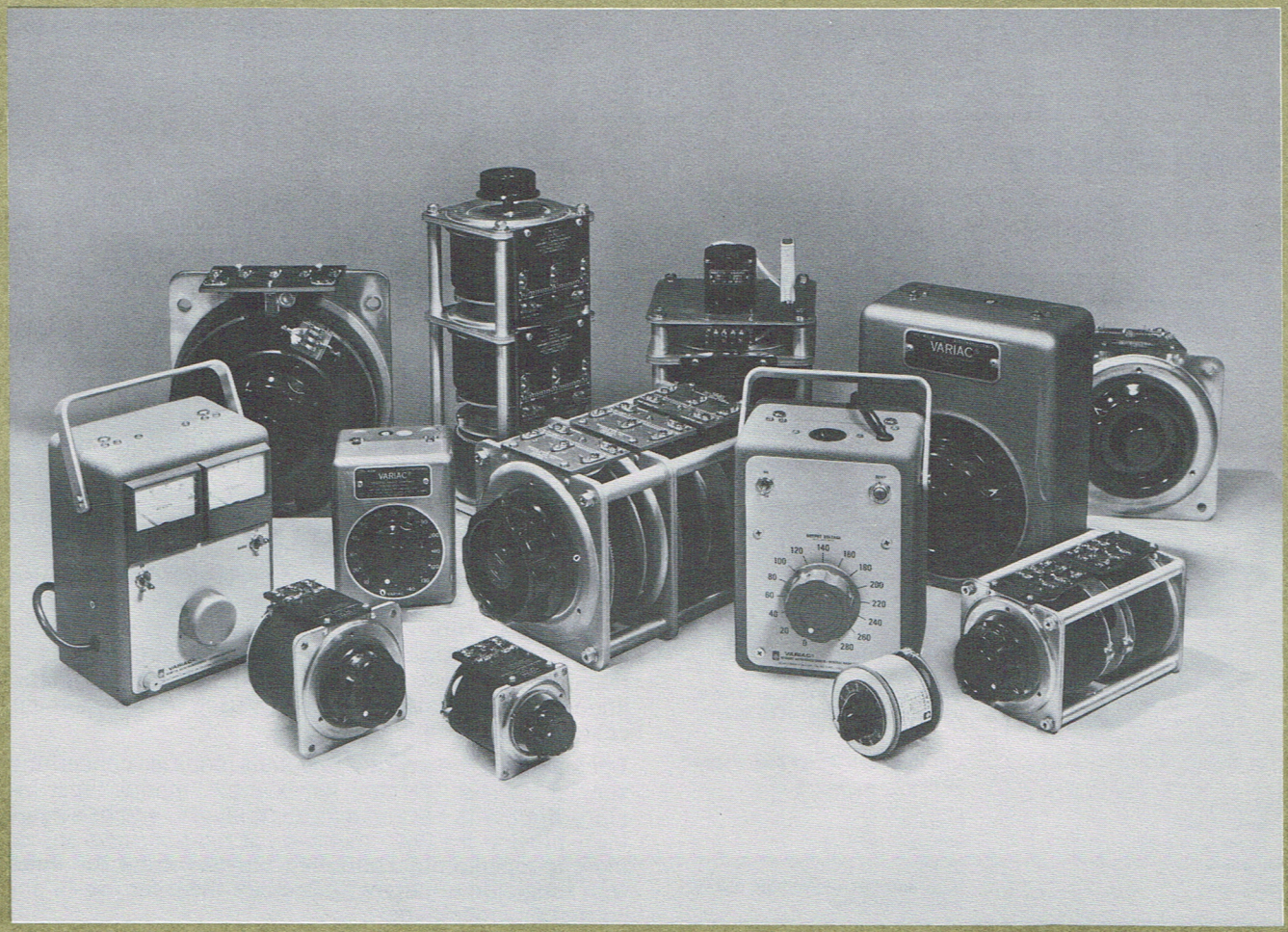
Variac® autotransformers



Variac® Adjustable Autotransformer

What Is a Variac?

The Variac® autotransformer is an efficient, trouble-free device for controlling ac voltage and any other quantities that derive from ac voltage: heat output, light intensity, motor speed, and the outputs of various power supplies. The name Variac comes from the unit's function—"vary ac"—and is GenRad's registered trade name for its continuously adjustable autotransformer.

