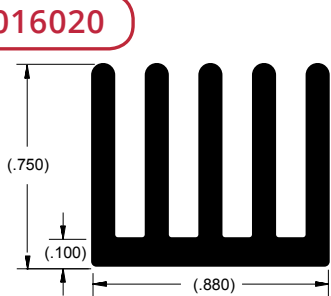
|      |       |         |
|------|-------|---------|
| Per. | 5.25  | in.     |
| WT.  | 0.14  | lb/ft   |
| θsa  | 12.00 | °C/w/3" |



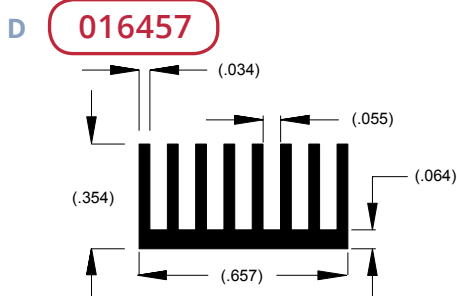
|      |      |         |
|------|------|---------|
| Per. | 8.71 | in.     |
| WT.  | 0.34 | lb/ft   |
| θsa  | 9.70 | °C/w/3" |



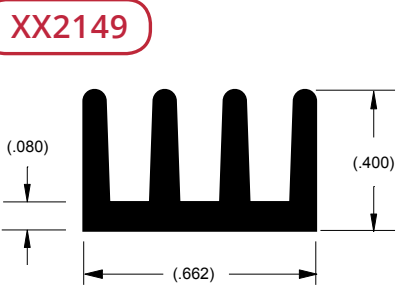
|      |       |         |
|------|-------|---------|
| Per. | 3.79  | in.     |
| WT.  | 0.13  | lb/ft   |
| θsa  | 17.10 | °C/w/3" |



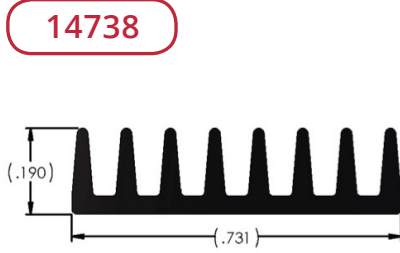
|      |      |         |
|------|------|---------|
| Per. | 8.90 | in.     |
| WT.  | 0.41 | lb/ft   |
| θsa  | 8.40 | °C/w/3" |



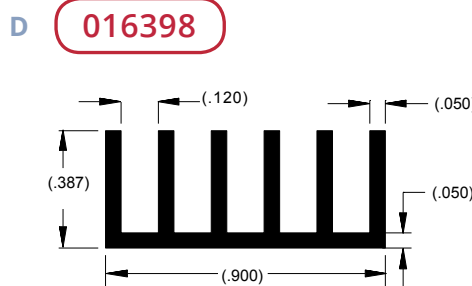
|      |       |         |
|------|-------|---------|
| Per. | 6.08  | in.     |
| WT.  | 0.15  | lb/ft   |
| θsa  | 15.80 | °C/w/3" |



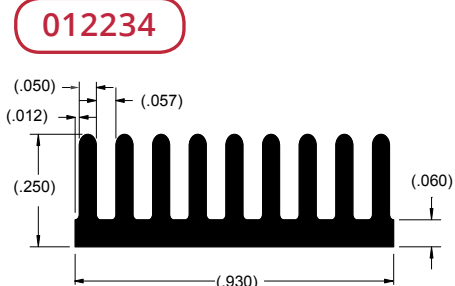
|      |      |         |
|------|------|---------|
| Per. | 3.86 | in.     |
| WT.  | 0.14 | lb/ft   |
| θsa  | 8.80 | °C/w/3" |



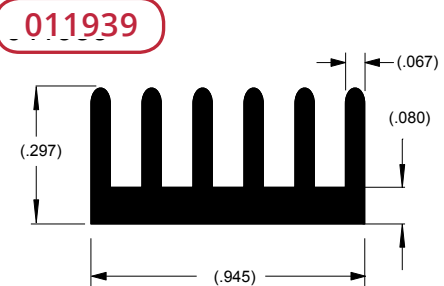
|      |       |         |
|------|-------|---------|
| Per. | 3.63  | in.     |
| WT.  | 0.08  | lb/ft   |
| θsa  | 19.29 | °C/w/3" |



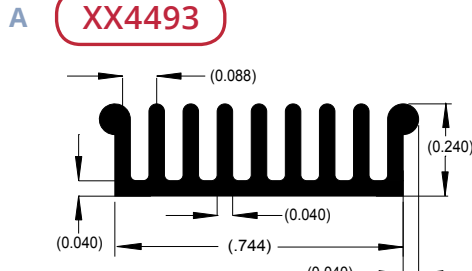
|      |       |         |
|------|-------|---------|
| Per. | 5.94  | in.     |
| WT.  | 0.18  | lb/ft   |
| θsa  | 12.30 | °C/w/3" |



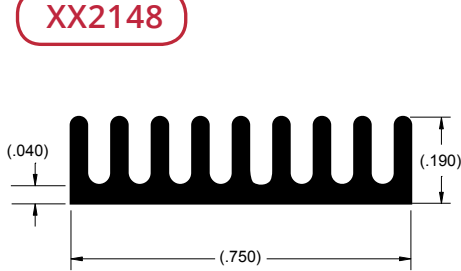
|      |       |         |
|------|-------|---------|
| Per. | 5.13  | in.     |
| WT.  | 0.16  | lb/ft   |
| θsa  | 13.64 | °C/w/3" |



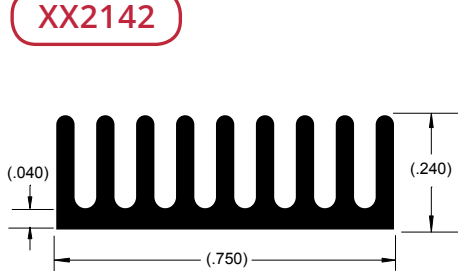
|      |       |         |
|------|-------|---------|
| Per. | 4.44  | in.     |
| WT.  | 0.19  | lb/ft   |
| θsa  | 15.60 | °C/w/3" |



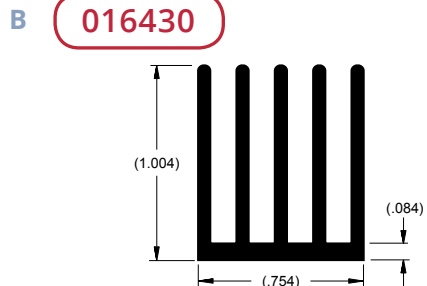
|      |       |         |
|------|-------|---------|
| Per. | 5.01  | in.     |
| WT.  | 0.13  | lb/ft   |
| θsa  | 18.00 | °C/w/3" |



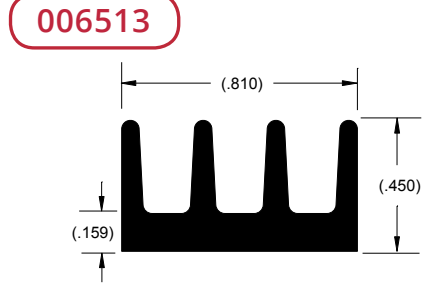
|      |      |         |
|------|------|---------|
| Per. | 3.96 | in.     |
| WT.  | 0.09 | lb/ft   |
| θsa  | 7.00 | °C/w/3" |



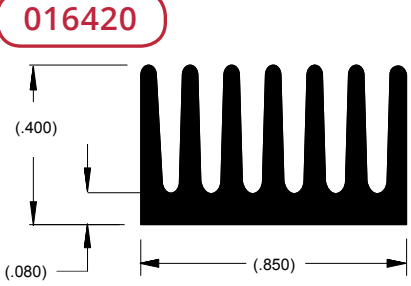
|      |      |         |
|------|------|---------|
| Per. | 4.86 | in.     |
| WT.  | 0.11 | lb/ft   |
| θsa  | 8.20 | °C/w/3" |



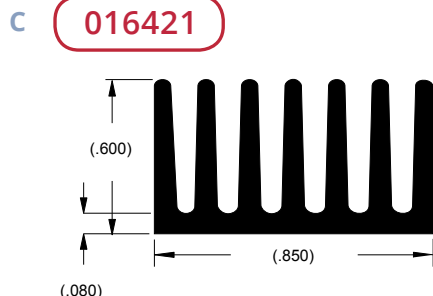
|      |       |         |
|------|-------|---------|
| Per. | 10.76 | in.     |
| WT.  | 0.37  | lb/ft   |
| θsa  | 7.90  | °C/w/3" |



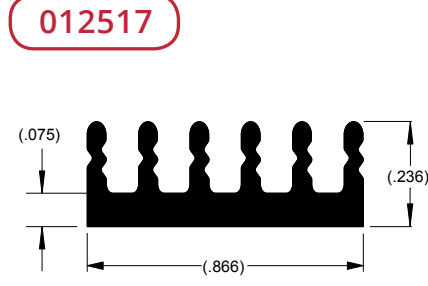
|      |       |         |
|------|-------|---------|
| Per. | 4.63  | in.     |
| WT.  | 0.24  | lb/ft   |
| θsa  | 15.10 | °C/w/3" |



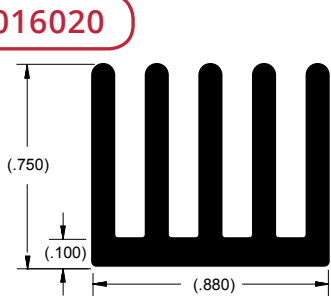
|      |       |         |
|------|-------|---------|
| Per. | 5.91  | in.     |
| WT.  | 0.24  | lb/ft   |
| θsa  | 12.50 | °C/w/3" |



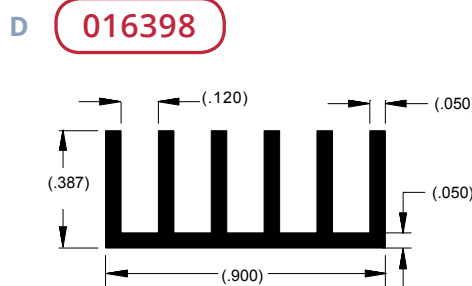
|      |      |         |
|------|------|---------|
| Per. | 8.71 | in.     |
| WT.  | 0.34 | lb/ft   |
| θsa  | 9.70 | °C/w/3" |



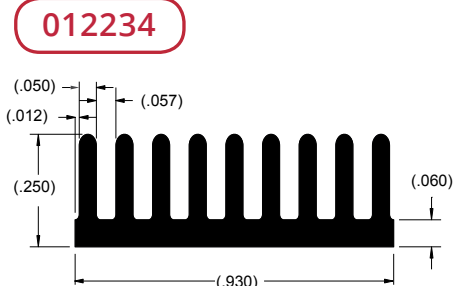
|      |       |         |
|------|-------|---------|
| Per. | 3.79  | in.     |
| WT.  | 0.13  | lb/ft   |
| θsa  | 17.10 | °C/w/3" |



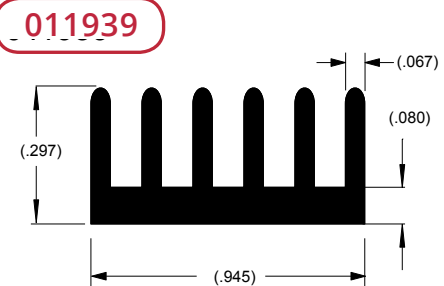
|      |      |         |
|------|------|---------|
| Per. | 8.90 | in.     |
| WT.  | 0.41 | lb/ft   |
| θsa  | 8.40 | °C/w/3" |



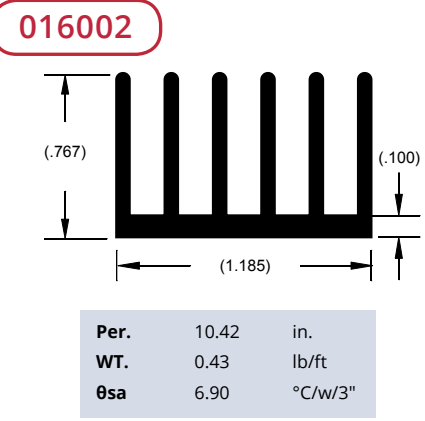
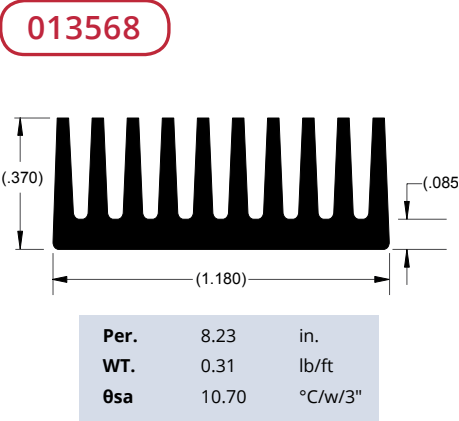
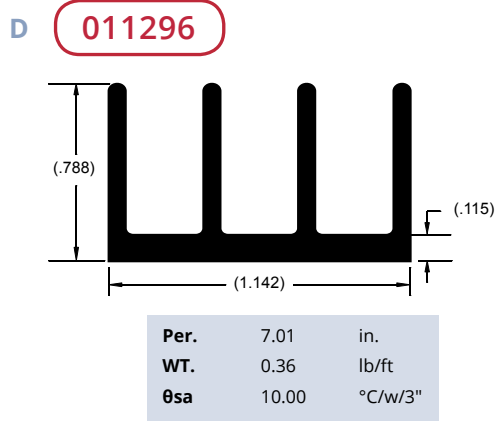
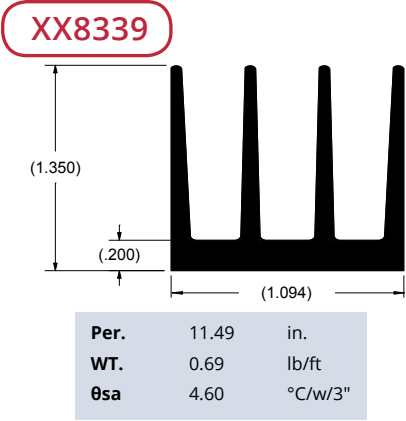
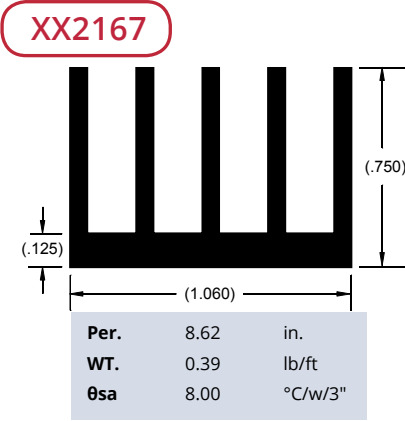
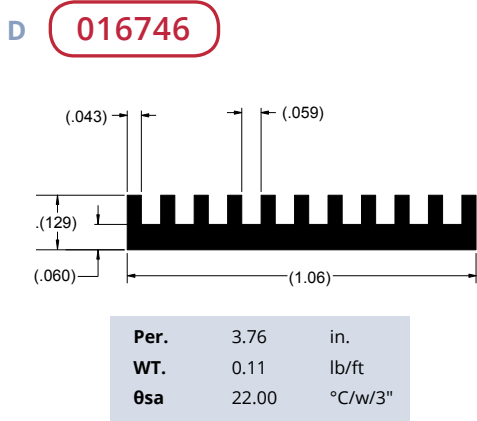
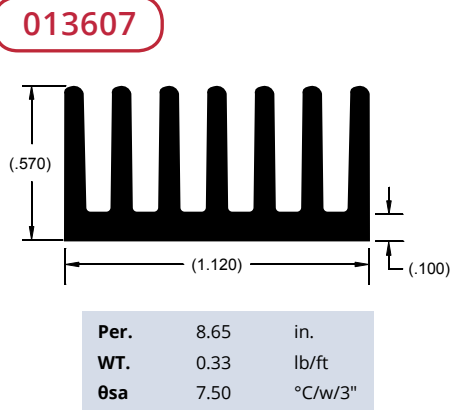
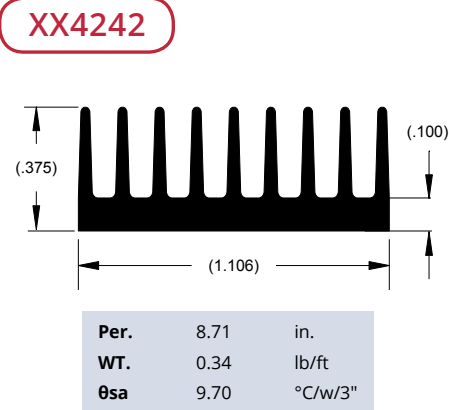
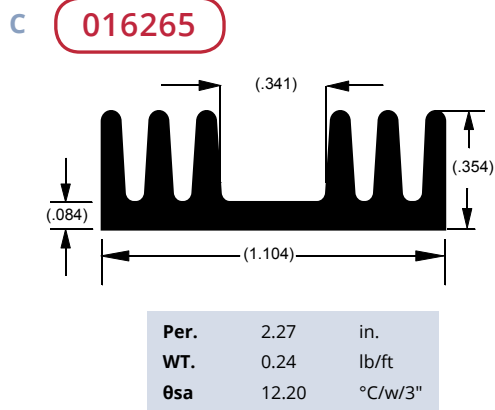
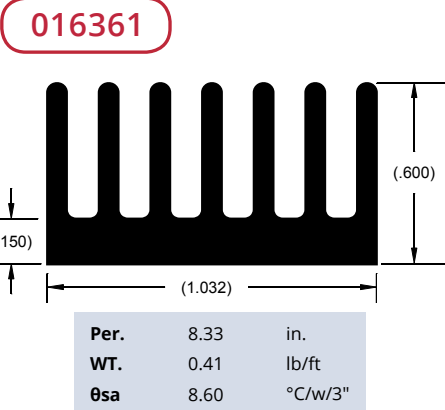
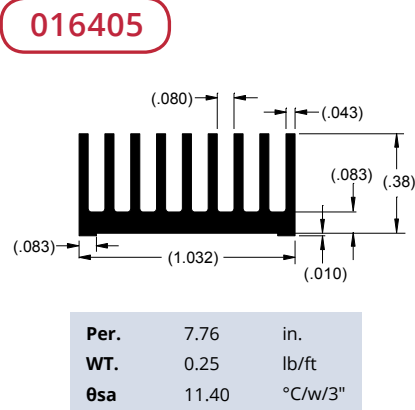
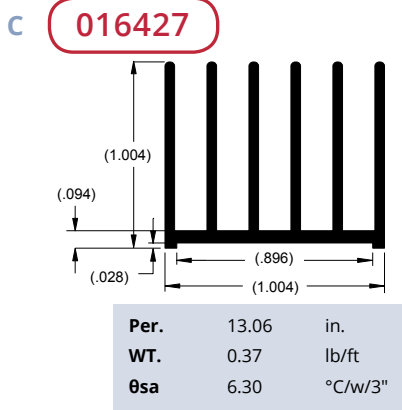
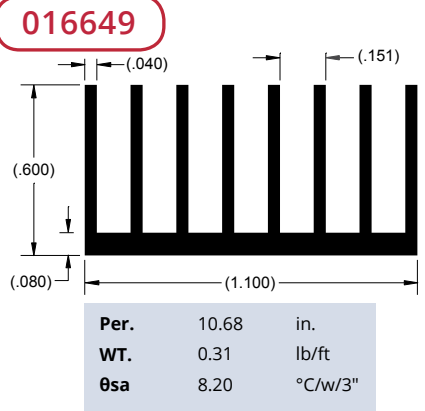
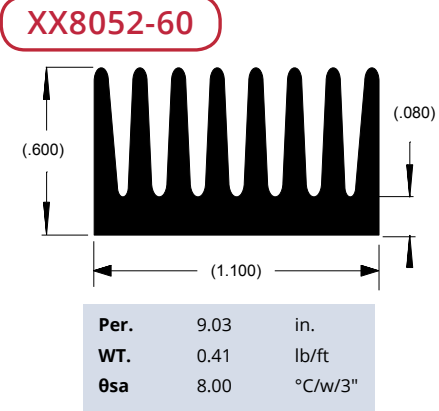
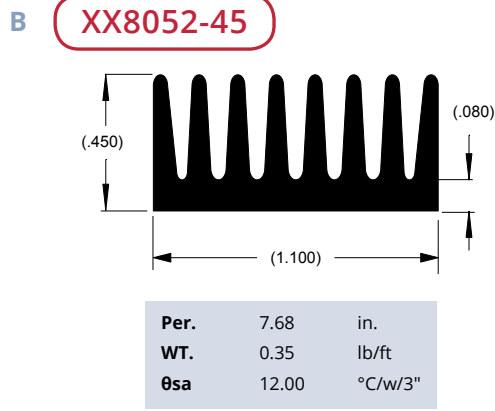
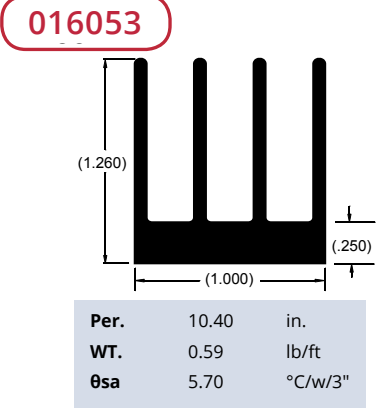
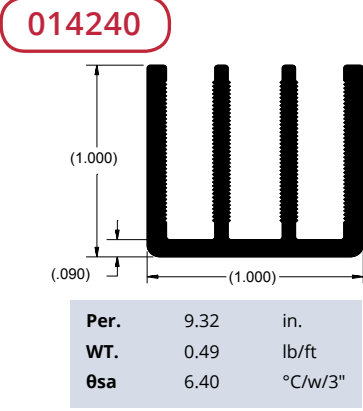
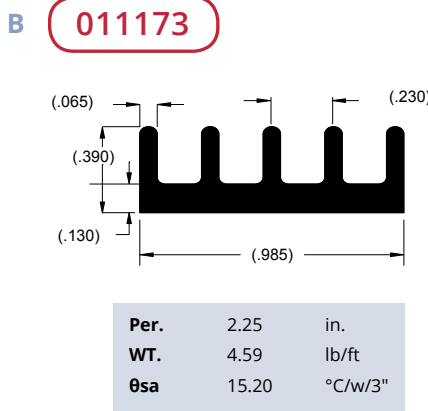
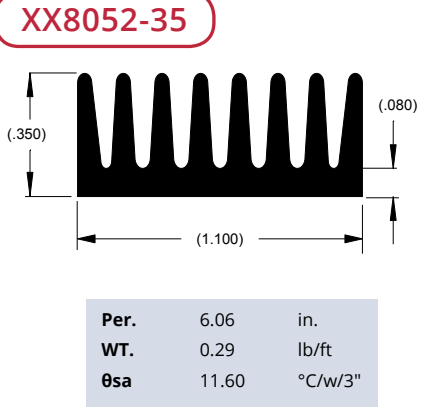
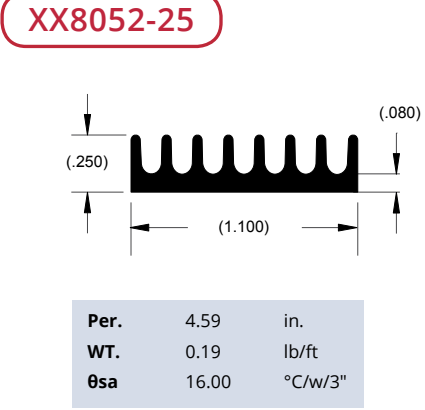
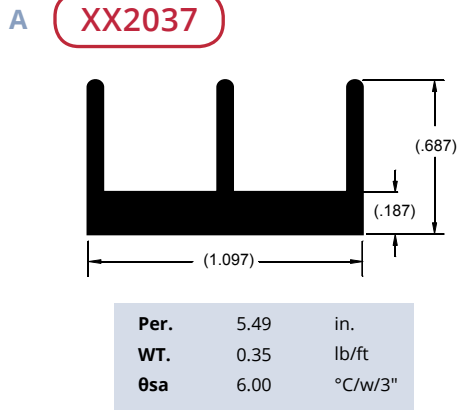
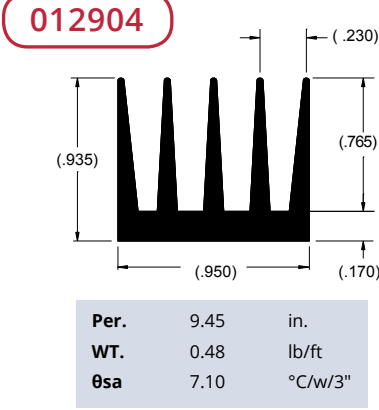
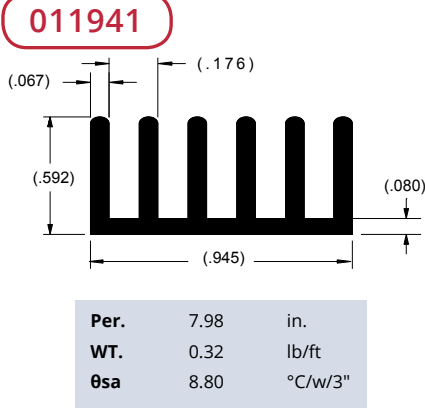
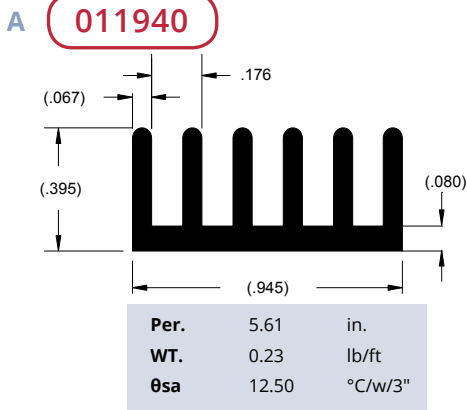
|      |       |         |
|------|-------|---------|
| Per. | 5.94  | in.     |
| WT.  | 0.18  | lb/ft   |
| θsa  | 12.30 | °C/w/3" |



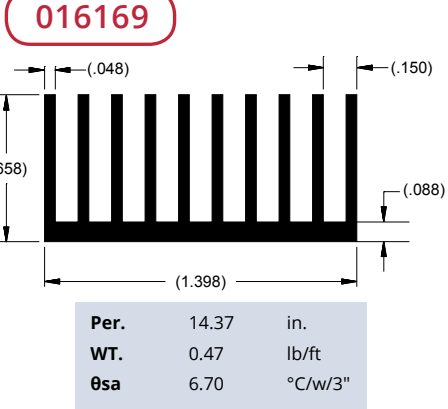
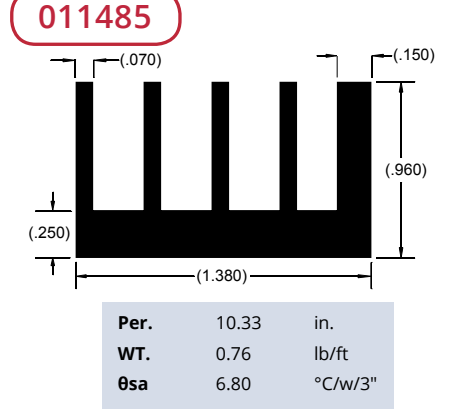
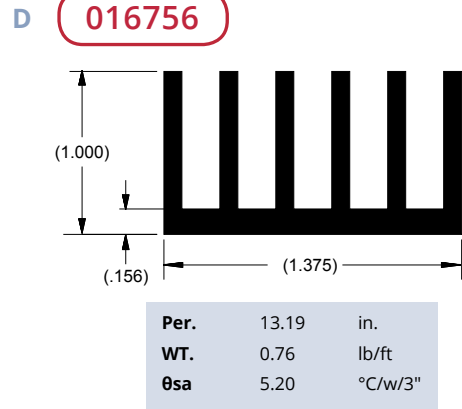
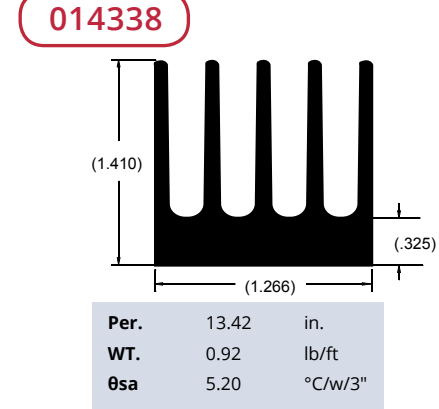
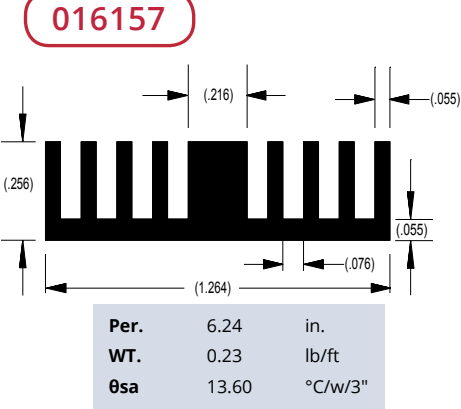
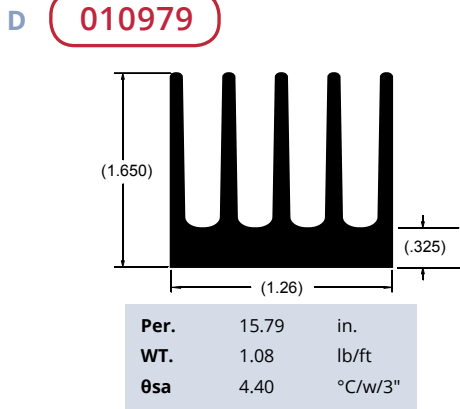
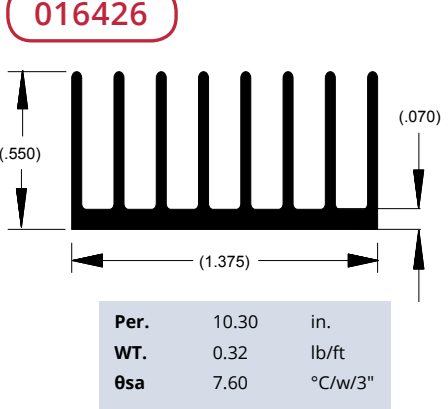
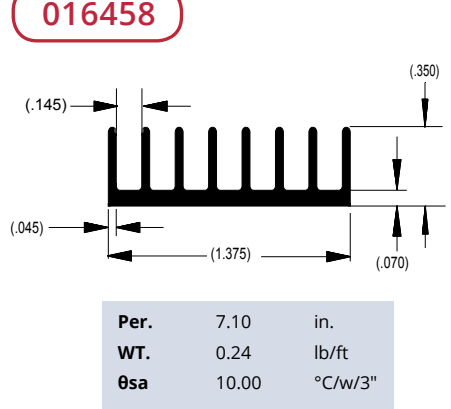
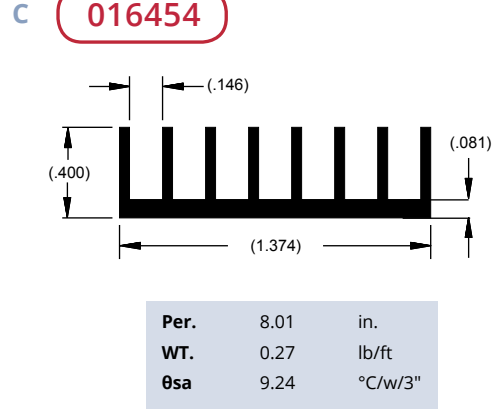
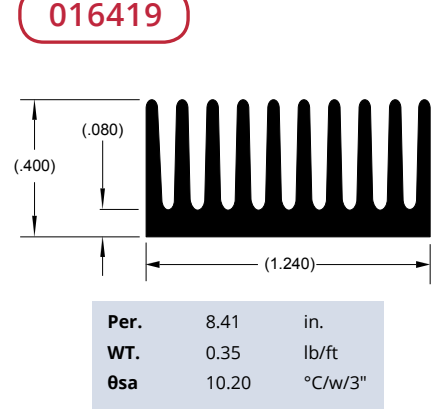
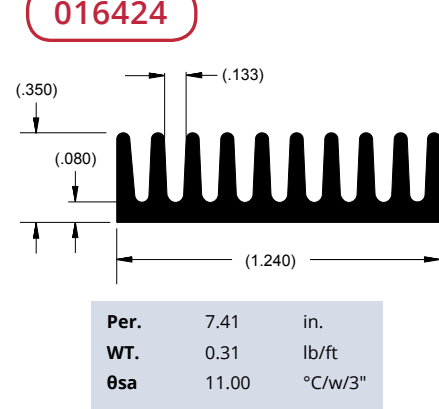
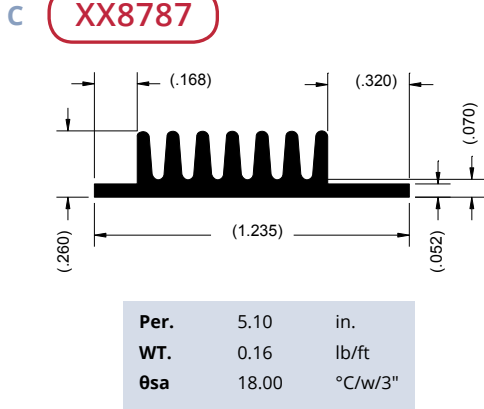
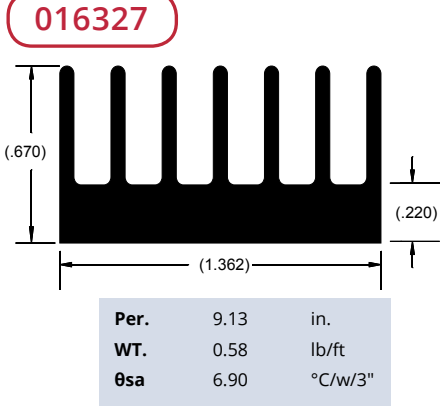
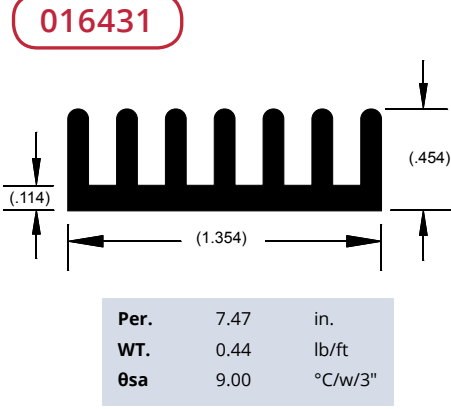
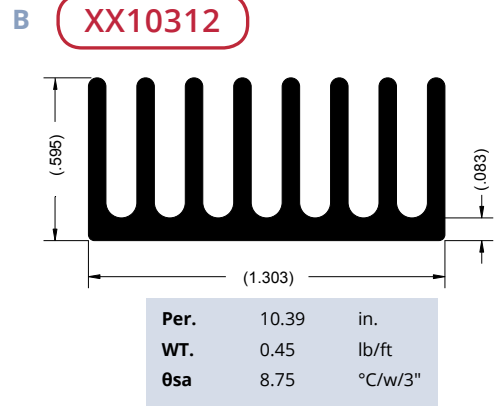
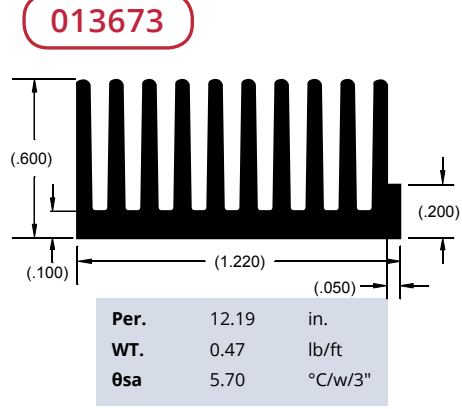
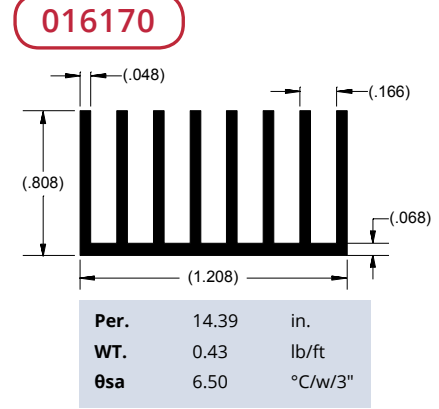
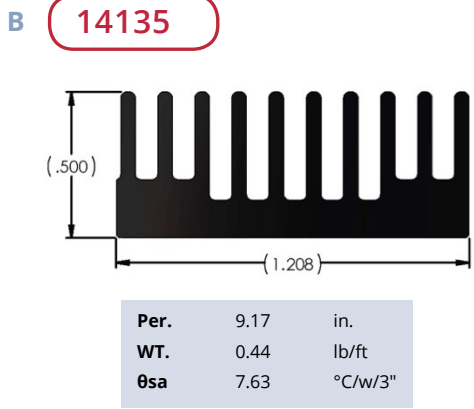
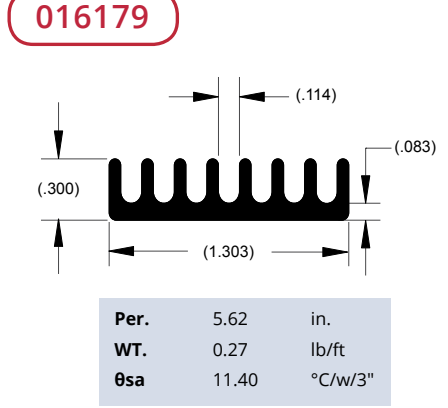
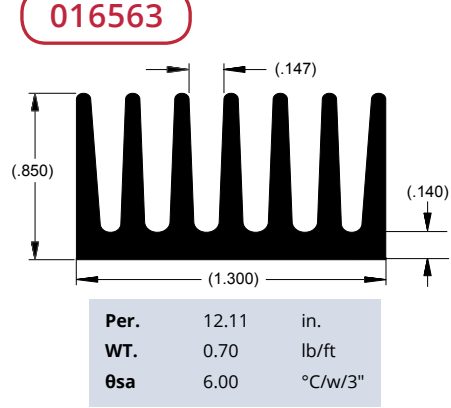
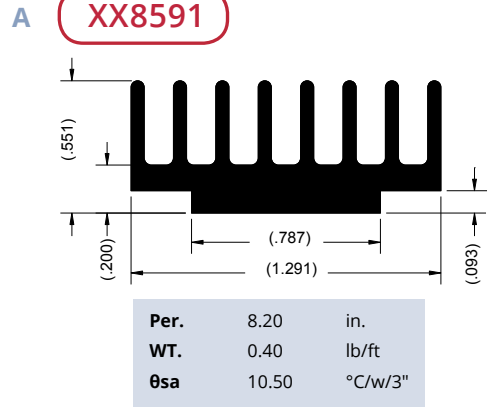
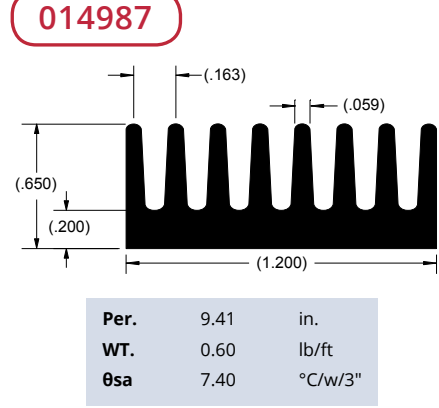
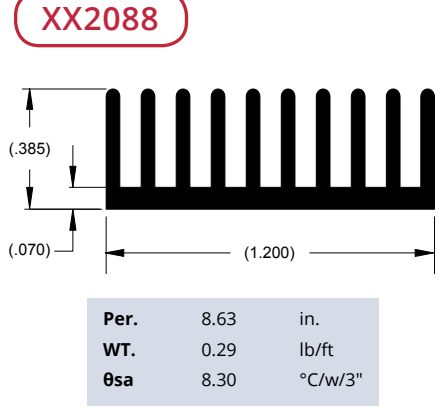
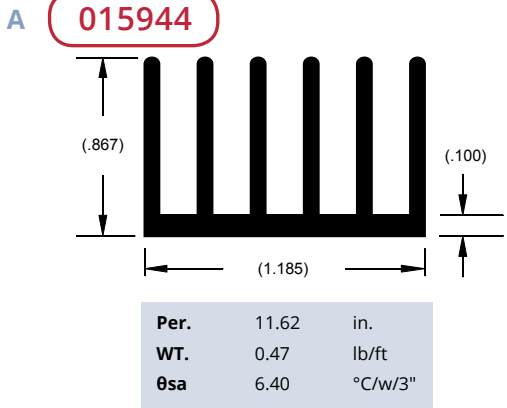
|      |       |         |
|------|-------|---------|
| Per. | 5.13  | in.     |
| WT.  | 0.16  | lb/ft   |
| θsa  | 13.64 | °C/w/3" |

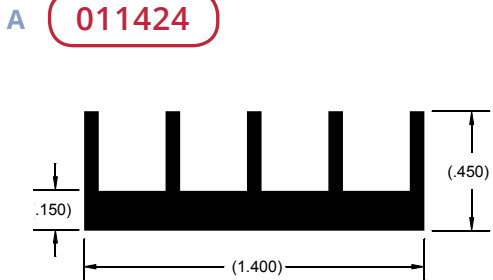


|      |       |         |
|------|-------|---------|
| Per. | 4.44  | in.     |
| WT.  | 0.19  | lb/ft   |
| θsa  | 15.60 | °C/w/3" |

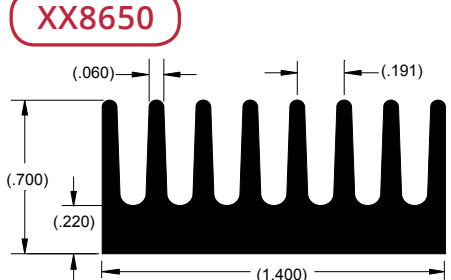




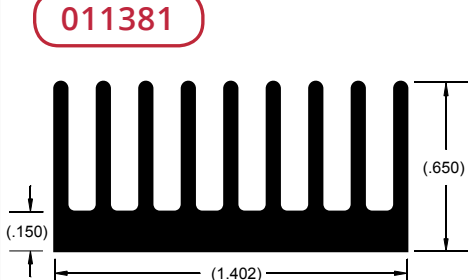




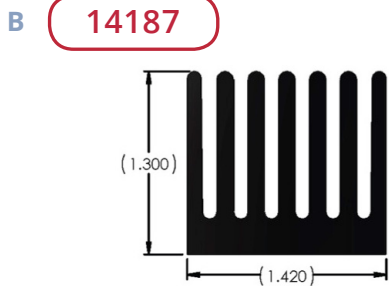
|      |       |         |
|------|-------|---------|
| Per. | 6.07  | in.     |
| WT.  | 0.35  | lb/ft   |
| θsa  | 11.50 | °C/w/3" |



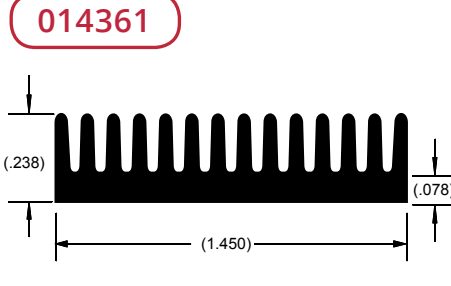
|      |       |         |
|------|-------|---------|
| Per. | 10.22 | in.     |
| WT.  | 0.70  | lb/ft   |
| θsa  | 8.80  | °C/w/3" |



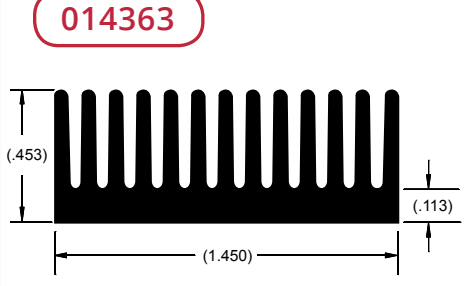
|      |       |         |
|------|-------|---------|
| Per. | 11.23 | in.     |
| WT.  | 0.52  | lb/ft   |
| θsa  | 6.20  | °C/w/3" |



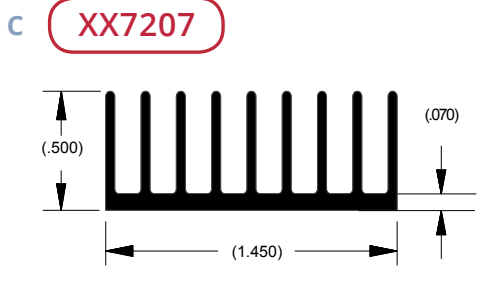
|      |       |         |
|------|-------|---------|
| Per. | 17.42 | in.     |
| WT.  | 1.44  | lb/ft   |
| θsa  | 4.01  | °C/w/3" |



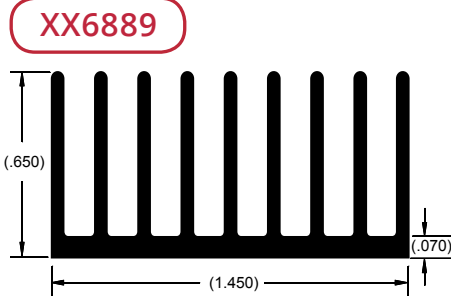
|      |       |         |
|------|-------|---------|
| Per. | 6.89  | in.     |
| WT.  | 0.25  | lb/ft   |
| θsa  | 10.20 | °C/w/3" |



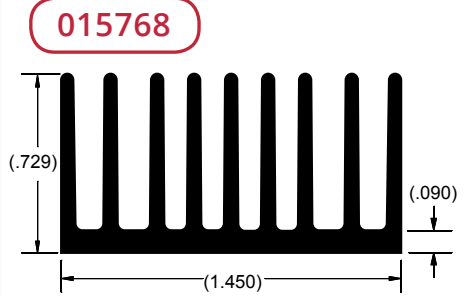
|      |       |         |
|------|-------|---------|
| Per. | 11.27 | in.     |
| WT.  | 0.47  | lb/ft   |
| θsa  | 6.20  | °C/w/3" |



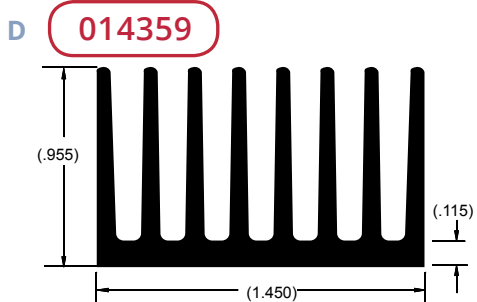
|      |       |         |
|------|-------|---------|
| Per. | 10.78 | in.     |
| WT.  | 0.33  | lb/ft   |
| θsa  | 7.00  | °C/w/3" |



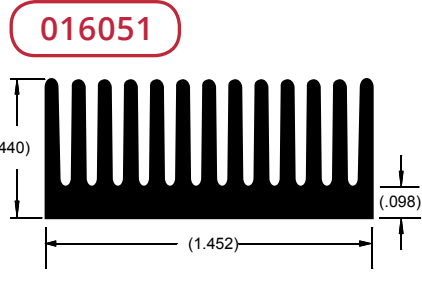
|      |       |         |
|------|-------|---------|
| Per. | 13.20 | in.     |
| WT.  | 0.40  | lb/ft   |
| θsa  | 6.20  | °C/w/3" |



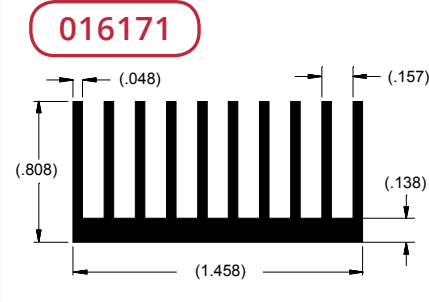
|      |       |         |
|------|-------|---------|
| Per. | 14.12 | in.     |
| WT.  | 0.54  | lb/ft   |
| θsa  | 6.20  | °C/w/3" |



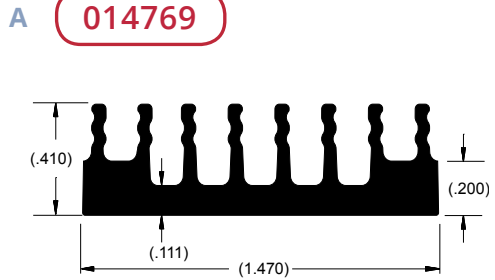
|      |       |         |
|------|-------|---------|
| Per. | 15.97 | in.     |
| WT.  | 0.70  | lb/ft   |
| θsa  | 4.40  | °C/w/3" |



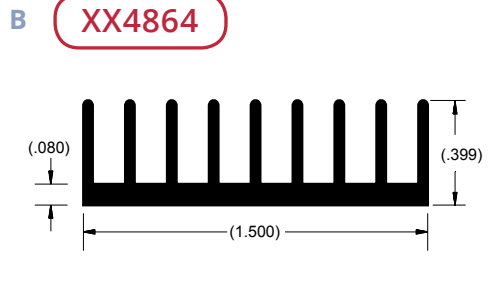
|      |       |         |
|------|-------|---------|
| Per. | 11.25 | in.     |
| WT.  | 0.47  | lb/ft   |
| θsa  | 9.40  | °C/w/3" |



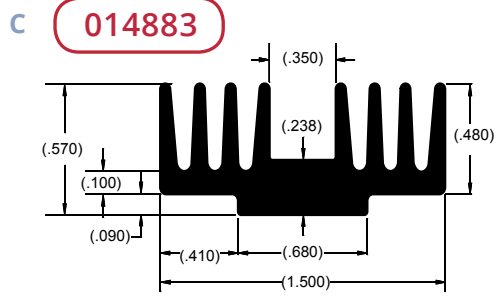
|      |       |         |
|------|-------|---------|
| Per. | 16.56 | in.     |
| WT.  | 0.63  | lb/ft   |
| θsa  | 5.70  | °C/w/3" |



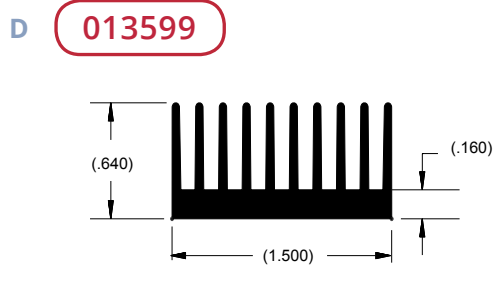
|      |      |         |
|------|------|---------|
| Per. | 7.44 | in.     |
| WT.  | 0.39 | lb/ft   |
| θsa  | 8.80 | °C/w/3" |



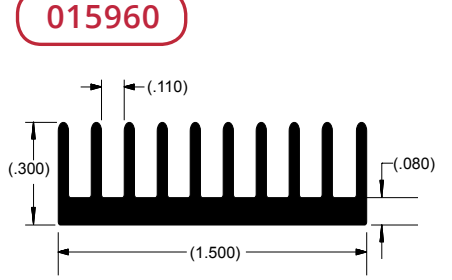
|      |      |         |
|------|------|---------|
| Per. | 8.47 | in.     |
| WT.  | 0.28 | lb/ft   |
| θsa  | 9.60 | °C/w/3" |



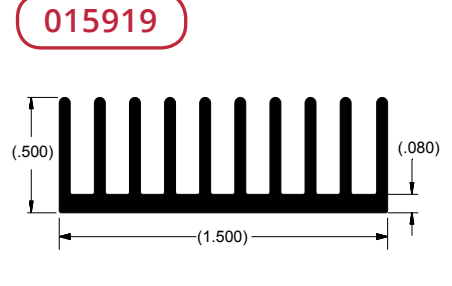
|      |      |         |
|------|------|---------|
| Per. | 8.65 | in.     |
| WT.  | 0.51 | lb/ft   |
| θsa  | 8.10 | °C/w/3" |



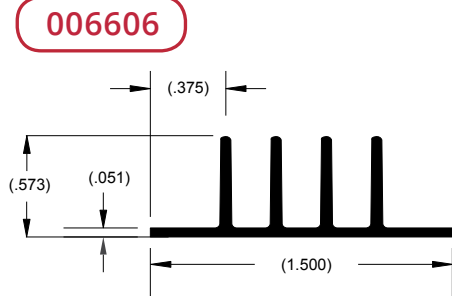
|      |       |         |
|------|-------|---------|
| Per. | 12.72 | in.     |
| WT.  | 6.07  | lb/ft   |
| θsa  | 6.80  | °C/w/3" |



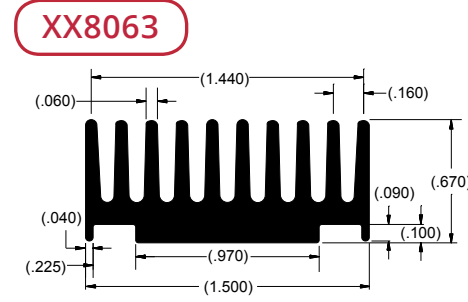
|      |       |         |
|------|-------|---------|
| Per. | 7.35  | in.     |
| WT.  | 0.27  | lb/ft   |
| θsa  | 10.50 | °C/w/3" |



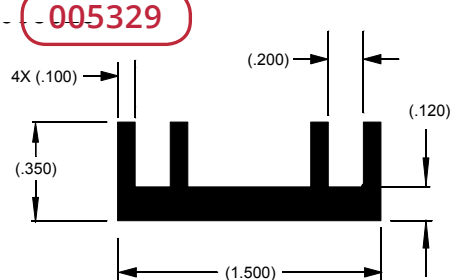
|      |       |         |
|------|-------|---------|
| Per. | 11.35 | in.     |
| WT.  | 0.39  | lb/ft   |
| θsa  | 7.70  | °C/w/3" |



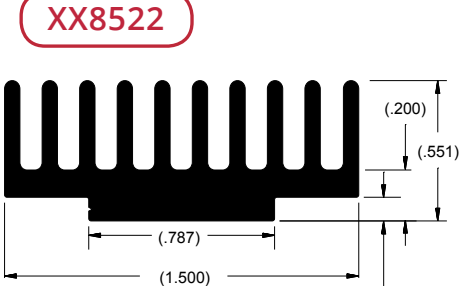
|      |      |         |
|------|------|---------|
| Per. | 7.07 | in.     |
| WT.  | 0.23 | lb/ft   |
| θsa  | 9.60 | °C/w/3" |



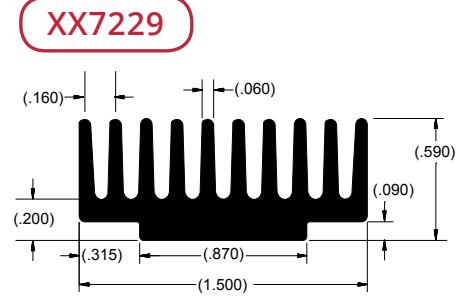
|      |       |         |
|------|-------|---------|
| Per. | 11.97 | in.     |
| WT.  | 0.72  | lb/ft   |
| θsa  | 6.00  | °C/w/3" |



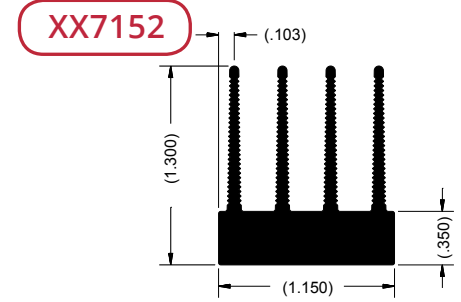
|      |       |         |
|------|-------|---------|
| Per. | 5.54  | in.     |
| WT.  | 0.33  | lb/ft   |
| θsa  | 12.70 | °C/w/3" |



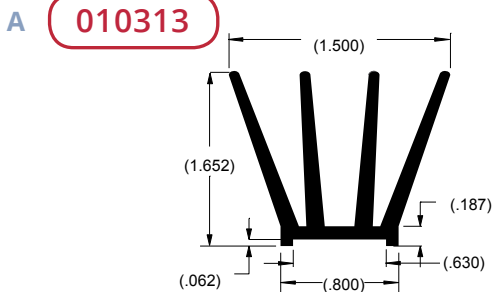
|      |      |         |
|------|------|---------|
| Per. | 9.88 | in.     |
| WT.  | 0.55 | lb/ft   |
| θsa  | 9.80 | °C/w/3" |



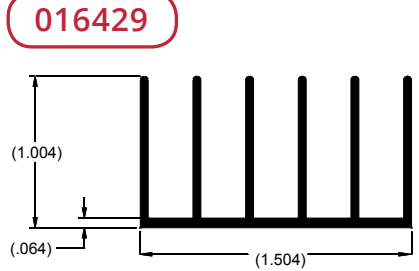
|      |       |         |
|------|-------|---------|
| Per. | 10.40 | in.     |
| WT.  | 0.61  | lb/ft   |
| θsa  | 7.00  | °C/w/3" |



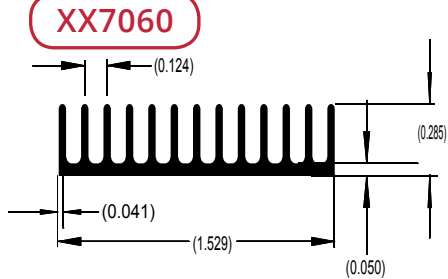
|      |       |         |
|------|-------|---------|
| Per. | 12.50 | in.     |
| WT.  | 0.75  | lb/ft   |
| θsa  | 5.00  | °C/w/3" |



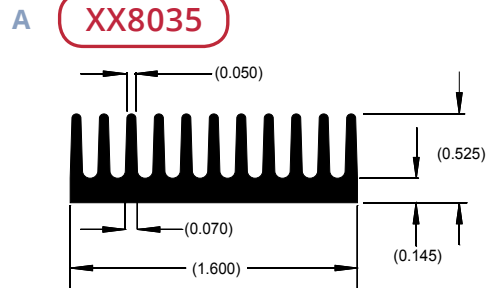
|      |       |         |
|------|-------|---------|
| Per. | 14.75 | in.     |
| WT.  | 0.84  | lb/ft   |
| θsa  | 4.70  | °C/w/3" |



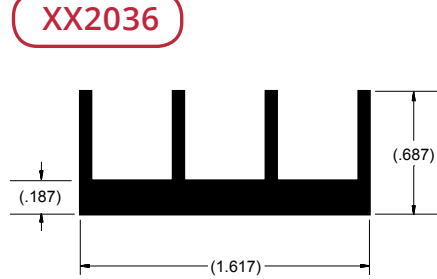
|      |        |         |
|------|--------|---------|
| Per. | 14.303 | in.     |
| WT.  | 0.412  | lb/ft   |
| θsa  | 4.90   | °C/w/3" |



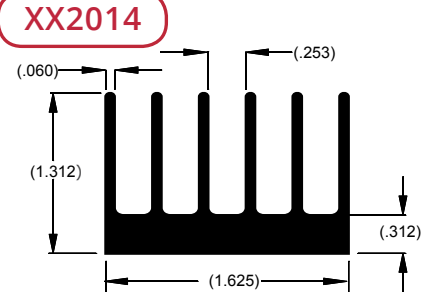
|      |       |         |
|------|-------|---------|
| Per. | 12.72 | in.     |
| WT.  | 0.61  | lb/ft   |
| θsa  | 14.00 | °C/w/3" |



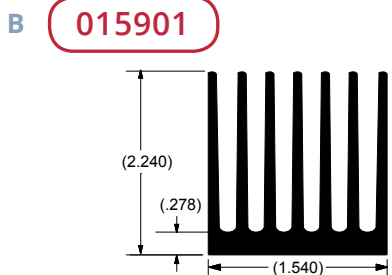
|      |       |         |
|------|-------|---------|
| Per. | 11.05 | in.     |
| WT.  | 0.58  | lb/ft   |
| θsa  | 7.00  | °C/w/3" |



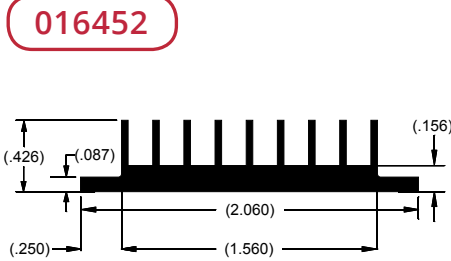
|      |      |         |
|------|------|---------|
| Per. | 7.58 | in.     |
| WT.  | 0.51 | lb/ft   |
| θsa  | 4.90 | °C/w/3" |



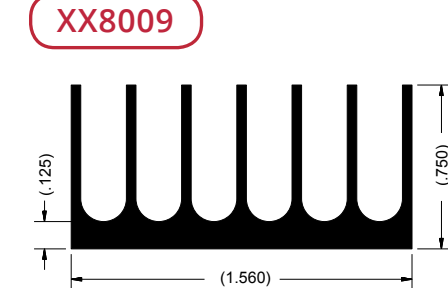
|      |       |         |
|------|-------|---------|
| Per. | 15.45 | in.     |
| WT.  | 1.05  | lb/ft   |
| θsa  | 3.20  | °C/w/3" |



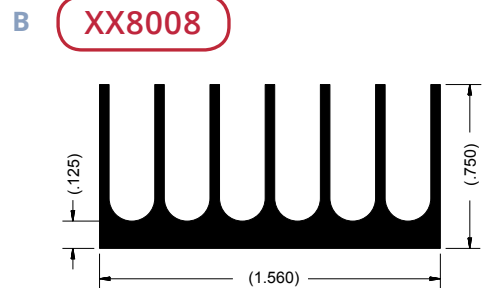
|      |       |         |
|------|-------|---------|
| Per. | 30.32 | in.     |
| WT.  | 1.93  | lb/ft   |
| θsa  | 3.30  | °C/w/3" |



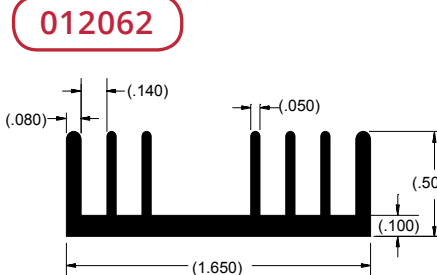
|      |      |         |
|------|------|---------|
| Per. | 9.29 | in.     |
| WT.  | 0.46 | lb/ft   |
| θsa  | 8.10 | °C/w/3" |



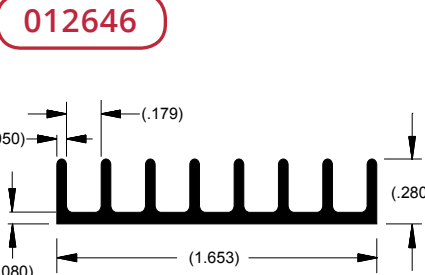
|      |      |         |
|------|------|---------|
| Per. | 9.00 | in.     |
| WT.  | 0.53 | lb/ft   |
| θsa  | 5.50 | °C/w/3" |



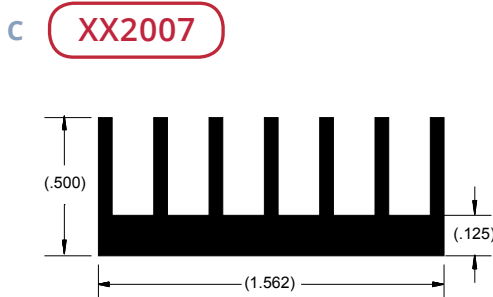
|      |      |         |
|------|------|---------|
| Per. | 9.00 | in.     |
| WT.  | 0.53 | lb/ft   |
| θsa  | 5.50 | °C/w/3" |



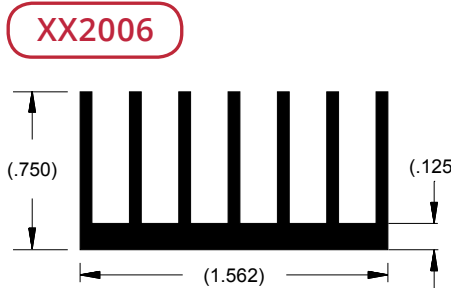
|      |      |         |
|------|------|---------|
| Per. | 8.92 | in.     |
| WT.  | 0.39 | lb/ft   |
| θsa  | 7.80 | °C/w/3" |



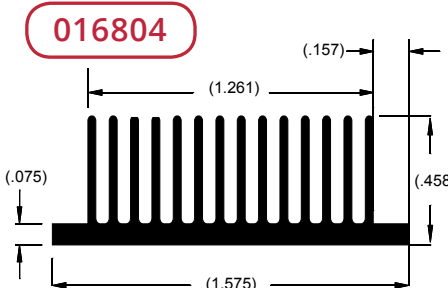
|      |       |         |
|------|-------|---------|
| Per. | 6.73  | in.     |
| WT.  | 0.20  | lb/ft   |
| θsa  | 10.40 | °C/w/3" |



|      |      |         |
|------|------|---------|
| Per. | 8.62 | in.     |
| WT.  | 0.43 | lb/ft   |
| θsa  | 8.00 | °C/w/3" |



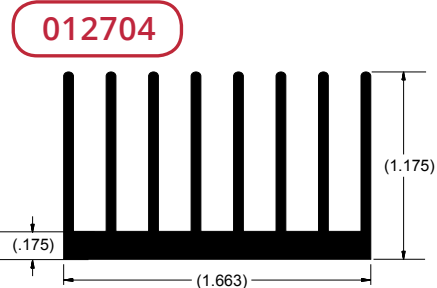
|      |       |         |
|------|-------|---------|
| Per. | 12.12 | in.     |
| WT.  | 0.57  | lb/ft   |
| θsa  | 5.40  | °C/w/3" |



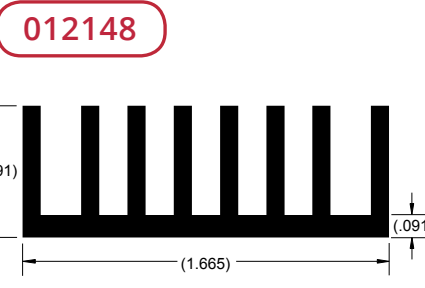
|      |       |         |
|------|-------|---------|
| Per. | 13.59 | in.     |
| WT.  | 0.36  | lb/ft   |
| θsa  | 9.80  | °C/w/3" |



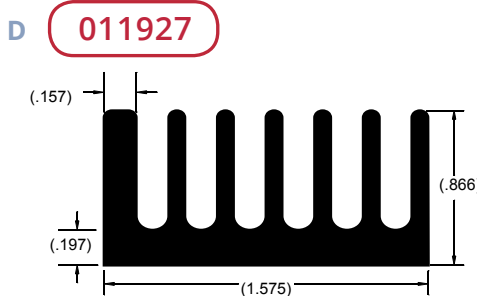
|      |       |         |
|------|-------|---------|
| Per. | 18.15 | in.     |
| WT.  | 1.03  | lb/ft   |
| θsa  | 4.90  | °C/w/3" |



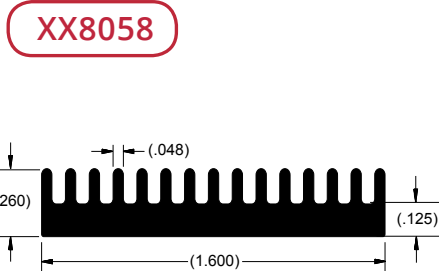
|      |       |         |
|------|-------|---------|
| Per. | 19.43 | in.     |
| WT.  | 0.83  | lb/ft   |
| θsa  | 3.60  | °C/w/3" |



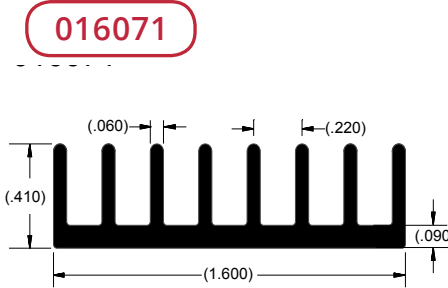
|      |       |         |
|------|-------|---------|
| Per. | 11.45 | in.     |
| WT.  | 0.51  | lb/ft   |
| θsa  | 6.10  | °C/w/3" |



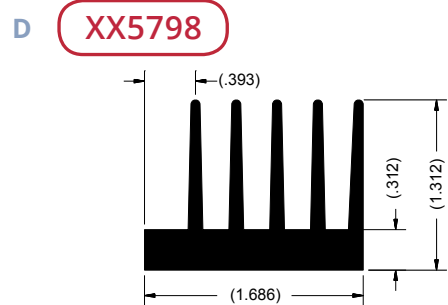
|      |       |         |
|------|-------|---------|
| Per. | 12.27 | in.     |
| WT.  | 0.87  | lb/ft   |
| θsa  | 5.70  | °C/w/3" |



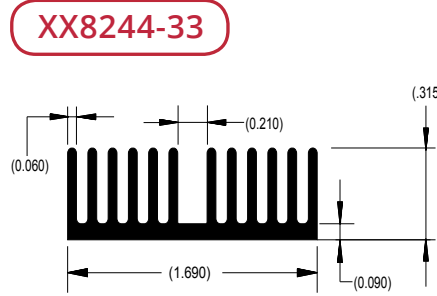
|      |       |         |
|------|-------|---------|
| Per. | 7.00  | in.     |
| WT.  | 0.34  | lb/ft   |
| θsa  | 14.00 | °C/w/3" |



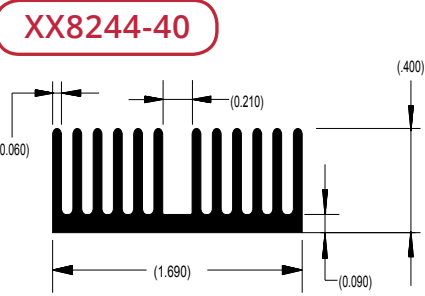
|      |      |         |
|------|------|---------|
| Per. | 8.20 | in.     |
| WT.  | 0.36 | lb/ft   |
| θsa  | 8.30 | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 13.66 | in.     |
| WT.  | 1.04  | lb/ft   |
| θsa  | 5.30  | °C/w/3" |

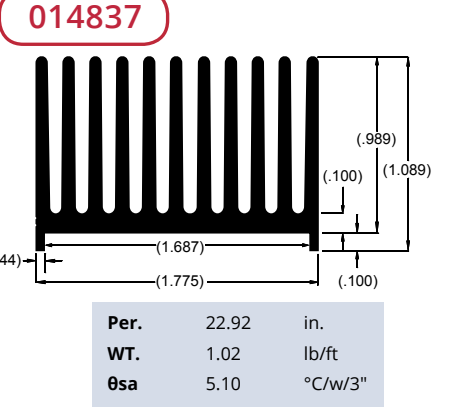
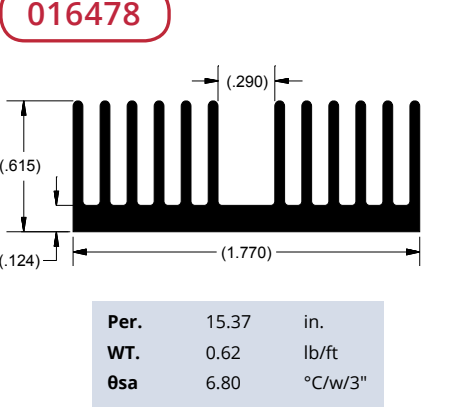
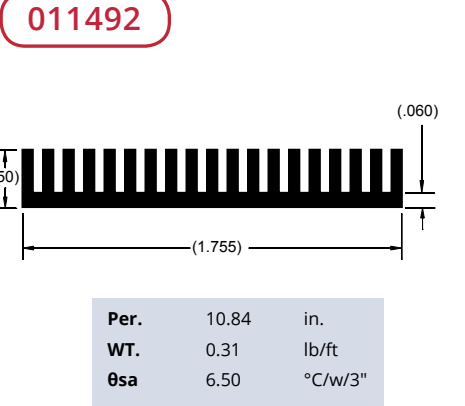
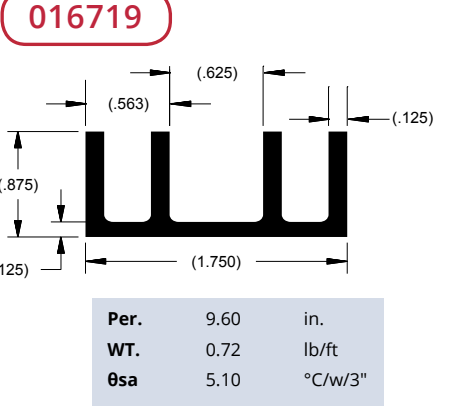
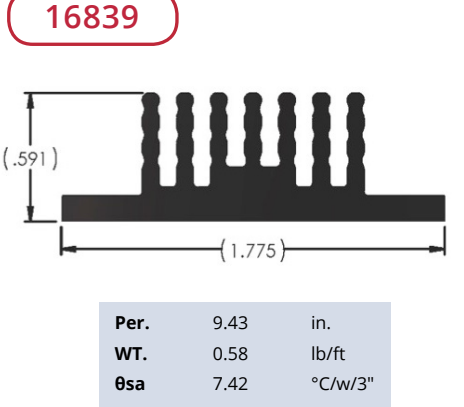
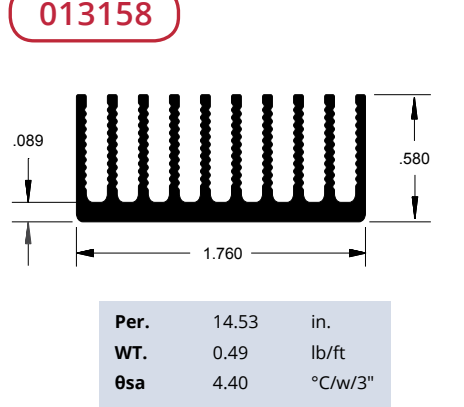
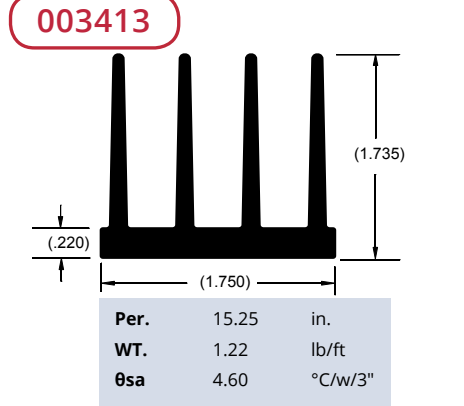
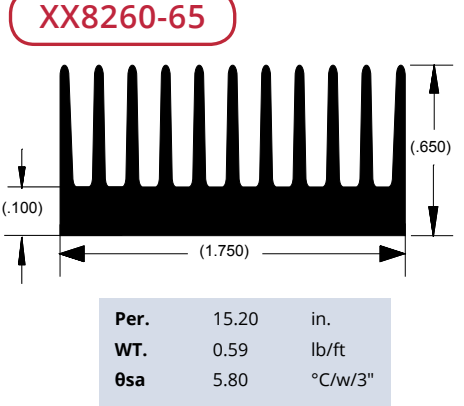
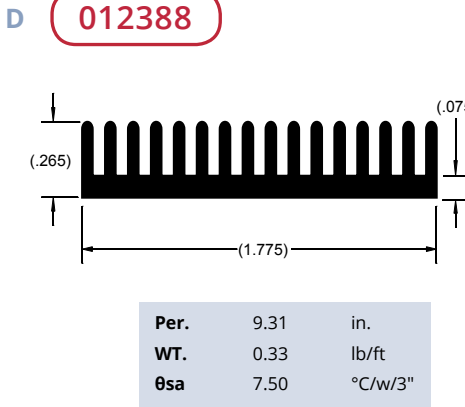
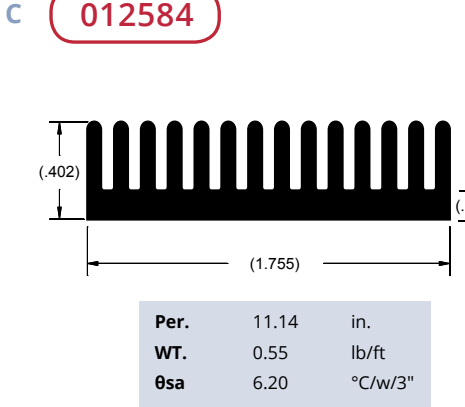
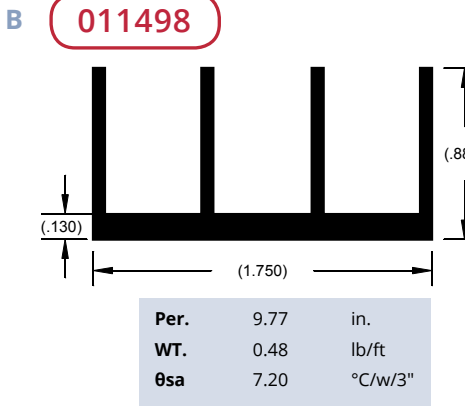
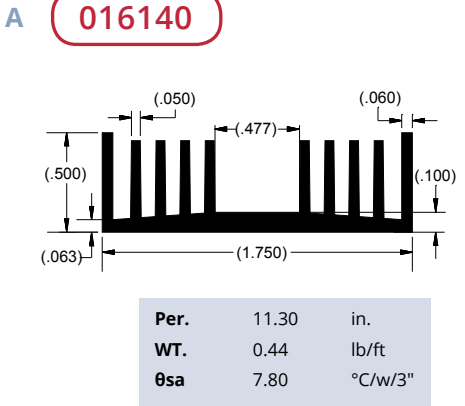
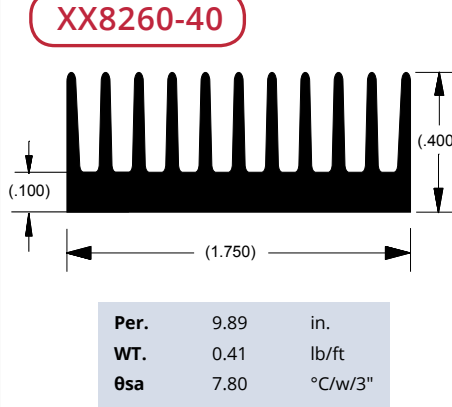
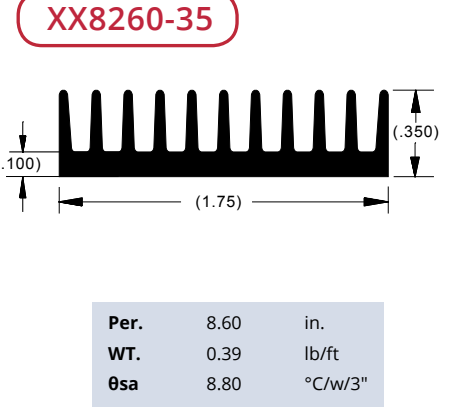
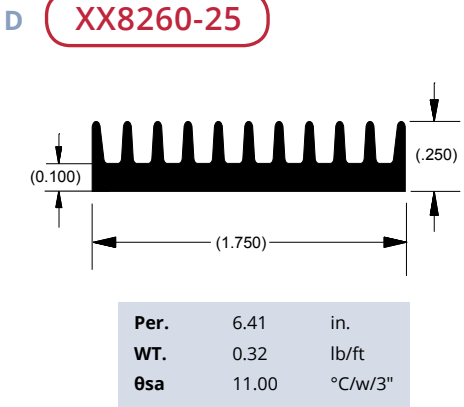
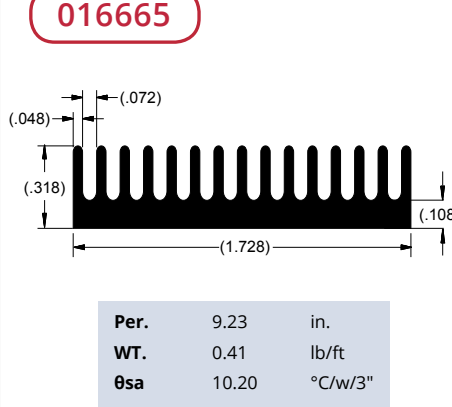
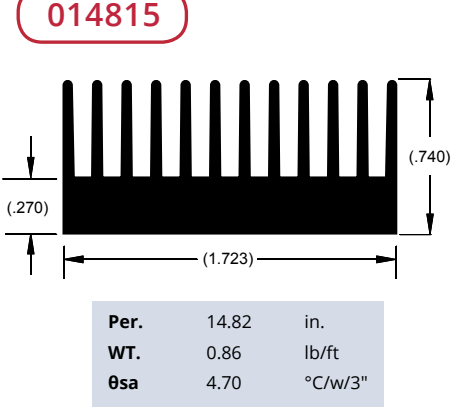
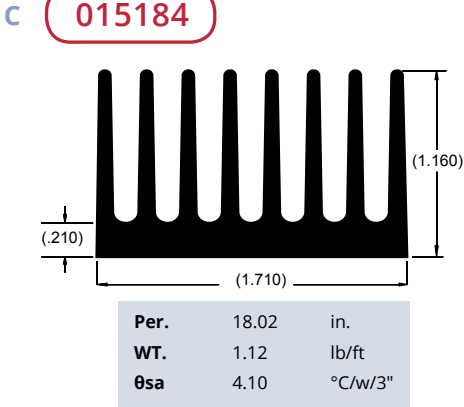
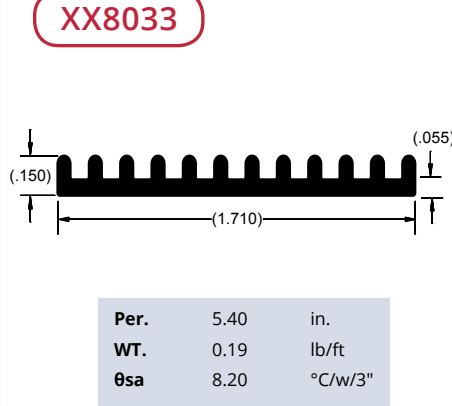
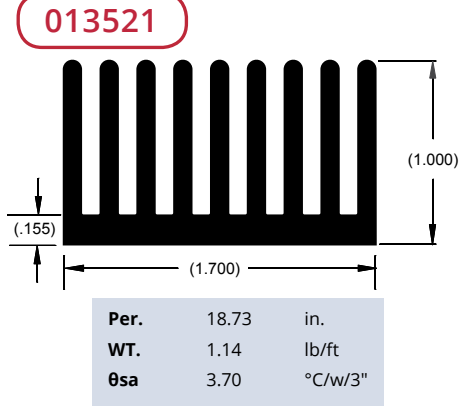
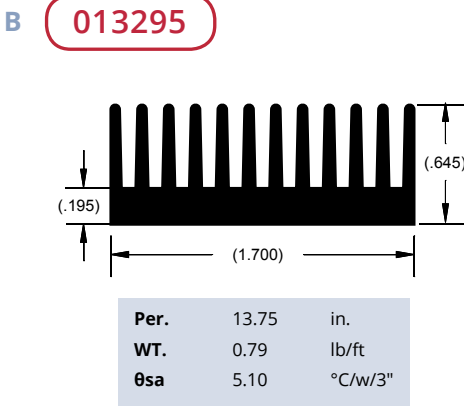
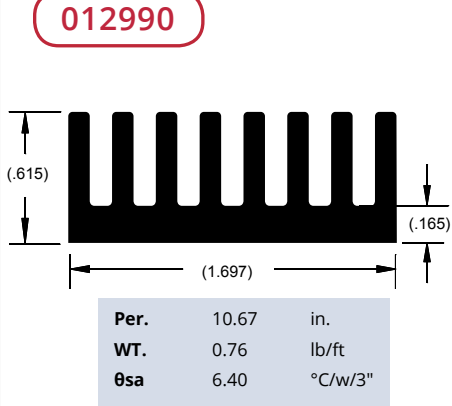
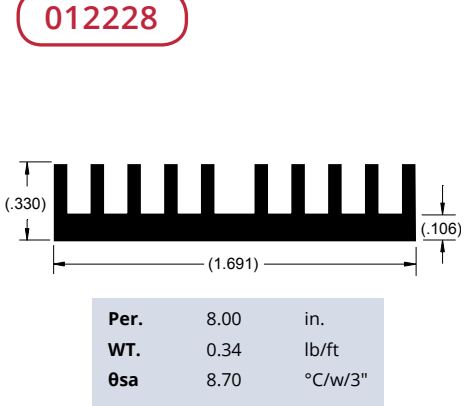
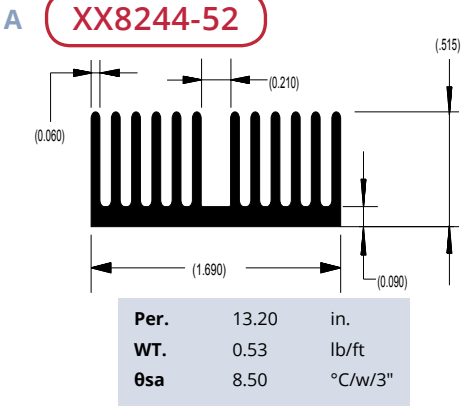


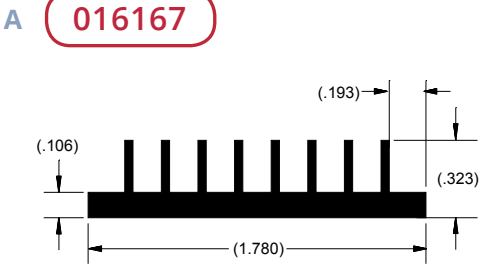
|      |       |         |
|------|-------|---------|
| Per. | 8.40  | in.     |
| WT.  | 0.37  | lb/ft   |
| θsa  | 10.00 | °C/w/3" |



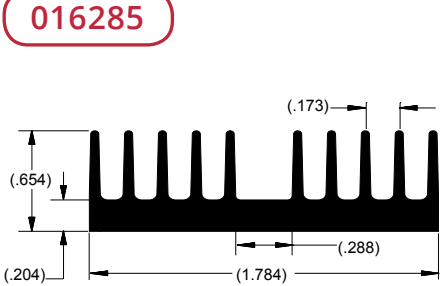
|      |       |         |
|------|-------|---------|
| Per. | 10.40 | in.     |
| WT.  | 0.45  | lb/ft   |
| θsa  | 9.30  | °C/w/3" |



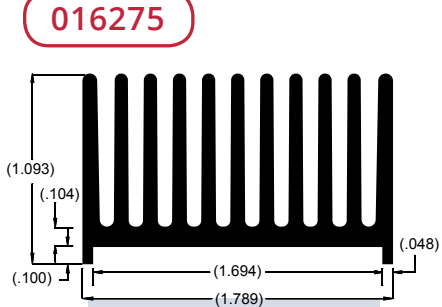




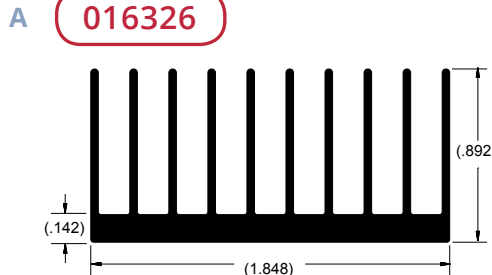
|      |      |         |
|------|------|---------|
| Per. | 7.24 | in.     |
| WT.  | 0.32 | lb/ft   |
| θsa  | 9.30 | °C/w/3" |



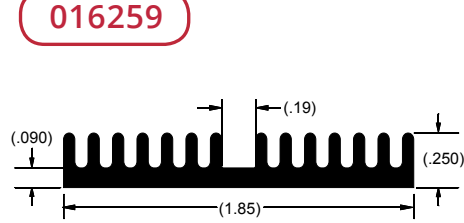
|      |       |         |
|------|-------|---------|
| Per. | 12.41 | in.     |
| WT.  | 0.70  | lb/ft   |
| θsa  | 5.80  | °C/w/3" |



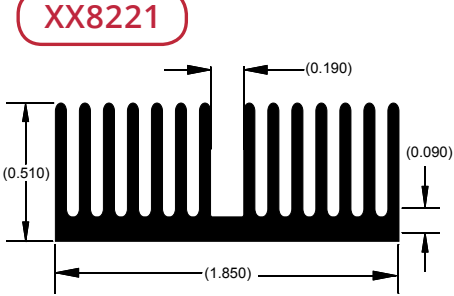
|      |       |         |
|------|-------|---------|
| Per. | 22.87 | in.     |
| WT.  | 1.10  | lb/ft   |
| θsa  | 4.60  | °C/w/3" |



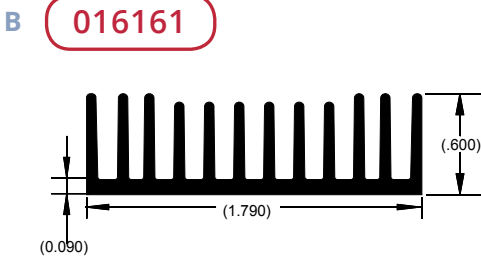
|      |       |         |
|------|-------|---------|
| Per. | 18.70 | in.     |
| WT.  | 0.66  | lb/ft   |
| θsa  | 4.60  | °C/w/3" |



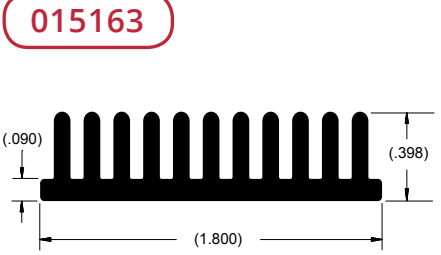
|      |       |         |
|------|-------|---------|
| Per. | 7.70  | in.     |
| WT.  | 0.36  | lb/ft   |
| θsa  | 10.90 | °C/w/3" |



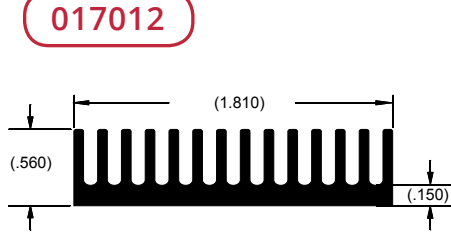
|      |       |         |
|------|-------|---------|
| Per. | 14.98 | in.     |
| WT.  | 0.63  | lb/ft   |
| θsa  | 6.20  | °C/w/3" |



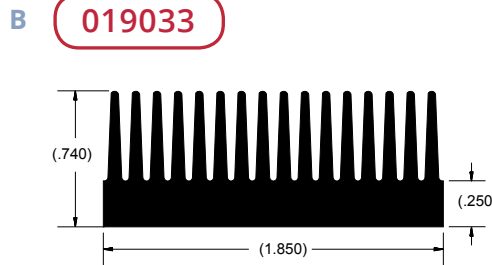
|      |       |         |
|------|-------|---------|
| Per. | 14.88 | in.     |
| WT.  | 0.57  | lb/ft   |
| θsa  | 6.30  | °C/w/3" |



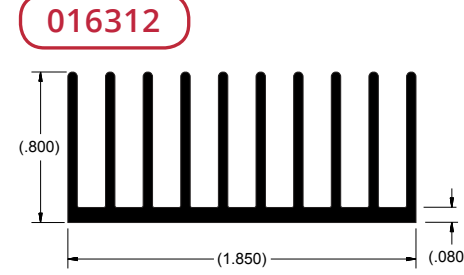
|      |       |         |
|------|-------|---------|
| Per. | 10.03 | in.     |
| WT.  | 0.49  | lb/ft   |
| θsa  | 7.00  | °C/w/3" |



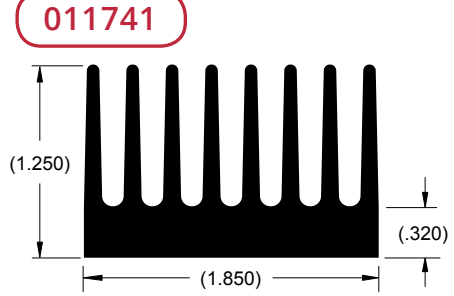
|      |       |         |
|------|-------|---------|
| Per. | 14.77 | in.     |
| WT.  | 0.71  | lb/ft   |
| θsa  | 6.80  | °C/w/3" |



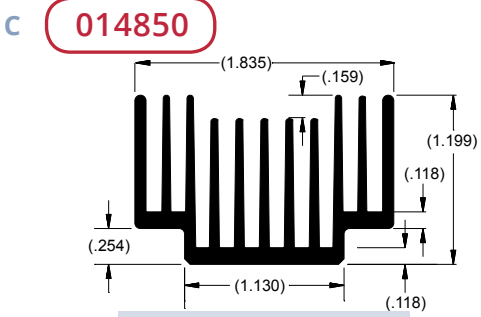
|      |       |         |
|------|-------|---------|
| Per. | 18.78 | in.     |
| WT.  | 1.10  | lb/ft   |
| θsa  | 6.50  | °C/w/3" |



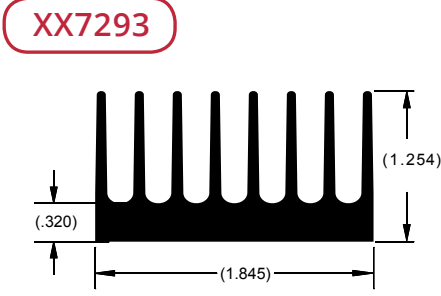
|      |       |         |
|------|-------|---------|
| Per. | 18.05 | in.     |
| WT.  | 0.58  | lb/ft   |
| θsa  | 5.20  | °C/w/3" |



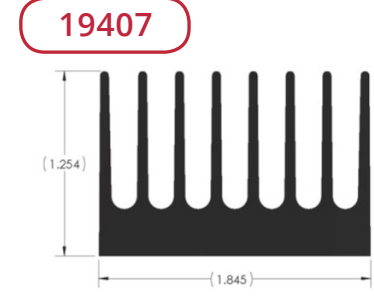
|      |       |         |
|------|-------|---------|
| Per. | 18.30 | in.     |
| WT.  | 1.45  | lb/ft   |
| θsa  | 3.80  | °C/w/3" |



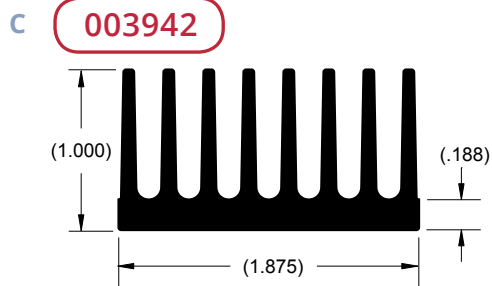
|      |       |         |
|------|-------|---------|
| Per. | 27.41 | in.     |
| WT.  | 1.07  | lb/ft   |
| θsa  | 4.80  | °C/w/3" |



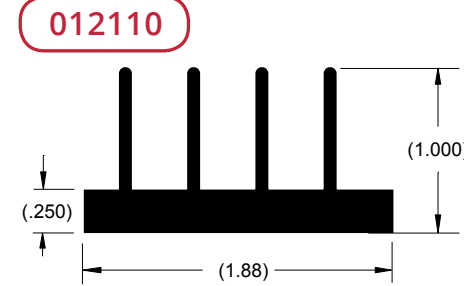
|      |       |         |
|------|-------|---------|
| Per. | 18.39 | in.     |
| WT.  | 1.36  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |



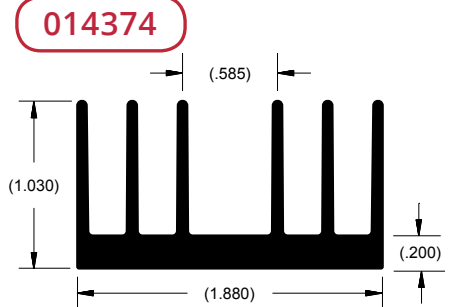
|      |        |         |
|------|--------|---------|
| Per. | 18.391 | in.     |
| WT.  | 1.36   | lb/ft   |
| θsa  | 3.80   | °C/w/3" |



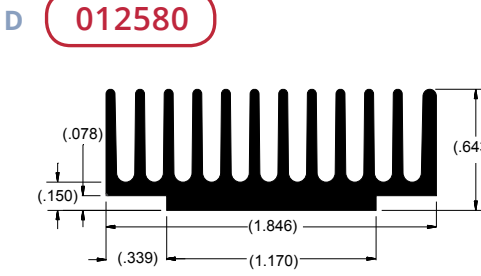
|      |       |         |
|------|-------|---------|
| Per. | 16.00 | in.     |
| WT.  | 1.08  | lb/ft   |
| θsa  | 4.40  | °C/w/3" |



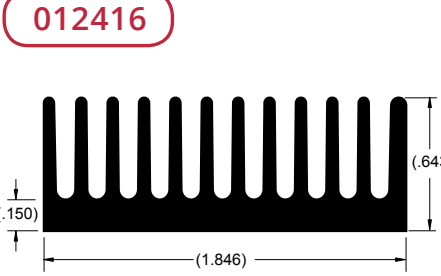
|      |       |         |
|------|-------|---------|
| Per. | 10.15 | in.     |
| WT.  | 0.79  | lb/ft   |
| θsa  | 6.90  | °C/w/3" |



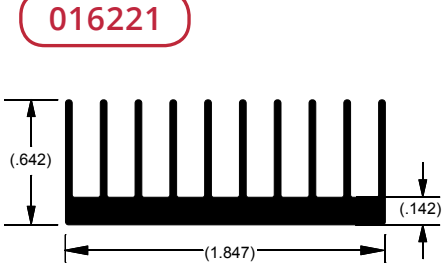
|      |       |         |
|------|-------|---------|
| Per. | 13.79 | in.     |
| WT.  | 0.45  | lb/ft   |
| θsa  | 5.10  | °C/w/3" |



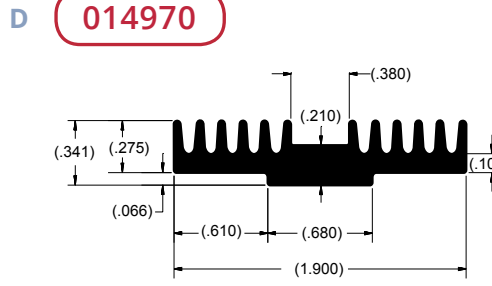
|      |       |         |
|------|-------|---------|
| Per. | 14.96 | in.     |
| WT.  | 0.67  | lb/ft   |
| θsa  | 4.70  | °C/w/3" |