Unlike most transformers, the Variac has a transformation ratio that can be smoothly and continuously changed so the output of the unit can be controlled from zero to line voltage or even higher. Because it is a transformer, the Variac is

- efficient—transforms power more efficiently than rheostats
- durable—because it runs cool
- overload-able—withstands 1000% overloads short term
- independent of load size or power factor—voltage to the load changes little from full load to none
- quiet—adds no noise or distortion to the line
- reliable—exclusive Duratrak® contact surface prevents injurious high-temperature oxidation and resultant brushtrack deterioration

In addition, the Variac is

- easy to install. All mounting hardware is included; wiring diagram is on the terminal plate; conduit knockouts are included on all enclosed models.
- available in hundreds of standard versions to satisfy line frequency, voltage, and phase requirements, load size, mounting demands (including portable and metered models). They can be supplied with motor drives, ball bearings, and in ganged assemblies to increase basic line-voltage and load-current ratings.
- assured safe by Underwriters' Laboratory listing and Canadian Standards approval of many models.
- available in militarized models for 400-hertz operation

Applications

In most applications, a full turn of the Variac control shaft (320°) varies the output voltage, applied to the load, from zero to line voltage or 17% above if connected for "overvoltage" operation. Thus, the light or heat output or speed or torque of the load is varied from zero to rated or above. Some typical applications are shown below.

Typical Applications for Variac® autotransformers

Type of Load	Function Controlled
Incandescent Lamps	Brilliance and color temperature
Fluorescent Lamps (both hot- and cold-cathode types)	Brilliance (special circuitry required for best results)
Heating Devices (resistive heaters and infra-red lamps)	Temperature
Motors	
AC Motors	
Universal Series Repulsion Two-phase Shaded-pole Split-phase induction Capacitor split phase	Use only on fan loads, or where torque is proportional to speed
DC Motors	Use with rectifier for motor-speed control
Rectifiers	
Electroplating	Current
Power and plate circuits	Voltage
Solenoids	Force
Test Loads	High and low line-voltage testing, breakdown tests

Narrow-range control Many times it is sufficient to be able to vary the output voltage over a limited range, for example, from 105 to 135 volts, for line-voltage correction, overvoltage and undervoltage testing and such. In these applications, much smaller Variac units can be used with resulting economy and increased resolution.

Voltage Doubling If the available line voltage is only about half that required by the load, the Variac can double the voltage while providing full control of the output. Units designated by an "H" (W20**H**) are supplied with an input connection for this use; output current rating of the transformer is one-half its normal value in this case. On special order, similar connections for other multiplying ratios can be supplied.

Other applications The Variac autotransformer can also be used as a phaseshifter in three-phase circuits, as a color-temperature control, for calibrating voltmeters, ammeters, and wattmeters, and in many unique applications. It is the basis of a wide line of GenRad automatic line-voltage regulators and can be used in many similar custom applications.

Special models GenRad welcomes inquiries concerning special models. We can, for example, modify taps, include limit switches, change shaft length, add ball bearings, provide for 360° mechanical rotation, add one or more independently controlled brushes, treat the units with fungicide or otherwise prepare them for use in abnormal environments.

How to Select a Variac

The Variac® adjustable autotransformers are grouped by line frequency, voltage, and phase, with brief specifications for each model. Within each group, the units are listed in order of increasing load rating that can be expressed in either current (amperes) or power (kVA). To make the selection you must know the line and load characteristics for your application. A brief look at these quantities may help.

Line frequency Most Variac models in the "W" series are designated for 50-to-60 Hz operation ("L" models are for 60 Hz only). Some "W" models can be used, without being derated, up to at least 400 Hz, but the regulation will be greater than normal and the physical size and weight larger than necessary. Therefore, we offer the "M" series Variac that is designed for operation from 350 to 1200 Hz. The M-series units are smaller and have better regulation at the higher frequencies. When series connected or when ordered specially, these units will also operate from 240-V lines.

Phase Variac models are available for both single- and three-phase operation. In general, three-phase ratings are governed by the ratings of each individual transformer in the assembly. That is, the voltage applied to, or the current drawn from, each individual unit must not exceed that specified for its single-phase uses. Thus, the considerations discussed below for single-phase applications apply separately to each unit in a three-phase assembly. A more detailed discussion on three-phase ratings and how to calculate them is given later in this section.

Line voltage Single-phase lines are normally either 120-volt or 240-volt, and GR Variac models come in two basic families to match. Should your line voltage be less than nominal, a unit rated for the nominal value will operate perfectly with no derating in current. Line voltage up to 17% above the nominal can be applied if overvoltage output is not required. For example, up to 140 volts line voltage can be applied to nominal 120-volt models if the maximum output voltage required is no more than the line voltage applied.

For single-phase line voltages from 480 to 560 volts, two Variac units rated for 240-V operation must be used with their coils connected in series across the line and the load connected one side to each of the Variac outputs. For such use, the load cannot be grounded at any point.

Load rating The load capacity of GR Variac autotransformers is specified in three ways: maximum current, rated current in amperes, and power in kVA (kilovolt-amperes). Although closely related, they are different and the differences are important to the proper selection of your Variac.

An autotransformer cannot supply as much current at midrange settings as it can at full-voltage setting without overheating. Yet some nonlinear loads, incandescent lights for example, may draw nearly as much current at half voltage as they do at rated voltage, while other (linear) loads will draw current proportional to the applied voltage. As a general rule, if the load is nonlinear, or if the overvoltage connection is used to apply more than line voltage to the load, a Variac should be chosen that has a Rated Current adequate for the load. Otherwise, the larger Maximum Current is the load-rating limit. Special applications may permit higher current to be drawn; for a more complete discussion of ratings, see "Get More Out of Your Variac," later in this section.