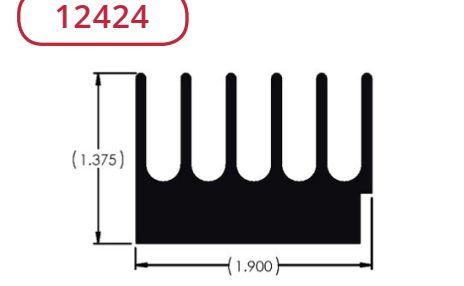
|      |       |         |
|------|-------|---------|
| Per. | 14.96 | in.     |
| WT.  | 0.73  | lb/ft   |
| θsa  | 4.70  | °C/w/3" |



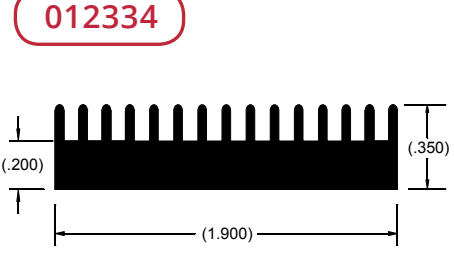
|      |       |         |
|------|-------|---------|
| Per. | 13.70 | in.     |
| WT.  | 0.52  | lb/ft   |
| θsa  | 5.80  | °C/w/3" |



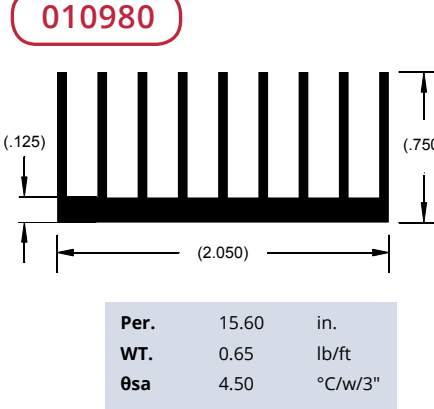
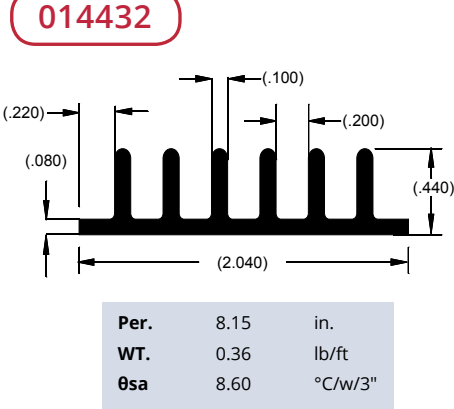
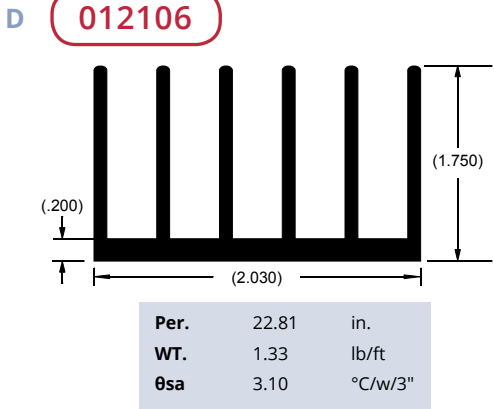
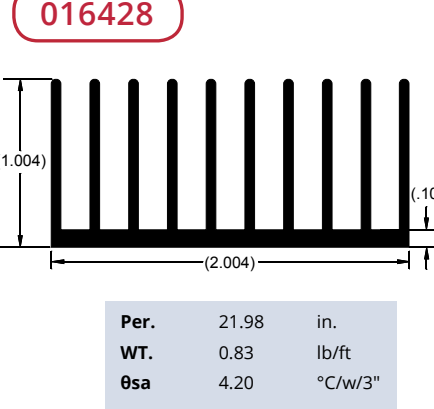
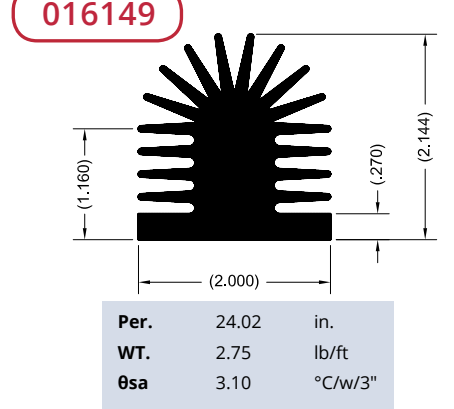
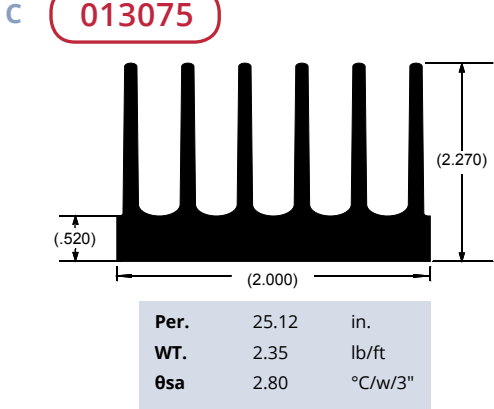
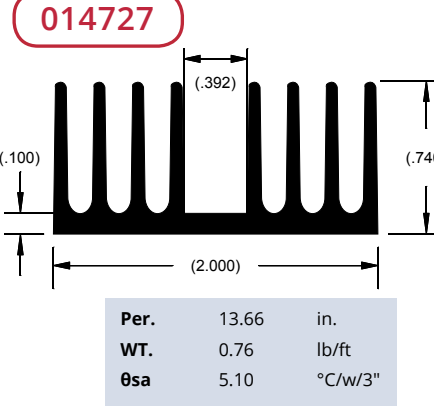
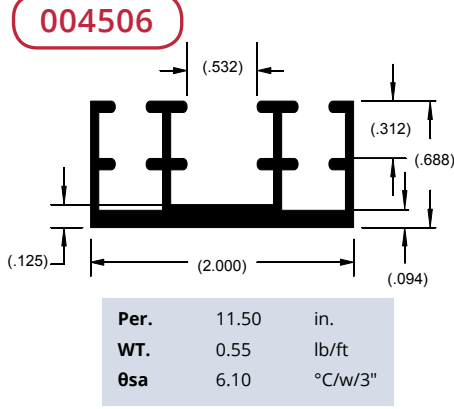
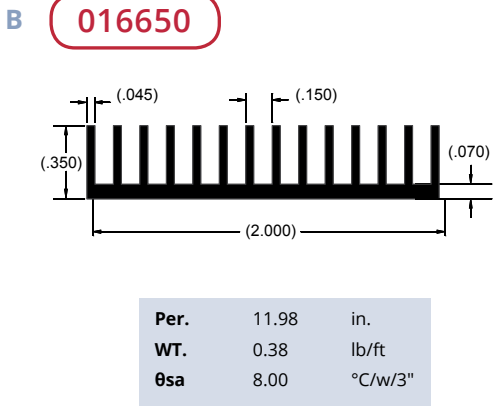
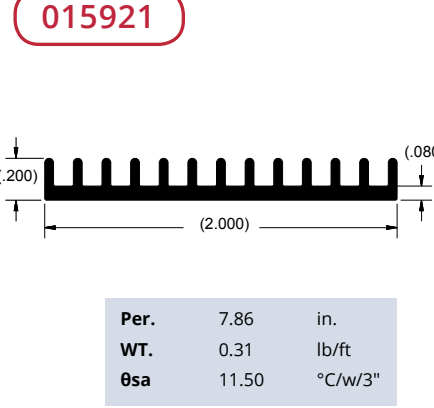
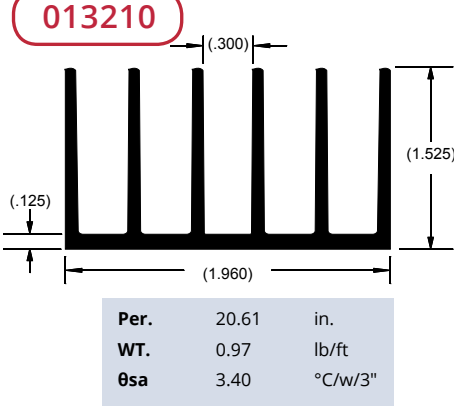
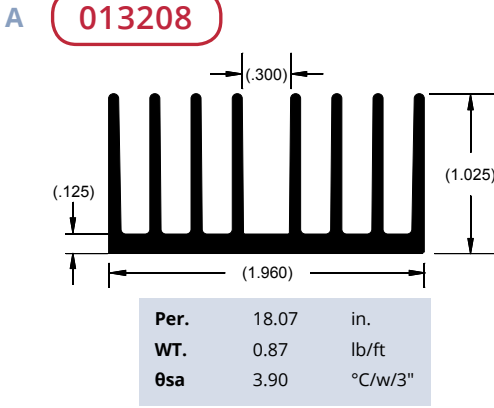
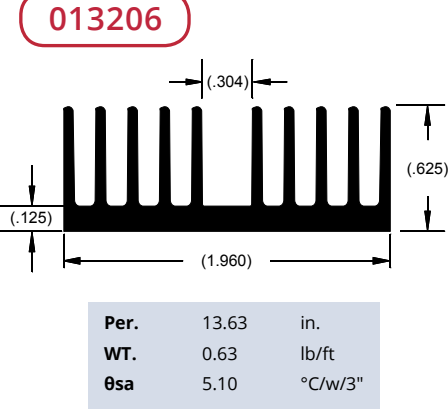
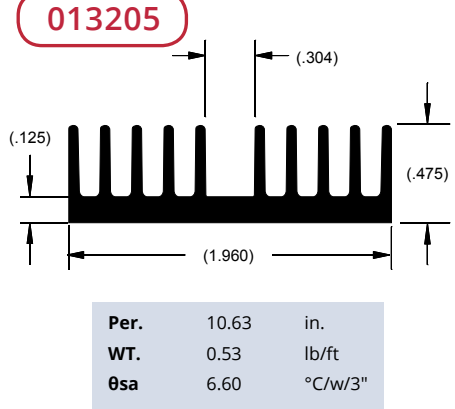
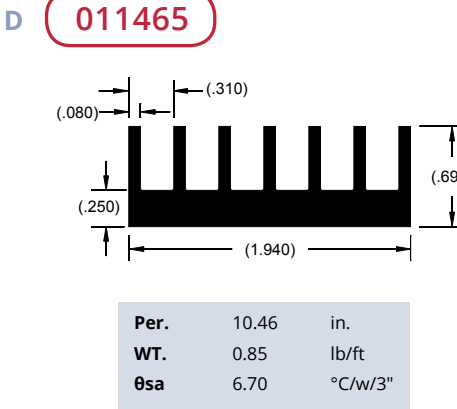
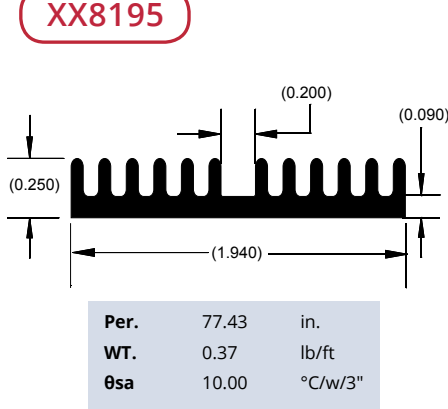
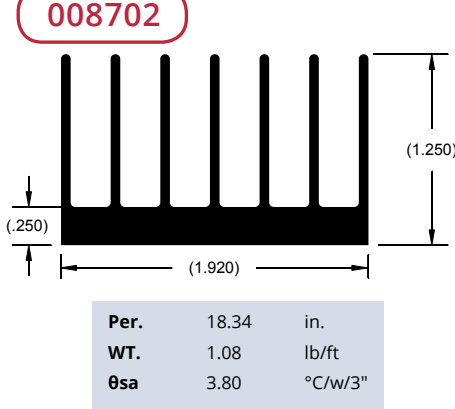
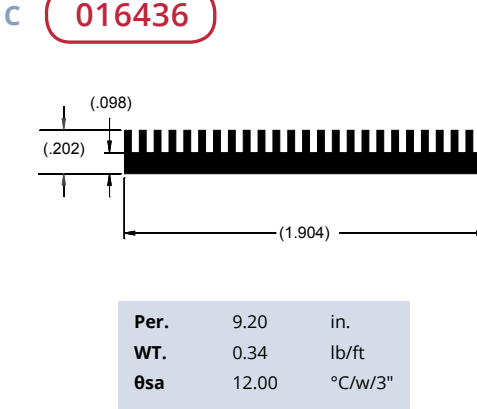
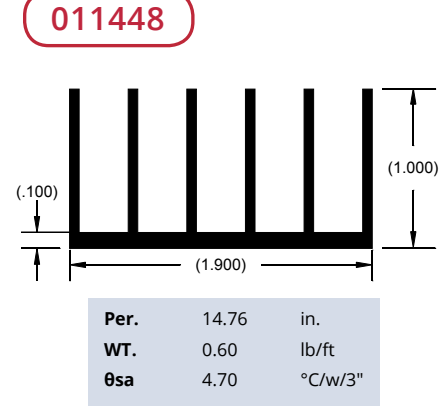
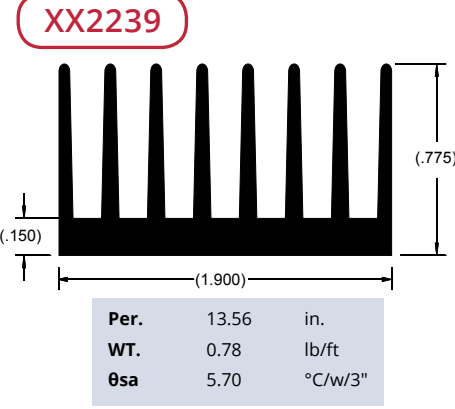
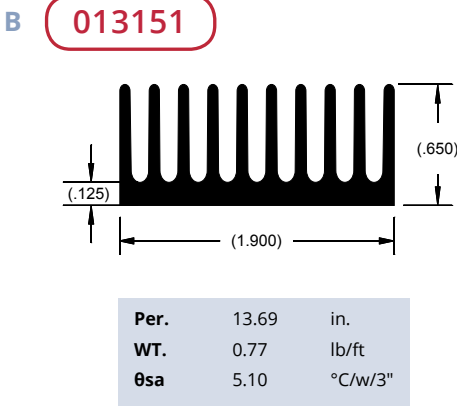
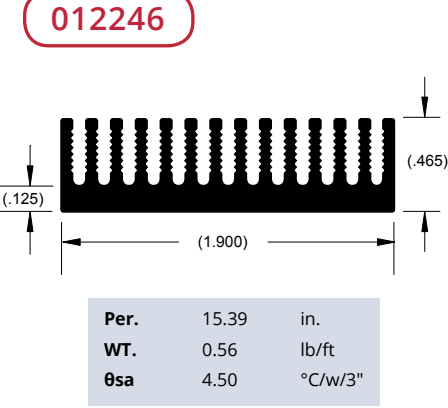
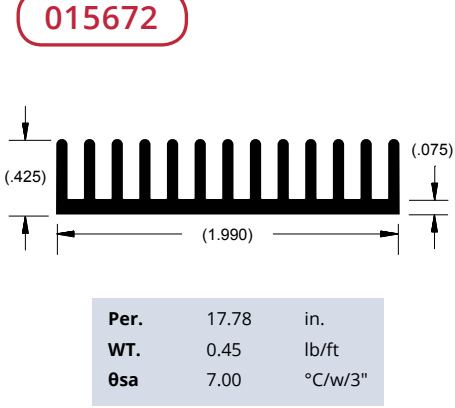
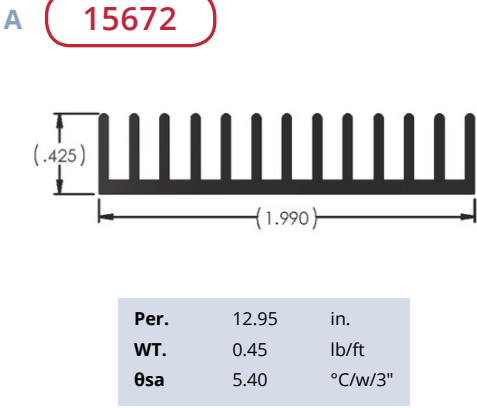
|      |       |         |
|------|-------|---------|
| Per. | 7.49  | in.     |
| WT.  | 0.44  | lb/ft   |
| θsa  | 10.20 | °C/w/3" |



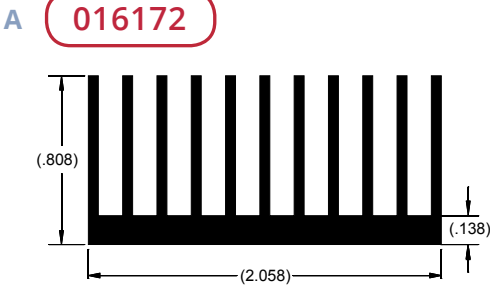
|      |       |         |
|------|-------|---------|
| Per. | 14.49 | in.     |
| WT.  | 1.65  | lb/ft   |
| θsa  | 4.83  | °C/w/3" |



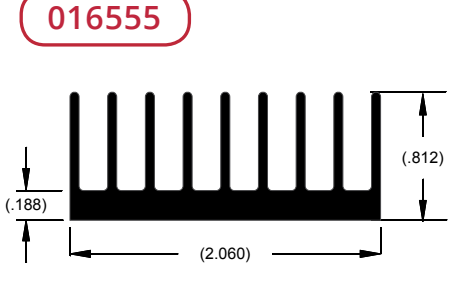
|      |      |         |
|------|------|---------|
| Per. | 8.27 | in.     |
| WT.  | 0.56 | lb/ft   |
| θsa  | 8.50 | °C/w/3" |



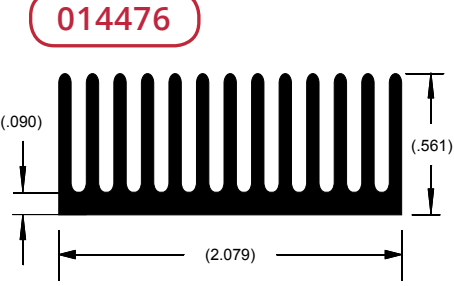




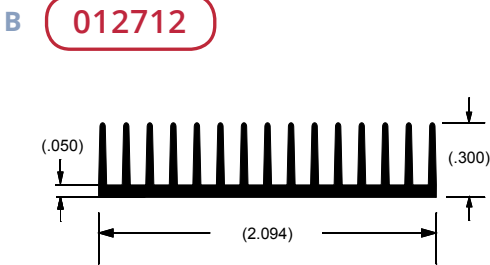
|      |       |         |
|------|-------|---------|
| Per. | 19.10 | in.     |
| WT.  | 0.76  | lb/ft   |
| θsa  | 4.70  | °C/w/3" |



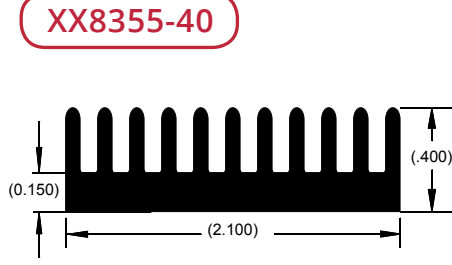
|      |       |         |
|------|-------|---------|
| Per. | 15.29 | in.     |
| WT.  | 0.87  | lb/ft   |
| θsa  | 4.70  | °C/w/3" |



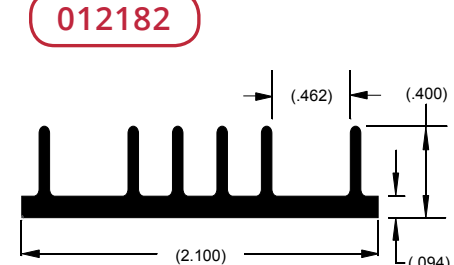
|      |       |         |
|------|-------|---------|
| Per. | 15.75 | in.     |
| WT.  | 0.74  | lb/ft   |
| θsa  | 4.40  | °C/w/3" |



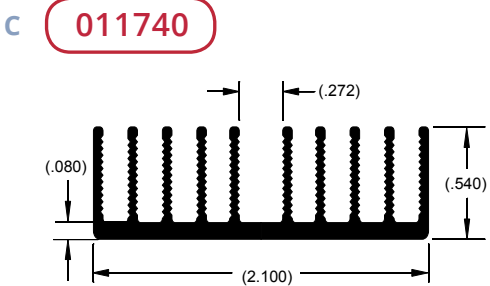
|      |       |         |
|------|-------|---------|
| Per. | 11.20 | in.     |
| WT.  | 0.30  | lb/ft   |
| θsa  | 6.20  | °C/w/3" |



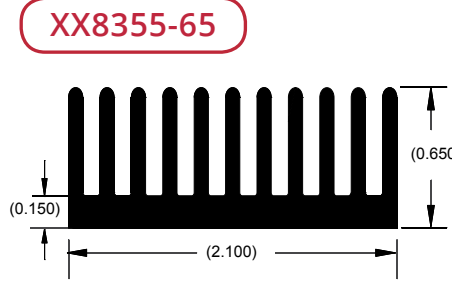
|      |      |         |
|------|------|---------|
| Per. | 9.44 | in.     |
| WT.  | 0.67 | lb/ft   |
| θsa  | 7.00 | °C/w/3" |



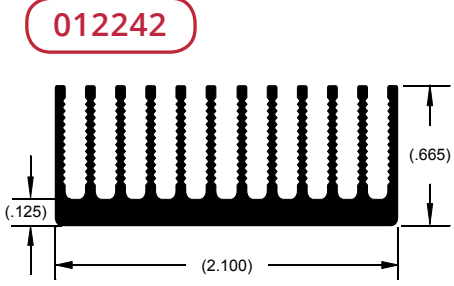
|      |      |         |
|------|------|---------|
| Per. | 7.74 | in.     |
| WT.  | 0.36 | lb/ft   |
| θsa  | 9.00 | °C/w/3" |



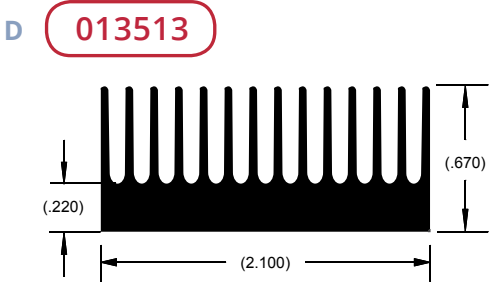
|      |       |         |
|------|-------|---------|
| Per. | 16.23 | in.     |
| WT.  | 0.45  | lb/ft   |
| θsa  | 4.30  | °C/w/3" |



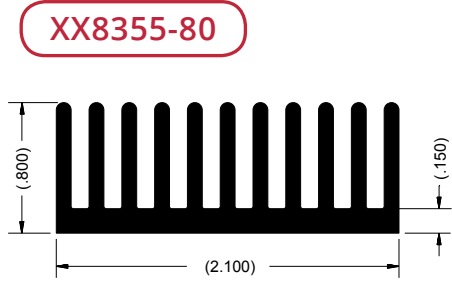
|      |       |         |
|------|-------|---------|
| Per. | 14.90 | in.     |
| WT.  | 0.95  | lb/ft   |
| θsa  | 5.20  | °C/w/3" |



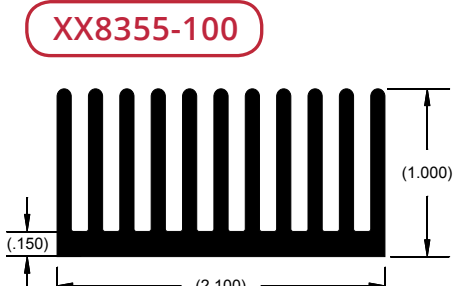
|      |       |         |
|------|-------|---------|
| Per. | 20.64 | in.     |
| WT.  | 0.68  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |



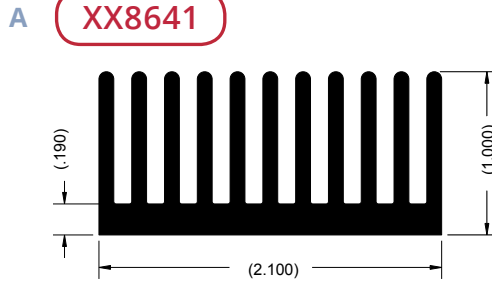
|      |       |         |
|------|-------|---------|
| Per. | 16.26 | in.     |
| WT.  | 0.97  | lb/ft   |
| θsa  | 4.30  | °C/w/3" |



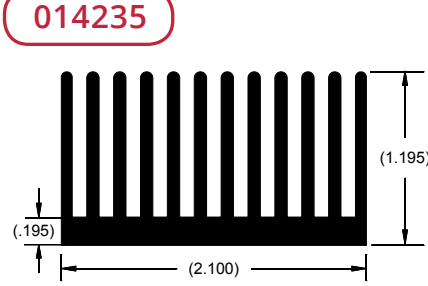
|      |        |         |
|------|--------|---------|
| Per. | 18.200 | in.     |
| WT.  | 1.120  | lb/ft   |
| θsa  | 4.40   | °C/w/3" |



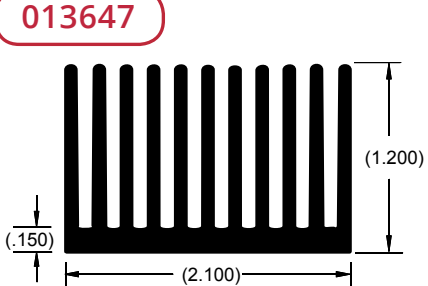
|      |       |         |
|------|-------|---------|
| Per. | 22.64 | in.     |
| WT.  | 1.39  | lb/ft   |
| θsa  | 3.80  | °C/w/3" |



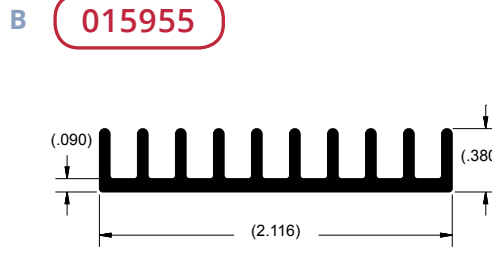
|      |       |         |
|------|-------|---------|
| Per. | 22.60 | in.     |
| WT.  | 1.36  | lb/ft   |
| θsa  | 5.20  | °C/w/3" |



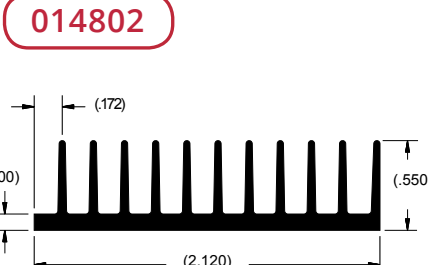
|      |       |         |
|------|-------|---------|
| Per. | 29.12 | in.     |
| WT.  | 1.79  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |



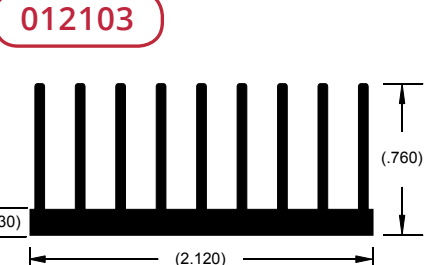
|      |       |         |
|------|-------|---------|
| Per. | 29.92 | in.     |
| WT.  | 1.41  | lb/ft   |
| θsa  | 2.60  | °C/w/3" |



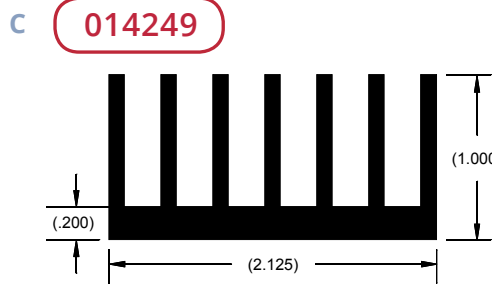
|      |      |         |
|------|------|---------|
| Per. | 9.95 | in.     |
| WT.  | 0.43 | lb/ft   |
| θsa  | 7.40 | °C/w/3" |



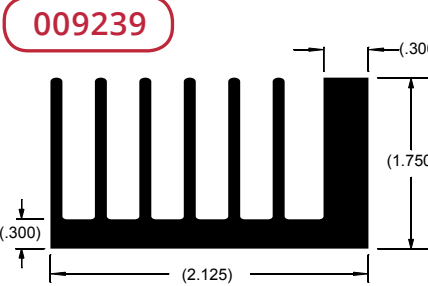
|      |       |         |
|------|-------|---------|
| Per. | 13.81 | in.     |
| WT.  | 0.53  | lb/ft   |
| θsa  | 6.10  | °C/w/3" |



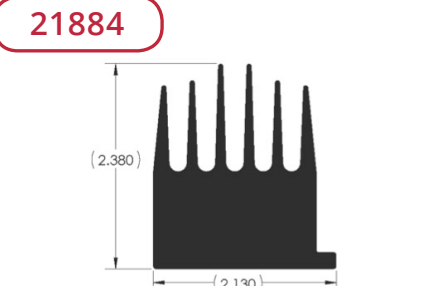
|      |       |         |
|------|-------|---------|
| Per. | 15.65 | in.     |
| WT.  | 0.72  | lb/ft   |
| θsa  | 4.50  | °C/w/3" |



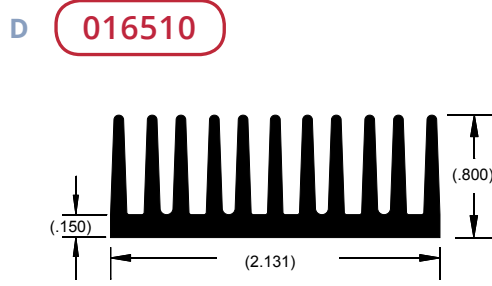
|      |       |         |
|------|-------|---------|
| Per. | 15.85 | in.     |
| WT.  | 1.18  | lb/ft   |
| θsa  | 4.40  | °C/w/3" |



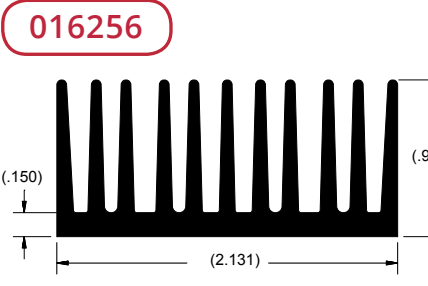
|      |       |         |
|------|-------|---------|
| Per. | 25.15 | in.     |
| WT.  | 2.23  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |



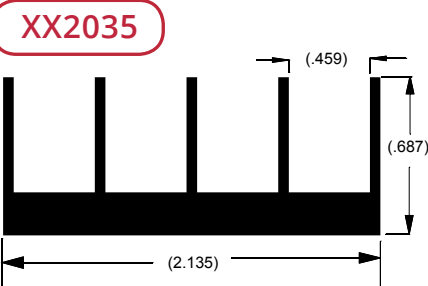
|      |       |         |
|------|-------|---------|
| Per. | 18.60 | in.     |
| WT.  | 3.49  | lb/ft   |
| θsa  | 3.76  | °C/w/3" |



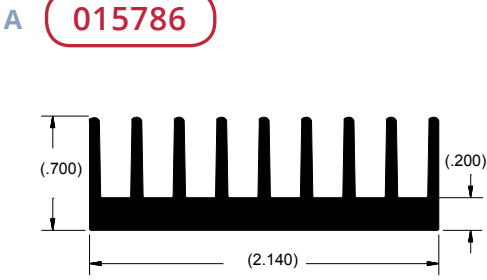
|      |       |         |
|------|-------|---------|
| Per. | 17.92 | in.     |
| WT.  | 1.09  | lb/ft   |
| θsa  | 4.80  | °C/w/3" |



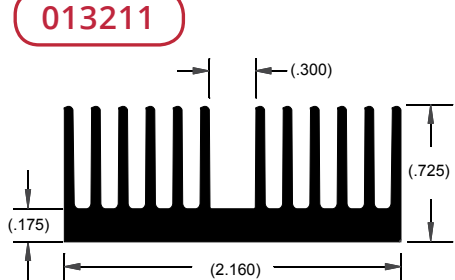
|      |       |         |
|------|-------|---------|
| Per. | 21.86 | in.     |
| WT.  | 1.28  | lb/ft   |
| θsa  | 5.10  | °C/w/3" |



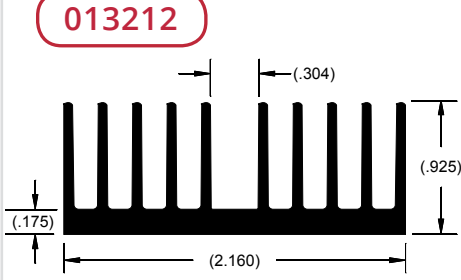
|      |      |         |
|------|------|---------|
| Per. | 9.64 | in.     |
| WT.  | 0.66 | lb/ft   |
| θsa  | 4.30 | °C/w/3" |



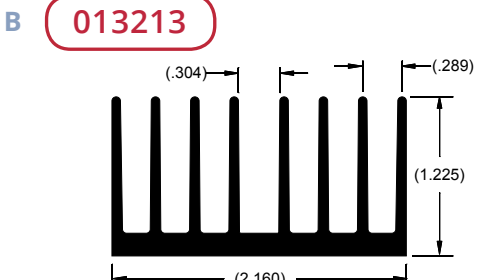
|      |       |         |
|------|-------|---------|
| Per. | 13.24 | in.     |
| WT.  | 0.87  | lb/ft   |
| θsa  | 5.10  | °C/w/3" |



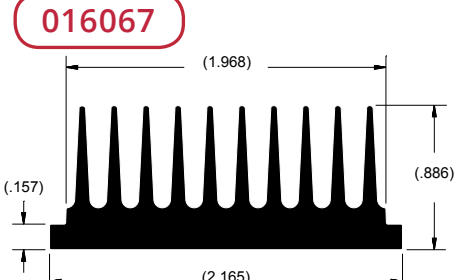
|      |       |         |
|------|-------|---------|
| Per. | 17.21 | in.     |
| WT.  | 0.90  | lb/ft   |
| θsa  | 4.10  | °C/w/3" |



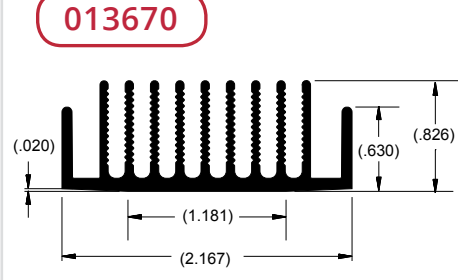
|      |       |         |
|------|-------|---------|
| Per. | 19.13 | in.     |
| WT.  | 0.96  | lb/ft   |
| θsa  | 3.70  | °C/w/3" |



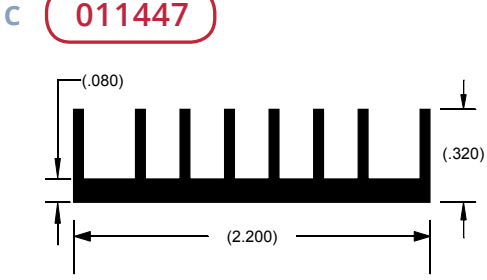
|      |       |         |
|------|-------|---------|
| Per. | 20.97 | in.     |
| WT.  | 1.12  | lb/ft   |
| θsa  | 3.30  | °C/w/3" |



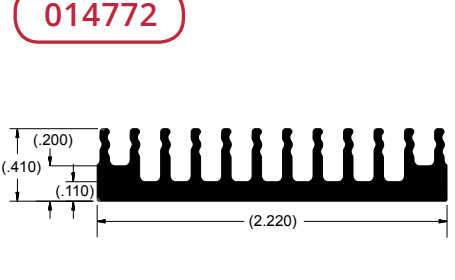
|      |       |         |
|------|-------|---------|
| Per. | 16.25 | in.     |
| WT.  | 1.17  | lb/ft   |
| θsa  | 5.20  | °C/w/3" |



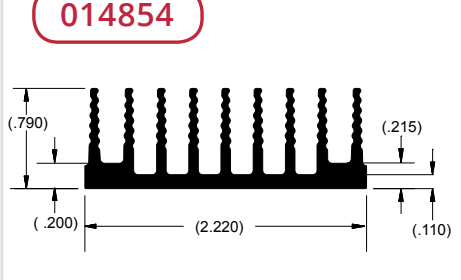
|      |       |         |
|------|-------|---------|
| Per. | 21.91 | in.     |
| WT.  | 0.81  | lb/ft   |
| θsa  | 3.20  | °C/w/3" |



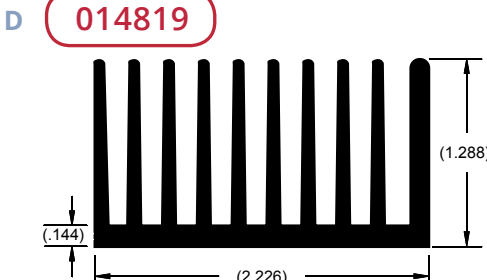
|      |      |         |
|------|------|---------|
| Per. | 8.34 | in.     |
| WT.  | 0.34 | lb/ft   |
| θsa  | 8.40 | °C/w/3" |



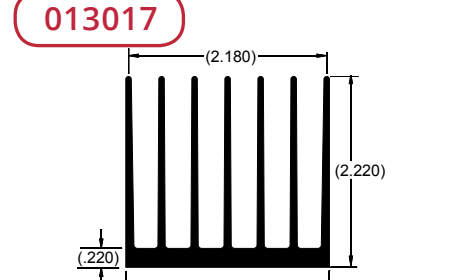
|      |       |         |
|------|-------|---------|
| Per. | 11.28 | in.     |
| WT.  | 0.56  | lb/ft   |
| θsa  | 7.00  | °C/w/3" |



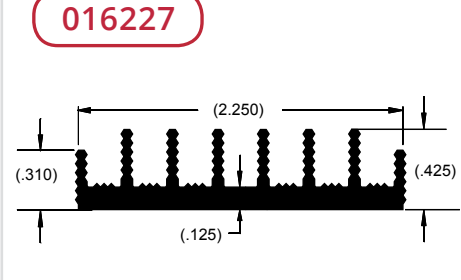
|      |       |         |
|------|-------|---------|
| Per. | 17.46 | in.     |
| WT.  | 0.80  | lb/ft   |
| θsa  | 4.60  | °C/w/3" |



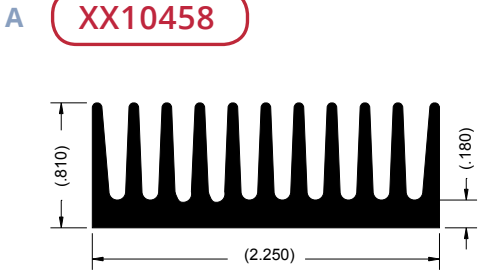
|      |       |         |
|------|-------|---------|
| Per. | 27.09 | in.     |
| WT.  | 1.48  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



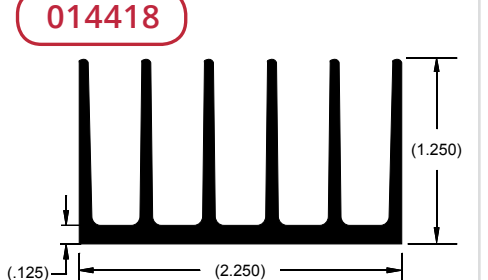
|      |       |         |
|------|-------|---------|
| Per. | 32.38 | in.     |
| WT.  | 1.79  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |



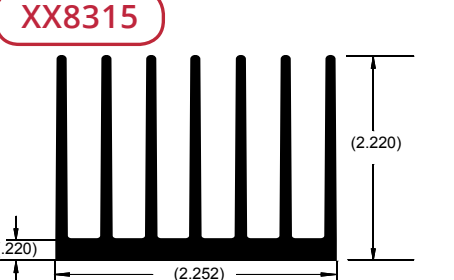
|      |       |         |
|------|-------|---------|
| Per. | 10.50 | in.     |
| WT.  | 0.53  | lb/ft   |
| θsa  | 6.60  | °C/w/3" |



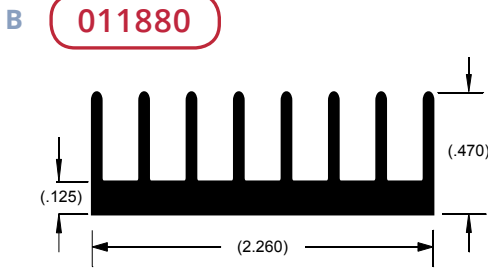
|      |       |         |
|------|-------|---------|
| Per. | 17.49 | in.     |
| WT.  | 1.21  | lb/ft   |
| θsa  | 4.80  | °C/w/3" |



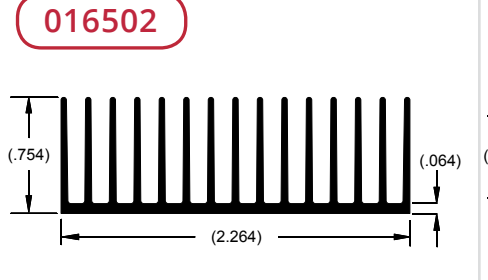
|      |       |         |
|------|-------|---------|
| Per. | 18.25 | in.     |
| WT.  | 0.84  | lb/ft   |
| θsa  | 3.80  | °C/w/3" |



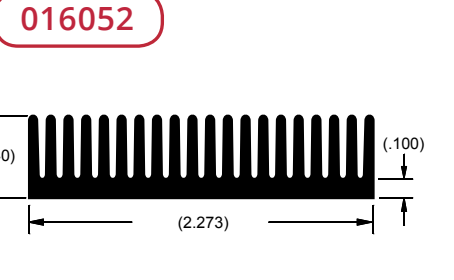
|      |       |         |
|------|-------|---------|
| Per. | 32.42 | in.     |
| WT.  | 1.79  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |



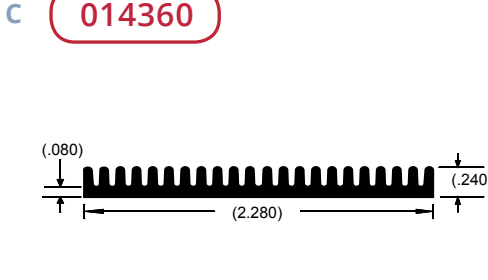
|      |       |         |
|------|-------|---------|
| Per. | 10.24 | in.     |
| WT.  | 0.54  | lb/ft   |
| θsa  | 6.80  | °C/w/3" |



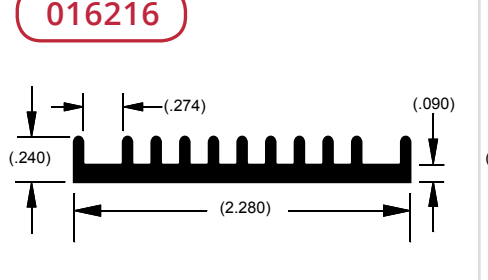
|      |       |         |
|------|-------|---------|
| Per. | 24.75 | in.     |
| WT.  | 0.67  | lb/ft   |
| θsa  | 4.80  | °C/w/3" |



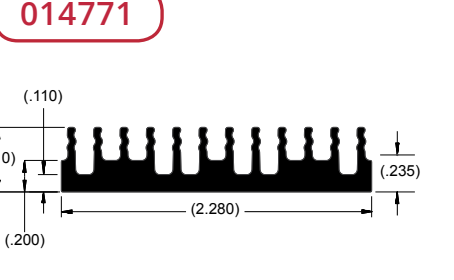
|      |       |         |
|------|-------|---------|
| Per. | 17.71 | in.     |
| WT.  | 0.72  | lb/ft   |
| θsa  | 7.60  | °C/w/3" |



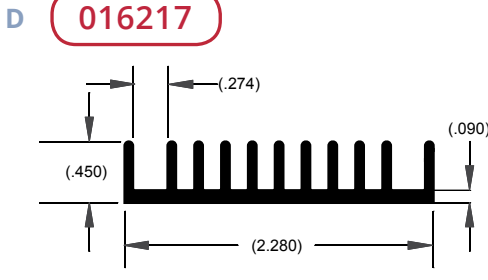
|      |       |         |
|------|-------|---------|
| Per. | 10.93 | in.     |
| WT.  | 0.39  | lb/ft   |
| θsa  | 10.40 | °C/w/3" |



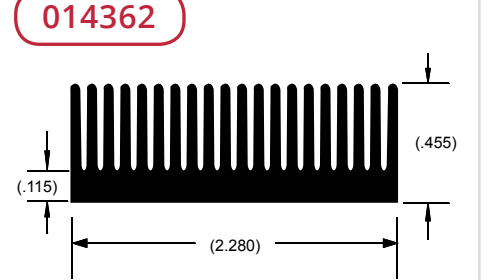
|      |      |         |
|------|------|---------|
| Per. | 7.58 | in.     |
| WT.  | 0.36 | lb/ft   |
| θsa  | 9.20 | °C/w/3" |



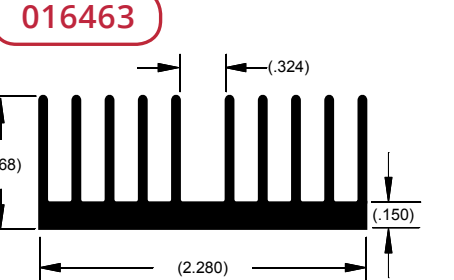
|      |       |         |
|------|-------|---------|
| Per. | 10.79 | in.     |
| WT.  | 0.63  | lb/ft   |
| θsa  | 7.80  | °C/w/3" |



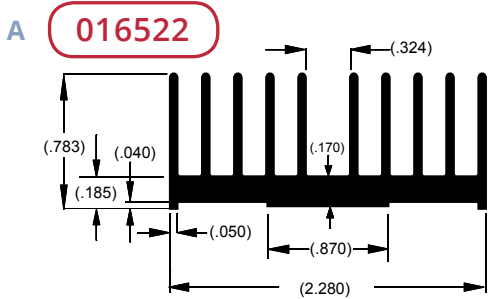
|      |       |         |
|------|-------|---------|
| Per. | 12.21 | in.     |
| WT.  | 0.52  | lb/ft   |
| θsa  | 6.40  | °C/w/3" |



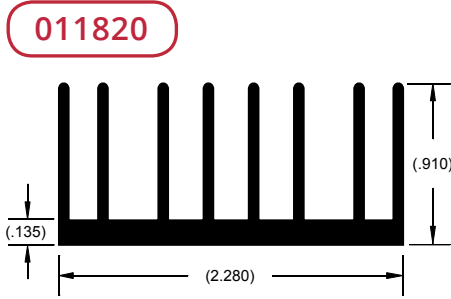
|      |       |         |
|------|-------|---------|
| Per. | 17.31 | in.     |
| WT.  | 0.73  | lb/ft   |
| θsa  | 4.00  | °C/w/3" |



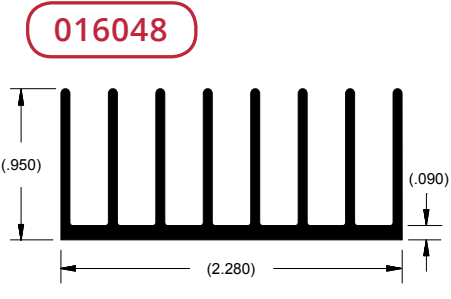
|      |       |         |
|------|-------|---------|
| Per. | 18.17 | in.     |
| WT.  | 0.75  | lb/ft   |
| θsa  | 4.20  | °C/w/3" |



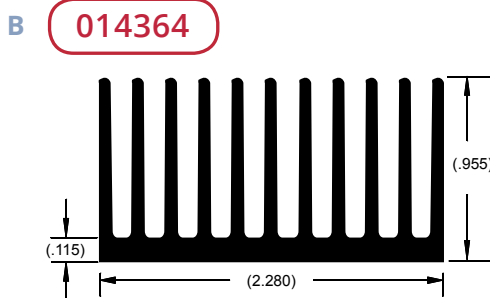
|      |       |         |
|------|-------|---------|
| Per. | 16.65 | in.     |
| WT.  | 0.79  | lb/ft   |
| θsa  | 4.80  | °C/w/3" |



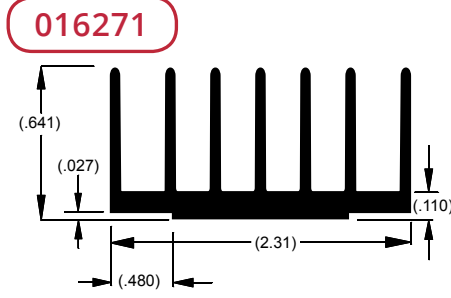
|      |       |         |
|------|-------|---------|
| Per. | 17.02 | in.     |
| WT.  | 0.81  | lb/ft   |
| θsa  | 4.10  | °C/w/3" |



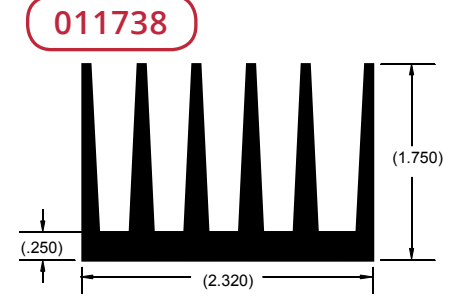
|      |       |         |
|------|-------|---------|
| Per. | 18.17 | in.     |
| WT.  | 0.75  | lb/ft   |
| θsa  | 4.20  | °C/w/3" |



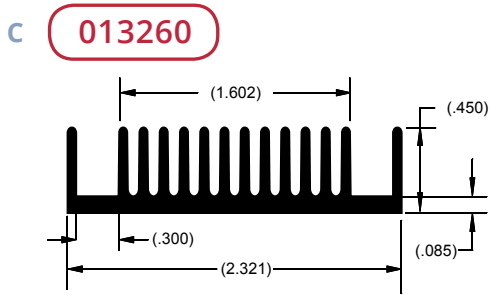
|      |       |         |
|------|-------|---------|
| Per. | 22.46 | in.     |
| WT.  | 1.03  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



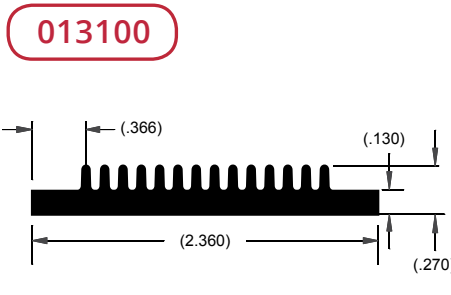
|      |       |         |
|------|-------|---------|
| Per. | 11.95 | in.     |
| WT.  | 0.56  | lb/ft   |
| θsa  | 5.10  | °C/w/3" |



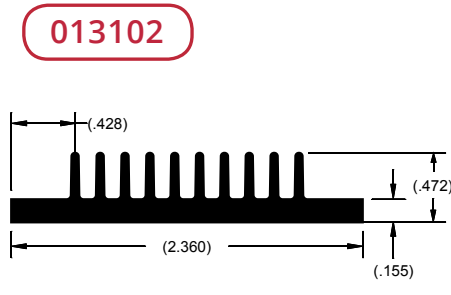
|      |       |         |
|------|-------|---------|
| Per. | 22.26 | in.     |
| WT.  | 1.88  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



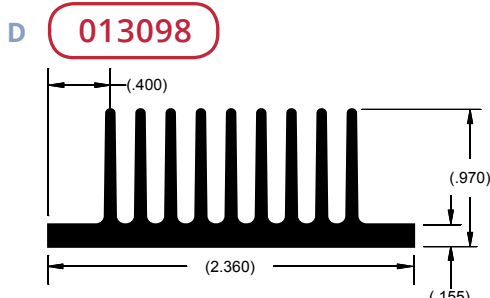
|      |       |         |
|------|-------|---------|
| Per. | 14.21 | in.     |
| WT.  | 0.58  | lb/ft   |
| θsa  | 4.90  | °C/w/3" |



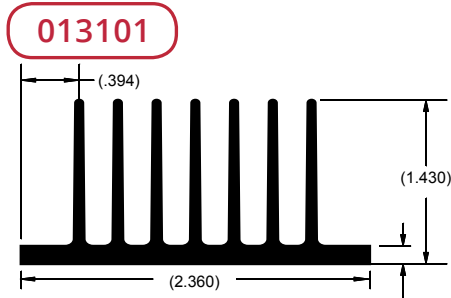
|      |      |         |
|------|------|---------|
| Per. | 8.13 | in.     |
| WT.  | 0.48 | lb/ft   |
| θsa  | 8.60 | °C/w/3" |



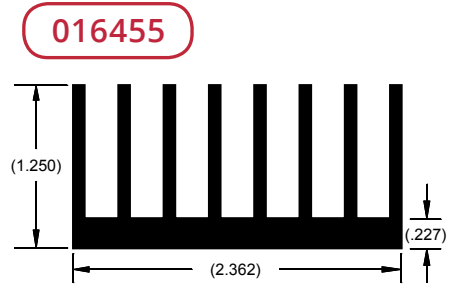
|      |       |         |
|------|-------|---------|
| Per. | 10.56 | in.     |
| WT.  | 0.63  | lb/ft   |
| θsa  | 6.60  | °C/w/3" |



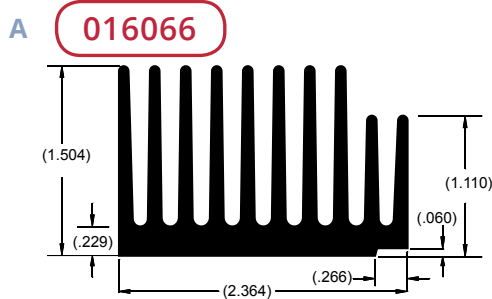
|      |       |         |
|------|-------|---------|
| Per. | 18.88 | in.     |
| WT.  | 0.95  | lb/ft   |
| θsa  | 3.70  | °C/w/3" |



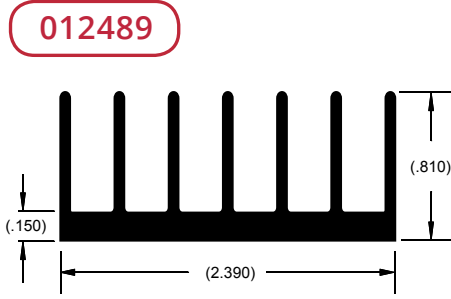
|      |       |         |
|------|-------|---------|
| Per. | 22.23 | in.     |
| WT.  | 1.07  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



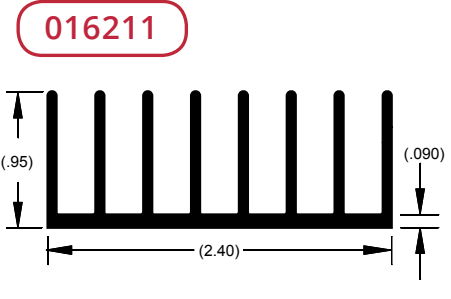
|      |       |         |
|------|-------|---------|
| Per. | 21.56 | in.     |
| WT.  | 1.42  | lb/ft   |
| θsa  | 3.30  | °C/w/3" |



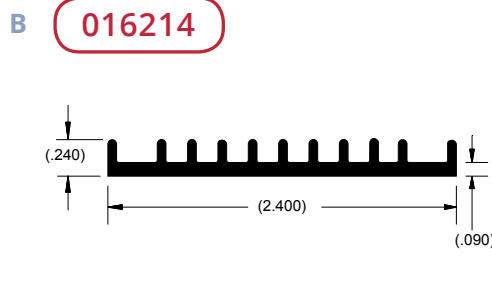
|      |       |         |
|------|-------|---------|
| Per. | 27.93 | in.     |
| WT.  | 1.95  | lb/ft   |
| θsa  | 3.20  | °C/w/3" |



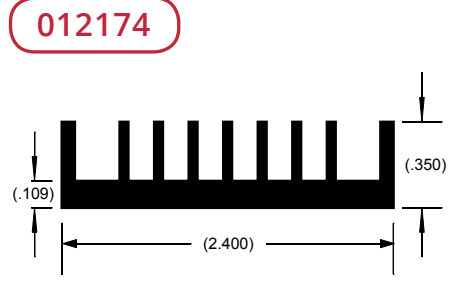
|      |       |         |
|------|-------|---------|
| Per. | 12.18 | in.     |
| WT.  | 0.79  | lb/ft   |
| θsa  | 5.70  | °C/w/3" |



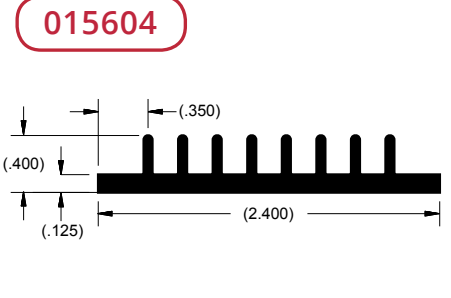
|      |       |         |
|------|-------|---------|
| Per. | 18.43 | in.     |
| WT.  | 0.75  | lb/ft   |
| θsa  | 3.80  | °C/w/3" |



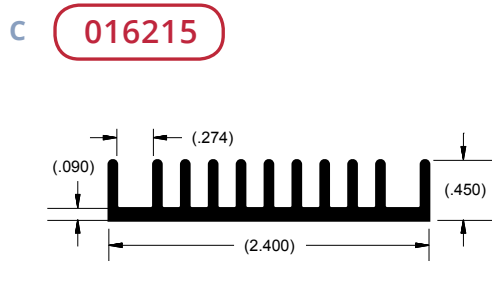
|      |      |         |
|------|------|---------|
| Per. | 7.82 | in.     |
| WT.  | 0.37 | lb/ft   |
| θsa  | 9.10 | °C/w/3" |



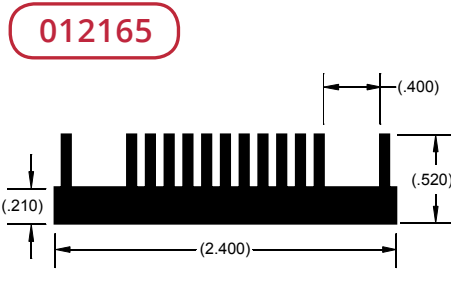
|      |      |         |
|------|------|---------|
| Per. | 9.29 | in.     |
| WT.  | 0.48 | lb/ft   |
| θsa  | 7.50 | °C/w/3" |



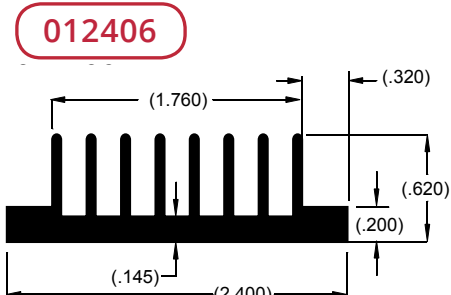
|      |      |         |
|------|------|---------|
| Per. | 9.14 | in.     |
| WT.  | 0.51 | lb/ft   |
| θsa  | 8.00 | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 12.44 | in.     |
| WT.  | 0.54  | lb/ft   |
| θsa  | 6.30  | °C/w/3" |



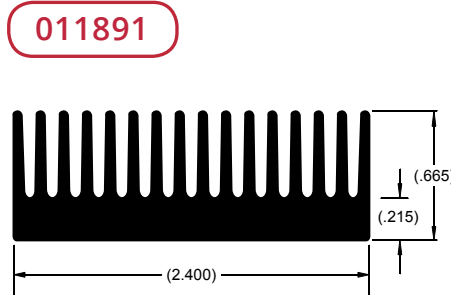
|      |       |         |
|------|-------|---------|
| Per. | 13.17 | in.     |
| WT.  | 0.87  | lb/ft   |
| θsa  | 5.30  | °C/w/3" |



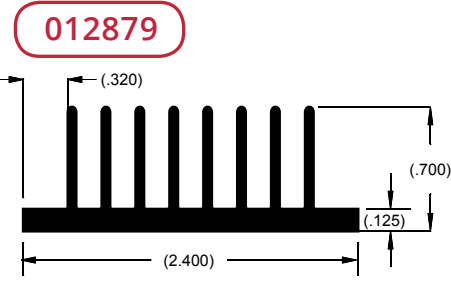
|      |       |         |
|------|-------|---------|
| Per. | 12.42 | in.     |
| WT.  | 0.71  | lb/ft   |
| θsa  | 5.60  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 18.95 | in.     |
| WT.  | 0.86  | lb/ft   |
| θsa  | 3.70  | °C/w/3" |

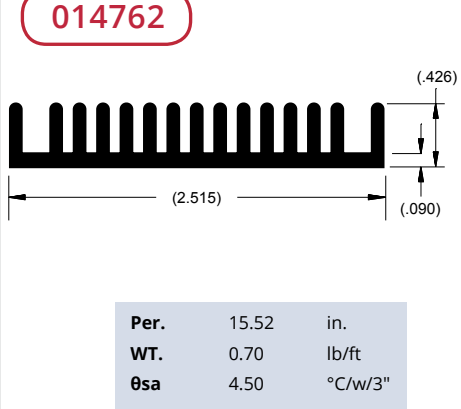
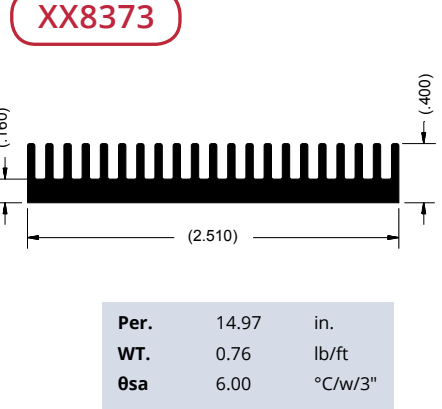
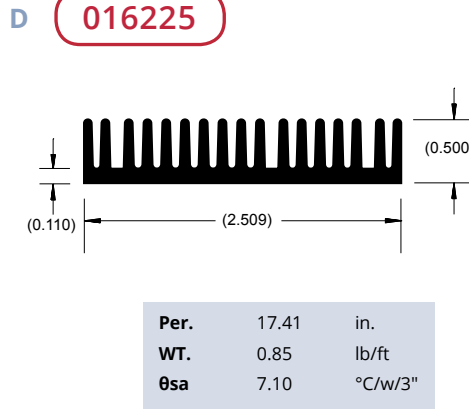
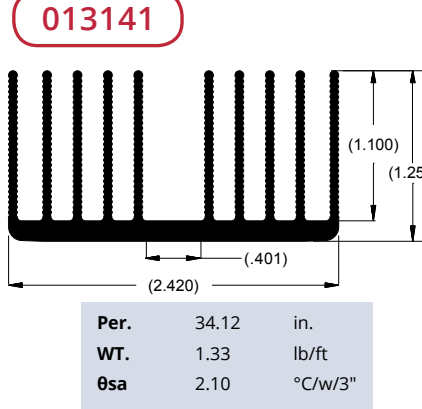
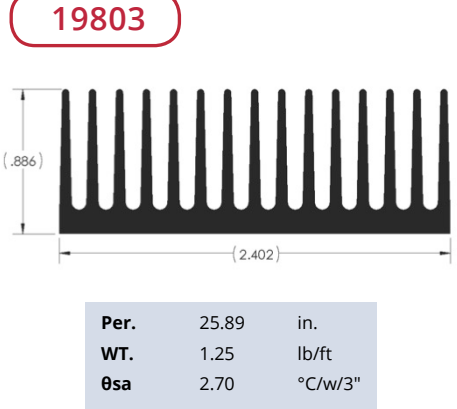
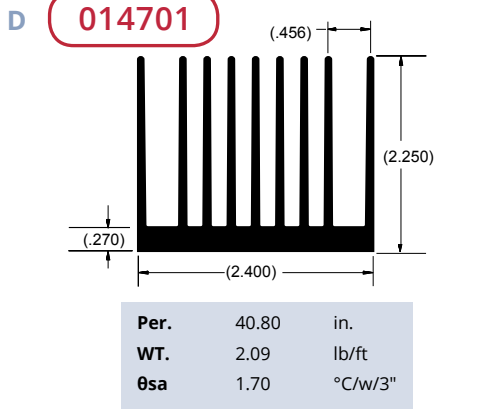
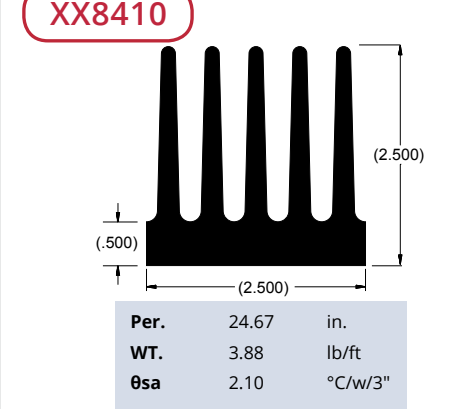
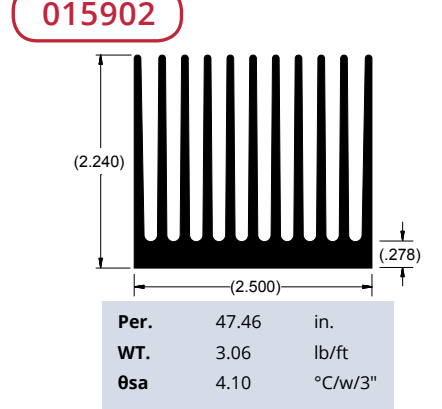
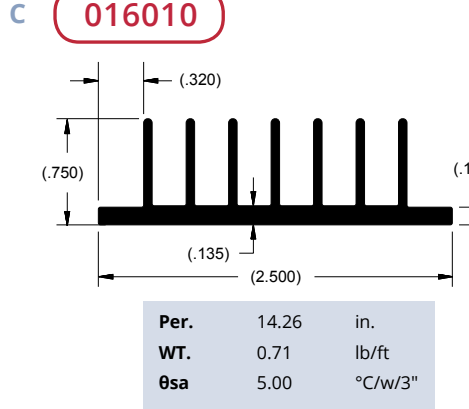
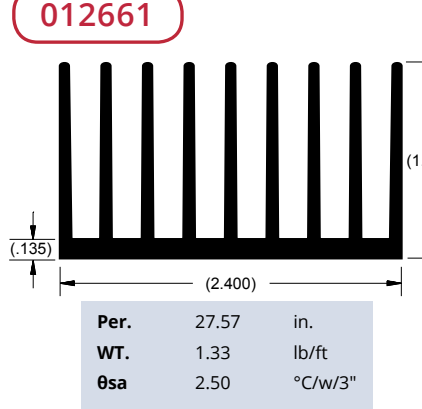
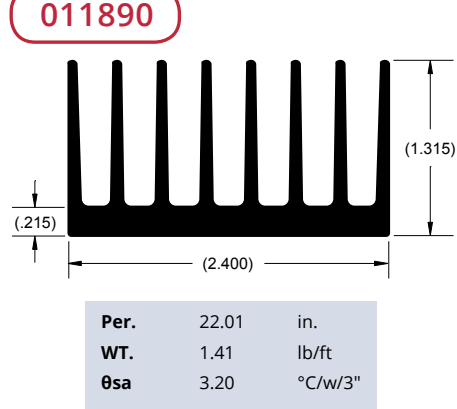
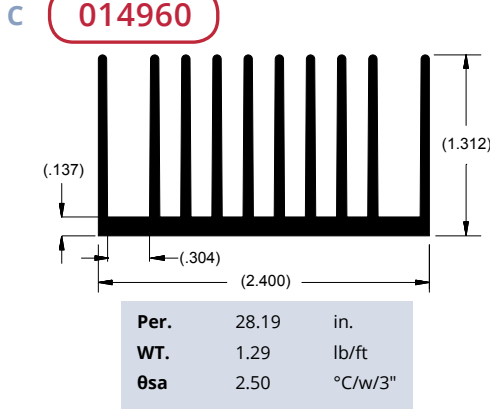
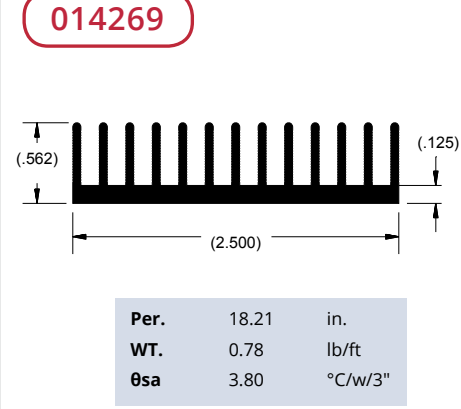
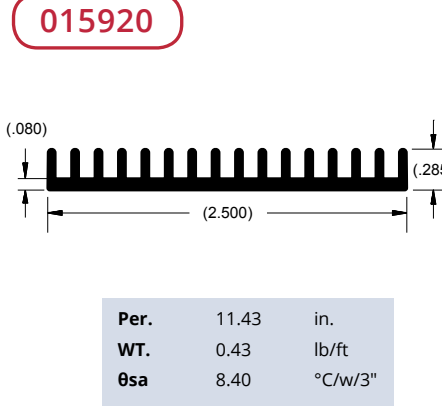
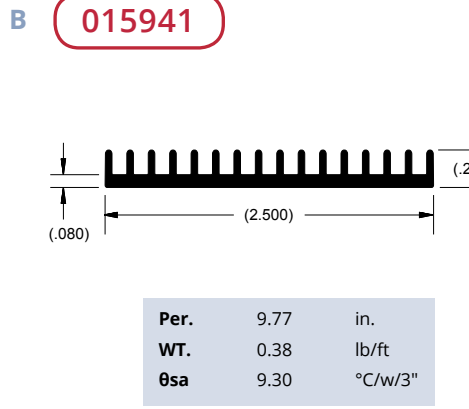
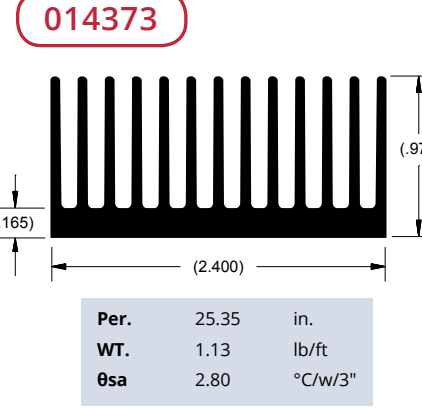
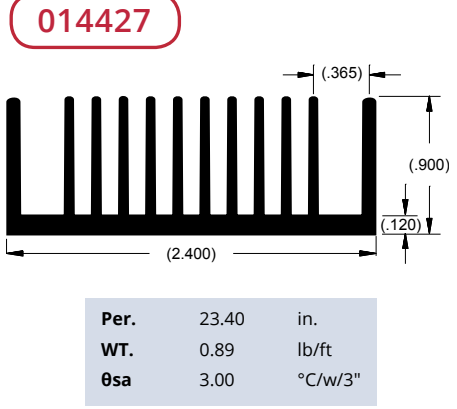
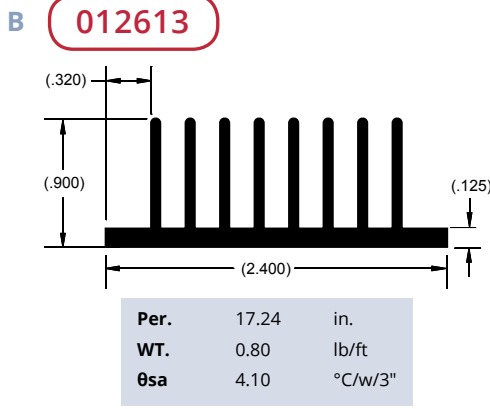
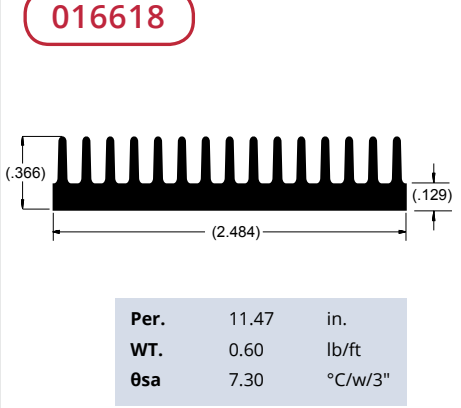
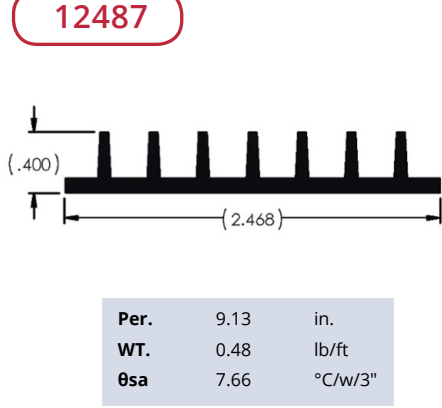
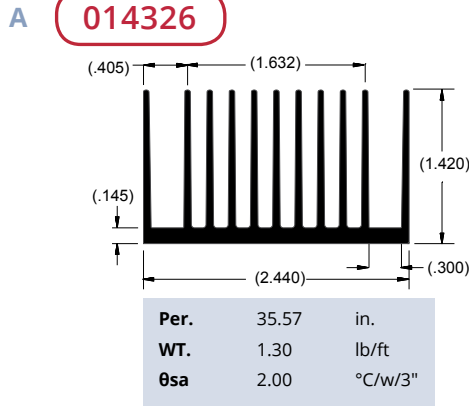
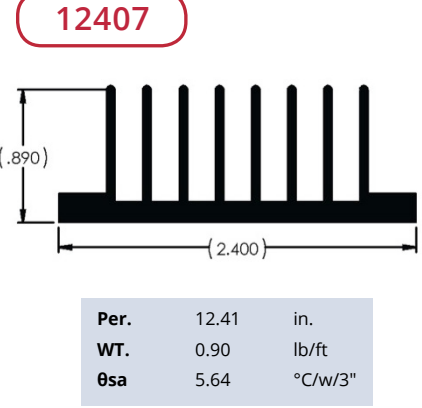
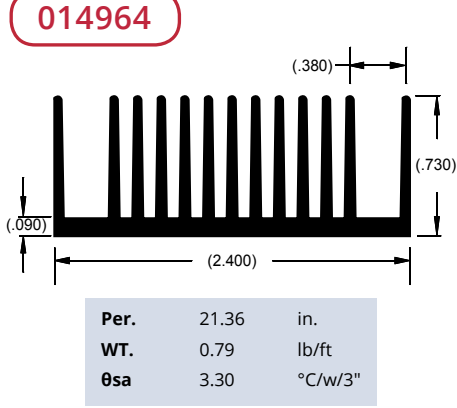
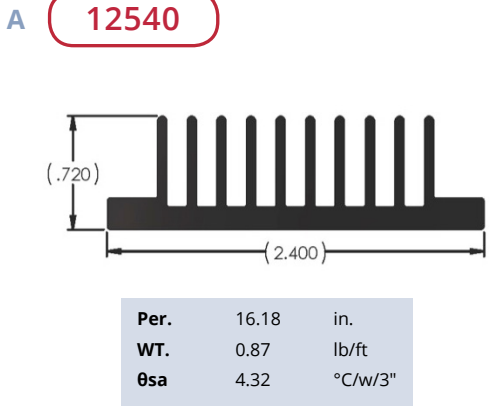


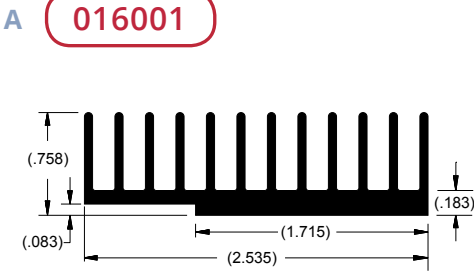
|      |       |         |
|------|-------|---------|
| Per. | 18.44 | in.     |
| WT.  | 1.25  | lb/ft   |
| θsa  | 3.80  | °C/w/3" |



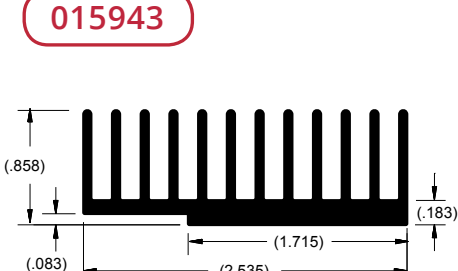
|      |       |         |
|------|-------|---------|
| Per. | 14.68 | in.     |
| WT.  | 0.70  | lb/ft   |
| θsa  | 4.80  | °C/w/3" |



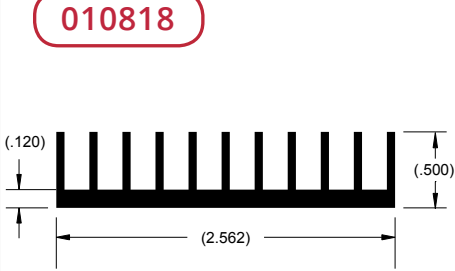




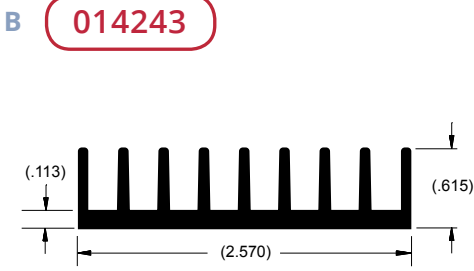
|      |       |         |
|------|-------|---------|
| Per. | 18.74 | in.     |
| WT.  | 0.97  | lb/ft   |
| θsa  | 4.60  | °C/w/3" |



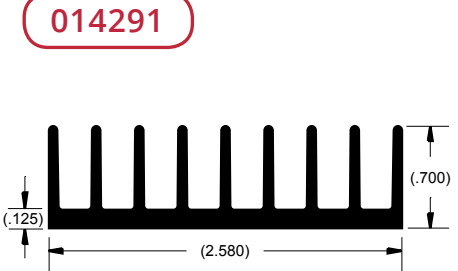
|      |       |         |
|------|-------|---------|
| Per. | 21.14 | in.     |
| WT.  | 1.14  | lb/ft   |
| θsa  | 4.20  | °C/w/3" |



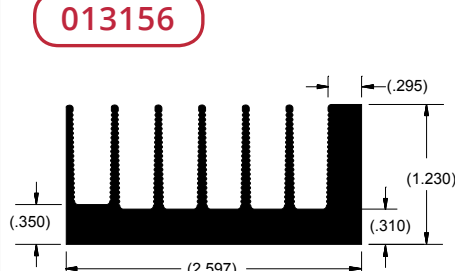
|      |       |         |
|------|-------|---------|
| Per. | 13.48 | in.     |
| WT.  | 0.68  | lb/ft   |
| θsa  | 5.20  | °C/w/3" |



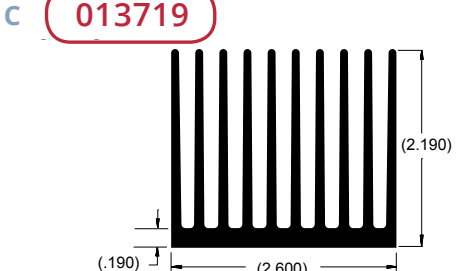
|      |       |         |
|------|-------|---------|
| Per. | 13.84 | in.     |
| WT.  | 0.76  | lb/ft   |
| θsa  | 5.10  | °C/w/3" |



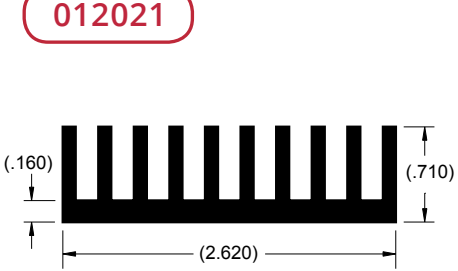
|      |       |         |
|------|-------|---------|
| Per. | 15.25 | in.     |
| WT.  | 0.79  | lb/ft   |
| θsa  | 4.60  | °C/w/3" |



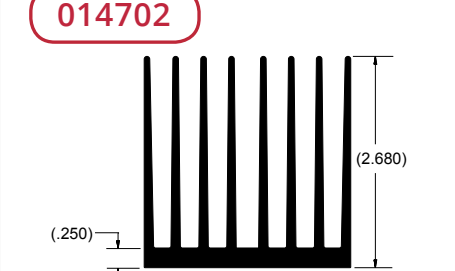
|      |       |         |
|------|-------|---------|
| Per. | 18.12 | in.     |
| WT.  | 1.74  | lb/ft   |
| θsa  | 3.90  | °C/w/3" |



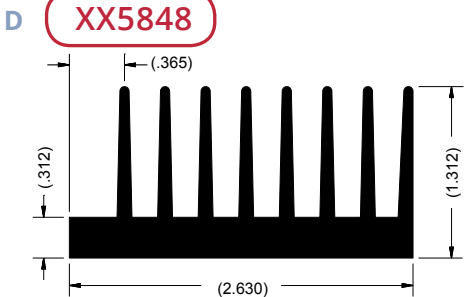
|      |       |         |
|------|-------|---------|
| Per. | 44.29 | in.     |
| WT.  | 2.58  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



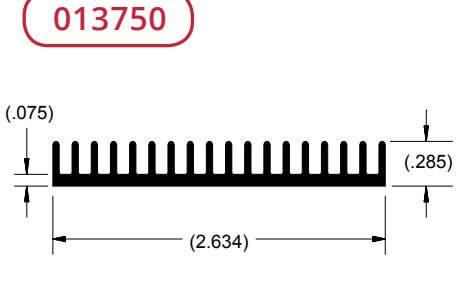
|      |       |         |
|------|-------|---------|
| Per. | 16.56 | in.     |
| WT.  | 1.16  | lb/ft   |
| θsa  | 4.20  | °C/w/3" |



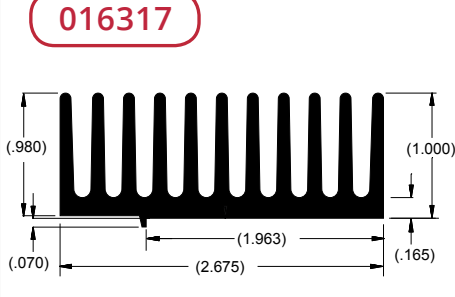
|      |       |         |
|------|-------|---------|
| Per. | 44.19 | in.     |
| WT.  | 2.91  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



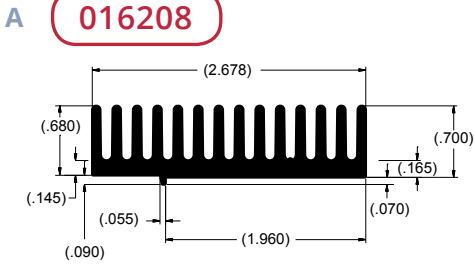
|      |       |         |
|------|-------|---------|
| Per. | 21.37 | in.     |
| WT.  | 1.63  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



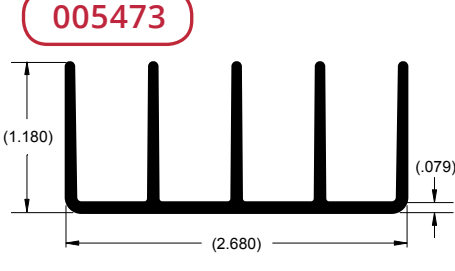
|      |       |         |
|------|-------|---------|
| Per. | 12.37 | in.     |
| WT.  | 0.47  | lb/ft   |
| θsa  | 5.70  | °C/w/3" |



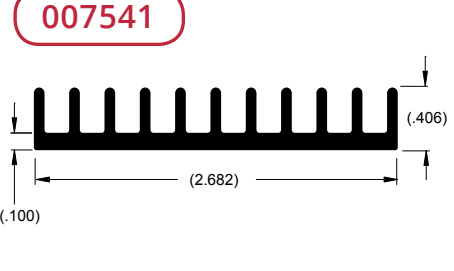
|      |       |         |
|------|-------|---------|
| Per. | 22.91 | in.     |
| WT.  | 1.67  | lb/ft   |
| θsa  | 3.90  | °C/w/3" |



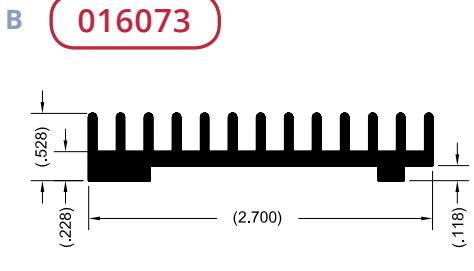
|      |      |         |
|------|------|---------|
| Per. | 5.54 | in.     |
| WT.  | 0.03 | lb/ft   |
| θsa  | 5.90 | °C/w/3" |



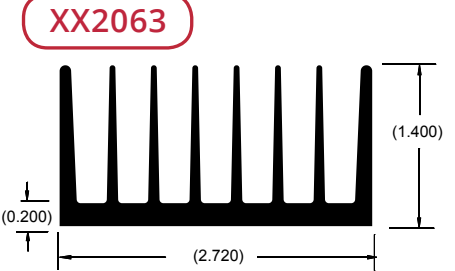
|      |       |         |
|------|-------|---------|
| Per. | 16.52 | in.     |
| WT.  | 0.70  | lb/ft   |
| θsa  | 4.20  | °C/w/3" |



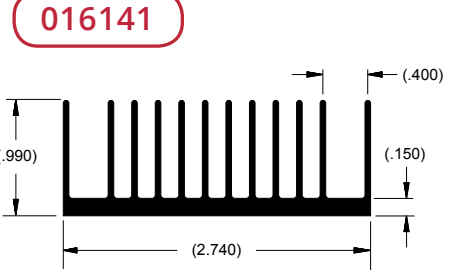
|      |       |         |
|------|-------|---------|
| Per. | 10.58 | in.     |
| WT.  | 0.50  | lb/ft   |
| θsa  | 6.60  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 13.80 | in.     |
| WT.  | 0.71  | lb/ft   |
| θsa  | 5.30  | °C/w/3" |



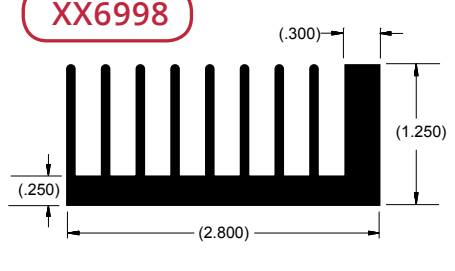
|      |       |         |
|------|-------|---------|
| Per. | 24.24 | in.     |
| WT.  | 1.65  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



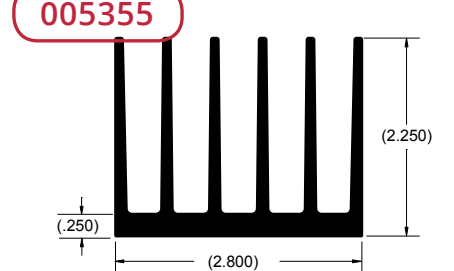
|      |       |         |
|------|-------|---------|
| Per. | 25.40 | in.     |
| WT.  | 1.10  | lb/ft   |
| θsa  | 3.60  | °C/w/3" |



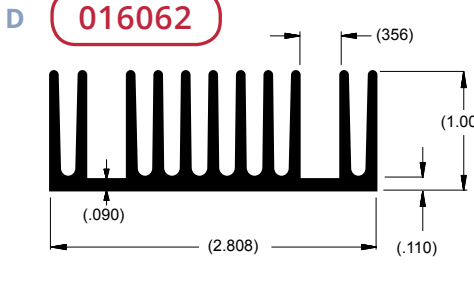
|      |       |         |
|------|-------|---------|
| Per. | 22.07 | in.     |
| WT.  | 1.07  | lb/ft   |
| θsa  | 6.10  | °C/w/3" |



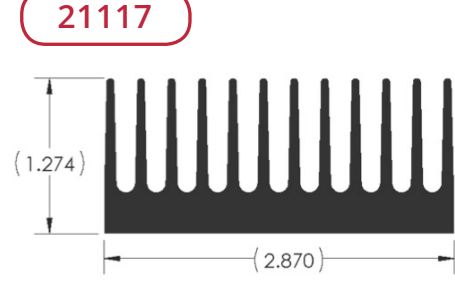
|      |       |         |
|------|-------|---------|
| Per. | 24.10 | in.     |
| WT.  | 1.80  | lb/ft   |
| θsa  | 2.90  | °C/w/3" |



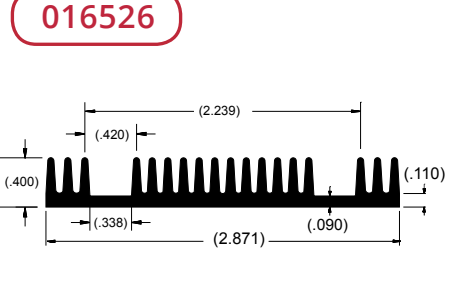
|      |       |         |
|------|-------|---------|
| Per. | 30.00 | in.     |
| WT.  | 2.33  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |



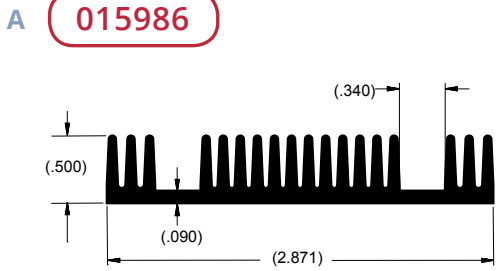
|      |       |         |
|------|-------|---------|
| Per. | 24.47 | in.     |
| WT.  | 1.20  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |



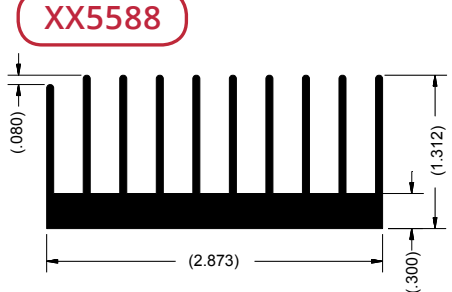
|      |       |         |
|------|-------|---------|
| Per. | 27.36 | in.     |
| WT.  | 2.32  | lb/ft   |
| θsa  | 2.56  | °C/w/3" |



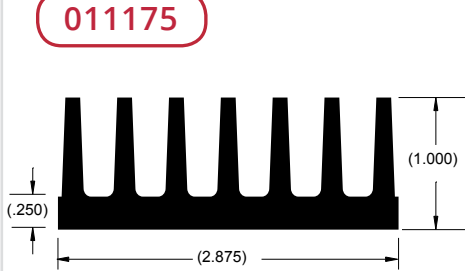
|      |       |         |
|------|-------|---------|
| Per. | 15.24 | in.     |
| WT.  | 0.77  | lb/ft   |
| θsa  | 7.00  | °C/w/3" |



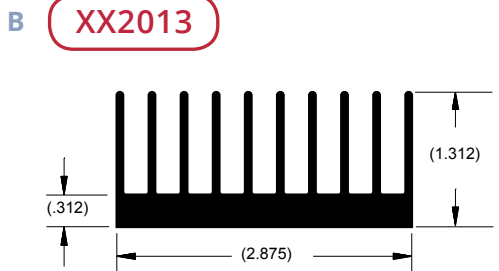
|      |       |         |
|------|-------|---------|
| Per. | 18.85 | in.     |
| WT.  | 0.88  | lb/ft   |
| θsa  | 6.30  | °C/w/3" |



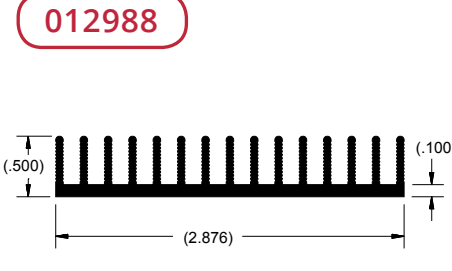
|      |       |         |
|------|-------|---------|
| Per. | 25.86 | in.     |
| WT.  | 1.81  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |



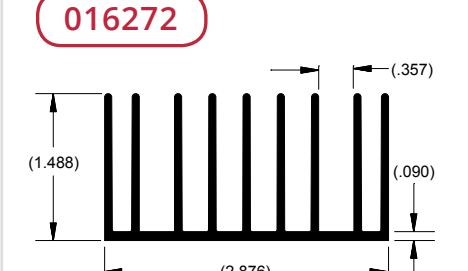
|      |       |         |
|------|-------|---------|
| Per. | 16.33 | in.     |
| WT.  | 1.86  | lb/ft   |
| θsa  | 4.30  | °C/w/3" |



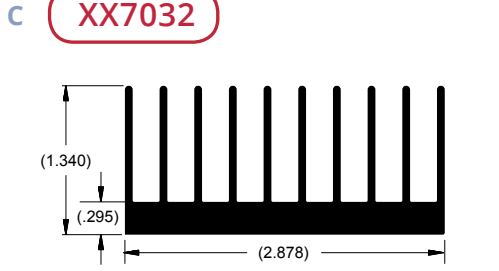
|      |       |         |
|------|-------|---------|
| Per. | 25.66 | in.     |
| WT.  | 1.76  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |



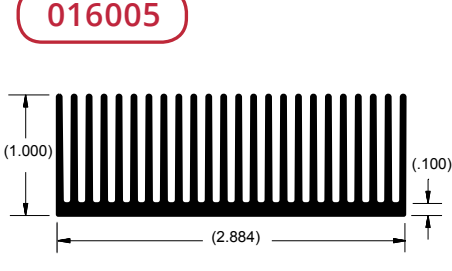
|      |       |         |
|------|-------|---------|
| Per. | 20.13 | in.     |
| WT.  | 0.72  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



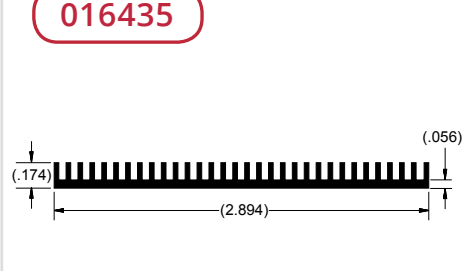
|      |       |         |
|------|-------|---------|
| Per. | 30.65 | in.     |
| WT.  | 1.44  | lb/ft   |
| θsa  | 2.60  | °C/w/3" |



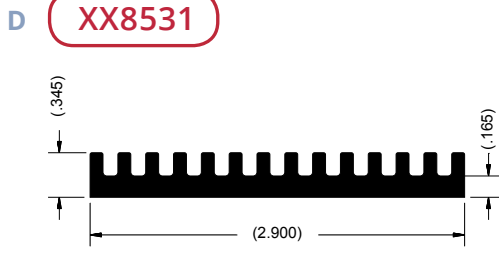
|      |       |         |
|------|-------|---------|
| Per. | 28.41 | in.     |
| WT.  | 1.91  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |



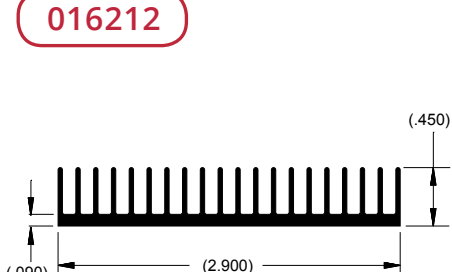
|      |       |         |
|------|-------|---------|
| Per. | 48.21 | in.     |
| WT.  | 1.23  | lb/ft   |
| θsa  | 5.80  | °C/w/3" |



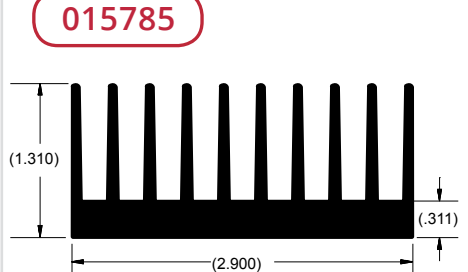
|      |       |         |
|------|-------|---------|
| Per. | 13.45 | in.     |
| WT.  | 0.36  | lb/ft   |
| θsa  | 12.10 | °C/w/3" |



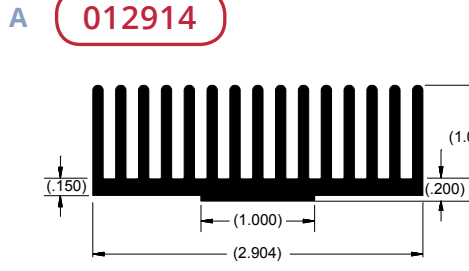
|      |       |         |
|------|-------|---------|
| Per. | 10.70 | in.     |
| WT.  | 0.83  | lb/ft   |
| θsa  | 8.50  | °C/w/3" |



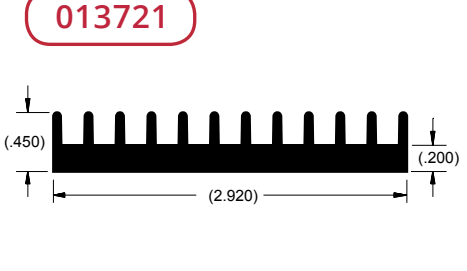
|      |       |         |
|------|-------|---------|
| Per. | 19.78 | in.     |
| WT.  | 0.63  | lb/ft   |
| θsa  | 5.60  | °C/w/3" |



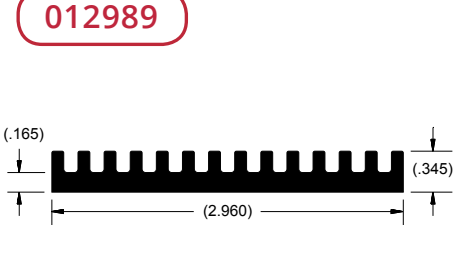
|      |       |         |
|------|-------|---------|
| Per. | 26.14 | in.     |
| WT.  | 1.82  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



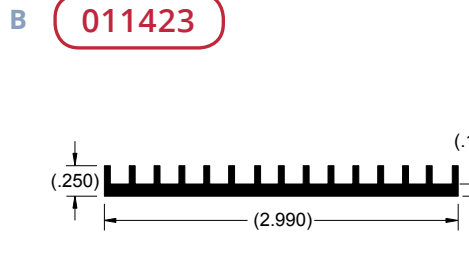
|      |       |         |
|------|-------|---------|
| Per. | 30.94 | in.     |
| WT.  | 1.86  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |



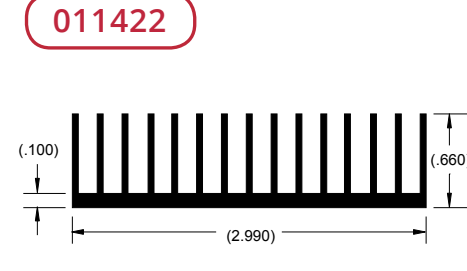
|      |       |         |
|------|-------|---------|
| Per. | 11.76 | in.     |
| WT.  | 0.91  | lb/ft   |
| θsa  | 6.00  | °C/w/3" |



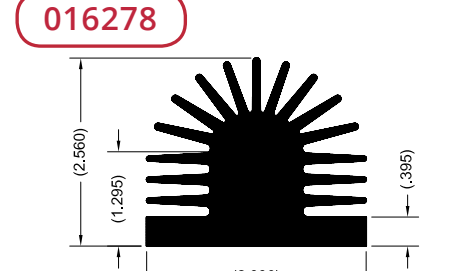
|      |       |         |
|------|-------|---------|
| Per. | 10.74 | in.     |
| WT.  | 0.89  | lb/ft   |
| θsa  | 6.50  | °C/w/3" |



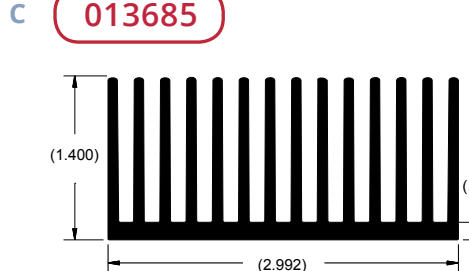
|      |       |         |
|------|-------|---------|
| Per. | 10.56 | in.     |
| WT.  | 0.48  | lb/ft   |
| θsa  | 6.60  | °C/w/3" |



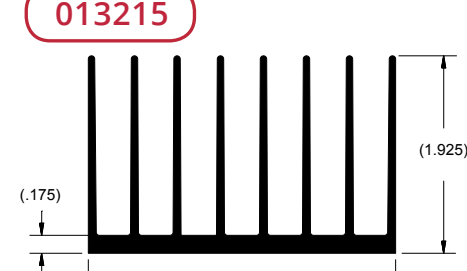
|      |       |         |
|------|-------|---------|
| Per. | 22.86 | in.     |
| WT.  | 0.84  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



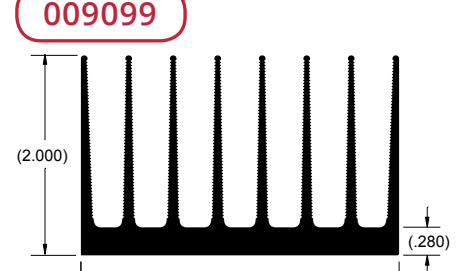
|      |       |         |
|------|-------|---------|
| Per. | 31.34 | in.     |
| WT.  | 4.84  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |



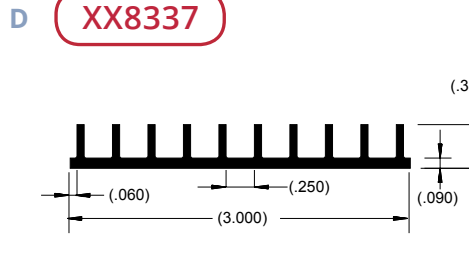
|      |       |         |
|------|-------|---------|
| Per. | 40.47 | in.     |
| WT.  | 2.32  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |



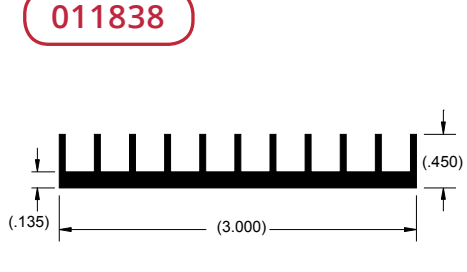
|      |       |         |
|------|-------|---------|
| Per. | 33.84 | in.     |
| WT.  | 1.80  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



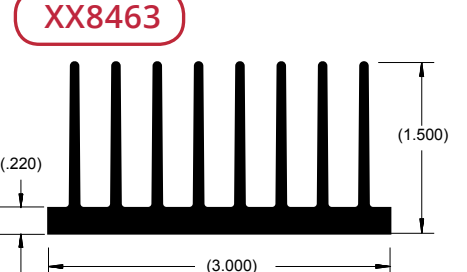
|      |       |         |
|------|-------|---------|
| Per. | 45.93 | in.     |
| WT.  | 2.56  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



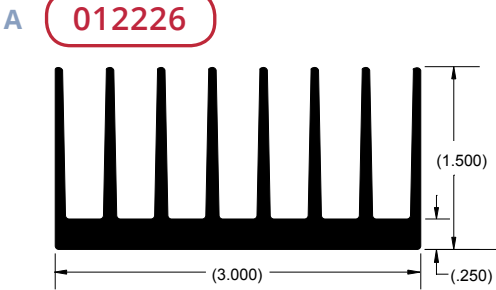
|      |       |         |
|------|-------|---------|
| Per. | 11.70 | in.     |
| WT.  | 0.51  | lb/ft   |
| θsa  | 5.50  | °C/w/3" |



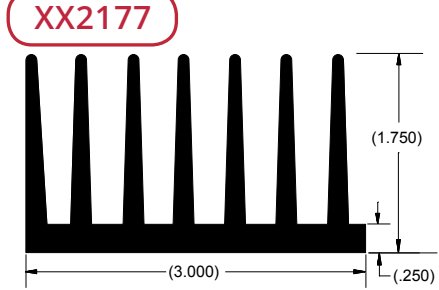
|      |       |         |
|------|-------|---------|
| Per. | 13.11 | in.     |
| WT.  | 0.67  | lb/ft   |
| θsa  | 5.30  | °C/w/3" |



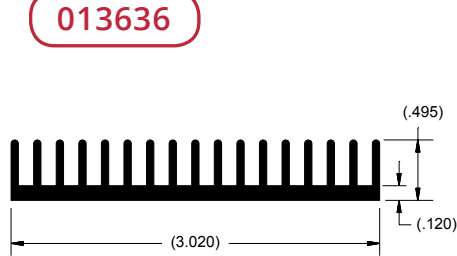
|      |       |         |
|------|-------|---------|
| Per. | 26.30 | in.     |
| WT.  | 1.54  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |



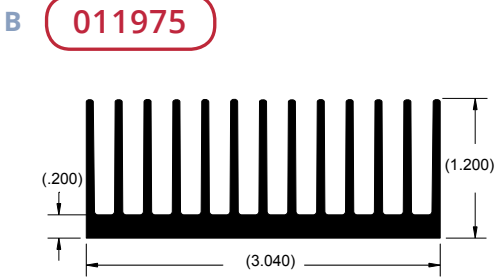
|      |       |         |
|------|-------|---------|
| Per. | 25.74 | in.     |
| WT.  | 1.83  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |



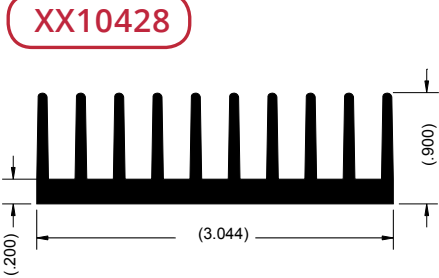
|      |       |         |
|------|-------|---------|
| Per. | 26.60 | in.     |
| WT.  | 2.64  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



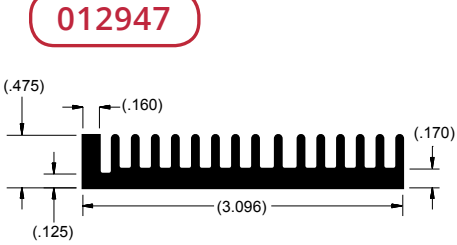
|      |       |         |
|------|-------|---------|
| Per. | 18.46 | in.     |
| WT.  | 0.86  | lb/ft   |
| θsa  | 3.80  | °C/w/3" |



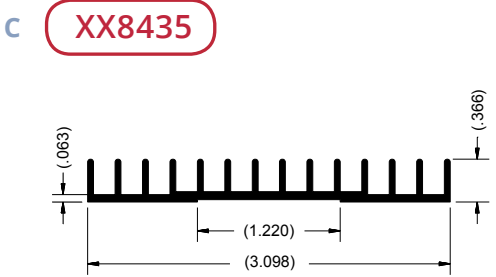
|      |       |         |
|------|-------|---------|
| Per. | 31.70 | in.     |
| WT.  | 1.75  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |



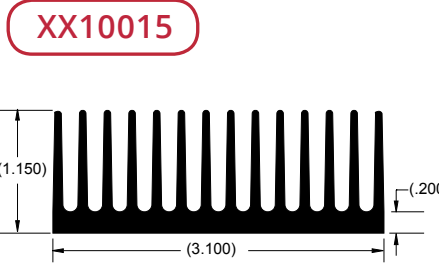
|      |       |         |
|------|-------|---------|
| Per. | 19.93 | in.     |
| WT.  | 1.46  | lb/ft   |
| θsa  | 3.90  | °C/w/3" |



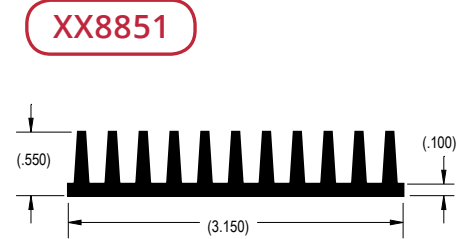
|      |       |         |
|------|-------|---------|
| Per. | 15.61 | in.     |
| WT.  | 1.01  | lb/ft   |
| θsa  | 4.50  | °C/w/3" |



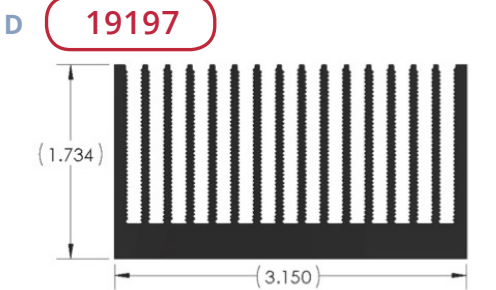
|      |       |         |
|------|-------|---------|
| Per. | 14.20 | in.     |
| WT.  | 0.49  | lb/ft   |
| θsa  | 6.00  | °C/w/3" |



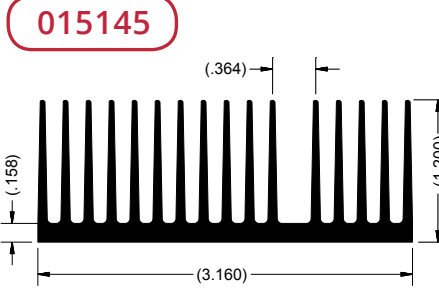
|      |       |         |
|------|-------|---------|
| Per. | 31.71 | in.     |
| WT.  | 1.91  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |



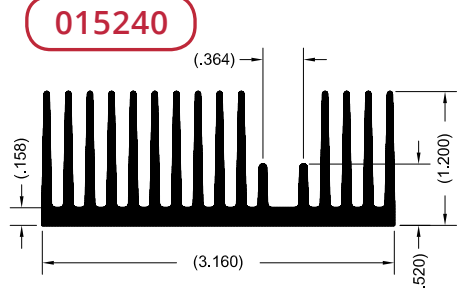
|      |       |         |
|------|-------|---------|
| Per. | 16.60 | in.     |
| WT.  | 0.93  | lb/ft   |
| θsa  | 4.90  | °C/w/3" |



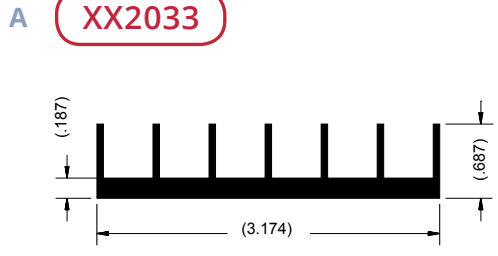
|      |       |         |
|------|-------|---------|
| Per. | 68.96 | in.     |
| WT.  | 2.88  | lb/ft   |
| θsa  | 1.01  | °C/w/3" |



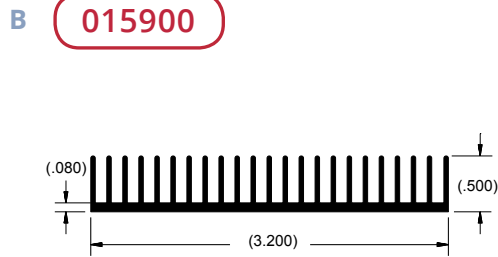
|      |       |         |
|------|-------|---------|
| Per. | 38.58 | in.     |
| WT.  | 1.80  | lb/ft   |
| θsa  | 4.40  | °C/w/3" |



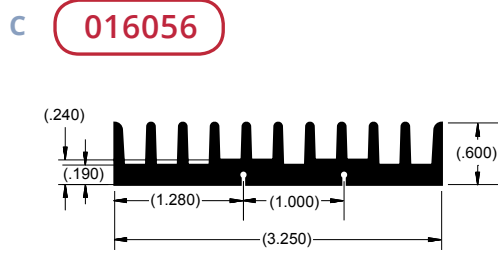
|      |       |         |
|------|-------|---------|
| Per. | 35.89 | in.     |
| WT.  | 1.72  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



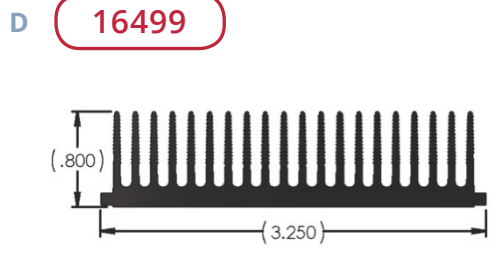
|      |       |         |
|------|-------|---------|
| Per. | 13.72 | in.     |
| WT.  | 0.97  | lb/ft   |
| θsa  | 3.30  | °C/w/3" |



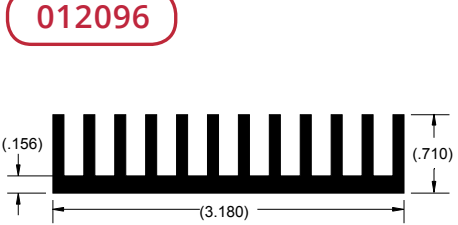
|      |       |         |
|------|-------|---------|
| Per. | 25.30 | in.     |
| WT.  | 0.77  | lb/ft   |
| θsa  | 6.00  | °C/w/3" |



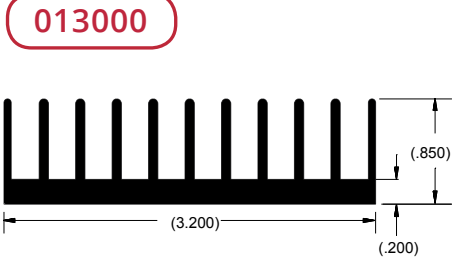
|      |       |         |
|------|-------|---------|
| Per. | 15.52 | in.     |
| WT.  | 1.20  | lb/ft   |
| θsa  | 4.60  | °C/w/3" |



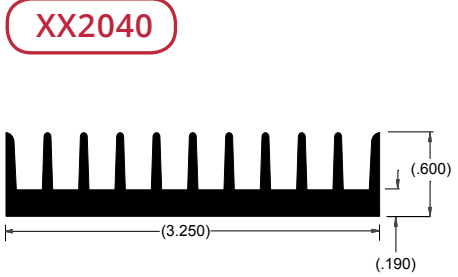
|      |       |         |
|------|-------|---------|
| Per. | 32.59 | in.     |
| WT.  | 1.46  | lb/ft   |
| θsa  | 2.15  | °C/w/3" |



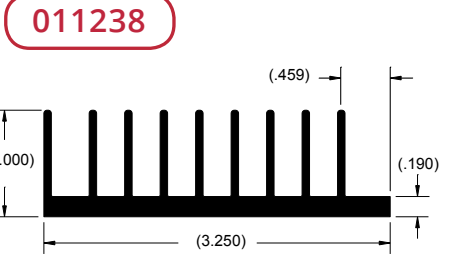
|      |       |         |
|------|-------|---------|
| Per. | 19.97 | in.     |
| WT.  | 1.39  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



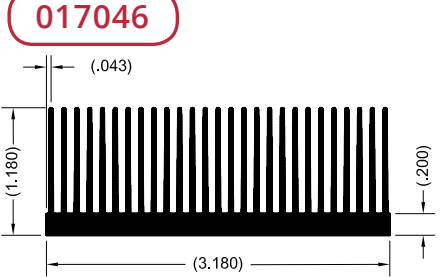
|      |       |         |
|------|-------|---------|
| Per. | 20.66 | in.     |
| WT.  | 1.41  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |



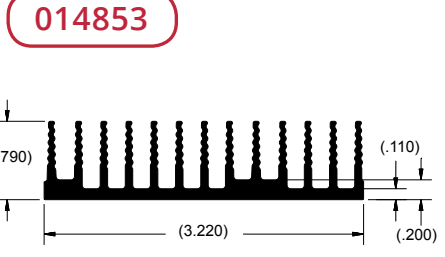
|      |       |         |
|------|-------|---------|
| Per. | 15.31 | in.     |
| WT.  | 1.14  | lb/ft   |
| θsa  | 3.00  | °C/w/3" |



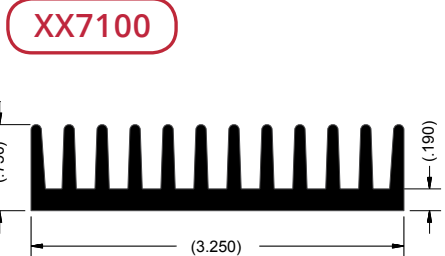
|      |       |         |
|------|-------|---------|
| Per. | 21.12 | in.     |
| WT.  | 1.35  | lb/ft   |
| θsa  | 3.30  | °C/w/3" |



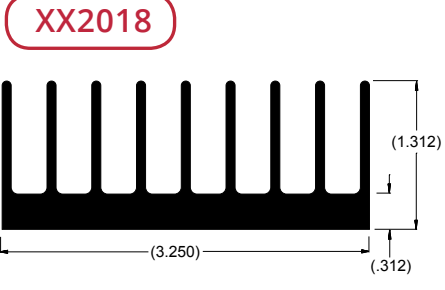
|      |       |         |
|------|-------|---------|
| Per. | 58.72 | in.     |
| WT.  | 1.87  | lb/ft   |
| θsa  | 3.20  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 24.00 | in.     |
| WT.  | 1.17  | lb/ft   |
| θsa  | 4.00  | °C/w/3" |

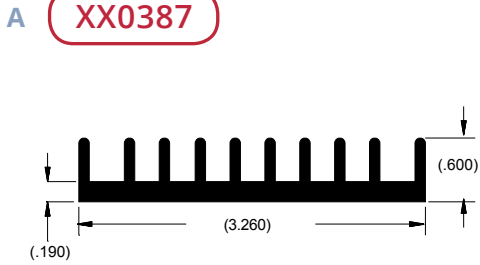


|      |       |         |
|------|-------|---------|
| Per. | 21.00 | in.     |
| WT.  | 1.35  | lb/ft   |
| θsa  | 2.60  | °C/w/3" |

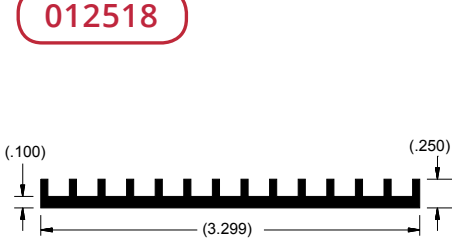


|      |       |         |
|------|-------|---------|
| Per. | 24.40 | in.     |
| WT.  | 2.09  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |

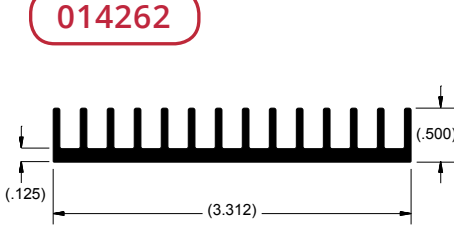




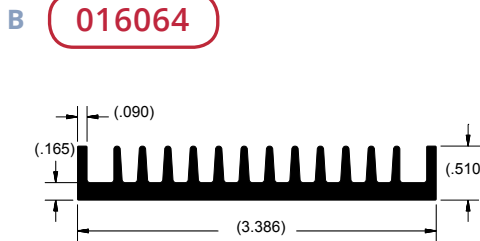
|      |       |         |
|------|-------|---------|
| Per. | 15.10 | in.     |
| WT.  | 1.23  | lb/ft   |
| θsa  | 4.40  | °C/w/3" |



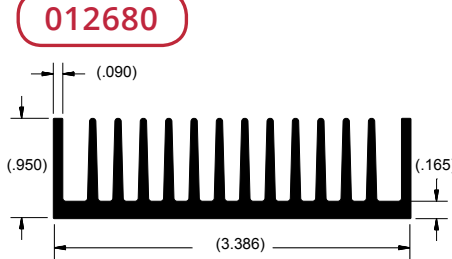
|      |       |         |
|------|-------|---------|
| Per. | 10.89 | in.     |
| WT.  | 0.54  | lb/ft   |
| θsa  | 6.40  | °C/w/3" |



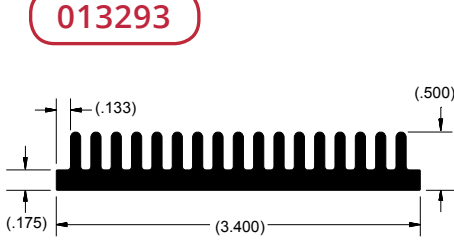
|      |       |         |
|------|-------|---------|
| Per. | 16.94 | in.     |
| WT.  | 0.88  | lb/ft   |
| θsa  | 4.10  | °C/w/3" |



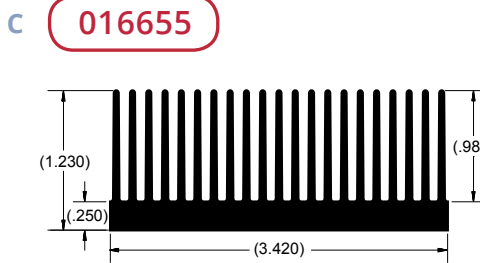
|      |       |         |
|------|-------|---------|
| Per. | 15.71 | in.     |
| WT.  | 1.13  | lb/ft   |
| θsa  | 5.20  | °C/w/3" |



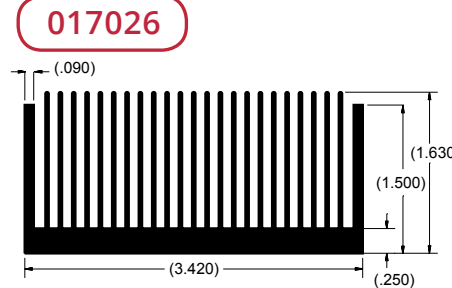
|      |       |         |
|------|-------|---------|
| Per. | 27.96 | in.     |
| WT.  | 1.74  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



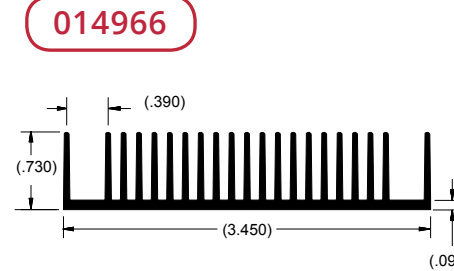
|      |       |         |
|------|-------|---------|
| Per. | 17.07 | in.     |
| WT.  | 1.29  | lb/ft   |
| θsa  | 4.10  | °C/w/3" |



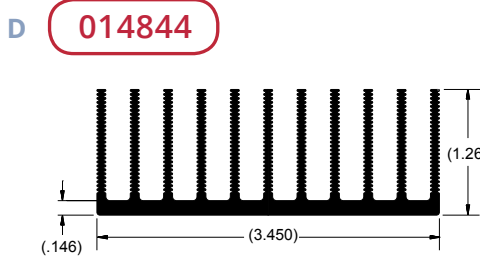
|      |       |         |
|------|-------|---------|
| Per. | 47.29 | in.     |
| WT.  | 2.33  | lb/ft   |
| θsa  | 4.90  | °C/w/3" |



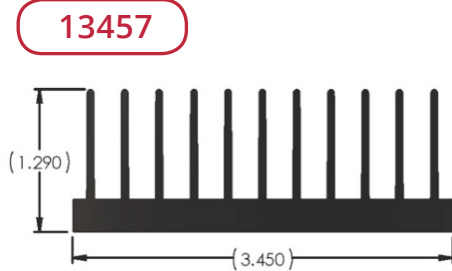
|      |       |         |
|------|-------|---------|
| Per. | 75.51 | in.     |
| WT.  | 2.47  | lb/ft   |
| θsa  | 5.40  | °C/w/3" |



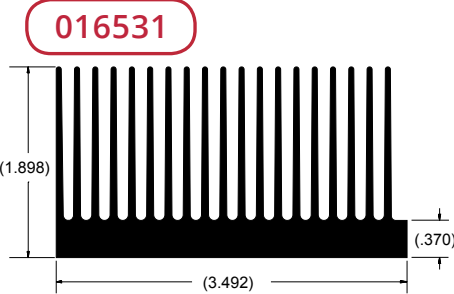
|      |       |         |
|------|-------|---------|
| Per. | 33.25 | in.     |
| WT.  | 1.22  | lb/ft   |
| θsa  | 4.80  | °C/w/3" |



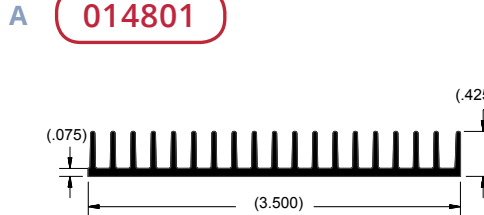
|      |       |         |
|------|-------|---------|
| Per. | 44.42 | in.     |
| WT.  | 1.62  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



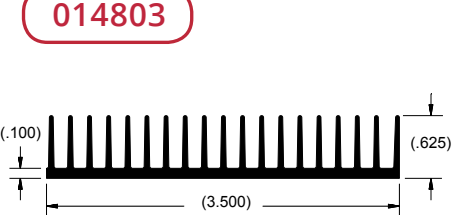
|      |       |         |
|------|-------|---------|
| Per. | 28.99 | in.     |
| WT.  | 2.07  | lb/ft   |
| θsa  | 2.41  | °C/w/3" |



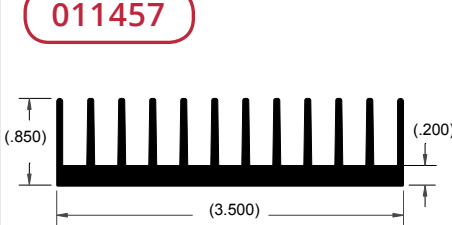
|      |       |         |
|------|-------|---------|
| Per. | 64.12 | in.     |
| WT.  | 3.67  | lb/ft   |
| θsa  | 2.60  | °C/w/3" |



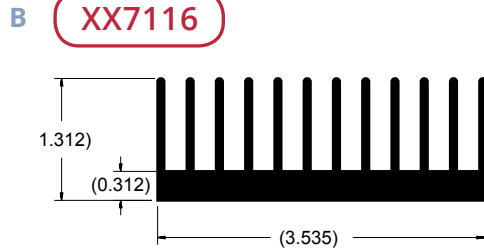
|      |       |         |
|------|-------|---------|
| Per. | 19.65 | in.     |
| WT.  | 0.67  | lb/ft   |
| θsa  | 5.30  | °C/w/3" |



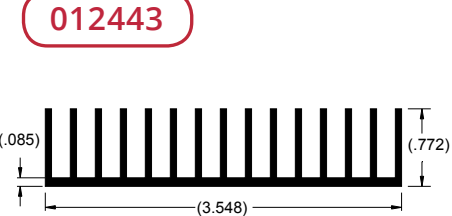
|      |       |         |
|------|-------|---------|
| Per. | 26.23 | in.     |
| WT.  | 0.98  | lb/ft   |
| θsa  | 4.50  | °C/w/3" |



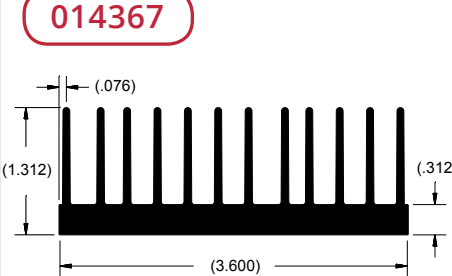
|      |       |         |
|------|-------|---------|
| Per. | 22.48 | in.     |
| WT.  | 1.48  | lb/ft   |
| θsa  | 3.00  | °C/w/3" |



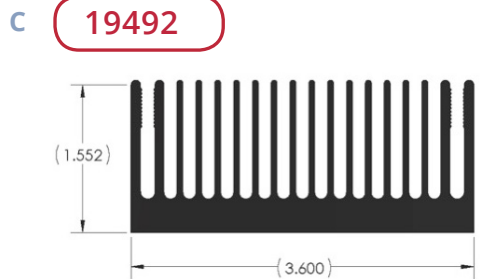
|      |       |         |
|------|-------|---------|
| Per. | 31.33 | in.     |
| WT.  | 2.32  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |



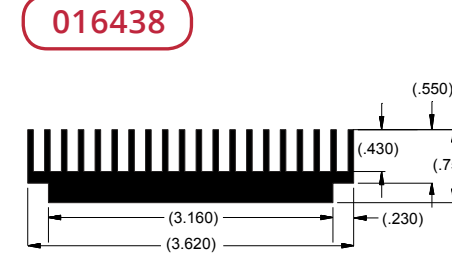
|      |       |         |
|------|-------|---------|
| Per. | 27.76 | in.     |
| WT.  | 1.10  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



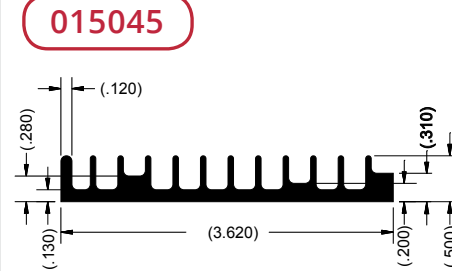
|      |       |         |
|------|-------|---------|
| Per. | 31.04 | in.     |
| WT.  | 2.42  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |



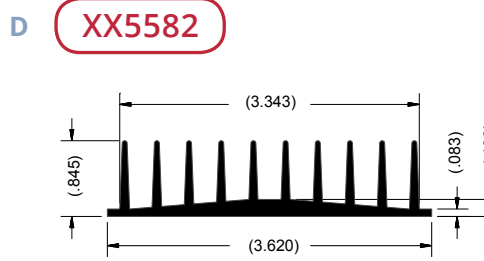
|      |       |         |
|------|-------|---------|
| Per. | 51.76 | in.     |
| WT.  | 3.39  | lb/ft   |
| θsa  | 1.35  | °C/w/3" |



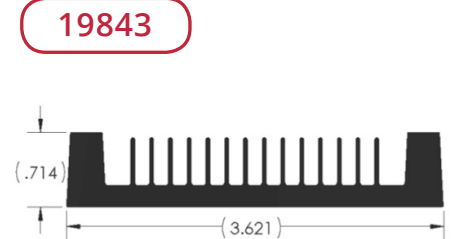
|      |       |         |
|------|-------|---------|
| Per. | 25.08 | in.     |
| WT.  | 1.92  | lb/ft   |
| θsa  | 4.20  | °C/w/3" |



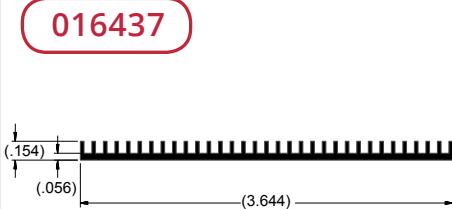
|      |       |         |
|------|-------|---------|
| Per. | 15.01 | in.     |
| WT.  | 1.04  | lb/ft   |
| θsa  | 4.90  | °C/w/3" |



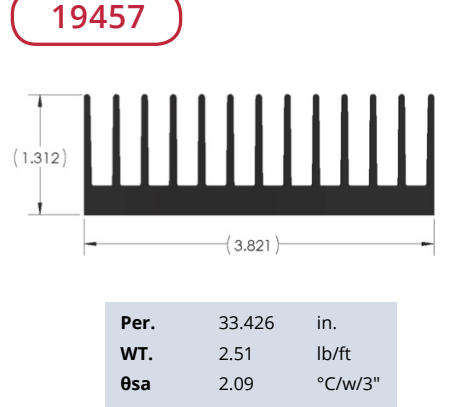
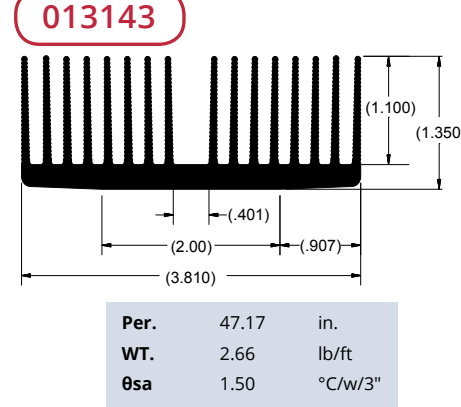
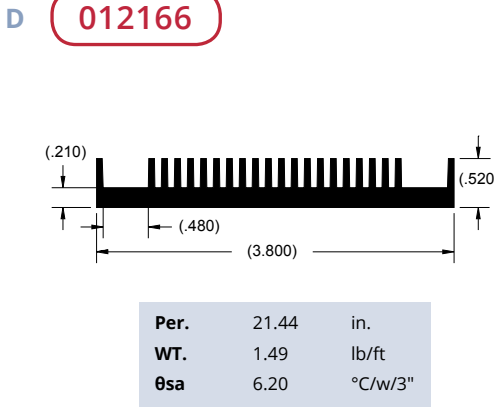
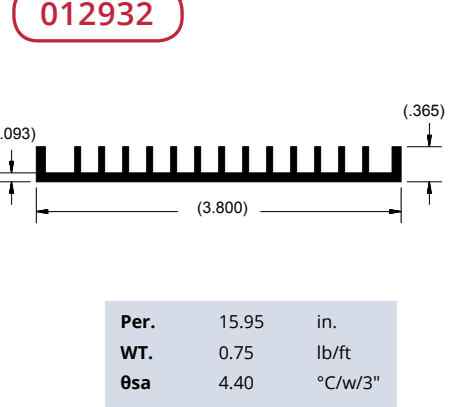
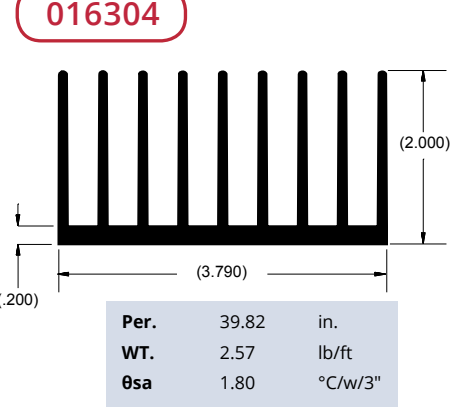
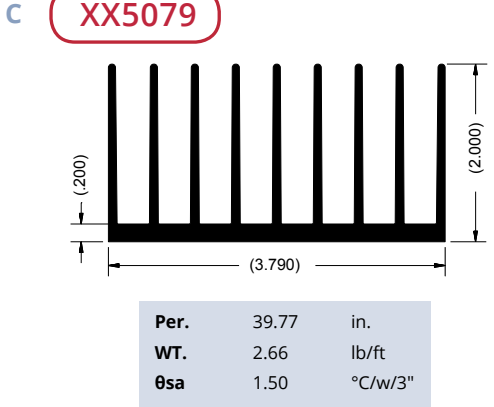
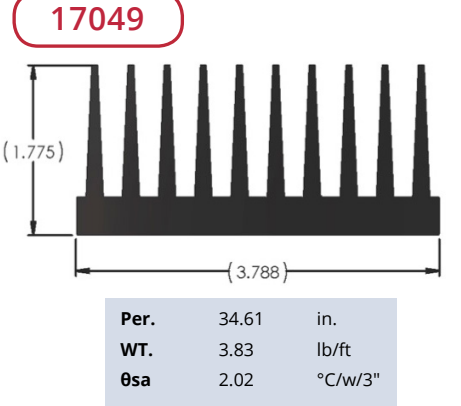
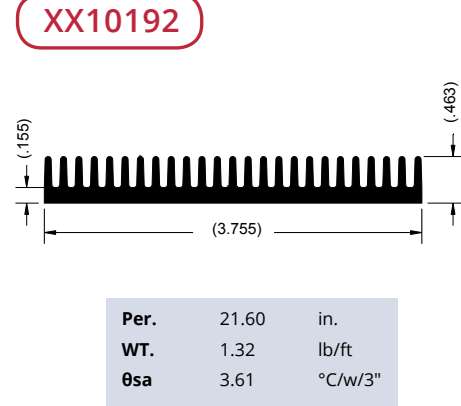
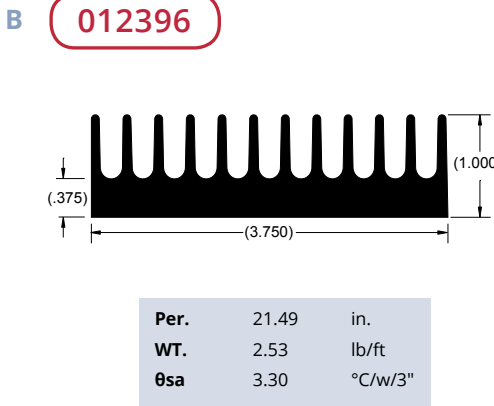
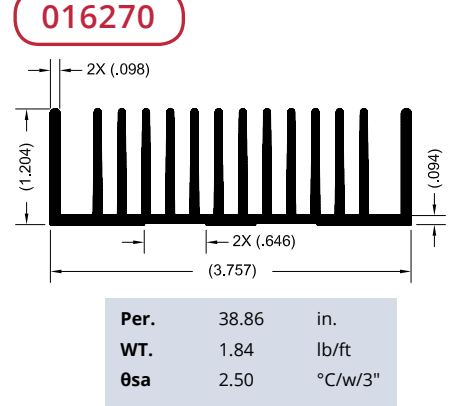
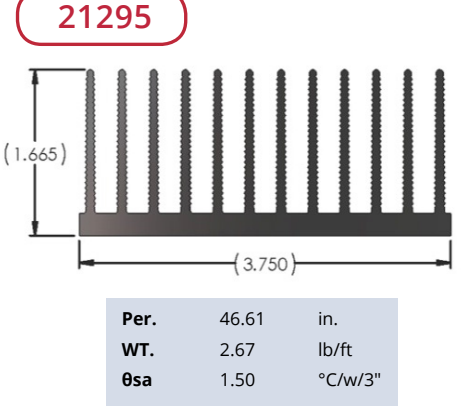
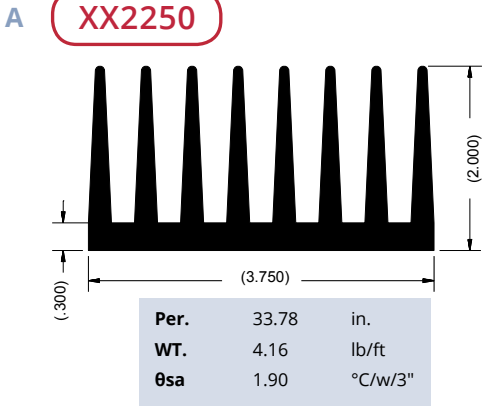
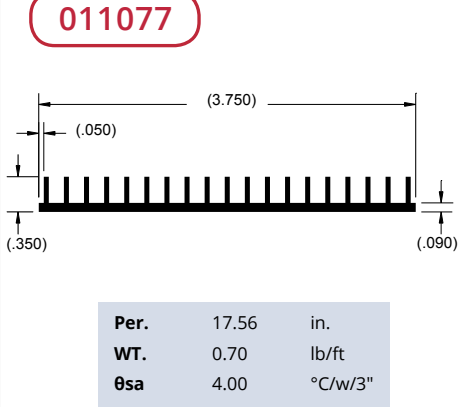
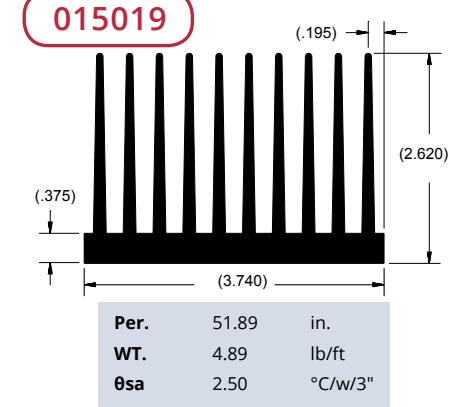
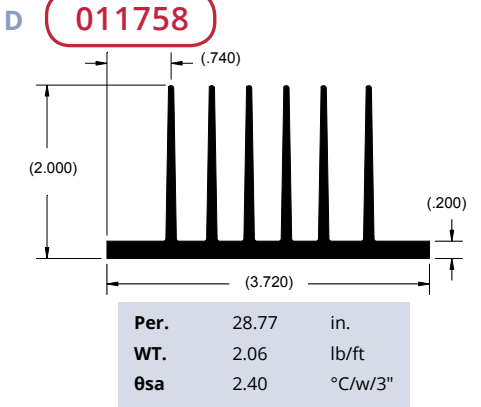
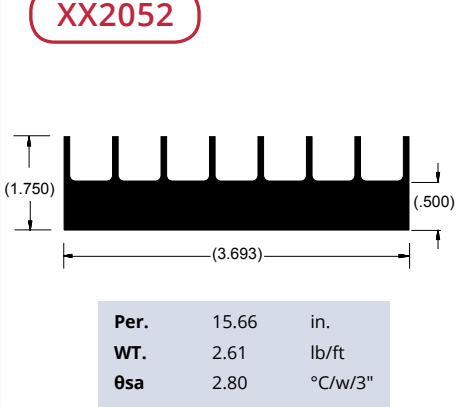
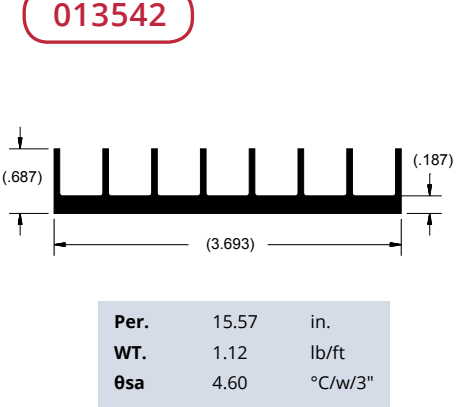
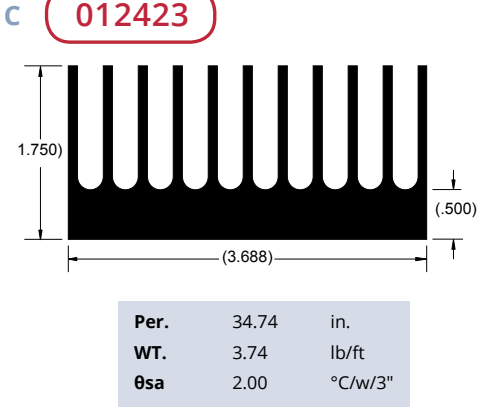
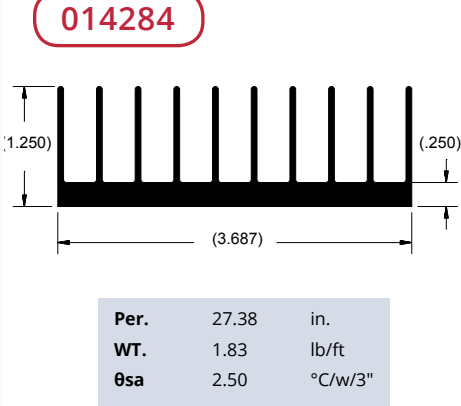
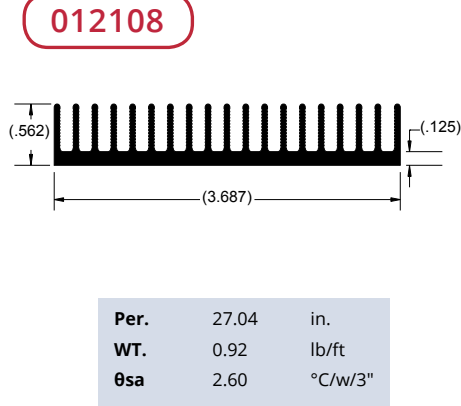
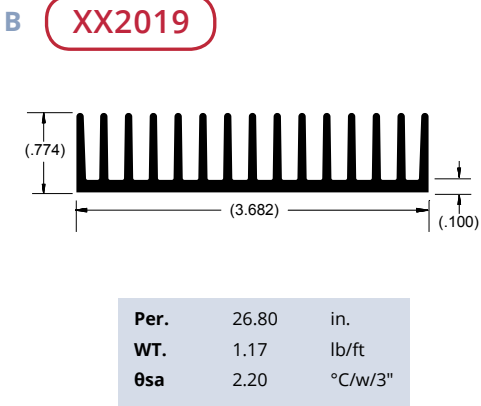
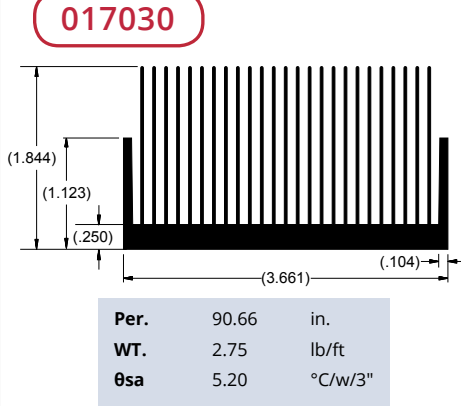
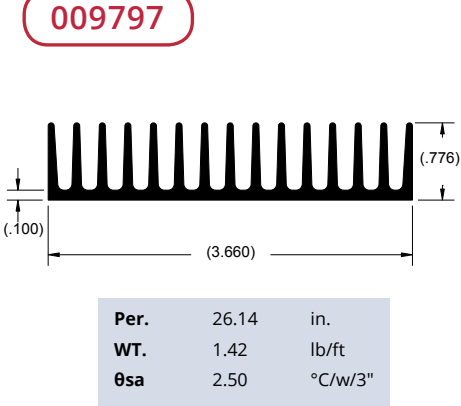
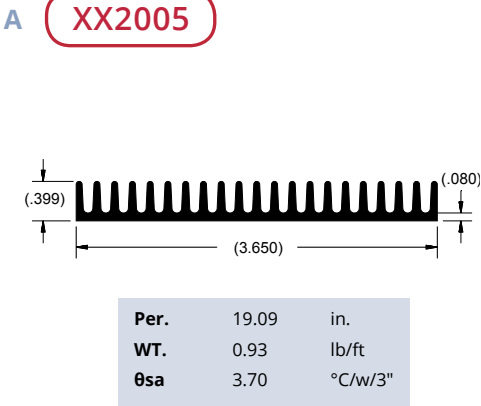
|      |       |         |
|------|-------|---------|
| Per. | 20.71 | in.     |
| WT.  | 1.26  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 21.58 | in.     |
| WT.  | 1.67  | lb/ft   |
| θsa  | 3.24  | °C/w/3" |

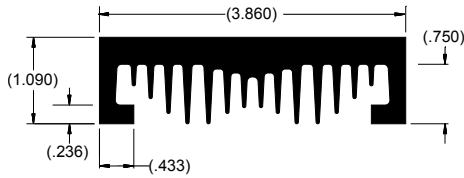


|      |       |         |
|------|-------|---------|
| Per. | 13.87 | in.     |
| WT.  | 0.38  | lb/ft   |
| θsa  | 12.00 | °C/w/3" |



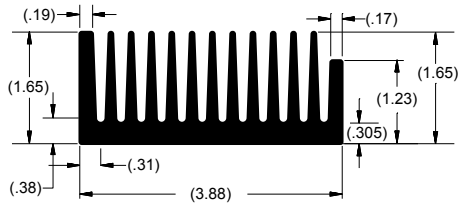
A

016269



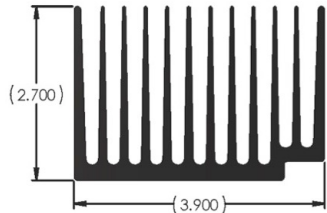
|      |       |         |
|------|-------|---------|
| Per. | 25.82 | in.     |
| WT.  | 2.93  | lb/ft   |
| θsa  | 3.30  | °C/w/3" |

016360



|      |       |         |
|------|-------|---------|
| Per. | 40.33 | in.     |
| WT.  | 3.89  | lb/ft   |
| θsa  | 2.90  | °C/w/3" |

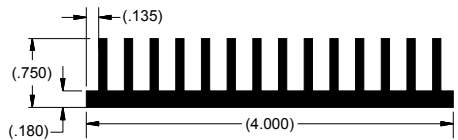
19529



|      |       |         |
|------|-------|---------|
| Per. | 63.88 | in.     |
| WT.  | 4.66  | lb/ft   |
| θsa  | 1.09  | °C/w/3" |

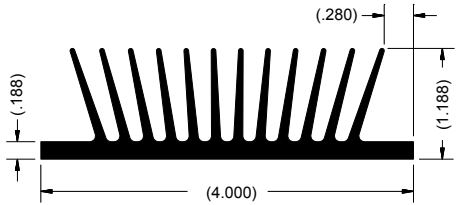
A

016573



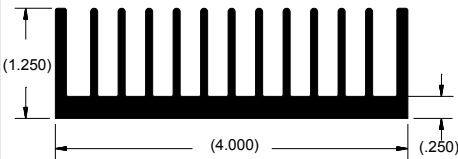
|      |       |         |
|------|-------|---------|
| Per. | 24.32 | in.     |
| WT.  | 1.73  | lb/ft   |
| θsa  | 3.70  | °C/w/3" |

XX4678



|      |       |         |
|------|-------|---------|
| Per. | 32.90 | in.     |
| WT.  | 1.93  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |

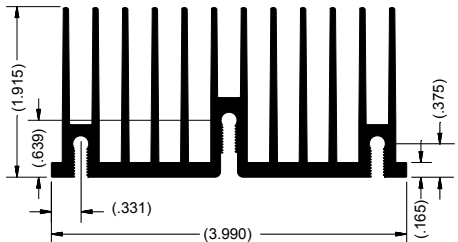
013605



|      |       |         |
|------|-------|---------|
| Per. | 33.87 | in.     |
| WT.  | 2.55  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |

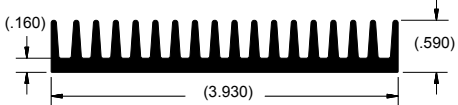
B

016061



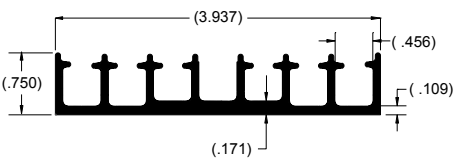
|      |       |         |
|------|-------|---------|
| Per. | 51.63 | in.     |
| WT.  | 2.81  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |

015878



|      |       |         |
|------|-------|---------|
| Per. | 21.95 | in.     |
| WT.  | 1.54  | lb/ft   |
| θsa  | 9.70  | °C/w/3" |

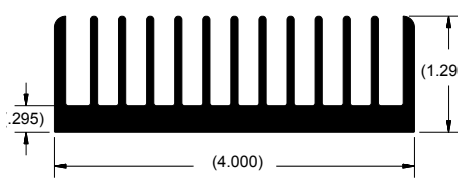
002853



|      |       |         |
|------|-------|---------|
| Per. | 22.00 | in.     |
| WT.  | 1.20  | lb/ft   |
| θsa  | 3.20  | °C/w/3" |

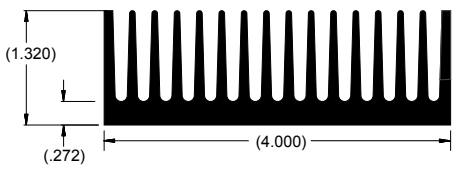
B

XX2039



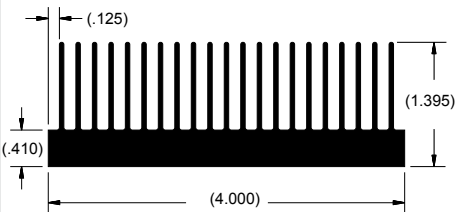
|      |       |         |
|------|-------|---------|
| Per. | 33.66 | in.     |
| WT.  | 2.75  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |

016047



|      |       |         |
|------|-------|---------|
| Per. | 40.03 | in.     |
| WT.  | 3.15  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |

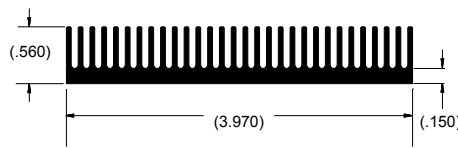
016403



|      |       |         |
|------|-------|---------|
| Per. | 49.20 | in.     |
| WT.  | 3.21  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |

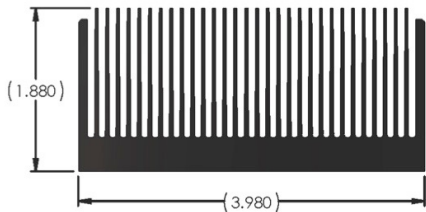
C

016501



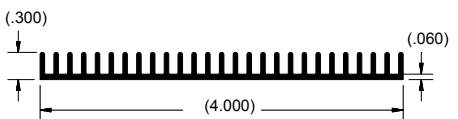
|      |       |         |
|------|-------|---------|
| Per. | 31.46 | in.     |
| WT.  | 1.55  | lb/ft   |
| θsa  | 6.10  | °C/w/3" |

17047



|      |        |         |
|------|--------|---------|
| Per. | 102.27 | in.     |
| WT.  | 4.33   | lb/ft   |
| θsa  | 0.68   | °C/w/3" |

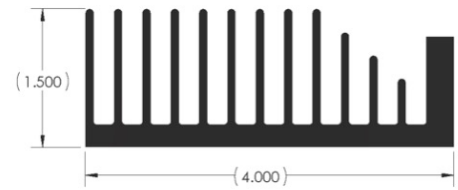
013569



|      |       |         |
|------|-------|---------|
| Per. | 20.17 | in.     |
| WT.  | 0.67  | lb/ft   |
| θsa  | 7.20  | °C/w/3" |

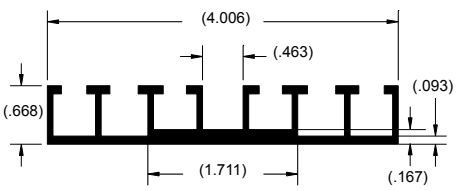
C

19353



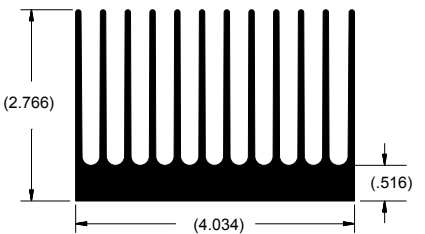
|      |       |         |
|------|-------|---------|
| Per. | 36.60 | in.     |
| WT.  | 2.99  | lb/ft   |
| θsa  | 1.91  | °C/w/3" |

XX9001



|      |       |         |
|------|-------|---------|
| Per. | 19.51 | in.     |
| WT.  | 1.08  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |

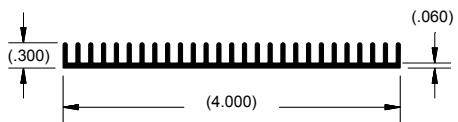
015273



|      |       |         |
|------|-------|---------|
| Per. | 61.28 | in.     |
| WT.  | 5.37  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |

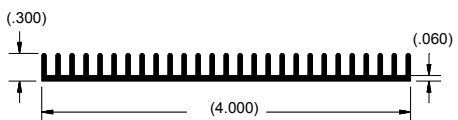
D

XX4434-P2



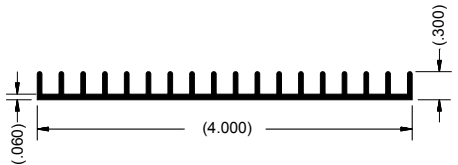
|      |       |         |
|------|-------|---------|
| Per. | 20.16 | in.     |
| WT.  | 0.67  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |

XX4434-P1



|      |       |         |
|------|-------|---------|
| Per. | 16.22 | in.     |
| WT.  | 0.55  | lb/ft   |
| θsa  | 3.00  | °C/w/3" |

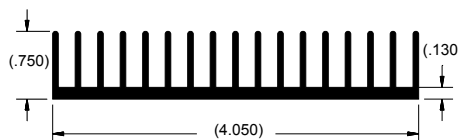
XX4434-P3



|      |       |         |
|------|-------|---------|
| Per. | 23.96 | in.     |
| WT.  | 0.76  | lb/ft   |
| θsa  | 7.00  | °C/w/3" |

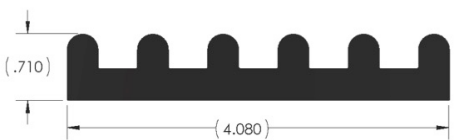
D

012696



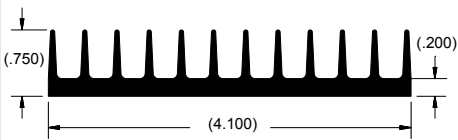
|      |       |         |
|------|-------|---------|
| Per. | 28.99 | in.     |
| WT.  | 1.41  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |

19694



|      |       |         |
|------|-------|---------|
| Per. | 12.34 | in.     |
| WT.  | 2.50  | lb/ft   |
| θsa  | 5.66  | °C/w/3" |

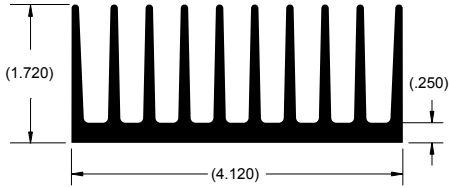
XX2096



|      |       |         |
|------|-------|---------|
| Per. | 20.48 | in.     |
| WT.  | 1.56  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |

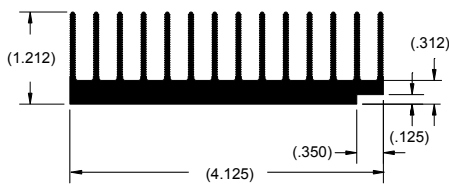
A

011299



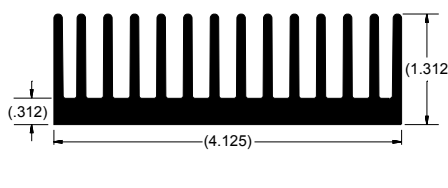
|      |       |         |
|------|-------|---------|
| Per. | 36.66 | in.     |
| WT.  | 3.41  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |

008658



|      |       |         |
|------|-------|---------|
| Per. | 42.61 | in.     |
| WT.  | 2.41  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |

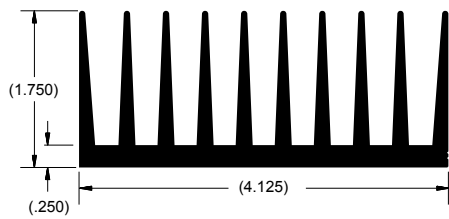
XX2012



|      |       |         |
|------|-------|---------|
| Per. | 35.79 | in.     |
| WT.  | 3.30  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |

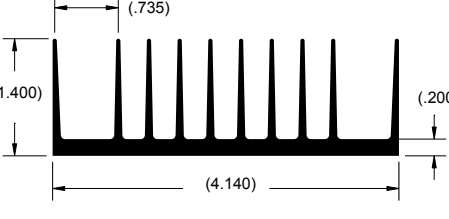
B

XX5138



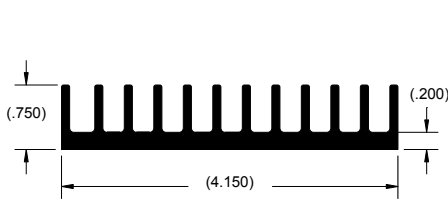
|      |       |         |
|------|-------|---------|
| Per. | 37.30 | in.     |
| WT.  | 3.53  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |

009396



|      |       |         |
|------|-------|---------|
| Per. | 31.61 | in.     |
| WT.  | 2.07  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |

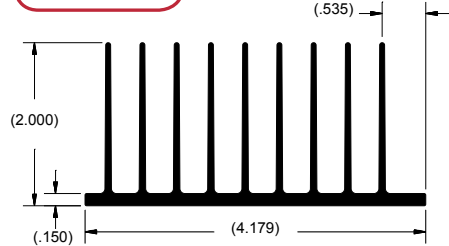
010785



|      |       |         |
|------|-------|---------|
| Per. | 21.17 | in.     |
| WT.  | 1.80  | lb/ft   |
| θsa  | 3.20  | °C/w/3" |

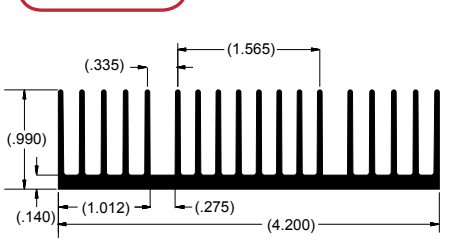
C

013733



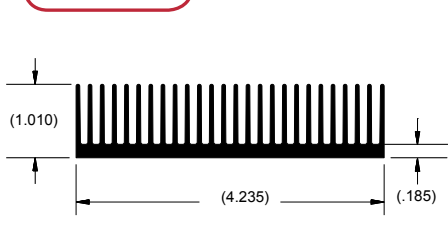
|      |       |         |
|------|-------|---------|
| Per. | 41.06 | in.     |
| WT.  | 2.16  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |

016423



|      |       |         |
|------|-------|---------|
| Per. | 38.35 | in.     |
| WT.  | 1.72  | lb/ft   |
| θsa  | 2.90  | °C/w/3" |

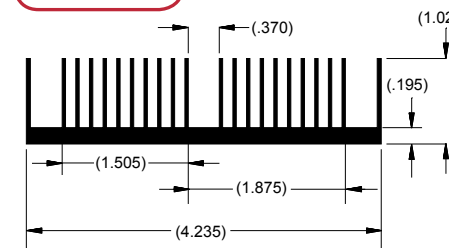
014813



|      |       |         |
|------|-------|---------|
| Per. | 50.61 | in.     |
| WT.  | 2.46  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |

D

016192



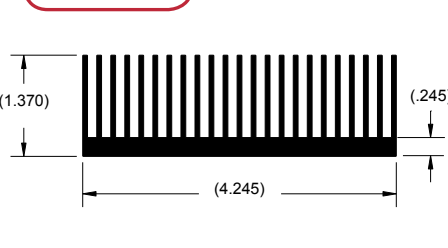
|      |       |         |
|------|-------|---------|
| Per. | 45.16 | in.     |
| WT.  | 1.88  | lb/ft   |
| θsa  | 3.60  | °C/w/3" |

016232



|      |       |         |
|------|-------|---------|
| Per. | 50.70 | in.     |
| WT.  | 2.49  | lb/ft   |
| θsa  | 3.70  | °C/w/3" |

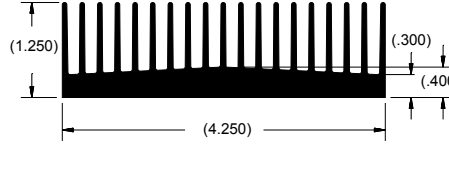
009168



|      |       |         |
|------|-------|---------|
| Per. | 59.90 | in.     |
| WT.  | 3.30  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |

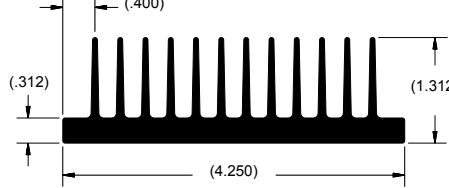
A

012677



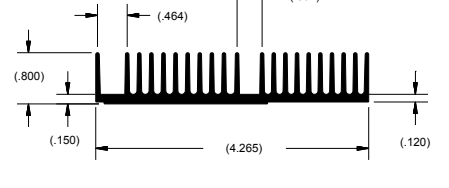
|      |       |         |
|------|-------|---------|
| Per. | 42.21 | in.     |
| WT.  | 3.16  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |

XX2004



|      |       |         |
|------|-------|---------|
| Per. | 31.70 | in.     |
| WT.  | 2.75  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |

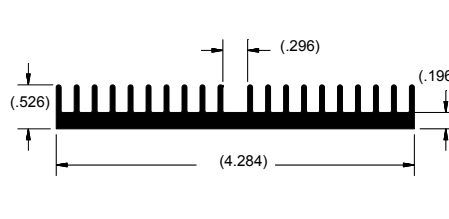
014793



|      |       |         |
|------|-------|---------|
| Per. | 34.36 | in.     |
| WT.  | 1.78  | lb/ft   |
| θsa  | 4.30  | °C/w/3" |

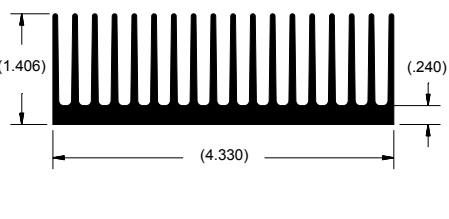
B

015936



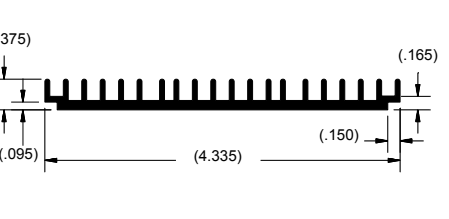
|      |       |         |
|------|-------|---------|
| Per. | 21.39 | in.     |
| WT.  | 1.47  | lb/ft   |
| θsa  | 4.50  | °C/w/3" |

013729



|      |       |         |
|------|-------|---------|
| Per. | 49.27 | in.     |
| WT.  | 3.13  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |

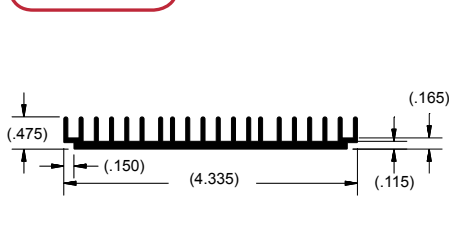
016003



|      |       |         |
|------|-------|---------|
| Per. | 18.90 | in.     |
| WT.  | 0.95  | lb/ft   |
| θsa  | 6.10  | °C/w/3" |

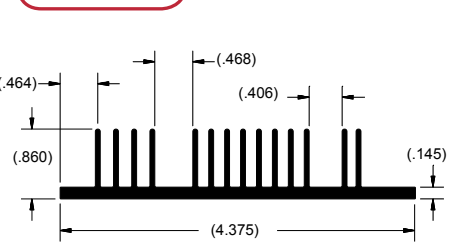
C

015945



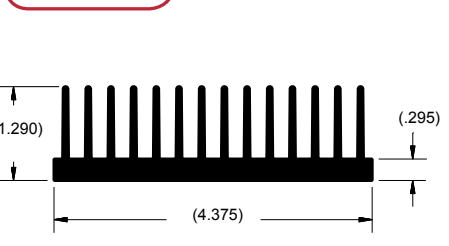
|      |       |         |
|------|-------|---------|
| Per. | 22.40 | in.     |
| WT.  | 1.09  | lb/ft   |
| θsa  | 5.80  | °C/w/3" |

015172



|      |       |         |
|------|-------|---------|
| Per. | 28.44 | in.     |
| WT.  | 1.48  | lb/ft   |
| θsa  | 4.20  | °C/w/3" |

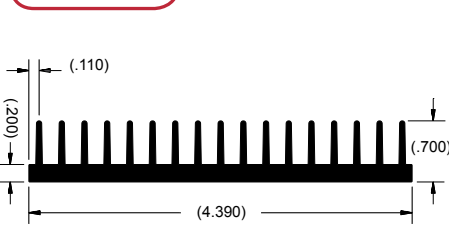
XX1527



|      |       |         |
|------|-------|---------|
| Per. | 36.45 | in.     |
| WT.  | 2.58  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |

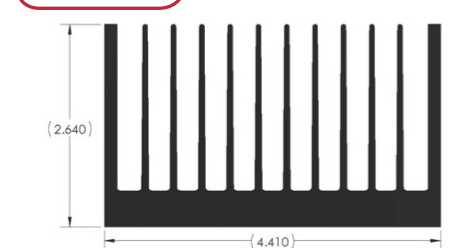
D

013564



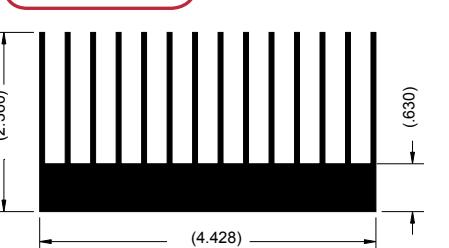
|      |       |         |
|------|-------|---------|
| Per. | 25.37 | in.     |
| WT.  | 1.74  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |

19249



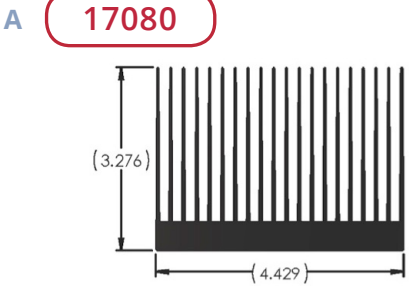
|      |       |         |
|------|-------|---------|
| Per. | 60.91 | in.     |
| WT.  | 5.27  | lb/ft   |
| θsa  | 1.15  | °C/w/3" |

XX10253

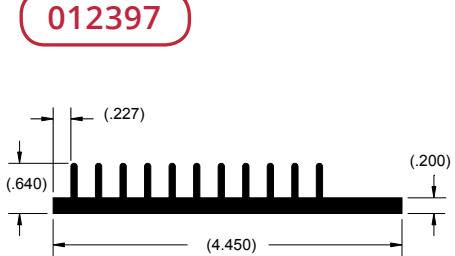


|      |       |         |
|------|-------|---------|
| Per. | 58.56 | in.     |
| WT.  | 5.24  | lb/ft   |
| θsa  | 1.36  | °C/w/3" |

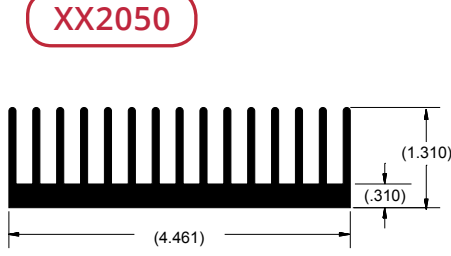




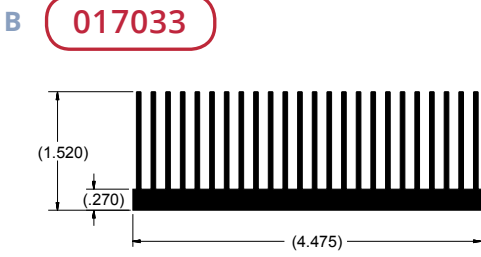
|      |        |         |
|------|--------|---------|
| Per. | 118.88 | in.     |
| WT.  | 6.34   | lb/ft   |
| θsa  | 0.59   | °C/w/3" |



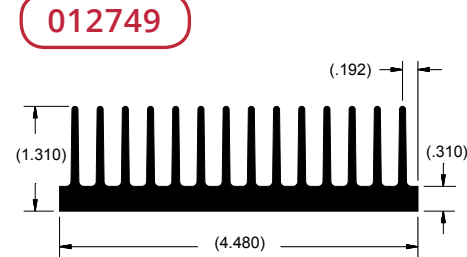
|      |       |         |
|------|-------|---------|
| Per. | 18.60 | in.     |
| WT.  | 1.52  | lb/ft   |
| θsa  | 3.80  | °C/w/3" |



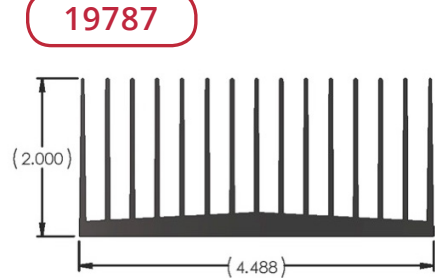
|      |       |         |
|------|-------|---------|
| Per. | 38.94 | in.     |
| WT.  | 3.32  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |



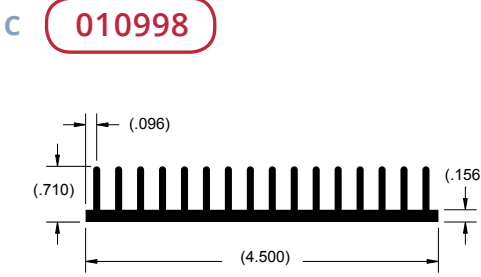
|      |       |         |
|------|-------|---------|
| Per. | 69.28 | in.     |
| WT.  | 3.57  | lb/ft   |
| θsa  | 3.60  | °C/w/3" |



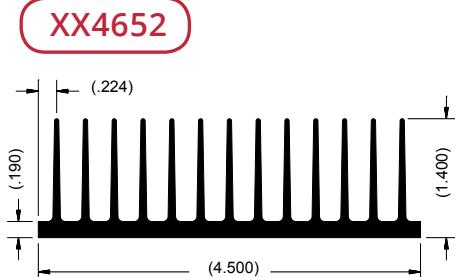
|      |       |         |
|------|-------|---------|
| Per. | 36.08 | in.     |
| WT.  | 3.14  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



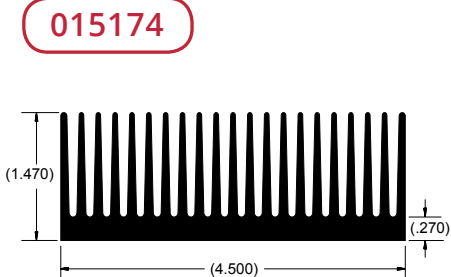
|      |       |         |
|------|-------|---------|
| Per. | 61.33 | in.     |
| WT.  | 2.97  | lb/ft   |
| θsa  | 1.14  | °C/w/3" |



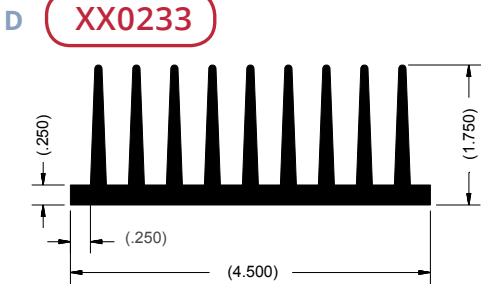
|      |       |         |
|------|-------|---------|
| Per. | 26.42 | in.     |
| WT.  | 1.78  | lb/ft   |
| θsa  | 2.60  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 40.32 | in.     |
| WT.  | 2.37  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



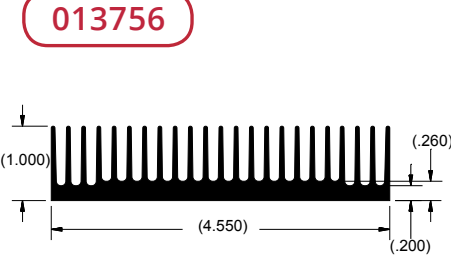
|      |       |         |
|------|-------|---------|
| Per. | 57.50 | in.     |
| WT.  | 4.19  | lb/ft   |
| θsa  | 1.20  | °C/w/3" |



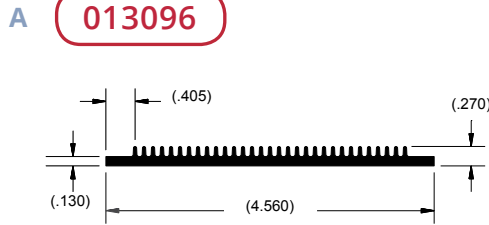
|      |       |         |
|------|-------|---------|
| Per. | 36.00 | in.     |
| WT.  | 3.15  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



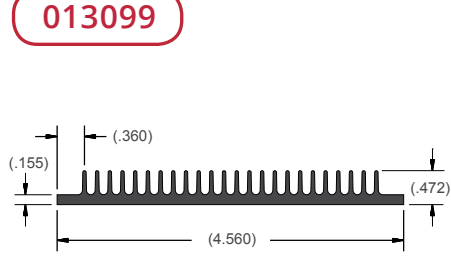
|      |        |         |
|------|--------|---------|
| Per. | 47.335 | in.     |
| WT.  | 3.37   | lb/ft   |
| θsa  | 1.48   | °C/w/3" |



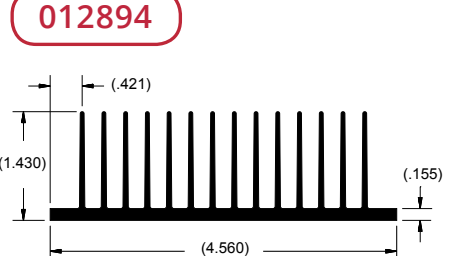
|      |       |         |
|------|-------|---------|
| Per. | 42.33 | in.     |
| WT.  | 2.61  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |



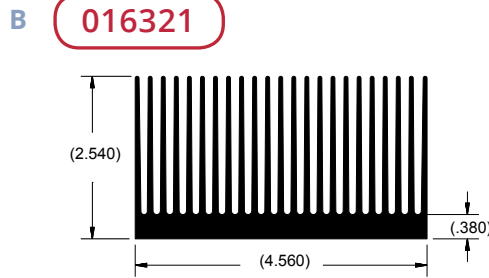
|      |       |         |
|------|-------|---------|
| Per. | 16.43 | in.     |
| WT.  | 0.97  | lb/ft   |
| θsa  | 4.30  | °C/w/3" |



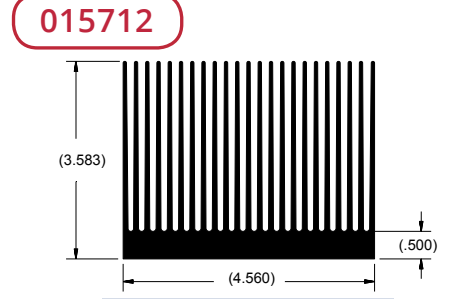
|      |       |         |
|------|-------|---------|
| Per. | 22.70 | in.     |
| WT.  | 1.20  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



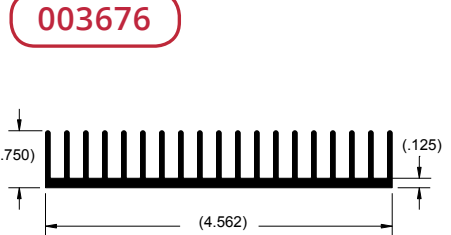
|      |       |         |
|------|-------|---------|
| Per. | 44.20 | in.     |
| WT.  | 2.13  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



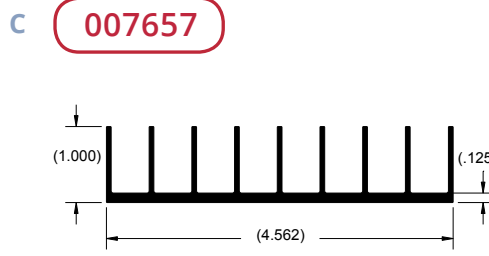
|      |        |         |
|------|--------|---------|
| Per. | 106.91 | in.     |
| WT.  | 6.57   | lb/ft   |
| θsa  | 3.40   | °C/w/3" |



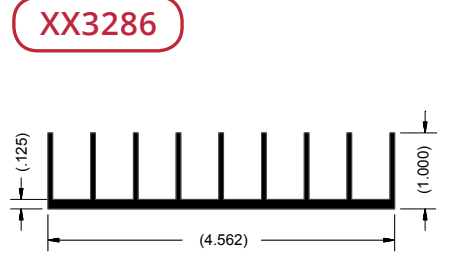
|      |        |         |
|------|--------|---------|
| Per. | 149.60 | in.     |
| WT.  | 9.13   | lb/ft   |
| θsa  | 2.90   | °C/w/3" |



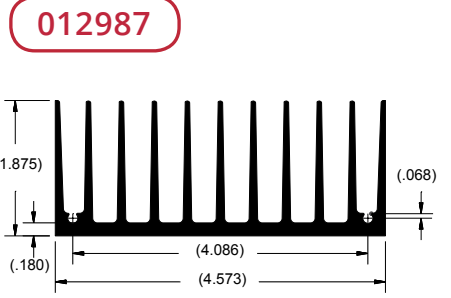
|      |       |         |
|------|-------|---------|
| Per. | 32.39 | in.     |
| WT.  | 1.56  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |



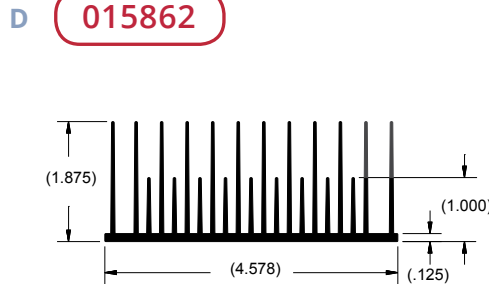
|      |       |         |
|------|-------|---------|
| Per. | 24.83 | in.     |
| WT.  | 1.27  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |



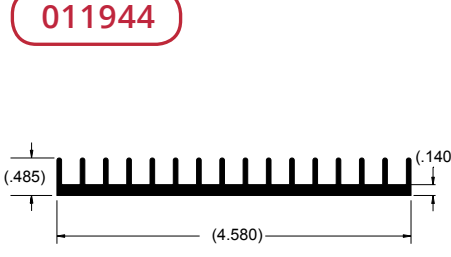
|      |       |         |
|------|-------|---------|
| Per. | 24.92 | in.     |
| WT.  | 1.28  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |



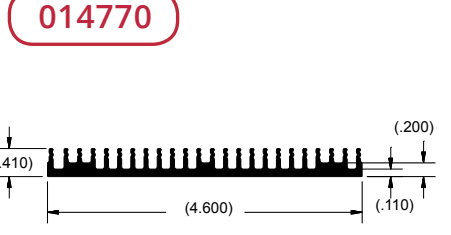
|      |       |         |
|------|-------|---------|
| Per. | 45.36 | in.     |
| WT.  | 3.07  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 65.91 | in.     |
| WT.  | 2.55  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |

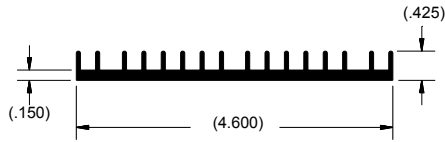


|      |       |         |
|------|-------|---------|
| Per. | 19.85 | in.     |
| WT.  | 1.16  | lb/ft   |
| θsa  | 3.90  | °C/w/3" |



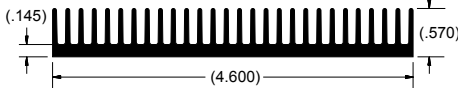
|      |       |         |
|------|-------|---------|
| Per. | 22.28 | in.     |
| WT.  | 1.18  | lb/ft   |
| θsa  | 6.20  | °C/w/3" |

A 013618



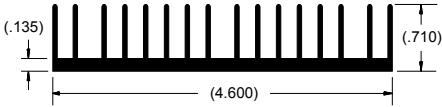
|      |       |         |
|------|-------|---------|
| Per. | 17.69 | in.     |
| WT.  | 1.14  | lb/ft   |
| θsa  | 4.00  | °C/w/3" |

013716



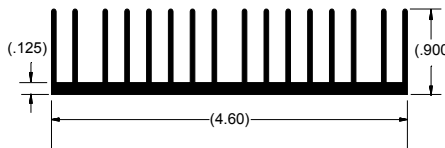
|      |       |         |
|------|-------|---------|
| Per. | 31.72 | in.     |
| WT.  | 1.54  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |

012823



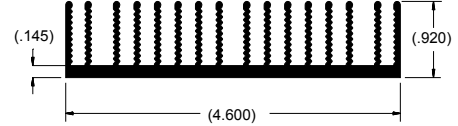
|      |       |         |
|------|-------|---------|
| Per. | 27.45 | in.     |
| WT.  | 1.40  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |

B 012614



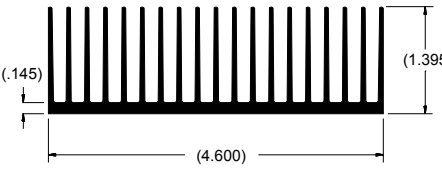
|      |       |         |
|------|-------|---------|
| Per. | 33.85 | in.     |
| WT.  | 1.63  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |

012777



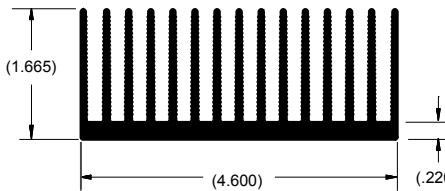
|      |       |         |
|------|-------|---------|
| Per. | 39.24 | in.     |
| WT.  | 1.77  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |

013717



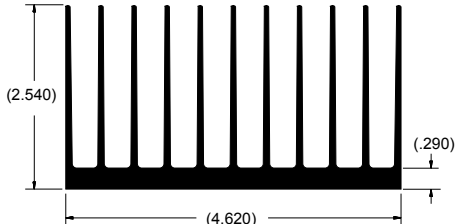
|      |       |         |
|------|-------|---------|
| Per. | 55.74 | in.     |
| WT.  | 2.44  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |

C 016374



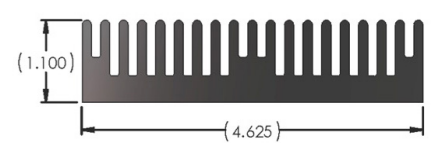
|      |       |         |
|------|-------|---------|
| Per. | 57.59 | in.     |
| WT.  | 3.29  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |

012918



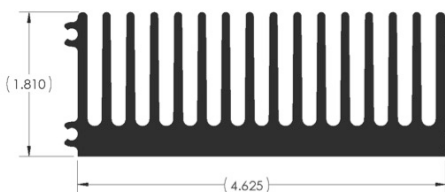
|      |       |         |
|------|-------|---------|
| Per. | 58.19 | in.     |
| WT.  | 3.74  | lb/ft   |
| θsa  | 1.20  | °C/w/3" |

21105



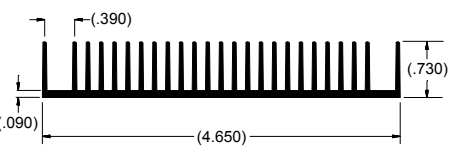
|      |       |         |
|------|-------|---------|
| Per. | 34.97 | in.     |
| WT.  | 4.20  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |

D 21139



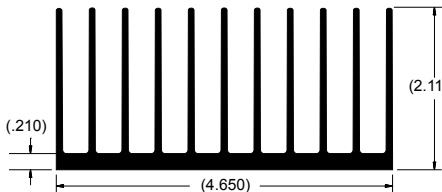
|      |       |         |
|------|-------|---------|
| Per. | 55.67 | in.     |
| WT.  | 5.45  | lb/ft   |
| θsa  | 1.26  | °C/w/3" |

014965



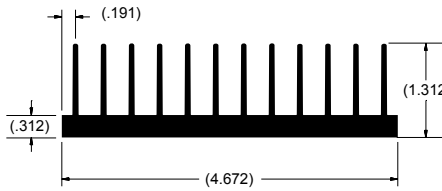
|      |       |         |
|------|-------|---------|
| Per. | 40.63 | in.     |
| WT.  | 1.52  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |

013203



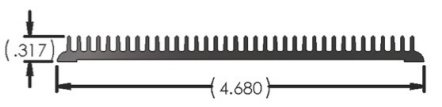
|      |       |         |
|------|-------|---------|
| Per. | 50.60 | in.     |
| WT.  | 3.17  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |

A 014320



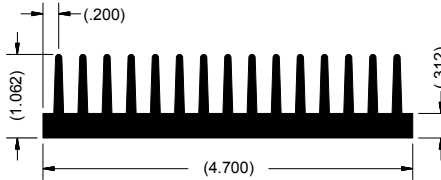
|      |       |         |
|------|-------|---------|
| Per. | 33.46 | in.     |
| WT.  | 2.81  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |

21153



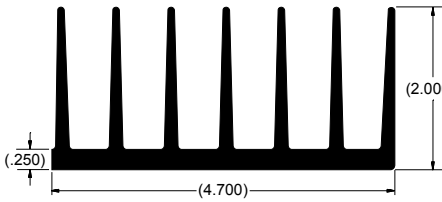
|      |       |         |
|------|-------|---------|
| Per. | 21.43 | in.     |
| WT.  | 0.89  | lb/ft   |
| θsa  | 3.26  | °C/w/3" |

XX7150



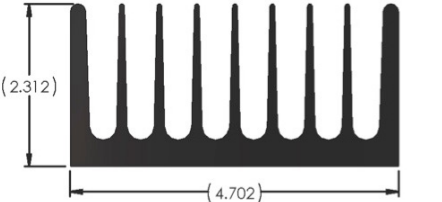
|      |       |         |
|------|-------|---------|
| Per. | 32.42 | in.     |
| WT.  | 2.85  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |

B 013664



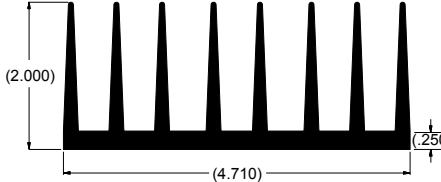
|      |       |         |
|------|-------|---------|
| Per. | 33.16 | in.     |
| WT.  | 3.45  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |

12447



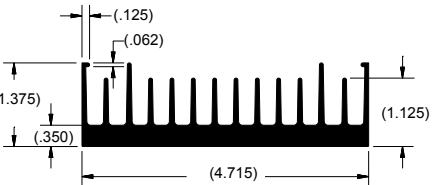
|      |       |         |
|------|-------|---------|
| Per. | 42.64 | in.     |
| WT.  | 5.23  | lb/ft   |
| θsa  | 1.64  | °C/w/3" |

016652



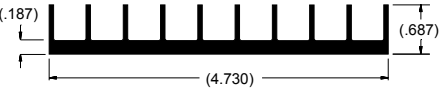
|      |       |         |
|------|-------|---------|
| Per. | 36.63 | in.     |
| WT.  | 3.66  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |

C 016242



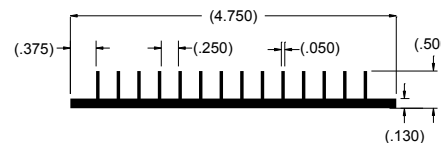
|      |       |         |
|------|-------|---------|
| Per. | 32.67 | in.     |
| WT.  | 3.07  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |

XX2030



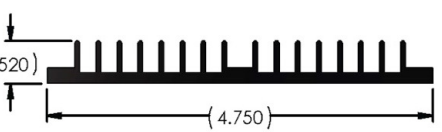
|      |       |         |
|------|-------|---------|
| Per. | 19.68 | in.     |
| WT.  | 1.40  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |

011005



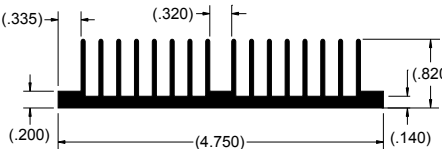
|      |       |         |
|------|-------|---------|
| Per. | 20.12 | in.     |
| WT.  | 1.05  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |

D 12405



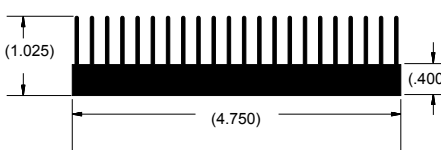
|      |       |         |
|------|-------|---------|
| Per. | 21.41 | in.     |
| WT.  | 1.30  | lb/ft   |
| θsa  | 3.27  | °C/w/3" |

011942

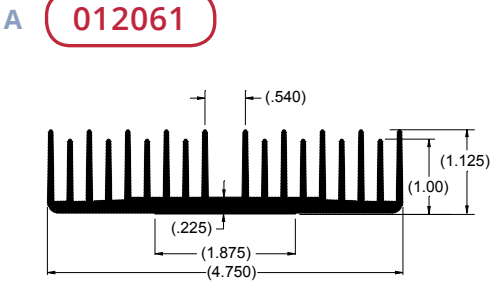


|      |       |         |
|------|-------|---------|
| Per. | 30.87 | in.     |
| WT.  | 1.60  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |

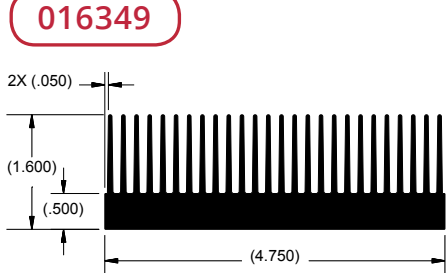
016123



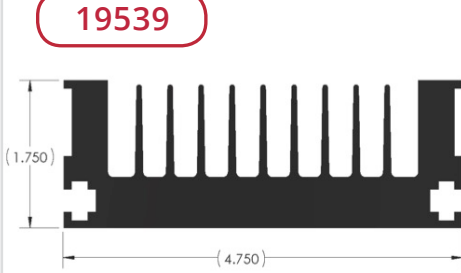
|      |       |         |
|------|-------|---------|
| Per. | 37.14 | in.     |
| WT.  | 3.09  | lb/ft   |
| θsa  | 3.60  | °C/w/3" |



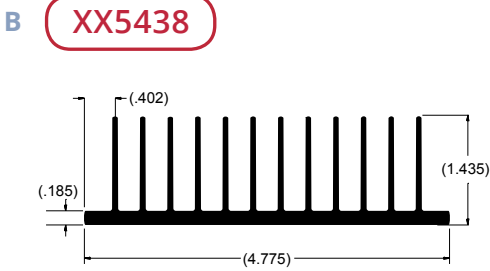
|      |       |         |
|------|-------|---------|
| Per. | 47.09 | in.     |
| WT.  | 2.40  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



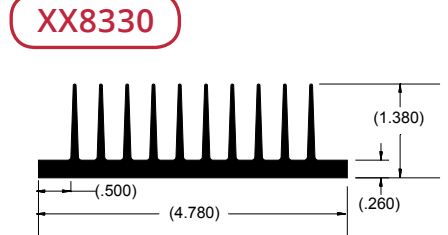
|      |       |         |
|------|-------|---------|
| Per. | 65.77 | in.     |
| WT.  | 5.04  | lb/ft   |
| θsa  | 3.80  | °C/w/3" |



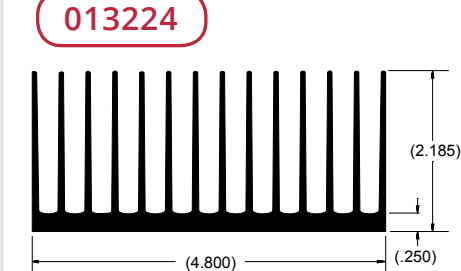
|      |       |         |
|------|-------|---------|
| Per. | 36.72 | in.     |
| WT.  | 5.37  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



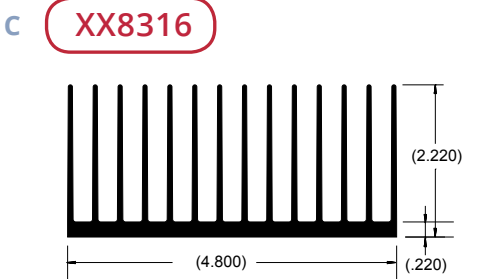
|      |       |         |
|------|-------|---------|
| Per. | 39.26 | in.     |
| WT.  | 2.41  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



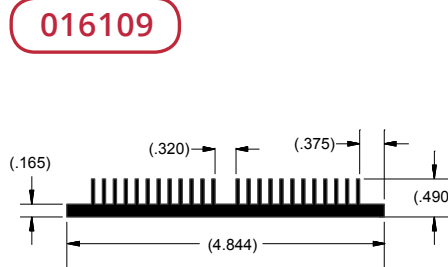
|      |       |         |
|------|-------|---------|
| Per. | 31.15 | in.     |
| WT.  | 2.50  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



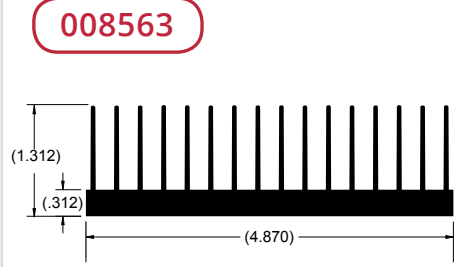
|      |       |         |
|------|-------|---------|
| Per. | 63.47 | in.     |
| WT.  | 3.88  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |



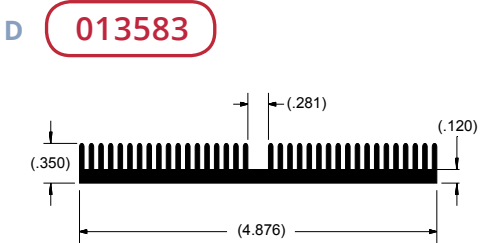
|      |       |         |
|------|-------|---------|
| Per. | 64.95 | in.     |
| WT.  | 3.52  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |



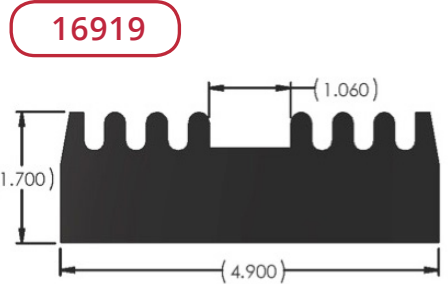
|      |       |         |
|------|-------|---------|
| Per. | 25.62 | in.     |
| WT.  | 1.43  | lb/ft   |
| θsa  | 4.84  | °C/w/3" |



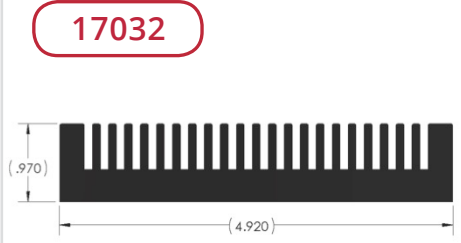
|      |       |         |
|------|-------|---------|
| Per. | 42.36 | in.     |
| WT.  | 3.07  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |



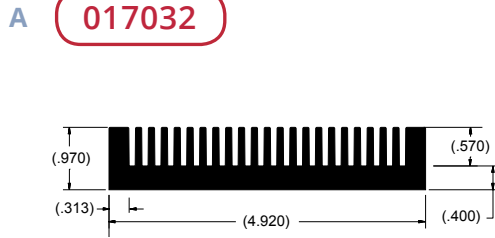
|      |       |         |
|------|-------|---------|
| Per. | 25.59 | in.     |
| WT.  | 1.30  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |



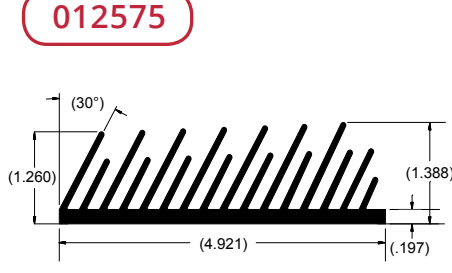
|      |       |         |
|------|-------|---------|
| Per. | 18.51 | in.     |
| WT.  | 8.34  | lb/ft   |
| θsa  | 3.78  | °C/w/3" |



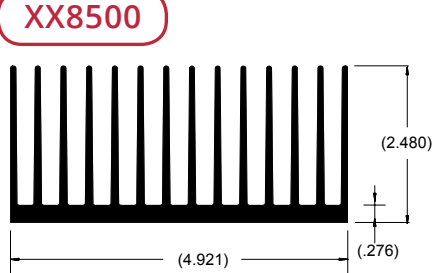
|      |       |         |
|------|-------|---------|
| Per. | 36.47 | in.     |
| WT.  | 4.31  | lb/ft   |
| θsa  | 1.92  | °C/w/3" |



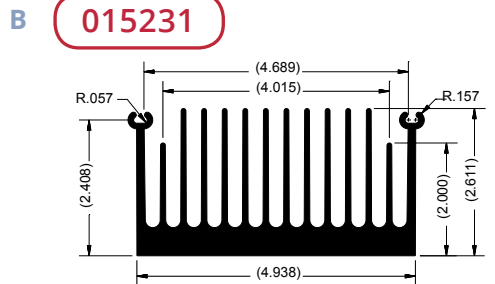
|      |      |         |
|------|------|---------|
| Per. | 2.70 | in.     |
| WT.  | 4.11 | lb/ft   |
| θsa  | 4.80 | °C/w/3" |



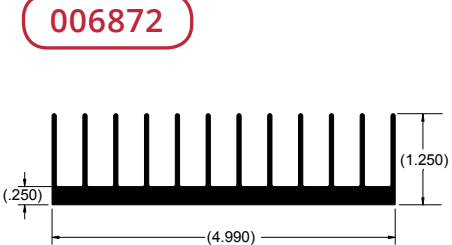
|      |       |         |
|------|-------|---------|
| Per. | 45.17 | in.     |
| WT.  | 2.92  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



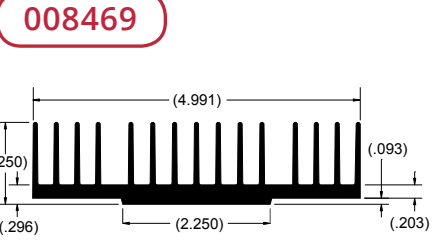
|      |       |         |
|------|-------|---------|
| Per. | 60.50 | in.     |
| WT.  | 6.47  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |



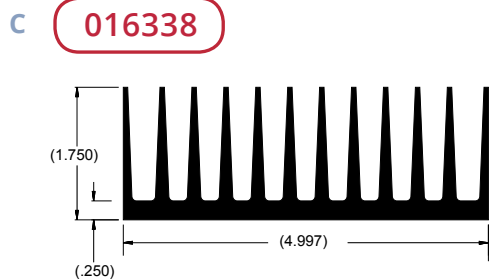
|      |       |         |
|------|-------|---------|
| Per. | 66.74 | in.     |
| WT.  | 6.52  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



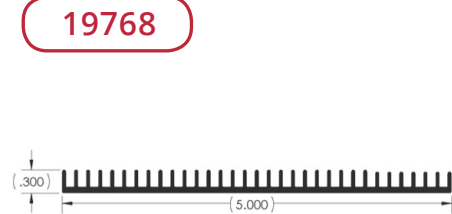
|      |       |         |
|------|-------|---------|
| Per. | 34.48 | in.     |
| WT.  | 2.39  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |



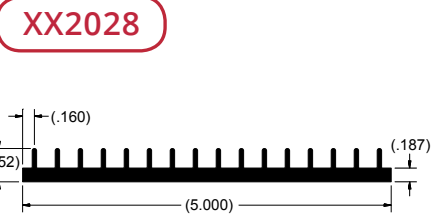
|      |       |         |
|------|-------|---------|
| Per. | 38.65 | in.     |
| WT.  | 2.74  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |



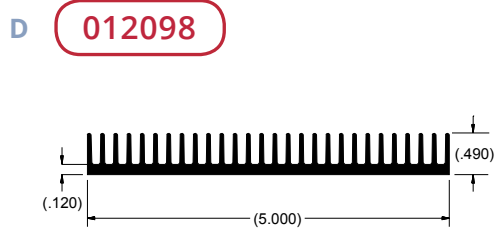
|      |       |         |
|------|-------|---------|
| Per. | 44.54 | in.     |
| WT.  | 4.08  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |



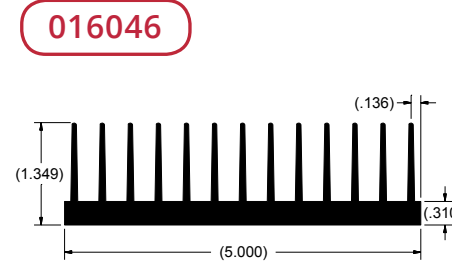
|      |       |         |
|------|-------|---------|
| Per. | 23.34 | in.     |
| WT.  | 0.89  | lb/ft   |
| θsa  | 3.00  | °C/w/3" |



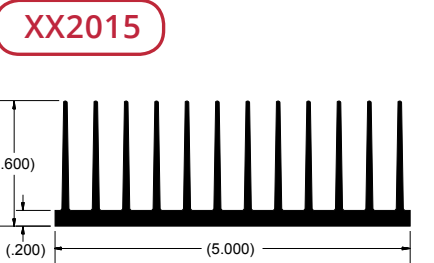
|      |       |         |
|------|-------|---------|
| Per. | 18.44 | in.     |
| WT.  | 1.42  | lb/ft   |
| θsa  | 3.00  | °C/w/3" |



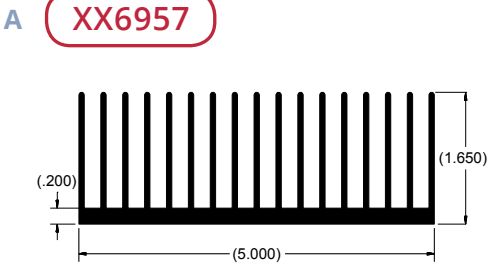
|      |       |         |
|------|-------|---------|
| Per. | 29.33 | in.     |
| WT.  | 1.38  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |



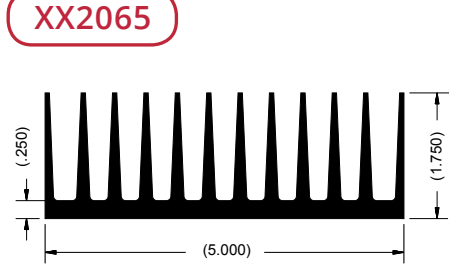
|      |       |         |
|------|-------|---------|
| Per. | 18.44 | in.     |
| WT.  | 1.42  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 42.85 | in.     |
| WT.  | 2.75  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



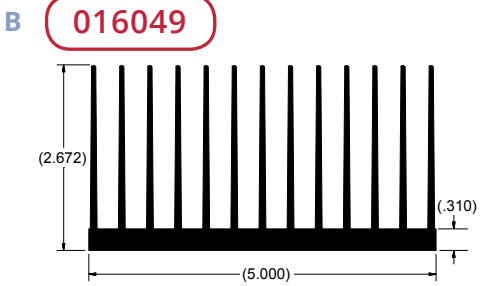
|      |       |         |
|------|-------|---------|
| Per. | 58.68 | in.     |
| WT.  | 3.32  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



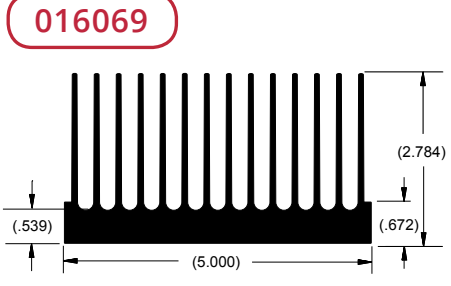
|      |       |         |
|------|-------|---------|
| Per. | 44.59 | in.     |
| WT.  | 4.08  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



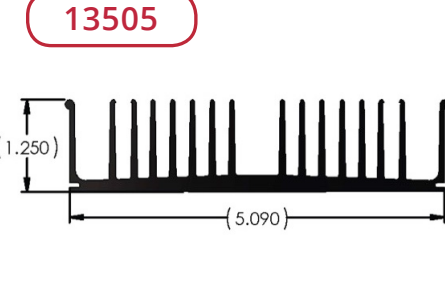
|      |       |         |
|------|-------|---------|
| Per. | 87.86 | in.     |
| WT.  | 5.49  | lb/ft   |
| θsa  | 0.80  | °C/w/3" |



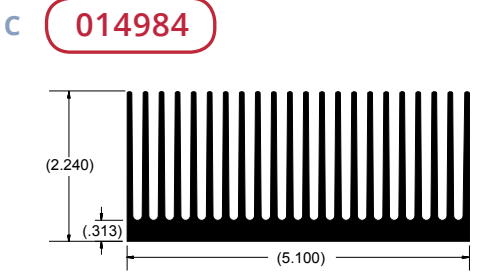
|      |       |         |
|------|-------|---------|
| Per. | 71.21 | in.     |
| WT.  | 4.76  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |



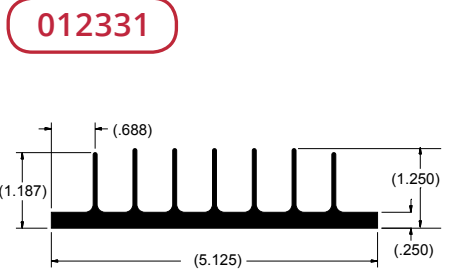
|      |       |         |
|------|-------|---------|
| Per. | 71.73 | in.     |
| WT.  | 6.65  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



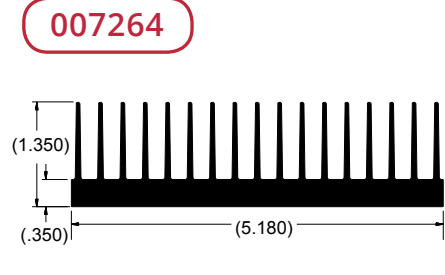
|      |       |         |
|------|-------|---------|
| Per. | 43.60 | in.     |
| WT.  | 2.61  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



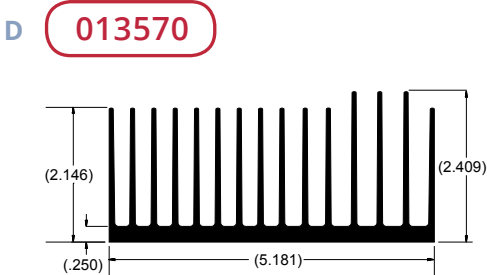
|      |       |         |
|------|-------|---------|
| Per. | 93.10 | in.     |
| WT.  | 5.28  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



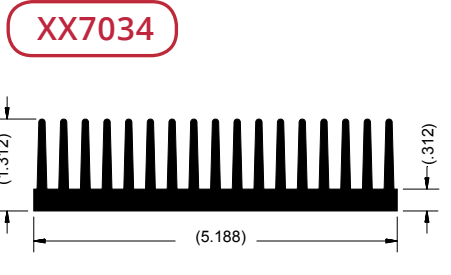
|      |       |         |
|------|-------|---------|
| Per. | 23.69 | in.     |
| WT.  | 2.04  | lb/ft   |
| θsa  | 3.00  | °C/w/3" |



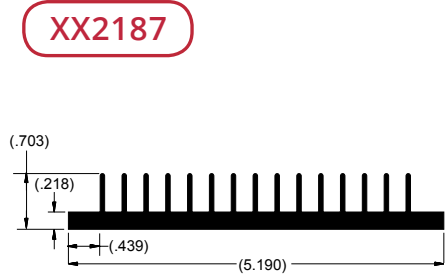
|      |       |         |
|------|-------|---------|
| Per. | 45.06 | in.     |
| WT.  | 3.50  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



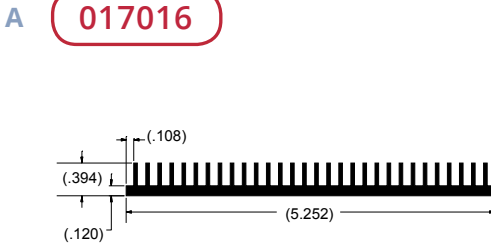
|      |       |         |
|------|-------|---------|
| Per. | 67.82 | in.     |
| WT.  | 4.28  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



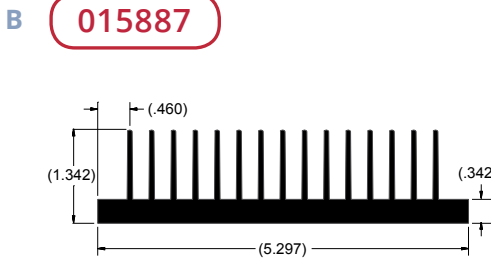
|      |       |         |
|------|-------|---------|
| Per. | 43.85 | in.     |
| WT.  | 3.52  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |



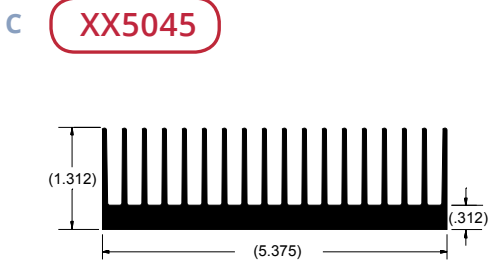
|      |       |         |
|------|-------|---------|
| Per. | 24.79 | in.     |
| WT.  | 1.90  | lb/ft   |
| θsa  | 2.90  | °C/w/3" |



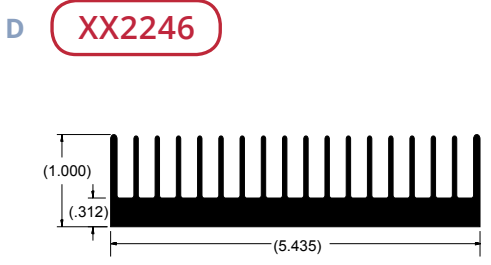
|      |       |         |
|------|-------|---------|
| Per. | 27.19 | in.     |
| WT.  | 1.26  | lb/ft   |
| θsa  | 4.90  | °C/w/3" |



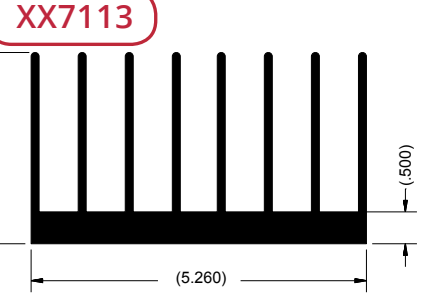
|      |       |         |
|------|-------|---------|
| Per. | 40.63 | in.     |
| WT.  | 3.46  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |



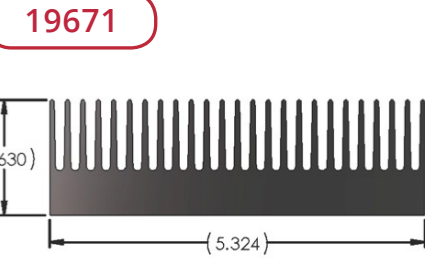
|      |       |         |
|------|-------|---------|
| Per. | 47.33 | in.     |
| WT.  | 3.55  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



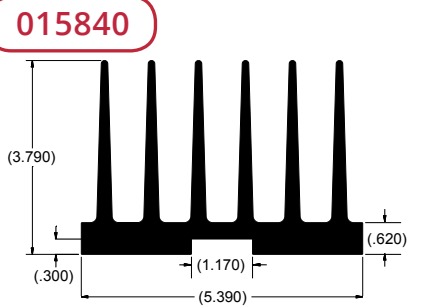
|      |       |         |
|------|-------|---------|
| Per. | 35.25 | in.     |
| WT.  | 3.02  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



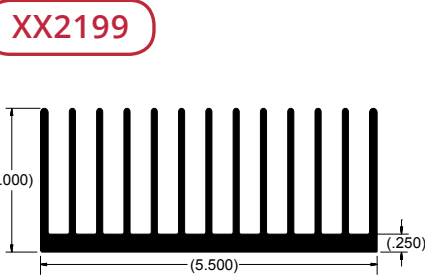
|      |       |         |
|------|-------|---------|
| Per. | 51.00 | in.     |
| WT.  | 6.73  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |



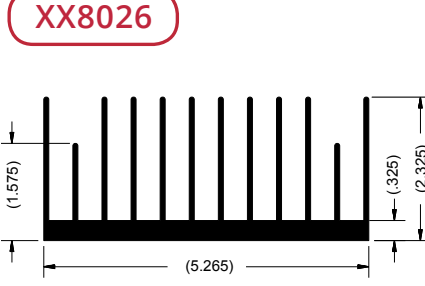
|      |       |         |
|------|-------|---------|
| Per. | 59.37 | in.     |
| WT.  | 6.37  | lb/ft   |
| θsa  | 1.18  | °C/w/3" |



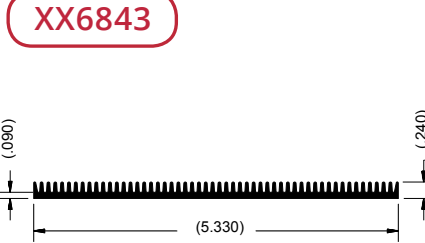
|      |       |         |
|------|-------|---------|
| Per. | 49.36 | in.     |
| WT.  | 8.43  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |



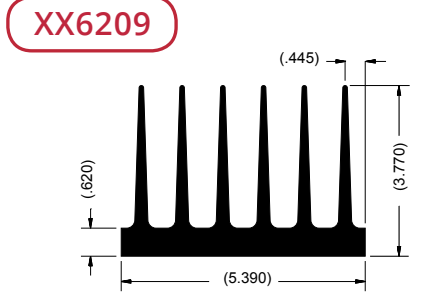
|      |       |         |
|------|-------|---------|
| Per. | 57.00 | in.     |
| WT.  | 4.48  | lb/ft   |
| θsa  | 1.20  | °C/w/3" |



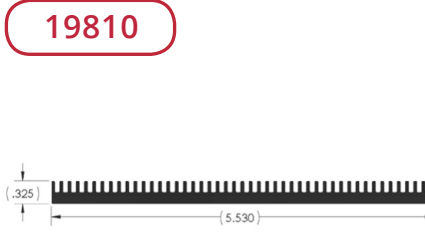
|      |       |         |
|------|-------|---------|
| Per. | 55.37 | in.     |
| WT.  | 4.40  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 23.00 | in.     |
| WT.  | 1.02  | lb/ft   |
| θsa  | 1.02  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 47.52 | in.     |
| WT.  | 8.60  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |

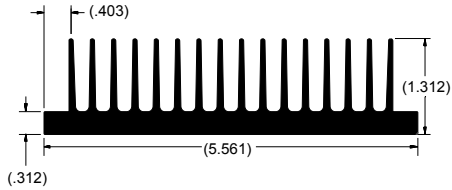


|      |       |         |
|------|-------|---------|
| Per. | 24.76 | in.     |
| WT.  | 1.60  | lb/ft   |
| θsa  | 2.82  | °C/w/3" |



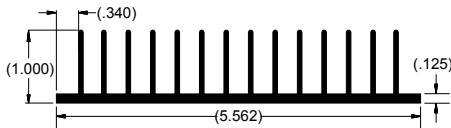
A

XX2002



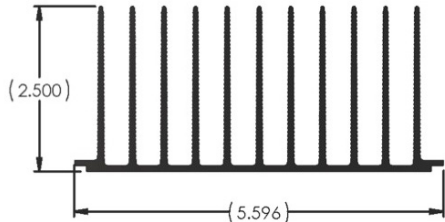
|      |       |         |
|------|-------|---------|
| Per. | 41.90 | in.     |
| WT.  | 3.67  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |

XX6933



|      |       |         |
|------|-------|---------|
| Per. | 35.45 | in.     |
| WT.  | 1.85  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |

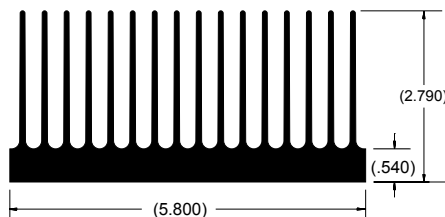
19036



|      |       |         |
|------|-------|---------|
| Per. | 65.83 | in.     |
| WT.  | 3.26  | lb/ft   |
| θsa  | 1.06  | °C/w/3" |

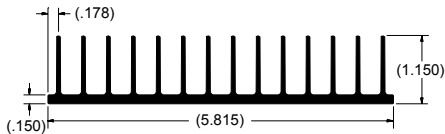
A

XX8415



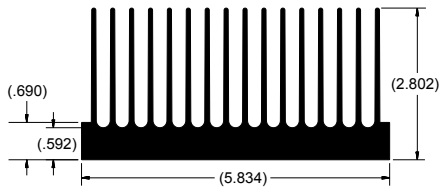
|      |       |         |
|------|-------|---------|
| Per. | 81.69 | in.     |
| WT.  | 7.37  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |

013237



|      |       |         |
|------|-------|---------|
| Per. | 38.67 | in.     |
| WT.  | 2.10  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |

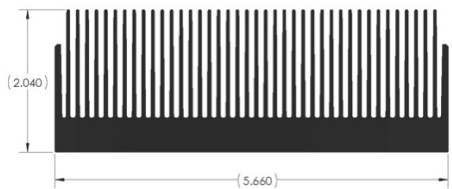
016060



|      |       |         |
|------|-------|---------|
| Per. | 81.06 | in.     |
| WT.  | 7.97  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |

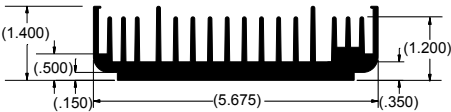
B

19350



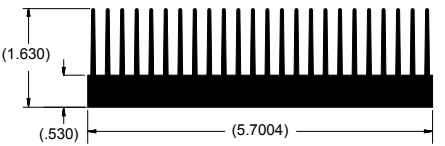
|      |        |         |
|------|--------|---------|
| Per. | 138.05 | in.     |
| WT.  | 7.10   | lb/ft   |
| θsa  | 0.51   | °C/w/3" |

016253



|      |       |         |
|------|-------|---------|
| Per. | 41.36 | in.     |
| WT.  | 4.06  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |

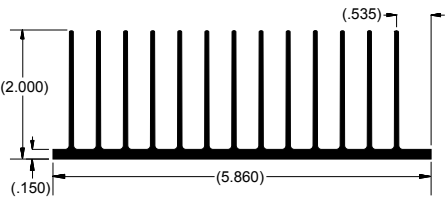
016138



|      |       |         |
|------|-------|---------|
| Per. | 64.08 | in.     |
| WT.  | 5.62  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |

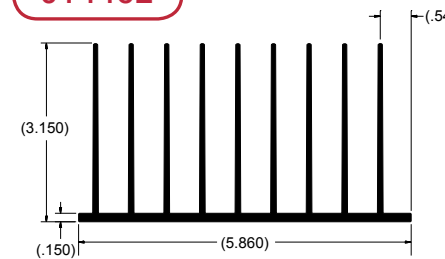
B

013601



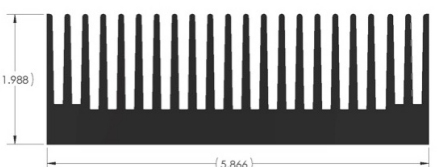
|      |       |         |
|------|-------|---------|
| Per. | 59.01 | in.     |
| WT.  | 2.86  | lb/ft   |
| θsa  | 1.20  | °C/w/3" |

014462



|      |       |         |
|------|-------|---------|
| Per. | 65.25 | in.     |
| WT.  | 3.89  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |

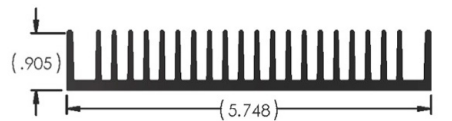
19343



|      |       |         |
|------|-------|---------|
| Per. | 74.30 | in.     |
| WT.  | 7.79  | lb/ft   |
| θsa  | 0.94  | °C/w/3" |

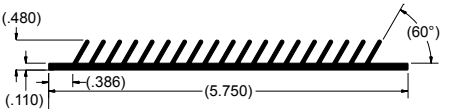
C

19155



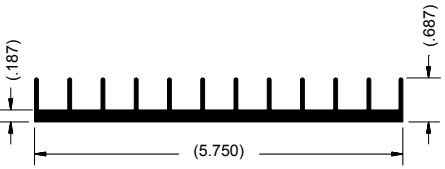
|      |       |         |
|------|-------|---------|
| Per. | 44.62 | in.     |
| WT.  | 2.73  | lb/ft   |
| θsa  | 1.57  | °C/w/3" |

012671



|      |       |         |
|------|-------|---------|
| Per. | 26.67 | in.     |
| WT.  | 1.29  | lb/ft   |
| θsa  | 2.60  | °C/w/3" |

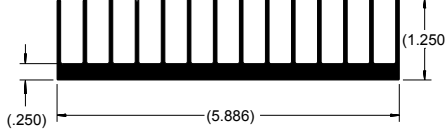
XX2903



|      |       |         |
|------|-------|---------|
| Per. | 23.87 | in.     |
| WT.  | 1.72  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |

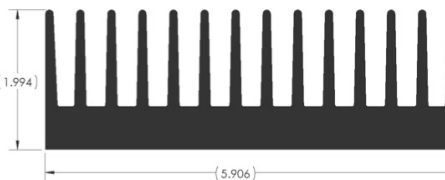
C

002981



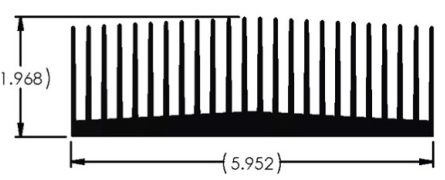
|      |       |         |
|------|-------|---------|
| Per. | 40.00 | in.     |
| WT.  | 2.90  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |

21257



|      |       |         |
|------|-------|---------|
| Per. | 49.78 | in.     |
| WT.  | 7.73  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |

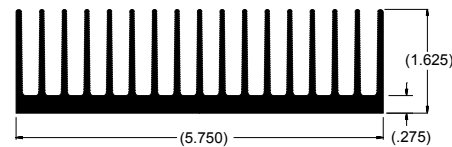
14407



|      |       |         |
|------|-------|---------|
| Per. | 85.79 | in.     |
| WT.  | 5.47  | lb/ft   |
| θsa  | 0.81  | °C/w/3" |

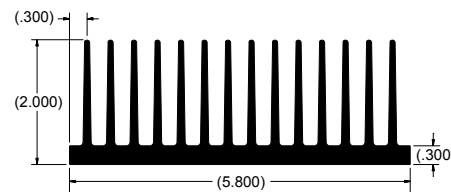
D

013532



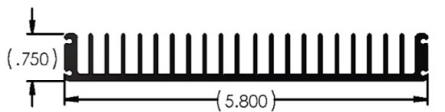
|      |       |         |
|------|-------|---------|
| Per. | 64.81 | in.     |
| WT.  | 4.02  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |

010248



|      |       |         |
|------|-------|---------|
| Per. | 59.80 | in.     |
| WT.  | 5.31  | lb/ft   |
| θsa  | 1.20  | °C/w/3" |

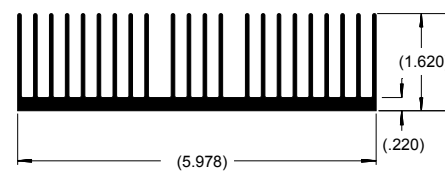
15037



|      |       |         |
|------|-------|---------|
| Per. | 40.40 | in.     |
| WT.  | 1.89  | lb/ft   |
| θsa  | 1.73  | °C/w/3" |

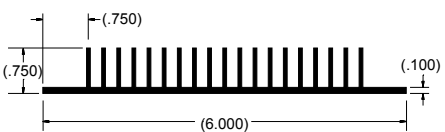
D

016168



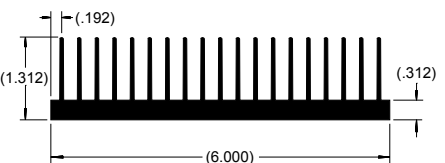
|      |       |         |
|------|-------|---------|
| Per. | 72.89 | in.     |
| WT.  | 3.78  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |

011743

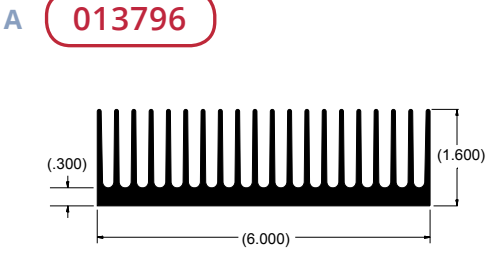


|      |       |         |
|------|-------|---------|
| Per. | 36.74 | in.     |
| WT.  | 1.59  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |

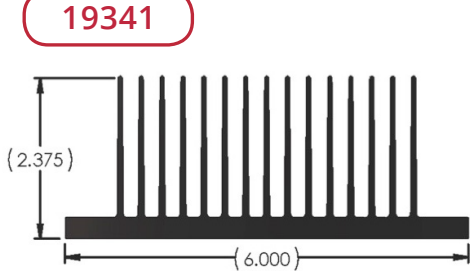
012464



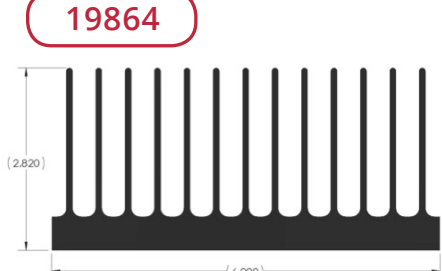
|      |       |         |
|------|-------|---------|
| Per. | 49.68 | in.     |
| WT.  | 3.61  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |



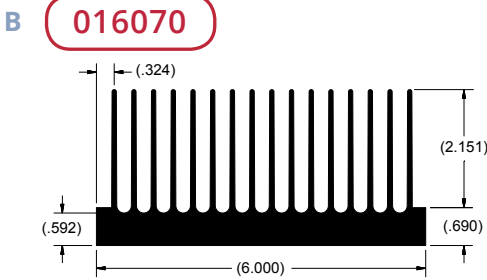
|      |       |         |
|------|-------|---------|
| Per. | 61.82 | in.     |
| WT.  | 4.76  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |



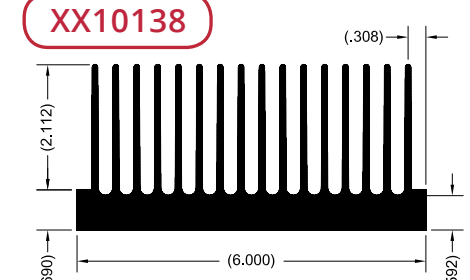
|      |       |         |
|------|-------|---------|
| Per. | 73.88 | in.     |
| WT.  | 5.07  | lb/ft   |
| θsa  | 0.95  | °C/w/3" |



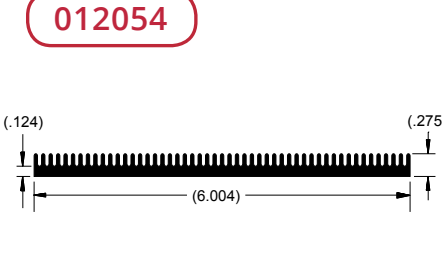
|      |       |         |
|------|-------|---------|
| Per. | 70.81 | in.     |
| WT.  | 7.43  | lb/ft   |
| θsa  | 0.99  | °C/w/3" |



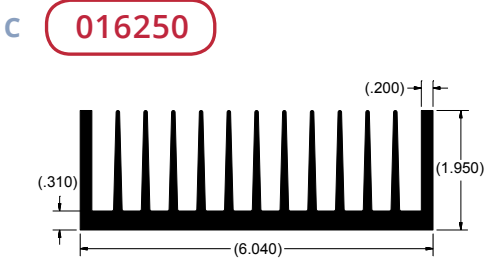
|      |       |         |
|------|-------|---------|
| Per. | 82.68 | in.     |
| WT.  | 8.16  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



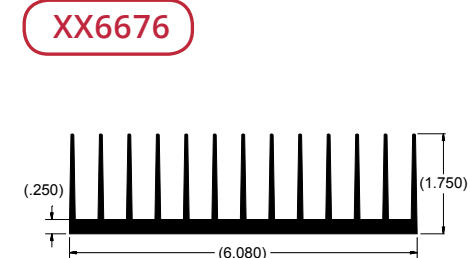
|      |       |         |
|------|-------|---------|
| Per. | 82.67 | in.     |
| WT.  | 8.17  | lb/ft   |
| θsa  | 0.97  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 25.08 | in.     |
| WT.  | 1.32  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |



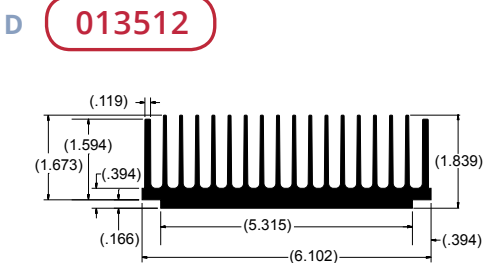
|      |       |         |
|------|-------|---------|
| Per. | 53.84 | in.     |
| WT.  | 5.27  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |



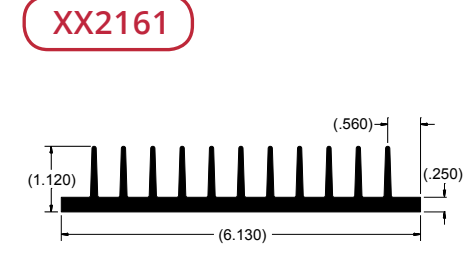
|      |       |         |
|------|-------|---------|
| Per. | 50.73 | in.     |
| WT.  | 3.56  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |



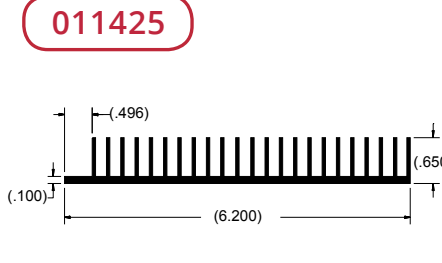
|      |       |         |
|------|-------|---------|
| Per. | 69.93 | in.     |
| WT.  | 5.53  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |



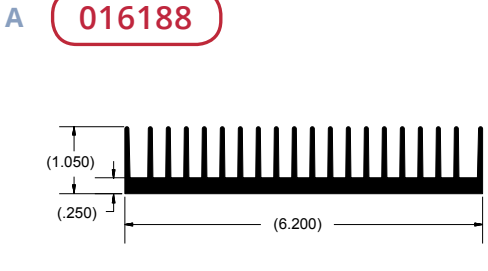
|      |       |         |
|------|-------|---------|
| Per. | 62.47 | in.     |
| WT.  | 5.21  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |



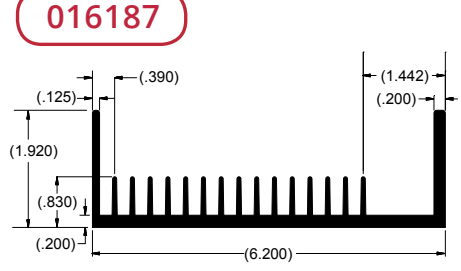
|      |       |         |
|------|-------|---------|
| Per. | 30.72 | in.     |
| WT.  | 2.96  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



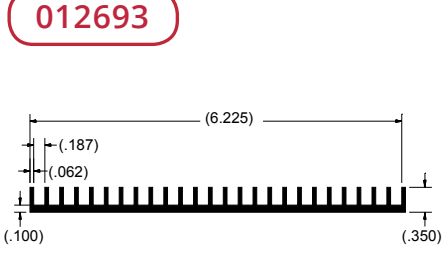
|      |       |         |
|------|-------|---------|
| Per. | 37.71 | in.     |
| WT.  | 1.61  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



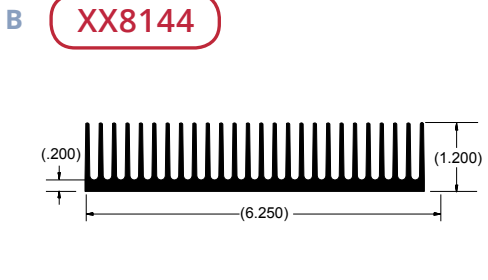
|      |       |         |
|------|-------|---------|
| Per. | 43.90 | in.     |
| WT.  | 3.38  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



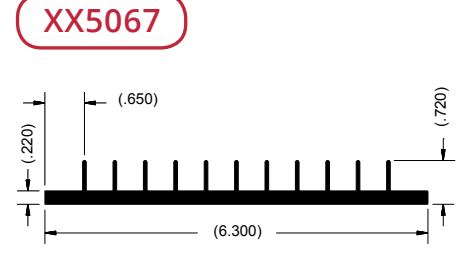
|      |       |         |
|------|-------|---------|
| Per. | 37.74 | in.     |
| WT.  | 3.05  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |



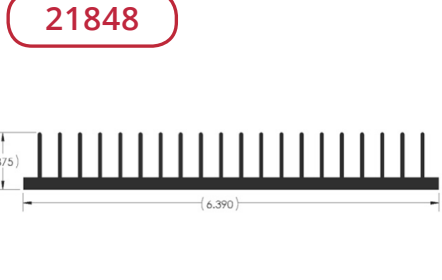
|      |       |         |
|------|-------|---------|
| Per. | 25.77 | in.     |
| WT.  | 1.24  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |



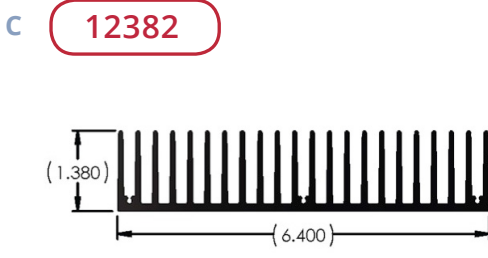
|      |       |         |
|------|-------|---------|
| Per. | 61.81 | in.     |
| WT.  | 3.78  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |



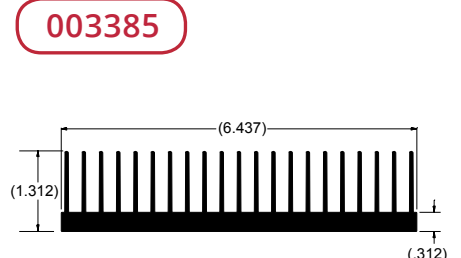
|      |       |         |
|------|-------|---------|
| Per. | 23.76 | in.     |
| WT.  | 2.07  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |



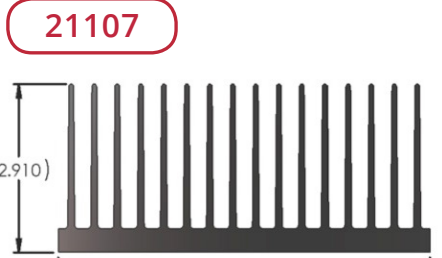
|      |       |         |
|------|-------|---------|
| Per. | 40.03 | in.     |
| WT.  | 2.47  | lb/ft   |
| θsa  | 1.75  | °C/w/3" |



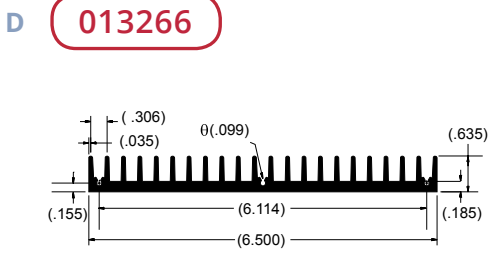
|      |       |         |
|------|-------|---------|
| Per. | 66.42 | in.     |
| WT.  | 3.81  | lb/ft   |
| θsa  | 1.05  | °C/w/3" |



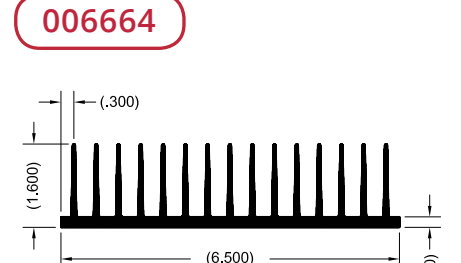
|      |       |         |
|------|-------|---------|
| Per. | 54.75 | in.     |
| WT.  | 4.03  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |



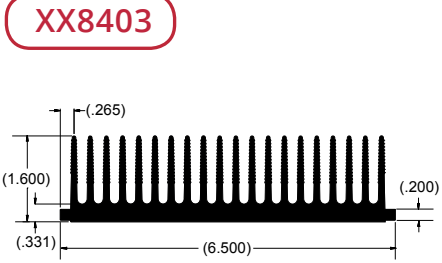
|      |       |         |
|------|-------|---------|
| Per. | 91.72 | in.     |
| WT.  | 7.98  | lb/ft   |
| θsa  | 0.76  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 32.29 | in.     |
| WT.  | 2.38  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |



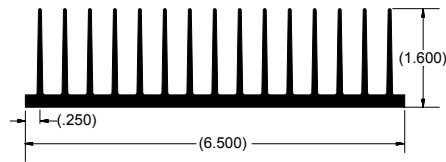
|      |       |         |
|------|-------|---------|
| Per. | 56.00 | in.     |
| WT.  | 3.42  | lb/ft   |
| θsa  | 0.0   | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 61.19 | in.     |
| WT.  | 5.49  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |

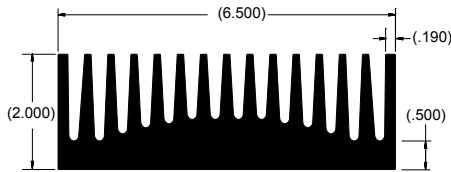
A

XX4509



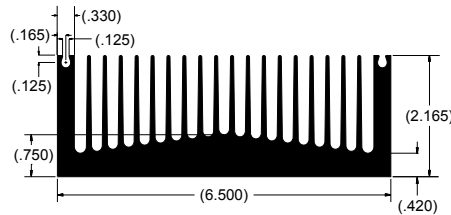
|      |       |         |
|------|-------|---------|
| Per. | 53.80 | in.     |
| WT.  | 3.45  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |

016593



|      |       |         |
|------|-------|---------|
| Per. | 50.24 | in.     |
| WT.  | 10.17 | lb/ft   |
| θsa  | 1.60  | °C/w/3" |

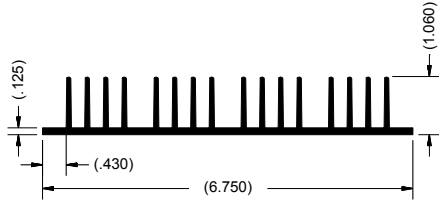
016607



|      |       |         |
|------|-------|---------|
| Per. | 75.67 | in.     |
| WT.  | 8.54  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |

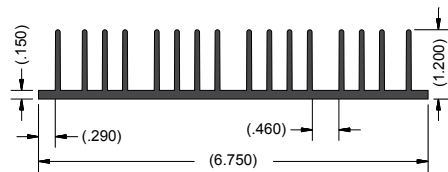
A

XX2494



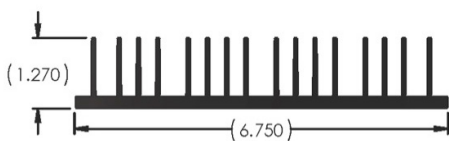
|      |       |         |
|------|-------|---------|
| Per. | 46.37 | in.     |
| WT.  | 2.65  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |

XX2027



|      |       |         |
|------|-------|---------|
| Per. | 46.69 | in.     |
| WT.  | 2.91  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |

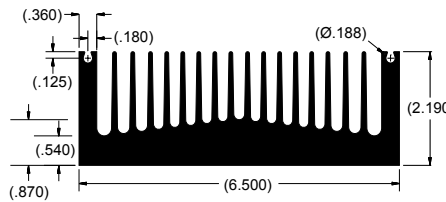
19596



|      |       |         |
|------|-------|---------|
| Per. | 47.01 | in.     |
| WT.  | 3.49  | lb/ft   |
| θsa  | 1.49  | °C/w/3" |

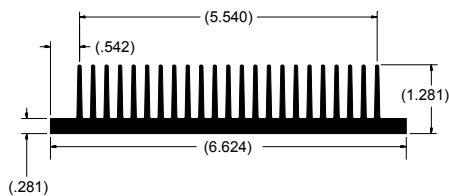
B

016222



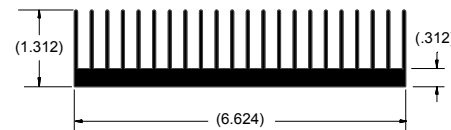
|      |       |         |
|------|-------|---------|
| Per. | 65.32 | in.     |
| WT.  | 9.66  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |

013621



|      |       |         |
|------|-------|---------|
| Per. | 57.72 | in.     |
| WT.  | 4.31  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |

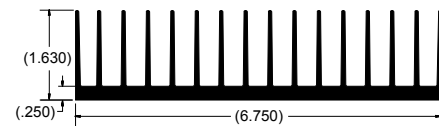
XX7031



|      |       |         |
|------|-------|---------|
| Per. | 57.29 | in.     |
| WT.  | 4.12  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |

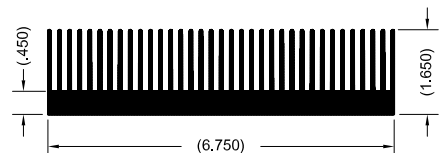
B

012116



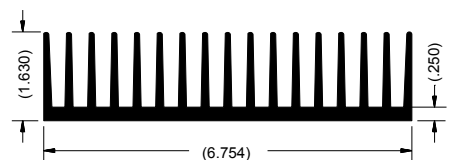
|      |       |         |
|------|-------|---------|
| Per. | 56.90 | in.     |
| WT.  | 4.00  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |

015769



|      |       |         |
|------|-------|---------|
| Per. | 97.40 | in.     |
| WT.  | 6.53  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |

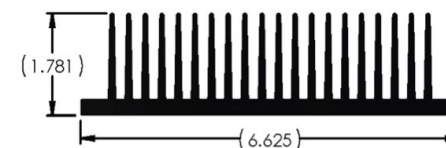
XX7029



|      |       |         |
|------|-------|---------|
| Per. | 57.28 | in.     |
| WT.  | 4.08  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |

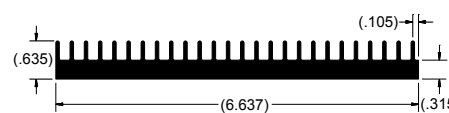
C

12714



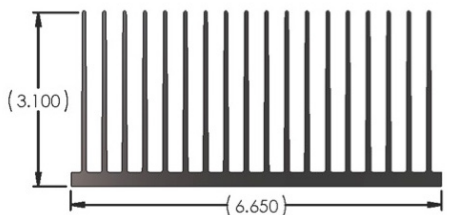
|      |       |         |
|------|-------|---------|
| Per. | 71.70 | in.     |
| WT.  | 5.99  | lb/ft   |
| θsa  | 0.98  | °C/w/3" |

015906



|      |       |         |
|------|-------|---------|
| Per. | 29.17 | in.     |
| WT.  | 3.15  | lb/ft   |
| θsa  | 3.30  | °C/w/3" |

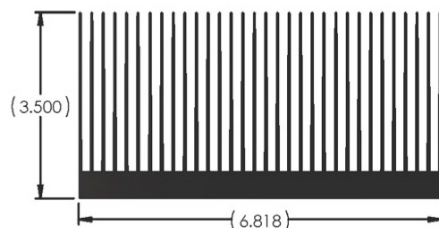
19679



|      |        |         |
|------|--------|---------|
| Per. | 116.00 | in.     |
| WT.  | 6.65   | lb/ft   |
| θsa  | 0.60   | °C/w/3" |

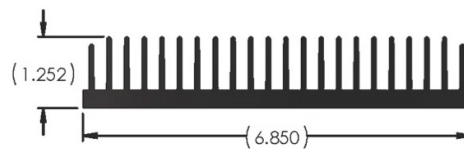
C

19333



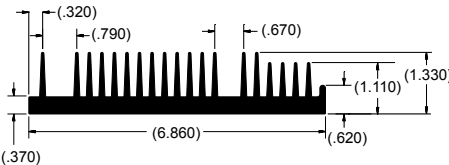
|      |        |         |
|------|--------|---------|
| Per. | 205.33 | in.     |
| WT.  | 9.80   | lb/ft   |
| θsa  | 0.34   | °C/w/3" |

16335



|      |       |         |
|------|-------|---------|
| Per. | 53.53 | in.     |
| WT.  | 4.67  | lb/ft   |
| θsa  | 1.31  | °C/w/3" |

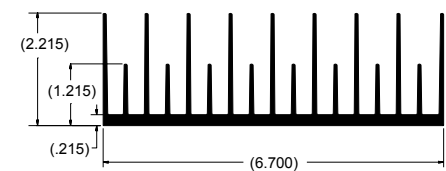
016362



|      |       |         |
|------|-------|---------|
| Per. | 47.30 | in.     |
| WT.  | 5.14  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |

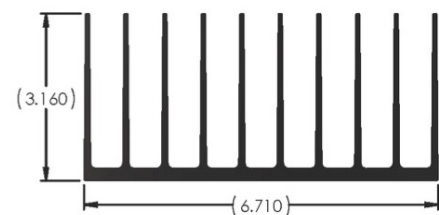
D

014746



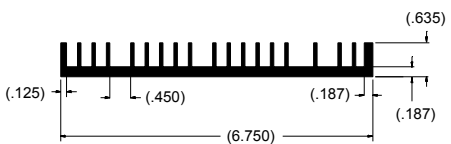
|      |       |         |
|------|-------|---------|
| Per. | 65.00 | in.     |
| WT.  | 3.80  | lb/ft   |
| θsa  | 1.20  | °C/w/3" |

21081



|      |       |         |
|------|-------|---------|
| Per. | 70.97 | in.     |
| WT.  | 5.55  | lb/ft   |
| θsa  | 0.99  | °C/w/3" |

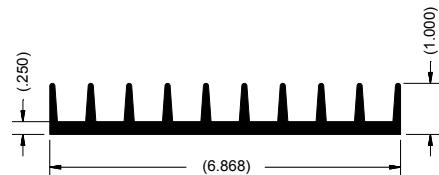
013659



|      |       |         |
|------|-------|---------|
| Per. | 31.75 | in.     |
| WT.  | 2.40  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |

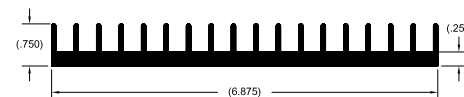
D

XX2071



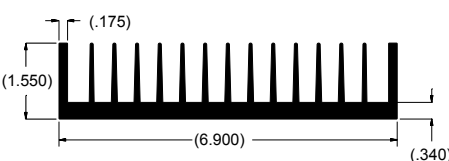
|      |       |         |
|------|-------|---------|
| Per. | 27.94 | in.     |
| WT.  | 3.33  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |

015633

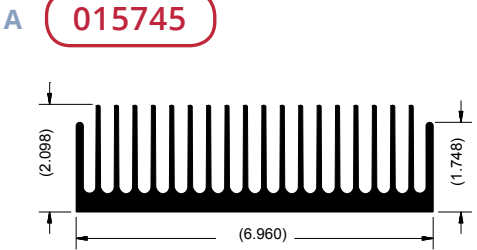


|      |       |         |
|------|-------|---------|
| Per. | 31.38 | in.     |
| WT.  | 2.86  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |

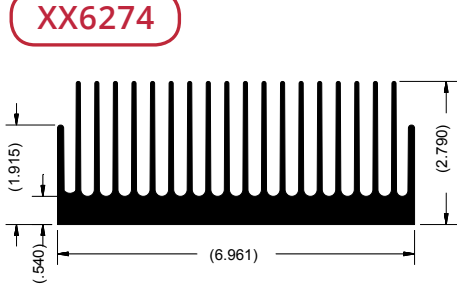
016290



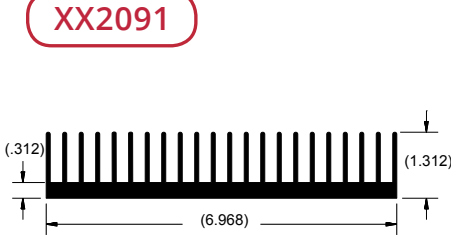
|      |       |         |
|------|-------|---------|
| Per. | 49.47 | in.     |
| WT.  | 5.04  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



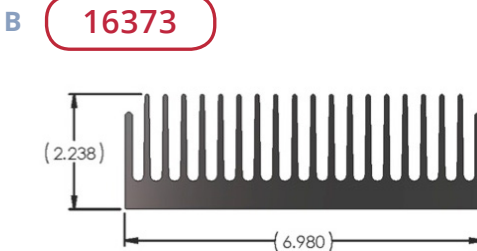
|      |       |         |
|------|-------|---------|
| Per. | 79.31 | in.     |
| WT.  | 6.91  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |



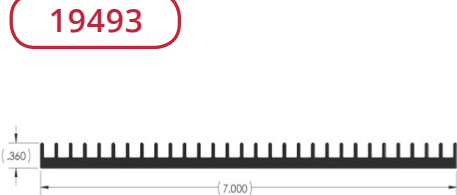
|      |       |         |
|------|-------|---------|
| Per. | 97.90 | in.     |
| WT.  | 9.15  | lb/ft   |
| θsa  | 0.80  | °C/w/3" |



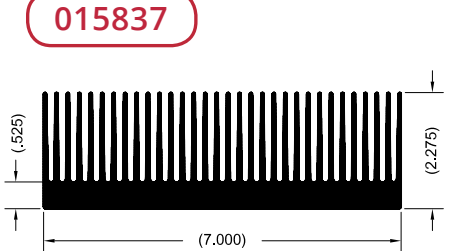
|      |       |         |
|------|-------|---------|
| Per. | 57.81 | in.     |
| WT.  | 4.70  | lb/ft   |
| θsa  | 1.20  | °C/w/3" |



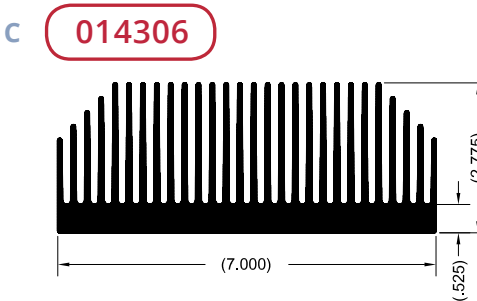
|      |       |         |
|------|-------|---------|
| Per. | 78.13 | in.     |
| WT.  | 8.87  | lb/ft   |
| θsa  | 0.89  | °C/w/3" |



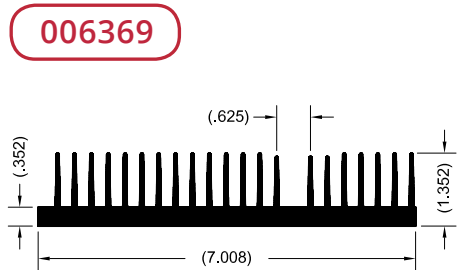
|      |       |         |
|------|-------|---------|
| Per. | 26.00 | in.     |
| WT.  | 1.63  | lb/ft   |
| θsa  | 2.69  | °C/w/3" |



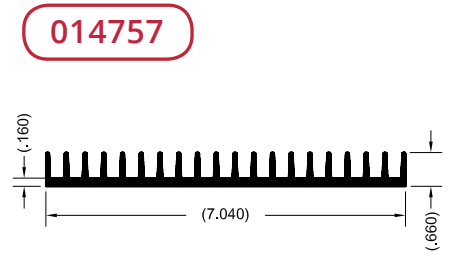
|      |        |         |
|------|--------|---------|
| Per. | 123.97 | in.     |
| WT.  | 9.16   | lb/ft   |
| θsa  | 1.30   | °C/w/3" |



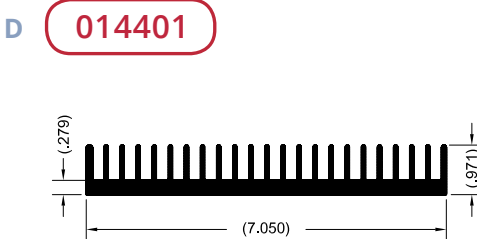
|      |        |         |
|------|--------|---------|
| Per. | 127.28 | in.     |
| WT.  | 10.34  | lb/ft   |
| θsa  | 0.90   | °C/w/3" |



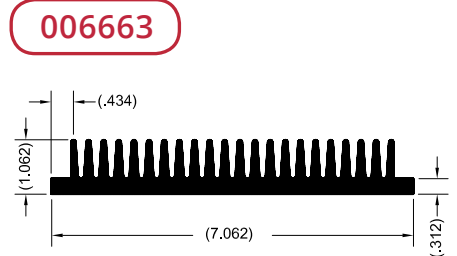
|      |       |         |
|------|-------|---------|
| Per. | 54.70 | in.     |
| WT.  | 4.57  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |



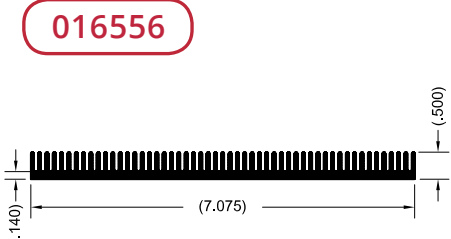
|      |       |         |
|------|-------|---------|
| Per. | 33.06 | in.     |
| WT.  | 2.34  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



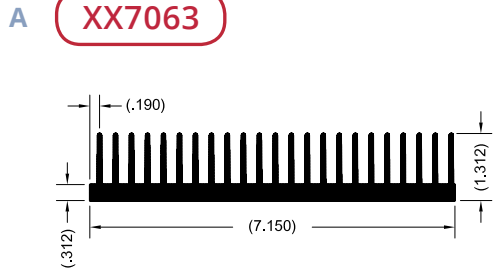
|      |       |         |
|------|-------|---------|
| Per. | 45.17 | in.     |
| WT.  | 3.79  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



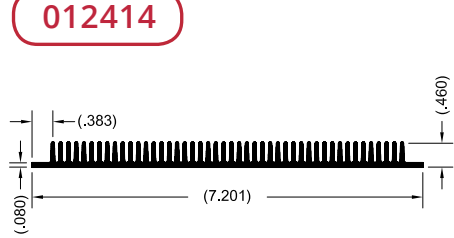
|      |       |         |
|------|-------|---------|
| Per. | 44.10 | in.     |
| WT.  | 5.28  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



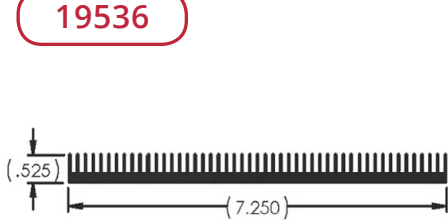
|      |       |         |
|------|-------|---------|
| Per. | 49.55 | in.     |
| WT.  | 2.47  | lb/ft   |
| θsa  | 5.30  | °C/w/3" |



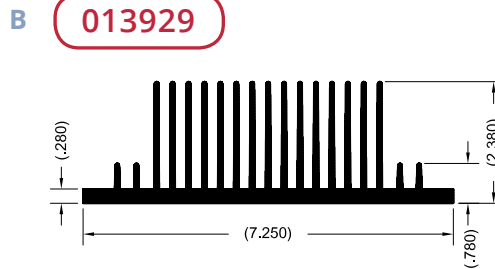
|      |       |         |
|------|-------|---------|
| Per. | 59.37 | in.     |
| WT.  | 4.74  | lb/ft   |
| θsa  | 1.20  | °C/w/3" |



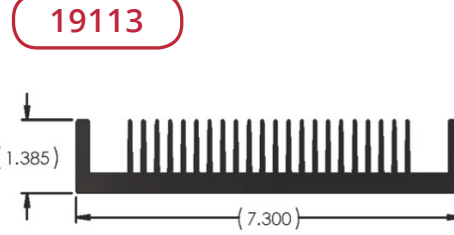
|      |       |         |
|------|-------|---------|
| Per. | 46.41 | in.     |
| WT.  | 1.77  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



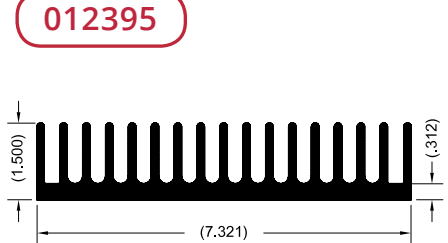
|      |       |         |
|------|-------|---------|
| Per. | 47.12 | in.     |
| WT.  | 2.77  | lb/ft   |
| θsa  | 1.48  | °C/w/3" |



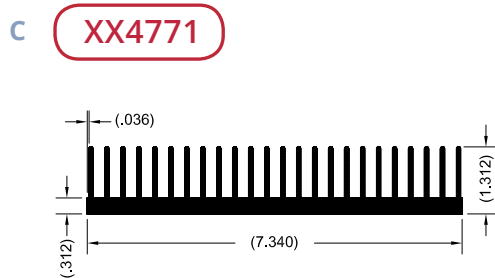
|      |       |         |
|------|-------|---------|
| Per. | 80.79 | in.     |
| WT.  | 6.03  | lb/ft   |
| θsa  | 0.90  | °C/w/3" |



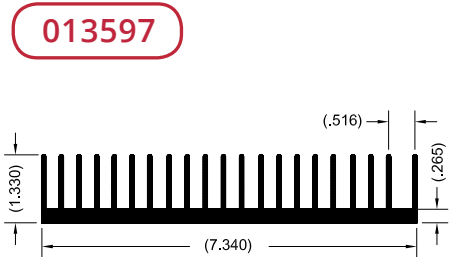
|      |       |         |
|------|-------|---------|
| Per. | 62.04 | in.     |
| WT.  | 5.99  | lb/ft   |
| θsa  | 1.13  | °C/w/3" |



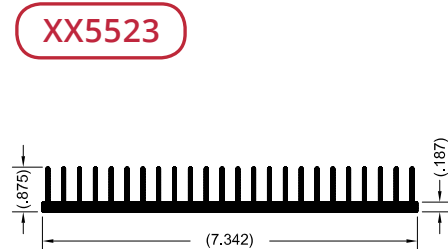
|      |       |         |
|------|-------|---------|
| Per. | 52.74 | in.     |
| WT.  | 6.18  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |



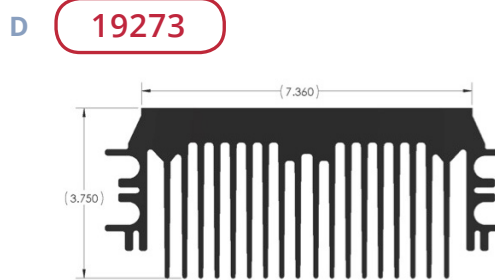
|      |       |         |
|------|-------|---------|
| Per. | 61.75 | in.     |
| WT.  | 4.54  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |



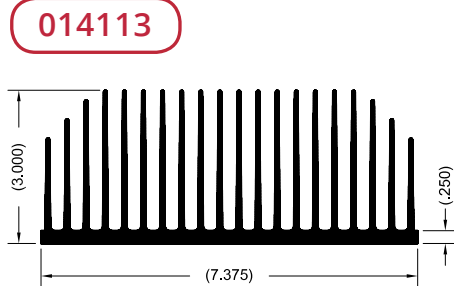
|      |       |         |
|------|-------|---------|
| Per. | 59.05 | in.     |
| WT.  | 4.20  | lb/ft   |
| θsa  | 1.20  | °C/w/3" |



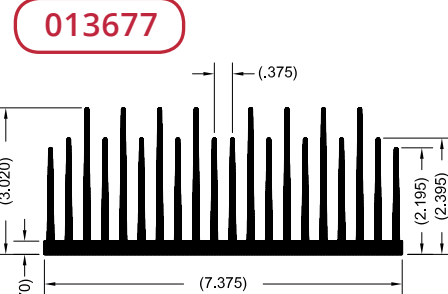
|      |       |         |
|------|-------|---------|
| Per. | 46.78 | in.     |
| WT.  | 2.88  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



|      |        |         |
|------|--------|---------|
| Per. | 136.54 | in.     |
| WT.  | 17.21  | lb/ft   |
| θsa  | 0.51   | °C/w/3" |

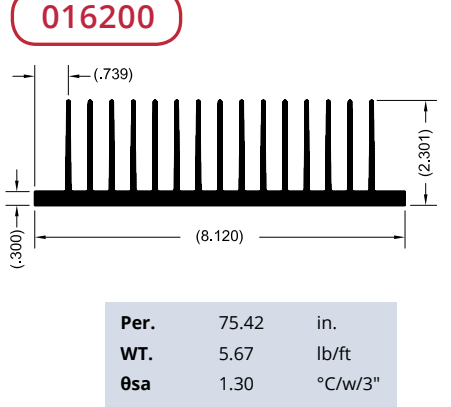
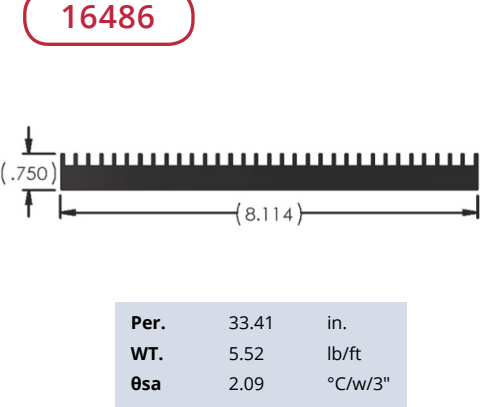
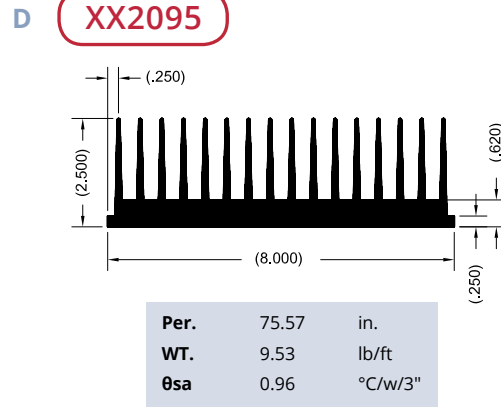
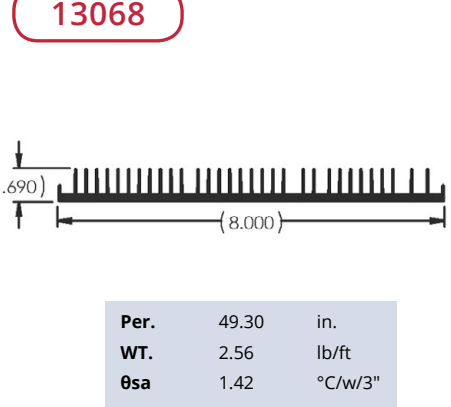
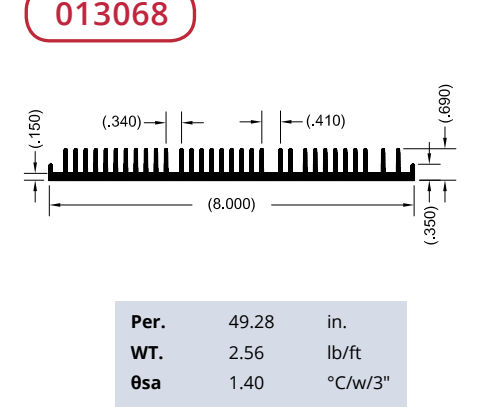
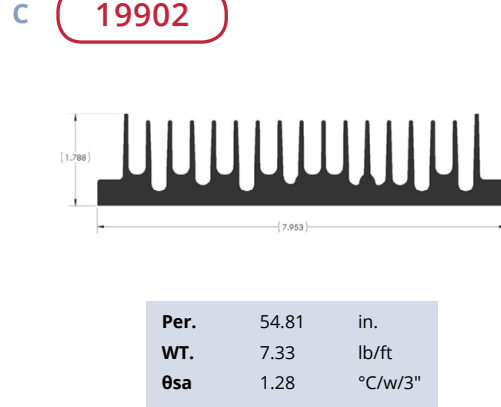
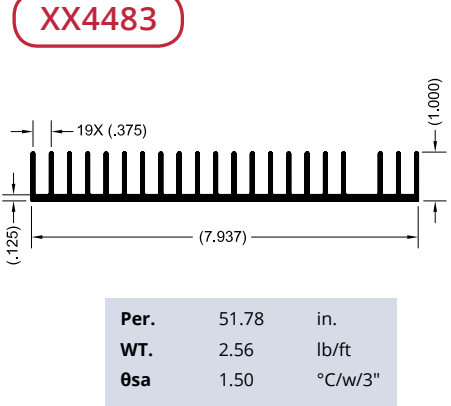
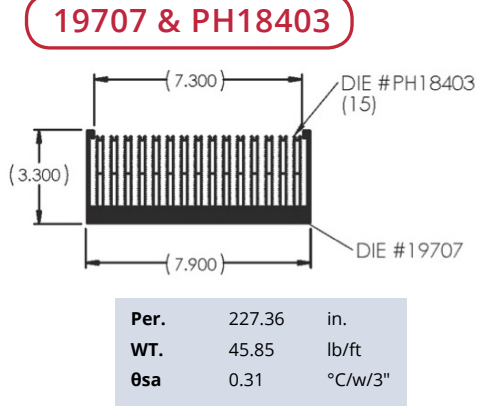
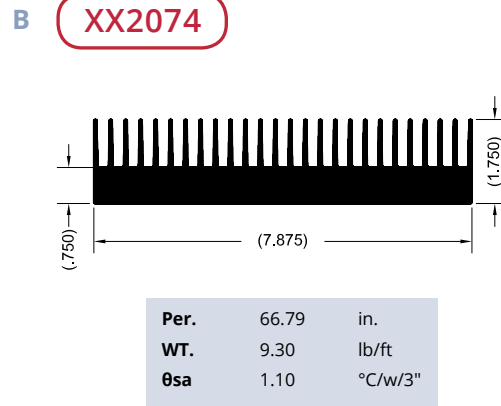
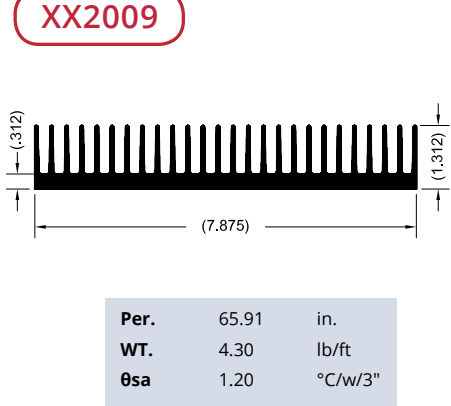
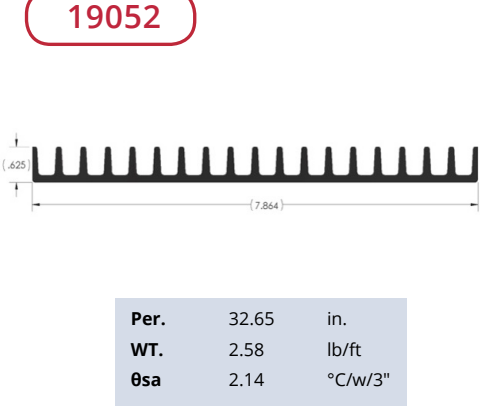
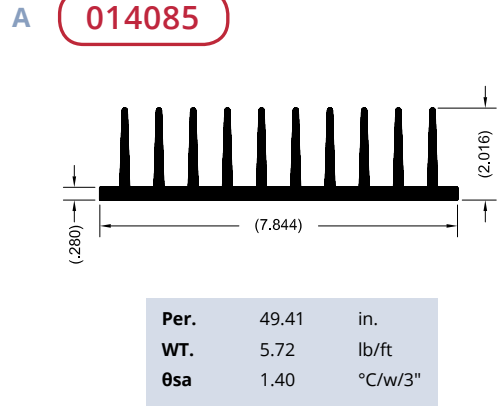
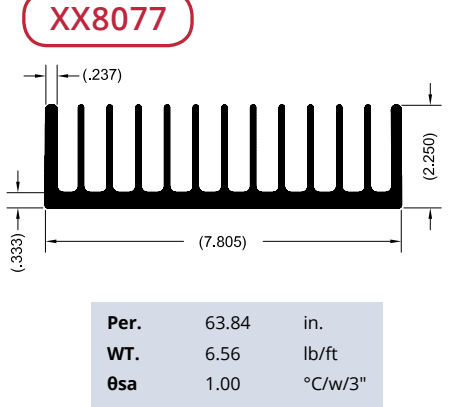
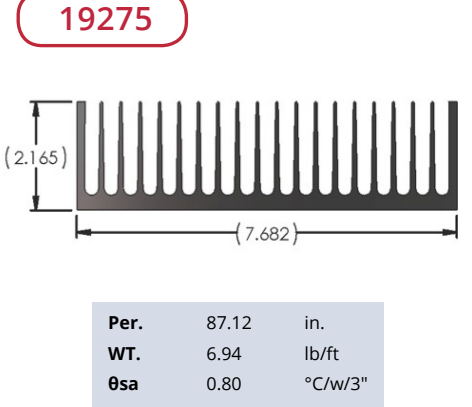
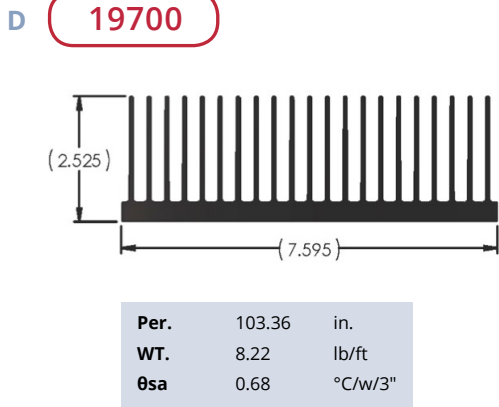
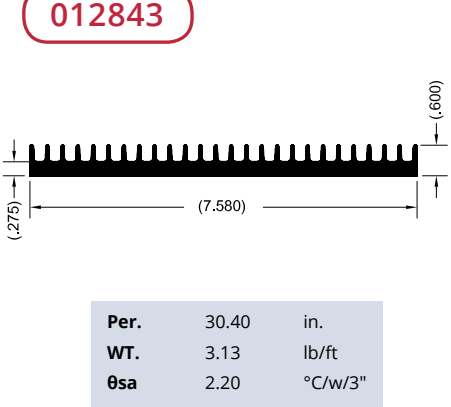
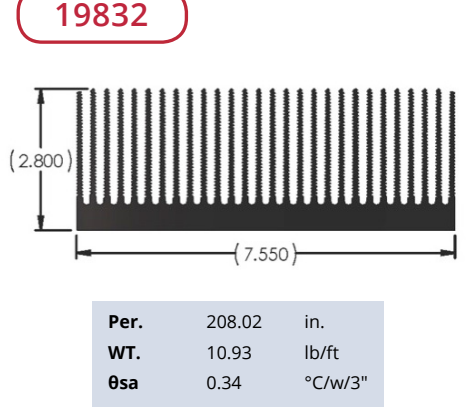
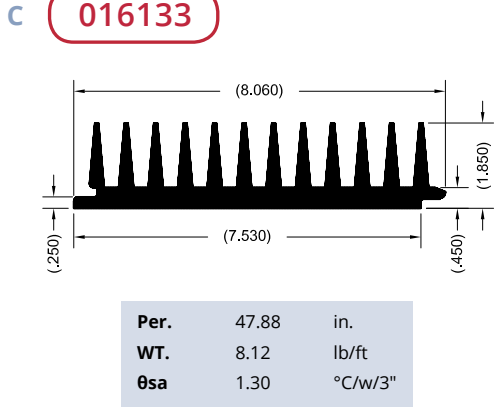
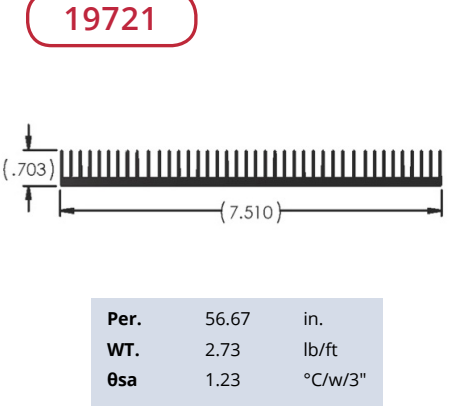
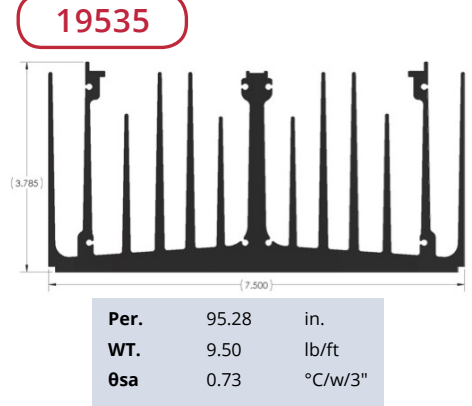
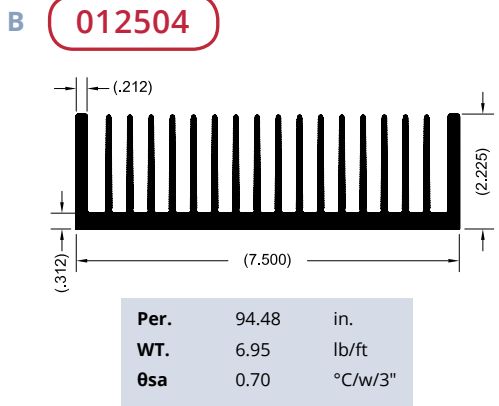
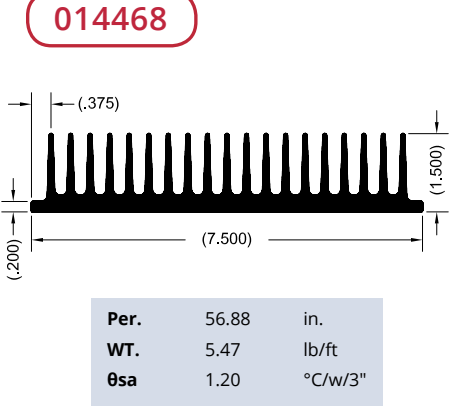
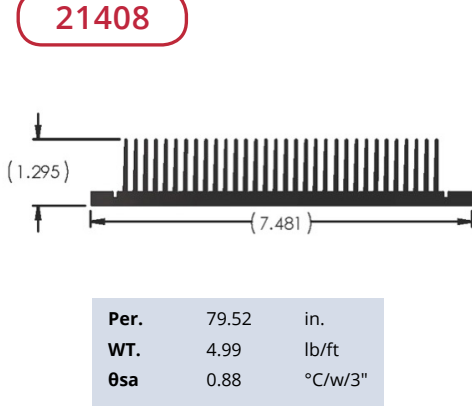
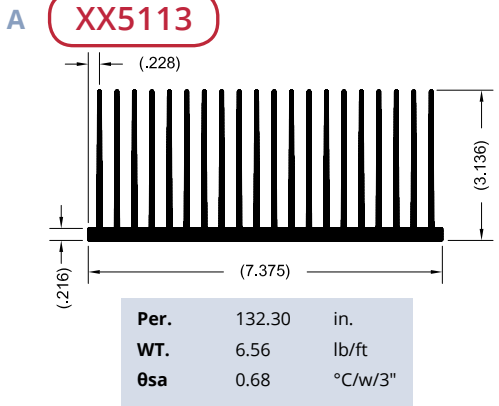


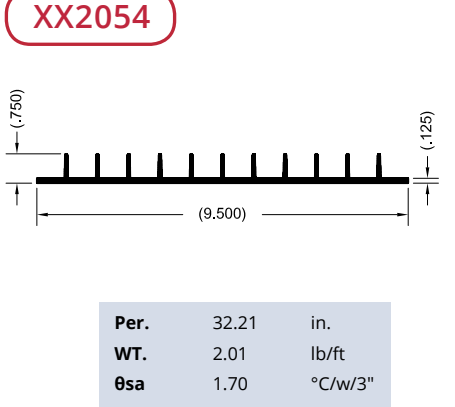
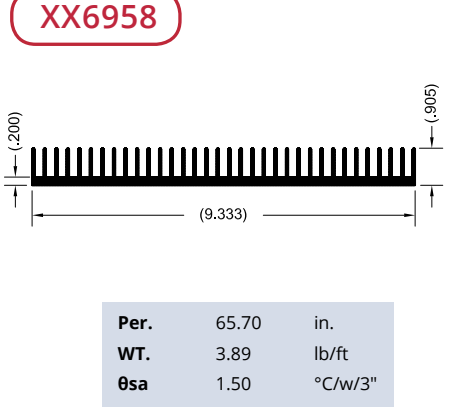
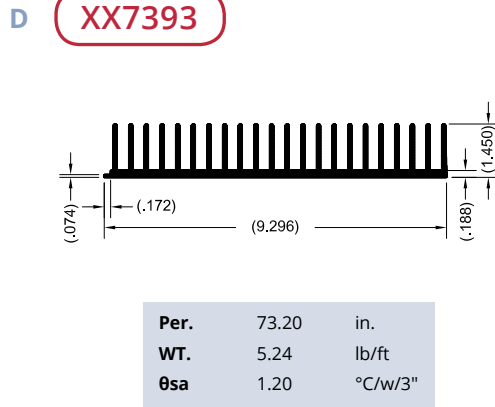
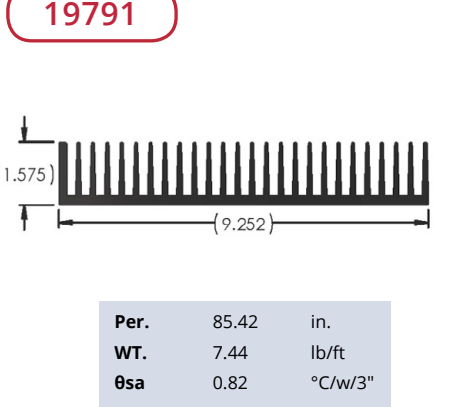
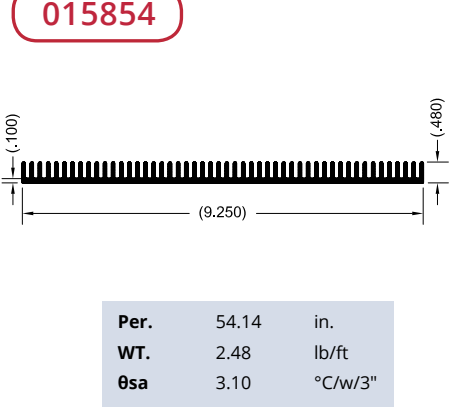
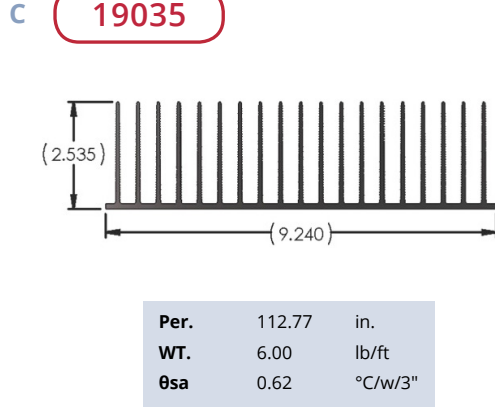
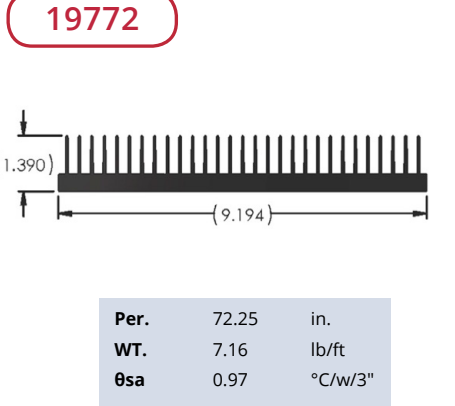
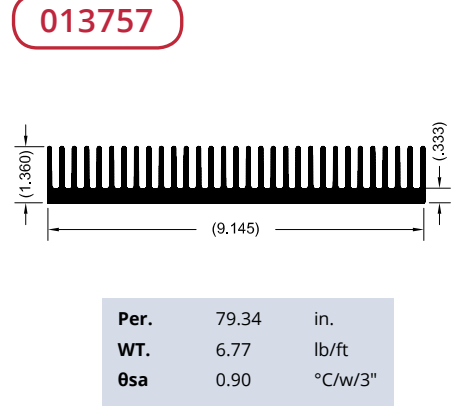
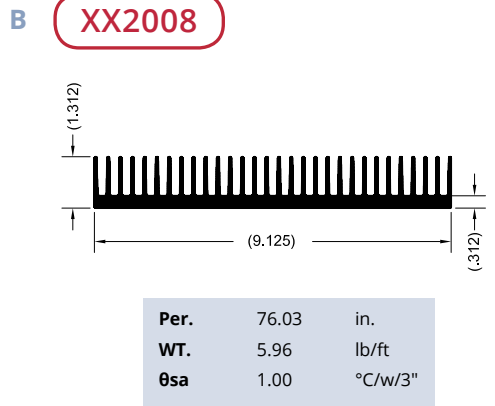
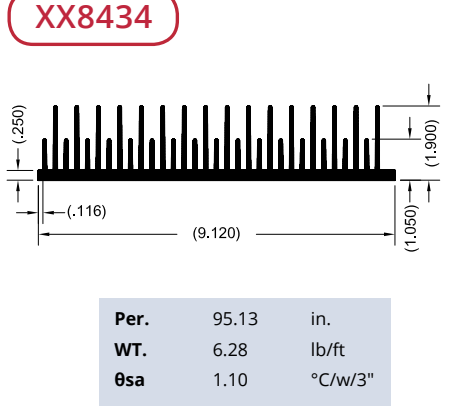
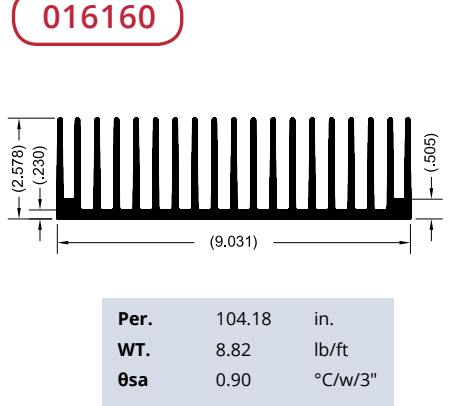
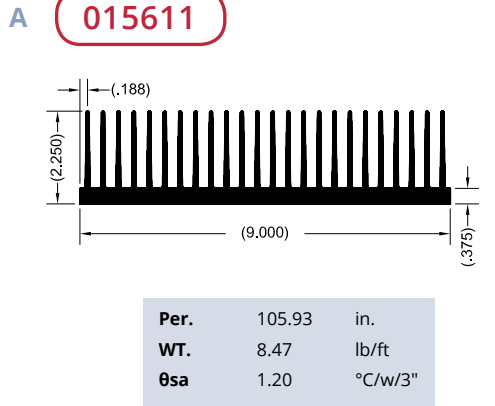
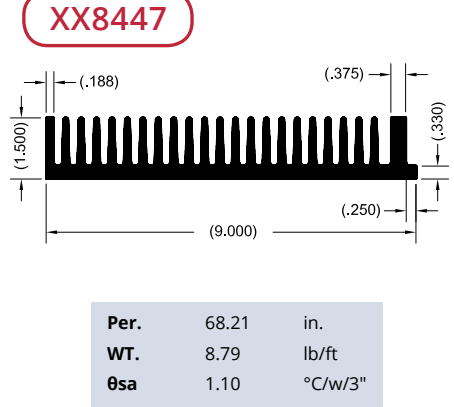
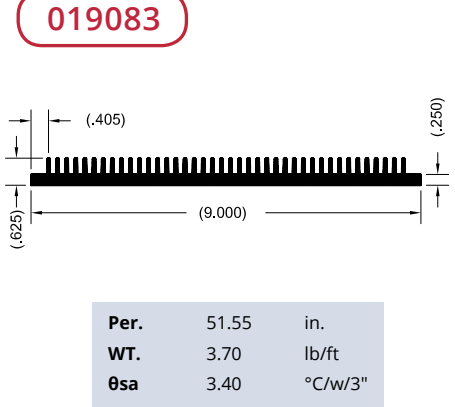
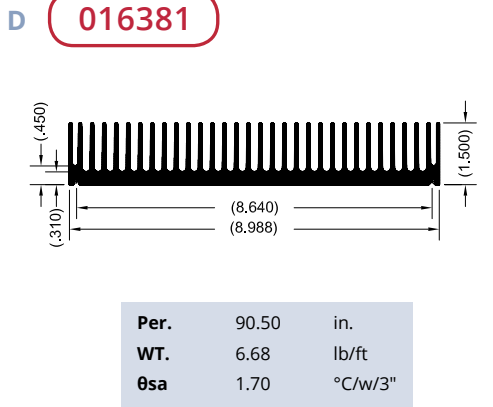
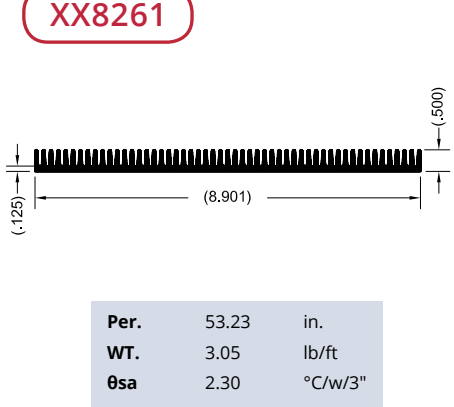
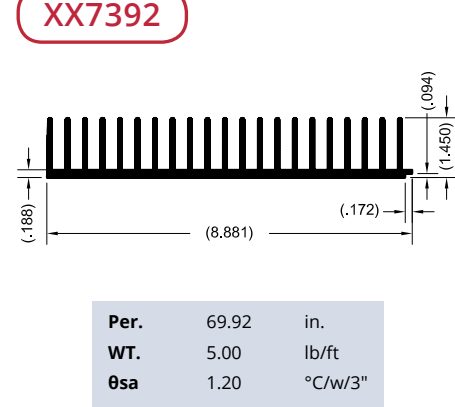
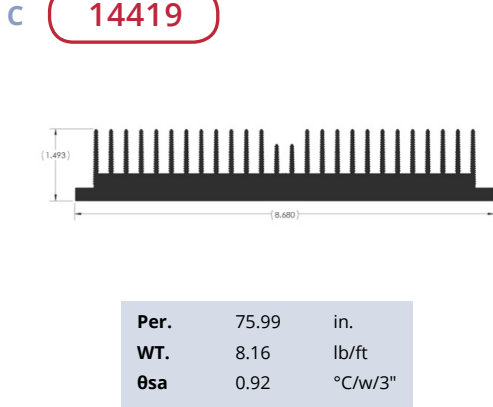
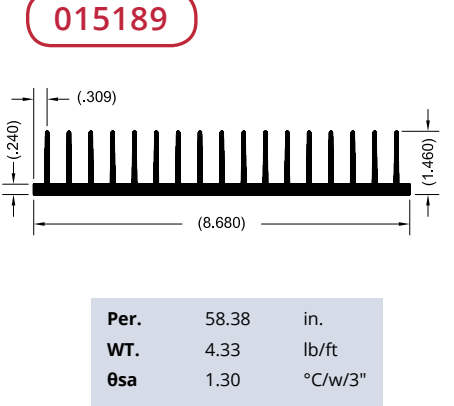
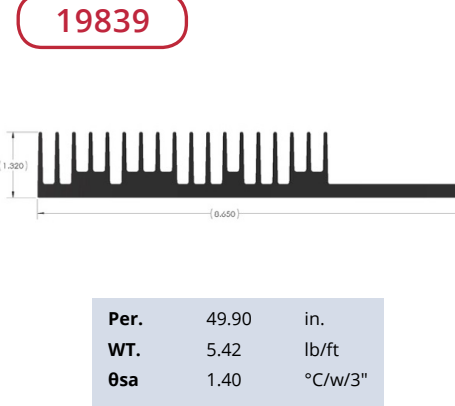
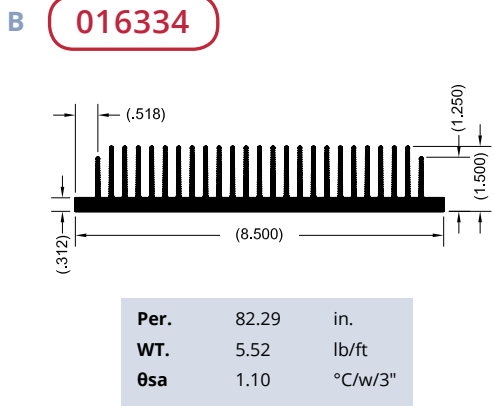
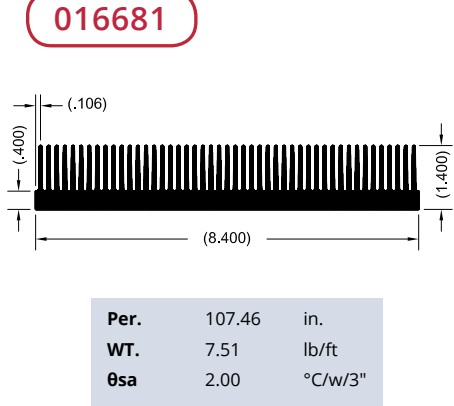
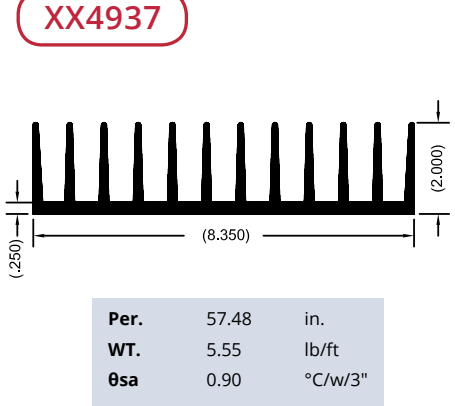
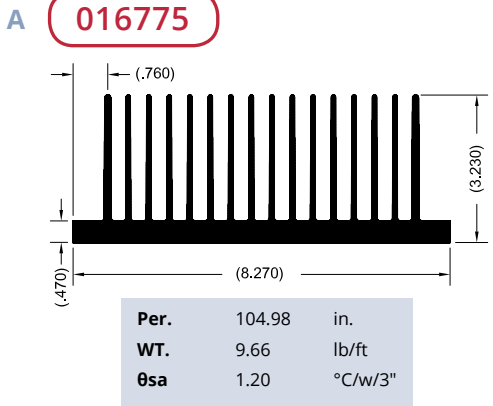
|      |        |         |
|------|--------|---------|
| Per. | 116.11 | in.     |
| WT.  | 7.30   | lb/ft   |
| θsa  | 0.60   | °C/w/3" |

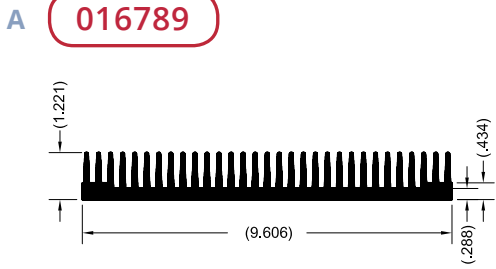


|      |        |         |
|------|--------|---------|
| Per. | 107.22 | in.     |
| WT.  | 7.68   | lb/ft   |
| θsa  | 0.60   | °C/w/3" |

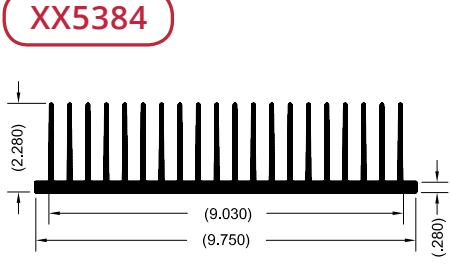




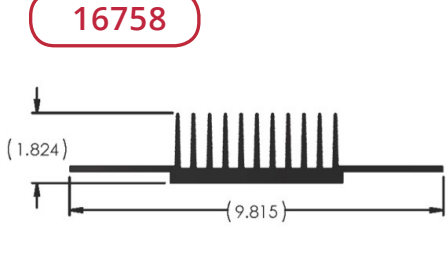




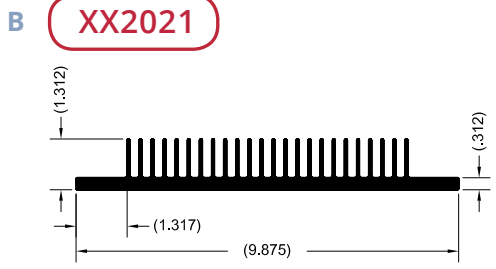
|      |       |         |
|------|-------|---------|
| Per. | 73.30 | in.     |
| WT.  | 7.25  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



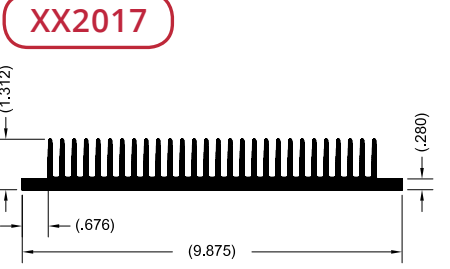
|      |       |         |
|------|-------|---------|
| Per. | 98.46 | in.     |
| WT.  | 7.40  | lb/ft   |
| θsa  | 0.75  | °C/w/3" |



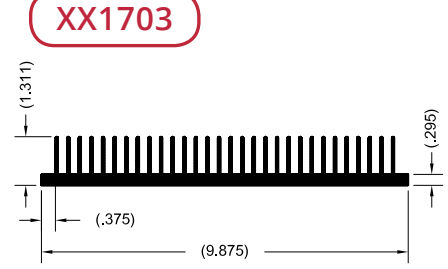
|      |       |         |
|------|-------|---------|
| Per. | 55.45 | in.     |
| WT.  | 5.02  | lb/ft   |
| θsa  | 1.26  | °C/w/3" |



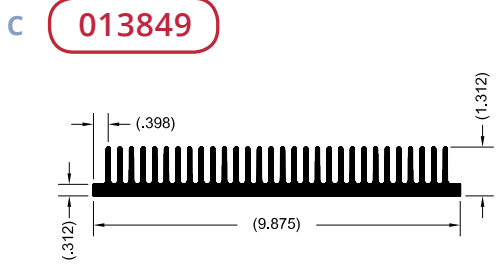
|      |       |         |
|------|-------|---------|
| Per. | 66.42 | in.     |
| WT.  | 5.58  | lb/ft   |
| θsa  | 1.20  | °C/w/3" |



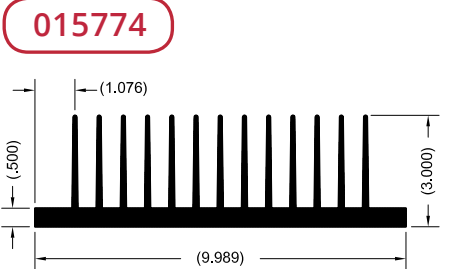
|      |       |         |
|------|-------|---------|
| Per. | 73.22 | in.     |
| WT.  | 6.38  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |



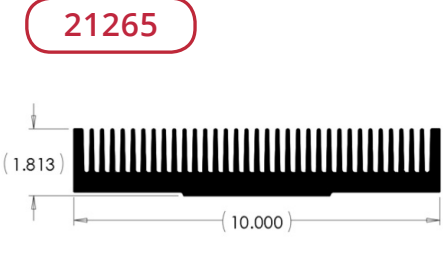
|      |       |         |
|------|-------|---------|
| Per. | 78.03 | in.     |
| WT.  | 6.15  | lb/ft   |
| θsa  | 0.91  | °C/w/3" |



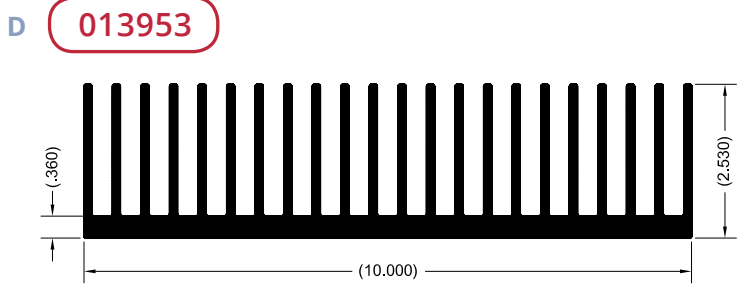
|      |       |         |
|------|-------|---------|
| Per. | 76.21 | in.     |
| WT.  | 7.25  | lb/ft   |
| θsa  | 1.00  | °C/w/3" |



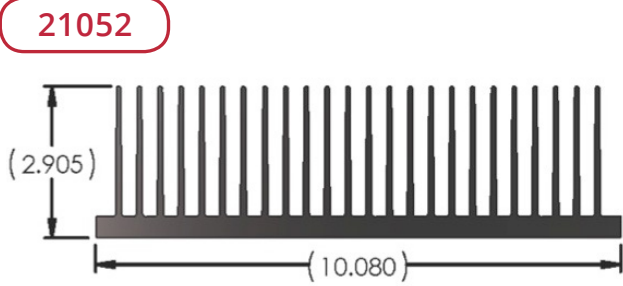
|      |       |         |
|------|-------|---------|
| Per. | 84.68 | in.     |
| WT.  | 10.74 | lb/ft   |
| θsa  | 0.90  | °C/w/3" |



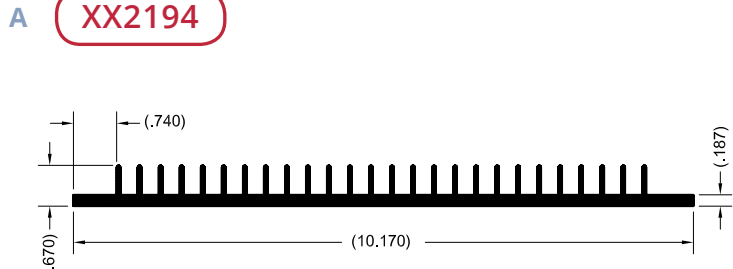
|      |        |         |
|------|--------|---------|
| Per. | 100.37 | in.     |
| WT.  | 12.27  | lb/ft   |
| θsa  | 0.70   | °C/w/3" |



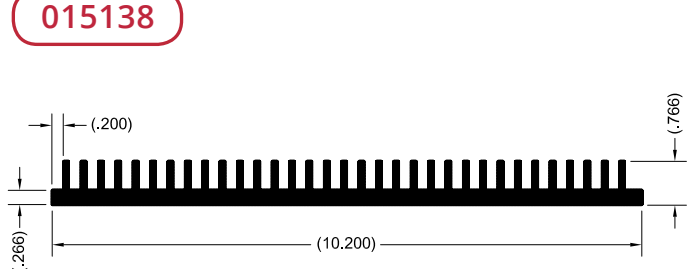
|      |        |         |
|------|--------|---------|
| Per. | 114.78 | in.     |
| WT.  | 11.26  | lb/ft   |
| θsa  | 0.60   | °C/w/3" |



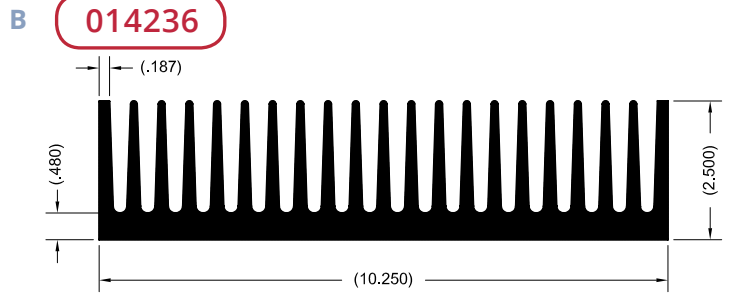
|      |        |         |
|------|--------|---------|
| Per. | 137.98 | in.     |
| WT.  | 12.10  | lb/ft   |
| θsa  | 0.51   | °C/w/3" |



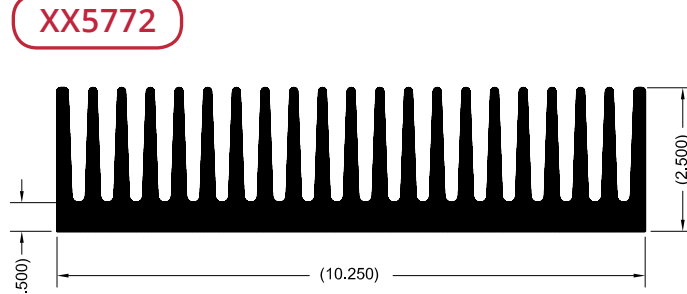
|      |       |         |
|------|-------|---------|
| Per. | 45.13 | in.     |
| WT.  | 3.24  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



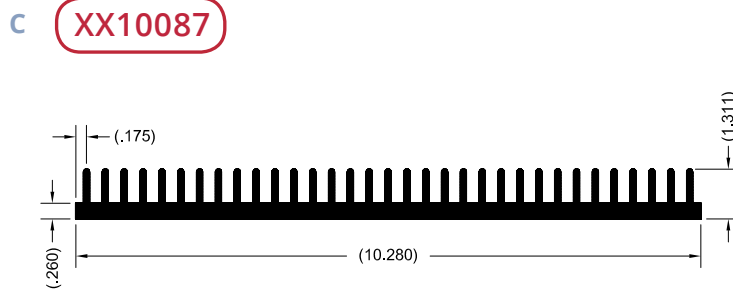
|      |       |         |
|------|-------|---------|
| Per. | 53.93 | in.     |
| WT.  | 5.24  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |



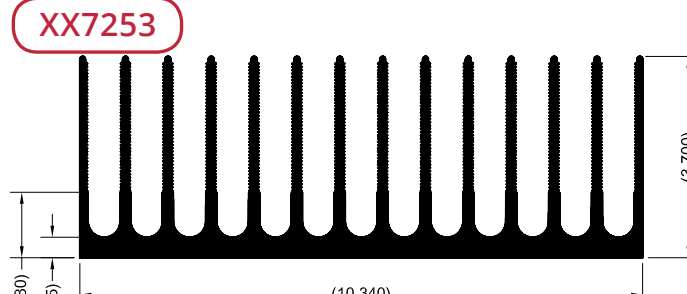
|      |        |         |
|------|--------|---------|
| Per. | 100.80 | in.     |
| WT.  | 15.28  | lb/ft   |
| θsa  | 1.10   | °C/w/3" |



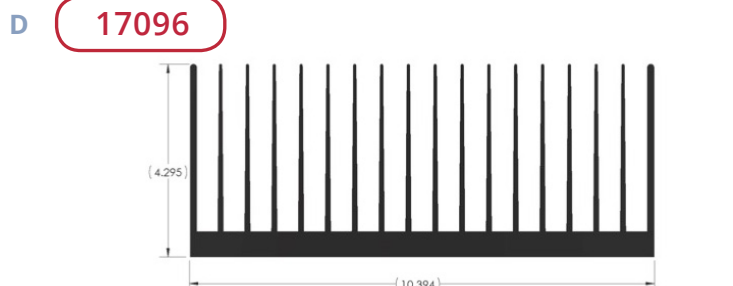
|      |       |         |
|------|-------|---------|
| Per. | 99.79 | in.     |
| WT.  | 15.90 | lb/ft   |
| θsa  | 0.71  | °C/w/3" |



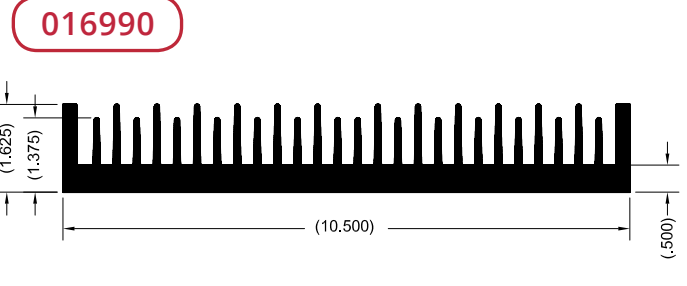
|      |       |         |
|------|-------|---------|
| Per. | 56.77 | in.     |
| WT.  | 5.17  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |



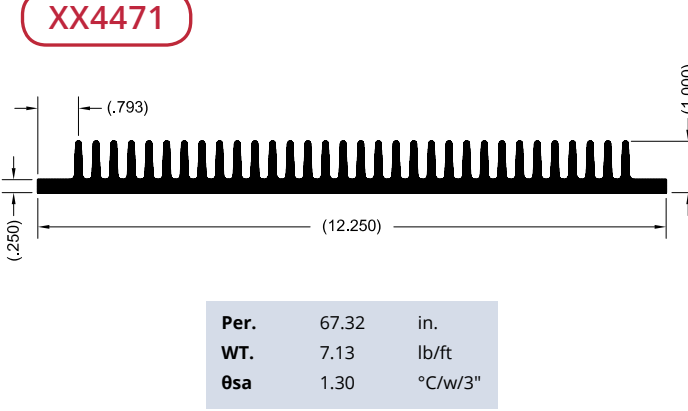
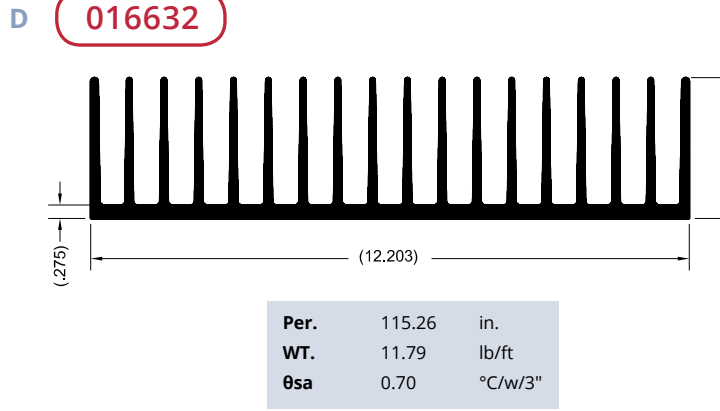
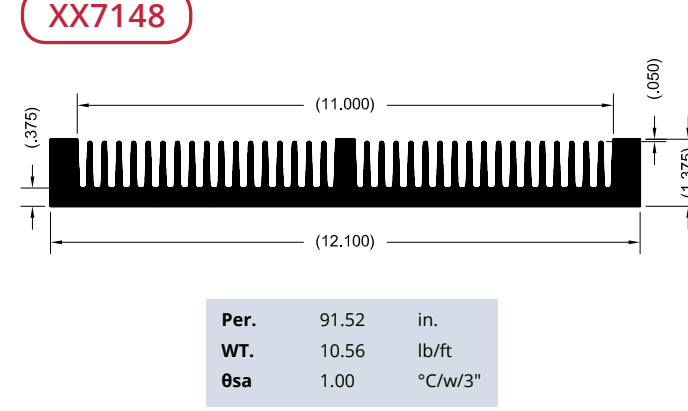
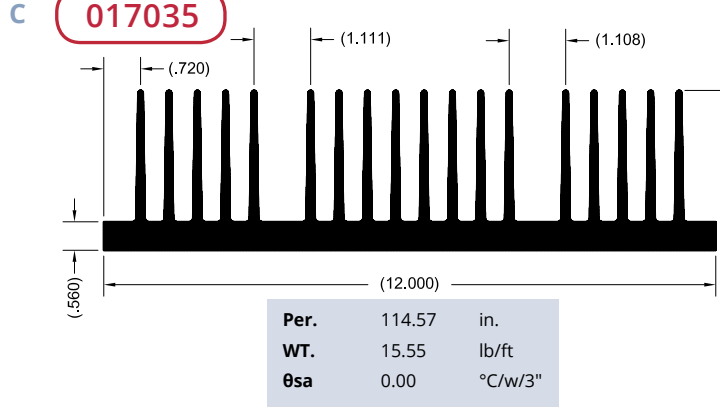
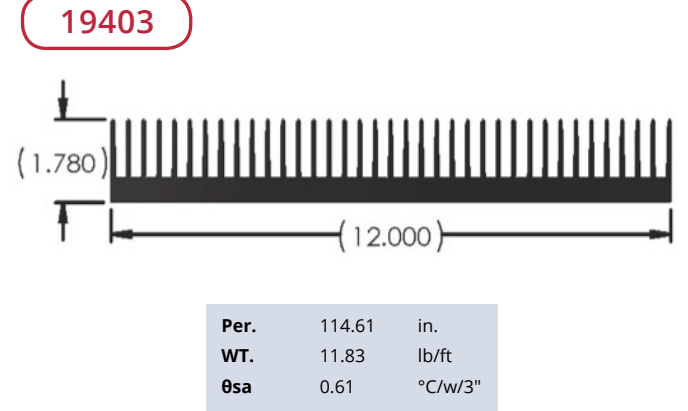
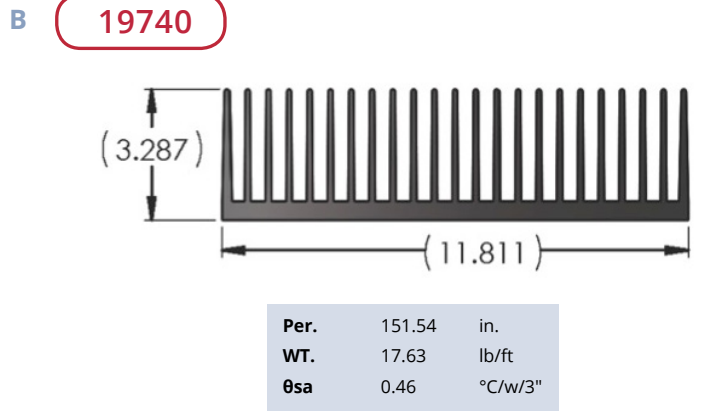
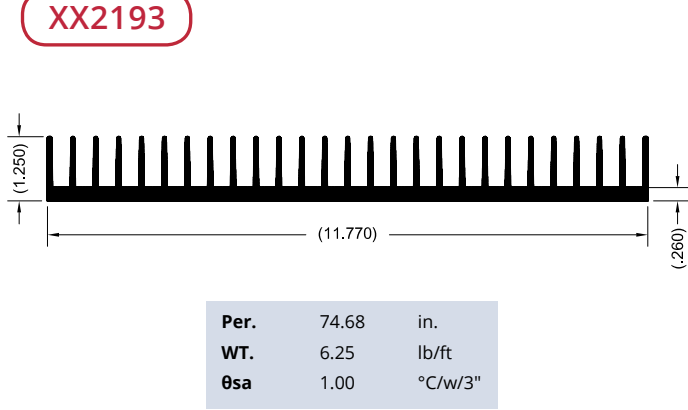
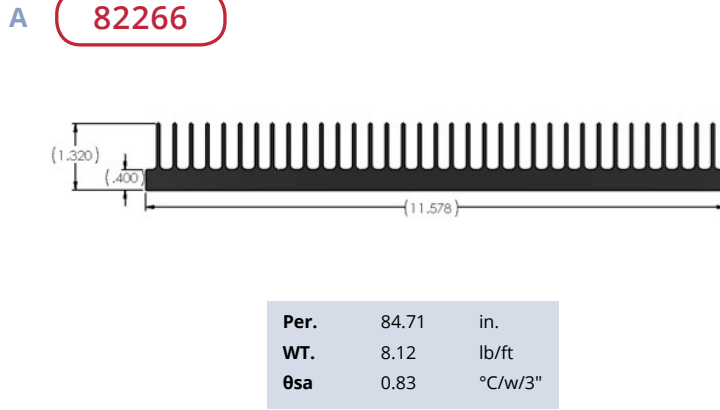
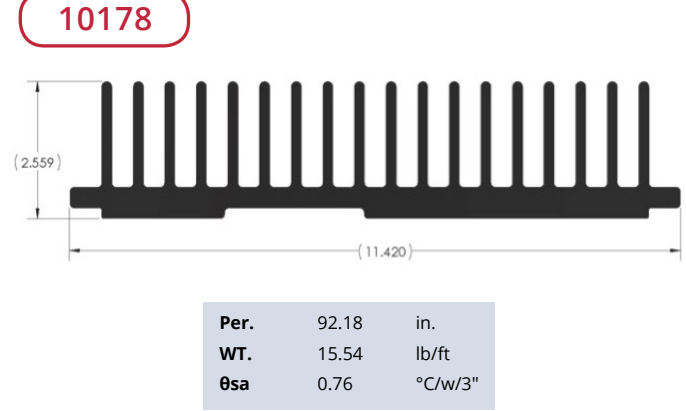
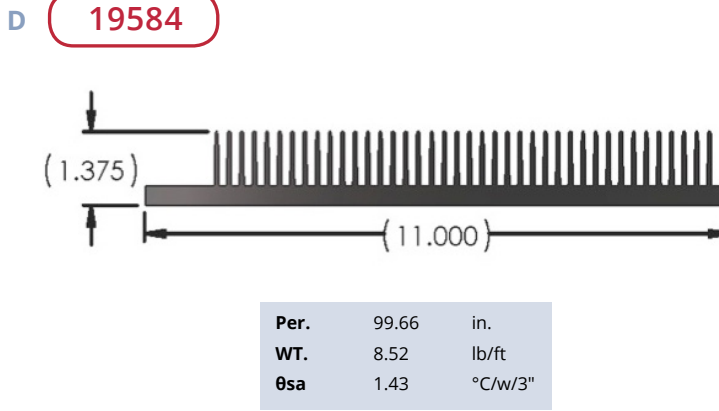
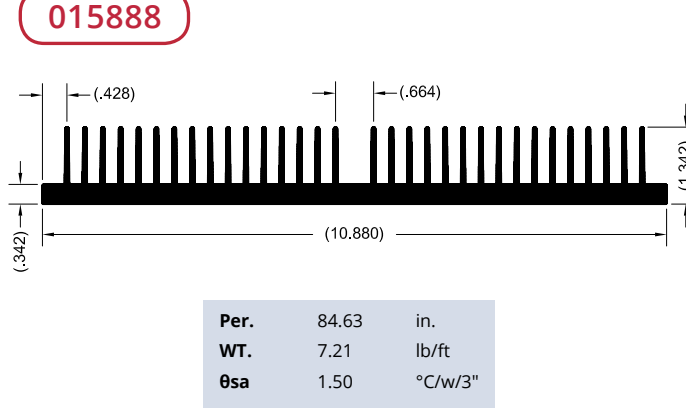
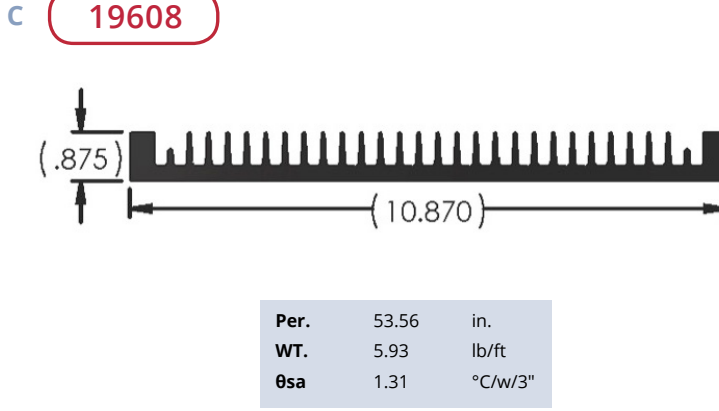
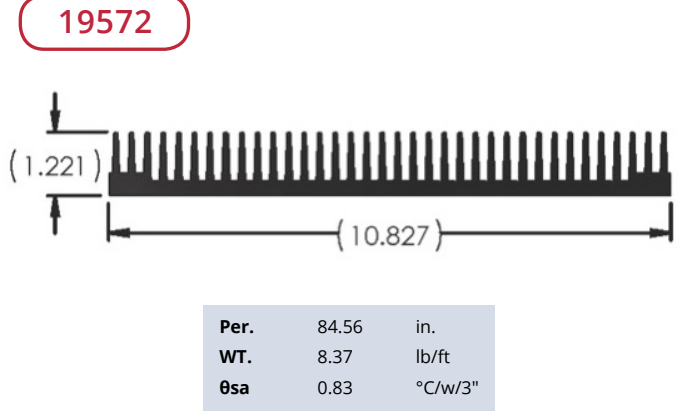
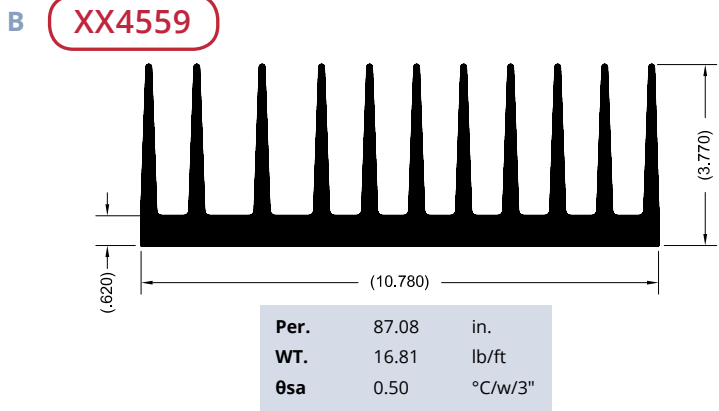
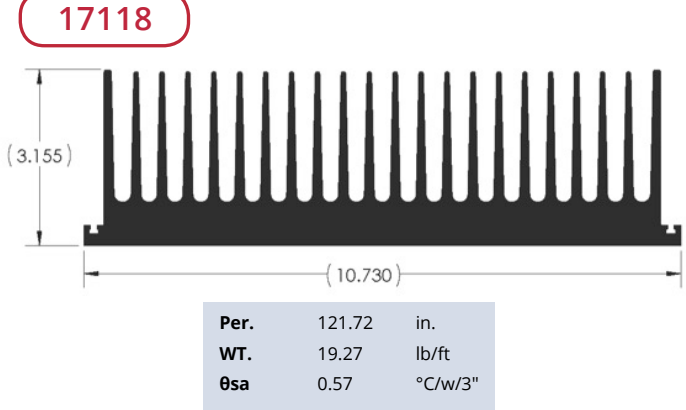
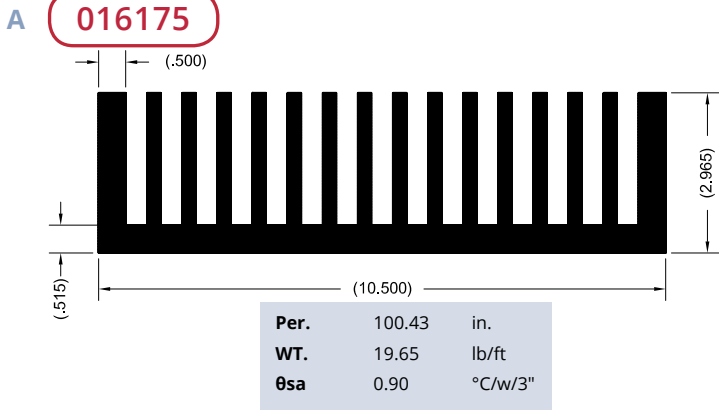
|      |        |         |
|------|--------|---------|
| Per. | 151.74 | in.     |
| WT.  | 13.89  | lb/ft   |
| θsa  | 0.69   | °C/w/3" |



|      |        |         |
|------|--------|---------|
| Per. | 154.23 | in.     |
| WT.  | 15.86  | lb/ft   |
| θsa  | 0.45   | °C/w/3" |



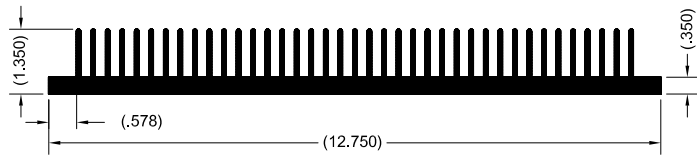
|      |       |         |
|------|-------|---------|
| Per. | 75.47 | in.     |
| WT.  | 10.06 | lb/ft   |
| θsa  | 1.30  | °C/w/3" |





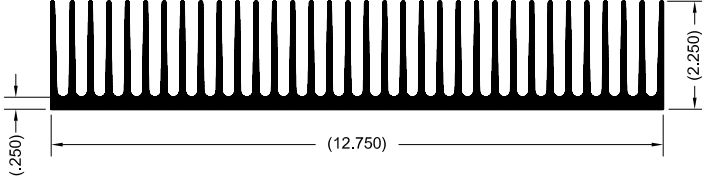
A

XX2170



|      |        |         |
|------|--------|---------|
| Per. | 102.86 | in.     |
| WT.  | 9.07   | lb/ft   |
| θsa  | 0.60   | °C/w/3" |

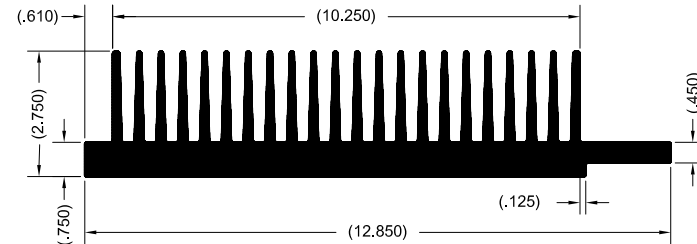
XX2044



|      |        |         |
|------|--------|---------|
| Per. | 155.65 | in.     |
| WT.  | 11.00  | lb/ft   |
| θsa  | 0.56   | °C/w/3" |

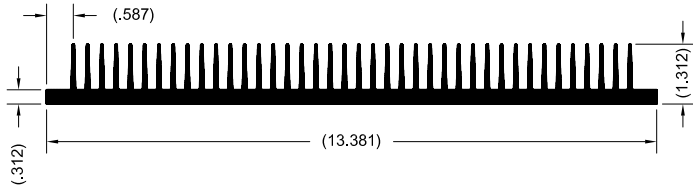
B

XX7214



|      |        |         |
|------|--------|---------|
| Per. | 110.91 | in.     |
| WT.  | 18.71  | lb/ft   |
| θsa  | 0.65   | °C/w/3" |

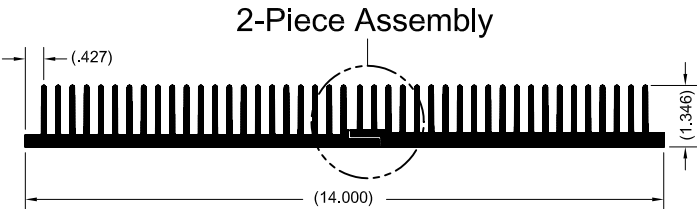
XX5429



|      |        |         |
|------|--------|---------|
| Per. | 110.91 | in.     |
| WT.  | 18.71  | lb/ft   |
| θsa  | 0.65   | °C/w/3" |

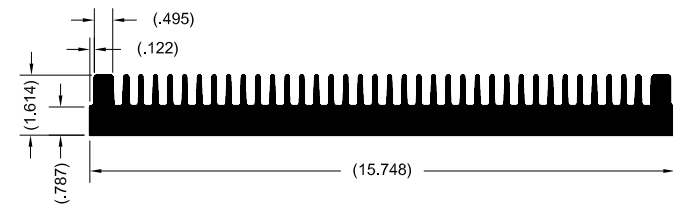
C

013772



|      |       |         |
|------|-------|---------|
| Per. | 60.84 | in.     |
| WT.  | 5.08  | lb/ft   |
| θsa  | 0.60  | °C/w/3" |

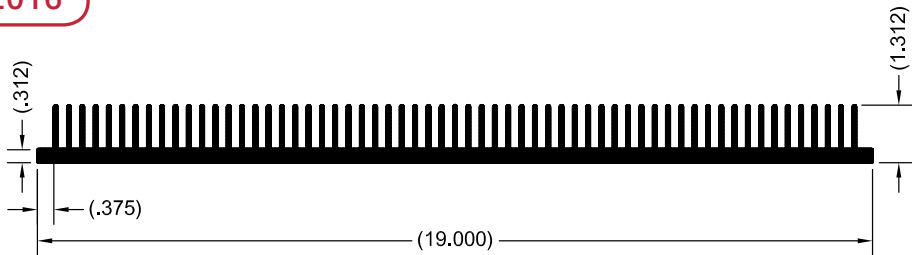
016543



|      |       |         |
|------|-------|---------|
| Per. | 91.53 | in.     |
| WT.  | 19.20 | lb/ft   |
| θsa  | 1.10  | °C/w/3" |

D

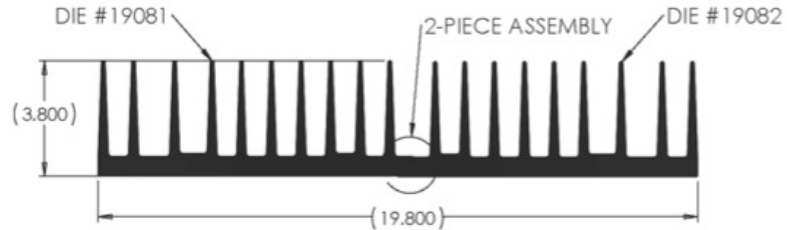
XX2016



|      |        |         |
|------|--------|---------|
| Per. | 110.91 | in.     |
| WT.  | 18.71  | lb/ft   |
| θsa  | 0.65   | °C/w/3" |

A

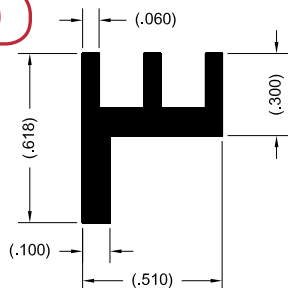
19081 & 19082



|      |        |         |
|------|--------|---------|
| Per. | 153.20 | in.     |
| WT.  | 30.19  | lb/ft   |
| θsa  | 0.46   | °C/w/3" |

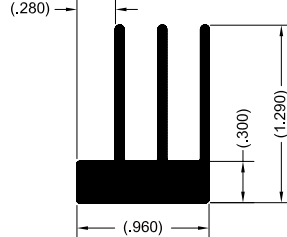
B

009350



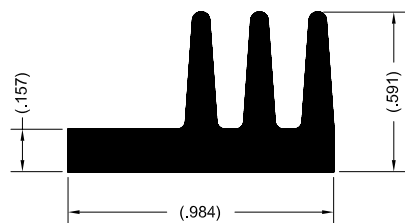
|      |       |         |
|------|-------|---------|
| Per. | 3.07  | in.     |
| WT.  | 0.14  | lb/ft   |
| θsa  | 22.80 | °C/w/3" |

012732



|      |      |         |
|------|------|---------|
| Per. | 8.22 | in.     |
| WT.  | 0.56 | lb/ft   |
| θsa  | 6.50 | °C/w/3" |

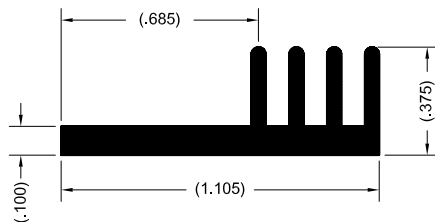
009304



|      |       |         |
|------|-------|---------|
| Per. | 4.89  | in.     |
| WT.  | 0.33  | lb/ft   |
| θsa  | 14.30 | °C/w/3" |

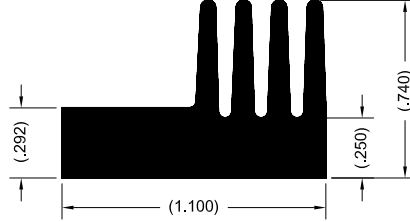
C

009893



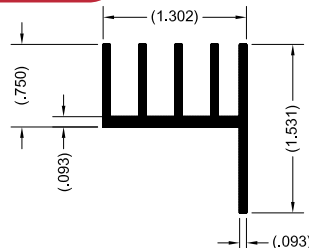
|      |       |         |
|------|-------|---------|
| Per. | 4.61  | in.     |
| WT.  | 0.20  | lb/ft   |
| θsa  | 15.20 | °C/w/3" |

013691



|      |       |         |
|------|-------|---------|
| Per. | 6.31  | in.     |
| WT.  | 0.52  | lb/ft   |
| θsa  | 11.10 | °C/w/3" |

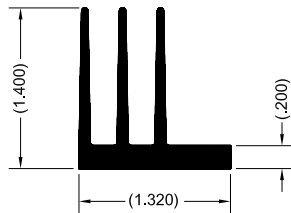
XX5269



|      |       |         |
|------|-------|---------|
| Per. | 10.92 | in.     |
| WT.  | 0.48  | lb/ft   |
| θsa  | 7.30  | °C/w/3" |

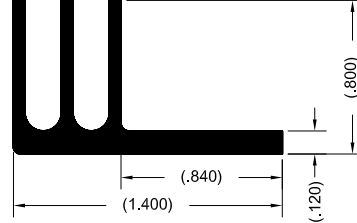
D

014755



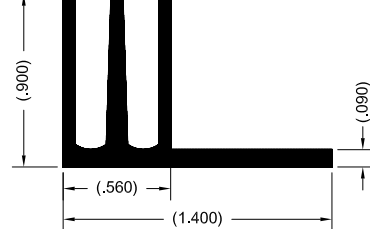
|      |      |         |
|------|------|---------|
| Per. | 9.97 | in.     |
| WT.  | 0.63 | lb/ft   |
| θsa  | 5.70 | °C/w/3" |

XX8627

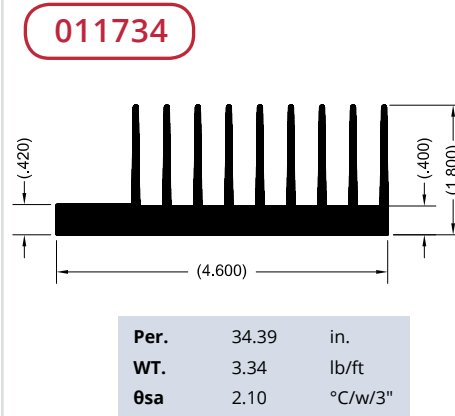
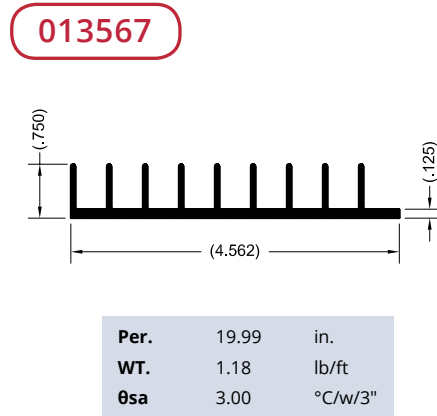
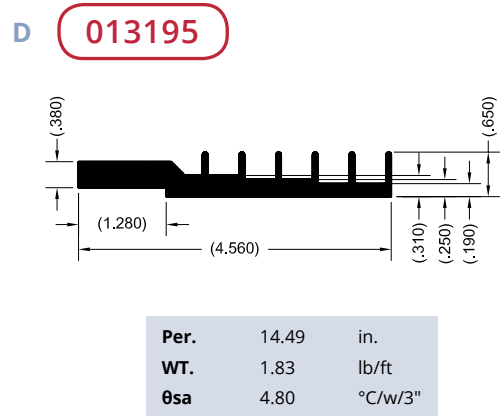
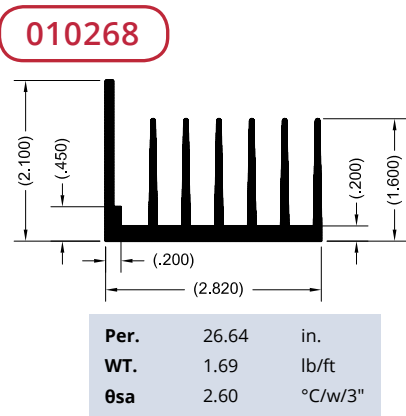
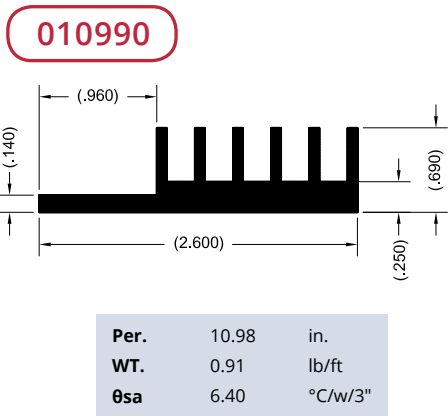
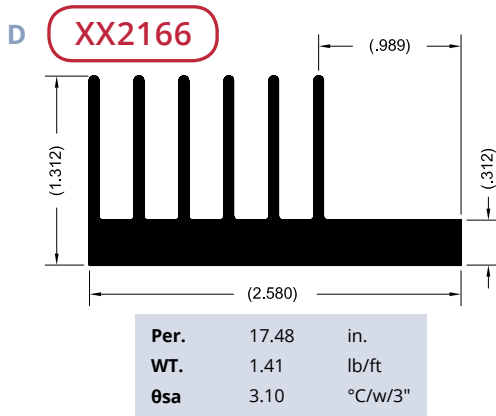
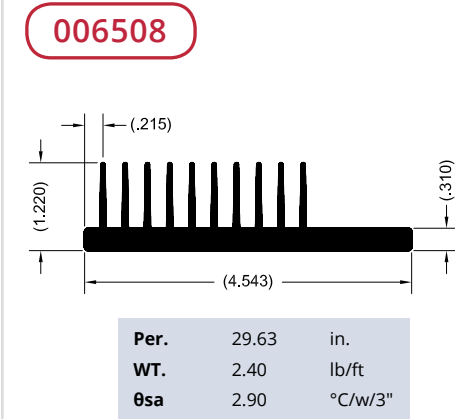
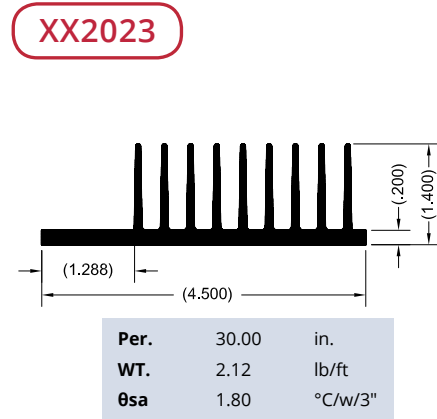
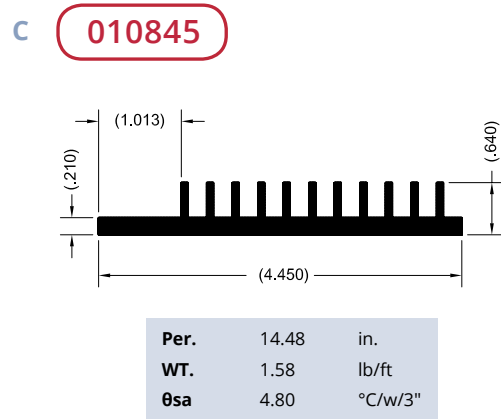
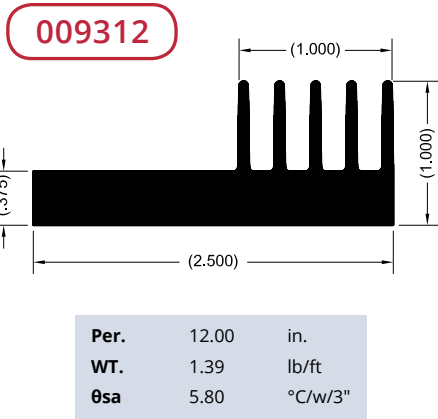
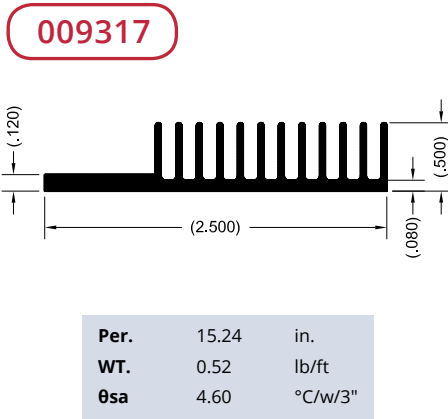
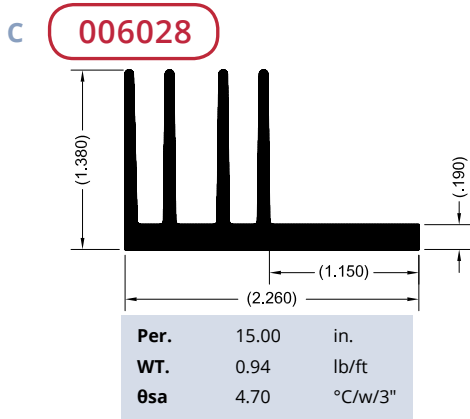
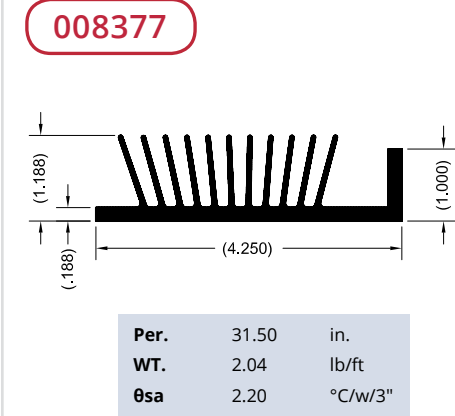
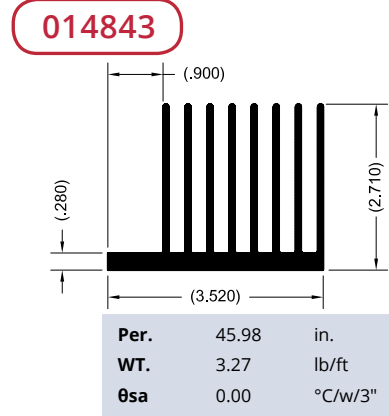
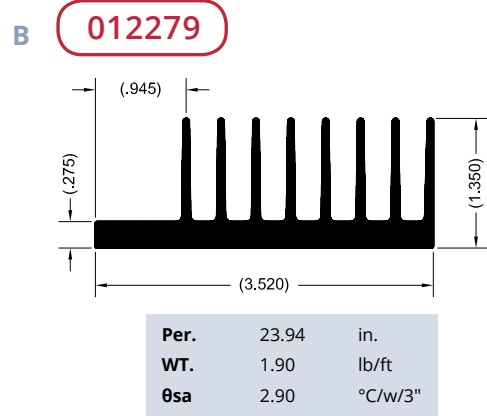
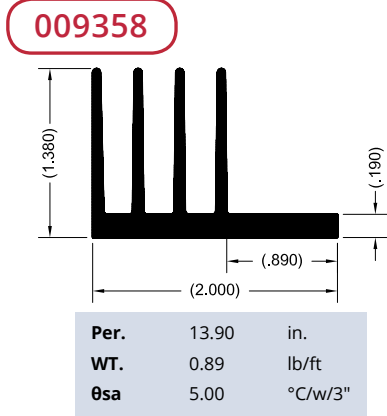
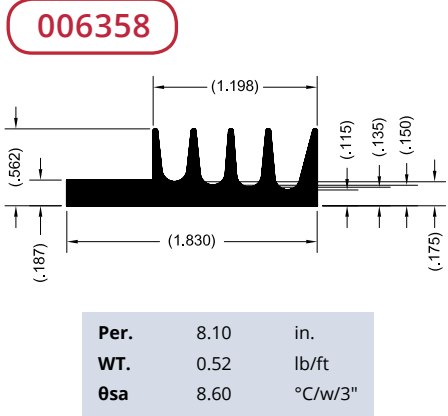
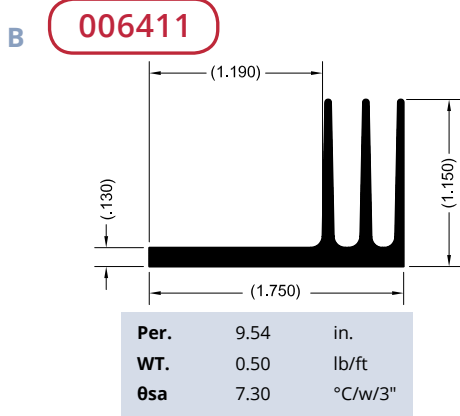
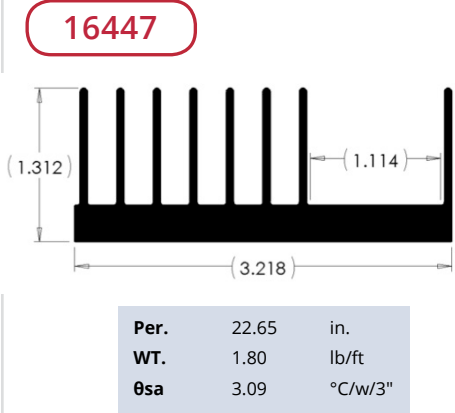
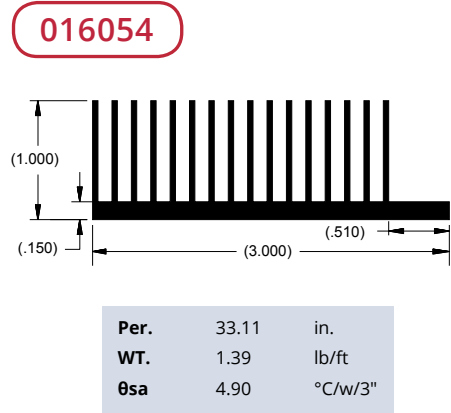
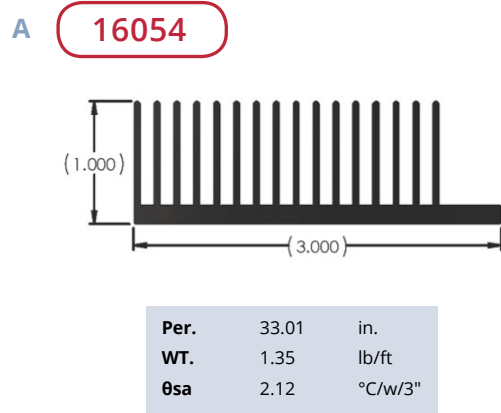
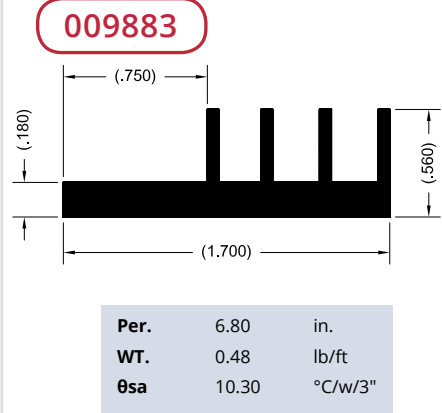
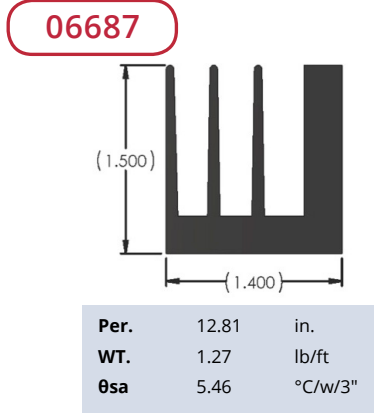
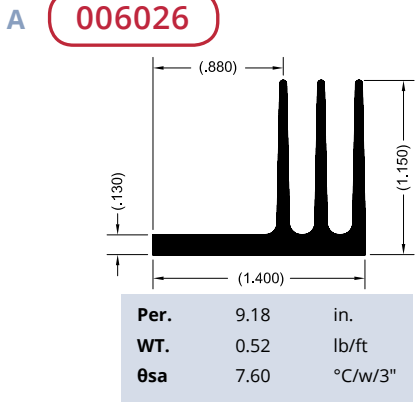


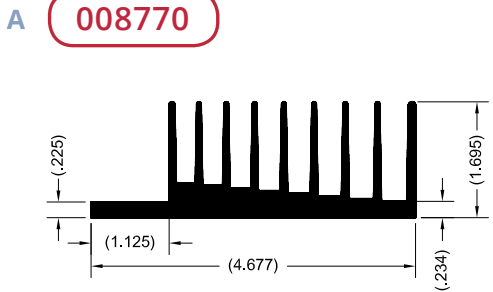
|      |      |         |
|------|------|---------|
| Per. | 6.92 | in.     |
| WT.  | 0.36 | lb/ft   |
| θsa  | 7.00 | °C/w/3" |

006248

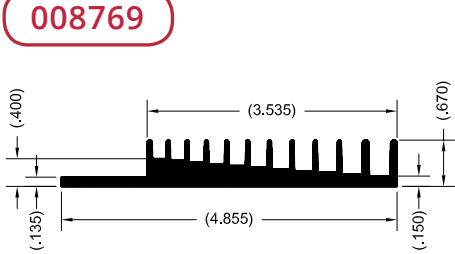


|      |      |         |
|------|------|---------|
| Per. | 7.61 | in.     |
| WT.  | 0.37 | lb/ft   |
| θsa  | 9.20 | °C/w/3" |

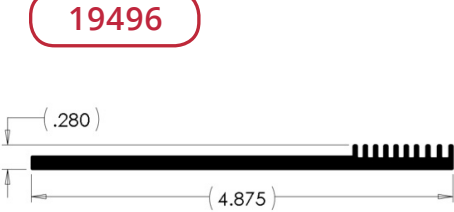




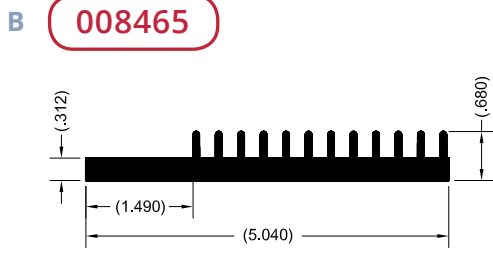
|      |       |         |
|------|-------|---------|
| Per. | 32.75 | in.     |
| WT.  | 3.04  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



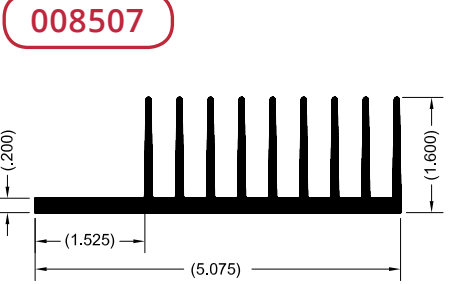
|      |       |         |
|------|-------|---------|
| Per. | 19.24 | in.     |
| WT.  | 1.65  | lb/ft   |
| θsa  | 3.60  | °C/w/3" |



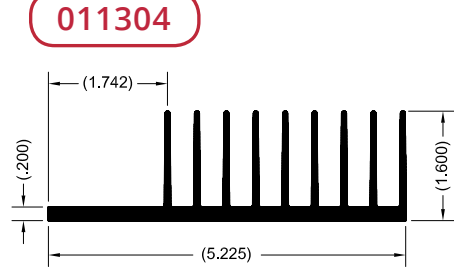
|      |       |         |
|------|-------|---------|
| Per. | 12.75 | in.     |
| WT.  | 0.93  | lb/ft   |
| θsa  | 5.48  | °C/w/3" |



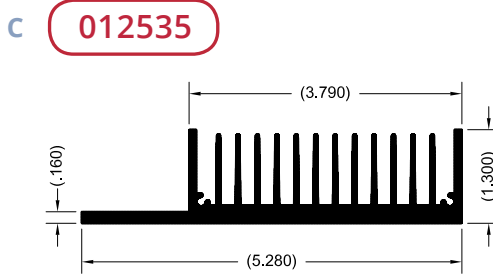
|      |       |         |
|------|-------|---------|
| Per. | 19.54 | in.     |
| WT.  | 2.34  | lb/ft   |
| θsa  | 3.60  | °C/w/3" |



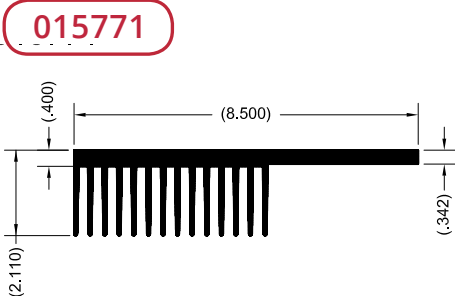
|      |       |         |
|------|-------|---------|
| Per. | 35.08 | in.     |
| WT.  | 2.43  | lb/ft   |
| θsa  | 2.60  | °C/w/3" |



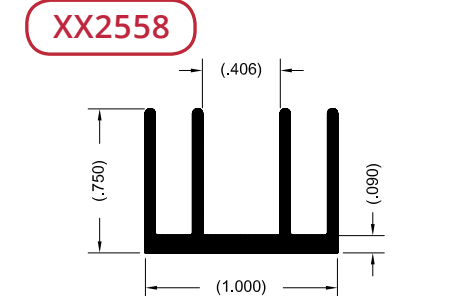
|      |       |         |
|------|-------|---------|
| Per. | 34.60 | in.     |
| WT.  | 2.37  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |



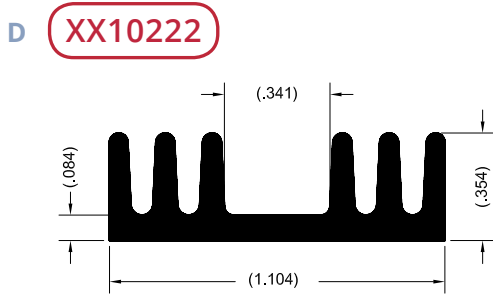
|      |       |         |
|------|-------|---------|
| Per. | 39.12 | in.     |
| WT.  | 2.54  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



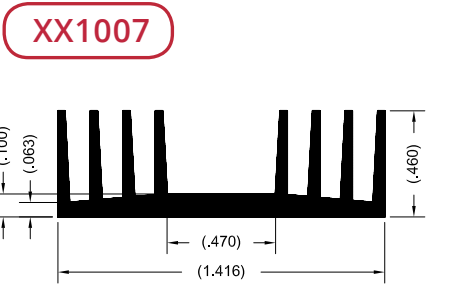
|      |       |         |
|------|-------|---------|
| Per. | 64.44 | in.     |
| WT.  | 6.35  | lb/ft   |
| θsa  | 0.00  | °C/w/3" |



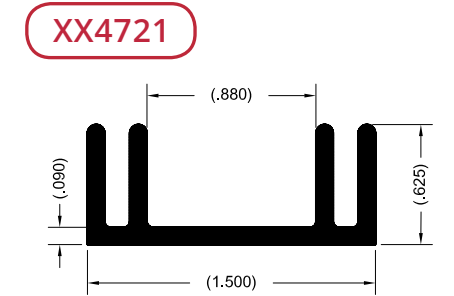
|      |      |         |
|------|------|---------|
| Per. | 7.46 | in.     |
| WT.  | 0.27 | lb/ft   |
| θsa  | 8.00 | °C/w/3" |



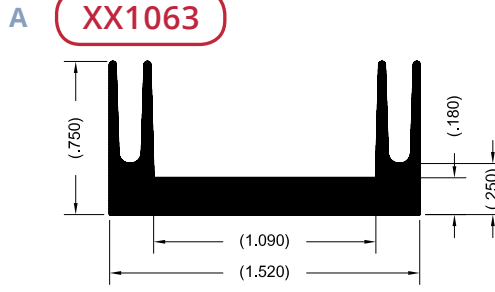
|      |       |         |
|------|-------|---------|
| Per. | 5.15  | in.     |
| WT.  | 0.99  | lb/ft   |
| θsa  | 10.00 | °C/w/3" |



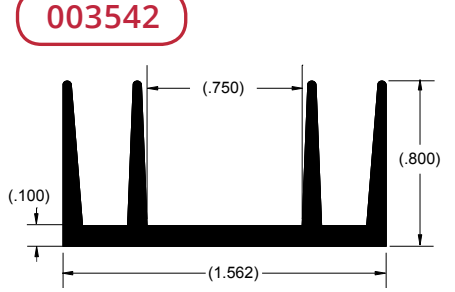
|      |      |         |
|------|------|---------|
| Per. | 8.88 | in.     |
| WT.  | 0.29 | lb/ft   |
| θsa  | 6.40 | °C/w/3" |



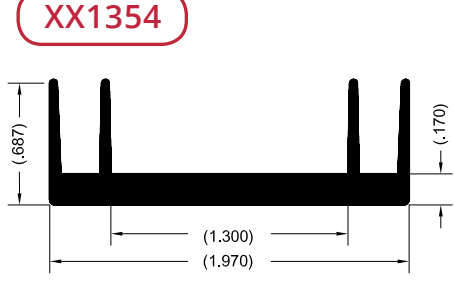
|      |       |         |
|------|-------|---------|
| Per. | 7.23  | in.     |
| WT.  | 0.39  | lb/ft   |
| θsa  | 10.30 | °C/w/3" |



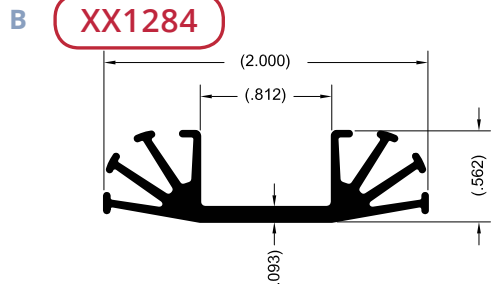
|      |      |         |
|------|------|---------|
| Per. | 7.45 | in.     |
| WT.  | 0.46 | lb/ft   |
| θsa  | 5.10 | °C/w/3" |



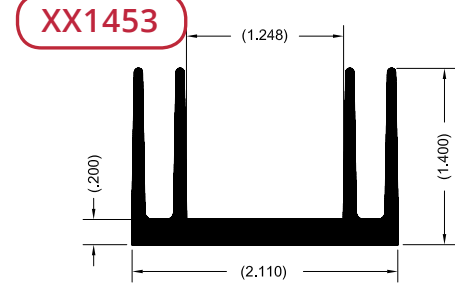
|      |      |         |
|------|------|---------|
| Per. | 8.95 | in.     |
| WT.  | 0.41 | lb/ft   |
| θsa  | 7.80 | °C/w/3" |



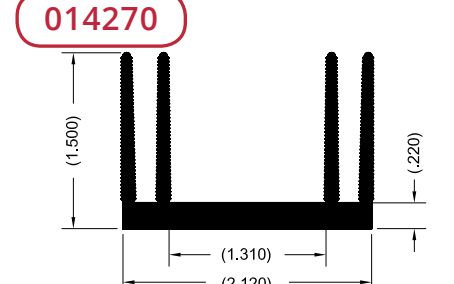
|      |      |         |
|------|------|---------|
| Per. | 8.24 | in.     |
| WT.  | 0.52 | lb/ft   |
| θsa  | 4.30 | °C/w/3" |



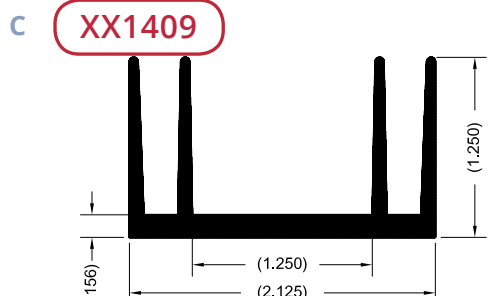
|      |      |         |
|------|------|---------|
| Per. | 9.96 | in.     |
| WT.  | 0.37 | lb/ft   |
| θsa  | 6.50 | °C/w/3" |



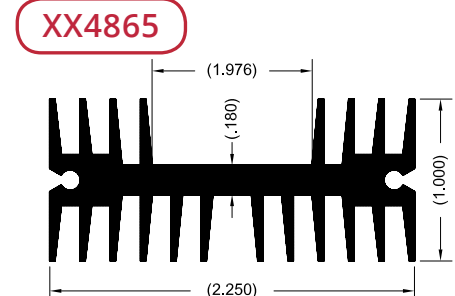
|      |       |         |
|------|-------|---------|
| Per. | 13.86 | in.     |
| WT.  | 1.00  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



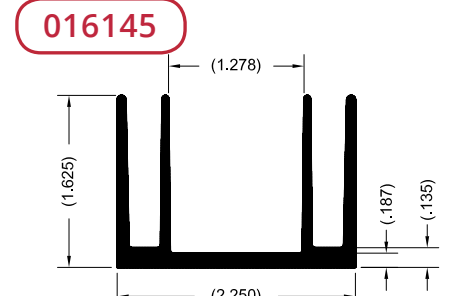
|      |       |         |
|------|-------|---------|
| Per. | 22.50 | in.     |
| WT.  | 1.07  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



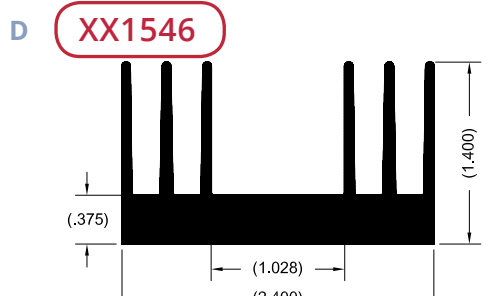
|      |       |         |
|------|-------|---------|
| Per. | 13.05 | in.     |
| WT.  | 0.81  | lb/ft   |
| θsa  | 3.80  | °C/w/3" |



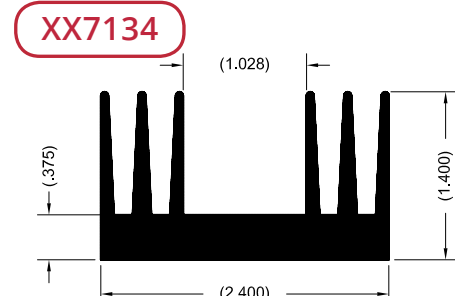
|      |       |         |
|------|-------|---------|
| Per. | 20.15 | in.     |
| WT.  | 1.02  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



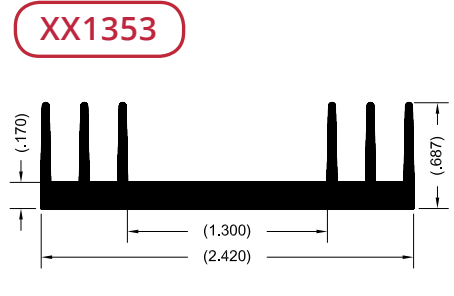
|      |       |         |
|------|-------|---------|
| Per. | 16.17 | in.     |
| WT.  | 1.01  | lb/ft   |
| θsa  | 3.70  | °C/w/3" |



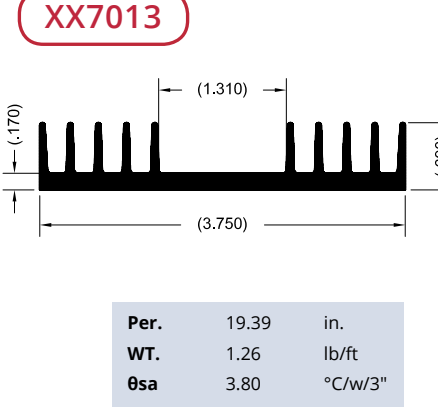
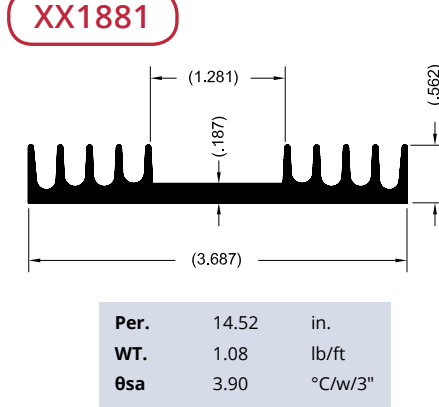
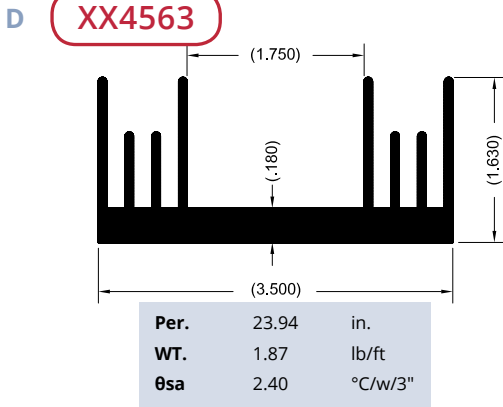
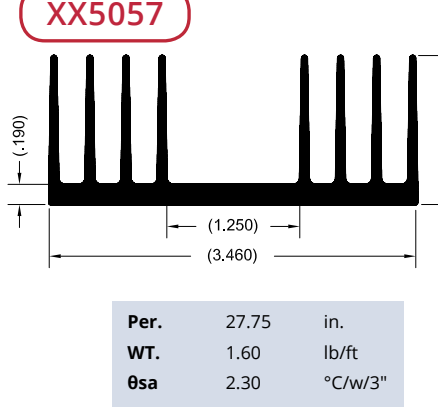
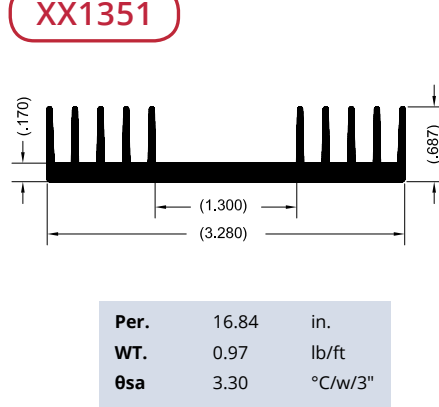
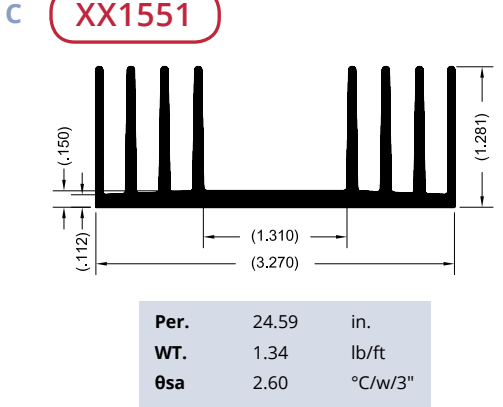
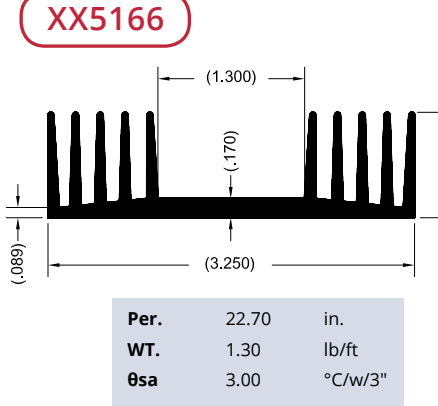
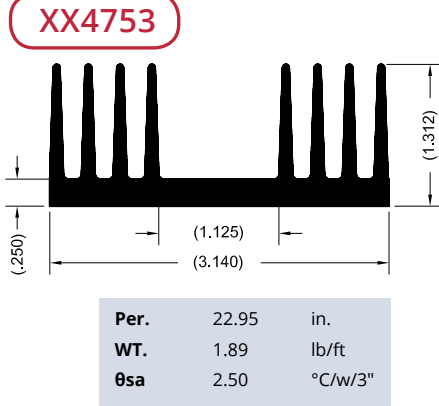
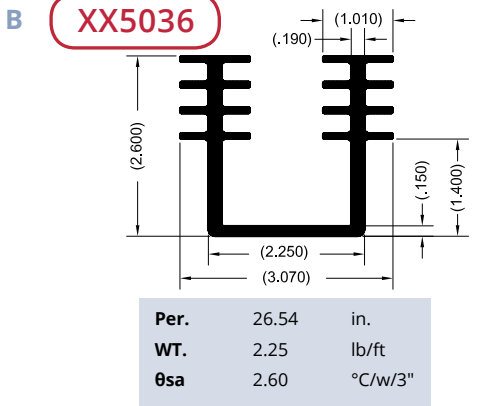
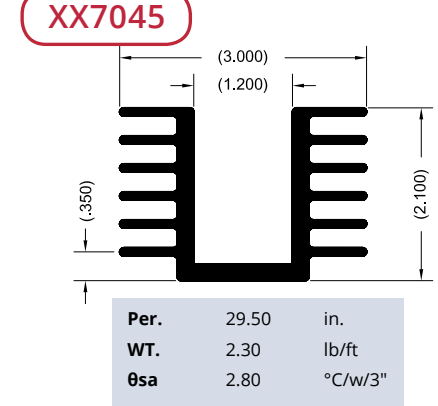
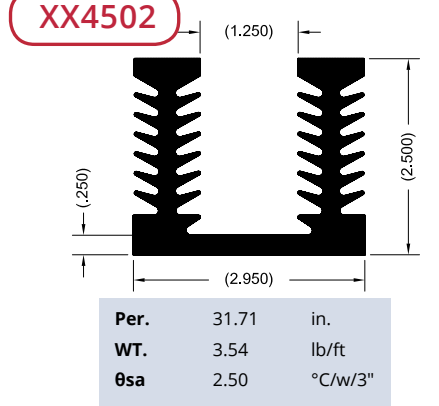
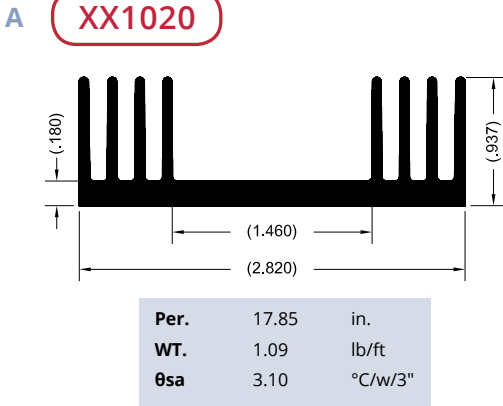
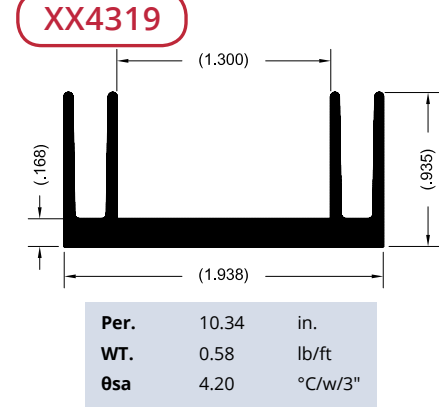
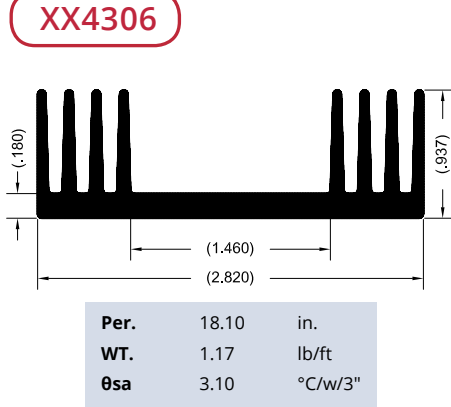
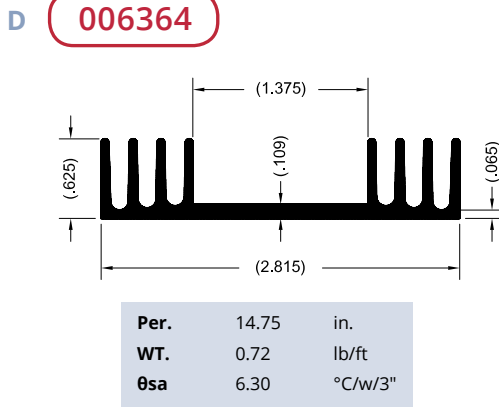
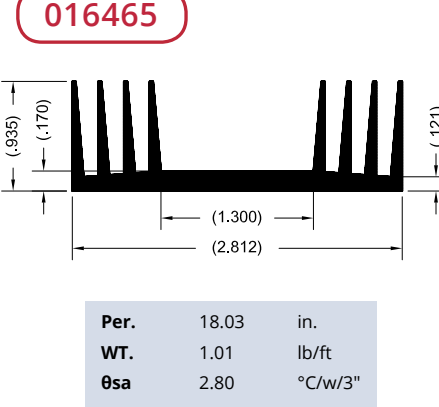
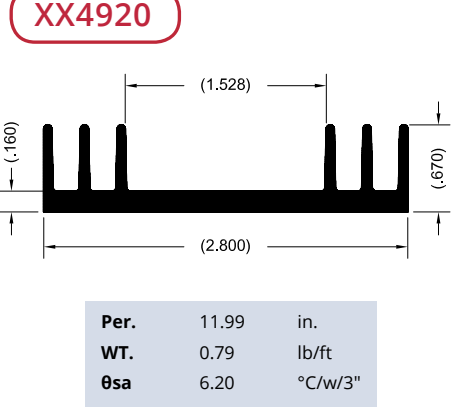
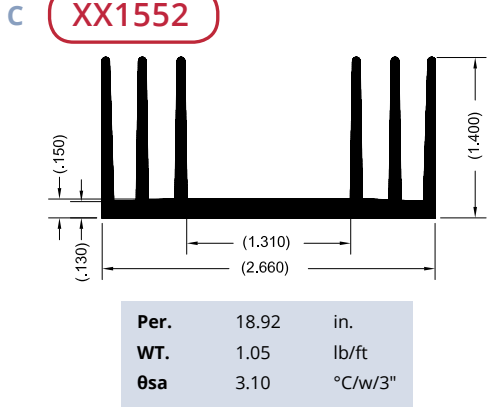
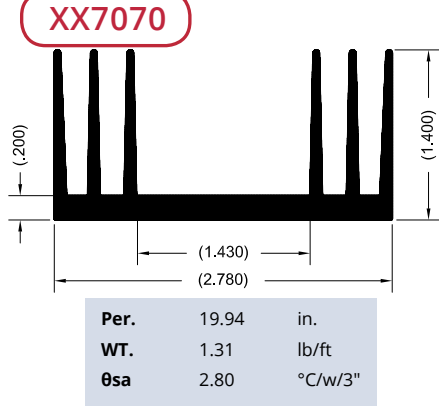
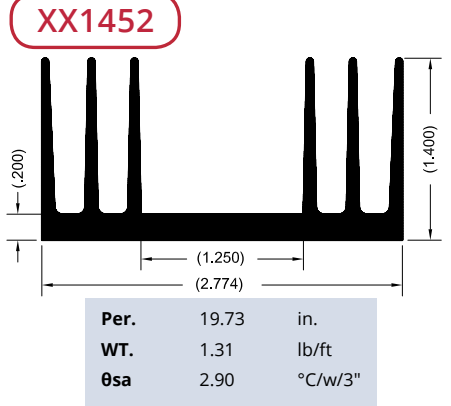
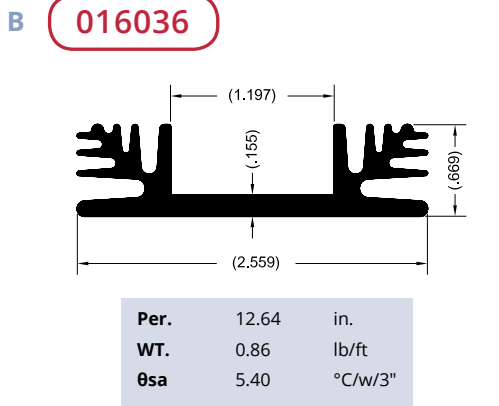
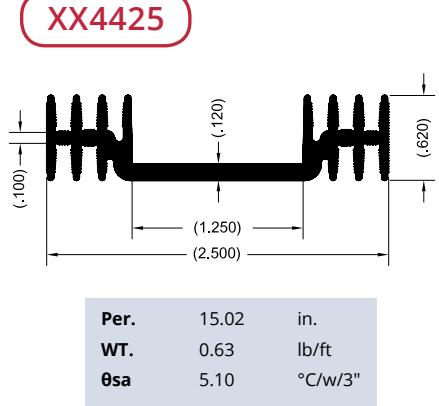
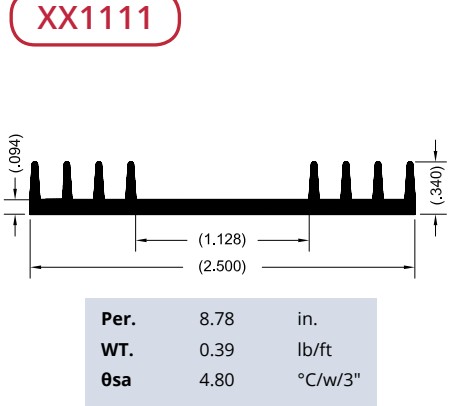
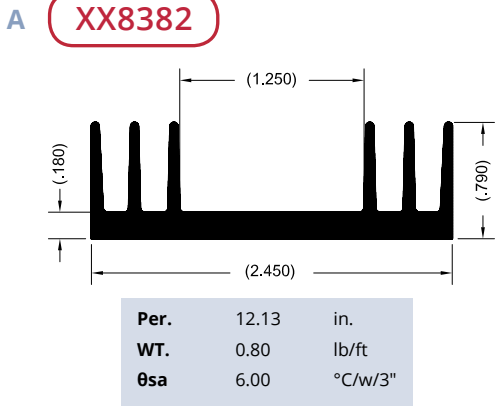
|      |       |         |
|------|-------|---------|
| Per. | 17.49 | in.     |
| WT.  | 1.61  | lb/ft   |
| θsa  | 3.70  | °C/w/3" |



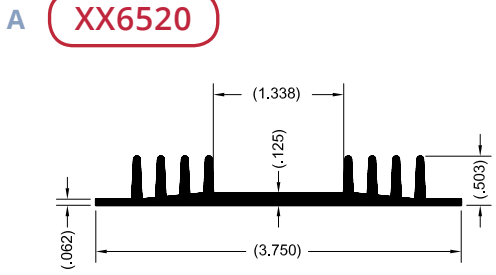
|      |       |         |
|------|-------|---------|
| Per. | 17.32 | in.     |
| WT.  | 1.76  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |



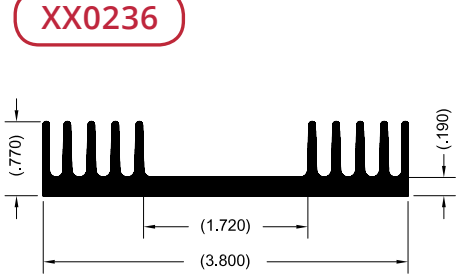
|      |       |         |
|------|-------|---------|
| Per. | 11.16 | in.     |
| WT.  | 0.68  | lb/ft   |
| θsa  | 4.00  | °C/w/3" |



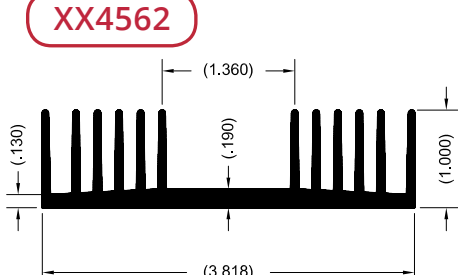




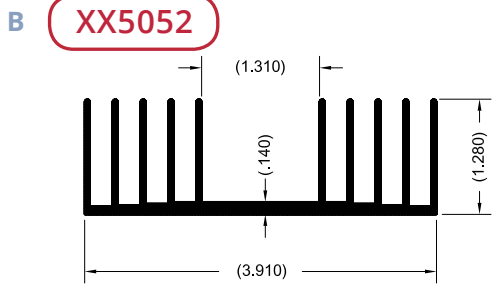
|      |       |         |
|------|-------|---------|
| Per. | 13.50 | in.     |
| WT.  | 0.74  | lb/ft   |
| θsa  | 4.00  | °C/w/3" |



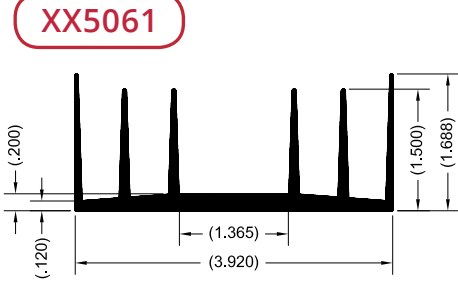
|      |       |         |
|------|-------|---------|
| Per. | 19.58 | in.     |
| WT.  | 1.39  | lb/ft   |
| θsa  | 4.50  | °C/w/3" |



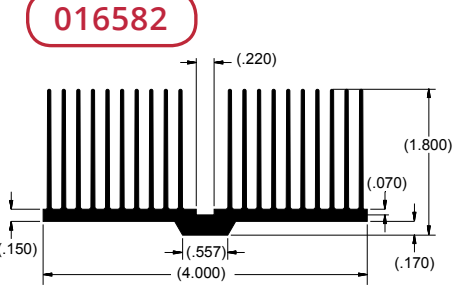
|      |       |         |
|------|-------|---------|
| Per. | 28.00 | in.     |
| WT.  | 1.62  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



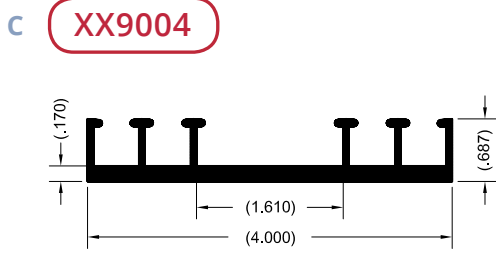
|      |       |         |
|------|-------|---------|
| Per. | 31.02 | in.     |
| WT.  | 1.39  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |



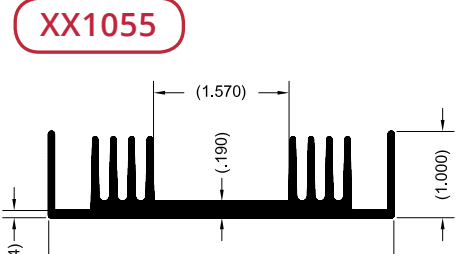
|      |       |         |
|------|-------|---------|
| Per. | 22.14 | in.     |
| WT.  | 1.85  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |



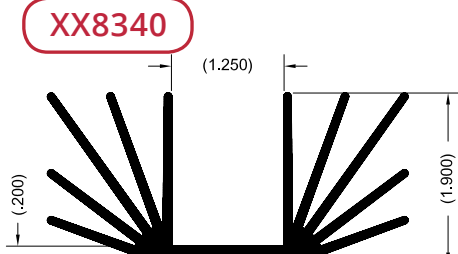
|      |       |         |
|------|-------|---------|
| Per. | 66.79 | in.     |
| WT.  | 2.44  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



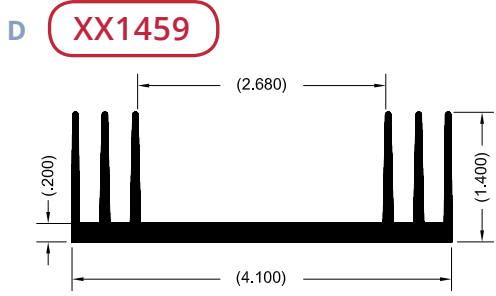
|      |       |         |
|------|-------|---------|
| Per. | 15.97 | in.     |
| WT.  | 1.14  | lb/ft   |
| θsa  | 2.90  | °C/w/3" |



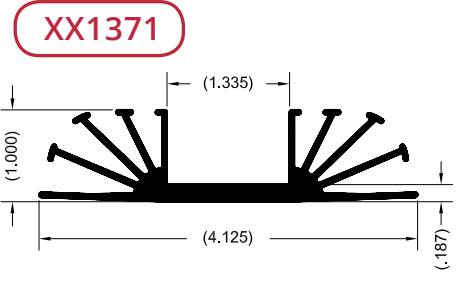
|      |       |         |
|------|-------|---------|
| Per. | 23.13 | in.     |
| WT.  | 1.43  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |



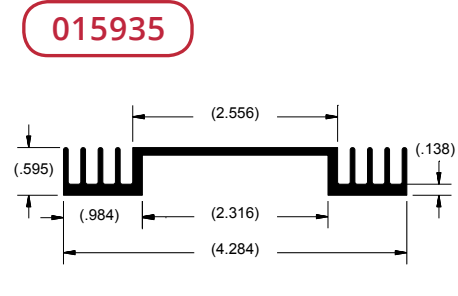
|      |       |         |
|------|-------|---------|
| Per. | 37.80 | in.     |
| WT.  | 2.27  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



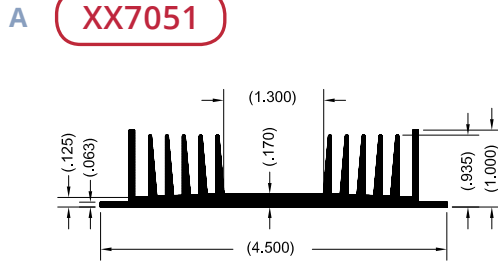
|      |       |         |
|------|-------|---------|
| Per. | 22.62 | in.     |
| WT.  | 1.59  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |



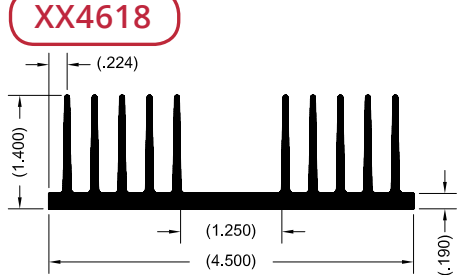
|      |       |         |
|------|-------|---------|
| Per. | 23.82 | in.     |
| WT.  | 1.10  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |



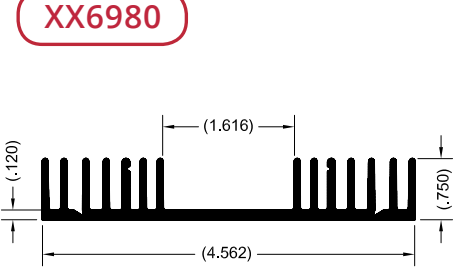
|      |       |         |
|------|-------|---------|
| Per. | 17.66 | in.     |
| WT.  | 0.98  | lb/ft   |
| θsa  | 5.90  | °C/w/3" |



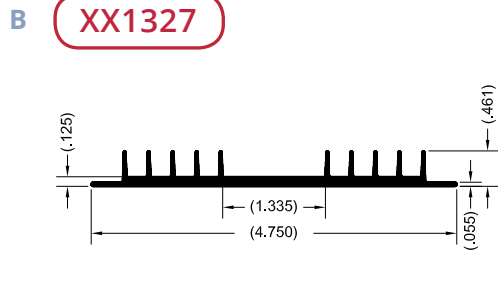
|      |       |         |
|------|-------|---------|
| Per. | 27.77 | in.     |
| WT.  | 1.54  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |



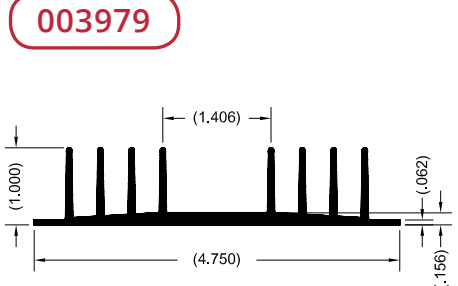
|      |       |         |
|------|-------|---------|
| Per. | 32.22 | in.     |
| WT.  | 2.05  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



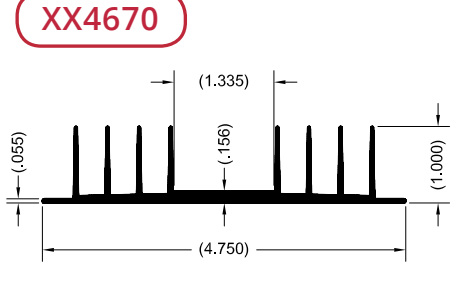
|      |       |         |
|------|-------|---------|
| Per. | 26.46 | in.     |
| WT.  | 1.36  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



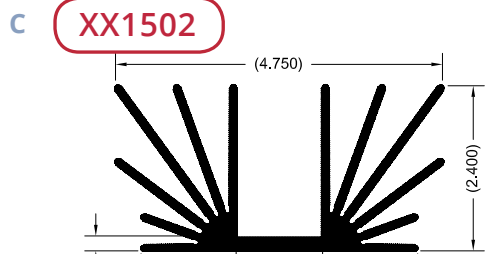
|      |       |         |
|------|-------|---------|
| Per. | 15.98 | in.     |
| WT.  | 0.81  | lb/ft   |
| θsa  | 3.30  | °C/w/3" |



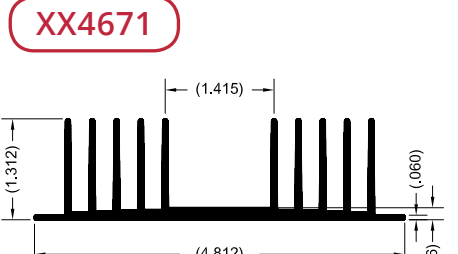
|      |       |         |
|------|-------|---------|
| Per. | 43.78 | in.     |
| WT.  | 1.19  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



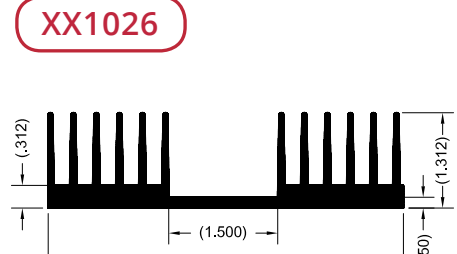
|      |       |         |
|------|-------|---------|
| Per. | 23.42 | in.     |
| WT.  | 1.02  | lb/ft   |
| θsa  | 3.20  | °C/w/3" |



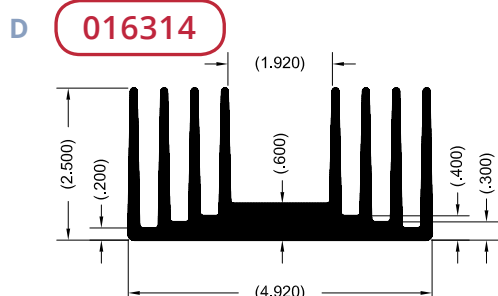
|      |       |         |
|------|-------|---------|
| Per. | 58.23 | in.     |
| WT.  | 3.06  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



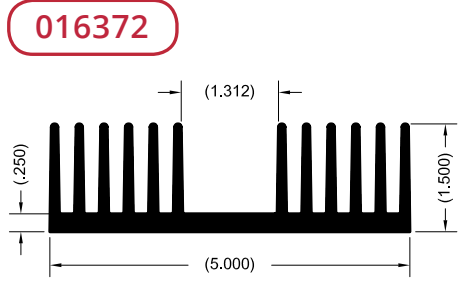
|      |       |         |
|------|-------|---------|
| Per. | 30.25 | in.     |
| WT.  | 1.67  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



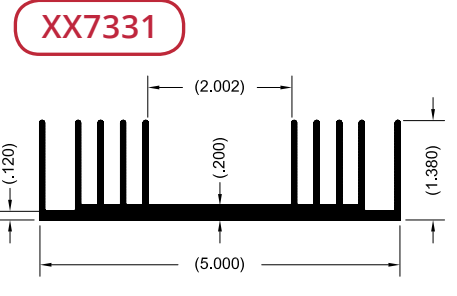
|      |       |         |
|------|-------|---------|
| Per. | 33.86 | in.     |
| WT.  | 2.67  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



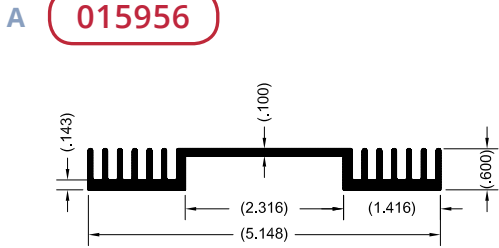
|      |       |         |
|------|-------|---------|
| Per. | 43.85 | in.     |
| WT.  | 5.33  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



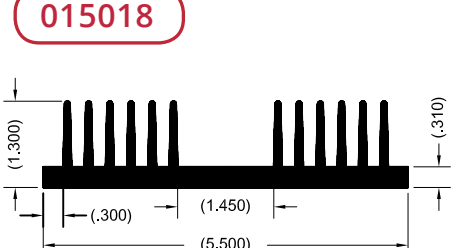
|      |       |         |
|------|-------|---------|
| Per. | 39.30 | in.     |
| WT.  | 3.46  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



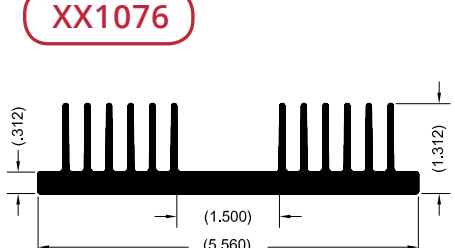
|      |       |         |
|------|-------|---------|
| Per. | 33.80 | in.     |
| WT.  | 1.90  | lb/ft   |
| θsa  | 3.00  | °C/w/3" |



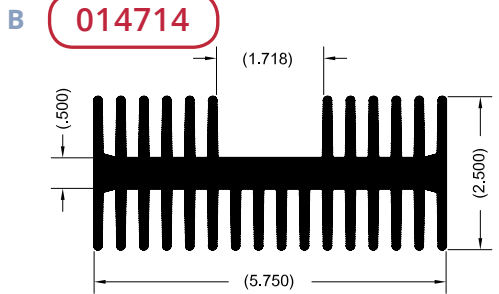
|      |       |         |
|------|-------|---------|
| Per. | 22.78 | in.     |
| WT.  | 1.26  | lb/ft   |
| θsa  | 4.90  | °C/w/3" |



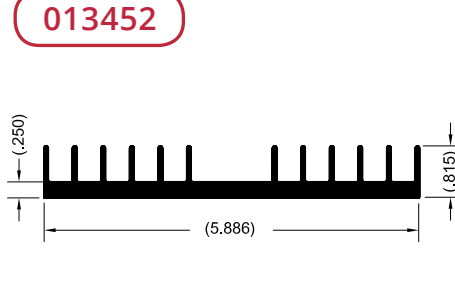
|      |       |         |
|------|-------|---------|
| Per. | 34.46 | in.     |
| WT.  | 3.46  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



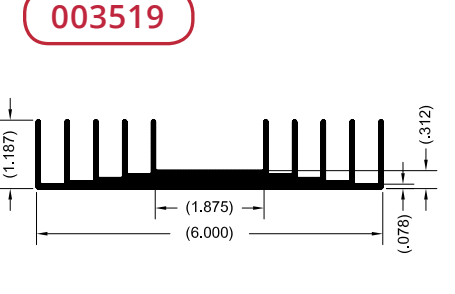
|      |       |         |
|------|-------|---------|
| Per. | 34.57 | in.     |
| WT.  | 3.14  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



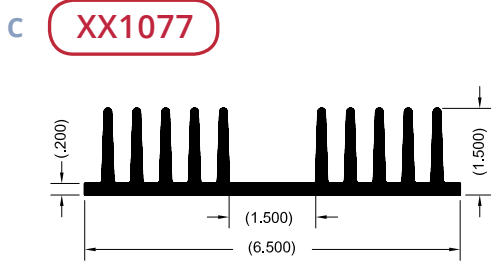
|      |       |         |
|------|-------|---------|
| Per. | 86.54 | in.     |
| WT.  | 7.43  | lb/ft   |
| θsa  | 0.80  | °C/w/3" |



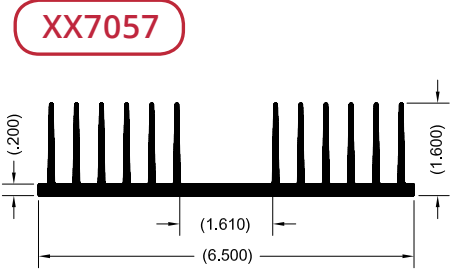
|      |       |         |
|------|-------|---------|
| Per. | 25.26 | in.     |
| WT.  | 2.27  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



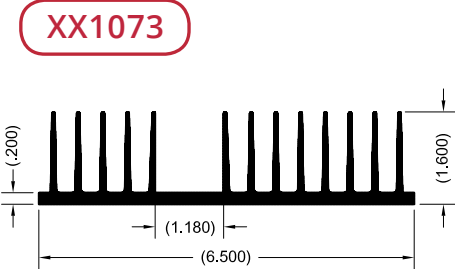
|      |       |         |
|------|-------|---------|
| Per. | 32.02 | in.     |
| WT.  | 2.26  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



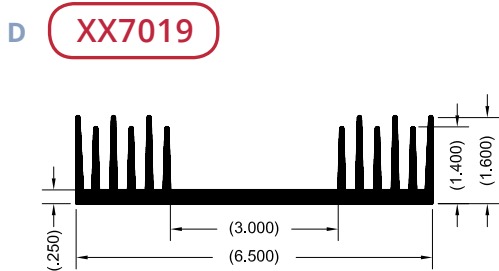
|      |       |         |
|------|-------|---------|
| Per. | 37.67 | in.     |
| WT.  | 4.03  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |



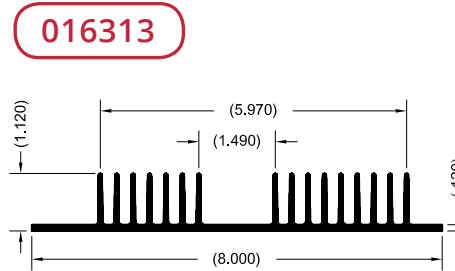
|      |       |         |
|------|-------|---------|
| Per. | 45.98 | in.     |
| WT.  | 3.07  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |



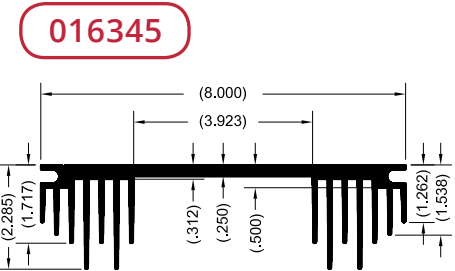
|      |       |         |
|------|-------|---------|
| Per. | 48.32 | in.     |
| WT.  | 3.20  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |



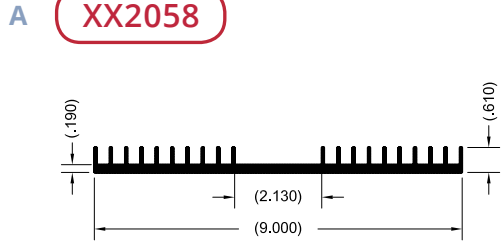
|      |       |         |
|------|-------|---------|
| Per. | 41.93 | in.     |
| WT.  | 3.63  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



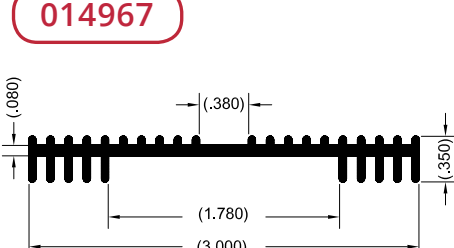
|      |       |         |
|------|-------|---------|
| Per. | 46.61 | in.     |
| WT.  | 2.70  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |



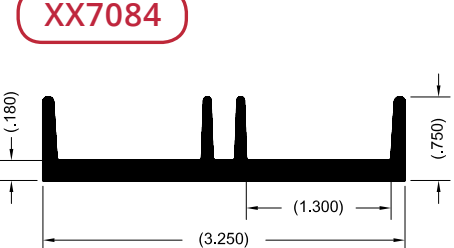
|      |       |         |
|------|-------|---------|
| Per. | 57.23 | in.     |
| WT.  | 4.66  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



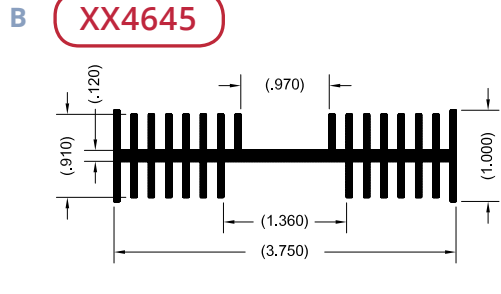
|      |       |         |
|------|-------|---------|
| Per. | 35.18 | in.     |
| WT.  | 2.66  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



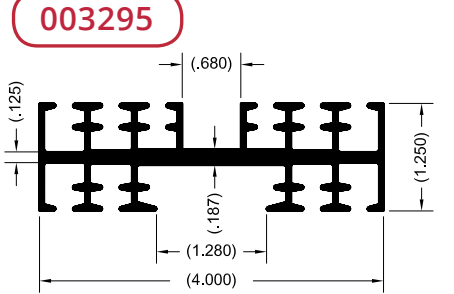
|      |       |         |
|------|-------|---------|
| Per. | 12.32 | in.     |
| WT.  | 0.48  | lb/ft   |
| θsa  | 5.70  | °C/w/3" |



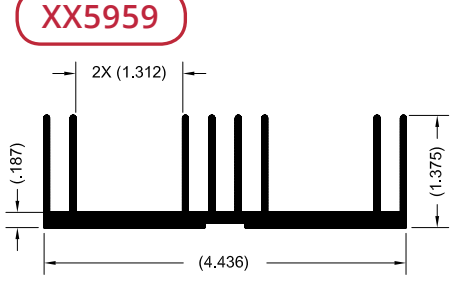
|      |       |         |
|------|-------|---------|
| Per. | 11.50 | in.     |
| WT.  | 0.96  | lb/ft   |
| θsa  | 4.50  | °C/w/3" |



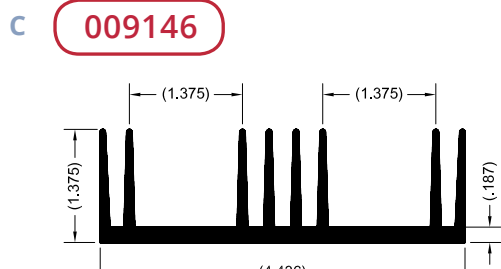
|      |       |         |
|------|-------|---------|
| Per. | 31.06 | in.     |
| WT.  | 1.41  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |



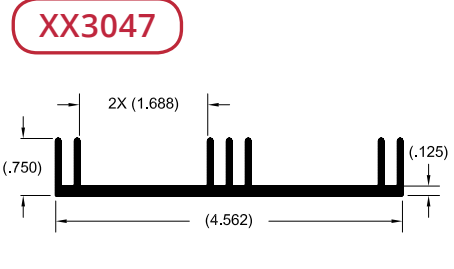
|      |       |         |
|------|-------|---------|
| Per. | 27.00 | in.     |
| WT.  | 1.56  | lb/ft   |
| θsa  | 2.60  | °C/w/3" |



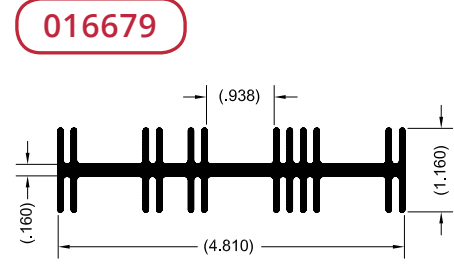
|      |       |         |
|------|-------|---------|
| Per. | 28.06 | in.     |
| WT.  | 1.70  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |



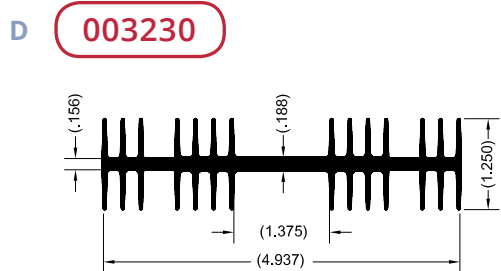
|      |       |         |
|------|-------|---------|
| Per. | 27.56 | in.     |
| WT.  | 2.13  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |



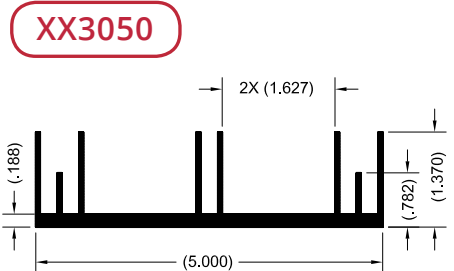
|      |       |         |
|------|-------|---------|
| Per. | 17.84 | in.     |
| WT.  | 1.01  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |



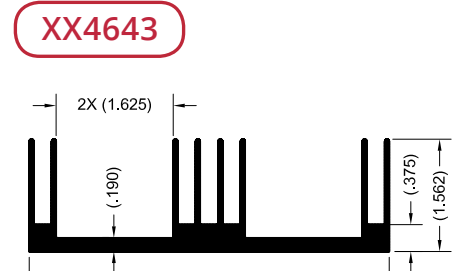
|      |       |         |
|------|-------|---------|
| Per. | 32.13 | in.     |
| WT.  | 1.85  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 34.75 | in.     |
| WT.  | 1.95  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |

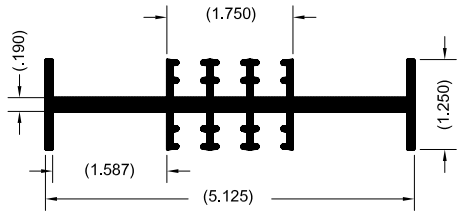


|      |       |         |
|------|-------|---------|
| Per. | 26.94 | in.     |
| WT.  | 1.73  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |



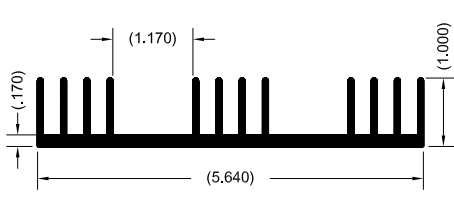
|      |       |         |
|------|-------|---------|
| Per. | 30.28 | in.     |
| WT.  | 2.24  | lb/ft   |
| θsa  | 2.30  | °C/w/3" |

A XX9014



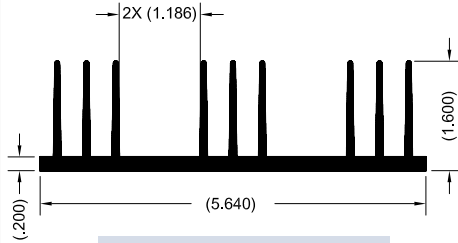
|      |       |         |
|------|-------|---------|
| Per. | 26.40 | in.     |
| WT.  | 1.99  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |

007999



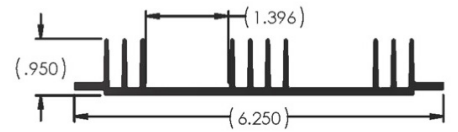
|      |       |         |
|------|-------|---------|
| Per. | 31.80 | in.     |
| WT.  | 2.04  | lb/ft   |
| θsa  | 2.26  | °C/w/3" |

XX4917



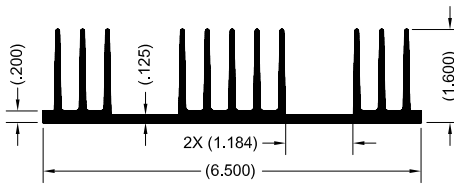
|      |       |         |
|------|-------|---------|
| Per. | 35.65 | in.     |
| WT.  | 2.47  | lb/ft   |
| θsa  | 1.25  | °C/w/3" |

B 04842



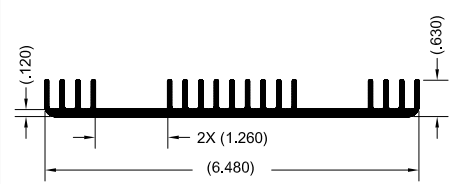
|      |       |         |
|------|-------|---------|
| Per. | 28.36 | in.     |
| WT.  | 1.68  | lb/ft   |
| θsa  | 2.47  | °C/w/3" |

XX4617



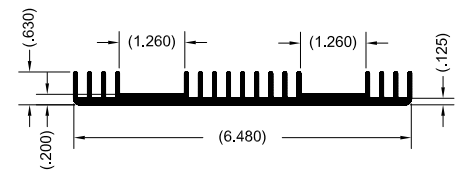
|      |       |         |
|------|-------|---------|
| Per. | 45.00 | in.     |
| WT.  | 2.74  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |

XX1112



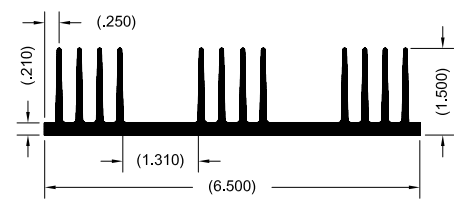
|      |       |         |
|------|-------|---------|
| Per. | 29.37 | in.     |
| WT.  | 1.58  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |

C 016529



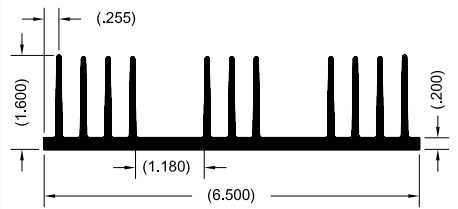
|      |       |         |
|------|-------|---------|
| Per. | 29.12 | in.     |
| WT.  | 1.81  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |

XX3022



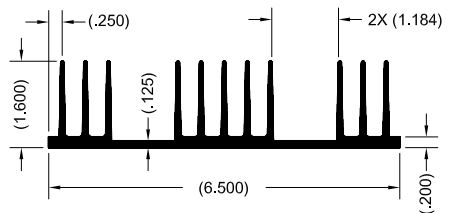
|      |       |         |
|------|-------|---------|
| Per. | 42.99 | in.     |
| WT.  | 3.04  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |

XX3017



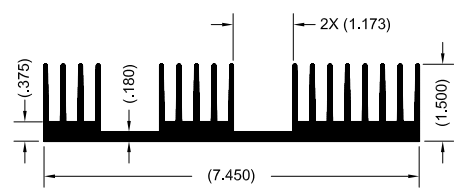
|      |       |         |
|------|-------|---------|
| Per. | 43.15 | in.     |
| WT.  | 3.21  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |

D 006412



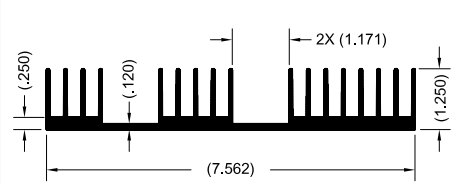
|      |       |         |
|------|-------|---------|
| Per. | 41.00 | in.     |
| WT.  | 2.82  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |

XX3012



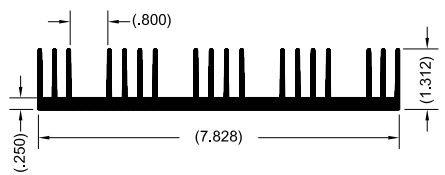
|      |       |         |
|------|-------|---------|
| Per. | 53.45 | in.     |
| WT.  | 4.46  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |

XX3013



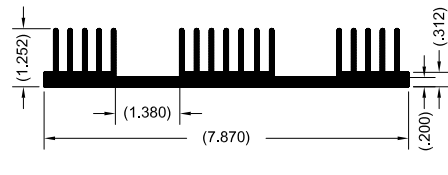
|      |       |         |
|------|-------|---------|
| Per. | 49.20 | in.     |
| WT.  | 3.21  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |

A 014324



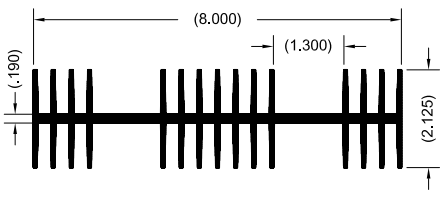
|      |       |         |
|------|-------|---------|
| Per. | 53.57 | in.     |
| WT.  | 3.94  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |

016333



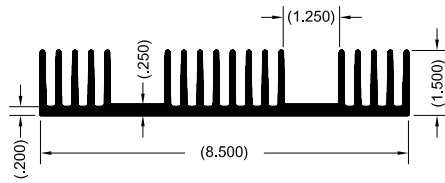
|      |       |         |
|------|-------|---------|
| Per. | 48.03 | in.     |
| WT.  | 4.08  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |

XX3002



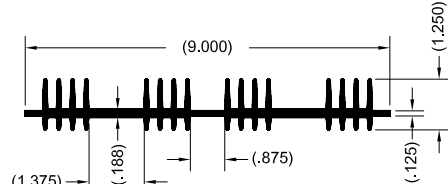
|      |       |         |
|------|-------|---------|
| Per. | 72.21 | in.     |
| WT.  | 4.83  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |

B XX5060



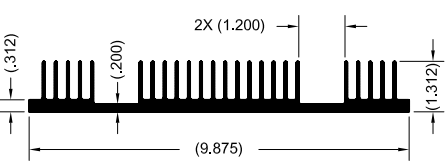
|      |       |         |
|------|-------|---------|
| Per. | 62.78 | in.     |
| WT.  | 5.21  | lb/ft   |
| θsa  | 0.87  | °C/w/3" |

XX8182



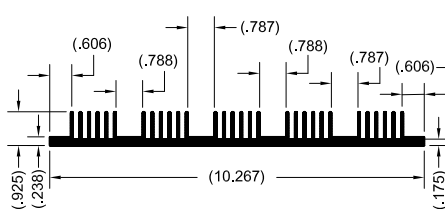
|      |       |         |
|------|-------|---------|
| Per. | 48.81 | in.     |
| WT.  | 3.49  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |

XX5541



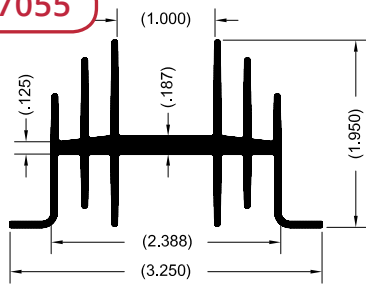
|      |       |         |
|------|-------|---------|
| Per. | 66.93 | in.     |
| WT.  | 5.14  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |

C 016503



|      |       |         |
|------|-------|---------|
| Per. | 64.61 | in.     |
| WT.  | 4.07  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |

XX7055



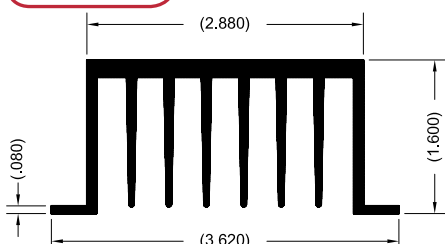
|      |       |         |
|------|-------|---------|
| Per. | 23.50 | in.     |
| WT.  | 1.15  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |

019133



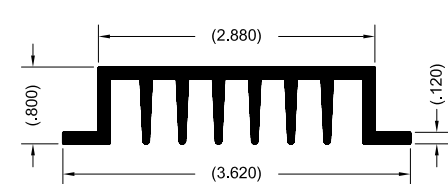
|      |       |         |
|------|-------|---------|
| Per. | 54.48 | in.     |
| WT.  | 4.04  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |

D 014343



|      |       |         |
|------|-------|---------|
| Per. | 29.47 | in.     |
| WT.  | 1.71  | lb/ft   |
| θsa  | 2.40  | °C/w/3" |

014344

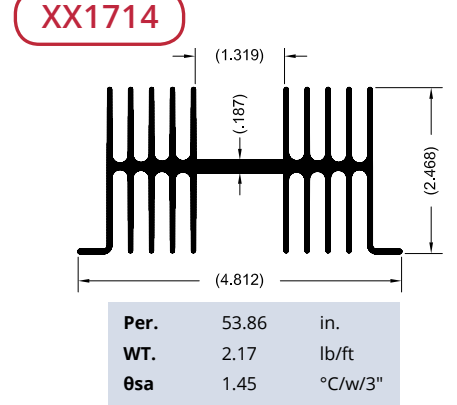
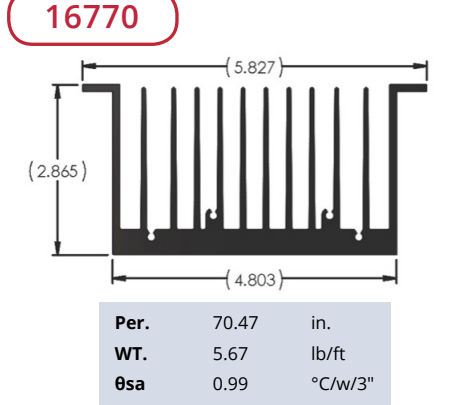
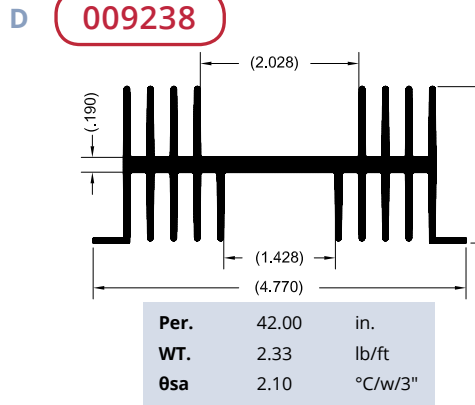
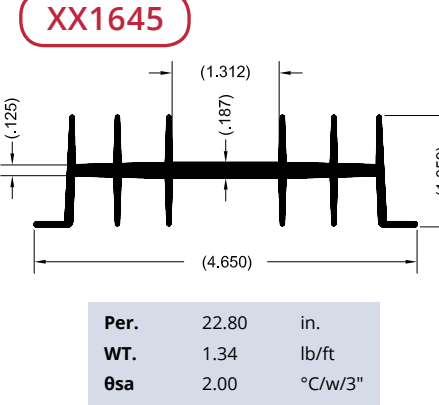
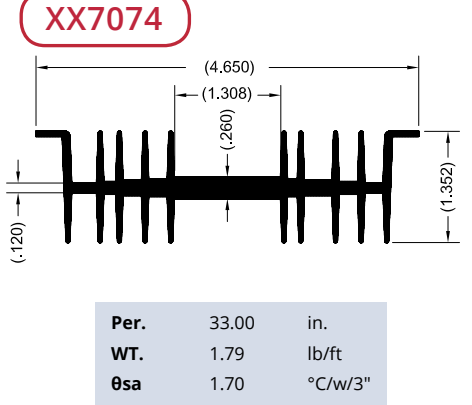
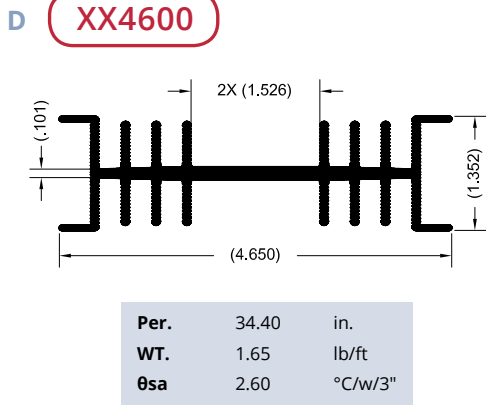
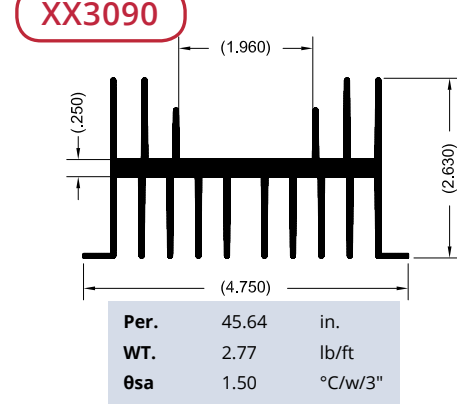
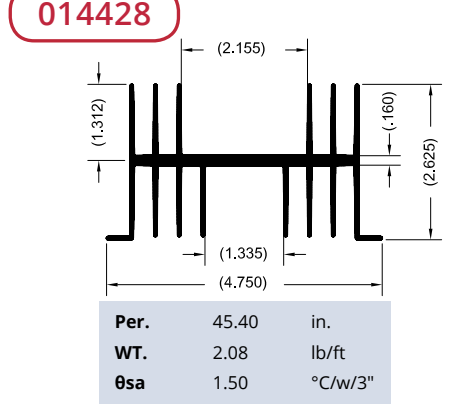
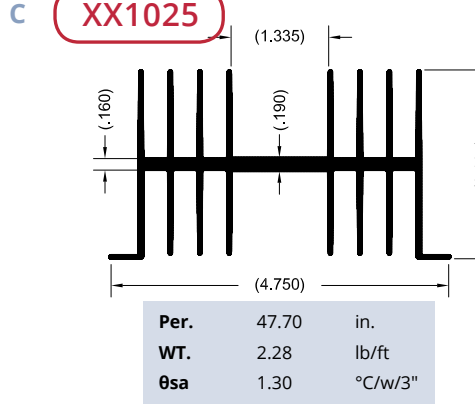
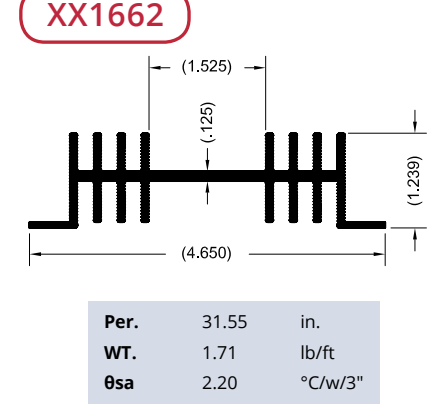
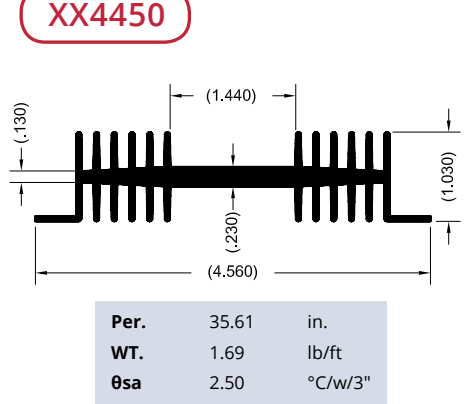
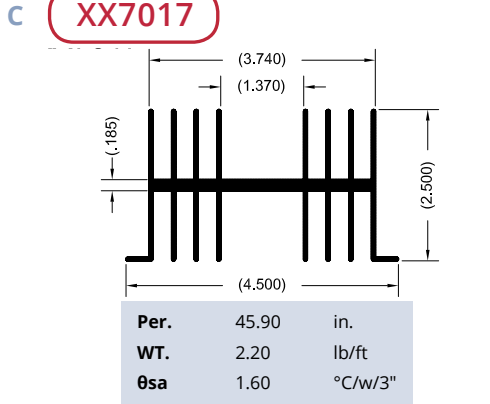
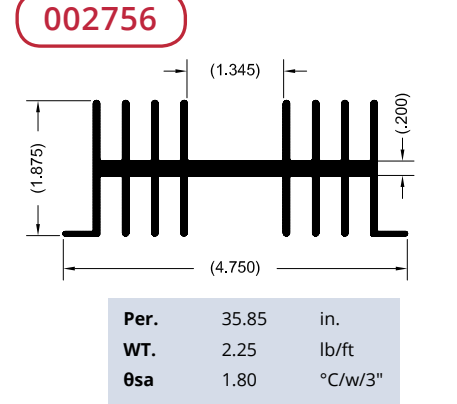
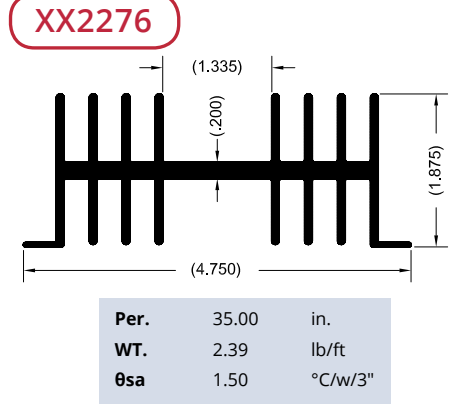
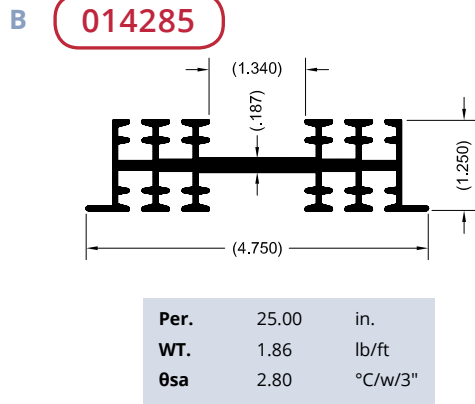
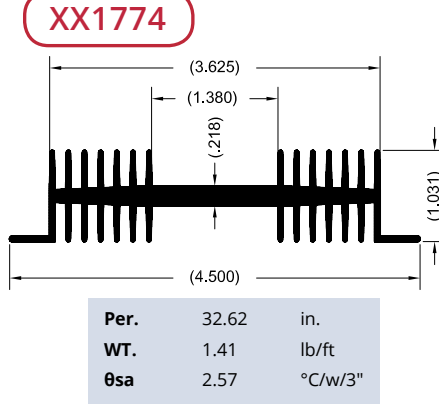
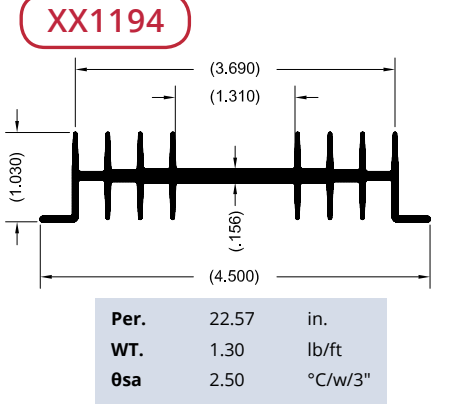
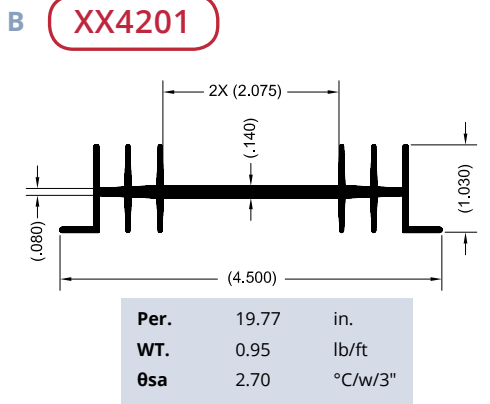
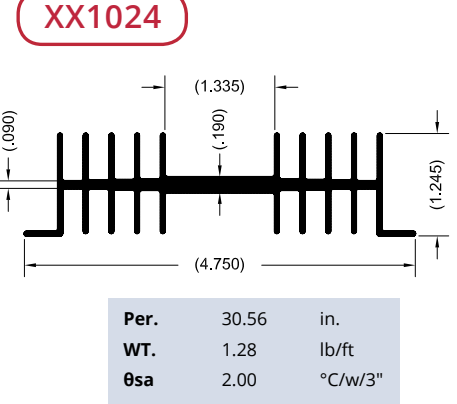
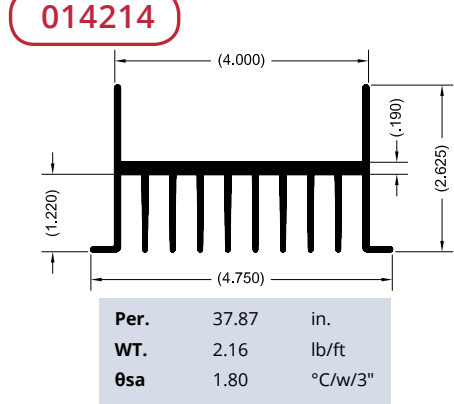
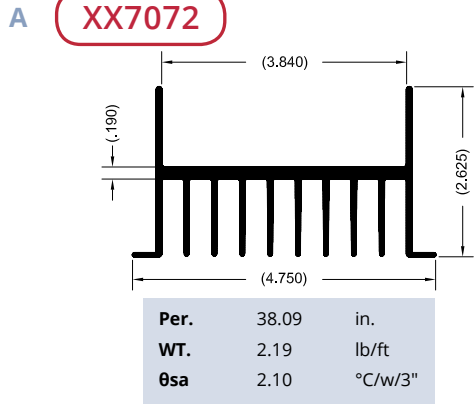
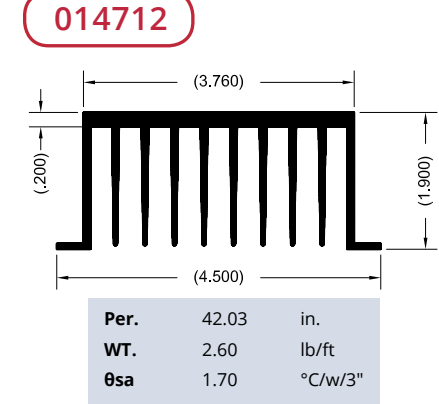
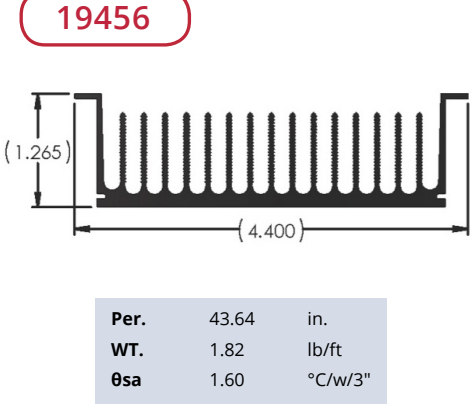
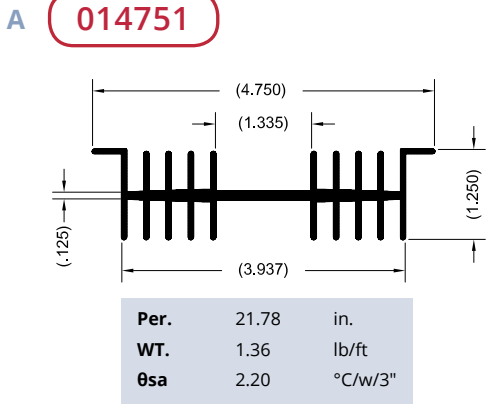


|      |       |         |
|------|-------|---------|
| Per. | 17.43 | in.     |
| WT.  | 0.90  | lb/ft   |
| θsa  | 4.00  | °C/w/3" |

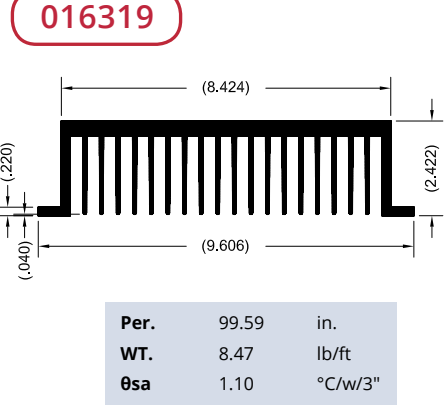
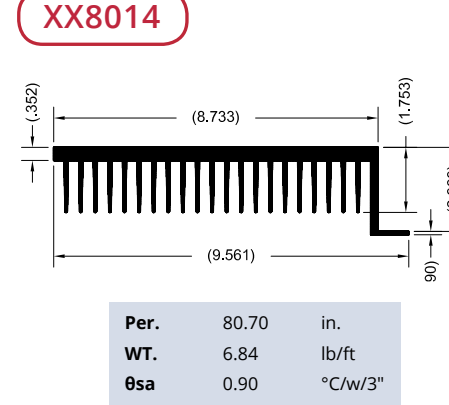
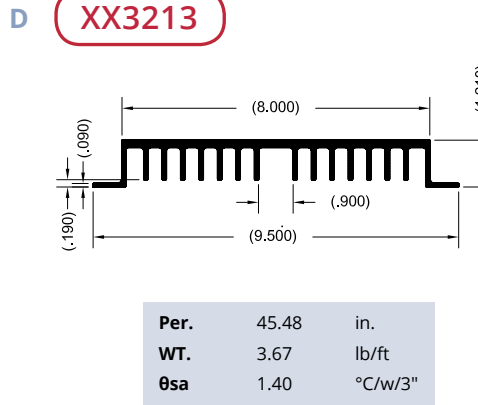
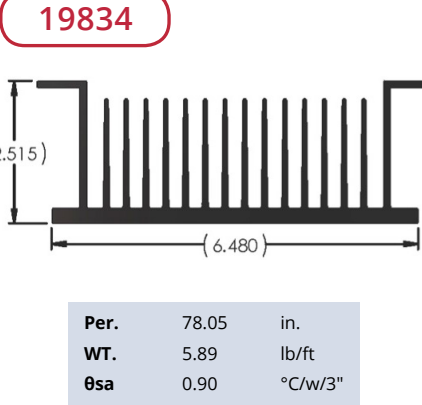
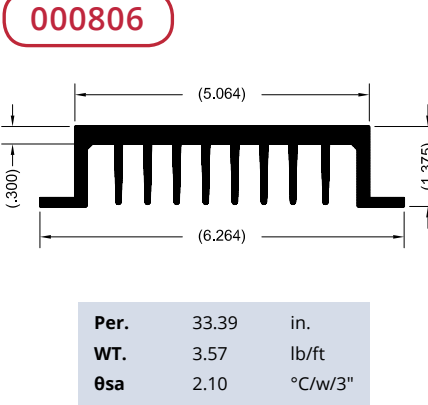
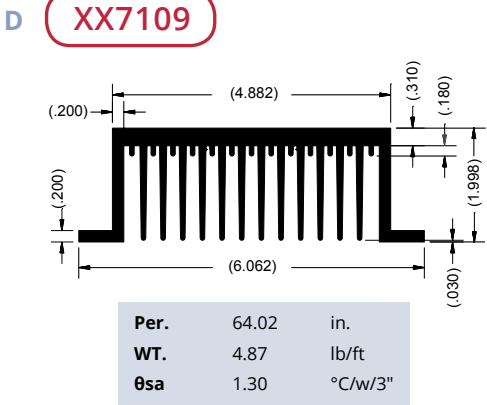
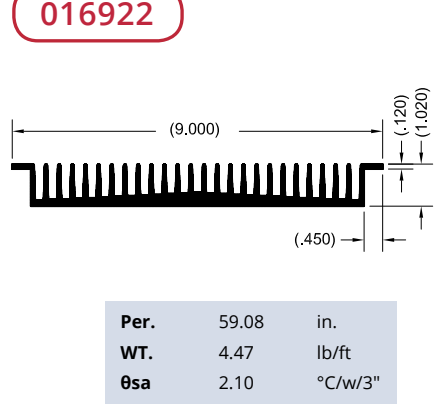
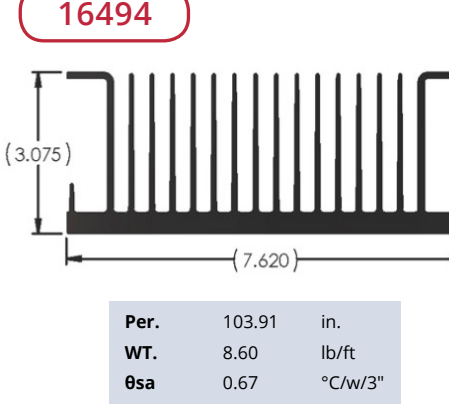
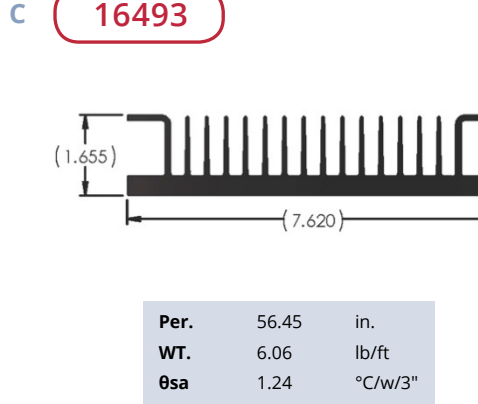
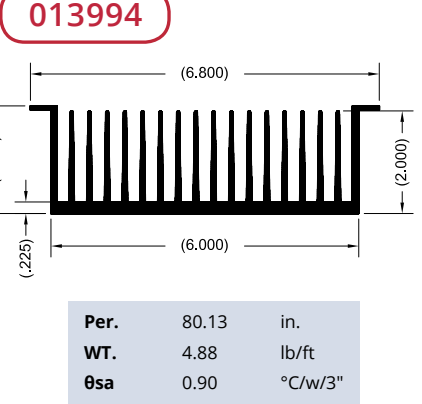
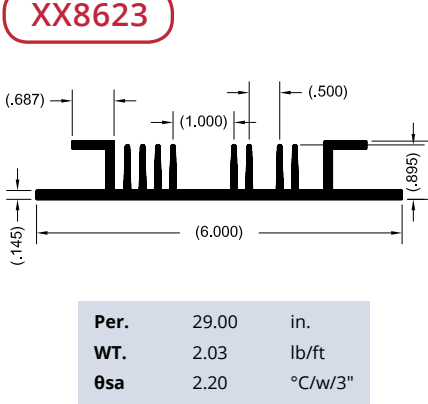
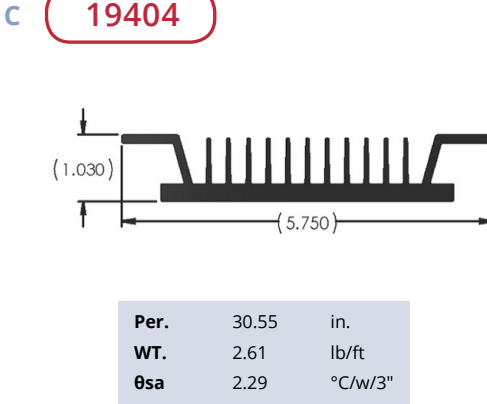
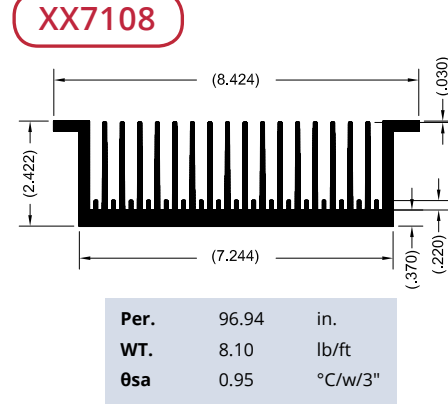
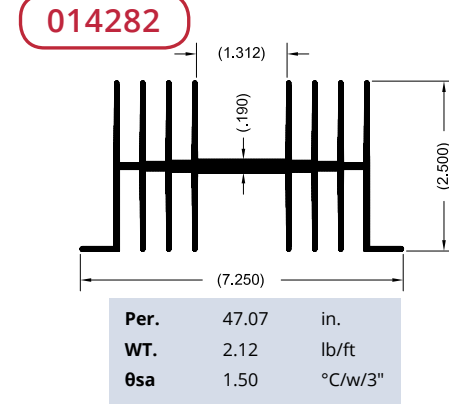
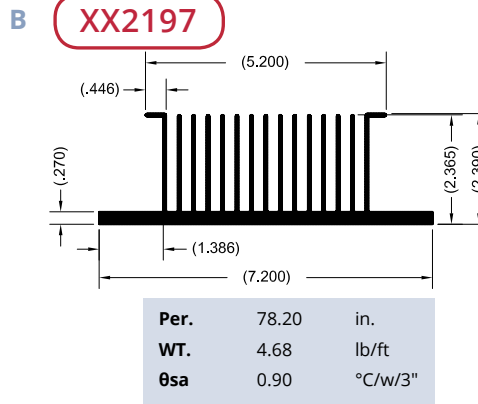
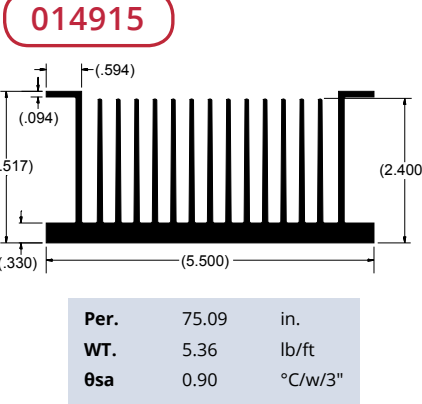
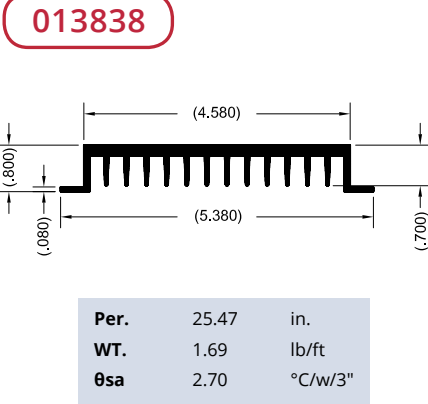
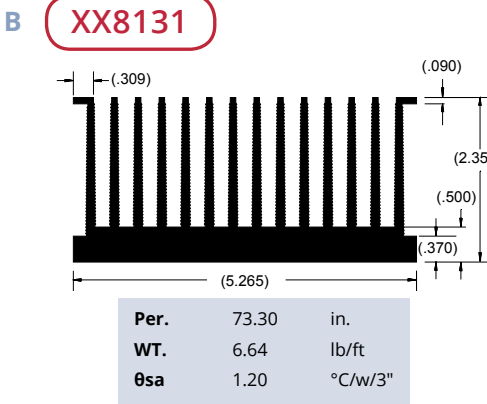
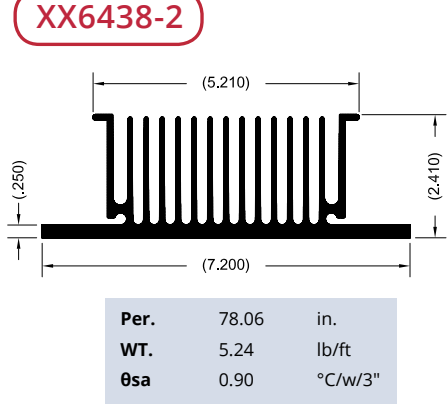
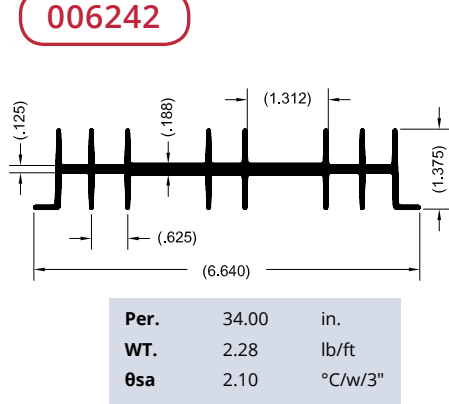
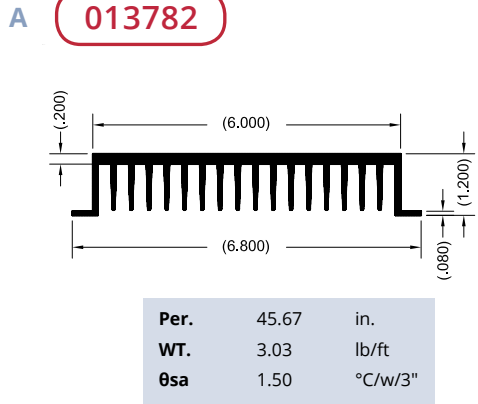
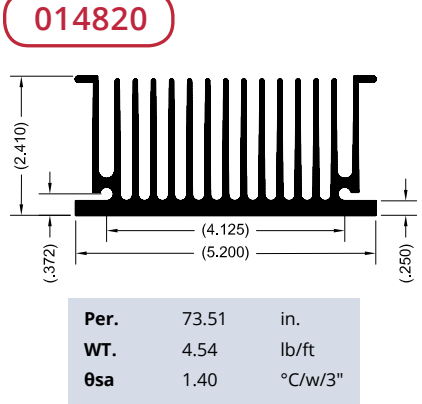
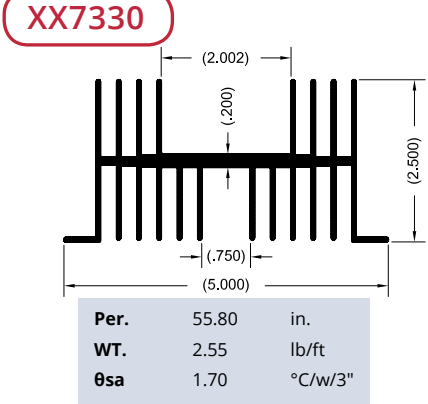
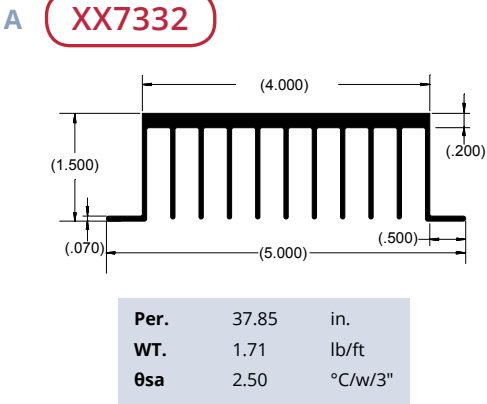
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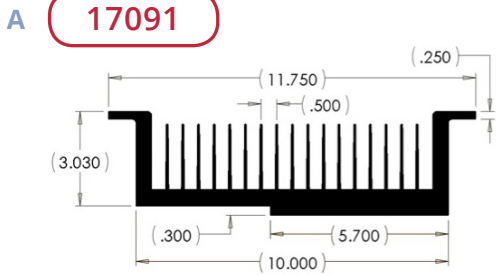


|      |       |         |
|------|-------|---------|
| Per. | 30.64 | in.     |
| WT.  | 2.60  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |

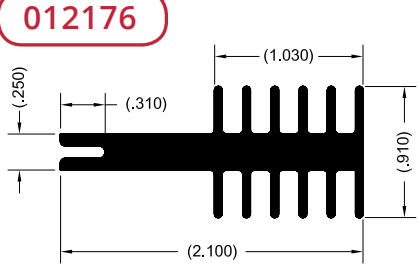




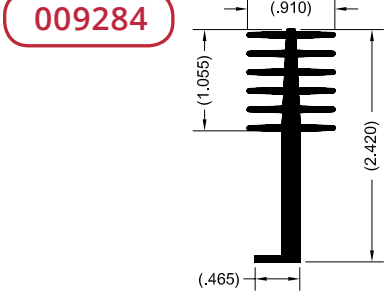




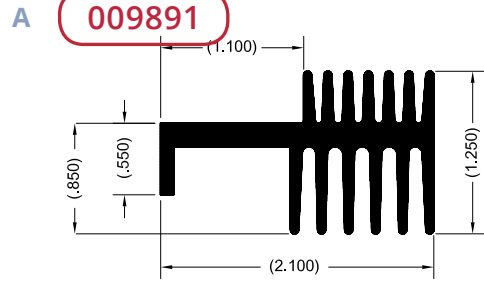
|      |        |         |
|------|--------|---------|
| Per. | 105.27 | in.     |
| WT.  | 15.43  | lb/ft   |
| θsa  | 0.66   | °C/w/3" |



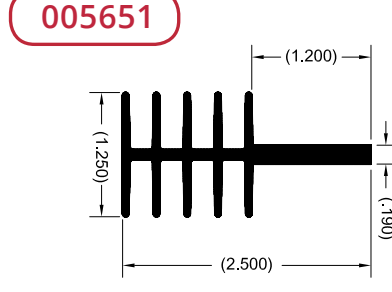
|      |       |         |
|------|-------|---------|
| Per. | 12.65 | in.     |
| WT.  | 0.81  | lb/ft   |
| θsa  | 5.50  | °C/w/3" |



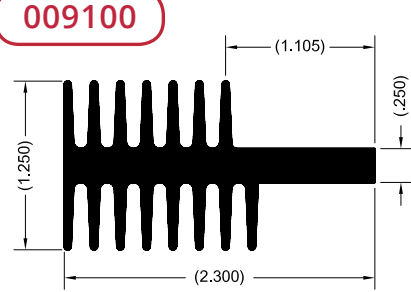
|      |       |         |
|------|-------|---------|
| Per. | 15.24 | in.     |
| WT.  | 0.80  | lb/ft   |
| θsa  | 4.60  | °C/w/3" |



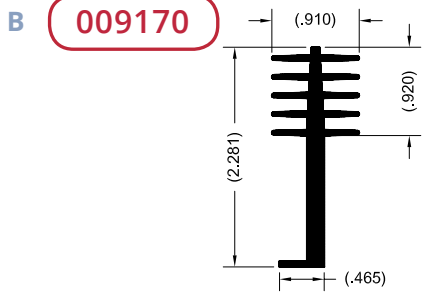
|      |       |         |
|------|-------|---------|
| Per. | 14.74 | in.     |
| WT.  | 1.11  | lb/ft   |
| θsa  | 4.70  | °C/w/3" |



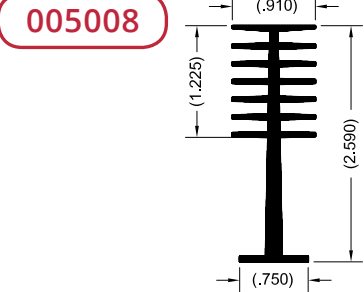
|      |       |         |
|------|-------|---------|
| Per. | 18.00 | in.     |
| WT.  | 0.88  | lb/ft   |
| θsa  | 3.90  | °C/w/3" |



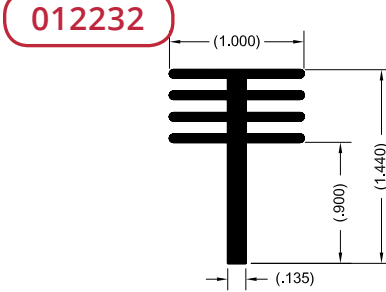
|      |       |         |
|------|-------|---------|
| Per. | 20.10 | in.     |
| WT.  | 1.23  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



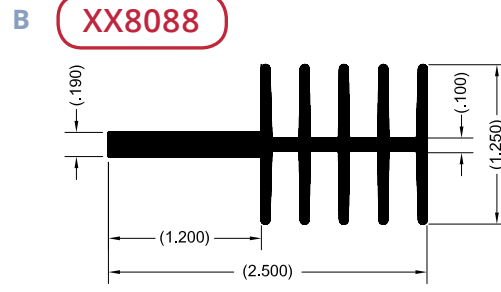
|      |       |         |
|------|-------|---------|
| Per. | 13.50 | in.     |
| WT.  | 0.73  | lb/ft   |
| θsa  | 5.20  | °C/w/3" |



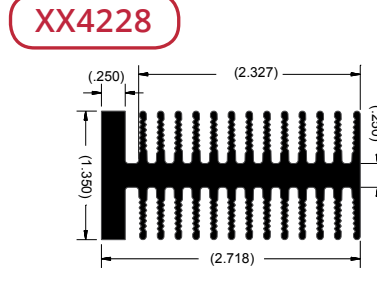
|      |       |         |
|------|-------|---------|
| Per. | 20.00 | in.     |
| WT.  | 0.81  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



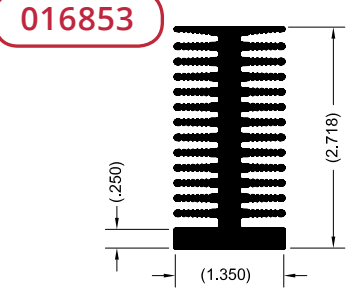
|      |      |         |
|------|------|---------|
| Per. | 9.80 | in.     |
| WT.  | 0.47 | lb/ft   |
| θsa  | 7.10 | °C/w/3" |



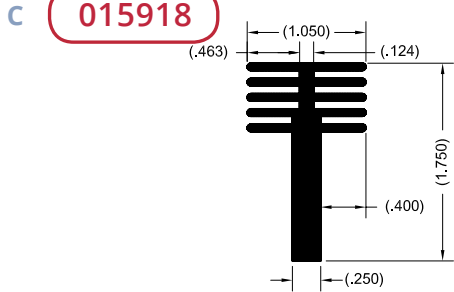
|      |       |         |
|------|-------|---------|
| Per. | 14.65 | in.     |
| WT.  | 0.93  | lb/ft   |
| θsa  | 4.20  | °C/w/3" |



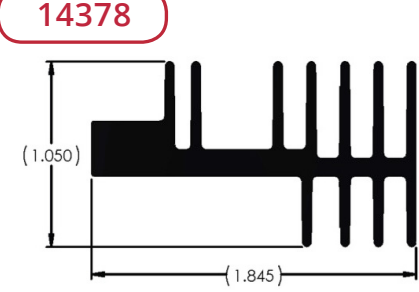
|      |       |         |
|------|-------|---------|
| Per. | 38.93 | in.     |
| WT.  | 2.29  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



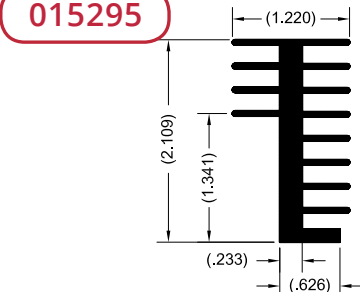
|      |       |         |
|------|-------|---------|
| Per. | 39.17 | in.     |
| WT.  | 2.28  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



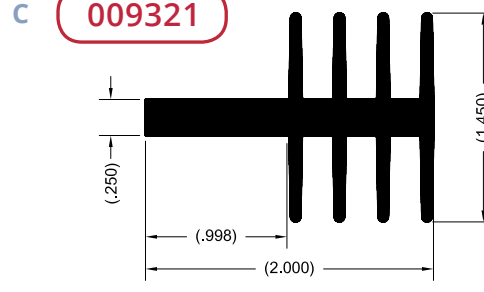
|      |       |         |
|------|-------|---------|
| Per. | 13.22 | in.     |
| WT.  | 0.78  | lb/ft   |
| θsa  | 0.00  | °C/w/3" |



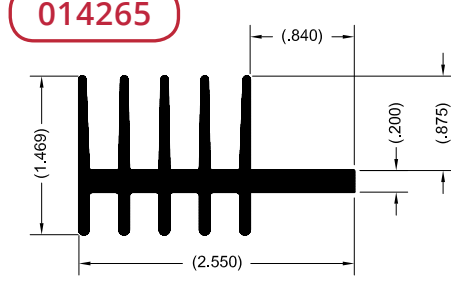
|      |       |         |
|------|-------|---------|
| Per. | 13.90 | in.     |
| WT.  | 0.72  | lb/ft   |
| θsa  | 5.03  | °C/w/3" |



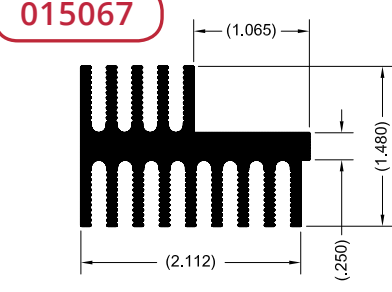
|      |       |         |
|------|-------|---------|
| Per. | 17.15 | in.     |
| WT.  | 1.04  | lb/ft   |
| θsa  | 0.00  | °C/w/3" |



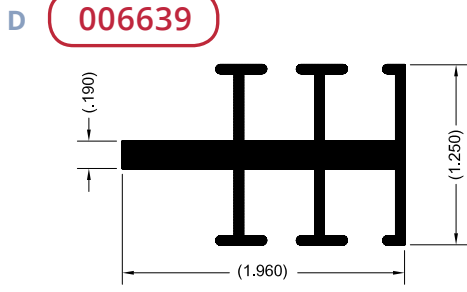
|      |       |         |
|------|-------|---------|
| Per. | 14.83 | in.     |
| WT.  | 1.02  | lb/ft   |
| θsa  | 4.70  | °C/w/3" |



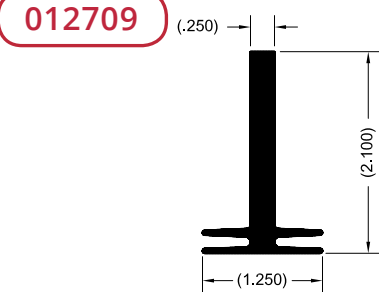
|      |       |         |
|------|-------|---------|
| Per. | 17.37 | in.     |
| WT.  | 1.33  | lb/ft   |
| θsa  | 4.00  | °C/w/3" |



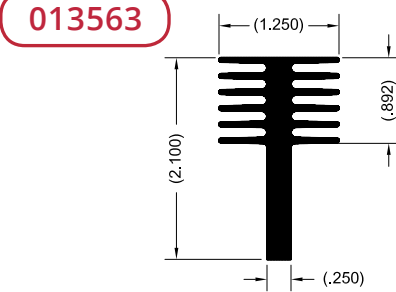
|      |       |         |
|------|-------|---------|
| Per. | 24.06 | in.     |
| WT.  | 1.50  | lb/ft   |
| θsa  | 2.90  | °C/w/3" |



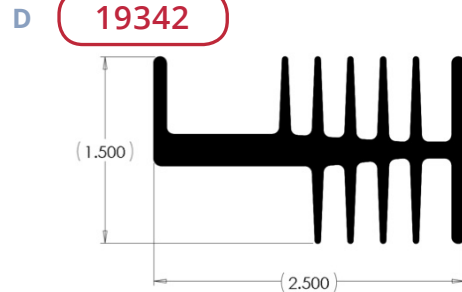
|      |       |         |
|------|-------|---------|
| Per. | 16.00 | in.     |
| WT.  | 0.73  | lb/ft   |
| θsa  | 4.40  | °C/w/3" |



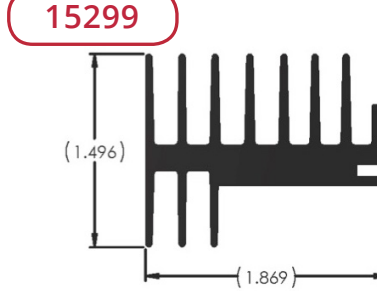
|      |      |         |
|------|------|---------|
| Per. | 8.40 | in.     |
| WT.  | 0.76 | lb/ft   |
| θsa  | 8.30 | °C/w/3" |



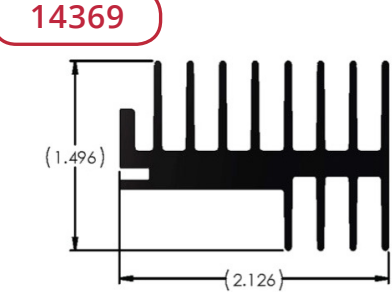
|      |       |         |
|------|-------|---------|
| Per. | 15.81 | in.     |
| WT.  | 1.02  | lb/ft   |
| θsa  | 4.40  | °C/w/3" |



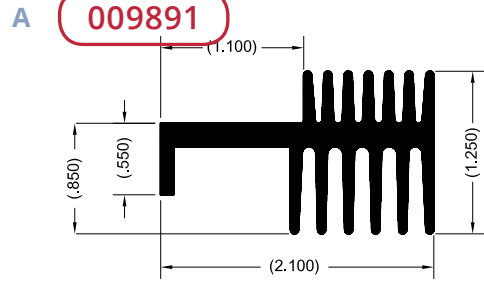
|      |       |         |
|------|-------|---------|
| Per. | 19.99 | in.     |
| WT.  | 1.32  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



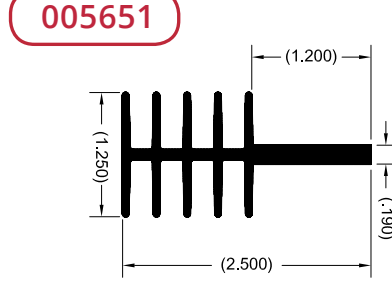
|      |       |         |
|------|-------|---------|
| Per. | 18.01 | in.     |
| WT.  | 1.14  | lb/ft   |
| θsa  | 3.88  | °C/w/3" |



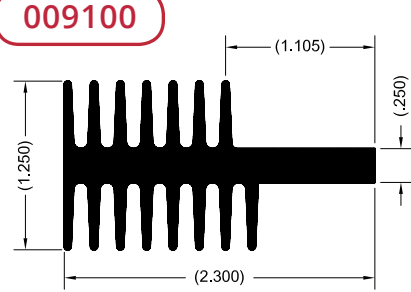
|      |       |         |
|------|-------|---------|
| Per. | 21.10 | in.     |
| WT.  | 1.23  | lb/ft   |
| θsa  | 3.31  | °C/w/3" |



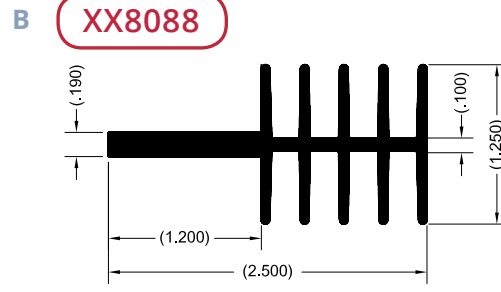
|      |       |         |
|------|-------|---------|
| Per. | 14.74 | in.     |
| WT.  | 1.11  | lb/ft   |
| θsa  | 4.70  | °C/w/3" |



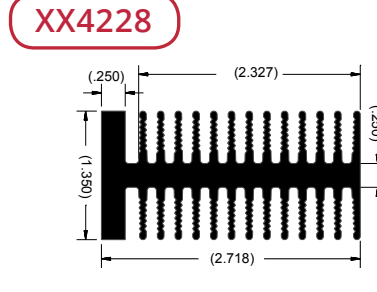
|      |       |         |
|------|-------|---------|
| Per. | 18.00 | in.     |
| WT.  | 0.88  | lb/ft   |
| θsa  | 3.90  | °C/w/3" |



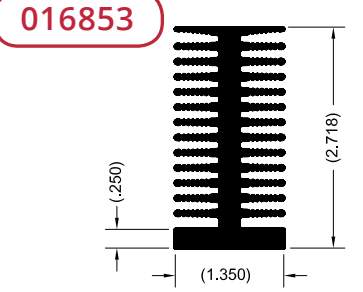
|      |       |         |
|------|-------|---------|
| Per. | 20.10 | in.     |
| WT.  | 1.23  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



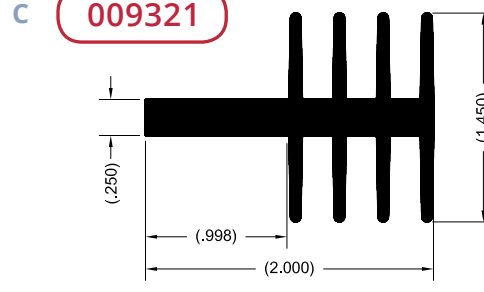
|      |       |         |
|------|-------|---------|
| Per. | 14.65 | in.     |
| WT.  | 0.93  | lb/ft   |
| θsa  | 4.20  | °C/w/3" |



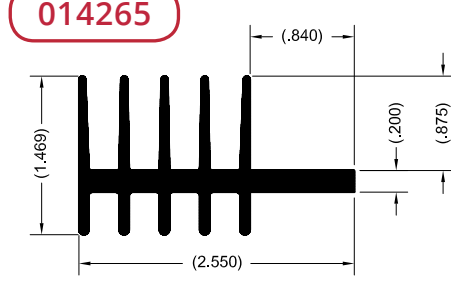
|      |       |         |
|------|-------|---------|
| Per. | 38.93 | in.     |
| WT.  | 2.29  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



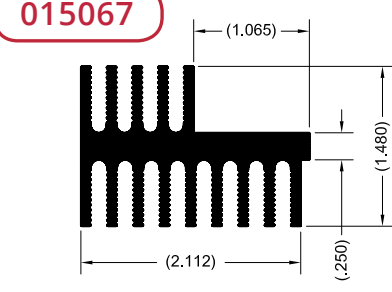
|      |       |         |
|------|-------|---------|
| Per. | 39.17 | in.     |
| WT.  | 2.28  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



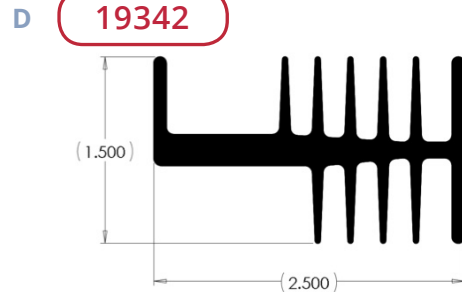
|      |       |         |
|------|-------|---------|
| Per. | 14.83 | in.     |
| WT.  | 1.02  | lb/ft   |
| θsa  | 4.70  | °C/w/3" |



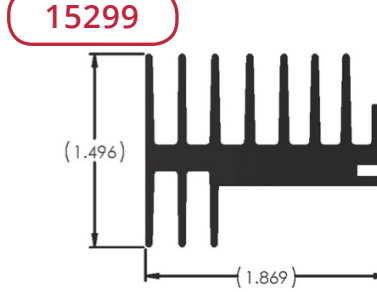
|      |       |         |
|------|-------|---------|
| Per. | 17.37 | in.     |
| WT.  | 1.33  | lb/ft   |
| θsa  | 4.00  | °C/w/3" |



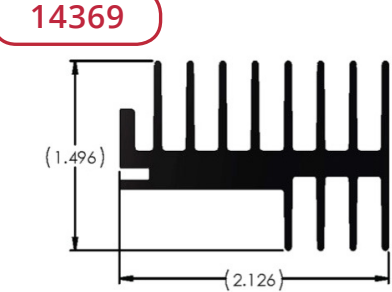
|      |       |         |
|------|-------|---------|
| Per. | 24.06 | in.     |
| WT.  | 1.50  | lb/ft   |
| θsa  | 2.90  | °C/w/3" |



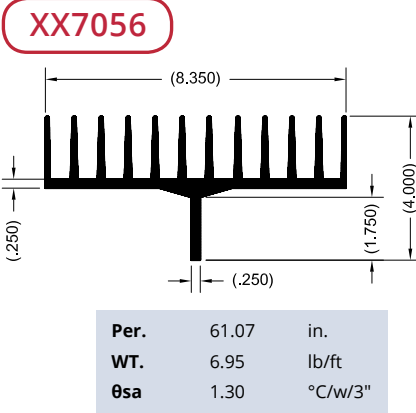
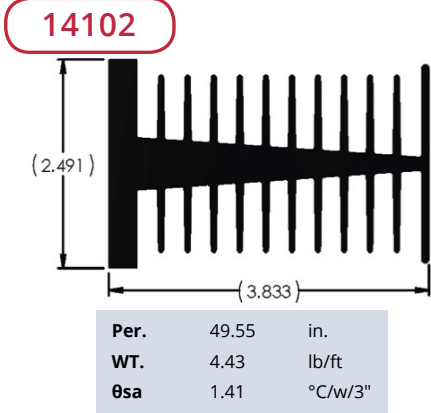
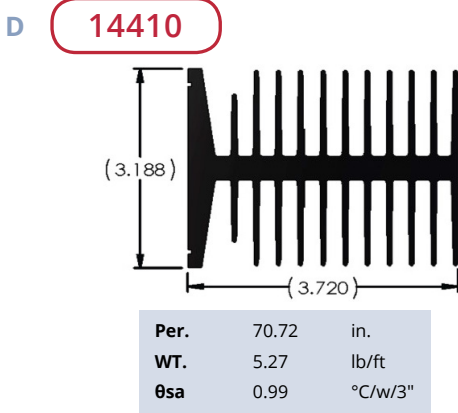
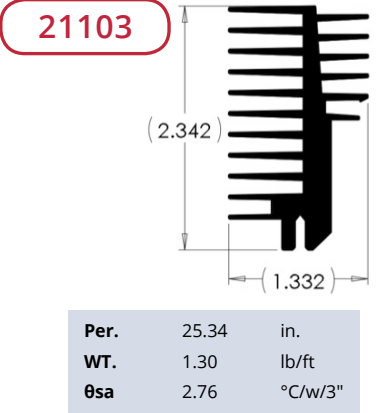
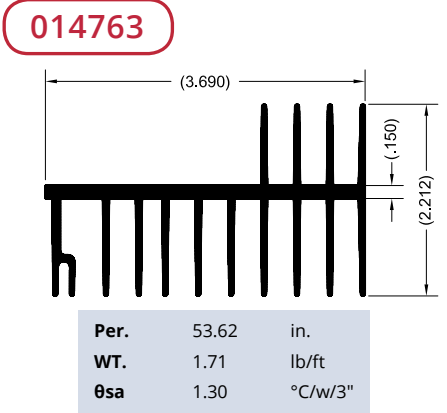
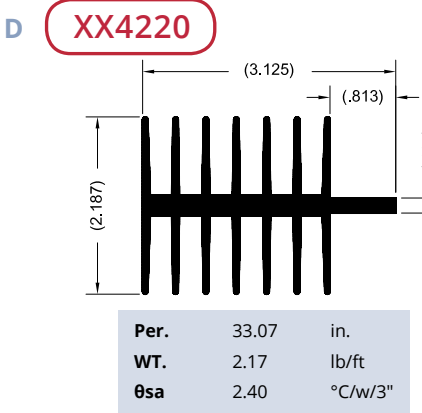
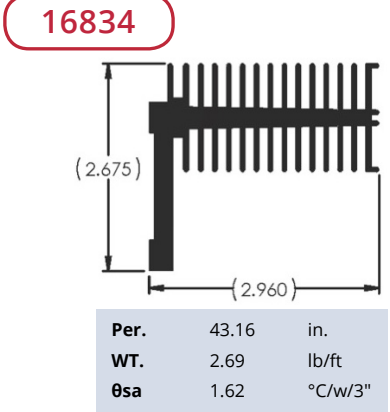
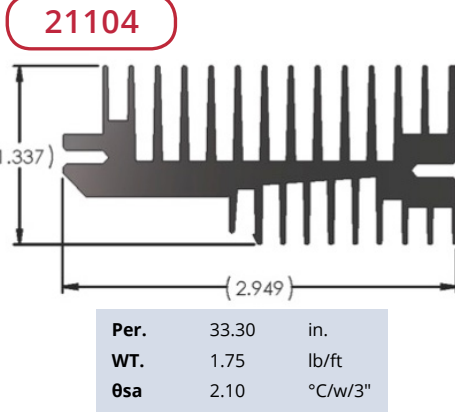
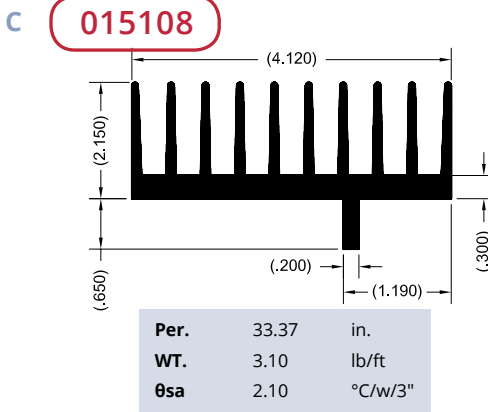
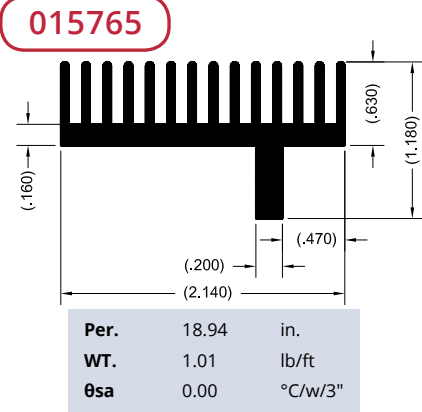
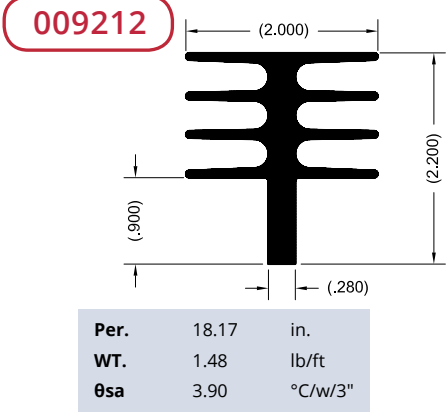
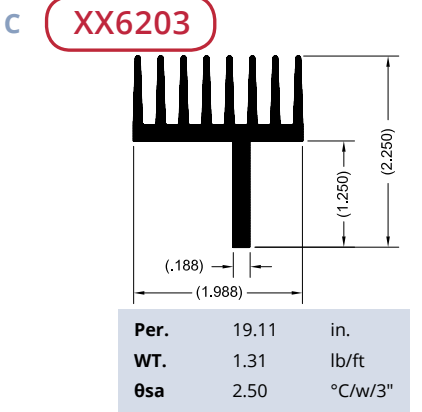
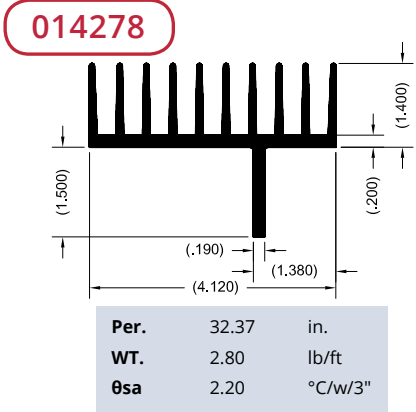
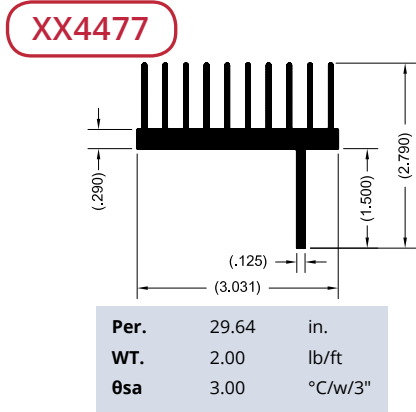
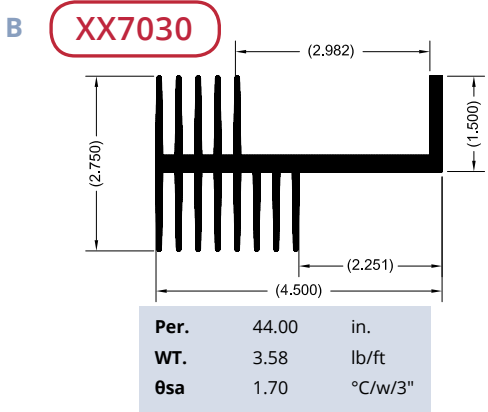
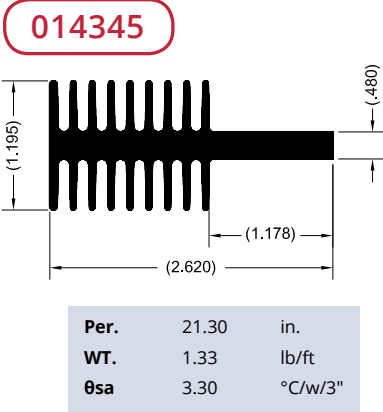
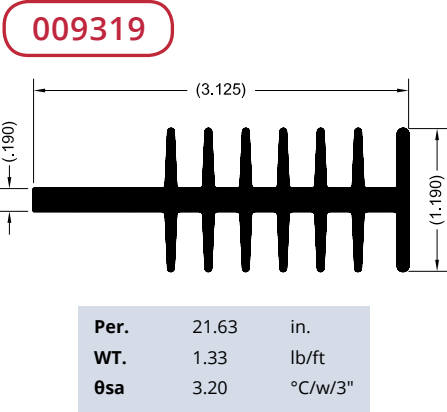
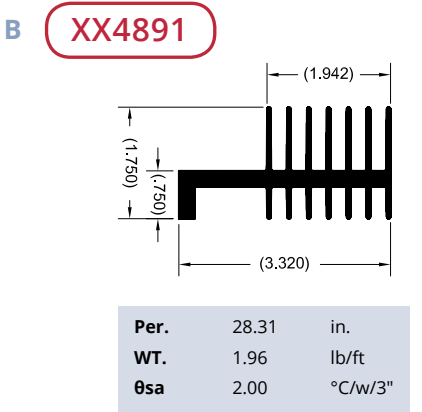
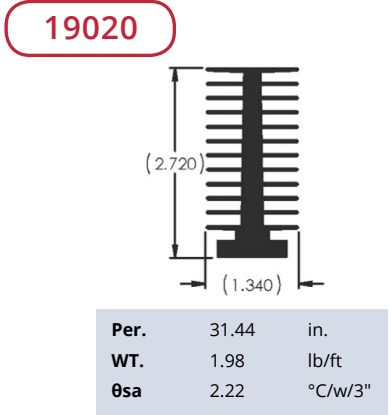
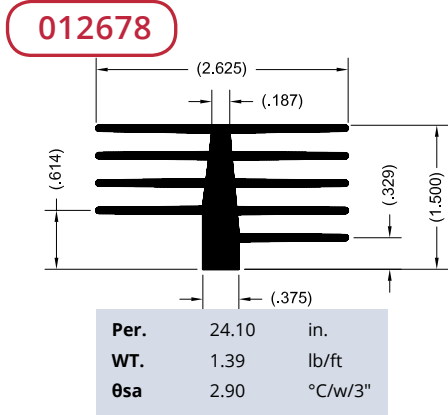
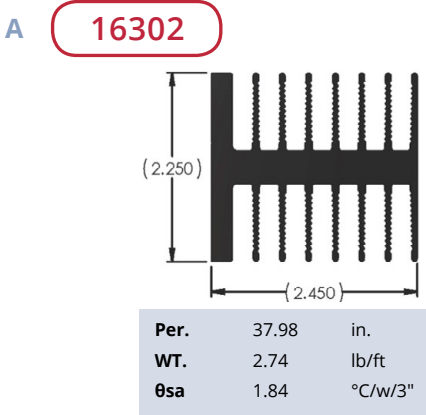
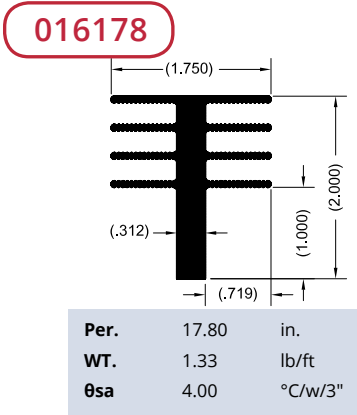
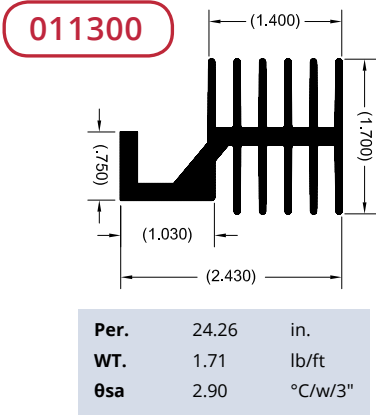
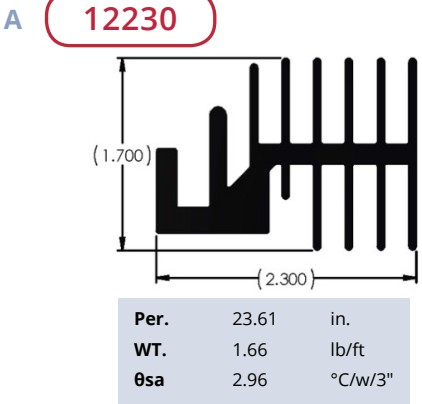
|      |       |         |
|------|-------|---------|
| Per. | 19.99 | in.     |
| WT.  | 1.32  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |

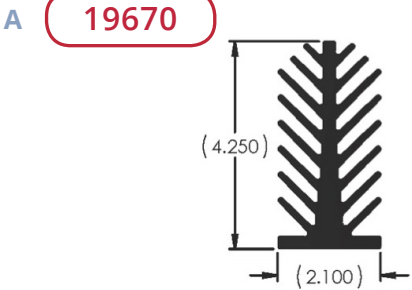


|      |       |         |
|------|-------|---------|
| Per. | 18.01 | in.     |
| WT.  | 1.14  | lb/ft   |
| θsa  | 3.88  | °C/w/3" |

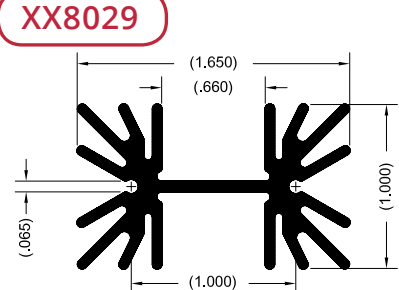


|      |       |         |
|------|-------|---------|
| Per. | 21.10 | in.     |
| WT.  | 1.23  | lb/ft   |
| θsa  | 3.31  | °C/w/3" |

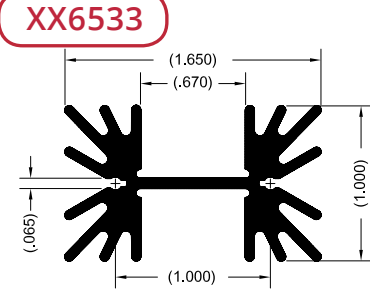




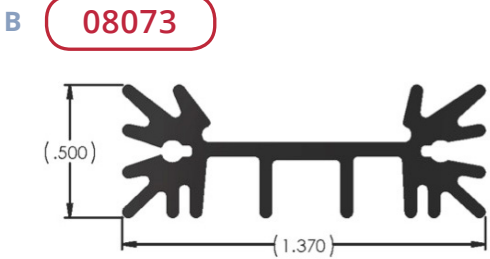
|      |       |         |
|------|-------|---------|
| Per. | 41.76 | in.     |
| WT.  | 5.11  | lb/ft   |
| θsa  | 1.67  | °C/w/3" |



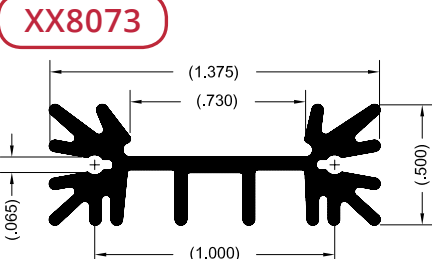
|      |       |         |
|------|-------|---------|
| Per. | 14.60 | in.     |
| WT.  | 0.48  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |



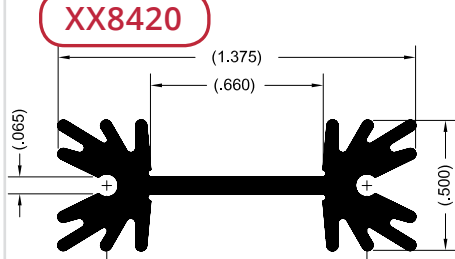
|      |       |         |
|------|-------|---------|
| Per. | 10.80 | in.     |
| WT.  | 0.65  | lb/ft   |
| θsa  | 3.60  | °C/w/3" |



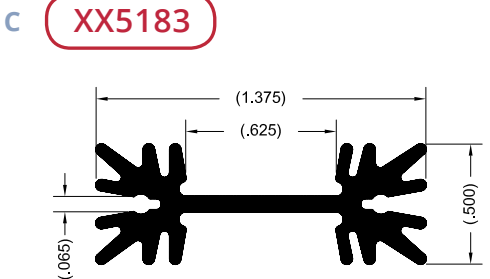
|      |      |         |
|------|------|---------|
| Per. | 7.78 | in.     |
| WT.  | 0.28 | lb/ft   |
| θsa  | 8.98 | °C/w/3" |



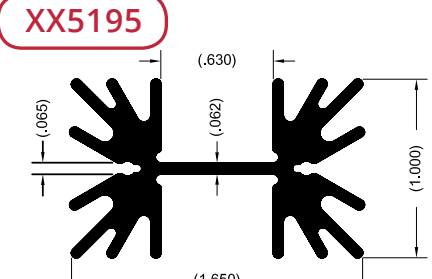
|      |      |         |
|------|------|---------|
| Per. | 7.79 | in.     |
| WT.  | 0.27 | lb/ft   |
| θsa  | 6.80 | °C/w/3" |



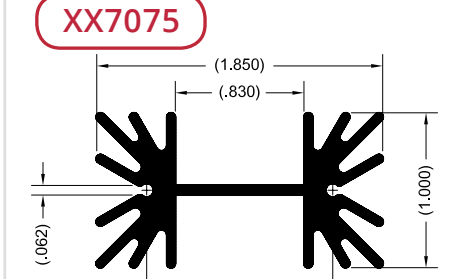
|      |      |         |
|------|------|---------|
| Per. | 7.07 | in.     |
| WT.  | 0.29 | lb/ft   |
| θsa  | 6.80 | °C/w/3" |



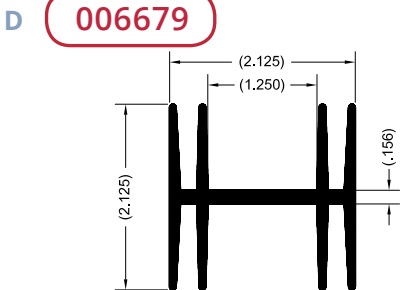
|      |      |         |
|------|------|---------|
| Per. | 7.35 | in.     |
| WT.  | 0.34 | lb/ft   |
| θsa  | 7.00 | °C/w/3" |



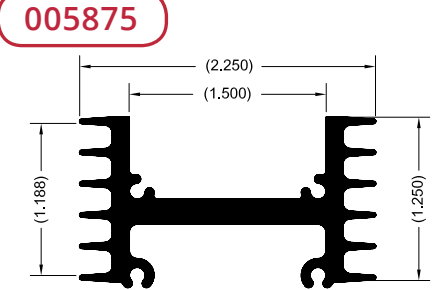
|      |       |         |
|------|-------|---------|
| Per. | 12.58 | in.     |
| WT.  | 0.68  | lb/ft   |
| θsa  | 3.60  | °C/w/3" |



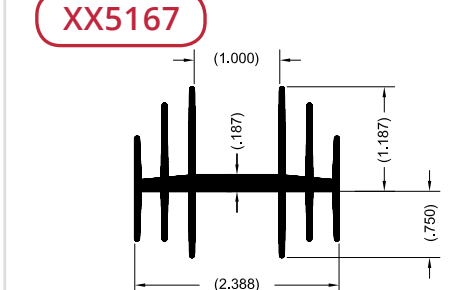
|      |       |         |
|------|-------|---------|
| Per. | 12.55 | in.     |
| WT.  | 0.70  | lb/ft   |
| θsa  | 6.00  | °C/w/3" |



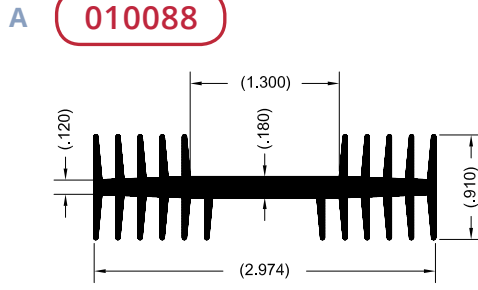
|      |       |         |
|------|-------|---------|
| Per. | 20.31 | in.     |
| WT.  | 1.34  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |



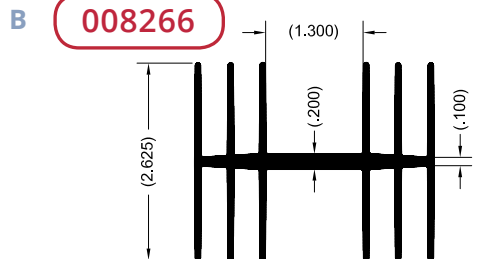
|      |       |         |
|------|-------|---------|
| Per. | 16.50 | in.     |
| WT.  | 1.04  | lb/ft   |
| θsa  | 4.20  | °C/w/3" |



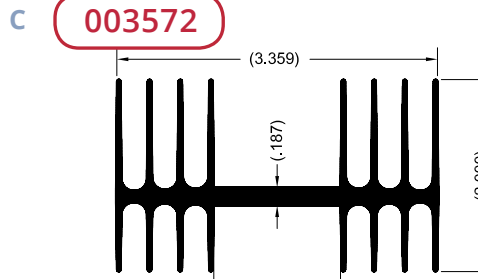
|      |       |         |
|------|-------|---------|
| Per. | 21.80 | in.     |
| WT.  | 1.09  | lb/ft   |
| θsa  | 3.40  | °C/w/3" |



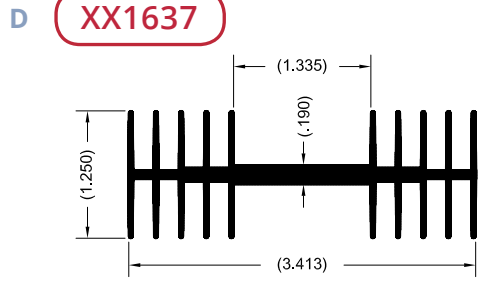
|      |       |         |
|------|-------|---------|
| Per. | 23.50 | in.     |
| WT.  | 1.12  | lb/ft   |
| θsa  | 3.00  | °C/w/3" |



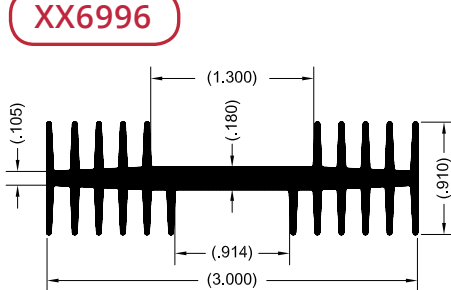
|      |       |         |
|------|-------|---------|
| Per. | 35.50 | in.     |
| WT.  | 1.80  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |



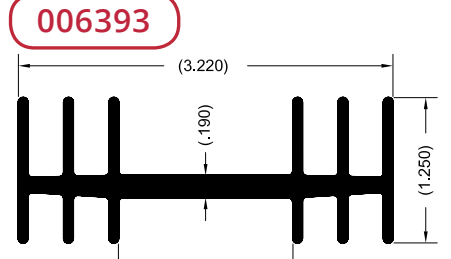
|      |       |         |
|------|-------|---------|
| Per. | 36.20 | in.     |
| WT.  | 1.62  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



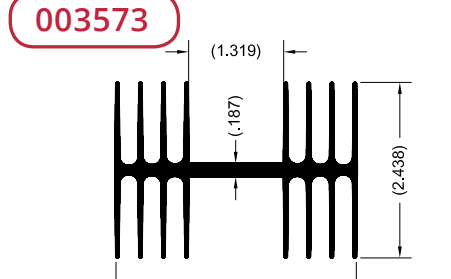
|      |       |         |
|------|-------|---------|
| Per. | 28.00 | in.     |
| WT.  | 1.20  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



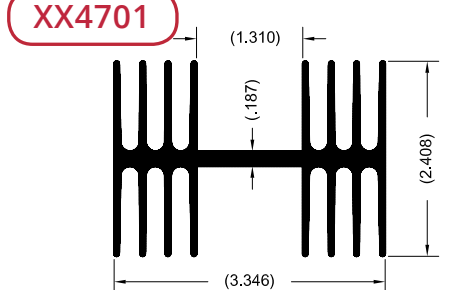
|      |       |         |
|------|-------|---------|
| Per. | 22.52 | in.     |
| WT.  | 1.02  | lb/ft   |
| θsa  | 3.20  | °C/w/3" |



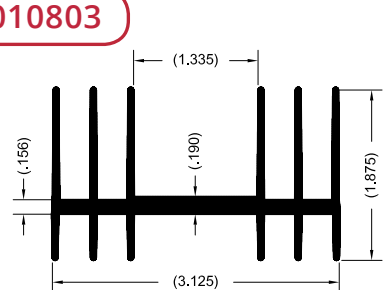
|      |       |         |
|------|-------|---------|
| Per. | 19.00 | in.     |
| WT.  | 1.36  | lb/ft   |
| θsa  | 3.70  | °C/w/3" |



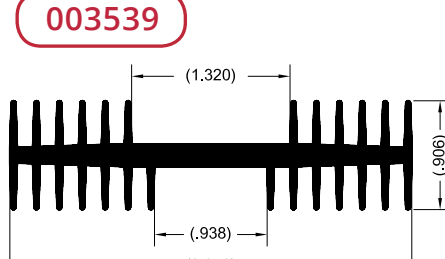
|      |       |         |
|------|-------|---------|
| Per. | 43.20 | in.     |
| WT.  | 1.91  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



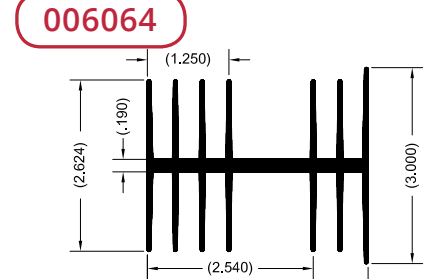
|      |       |         |
|------|-------|---------|
| Per. | 40.71 | in.     |
| WT.  | 2.35  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



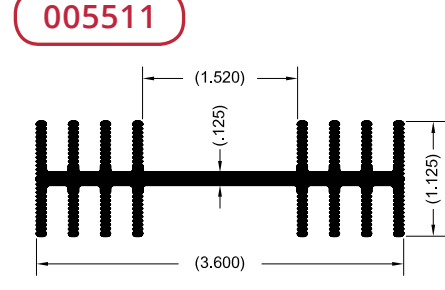
|      |       |         |
|------|-------|---------|
| Per. | 27.00 | in.     |
| WT.  | 1.47  | lb/ft   |
| θsa  | 2.60  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 26.50 | in.     |
| WT.  | 1.18  | lb/ft   |
| θsa  | 2.60  | °C/w/3" |

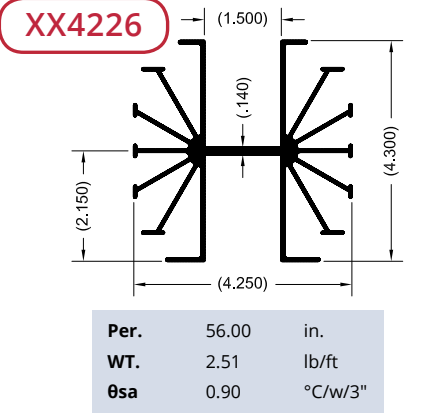
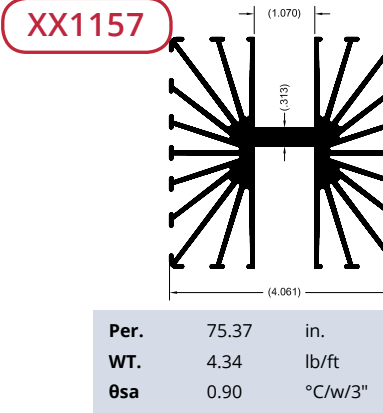
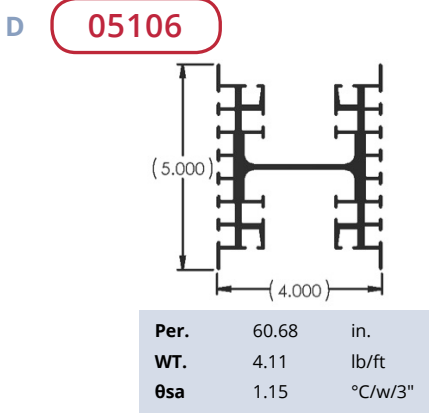
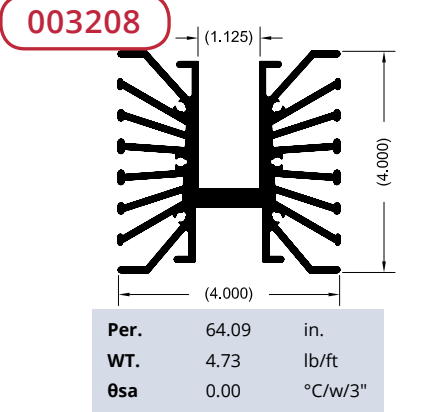
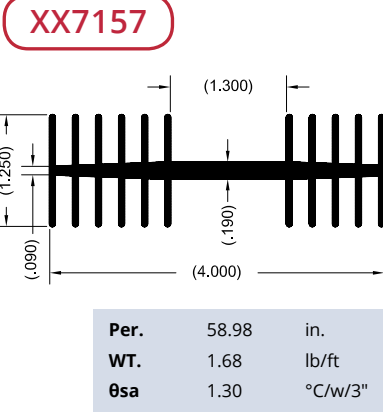
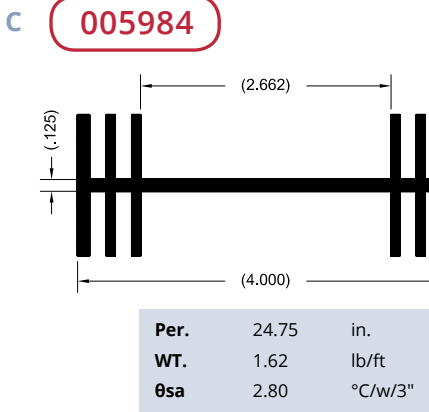
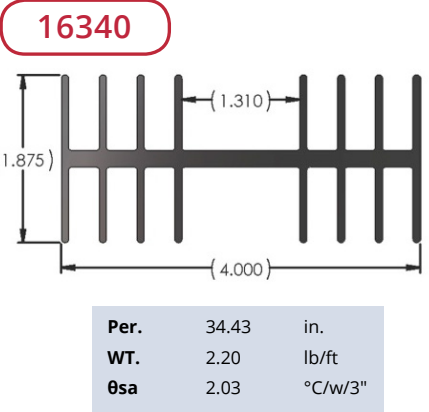
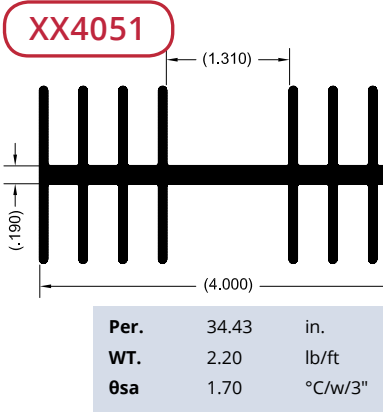
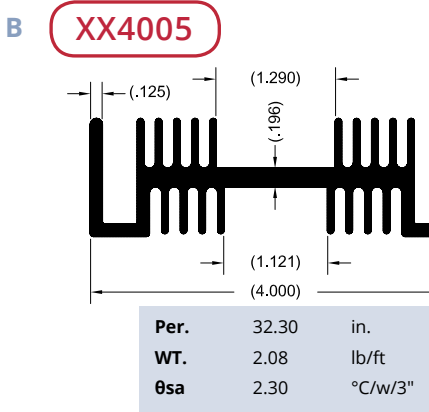
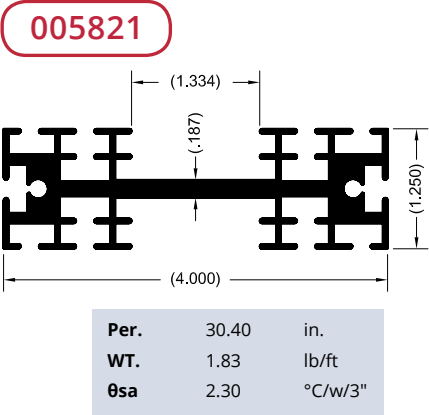
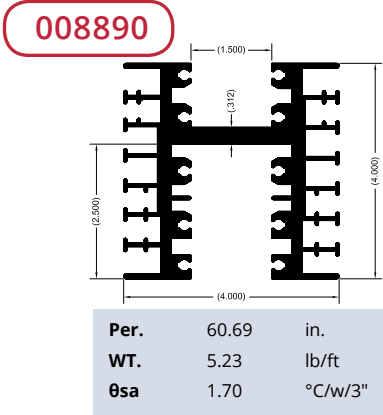
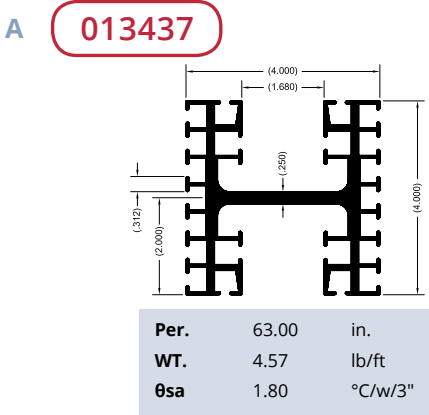
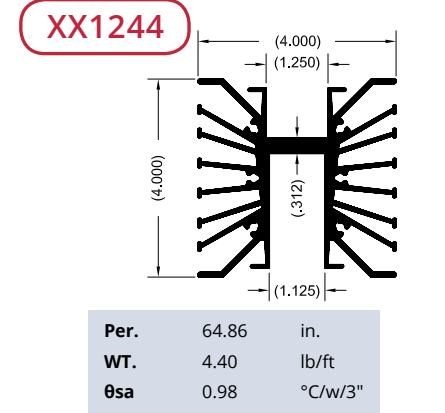
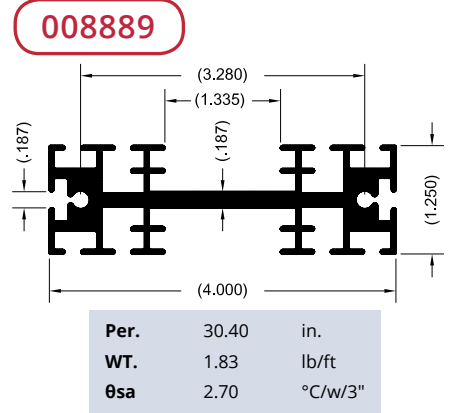
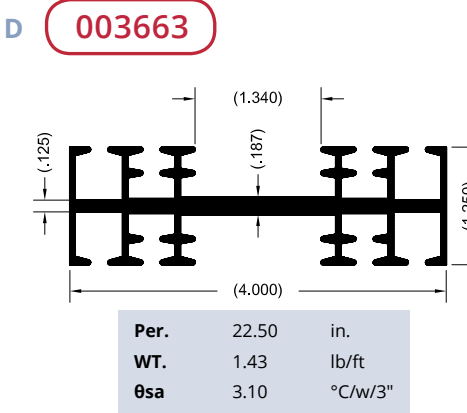
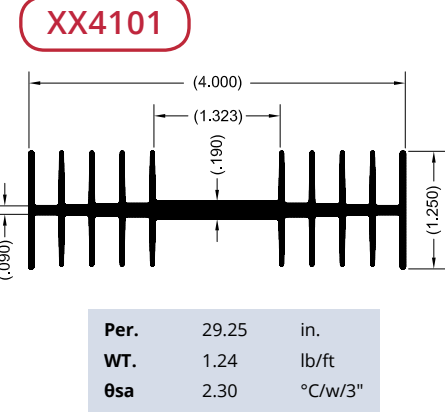
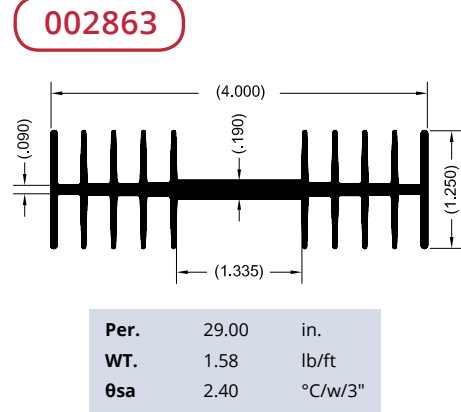
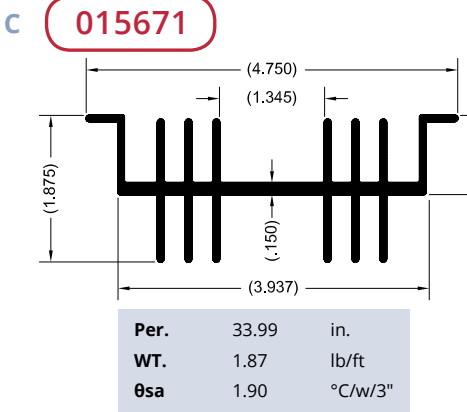
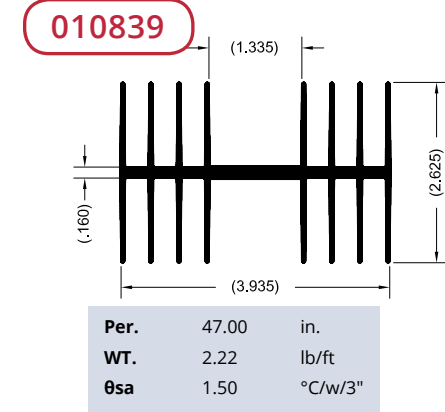
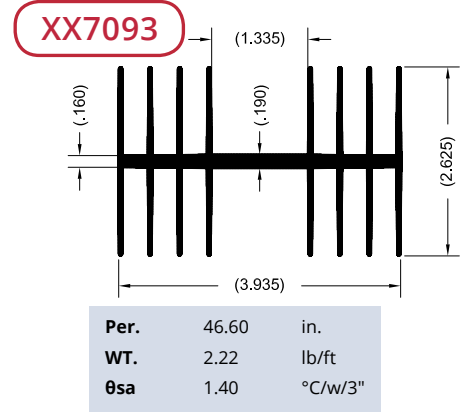
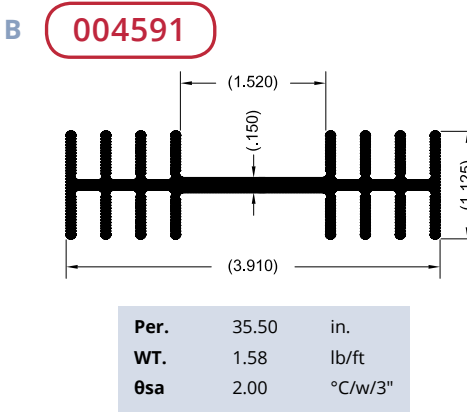
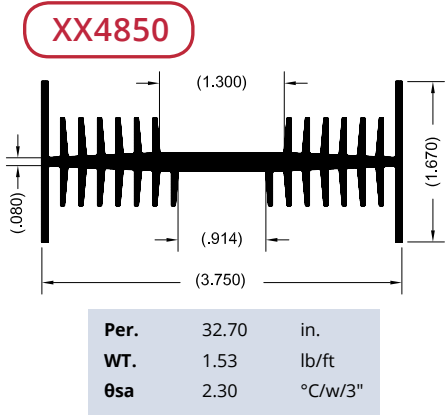
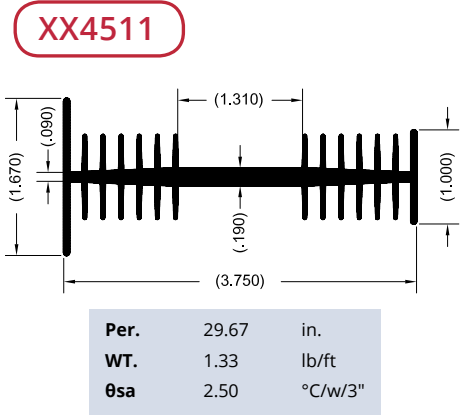
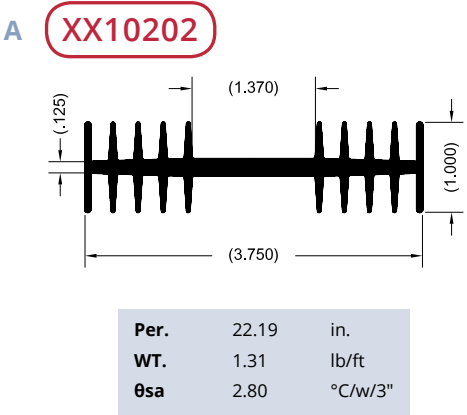


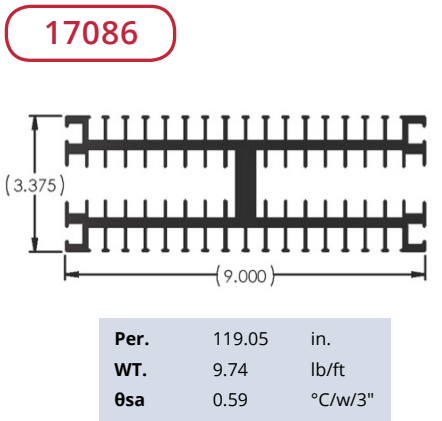
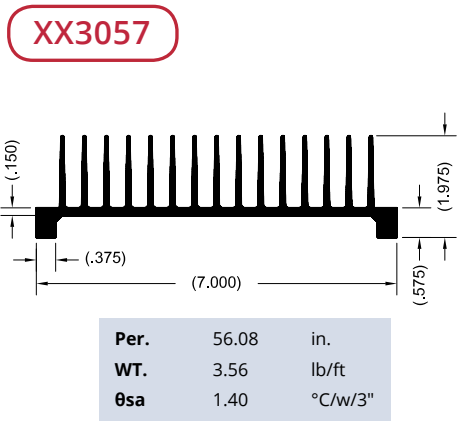
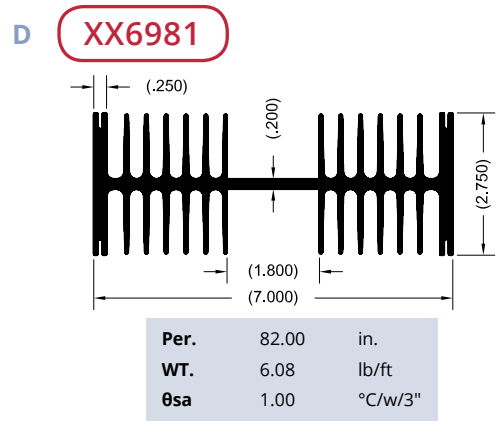
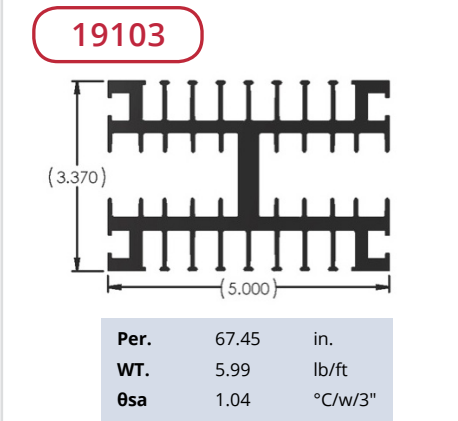
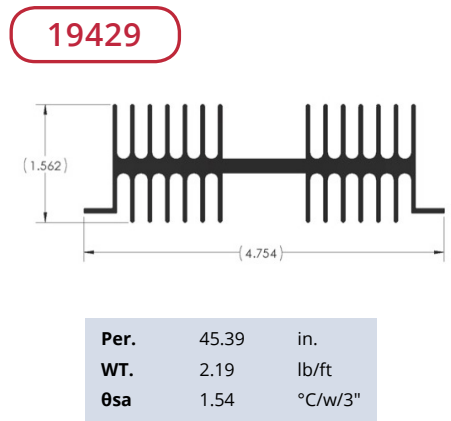
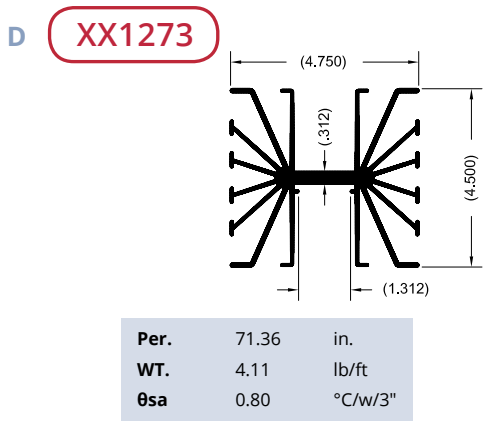
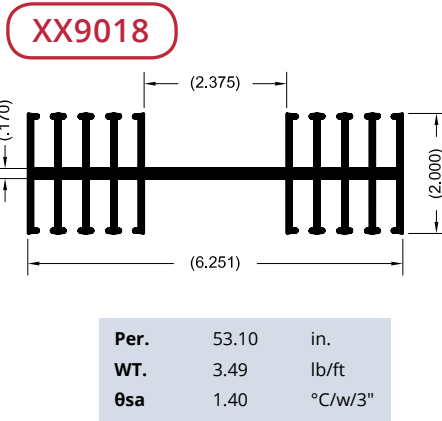
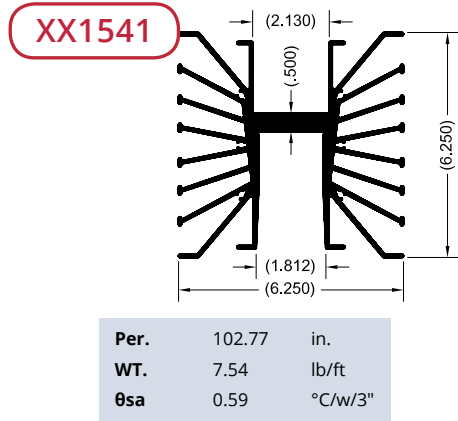
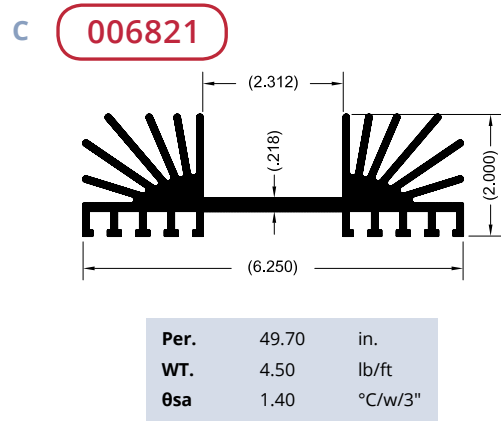
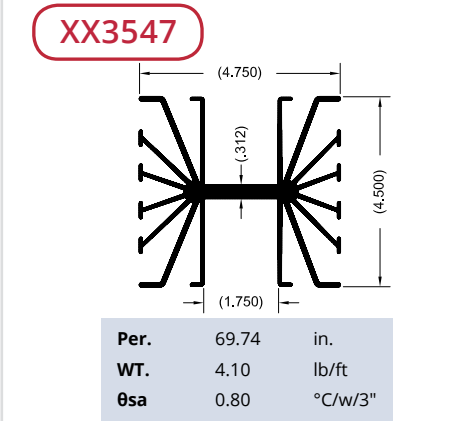
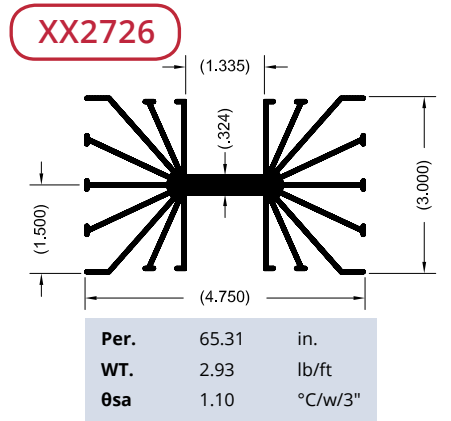
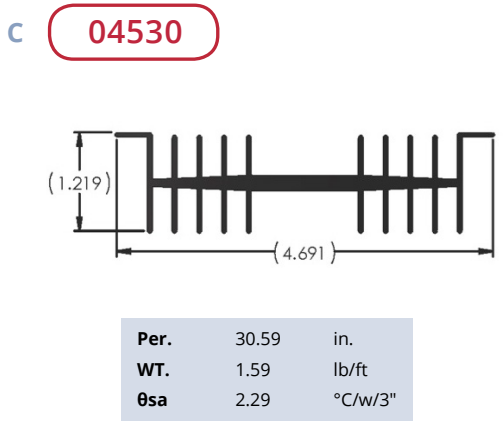
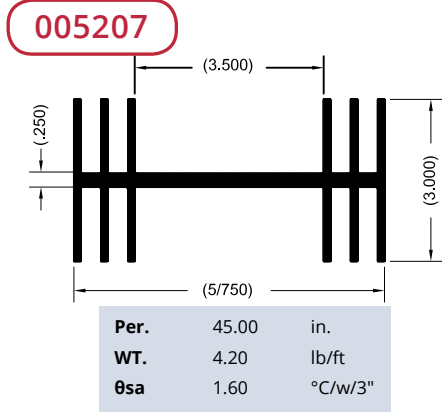
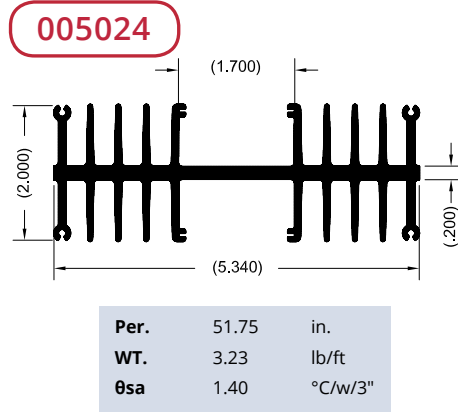
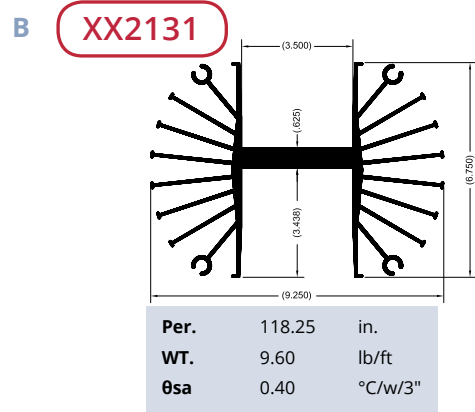
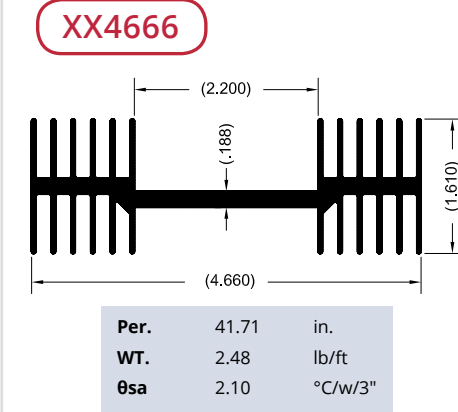
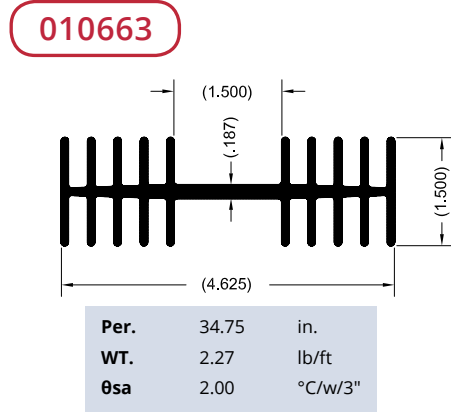
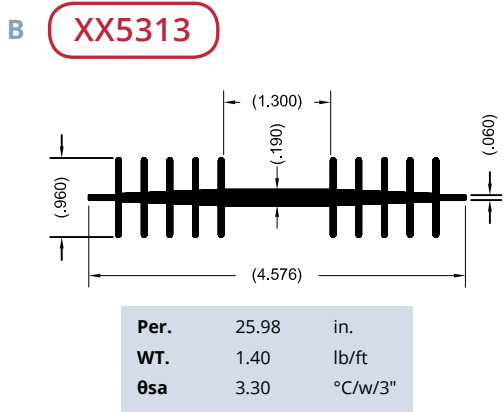
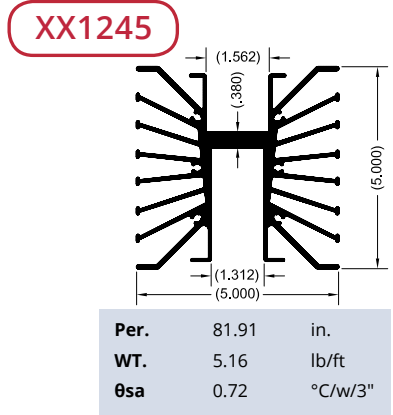
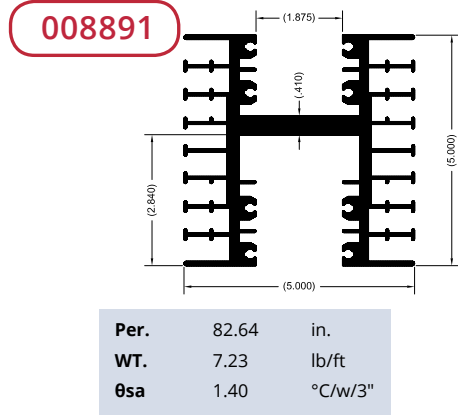
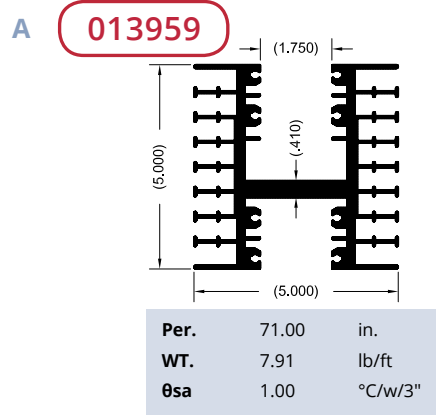
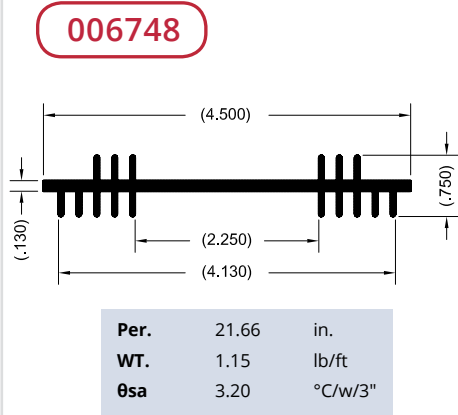
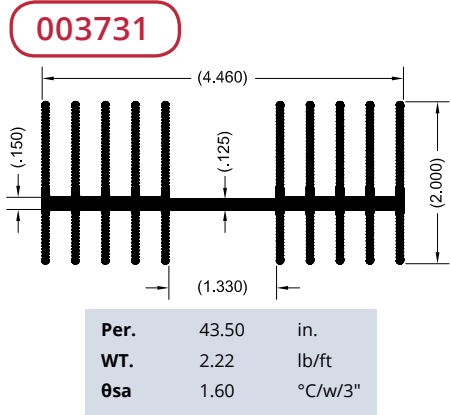
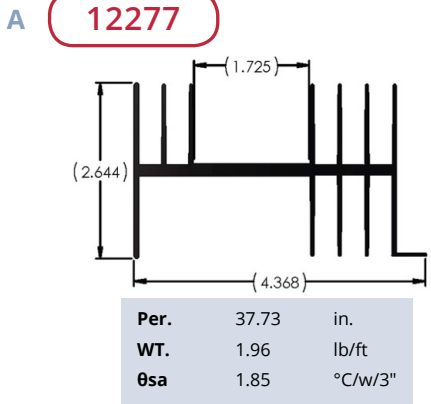
|      |       |         |
|------|-------|---------|
| Per. | 42.00 | in.     |
| WT.  | 2.45  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |

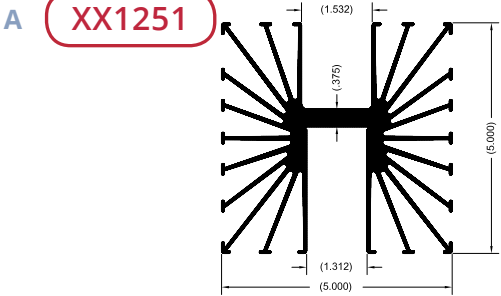


|      |       |         |
|------|-------|---------|
| Per. | 24.00 | in.     |
| WT.  | 1.31  | lb/ft   |
| θsa  | 2.90  | °C/w/3" |

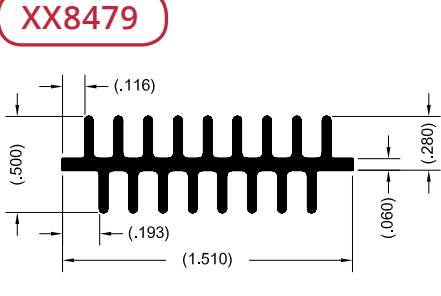




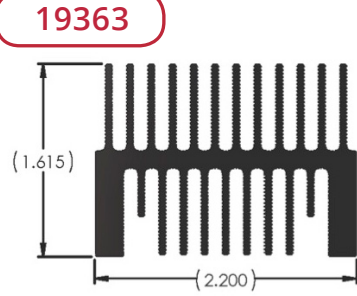




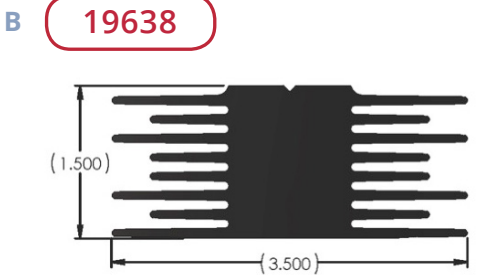
|      |       |         |
|------|-------|---------|
| Per. | 89.93 | in.     |
| WT.  | 5.74  | lb/ft   |
| θsa  | 0.70  | °C/w/3" |



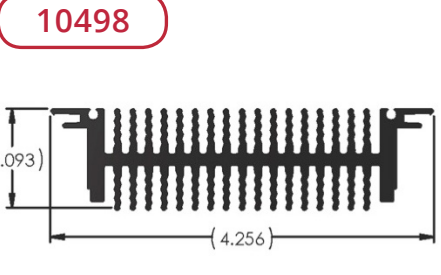
|      |      |         |
|------|------|---------|
| Per. | 9.90 | in.     |
| WT.  | 0.27 | lb/ft   |
| θsa  | 7.80 | °C/w/3" |



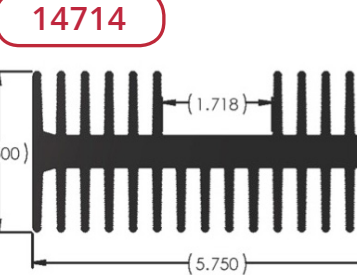
|      |       |         |
|------|-------|---------|
| Per. | 43.93 | in.     |
| WT.  | 1.78  | lb/ft   |
| θsa  | 1.59  | °C/w/3" |



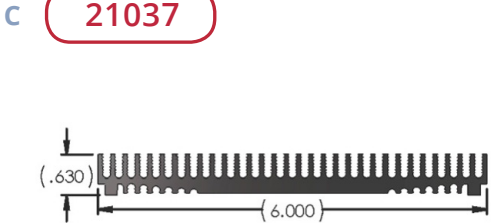
|      |       |         |
|------|-------|---------|
| Per. | 34.70 | in.     |
| WT.  | 3.72  | lb/ft   |
| θsa  | 2.02  | °C/w/3" |



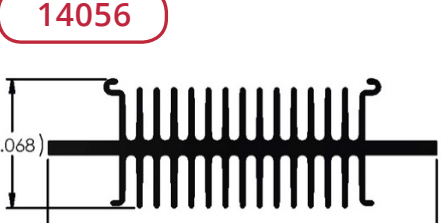
|      |       |         |
|------|-------|---------|
| Per. | 46.35 | in.     |
| WT.  | 2.32  | lb/ft   |
| θsa  | 1.51  | °C/w/3" |



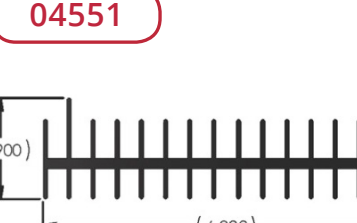
|      |       |         |
|------|-------|---------|
| Per. | 84.15 | in.     |
| WT.  | 7.71  | lb/ft   |
| θsa  | 0.83  | °C/w/3" |



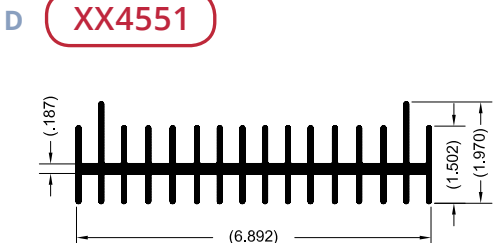
|      |       |         |
|------|-------|---------|
| Per. | 42.34 | in.     |
| WT.  | 2.46  | lb/ft   |
| θsa  | 1.65  | °C/w/3" |



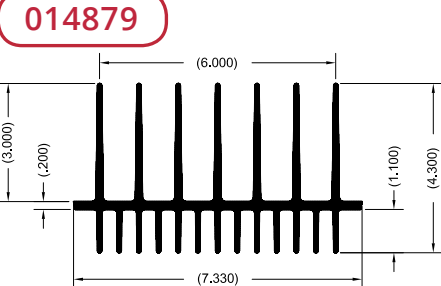
|      |       |         |
|------|-------|---------|
| Per. | 62.77 | in.     |
| WT.  | 4.48  | lb/ft   |
| θsa  | 1.11  | °C/w/3" |



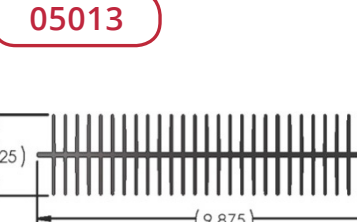
|      |       |         |
|------|-------|---------|
| Per. | 46.76 | in.     |
| WT.  | 3.57  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



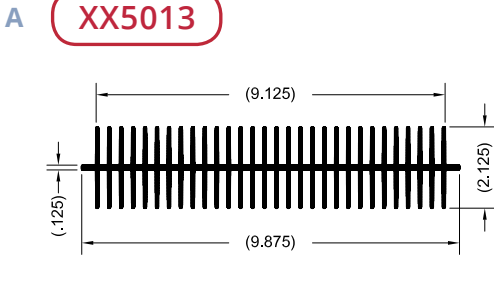
|      |       |         |
|------|-------|---------|
| Per. | 57.73 | in.     |
| WT.  | 3.59  | lb/ft   |
| θsa  | 1.26  | °C/w/3" |



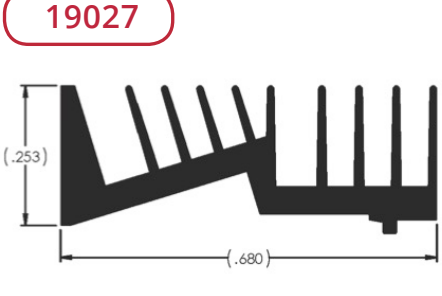
|      |       |         |
|------|-------|---------|
| Per. | 82.26 | in.     |
| WT.  | 7.16  | lb/ft   |
| θsa  | 0.85  | °C/w/3" |



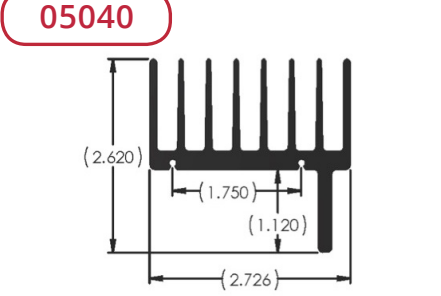
|      |        |         |
|------|--------|---------|
| Per. | 136.05 | in.     |
| WT.  | 6.40   | lb/ft   |
| θsa  | 0.51   | °C/w/3" |



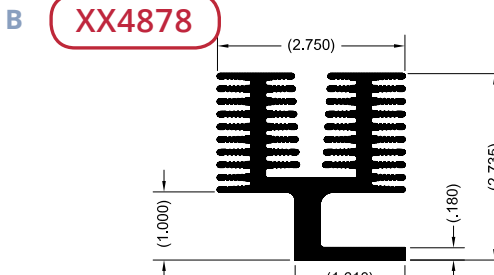
|      |        |         |
|------|--------|---------|
| Per. | 139.22 | in.     |
| WT.  | 6.41   | lb/ft   |
| θsa  | 0.96   | °C/w/3" |



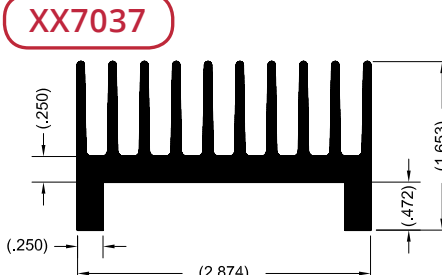
|      |       |         |
|------|-------|---------|
| Per. | 4.65  | in.     |
| WT.  | 0.09  | lb/ft   |
| θsa  | 15.05 | °C/w/3" |



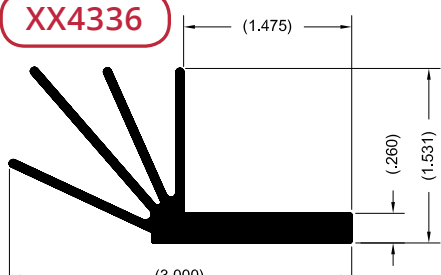
|      |       |         |
|------|-------|---------|
| Per. | 27.74 | in.     |
| WT.  | 2.05  | lb/ft   |
| θsa  | 2.52  | °C/w/3" |



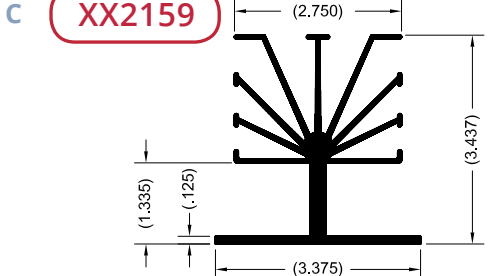
|      |       |         |
|------|-------|---------|
| Per. | 50.88 | in.     |
| WT.  | 3.30  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



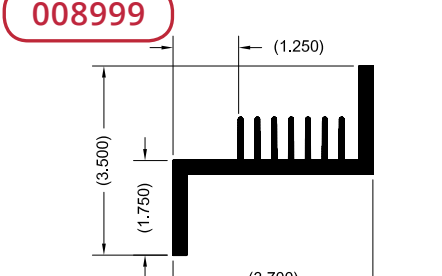
|      |       |         |
|------|-------|---------|
| Per. | 26.00 | in.     |
| WT.  | 2.03  | lb/ft   |
| θsa  | 2.80  | °C/w/3" |



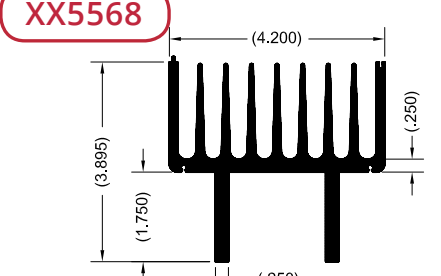
|      |       |         |
|------|-------|---------|
| Per. | 14.66 | in.     |
| WT.  | 1.02  | lb/ft   |
| θsa  | 5.10  | °C/w/3" |



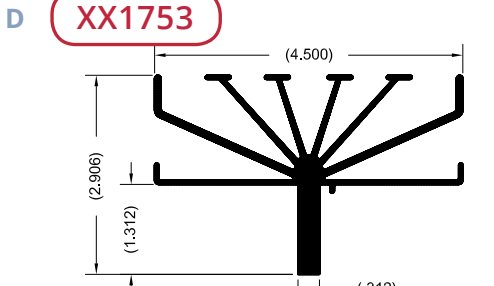
|      |       |         |
|------|-------|---------|
| Per. | 40.23 | in.     |
| WT.  | 2.47  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



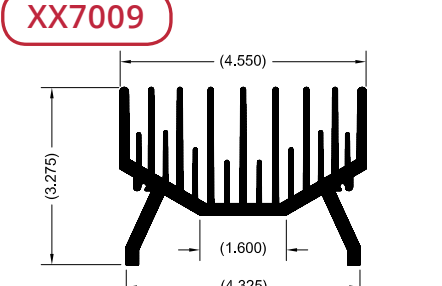
|      |       |         |
|------|-------|---------|
| Per. | 25.60 | in.     |
| WT.  | 2.59  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |



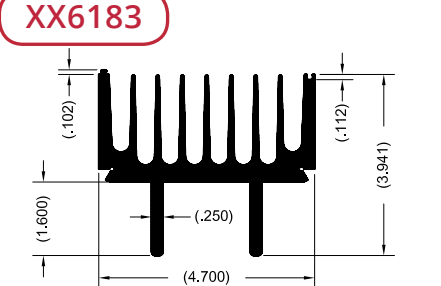
|      |       |         |
|------|-------|---------|
| Per. | 48.40 | in.     |
| WT.  | 5.01  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |



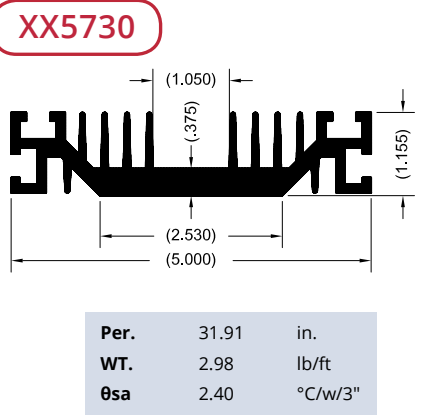
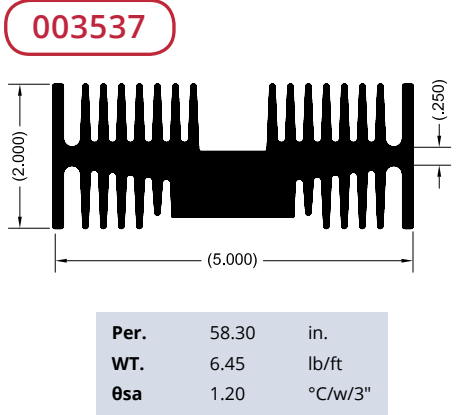
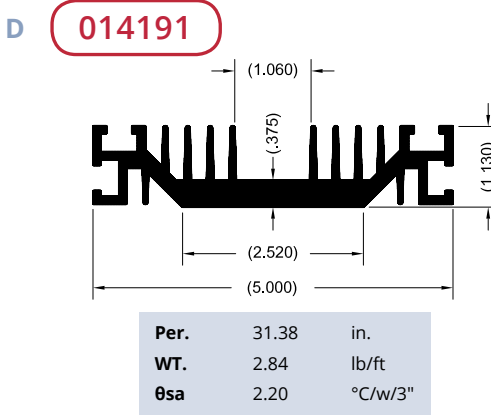
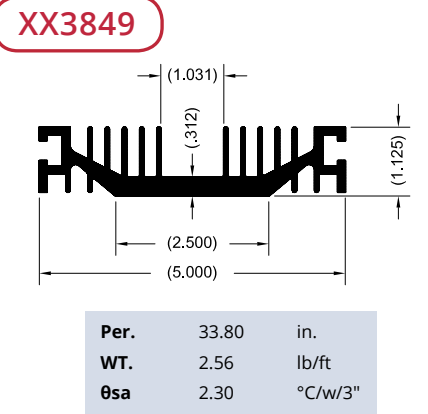
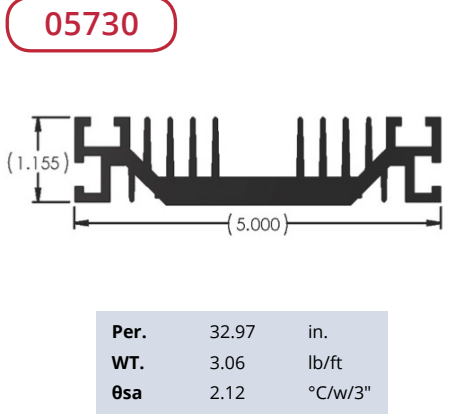
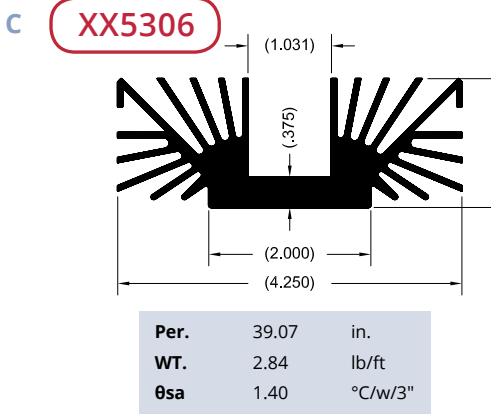
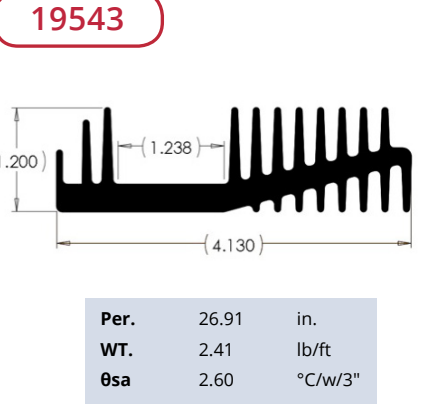
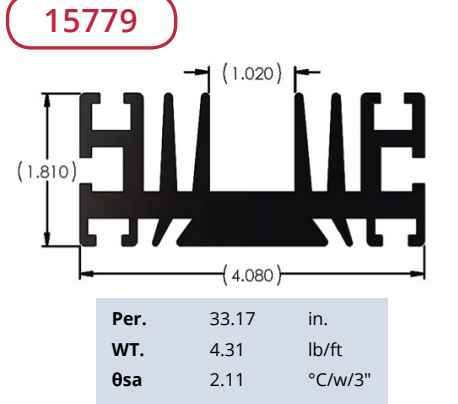
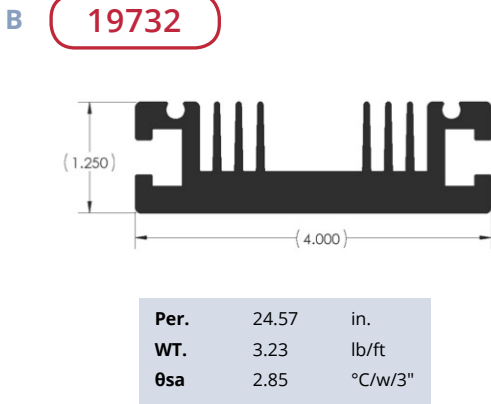
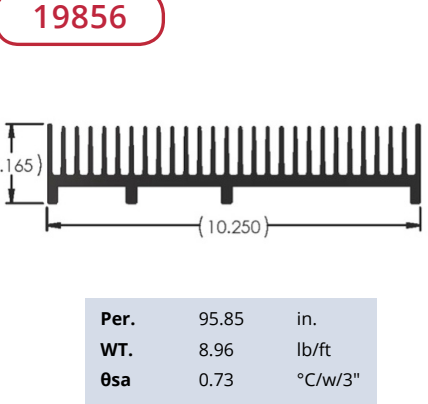
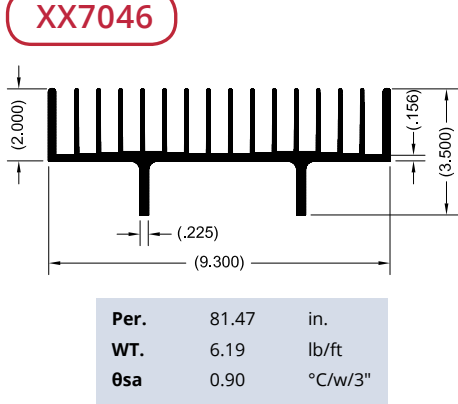
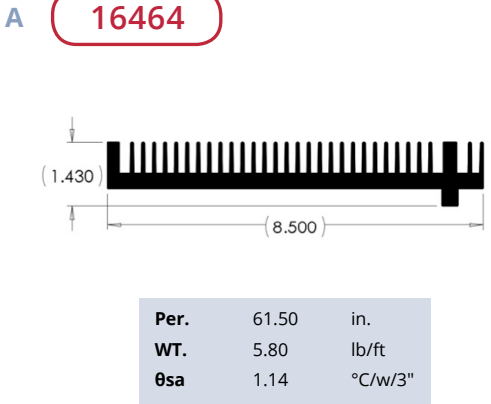
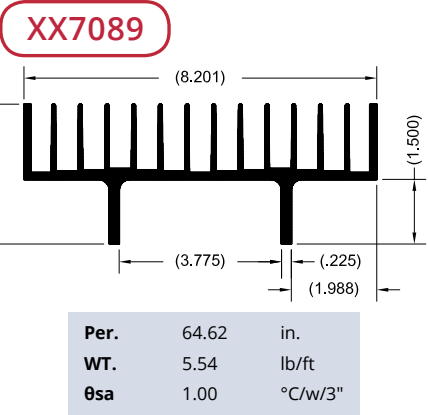
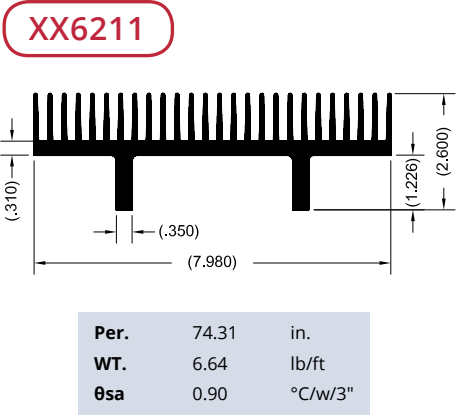
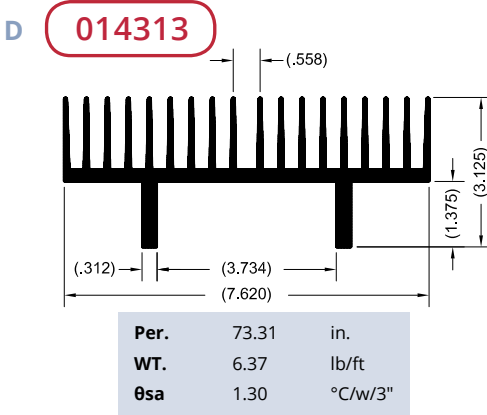
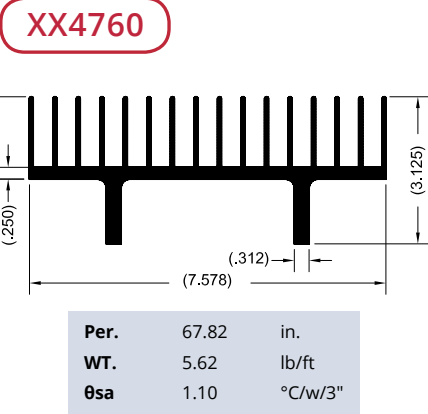
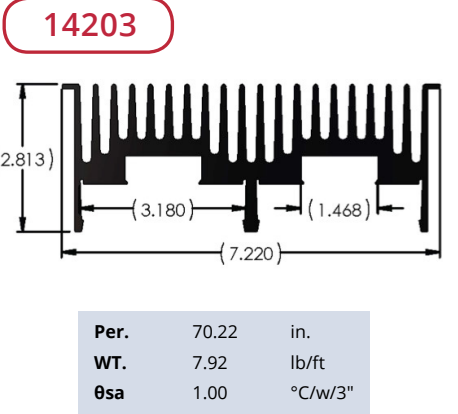
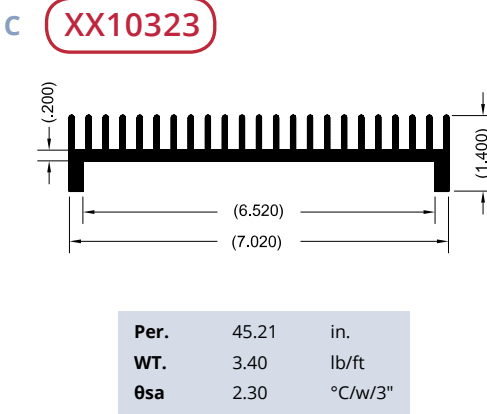
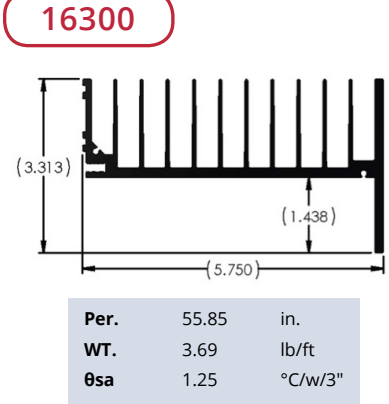
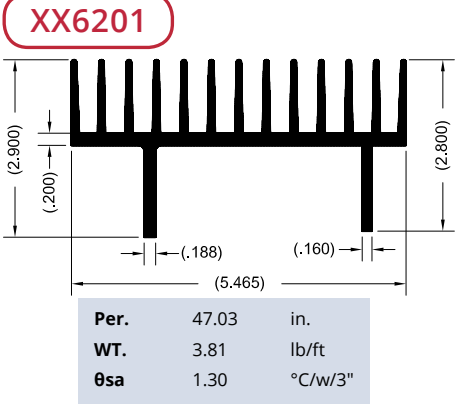
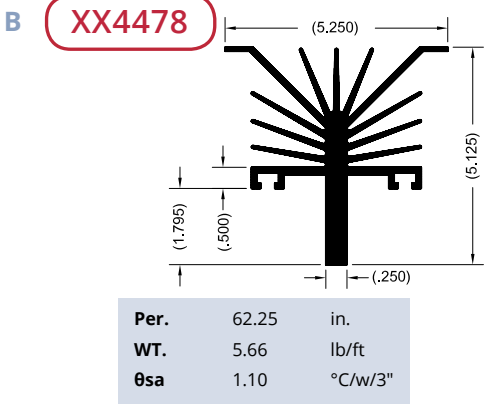
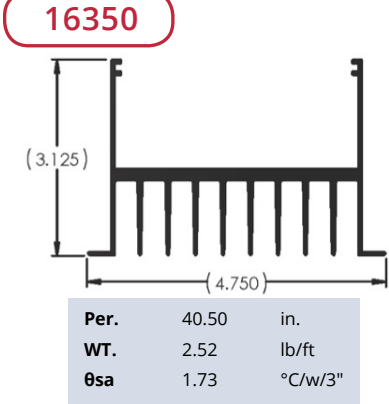
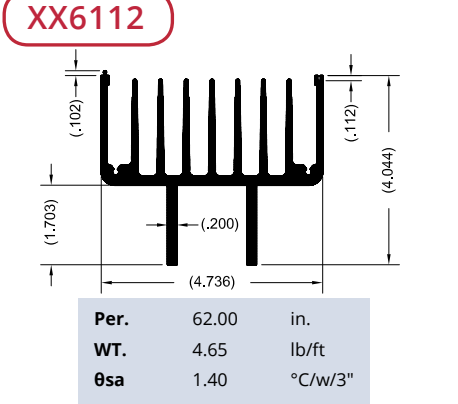
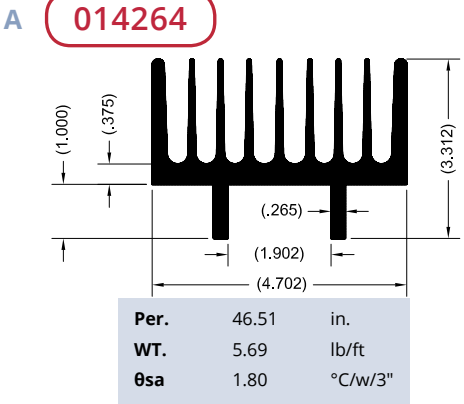
|      |       |         |
|------|-------|---------|
| Per. | 36.88 | in.     |
| WT.  | 2.16  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |



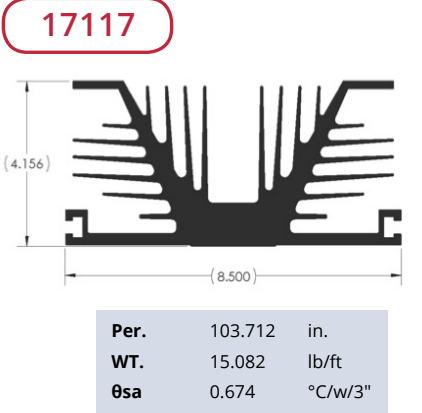
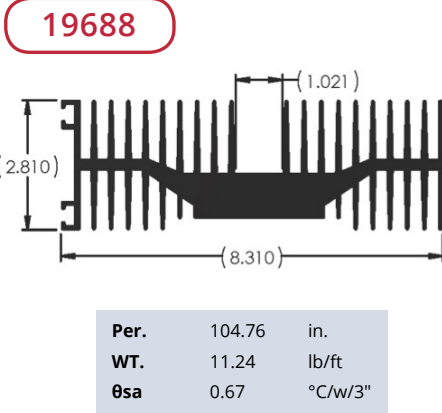
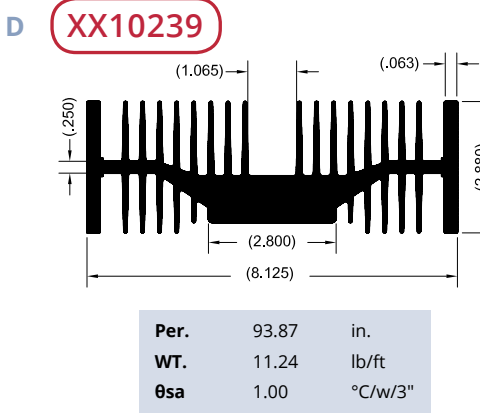
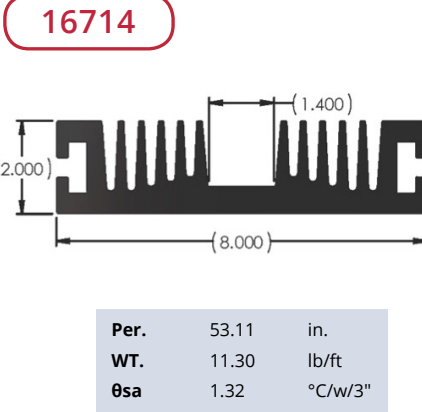
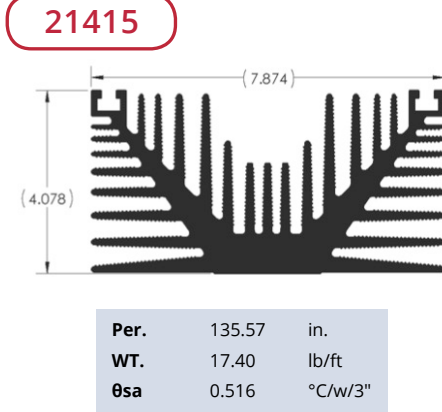
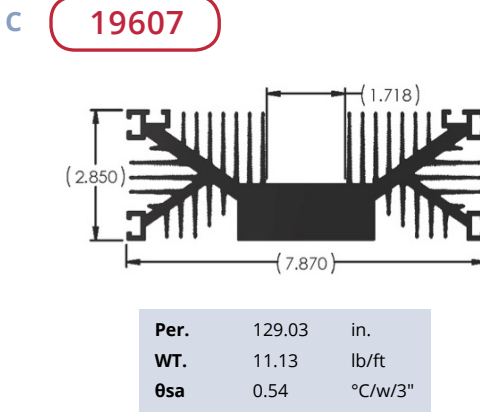
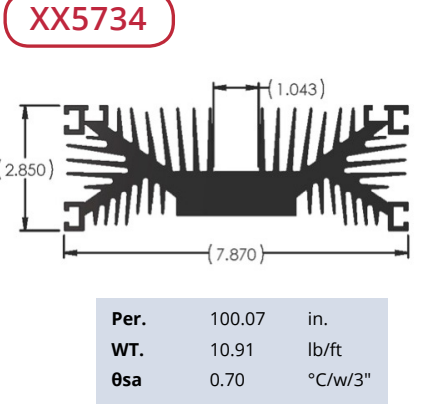
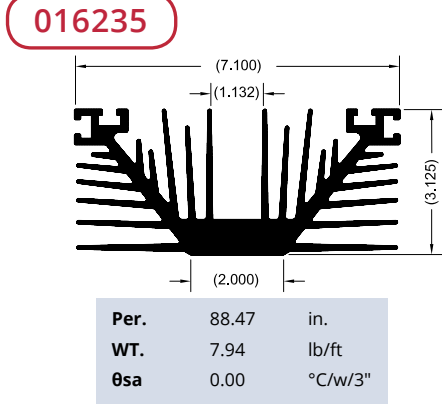
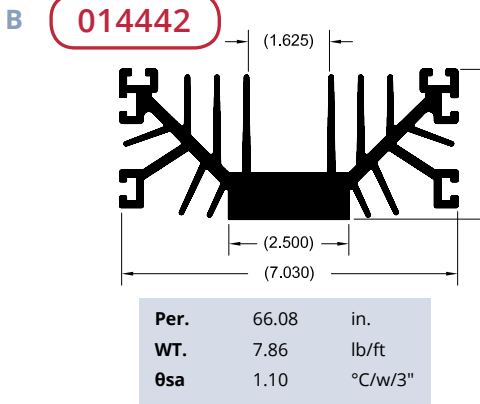
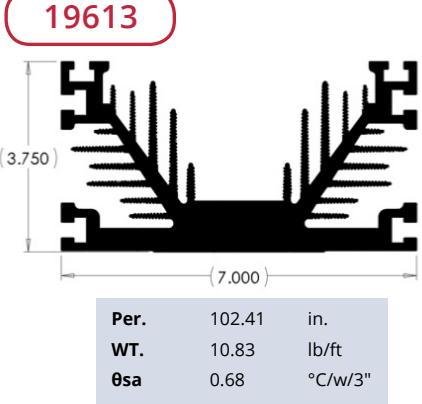
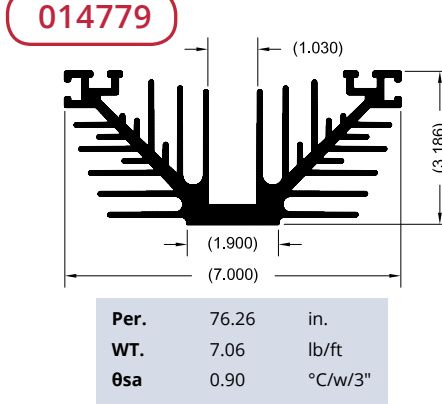
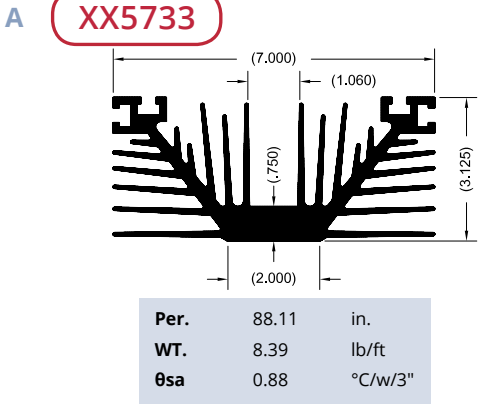
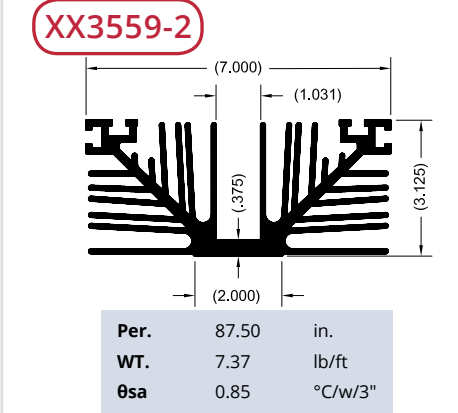
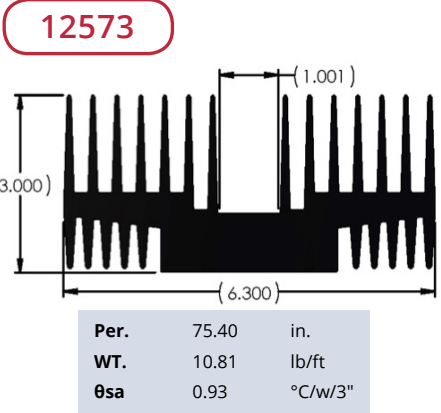
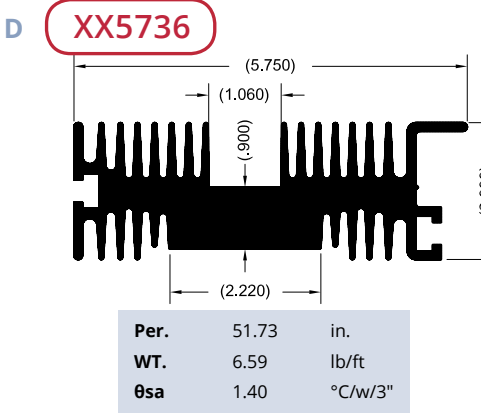
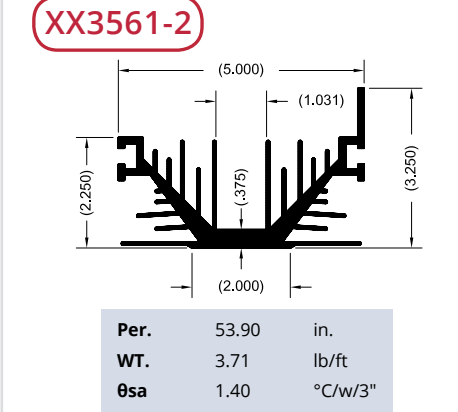
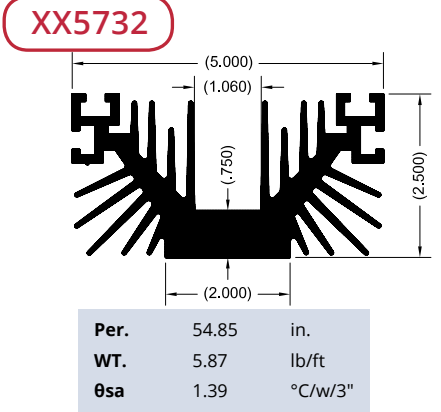
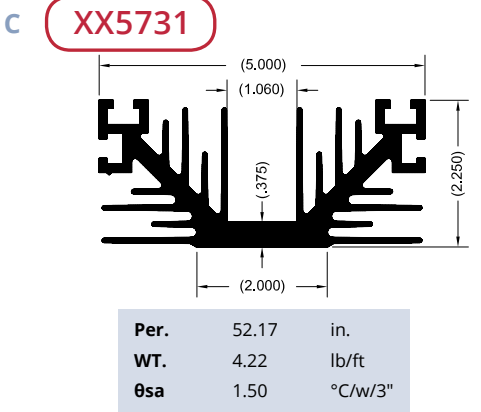
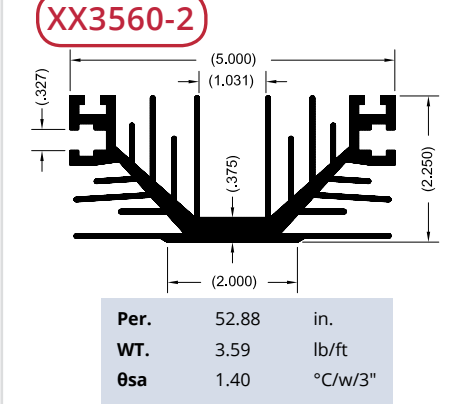
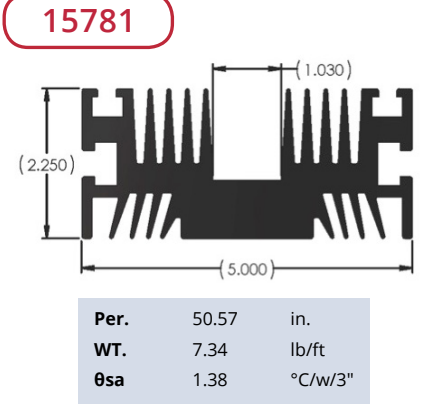
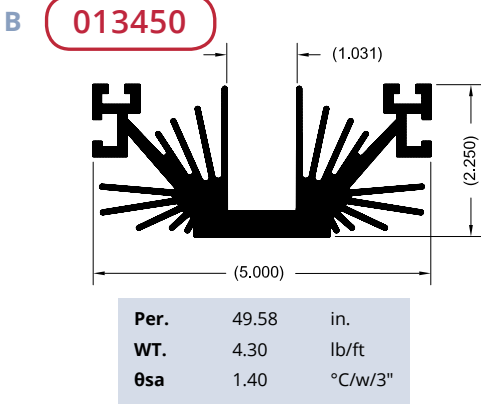
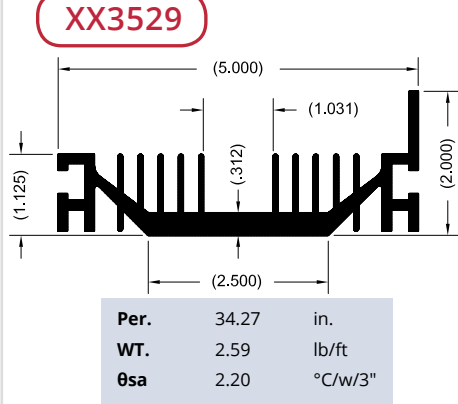
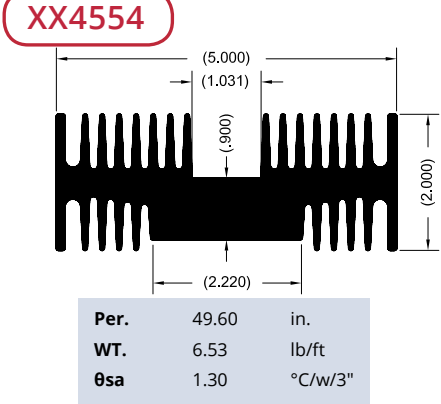
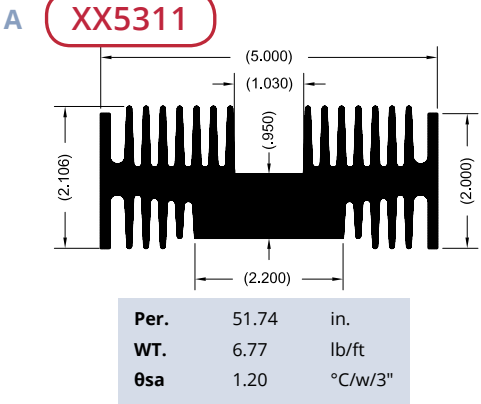
|      |       |         |
|------|-------|---------|
| Per. | 59.68 | in.     |
| WT.  | 4.57  | lb/ft   |
| θsa  | 1.30  | °C/w/3" |

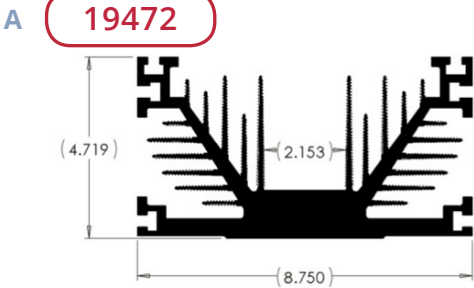


|      |       |         |
|------|-------|---------|
| Per. | 49.44 | in.     |
| WT.  | 6.18  | lb/ft   |
| θsa  | 1.50  | °C/w/3" |

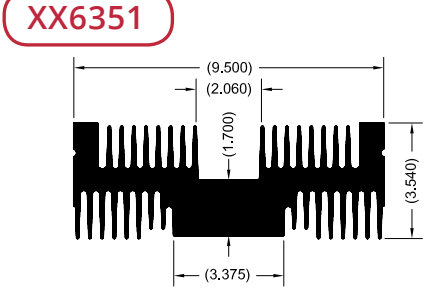




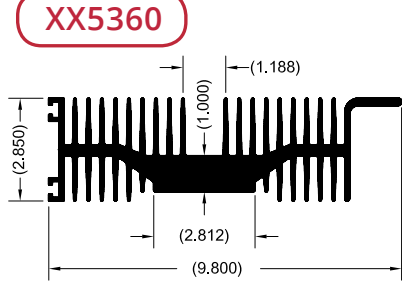




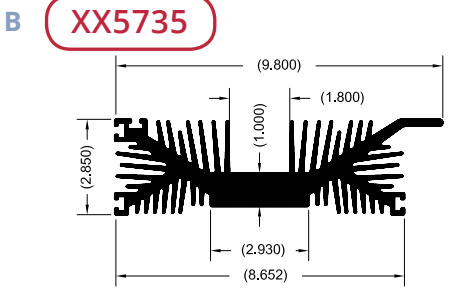
|      |        |         |
|------|--------|---------|
| Per. | 143.25 | in.     |
| WT.  | 15.91  | lb/ft   |
| θsa  | 0.49   | °C/w/3" |



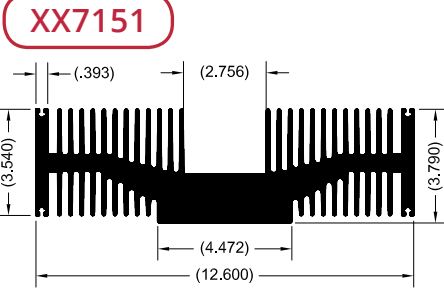
|      |        |         |
|------|--------|---------|
| Per. | 104.67 | in.     |
| WT.  | 21.45  | lb/ft   |
| θsa  | 0.70   | °C/w/3" |



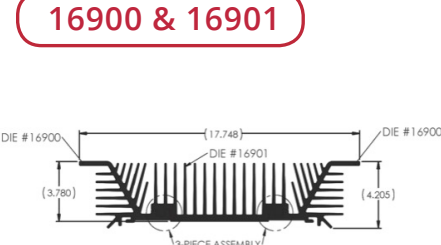
|      |        |         |
|------|--------|---------|
| Per. | 106.79 | in.     |
| WT.  | 11.00  | lb/ft   |
| θsa  | 0.74   | °C/w/3" |



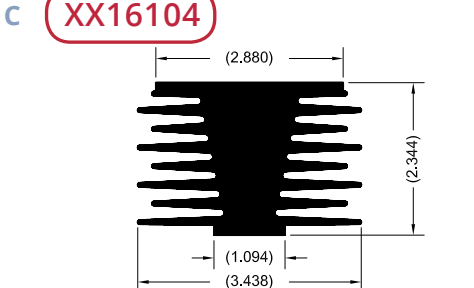
|      |        |         |
|------|--------|---------|
| Per. | 104.86 | in.     |
| WT.  | 12.80  | lb/ft   |
| θsa  | 0.71   | °C/w/3" |



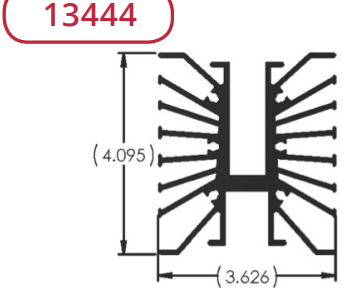
|      |        |         |
|------|--------|---------|
| Per. | 163.33 | in.     |
| WT.  | 25.62  | lb/ft   |
| θsa  | 0.55   | °C/w/3" |



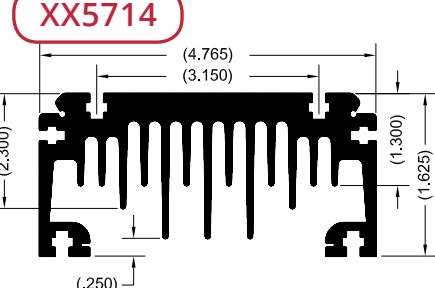
|      |        |         |
|------|--------|---------|
| Per. | 206.98 | in.     |
| WT.  | 24.10  | lb/ft   |
| θsa  | 0.34   | °C/w/3" |



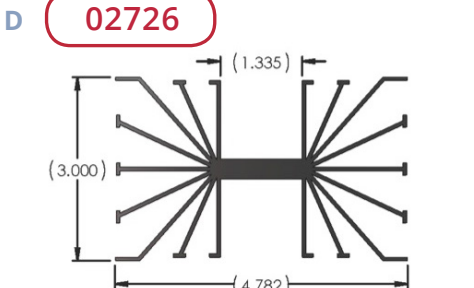
|      |       |         |
|------|-------|---------|
| Per. | 37.97 | in.     |
| WT.  | 5.52  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



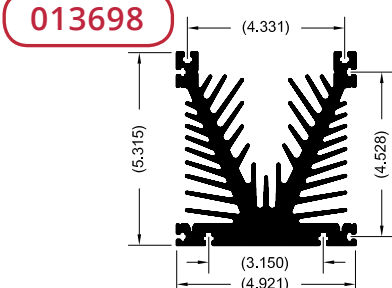
|      |       |         |
|------|-------|---------|
| Per. | 63.79 | in.     |
| WT.  | 4.73  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |



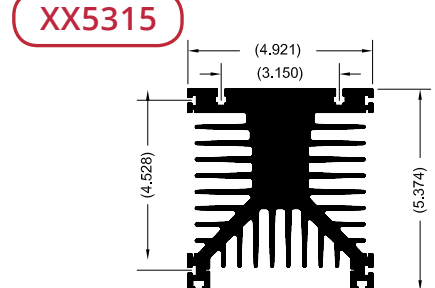
|      |       |         |
|------|-------|---------|
| Per. | 50.30 | in.     |
| WT.  | 5.38  | lb/ft   |
| θsa  | 1.40  | °C/w/3" |



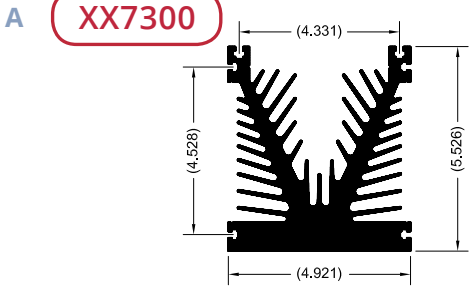
|      |       |         |
|------|-------|---------|
| Per. | 66.36 | in.     |
| WT.  | 2.88  | lb/ft   |
| θsa  | 1.05  | °C/w/3" |



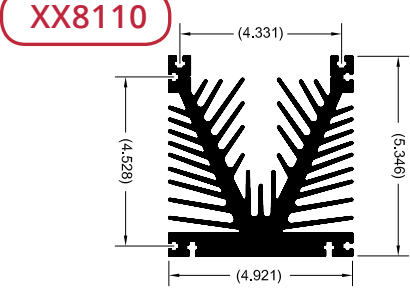
|      |       |         |
|------|-------|---------|
| Per. | 92.26 | in.     |
| WT.  | 10.99 | lb/ft   |
| θsa  | 0.80  | °C/w/3" |



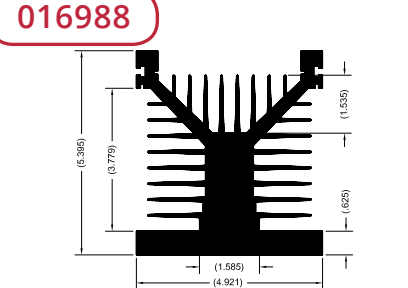
|      |       |         |
|------|-------|---------|
| Per. | 90.05 | in.     |
| WT.  | 12.84 | lb/ft   |
| θsa  | 0.80  | °C/w/3" |



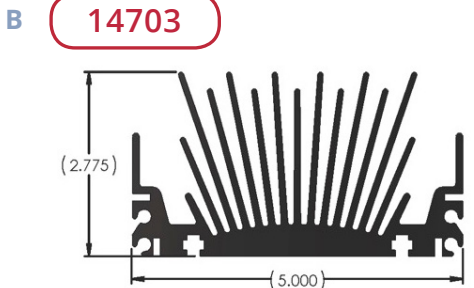
|      |       |         |
|------|-------|---------|
| Per. | 88.85 | in.     |
| WT.  | 12.31 | lb/ft   |
| θsa  | 0.88  | °C/w/3" |



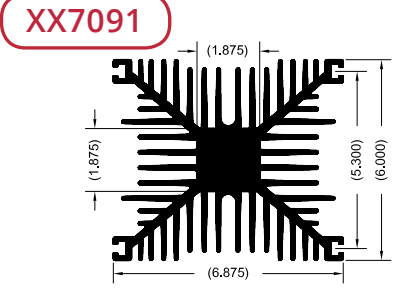
|      |       |         |
|------|-------|---------|
| Per. | 97.96 | in.     |
| WT.  | 11.45 | lb/ft   |
| θsa  | 0.80  | °C/w/3" |



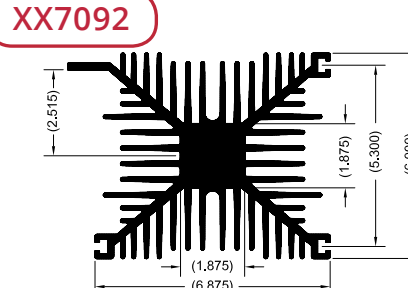
|      |       |         |
|------|-------|---------|
| Per. | 85.21 | in.     |
| WT.  | 13.30 | lb/ft   |
| θsa  | 0.90  | °C/w/3" |



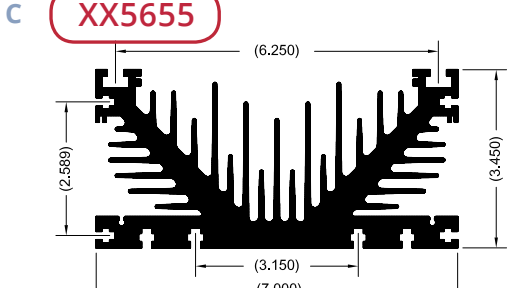
|      |       |         |
|------|-------|---------|
| Per. | 79.25 | in.     |
| WT.  | 6.08  | lb/ft   |
| θsa  | 0.88  | °C/w/3" |



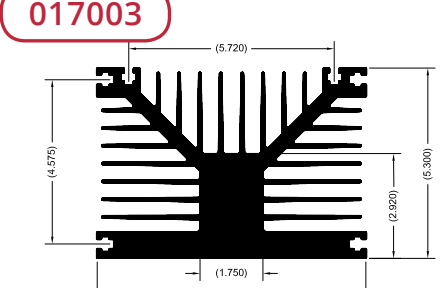
|      |        |         |
|------|--------|---------|
| Per. | 148.59 | in.     |
| WT.  | 12.48  | lb/ft   |
| θsa  | 0.55   | °C/w/3" |



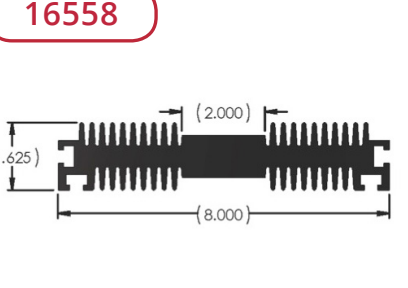
|      |        |         |
|------|--------|---------|
| Per. | 147.32 | in.     |
| WT.  | 12.44  | lb/ft   |
| θsa  | 0.55   | °C/w/3" |



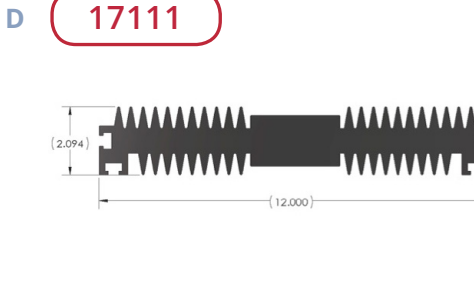
|      |       |         |
|------|-------|---------|
| Per. | 90.52 | in.     |
| WT.  | 11.80 | lb/ft   |
| θsa  | 0.71  | °C/w/3" |



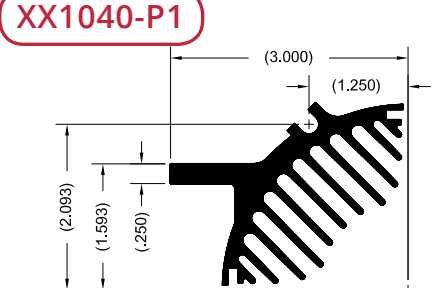
|      |        |         |
|------|--------|---------|
| Per. | 129.68 | in.     |
| WT.  | 20.20  | lb/ft   |
| θsa  | 0.65   | °C/w/3" |



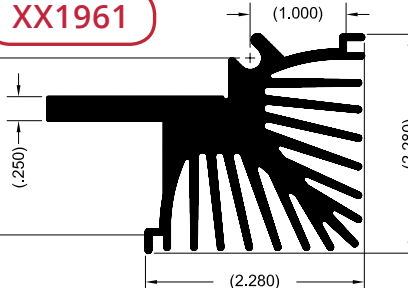
|      |       |         |
|------|-------|---------|
| Per. | 59.93 | in.     |
| WT.  | 9.57  | lb/ft   |
| θsa  | 1.17  | °C/w/3" |



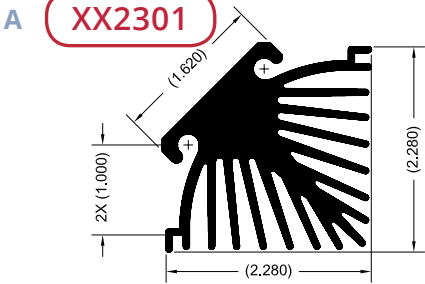
|      |       |         |
|------|-------|---------|
| Per. | 76.53 | in.     |
| WT.  | 20.11 | lb/ft   |
| θsa  | 0.91  | °C/w/3" |



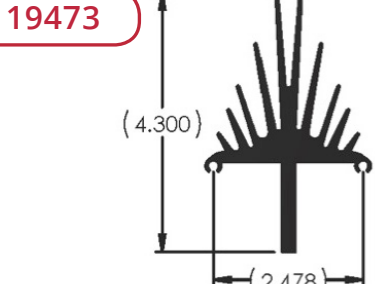
|      |       |         |
|------|-------|---------|
| Per. | 25.74 | in.     |
| WT.  | 2.09  | lb/ft   |
| θsa  | 2.70  | °C/w/3" |



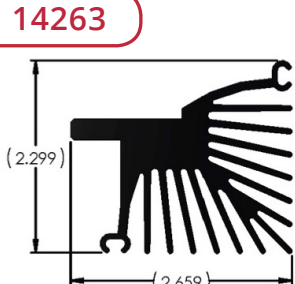
|      |       |         |
|------|-------|---------|
| Per. | 36.22 | in.     |
| WT.  | 2.66  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



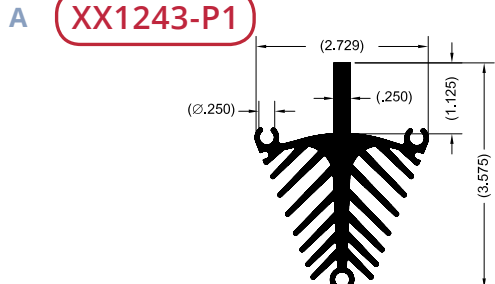
|      |       |         |
|------|-------|---------|
| Per. | 34.48 | in.     |
| WT.  | 2.48  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



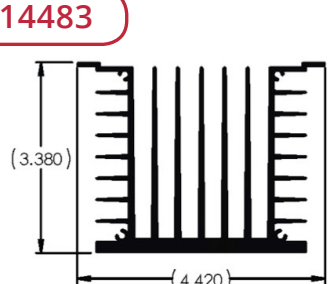
|      |       |         |
|------|-------|---------|
| Per. | 30.97 | in.     |
| WT.  | 2.85  | lb/ft   |
| θsa  | 2.26  | °C/w/3" |



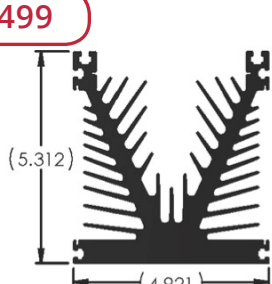
|      |       |         |
|------|-------|---------|
| Per. | 34.15 | in.     |
| WT.  | 2.51  | lb/ft   |
| θsa  | 2.05  | °C/w/3" |



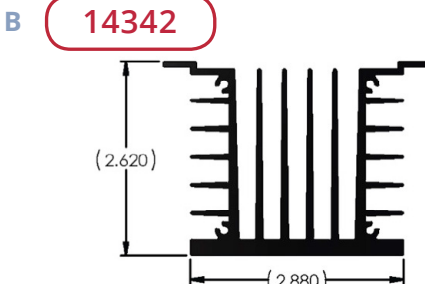
|      |       |         |
|------|-------|---------|
| Per. | 36.25 | in.     |
| WT.  | 2.53  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



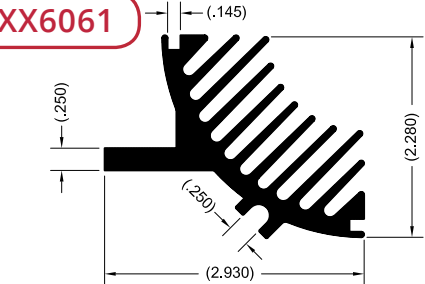
|      |       |         |
|------|-------|---------|
| Per. | 70.37 | in.     |
| WT.  | 4.32  | lb/ft   |
| θsa  | 0.99  | °C/w/3" |



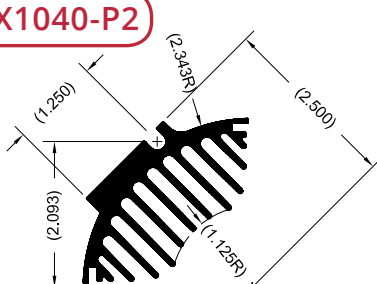
|      |       |         |
|------|-------|---------|
| Per. | 88.60 | in.     |
| WT.  | 11.46 | lb/ft   |
| θsa  | 0.79  | °C/w/3" |



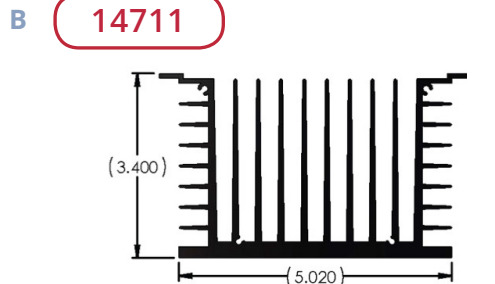
|      |       |         |
|------|-------|---------|
| Per. | 48.06 | in.     |
| WT.  | 2.88  | lb/ft   |
| θsa  | 1.45  | °C/w/3" |



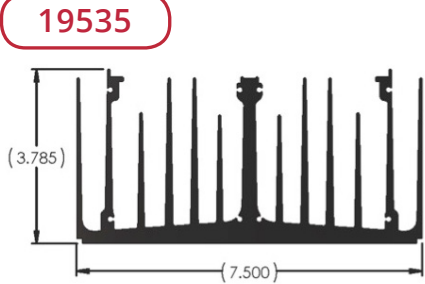
|      |       |         |
|------|-------|---------|
| Per. | 28.28 | in.     |
| WT.  | 2.23  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |



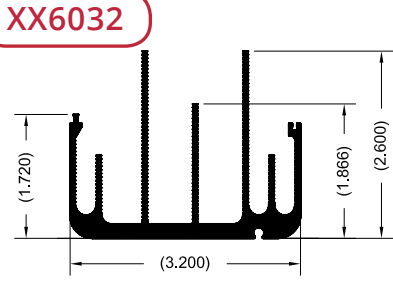
|      |       |         |
|------|-------|---------|
| Per. | 24.00 | in.     |
| WT.  | 1.87  | lb/ft   |
| θsa  | 2.90  | °C/w/3" |



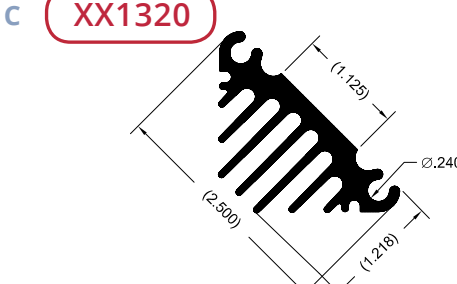
|      |       |         |
|------|-------|---------|
| Per. | 89.05 | in.     |
| WT.  | 5.95  | lb/ft   |
| θsa  | 0.79  | °C/w/3" |



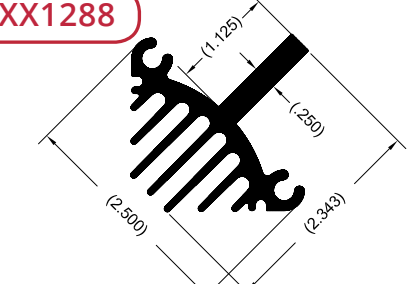
|      |       |         |
|------|-------|---------|
| Per. | 95.28 | in.     |
| WT.  | 9.50  | lb/ft   |
| θsa  | 0.73  | °C/w/3" |



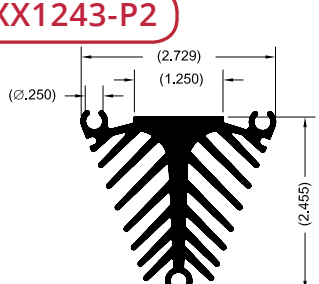
|      |       |         |
|------|-------|---------|
| Per. | 31.61 | in.     |
| WT.  | 1.75  | lb/ft   |
| θsa  | 2.02  | °C/w/3" |



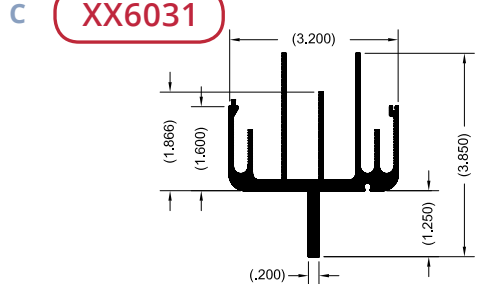
|      |       |         |
|------|-------|---------|
| Per. | 16.50 | in.     |
| WT.  | 1.36  | lb/ft   |
| θsa  | 3.90  | °C/w/3" |



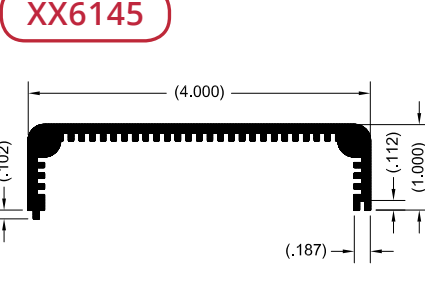
|      |       |         |
|------|-------|---------|
| Per. | 18.77 | in.     |
| WT.  | 1.41  | lb/ft   |
| θsa  | 3.90  | °C/w/3" |



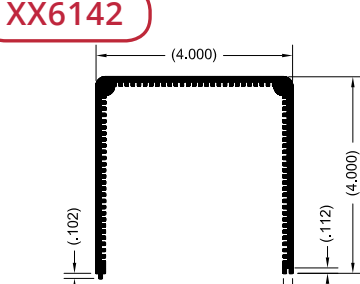
|      |       |         |
|------|-------|---------|
| Per. | 34.14 | in.     |
| WT.  | 2.24  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |



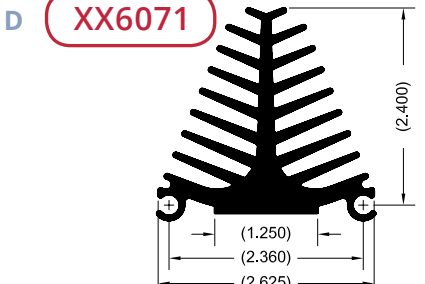
|      |       |         |
|------|-------|---------|
| Per. | 33.93 | in.     |
| WT.  | 2.06  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |



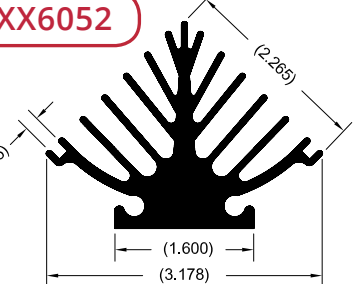
|      |       |         |
|------|-------|---------|
| Per. | 18.06 | in.     |
| WT.  | 1.03  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



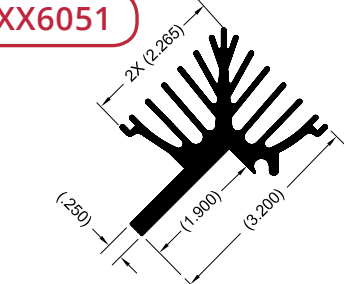
|      |       |         |
|------|-------|---------|
| Per. | 38.61 | in.     |
| WT.  | 2.05  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



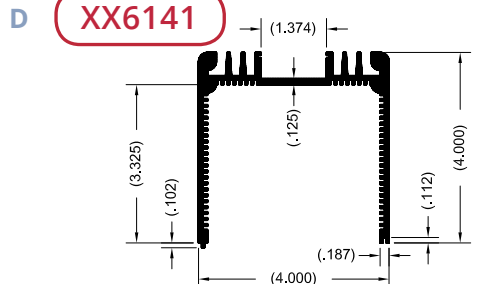
|      |       |         |
|------|-------|---------|
| Per. | 31.70 | in.     |
| WT.  | 2.45  | lb/ft   |
| θsa  | 1.80  | °C/w/3" |



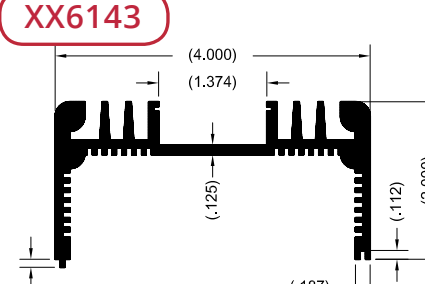
|      |       |         |
|------|-------|---------|
| Per. | 27.55 | in.     |
| WT.  | 2.19  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



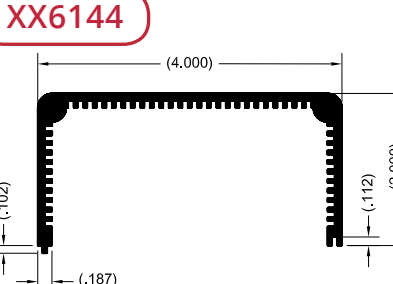
|      |       |         |
|------|-------|---------|
| Per. | 28.91 | in.     |
| WT.  | 2.18  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



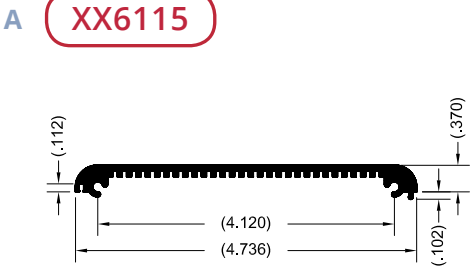
|      |       |         |
|------|-------|---------|
| Per. | 41.54 | in.     |
| WT.  | 2.57  | lb/ft   |
| θsa  | 1.70  | °C/w/3" |



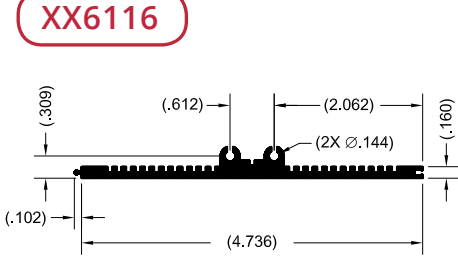
|      |       |         |
|------|-------|---------|
| Per. | 27.55 | in.     |
| WT.  | 1.92  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



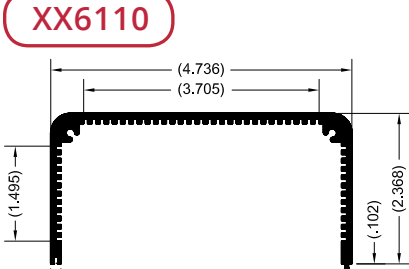
|      |       |         |
|------|-------|---------|
| Per. | 24.66 | in.     |
| WT.  | 1.37  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |



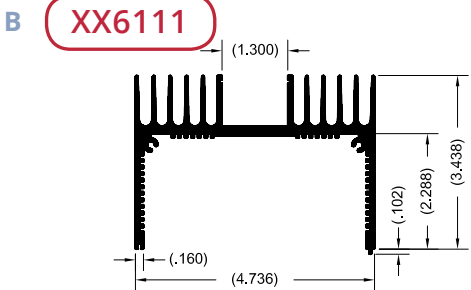
|      |       |         |
|------|-------|---------|
| Per. | 16.06 | in.     |
| WT.  | 0.87  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



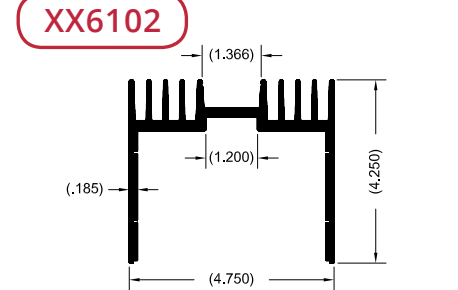
|      |       |         |
|------|-------|---------|
| Per. | 15.79 | in.     |
| WT.  | 0.90  | lb/ft   |
| θsa  | 3.10  | °C/w/3" |



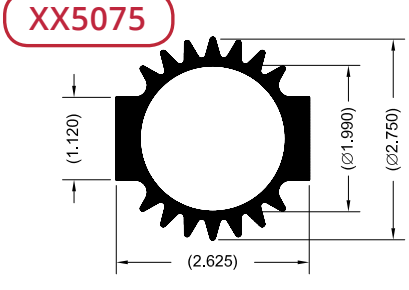
|      |       |         |
|------|-------|---------|
| Per. | 27.72 | in.     |
| WT.  | 1.50  | lb/ft   |
| θsa  | 2.00  | °C/w/3" |



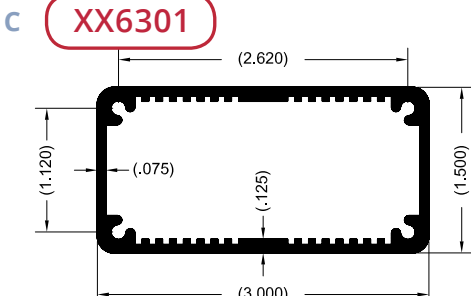
|      |       |         |
|------|-------|---------|
| Per. | 48.90 | in.     |
| WT.  | 2.95  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



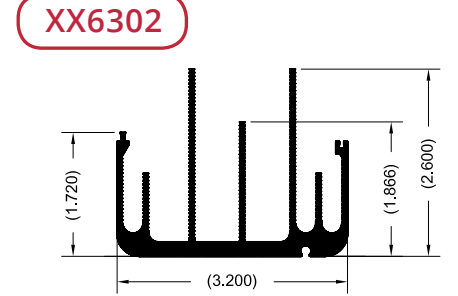
|      |       |         |
|------|-------|---------|
| Per. | 41.15 | in.     |
| WT.  | 3.79  | lb/ft   |
| θsa  | 1.90  | °C/w/3" |



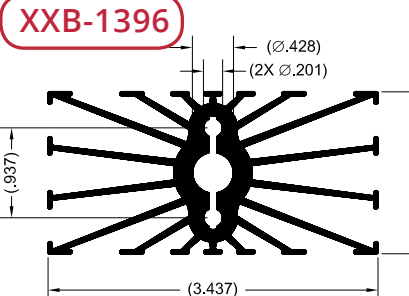
|      |       |         |
|------|-------|---------|
| Per. | 19.85 | in.     |
| WT.  | 2.14  | lb/ft   |
| θsa  | 3.90  | °C/w/3" |



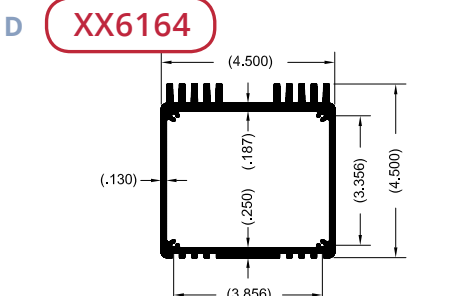
|      |       |         |
|------|-------|---------|
| Per. | 21.07 | in.     |
| WT.  | 0.90  | lb/ft   |
| θsa  | 3.50  | °C/w/3" |



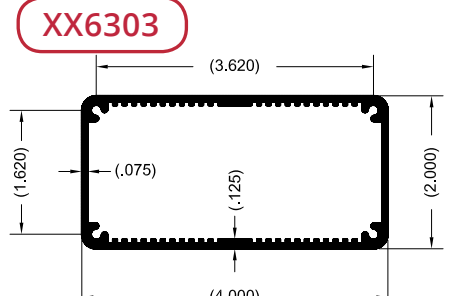
|      |       |         |
|------|-------|---------|
| Per. | 31.61 | in.     |
| WT.  | 1.75  | lb/ft   |
| θsa  | 2.02  | °C/w/3" |



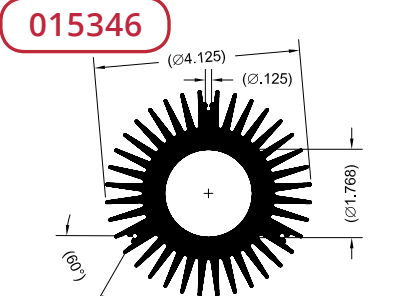
|      |       |         |
|------|-------|---------|
| Per. | 41.34 | in.     |
| WT.  | 1.75  | lb/ft   |
| θsa  | 2.20  | °C/w/3" |



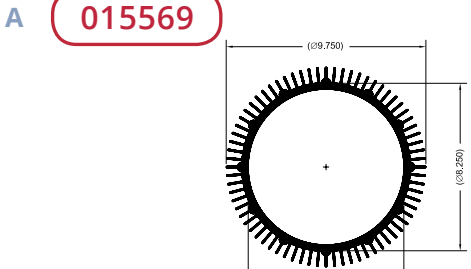
|      |       |         |
|------|-------|---------|
| Per. | 45.33 | in.     |
| WT.  | 4.26  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



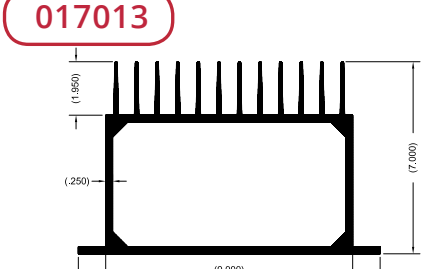
|      |       |         |
|------|-------|---------|
| Per. | 28.62 | in.     |
| WT.  | 1.40  | lb/ft   |
| θsa  | 3.90  | °C/w/3" |



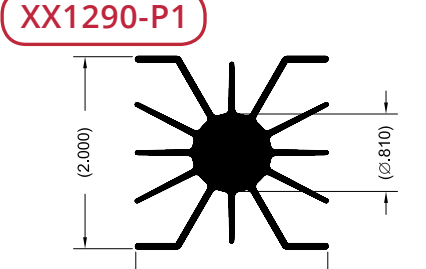
|      |       |         |
|------|-------|---------|
| Per. | 62.02 | in.     |
| WT.  | 6.47  | lb/ft   |
| θsa  | 1.60  | °C/w/3" |



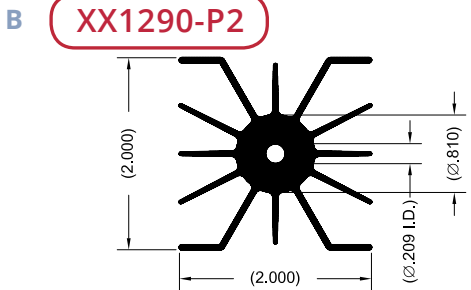
|      |        |         |
|------|--------|---------|
| Per. | 153.16 | in.     |
| WT.  | 15.66  | lb/ft   |
| θsa  | 0.90   | °C/w/3" |



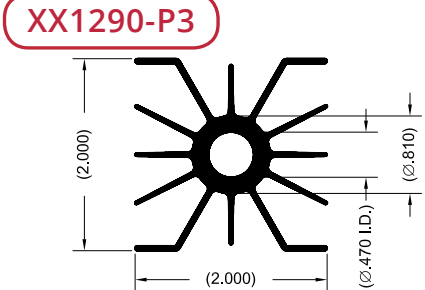
|      |        |         |
|------|--------|---------|
| Per. | 101.85 | in.     |
| WT.  | 12.90  | lb/ft   |
| θsa  | 0.95   | °C/w/3" |



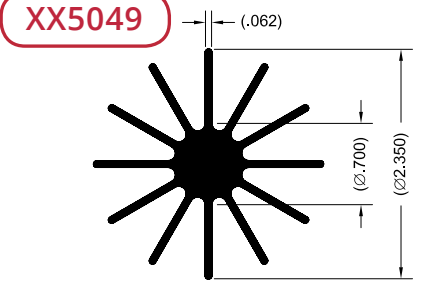
|      |       |         |
|------|-------|---------|
| Per. | 23.00 | in.     |
| WT.  | 0.97  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



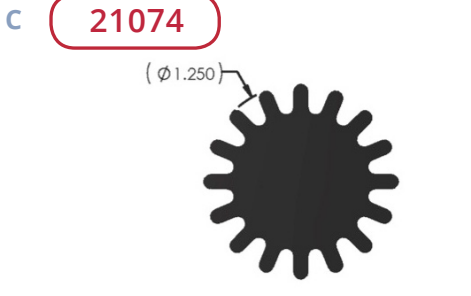
|      |       |         |
|------|-------|---------|
| Per. | 23.18 | in.     |
| WT.  | 0.93  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



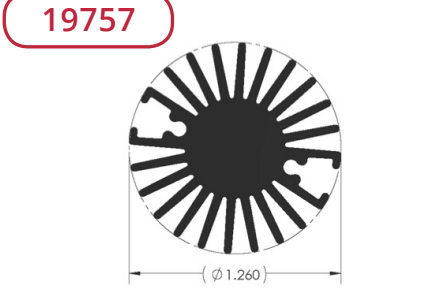
|      |       |         |
|------|-------|---------|
| Per. | 23.98 | in.     |
| WT.  | 0.77  | lb/ft   |
| θsa  | 2.50  | °C/w/3" |



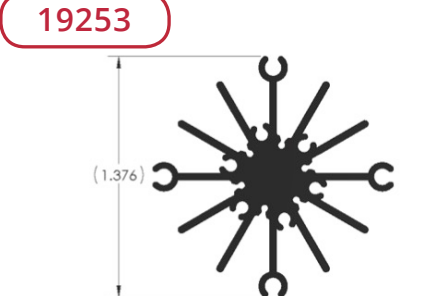
|      |       |         |
|------|-------|---------|
| Per. | 21.17 | in.     |
| WT.  | 1.22  | lb/ft   |
| θsa  | 2.10  | °C/w/3" |



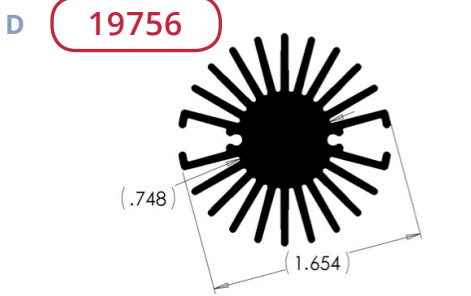
|      |      |         |
|------|------|---------|
| Per. | 7.72 | in.     |
| WT.  | 1.05 | lb/ft   |
| θsa  | 9.06 | °C/w/3" |



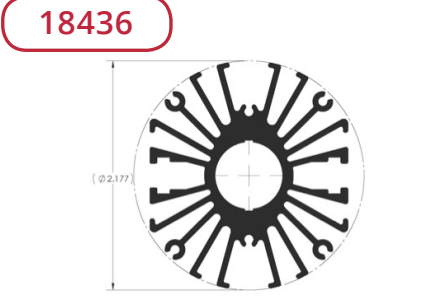
|      |       |         |
|------|-------|---------|
| Per. | 16.29 | in.     |
| WT.  | 0.76  | lb/ft   |
| θsa  | 4.29  | °C/w/3" |



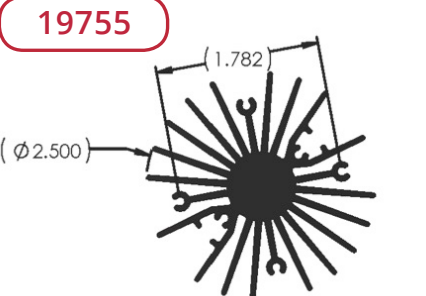
|      |       |         |
|------|-------|---------|
| Per. | 14.08 | in.     |
| WT.  | 0.45  | lb/ft   |
| θsa  | 4.97  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 22.20 | in.     |
| WT.  | 1.21  | lb/ft   |
| θsa  | 3.15  | °C/w/3" |

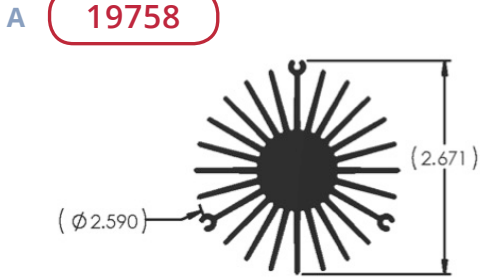


|      |       |         |
|------|-------|---------|
| Per. | 32.13 | in.     |
| WT.  | 1.35  | lb/ft   |
| θsa  | 2.18  | °C/w/3" |

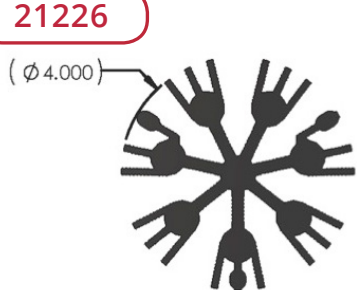


|      |       |         |
|------|-------|---------|
| Per. | 39.98 | in.     |
| WT.  | 1.97  | lb/ft   |
| θsa  | 1.75  | °C/w/3" |

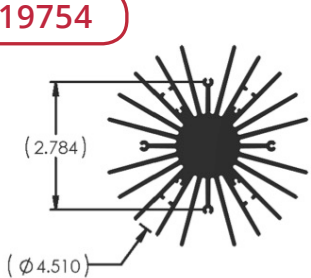




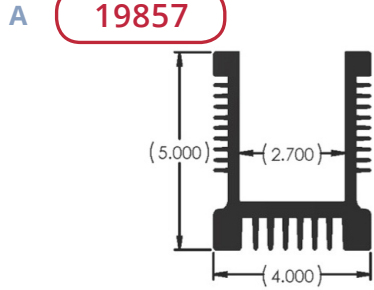
|      |       |         |
|------|-------|---------|
| Per. | 41.59 | in.     |
| WT.  | 2.39  | lb/ft   |
| θsa  | 1.68  | °C/w/3" |



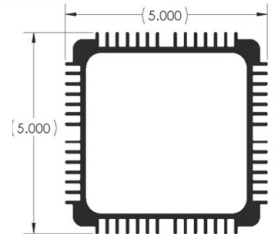
|      |       |         |
|------|-------|---------|
| Per. | 47.15 | in.     |
| WT.  | 5.64  | lb/ft   |
| θsa  | 1.48  | °C/w/3" |



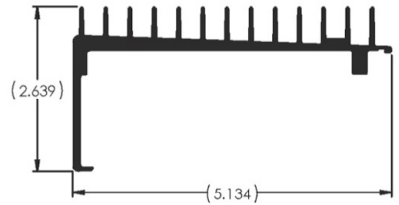
|      |       |         |
|------|-------|---------|
| Per. | 72.55 | in.     |
| WT.  | 5.02  | lb/ft   |
| θsa  | 0.96  | °C/w/3" |



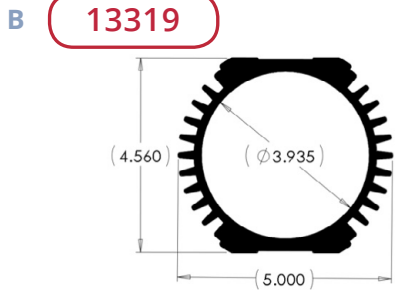
|      |       |         |
|------|-------|---------|
| Per. | 49.06 | in.     |
| WT.  | 7.54  | lb/ft   |
| θsa  | 1.43  | °C/w/3" |



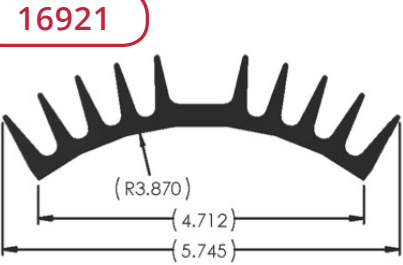
|      |       |         |
|------|-------|---------|
| Per. | 70.99 | in.     |
| WT.  | 4.96  | lb/ft   |
| θsa  | 0.98  | °C/w/3" |



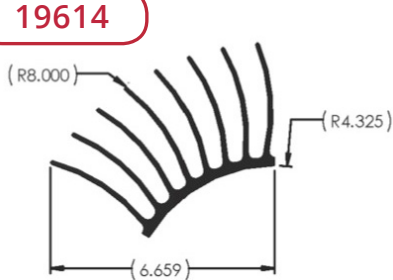
|      |       |         |
|------|-------|---------|
| Per. | 28.46 | in.     |
| WT.  | 2.04  | lb/ft   |
| θsa  | 2.46  | °C/w/3" |



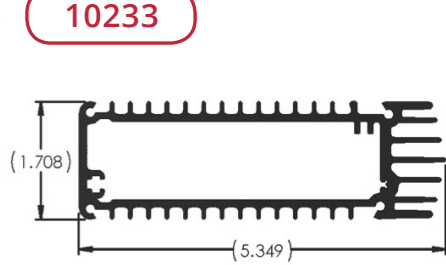
|      |       |         |
|------|-------|---------|
| Per. | 39.94 | in.     |
| WT.  | 5.90  | lb/ft   |
| θsa  | 1.75  | °C/w/3" |



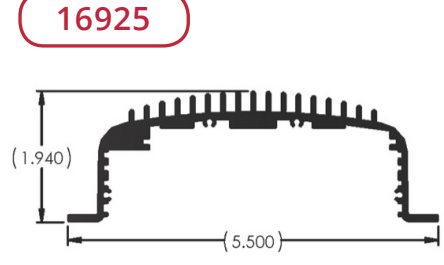
|      |       |         |
|------|-------|---------|
| Per. | 25.10 | in.     |
| WT.  | 2.93  | lb/ft   |
| θsa  | 2.79  | °C/w/3" |



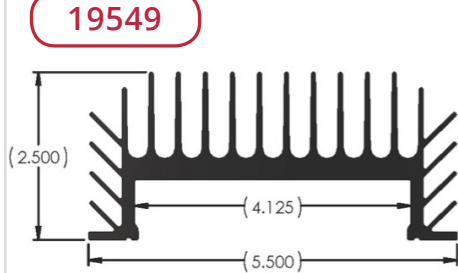
|      |       |         |
|------|-------|---------|
| Per. | 63.45 | in.     |
| WT.  | 6.04  | lb/ft   |
| θsa  | 1.10  | °C/w/3" |



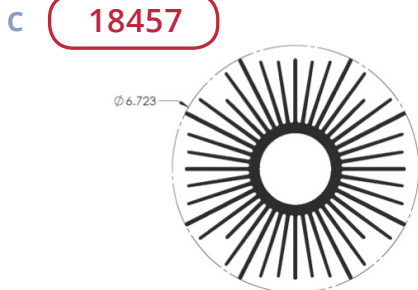
|      |       |         |
|------|-------|---------|
| Per. | 43.52 | in.     |
| WT.  | 2.58  | lb/ft   |
| θsa  | 1.61  | °C/w/3" |



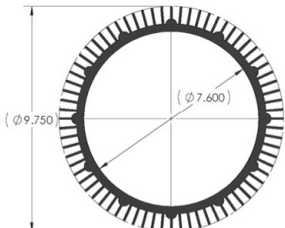
|      |       |         |
|------|-------|---------|
| Per. | 27.11 | in.     |
| WT.  | 1.92  | lb/ft   |
| θsa  | 2.58  | °C/w/3" |



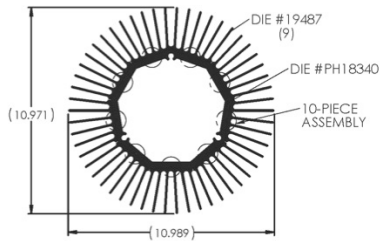
|      |       |         |
|------|-------|---------|
| Per. | 52.62 | in.     |
| WT.  | 4.17  | lb/ft   |
| θsa  | 1.33  | °C/w/3" |



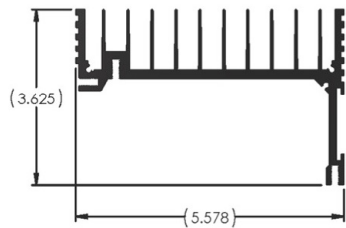
|      |        |         |
|------|--------|---------|
| Per. | 158.40 | in.     |
| WT.  | 9.37   | lb/ft   |
| θsa  | 0.44   | °C/w/3" |



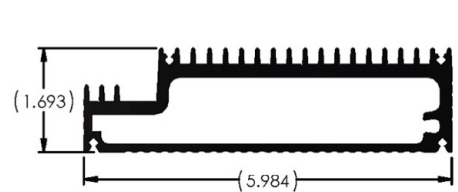
|      |        |         |
|------|--------|---------|
| Per. | 153.13 | in.     |
| WT.  | 15.66  | lb/ft   |
| θsa  | 0.46   | °C/w/3" |



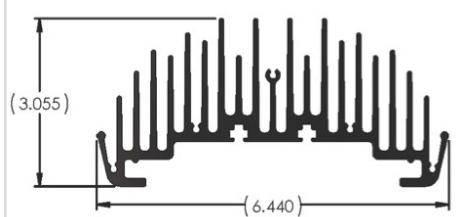
|      |        |         |
|------|--------|---------|
| Per. | 311.01 | in.     |
| WT.  | 25.59  | lb/ft   |
| θsa  | 0.22   | °C/w/3" |



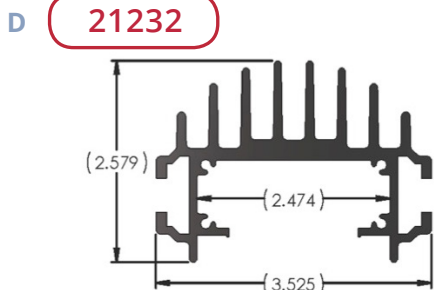
|      |       |         |
|------|-------|---------|
| Per. | 51.00 | in.     |
| WT.  | 3.38  | lb/ft   |
| θsa  | 1.37  | °C/w/3" |



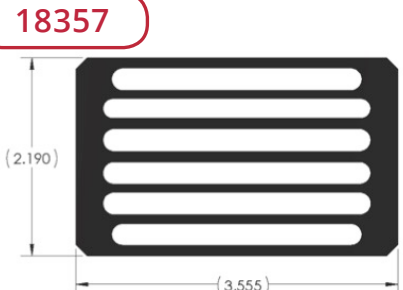
|      |       |         |
|------|-------|---------|
| Per. | 40.28 | in.     |
| WT.  | 3.43  | lb/ft   |
| θsa  | 1.74  | °C/w/3" |



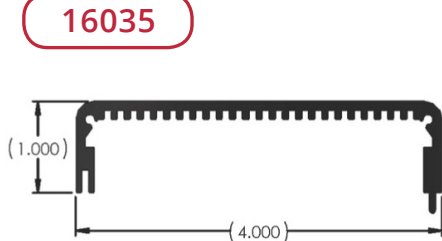
|      |       |         |
|------|-------|---------|
| Per. | 78.90 | in.     |
| WT.  | 5.55  | lb/ft   |
| θsa  | 0.89  | °C/w/3" |



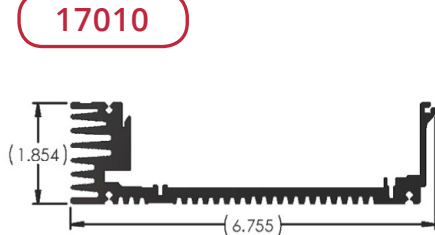
|      |       |         |
|------|-------|---------|
| Per. | 30.59 | in.     |
| WT.  | 2.33  | lb/ft   |
| θsa  | 2.29  | °C/w/3" |



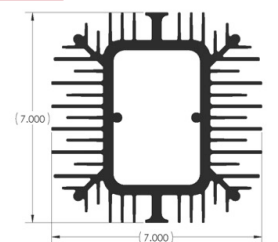
|      |       |         |
|------|-------|---------|
| Per. | 47.69 | in.     |
| WT.  | 4.25  | lb/ft   |
| θsa  | 1.47  | °C/w/3" |



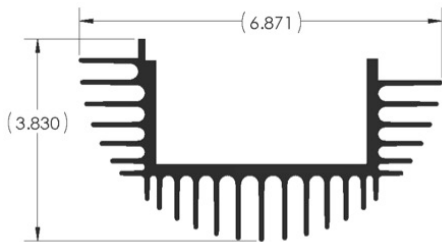
|      |       |         |
|------|-------|---------|
| Per. | 17.40 | in.     |
| WT.  | 1.05  | lb/ft   |
| θsa  | 4.02  | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 39.79 | in.     |
| WT.  | 3.31  | lb/ft   |
| θsa  | 1.76  | °C/w/3" |



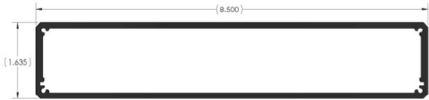
|      |        |         |
|------|--------|---------|
| Per. | 139.00 | in.     |
| WT.  | 13.95  | lb/ft   |
| θsa  | 0.50   | °C/w/3" |



|      |       |         |
|------|-------|---------|
| Per. | 61.60 | in.     |
| WT.  | 4.60  | lb/ft   |
| θsa  | 1.14  | °C/w/3" |

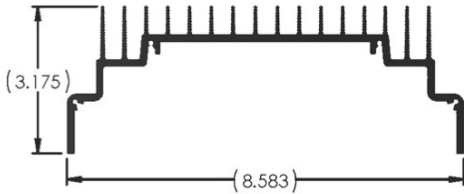
A

18395



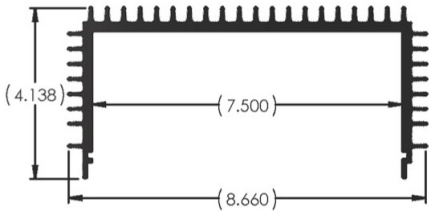
|      |       |         |
|------|-------|---------|
| Per. | 40.24 | in.     |
| WT.  | 2.94  | lb/ft   |
| θsa  | 1.74  | °C/w/3" |

16517



|      |       |         |
|------|-------|---------|
| Per. | 52.66 | in.     |
| WT.  | 3.22  | lb/ft   |
| θsa  | 1.33  | °C/w/3" |

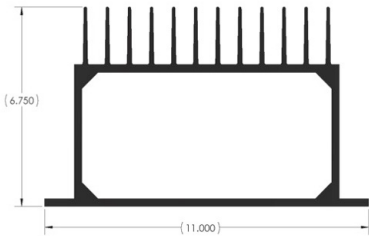
19384



|      |       |         |
|------|-------|---------|
| Per. | 68.16 | in.     |
| WT.  | 5.89  | lb/ft   |
| θsa  | 1.03  | °C/w/3" |

B

17013

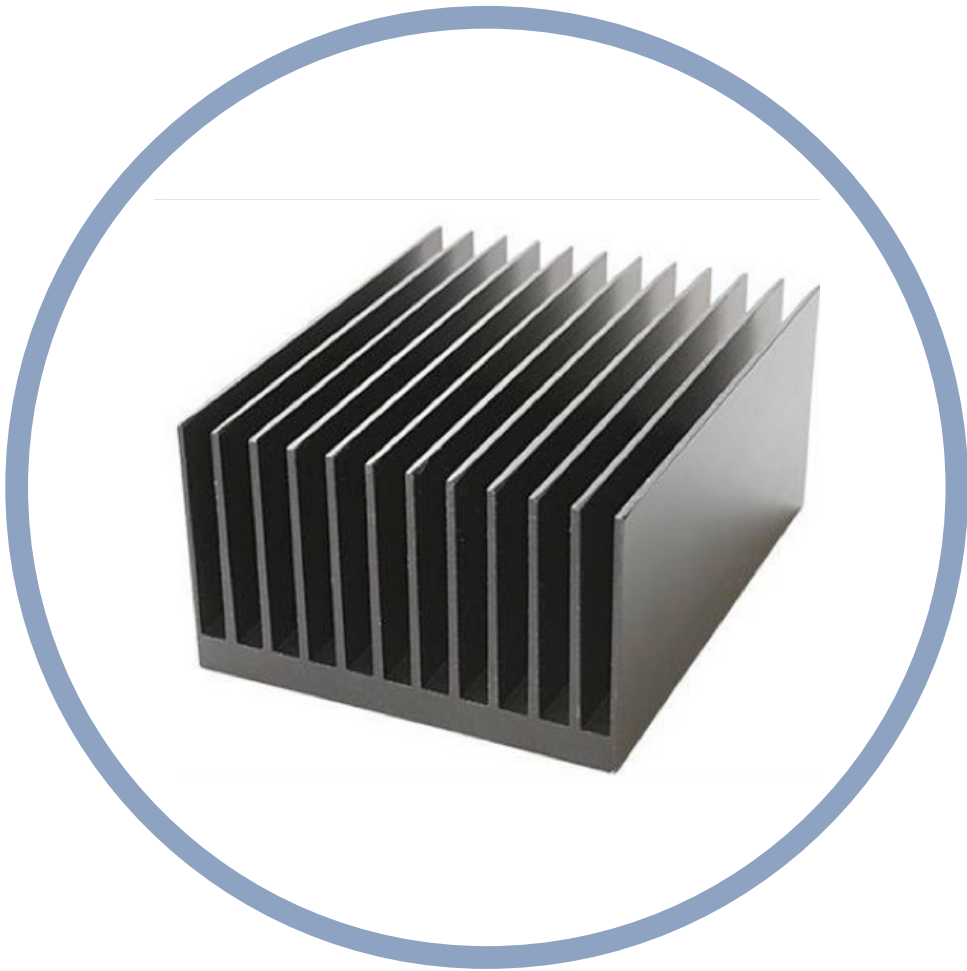


|      |        |         |
|------|--------|---------|
| Per. | 100.85 | in.     |
| WT.  | 12.75  | lb/ft   |
| θsa  | 0.69   | °C/w/3" |

# HIGH ASPECT RATIO THERMAL EXTRUSIONS

*12 Inch High Aspect Ratio Thermal Extrusions* ..... 280-285

*High Aspect Ratio Thermal Extrusions* ..... 286



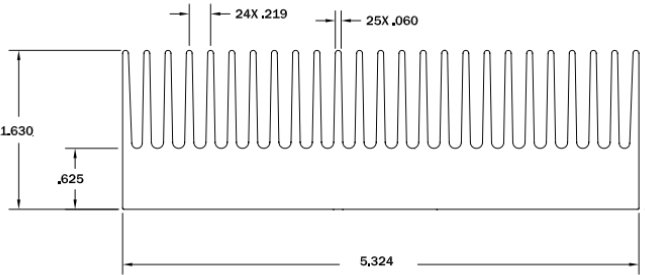
12 INCH HIGH ASPECT RATIO THERMAL EXTRUSIONS



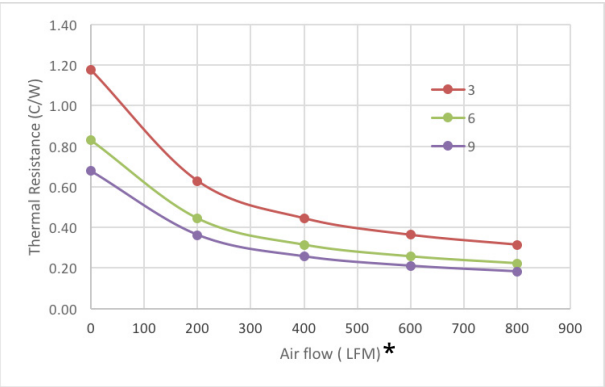
PART NUMBER 122254

**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 19671  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122254      | 19671 Profile Cut to 12 inches | 12     | 5.324  | 1.63   | 0.625        | 0.096       |



THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS

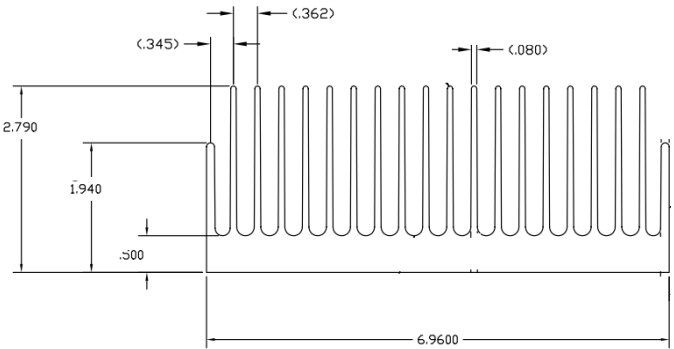


PART NUMBER 122255

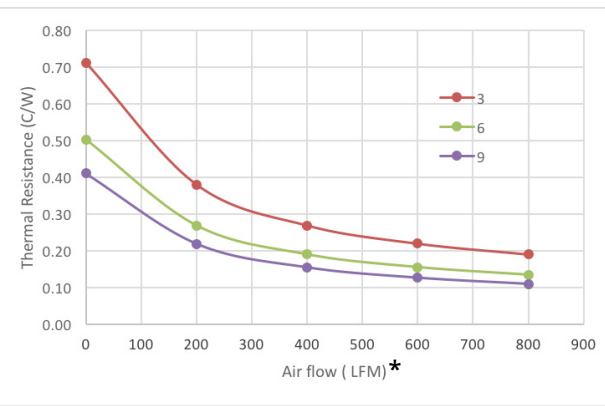


**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 13694  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122255      | 13694 Profile Cut to 12 inches | 12     | 6.96   | 2.79   | .05          | 0.1         |



THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS



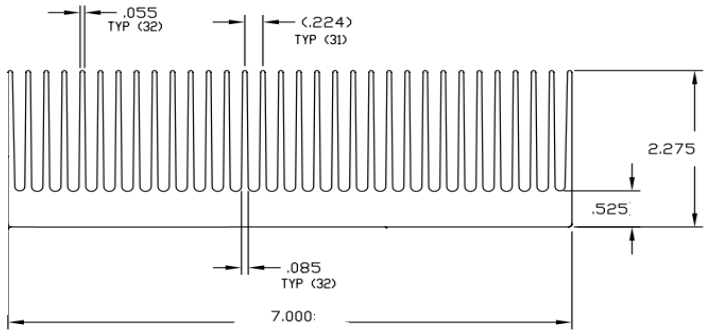
\*Thermal performance data is for reference only and may vary by application  
\*0 LFM represents a natural convection environment with a vertical heat sink  
\*All data is based on a fully distributed load on the base of the heat sink  
\*All forced convection data is based on an open duct configuration



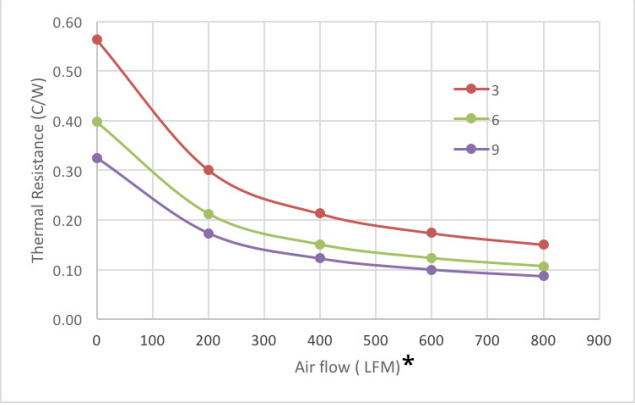
PART NUMBER 122256

**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 15837  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122256      | 15837 Profile Cut to 12 inches | 12     | 7      | 2.275  | 0.525        | 0.085       |



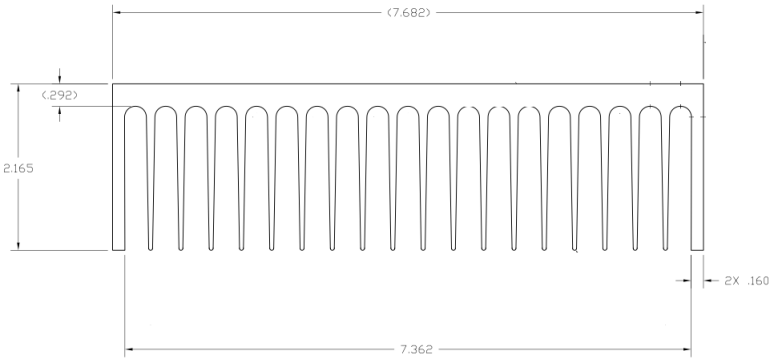
THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS



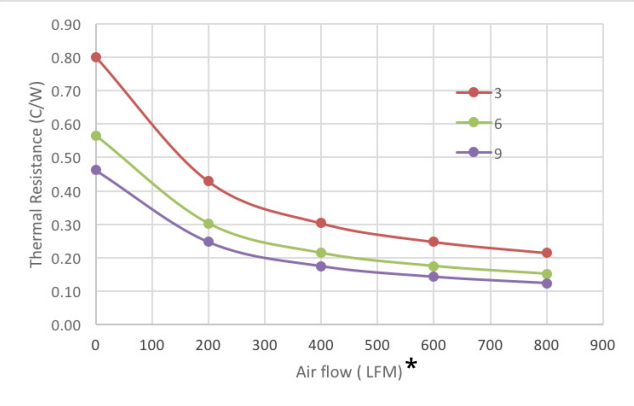
PART NUMBER 122257

**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 19275  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122257      | 19275 Profile Cut to 12 inches | 12     | 7.362  | 2.165  | 0.292        | 0.051       |



THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS



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\*0 LFM represents a natural convection environment with a vertical heat sink  
\*All data is based on a fully distributed load on the base of the heat sink  
\*All forced convection data is based on an open duct configuration



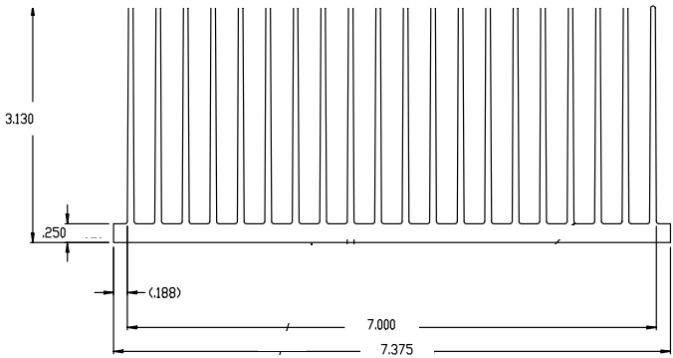
12 INCH HIGH ASPECT RATIO THERMAL EXTRUSIONS



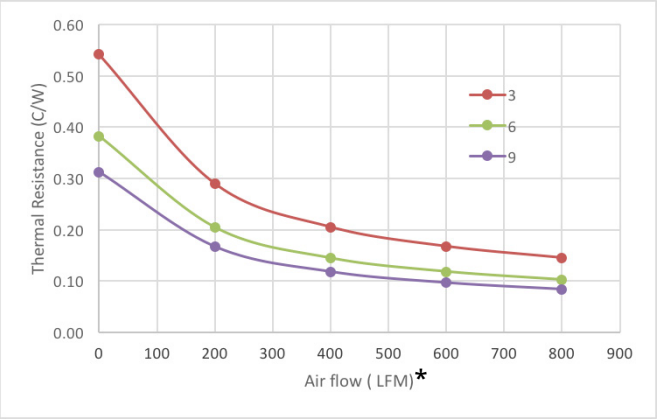
PART NUMBER 122258

**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 15817  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122258      | 15817 Profile Cut to 12 inches | 12     | 7.375  | 3.13   | 0.25         | 0.09        |



THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS

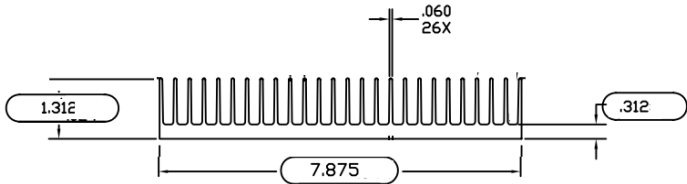


PART NUMBER 122259

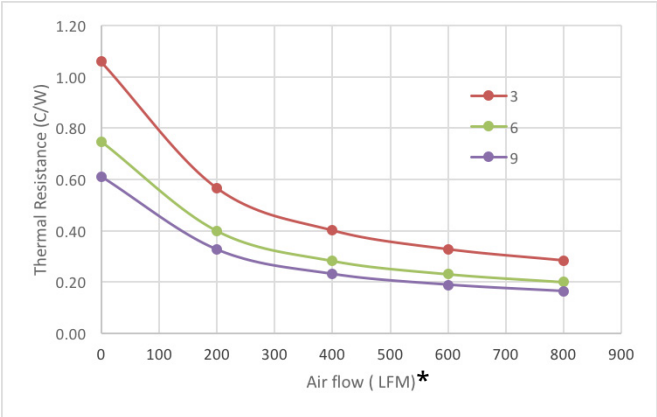


**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 16639  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122259      | 16639 Profile Cut to 12 inches | 12     | 7.875  | 1.312  | 0.312        | 0.08        |



THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS



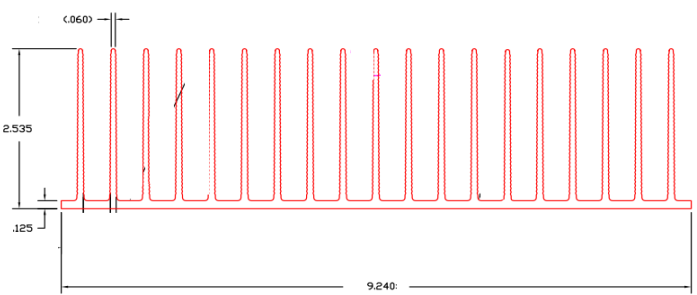
*\*Thermal performance data is for reference only and may vary by application*  
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*\*All forced convection data is based on an open duct configuration*



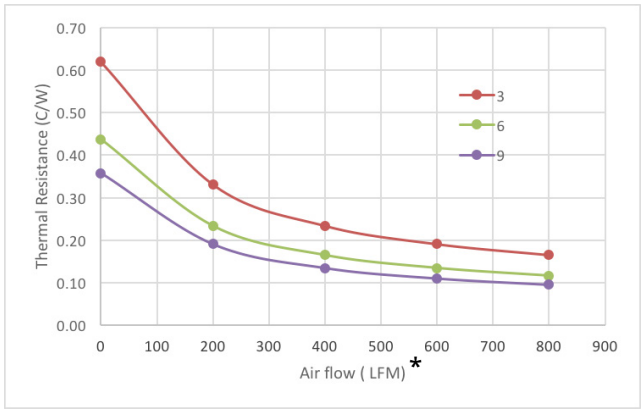
PART NUMBER 122260

**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 16639  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122260      | 16639 Profile Cut to 12 inches | 12     | 9.24   | 2.66   | 0.125        | 0.085       |



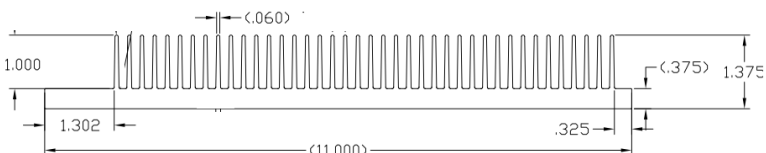
THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS



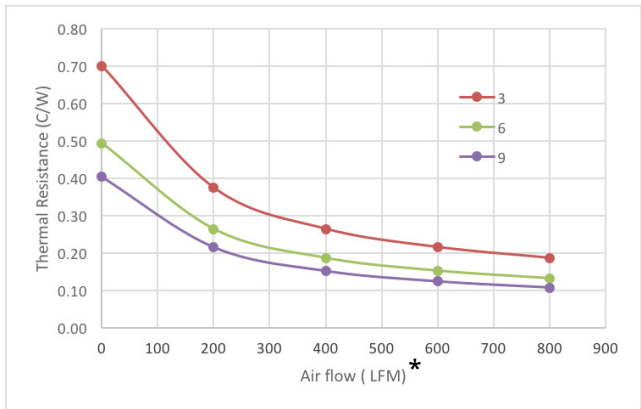
PART NUMBER 122261

**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 19584  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122261      | 19584 Profile Cut to 12 inches | 12     | 11     | 1.375  | 0.375        | 0.09        |



THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS



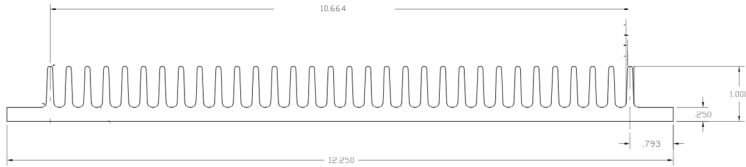
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*\*All forced convection data is based on an open duct configuration*

12 INCH HIGH ASPECT RATIO THERMAL EXTRUSIONS

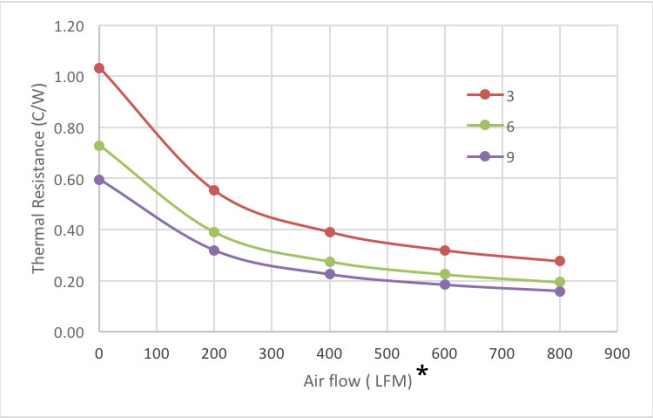


**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 19152  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122262      | 19152 Profile Cut to 12 inches | 12     | 12.25  | 1      | 0.25         | 0.146       |



THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS

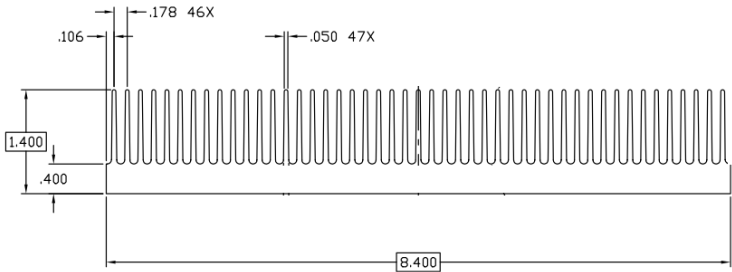


PART NUMBER 122263

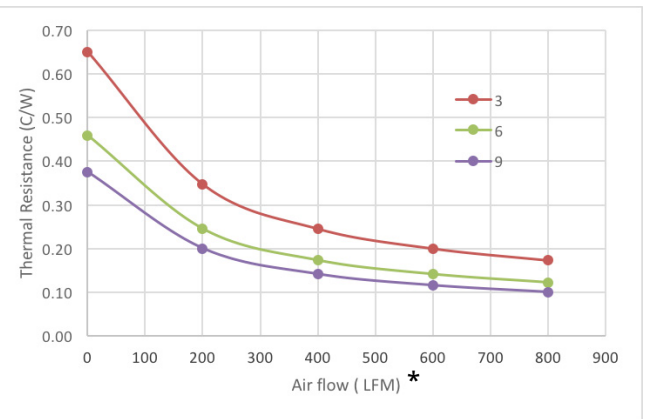


**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 16681  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122263      | 16681 Profile Cut to 12 inches | 12     | 8.4    | 1.4    | 0.4          | 0.5         |



THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS



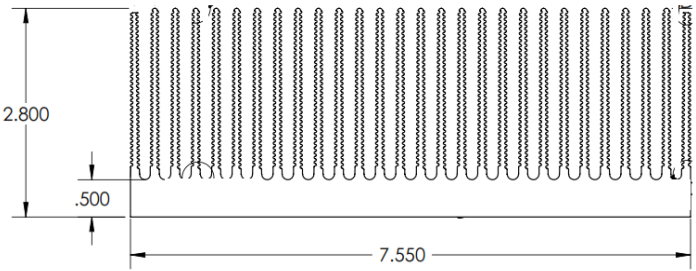
\*Thermal performance data is for reference only and may vary by application  
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\*All forced convection data is based on an open duct configuration



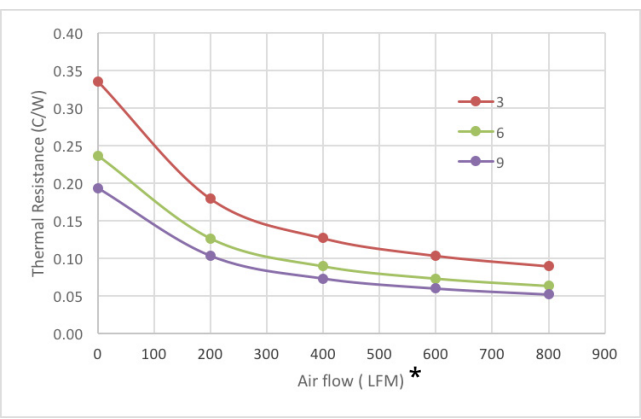
PART NUMBER 122264

**Material:** 6063 Aluminum  
**Description:** 12 Inch Cut Length of Extrusion Profile 19832  
Cut, Deburred, Washed  
No Finish

| Part Number | Description                    | Length | Inches |        |              |             |
|-------------|--------------------------------|--------|--------|--------|--------------|-------------|
|             |                                |        | Width  | Height | Avg Base Thk | Avg Fin Thk |
| 122264      | 19832 Profile Cut to 12 inches | 12     | 7.55   | 2.8    | 0.5          | 0.57        |



THERMAL RESISTANCE FOR 3", 6", 9" CUT LENGTHS



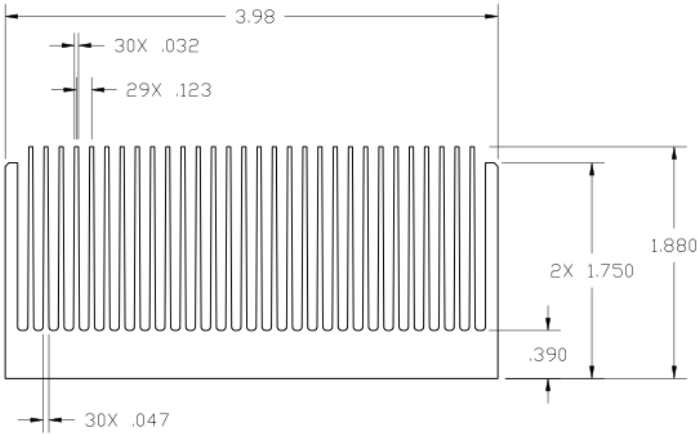
\*Thermal performance data is for reference only and may vary by application  
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\*All data is based on a fully distributed load on the base of the heat sink  
\*All forced convection data is based on an open duct configuration

HIGH ASPECT RATIO THERMAL EXTRUSIONS

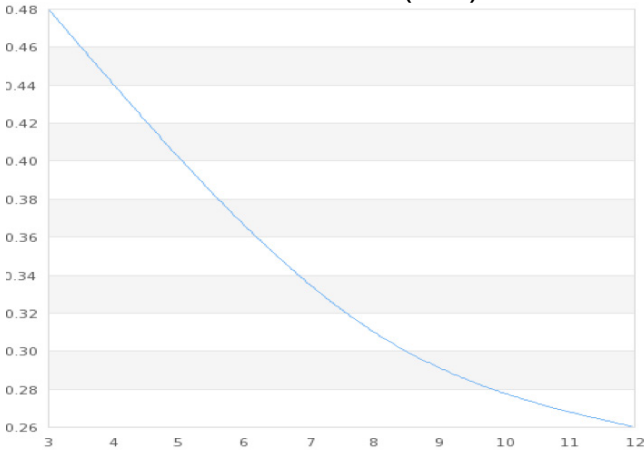


PART NUMBER 122547

| Part Number | Description                            | Inches |       |        |              |             |           | Weight<br>Per Piece | Natural Convection<br>(3 in.) |
|-------------|----------------------------------------|--------|-------|--------|--------------|-------------|-----------|---------------------|-------------------------------|
|             |                                        | Length | Width | Height | Avg Base Thk | Avg Fin Thk | Perimeter |                     |                               |
| 122547      | High Aspect Heat Sink for Power Module | 15.25  | 3.98  | 1.88   | 0.39         | 0.123       | 145       | 5.5                 | 0.48                          |



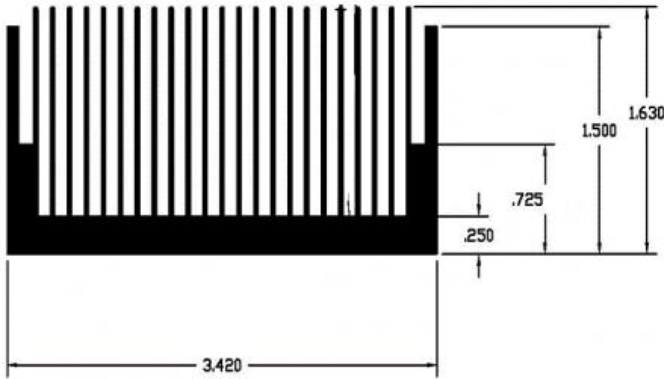
THERMAL RESISTANCE  
Natural Convection (°C/W)



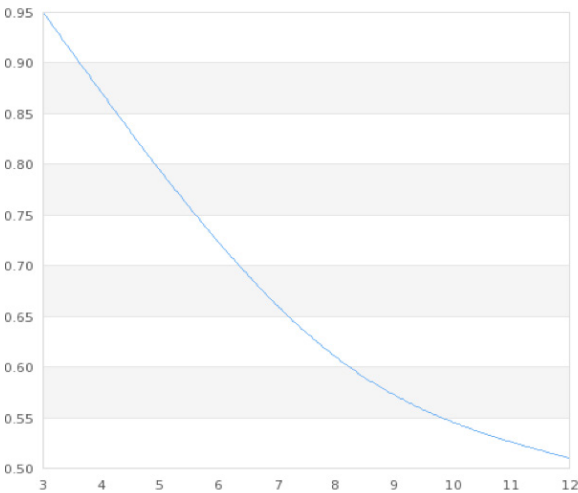
PART NUMBER 122551



| Part Number | Description                            | Inches |       |        |              |             |           | Weight<br>Per Piece | Natural Convection<br>(3 in.) |
|-------------|----------------------------------------|--------|-------|--------|--------------|-------------|-----------|---------------------|-------------------------------|
|             |                                        | Length | Width | Height | Avg Base Thk | Avg Fin Thk | Perimeter |                     |                               |
| 122551      | High Aspect Heat Sink for Power Module | 12.32  | 3.42  | 1.63   | 0.25         | 0.031       | 73.61     | 2.61                | 0.95                          |



THERMAL RESISTANCE  
Natural Convection (°C/W)



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\*All data is based on a fully distributed load on the base of the heat sink  
\*All forced convection data is based on an open duct configuration

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| 510-14U    | 100  |
| 510-3M     | 100  |
| 510-3U     | 100  |
| 510-6M     | 100  |
| 510-6U     | 100  |
| 510-9M     | 100  |
| 510-9U     | 100  |
| 511-U      | 100  |
| 511-M      | 100  |
| 511-12M    | 100  |
| 511-12U    | 100  |
| 511-3M     | 100  |
| 511-3U     | 100  |
| 511-6M     | 100  |
| 511-6U     | 100  |
| 511-9M     | 100  |
| 511-9U     | 100  |
| 512-U      | 100  |
| 512-M      | 100  |
| 512-12M    | 100  |
| 512-12U    | 100  |
| 512-3M     | 100  |
| 512-3U     | 100  |
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EXTRUDED ALUMINUM HEAT SINK PROFILES

Wakefield Engineering offers a wide variety of standard profiles. If an extrusion profile that meets your needs is not offered, consult the factory for additional profiles as they become available, alternatives or custom solutions. Six foot lengths are standard; however, other lengths are available.

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| 12382                   | 221        | C           |
| 12424                   | 185        | D           |
| 12405                   | 213        | D           |
| 12407                   | 194        | A           |
| 12447                   | 213        | B           |
| 12487                   | 195        | A           |
| 12540                   | 194        | A           |
| 12714                   | 222        | C           |
| 13068                   | 227        | C           |
| 13457                   | 202        | D           |
| 13505                   | 216        | B           |
| 14135                   | 176        | B           |
| 14187                   | 178        | B           |
| 14407                   | 219        | C           |
| 14419                   | 228        | C           |
| 14738                   | 172        | D           |
| 15037                   | 218        | D           |
| 15672                   | 186        | A           |
| 16335                   | 223        | C           |
| 16373                   | 224        | B           |
| 16486                   | 227        | D           |
| 16499                   | 201        | D           |
| 16758                   | 230        | A           |
| 16839                   | 183        | D           |
| 16919                   | 214        | D           |
| 17032                   | 214        | D           |
| 17047                   | 206        | C           |
| 17049                   | 205        | B           |
| 17080                   | 210        | A           |
| 17096                   | 231        | D           |
| 17118                   | 232        | A           |
| 19035                   | 229        | C           |
| 19036                   | 218        | A           |
| 19052                   | 227        | A           |
| 19081                   | 235        | A           |
| 19082                   | 235        | A           |
| 19113                   | 225        | B           |
| 19155                   | 218        | C           |
| 19197                   | 200        | D           |
| 19249                   | 209        | D           |
| 19273                   | 225        | D           |
| 19275                   | 226        | D           |
| 19260                   | 216        | A           |
| 19333                   | 223        | C           |
| 19341                   | 220        | A           |
| 19343                   | 219        | B           |
| 19350                   | 218        | B           |
| 19353                   | 207        | C           |
| 19403                   | 233        | B           |
| 19407                   | 184        | C           |
| 19409                   | 210        | D           |
| 19457                   | 205        | D           |
| 19492                   | 203        | C           |
| 19493                   | 224        | B           |
| 19529                   | 206        | A           |
| 19535                   | 226        | B           |
| 19536                   | 225        | A           |
| 19539                   | 214        | A           |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| 19572                   | 232        | B           |
| 19584                   | 232        | D           |
| 19596                   | 223        | A           |
| 19608                   | 232        | C           |
| 19671                   | 217        | B           |
| 19679                   | 222        | C           |
| 19694                   | 207        | D           |
| 19700                   | 226        | D           |
| 19707                   | 227        | B           |
| PH18403                 | 227        | B           |
| 19721                   | 226        | B           |
| 19740                   | 233        | B           |
| 19768                   | 215        | C           |
| 19772                   | 229        | B           |
| 19787                   | 210        | C           |
| 19791                   | 229        | C           |
| 19803                   | 194        | D           |
| 19810                   | 217        | D           |
| 19832                   | 226        | C           |
| 19839                   | 228        | B           |
| 19843                   | 203        | D           |
| 19864                   | 220        | A           |
| 19902                   | 227        | C           |
| 21052                   | 230        | D           |
| 21081                   | 222        | D           |
| 21105                   | 212        | C           |
| 21107                   | 221        | C           |
| 21117                   | 197        | D           |
| 21139                   | 212        | D           |
| 21153                   | 213        | A           |
| 21257                   | 219        | C           |
| 21265                   | 230        | C           |
| 21295                   | 205        | A           |
| 21408                   | 226        | A           |
| 21848                   | 221        | B           |
| 21884                   | 189        | C           |
| 82266                   | 233        | A           |
| 002853                  | 206        | B           |
| 002981                  | 219        | C           |
| 003385                  | 221        | C           |
| 003413                  | 183        | B           |
| 003676                  | 221        | B           |
| 003942                  | 185        | C           |
| 004506                  | 187        | B           |
| 005329                  | 179        | A           |
| 005355                  | 197        | C           |
| 005473                  | 197        | A           |
| 006369                  | 224        | C           |
| 006513                  | 173        | B           |
| 006606                  | 179        | C           |
| 006663                  | 224        | D           |
| 006664                  | 221        | D           |
| 006872                  | 215        | B           |
| 007264                  | 216        | C           |
| 007541                  | 197        | A           |
| 007657                  | 221        | C           |
| 008469                  | 215        | B           |
| 008563                  | 214        | C           |
| 008658                  | 208        | A           |
| 008702                  | 186        | C           |

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|-------------------------|------------|-------------|
| 008842                  | 181        | C           |
| 009099                  | 199        | C           |
| 009168                  | 208        | D           |
| 009239                  | 189        | C           |
| 009396                  | 208        | B           |
| 009797                  | 204        | A           |
| 010248                  | 218        | D           |
| 010313                  | 180        | A           |
| 010785                  | 208        | B           |
| 010818                  | 196        | A           |
| 010979                  | 175        | D           |
| 010980                  | 187        | D           |
| 010998                  | 210        | C           |
| 011005                  | 213        | C           |
| 011077                  | 204        | D           |
| 011173                  | 174        | B           |
| 011175                  | 198        | A           |
| 011238                  | 201        | D           |
| 011296                  | 175        | D           |
| 011299                  | 208        | A           |
| 011381                  | 178        | A           |
| 011422                  | 199        | B           |
| 011423                  | 199        | B           |
| 011424                  | 178        | A           |
| 011425                  | 220        | D           |
| 011447                  | 190        | C           |
| 011448                  | 186        | B           |
| 011457                  | 203        | A           |
| 011465                  | 186        | D           |
| 011485                  | 177        | D           |
| 011492                  | 183        | B           |
| 011498                  | 183        | B           |
| 011738                  | 192        | B           |
| 011740                  | 188        | C           |
| 011741                  | 185        | B           |
| 011743                  | 219        | D           |
| 011758                  | 204        | D           |
| 011820                  | 192        | A           |
| 011838                  | 199        | D           |
| 011880                  | 191        | B           |
| 011890                  | 194        | C           |
| 011891                  | 193        | D           |
| 011927                  | 180        | D           |
| 011939                  | 173        | D           |
| 011940                  | 174        | A           |
| 011941                  | 174        | A           |
| 011942                  | 213        | D           |
| 011944                  | 211        | D           |
| 011975                  | 200        | B           |
| 012021                  | 196        | C           |
| 012054                  | 220        | B           |
| 012061                  | 214        | A           |
| 012062                  | 181        | B           |
| 012096                  | 201        | A           |
| 012098                  | 215        | D           |
| 012103                  | 189        | B           |
| 012106                  | 187        | D           |
| 012108                  | 204        | B           |
| 012110                  | 185        | C           |
| 012116                  | 223        | B           |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| 012148                  | 181        | C           |
| 012165                  | 193        | C           |
| 012166                  | 205        | D           |
| 012174                  | 193        | B           |
| 012182                  | 188        | B           |
| 012226                  | 200        | A           |
| 012228                  | 182        | A           |
| 012234                  | 173        | D           |
| 012235                  | 172        | B           |
| 012242                  | 188        | C           |
| 012246                  | 186        | A           |
| 012331                  | 216        | C           |
| 012334                  | 185        | D           |
| 012388                  | 183        | D           |
| 012395                  | 225        | B           |
| 012396                  | 205        | B           |
| 012397                  | 210        | A           |
| 012401                  | 193        | D           |
| 012406                  | 193        | C           |
| 012414                  | 225        | A           |
| 012416                  | 184        | D           |
| 012423                  | 204        | C           |
| 012443                  | 203        | B           |
| 012464                  | 219        | D           |
| 012489                  | 193        | A           |
| 012504                  | 226        | B           |
| 012517                  | 173        | C           |
| 012518                  | 202        | A           |
| 012575                  | 215        | A           |
| 012580                  | 184        | D           |
| 012584                  | 183        | C           |
| 012613                  | 194        | B           |
| 012614                  | 212        | B           |
| 012646                  | 181        | B           |
| 012661                  | 194        | C           |
| 012671                  | 218        | C           |
| 012677                  | 209        | A           |
| 012680                  | 202        | B           |
| 012693                  | 221        | A           |
| 012696                  | 207        | D           |
| 012704                  | 181        | C           |
| 012712                  | 188        | B           |
| 012749                  | 210        | B           |
| 012777                  | 212        | B           |
| 012823                  | 212        | A           |
| 012843                  | 226        | C           |
| 012879                  | 193        | D           |
| 012894                  | 211        | A           |
| 012904                  | 174        | A           |
| 012914                  | 199        | A           |
| 012918                  | 212        | C           |
| 012932                  | 205        | C           |
| 012947                  | 200        | B           |
| 012987                  | 211        | C           |
| 012988                  | 198        | B           |
| 012989                  | 199        | A           |
| 012990                  | 182        | A           |
| 013000                  | 201        | B           |
| 013017                  | 190        | D           |
| 013068                  | 227        | C           |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| 013075                  | 187        | C           |
| 013096                  | 211        | A           |
| 013098                  | 192        | D           |
| 013099                  | 211        | A           |
| 013100                  | 192        | C           |
| 013101                  | 192        | D           |
| 013102                  | 192        | C           |
| 013141                  | 194        | D           |
| 013143                  | 205        | D           |
| 013151                  | 186        | B           |
| 013156                  | 196        | B           |
| 013158                  | 183        | C           |
| 013203                  | 212        | D           |
| 013205                  | 186        | D           |
| 013206                  | 186        | D           |
| 013208                  | 187        | A           |
| 013210                  | 187        | D           |
| 013211                  | 190        | A           |
| 013212                  | 190        | A           |
| 013213                  | 190        | B           |
| 013215                  | 199        | C           |
| 013224                  | 214        | B           |
| 013237                  | 219        | A           |
| 013254                  | 172        | B           |
| 013260                  | 192        | C           |
| 013266                  | 221        | D           |
| 013277                  | 220        | C           |
| 013293                  | 202        | B           |
| 013295                  | 182        | B           |
| 013512                  | 220        | D           |
| 013513                  | 188        | D           |
| 013521                  | 182        | B           |
| 013532                  | 218        | D           |
| 013542                  | 204        | C           |
| 013564                  | 209        | D           |
| 013568                  | 175        | D           |
| 013569                  | 206        | C           |
| 013570                  | 216        | D           |
| 013583                  | 214        | D           |
| 013597                  | 225        | C           |
| 013599                  | 179        | D           |
| 013601                  | 219        | B           |
| 013605                  | 207        | A           |
| 013607                  | 175        | C           |
| 013618                  | 212        | A           |
| 013621                  | 222        | B           |
| 013636                  | 200        | A           |
| 013647                  | 189        | A           |
| 013659                  | 222        | D           |
| 013664                  | 213        | B           |
| 013670                  | 190        | B           |
| 013673                  | 176        | B           |
| 013677                  | 225        | D           |
| 013685                  | 199        | C           |
| 013716                  | 212        | A           |
| 013717                  | 212        | B           |
| 013719                  | 196        | C           |
| 013721                  | 199        | A           |
| 013729                  | 209        | B           |
| 013733                  | 208        | C           |
| 013750                  | 196        | D           |
| 013756                  | 210        | D           |
| 013757                  | 229        | D           |
| 013772                  | 234        | C           |
| 013796                  | 220        | A           |
| 013849                  | 230        | C           |
| 013929                  | 225        | B           |
| 013953                  | 230        | D           |
| 014085                  | 227        | B           |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| 014113                  | 225        | D           |
| 014235                  | 189        | A           |
| 014236                  | 231        | B           |
| 014240                  | 174        | B           |
| 014243                  | 196        | B           |
| 014249                  | 189        | C           |
| 014262                  | 202        | A           |
| 014269                  | 195        | B           |
| 014284                  | 204        | B           |
| 014291                  | 196        | B           |
| 014306                  | 224        | C           |
| 014320                  | 213        | A           |
| 014326                  | 195        | A           |
| 014338                  | 176        | D           |
| 014359                  | 178        | D           |
| 014360                  | 191        | C           |
| 014361                  | 178        | B           |
| 014362                  | 191        | D           |
| 014363                  | 178        | B           |
| 014364                  | 192        | B           |
| 014367                  | 203        | B           |
| 014373                  | 194        | B           |
| 014374                  | 185        | C           |
| 014401                  | 224        | D           |
| 014418                  | 191        | A           |
| 014427                  | 194        | B           |
| 014432                  | 187        | D           |
| 014462                  | 219        | B           |
| 014468                  | 226        | A           |
| 014476                  | 188        | A           |
| 014701                  | 194        | D           |
| 014702                  | 196        | C           |
| 014727                  | 187        | B           |
| 014746                  | 222        | D           |
| 014757                  | 224        | C           |
| 014762                  | 195        | D           |
| 014769                  | 179        | A           |
| 014770                  | 211        | D           |
| 014771                  | 191        | C           |
| 014772                  | 190        | C           |
| 014793                  | 209        | A           |
| 014801                  | 203        | A           |
| 014802                  | 189        | B           |
| 014803                  | 203        | A           |
| 014813                  | 208        | C           |
| 014815                  | 182        | C           |
| 014819                  | 190        | D           |
| 014837                  | 183        | D           |
| 014844                  | 202        | D           |
| 014850                  | 184        | C           |
| 014853                  | 201        | B           |
| 014854                  | 190        | C           |
| 014883                  | 179        | C           |
| 014960                  | 194        | C           |
| 014964                  | 194        | A           |
| 014965                  | 212        | D           |
| 014966                  | 202        | C           |
| 014970                  | 185        | D           |
| 014984                  | 216        | C           |
| 014987                  | 176        | A           |
| 015019                  | 204        | D           |
| 015045                  | 203        | C           |
| 015138                  | 213        | A           |
| 015145                  | 200        | D           |
| 015163                  | 184        | C           |
| 015172                  | 209        | C           |
| 015174                  | 210        | C           |
| 015184                  | 182        | C           |
| 015189                  | 228        | B           |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| 015231                  | 215        | B           |
| 015240                  | 200        | D           |
| 015273                  | 207        | C           |
| 015604                  | 193        | B           |
| 015611                  | 229        | A           |
| 015633                  | 223        | D           |
| 015672                  | 186        | A           |
| 015712                  | 211        | B           |
| 015745                  | 224        | A           |
| 015768                  | 178        | C           |
| 015769                  | 223        | B           |
| 015774                  | 230        | C           |
| 015785                  | 198        | D           |
| 015786                  | 190        | A           |
| 015837                  | 224        | B           |
| 015840                  | 217        | C           |
| 015854                  | 229        | C           |
| 015862                  | 221        | D           |
| 015878                  | 206        | B           |
| 015887                  | 217        | B           |
| 015888                  | 232        | C           |
| 015900                  | 201        | B           |
| 015901                  | 180        | B           |
| 015902                  | 195        | C           |
| 015906                  | 222        | C           |
| 015919                  | 179        | B           |
| 015920                  | 195        | B           |
| 015921                  | 187        | A           |
| 015936                  | 209        | B           |
| 015941                  | 195        | B           |
| 015943                  | 196        | A           |
| 015944                  | 176        | A           |
| 015945                  | 209        | C           |
| 015955                  | 189        | B           |
| 015960                  | 179        | A           |
| 015986                  | 198        | A           |
| 016001                  | 196        | A           |
| 016002                  | 175        | D           |
| 016003                  | 209        | B           |
| 016005                  | 198        | C           |
| 016010                  | 195        | C           |
| 016020                  | 173        | C           |
| 016046                  | 215        | D           |
| 016047                  | 207        | B           |
| 016048                  | 192        | A           |
| 016049                  | 216        | B           |
| 016051                  | 178        | D           |
| 016052                  | 191        | B           |
| 016053                  | 174        | B           |
| 016056                  | 201        | C           |
| 016060                  | 219        | A           |
| 016061                  | 206        | B           |
| 016062                  | 197        | D           |
| 016064                  | 202        | B           |
| 016066                  | 193        | A           |
| 016067                  | 190        | B           |
| 016069                  | 216        | B           |
| 016070                  | 220        | B           |
| 016071                  | 180        | D           |
| 016073                  | 197        | B           |
| 016109                  | 214        | C           |
| 016123                  | 213        | D           |
| 016133                  | 226        | C           |
| 016138                  | 218        | B           |
| 016140                  | 183        | A           |
| 016141                  | 197        | B           |
| 016149                  | 187        | C           |
| 016157                  | 176        | D           |
| 016160                  | 229        | A           |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| 014270                  | 239        | B           |
| 014714                  | 244        | B           |
| 015018                  | 244        | A           |
| 015935                  | 242        | D           |
| 015956                  | 244        | A           |
| 016036                  | 240        | B           |
| 016145                  | 239        | C           |
| 016313                  | 244        | D           |
| 016314                  | 243        | D           |
| 016345                  | 244        | D           |
| 016372                  | 243        | D           |
| 016465                  | 240        | C           |
| 016582                  | 242        | B           |
| XX0236                  | 242        | A           |
| XX1007                  | 238        | D           |
| XX1020                  | 241        | A           |
| XX10222                 | 238        | D           |
| XX1026                  | 243        | C           |
| XX1055                  | 242        | C           |
| XX1063                  | 239        | A           |
| XX1073                  | 244        | C           |
| XX1076                  | 244        | A           |
| XX1077                  | 244        | C           |
| XX1111                  | 240        | A           |
| XX1284                  | 239        | B           |
| XX1327                  | 243        | B           |
| XX1351                  | 241        | C           |
| XX1353                  | 239        | D           |
| XX1354                  | 239        | A           |
|                         |            |             |
| XX1371                  | 242        | D           |
| XX1409                  | 239        | C           |
| XX1452                  | 240        | B           |
| XX1453                  | 239        | B           |
| XX1459                  | 242        | D           |
| XX1502                  | 243        | C           |
| XX1546                  | 239        | D           |
| XX1551                  | 241        | C           |
| XX1552                  | 240        | C           |
| XX1881                  | 241        | D           |
| XX2058                  | 245        | A           |
| XX2558                  | 238        | C           |
| XX4306                  | 240        | D           |
| XX4319                  | 240        | D           |
| XX4425                  | 240        | A           |
| XX4502                  | 241        | A           |
| XX4562                  | 242        | A           |
| XX4563                  | 241        | D           |
| XX4618                  | 243        | A           |
| XX4670                  | 243        | B           |
| XX4671                  | 243        | C           |
| XX4721                  | 238        | D           |
| XX4753                  | 241        | B           |
| XX4865                  | 239        | C           |
| XX4920                  | 240        | C           |
| XX5036                  | 241        | B           |
| XX5052                  | 242        | B           |
| XX5057                  | 241        | C           |
| XX5061                  | 242        | B           |
| XX5166                  | 241        | B           |
| XX6520                  | 242        | A           |
| XX6980                  | 243        | A           |
| XX7013                  | 241        | D           |
| XX7019                  | 244        | D           |
| XX7045                  | 241        | A           |
| XX7051                  | 243        | A           |
| XX7057                  | 244        | C           |
| XX7070                  | 240        | B           |
| XX7134                  | 239        | D           |
|                         |            |             |

| Extrusion/<br>Heat Sink              | Pg.<br>No. | Row<br>Loc. |
|--------------------------------------|------------|-------------|
| XX7331                               | 243        | D           |
| XX8340                               | 242        | C           |
| XX8382                               | 240        | A           |
| XX9004                               | 242        | C           |
|                                      |            |             |
| MULTI CHANNEL                        |            |             |
| 04842                                | 246        | B           |
| 003230                               | 245        | D           |
| 003295                               | 245        | B           |
| 006412                               | 246        | D           |
| 007999                               | 246        | A           |
| 009146                               | 245        | C           |
| 014324                               | 247        | A           |
| 014967                               | 245        | A           |
| 016333                               | 247        | A           |
| 016503                               | 247        | C           |
| 016529                               | 246        | C           |
| 016679                               | 245        | C           |
| XX1112                               | 246        | B           |
| XX3002                               | 247        | A           |
| XX3012                               | 246        | D           |
| XX3013                               | 246        | D           |
| XX3017                               | 246        | C           |
| XX3022                               | 246        | C           |
| XX3047                               | 245        | C           |
| XX3050                               | 245        | D           |
| XX4617                               | 246        | B           |
| XX4643                               | 245        | D           |
| XX4645                               | 245        | B           |
| XX4917                               | 246        | A           |
| XX5060                               | 247        | B           |
| XX5541                               | 247        | B           |
| XX5959                               | 245        | B           |
| XX7055                               | 247        | C           |
| XX7084                               | 245        | A           |
| XX8182                               | 247        | B           |
| XX9014                               | 246        | A           |
|                                      |            |             |
|                                      |            |             |
| FLATBACK W/ INTER-GRAL MOUNTING FEET |            |             |
| 16493                                | 251        | C           |
| 16494                                | 251        | C           |
| 16770                                | 249        | D           |
| 17091                                | 252        | A           |
| 19404                                | 250        | C           |
| 19456                                | 248        | A           |
| 19834                                | 250        | D           |
| 000806                               | 250        | D           |
| 002756                               | 249        | B           |
| 006242                               | 251        | A           |
| 009238                               | 249        | D           |
| 013782                               | 251        | A           |
| 013838                               | 250        | B           |
| 013994                               | 250        | C           |
| 014214                               | 249        | A           |
| 014282                               | 251        | B           |
| 014285                               | 249        | B           |
| 014343                               | 247        | D           |
| 014344                               | 247        | D           |
| 014428                               | 249        | C           |
| 014712                               | 248        | A           |
| 014751                               | 248        | A           |
| 014820                               | 250        | A           |
| 014915                               | 250        | B           |
| 016319                               | 251        | D           |
| 016922                               | 251        | C           |
| 019133                               | 247        | C           |
| XX1024                               | 249        | A           |
| XX1025                               | 249        | C           |
|                                      |            |             |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| XX1194                  | 248        | B           |
| XX1645                  | 248        | D           |
| XX1662                  | 248        | C           |
| XX1714                  | 249        | D           |
| XX1774                  | 248        | B           |
| XX2197                  | 251        | B           |
| XX2276                  | 249        | B           |
| XX3090                  | 249        | C           |
| XX3213                  | 251        | D           |
| XX4201                  | 248        | B           |
| XX4450                  | 248        | C           |
| XX4600                  | 248        | D           |
| XX4874                  | 247        | D           |
| XX6438-2                | 251        | A           |
| XX7017                  | 248        | C           |
| XX7072                  | 249        | A           |
| XX7074                  | 248        | D           |
| XX7108                  | 251        | B           |
| XX7109                  | 250        | D           |
| XX7330                  | 250        | A           |
| XX7332                  | 250        | A           |
| XX8014                  | 251        | D           |
| XX8131                  | 250        | B           |
| XX8623                  | 250        | C           |
|                         |            |             |
| T-STYLE                 |            |             |
| 12230                   | 254        | A           |
| 14102                   | 255        | D           |
| 14378                   | 252        | C           |
| 14369                   | 253        | D           |
| 14410                   | 255        | D           |
| 15299                   | 253        | D           |
| 16302                   | 255        | A           |
| 19670                   | 256        | A           |
| 16834                   | 255        | C           |
| 19020                   | 255        | A           |
| 19342                   | 253        | D           |
| 21103                   | 254        | D           |
| 21104                   | 255        | C           |
| 005008                  | 252        | B           |
| 005651                  | 253        | A           |
| 006639                  | 252        | D           |
| 009100                  | 253        | A           |
| 009170                  | 252        | B           |
| 009212                  | 254        | C           |
| 009284                  | 252        | A           |
| 009319                  | 254        | B           |
| 009321                  | 253        | C           |
| 009891                  | 253        | A           |
| 011300                  | 254        | A           |
| 012176                  | 252        | A           |
| 012232                  | 252        | B           |
| 012678                  | 255        | A           |
| 012709                  | 252        | D           |
| 013563                  | 252        | D           |
| 014265                  | 253        | C           |
| 014278                  | 255        | B           |
| 014345                  | 254        | B           |
| 014763                  | 254        | D           |
| 015067                  | 253        | C           |
| 015108                  | 255        | C           |
| 015295                  | 252        | C           |
| 015765                  | 254        | C           |
| 015918                  | 252        | C           |
| 016178                  | 254        | A           |
| 016853                  | 253        | B           |
| XX4220                  | 254        | D           |
| XX4228                  | 253        | B           |
| XX4477                  | 255        | B           |
|                         |            |             |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| XX4891                  | 254        | B           |
| XX6203                  | 254        | C           |
| XX7030                  | 255        | B           |
| XX7056                  | 255        | D           |
| XX8088                  | 253        | B           |
|                         |            |             |
| H-STYLE                 |            |             |
| 04530                   | 260        | C           |
| 05106                   | 259        | D           |
| 08073                   | 256        | B           |
| 12277                   | 260        | A           |
| 16340                   | 259        | B           |
| 17086                   | 261        | D           |
| 19103                   | 260        | D           |
| 19429                   | 260        | D           |
| 002863                  | 258        | C           |
| 003208                  | 259        | C           |
| 003539                  | 257        | B           |
| 003572                  | 257        | C           |
| 003573                  | 257        | C           |
| 003663                  | 258        | D           |
| 003731                  | 260        | A           |
| 004591                  | 258        | B           |
| 005024                  | 261        | B           |
| 005207                  | 261        | B           |
| 005511                  | 257        | D           |
| 005821                  | 259        | A           |
| 005875                  | 256        | D           |
| 005984                  | 259        | C           |
| 006064                  | 257        | C           |
| 006393                  | 257        | B           |
| 006679                  | 256        | D           |
| 006748                  | 260        | A           |
| 006821                  | 261        | C           |
| 008266                  | 257        | B           |
| 008889                  | 258        | D           |
| 008890                  | 259        | A           |
| 008891                  | 261        | A           |
| 010088                  | 257        | A           |
| 010663                  | 260        | B           |
| 010803                  | 257        | B           |
| 010839                  | 258        | B           |
| 013437                  | 259        | A           |
| 013959                  | 261        | A           |
| 015671                  | 258        | C           |
| XX10202                 | 258        | A           |
| XX1157                  | 259        | D           |
| XX1244                  | 258        | D           |
| XX1245                  | 261        | A           |
| XX1251                  | 262        | A           |
| XX1273                  | 260        | D           |
| XX1541                  | 261        | C           |
| XX1637                  | 257        | D           |
| XX2131                  | 261        | B           |
| XX2726                  | 260        | C           |
| XX3057                  | 261        | D           |
| XX3547                  | 260        | C           |
| XX4005                  | 259        | B           |
| XX4051                  | 259        | B           |
| XX4101                  | 258        | C           |
| XX4226                  | 259        | D           |
| XX4511                  | 258        | A           |
| XX4666                  | 260        | B           |
| XX4701                  | 257        | D           |
| XX4850                  | 258        | A           |
| XX5167                  | 256        | D           |
| XX5183                  | 256        | C           |
| XX5195                  | 256        | C           |
| XX5313                  | 260        | B           |
|                         |            |             |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| XX6533                  | 256        | A           |
| XX6981                  | 261        | D           |
| XX6996                  | 257        | A           |
| XX7075                  | 256        | C           |
| XX7093                  | 258        | B           |
| XX7157                  | 259        | C           |
| XX8029                  | 256        | A           |
| XX8073                  | 256        | B           |
| XX8420                  | 256        | B           |
| XX9018                  | 261        | C           |
|                         |            |             |
| DOUBLE-SIDED            |            |             |
| 04551                   | 262        | C           |
| 05013                   | 262        | D           |
| 10498                   | 262        | B           |
| 14056                   | 262        | C           |
| 14714                   | 262        | B           |
| 19638                   | 262        | B           |
| 19363                   | 262        | A           |
| 21037                   | 262        | C           |
| 014879                  | 262        | D           |
| XX4551                  | 262        | D           |
| XX5013                  | 263        | A           |
| XX8479                  | 262        | A           |
|                         |            |             |
| MOUNTING SHELF          |            |             |
| 05040                   | 263        | A           |
| 14203                   | 264        | C           |
| 16300                   | 264        | B           |
| 16350                   | 264        | A           |
| 16464                   | 265        | A           |
| 19027                   | 263        | A           |
| 19856                   | 265        | A           |
| 008999                  | 263        | C           |
| 014264                  | 264        | A           |
| 014313                  | 264        | D           |
| XX10323                 | 264        | C           |
| XX1753                  | 263        | D           |
| XX2159                  | 263        | C           |
| XX4336                  | 263        | B           |
| XX4478                  | 264        | B           |
| XX4760                  | 264        | C           |
| XX4878                  | 263        | B           |
| XX5568                  | 263        | C           |
| XX6112                  | 264        | A           |
| XX6183                  | 263        | D           |
| XX6201                  | 264        | B           |
| XX6211                  | 264        | D           |
| XX7009                  | 263        | D           |
| XX7037                  | 263        | B           |
| XX7046                  | 265        | A           |
| XX7089                  | 264        | D           |
|                         |            |             |
| PRESS PACK              |            |             |
| 05730                   | 265        | C           |
| 12573                   | 266        | D           |
| 15779                   | 265        | B           |
| 15781                   | 266        | B           |
| 16714                   | 267        | C           |
| 16900                   | 268        | B           |
| 16901                   | 268        | B           |
| 17117                   | 267        | D           |
| 19472                   | 268        | A           |
| 19543                   | 265        | B           |
| 19607                   | 267        | C           |
| 19613                   | 267        | A           |
| 19688                   | 267        | D           |
| 19732                   | 265        | B           |
| 21415                   | 267        | C           |
|                         |            |             |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| 003537                  | 265        | D           |
| 013450                  | 266        | B           |
| 014191                  | 265        | D           |
| 014442                  | 267        | B           |
| 014779                  | 267        | A           |
| 016235                  | 267        | B           |
| XX10239                 | 267        | D           |
| XX3529                  | 266        | A           |
| XX3559-2                | 266        | D           |
| XX3560-2                | 266        | B           |
| XX3561-2                | 266        | C           |
| XX3849                  | 265        | C           |
| XX4554                  | 266        | A           |
| XX5306                  | 265        | C           |
| XX5311                  | 266        | A           |
| XX5360                  | 268        | A           |
| XX5730                  | 265        | D           |
| XX5731                  | 266        | C           |
| XX5732                  | 266        | C           |
| XX5733                  | 267        | A           |
| XX5734                  | 267        | B           |
| XX5735                  | 268        | B           |
| XX5736                  | 266        | D           |
| XX6351                  | 268        | A           |
| XX7151                  | 268        | B           |
|                         |            |             |
| POWER MODULE            |            |             |
| 02726                   | 268        | D           |
| 13444                   | 268        | C           |
| 14703                   | 269        | B           |
| 16558                   | 269        | C           |
| 17111                   | 269        | D           |
| 013698                  | 268        | D           |
| 016988                  | 269        | A           |
| 017003                  | 269        | C           |
| XX16104                 | 268        | C           |
| XX5315                  | 268        | D           |
| XX5655                  | 269        | C           |
| XX5714                  | 268        | C           |
| XX7091                  | 269        | B           |
| XX7092                  | 269        | B           |
| XX7300                  | 269        | A           |
| XX8110                  | 269        | A           |
|                         |            |             |
| FORCED CONVECTION       |            |             |
| 14263                   | 270        | A           |
| 14342                   | 270        | B           |
| 14499                   | 271        | A           |
| 14483                   | 271        | A           |
| 14711                   | 271        | B           |
| 19473                   | 270        | A           |
| 19535                   | 271        | B           |
| XX1040-P1               | 269        | D           |
| XX1040-P2               | 270        | B           |
| XX1243-P1               | 271        | A           |
| XX1243-P2               | 270        | C           |
| XX1288                  | 270        | C           |
| XX1320                  | 270        | C           |
| XX1961                  | 269        | D           |
| XX1290-P3               | 270        | A           |
| XX6051                  | 270        | D           |
| XX6052                  | 270        | D           |
| XX6061                  | 270        | B           |
| XX6071                  | 270        | D           |
|                         |            |             |
| MODULAR                 |            |             |
| XX6031                  | 271        | C           |
| XX6032                  | 271        | B           |
| XX6102                  | 272        | B           |
|                         |            |             |

| Extrusion/<br>Heat Sink | Pg.<br>No. | Row<br>Loc. |
|-------------------------|------------|-------------|
| XX6110                  | 272        | A           |
| XX6111                  | 272        | B           |
| XX6115                  | 272        | A           |
| XX6116                  | 272        | A           |
| XX6141                  | 271        | D           |
| XX6142                  | 271        | C           |
| XX6143                  | 271        | D           |
| XX6144                  | 271        | D           |
| XX6145                  | 271        | C           |
|                         |            |             |
| HOLLOW                  |            |             |
| 015346                  | 272        | D           |
| 015569                  | 273        | A           |
| 017013                  | 276        | B           |
| XX5075                  | 272        | B           |
| XX6164                  | 272        | D           |
| XX6301                  | 272        | C           |
| XX6302                  | 272        | C           |
| XX6303                  | 272        | D           |
| XXB-1396                | 272        | C           |
|                         |            |             |
| MISCELLANEOUS           |            |             |
| 10233                   | 275        | B           |
| 10593                   | 275        | C           |
| 13319                   | 274        | B           |
| 15569                   | 274        | C           |
| 16035                   | 274        | D           |
| 16517                   | 276        | A           |
| 19614                   | 274        | B           |
| 16921                   | 274        | B           |
| 16523                   | 275        | C           |
| 16925                   | 275        | B           |
| 17010                   | 275        | D           |
| 17013                   | 276        | B           |
| 18357                   | 274        | D           |
| 18395                   | 276        | A           |
| 18436                   | 273        | D           |
| 18453                   | 275        | D           |
| 18457                   | 274        | C           |
| 18546                   | 275        | A           |
| 19253                   | 273        | C           |
| 19257                   | 275        | A           |
| 19384                   | 276        | A           |
| 19487                   | 274        | C           |
| PH18340                 | 274        | C           |
| 19549                   | 275        | B           |
| 19754                   | 274        | A           |
| 19755                   | 273        | D           |
| 19756                   | 273        | D           |
| 19757                   | 273        | C           |
| 19758                   | 274        | A           |
| 19857                   | 275        | A           |
| 19866                   | 275        | D           |
| 19954                   | 275        | C           |
| 21074                   | 273        | C           |
| 21226                   | 274        | A           |
| 21232                   | 274        | D           |
| XX1290-P1               | 273        | A           |
| XX1290-P2               | 273        | B           |
| XX1290-P3               | 273        | B           |
| XX5049                  | 273        | B           |
|                         |            |             |
|                         |            |             |
|                         |            |             |
|                         |            |             |
|                         |            |             |
|                         |            |             |
|                         |            |             |
|                         |            |             |



**Resin** - A term used for an organic polymer that when mixed with a curing agent crosslinks to form a thermosetting plastic.

**Resistance** - The property of a conductor that opposes the flow of current by dissipating energy as heat. In packages, it causes voltage and current loss in signal and power distribution systems.

**SCR** - Silicon controlled rectifier.

**Shrinkage** - The decrease in volume, or contraction of a material by the escape of any volatile substance, or by a chemical or physical change in the material.

**Single-in-Line (SIP)** - DIP-like package with single line of leads as opposed to two for DIP.

**Solvent Cleaner** - The process of removing soil from a substrate surface with an organic solvent. The solvent cleaning process does not alter the substrate physically or chemically.

**Specific Heat** - The ratio of thermal energy required to raise the temperature of a body 1° to the thermal energy required to raise an equal mass of water 1°.

**Storage Life** - The period of time during which a packaged adhesive can be stored under specific temperature conditions and remain suitable for use. Often called “Shelf Life.”

**Surface Mount Technology (SMT)** - A method of assembling hybrid circuits and printed wiring boards, where component parts are mounted onto, rather than into, the printed wiring board, as in the mounting of components on substrates in hybrid technology.

**Tack (Green Strength)** - The property of an adhesive that enables it to form a bond of measurable strength immediately after adhesive and adherend are brought into contact under little or no pressure.

**Tape Automated Bonding (TAB)** - The process where silicon chips are joined to patterned metal or polymer tape using thermocompression bonding, and subsequently attached to a substrate or board by outer lead bonding. Intermediate processing may be carried out in strip form through operations such as testing, encapsulation, bum-in, and excising the individual packages from the tape.

**TCE** - Temperature coefficient of expansion.

**Temperature, Curing** - The temperature at which an adhesive or assembly is subject to curing.

**Temperature Cycling** - An environmental test where the film circuit is subjected to several temperature changes from a low temperature to a high temperature over a period of time.

**Thermal Conductivity** - A measure of a material's ability to conduct heat; physical constant for quantity of heat that passes through unit volume of a substance in unit of time when difference in temperature of two opposite faces is unity.

**Thermal Cycling** - A method to impose cyclical stress on an assembly of microelectronic components by alternately heating and cooling in an oven. It is used for accelerated reliability testing of assemblies.

**Thermal Expansion** - An increase in size due to an increase in temperature expressed in units of an increase in length or increase in size per degree.

**Thermal Gradient** - The plot of temperature variances across the bulk thickness of a material being heated.

**Thermal Mismatch** - Difference in thermal coefficients of expansion of materials which are bonded together.

**Thermal Resistance (°C/W)** - The opposition offered by a medium to the passage through it of thermal energy.

**Thermocouple** - The junction of two dissimilar metals which has a voltage output proportional to the difference in temperature between the hot junction and the lead wires.

**Thermoset** - Material that will undergo or has undergone a chemical reaction by the action of heat, catalyst, ultraviolet light, etc., leading to a relatively infusible state.

**Transistor Outline (TO)** - Industry standard package designation established by JEDEC of the EIA.

**Trim Die** - Die for shearing or shaving flash from a casting. Either the die is forced over the casting, or the casting is forced through the die.

**Viscosity** - A measure of the resistance of a fluid to flow or the internal friction within the body or fluid.

**Working Life** - The period of time during which a liquid resin or adhesive, after mixing with a catalyst, solvent, or other compounding ingredients, remains usable. Also known as “Pot Life”.

**Zero-insertion-Force Connection (ZIF)** - A form of connector that allows the connector pins to be brought together under very low force, then wiped and pressed together during cam activation. Low insertion force is LIF.