The Variac power rating in kVA is given as a convenience in matching the right Variac to the load. It is the product of the rated line voltage and the *maximum* current rating of the Variac. There is a risk of misinterpreting it and exceeding the limits mentioned above; the kVA rating can be used only if the load is linear and the overvoltage connection is *not* used. Otherwise, load *current* must be determined and a Variac selected that has adequate rating.

Power ratings in kVA are given for three-phase Variac applications and must be interpreted as described above.

Trade-offs While some trade-offs, like those mentioned above, are included in the selection tables, there are others you may wish to consider. The load-current capacity of the Variac is limited by temperature and life. Specified ratings assume a maximum ambient temperature of 50°C and a minimum life span of 7 years. If the expected ambient is lower or forced cooling is possible, the autotransformer can be uprated without affecting life. Also, if a shortened life is not a problem in your application, a further uprating can be realized.

Finally, if the load is expected to be switched on and off regularly (as with a thermostatically-controlled heater), the Variac can be uprated. In general, if the time for an on-off cycle is 2 hours or less and the off time is 10% or more of the total cycle time, some significant improvement in rating can be realized.

Calculations and curves for duty-cycle and temperature are given in detail later in this section.

Selecting the proper Variac Autotransformer Knowledge of the line frequency, voltage, and phase of your application will lead you to one of several tables that follow. The considerations above will have helped you determine the current or power that the Variac must be capable of handling. Now, merely scan down the left columns in the table ("Rated Current," "Maximum Current," or "kVA") until you find an entry that equals or exceeds the value determined by your load. It may be rewarding to consider several models, including those with slightly higher ratings than necessary, as there is the possibility of saving money, space, or both. Some models (designated "L" as in W5L) offer higher ratings per dollar and have only the minor restrictions of 60-Hz operation only and no overvoltage connection.

Parallel connections In some instances, the selection tables will indicate that the ganged assembly you have chosen requires parallel connection of the individual

units. Reference is made to a Type W50-P1 Choke, which *must* be used between the output connections of the individual units in the assembly to prevent one unit from forcing current into another, possibly causing excessive temperature and early failure. One choke is needed if two units are to be paralleled; three or more parallel units require one choke for each Variac. The chokes are *not* included with the ganged assembly and must be ordered separately (except for 9- and 12-gang W50 and W50H units which are shipped prewired *with* chokes).

How to order When you have chosen the right Variac autotransformer from the selection tables, record the 8-digit catalog number and type number. Your order should include this information and a complete description of the unit. This permits us to cross-check your order and catch any typographic errors.

Note that there are no 8-digit numbers given for motor-driven or ball-bearing models; ordering should be done by a constructed type number (see below) and full description.

Type Number Terminology

In their various combinations, type numbers for Variac autotransformers consist of letters and numerals that indicate exactly what elements are included in each assembly. The following examples show the various combinations:

M	350-to-1200 Hz operation
W	50-to-60 Hz operation
W**5**	Model size, 120 V input
W5**H**	240-V input
W5**L**	60-Hz only, no overvoltage
W5H**G2**	2-gang W5H (substitute 3 for 3-gang, etc)
W5HG2**BB**	Adds ball bearings
W5HG2BB**M**	Adds complete enclosure
W5HG2**D4CK**	D indicates motor drive; 2, 4, 8, 16, 32, 64, or 128 following D indicates number of seconds for full traverse. C indicates phase-splitter capacitor and K indicates limit switches. Omit BB from motor-drive type numbers since motor-driven units are always equipped with ball bearings.
W5**MT**	Portable units with 2-wire line cord
W5MT**3**	With 3-wire line cord
W5MT3**VM**	With voltmeter
W5MT3**A**	With voltmeter and ammeter
W5MT3**W**	With voltmeter and wattmeter
W5MT3**AW**	With voltmeter, ammeter and wattmeter

Where Variac Autotransformers are Produced

GenRad manufactures Variac® autotransformers at its plants in Massachusetts and offers them for sale throughout the United States and its territories, Canada, Central and South America, Australia, and Asia.

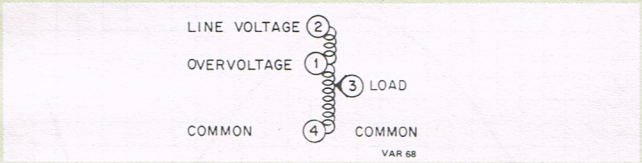
In Europe, Variac autotransformers are manufactured by EAB Elektroapparatebau AG, Courtelary, Switzerland, a member of the Bircher Group, which firm is licensed by GenRad to use the trademark Variac in connection with its manufacture and sale of autotransformers. These Variacs conform to GR design specifications except for metric threads and dimensions and 127 volts on low-voltage input.

For catalog information relative to the Variac products made in Europe, please direct your inquiries to GenRad, Ltd. in England, at the address given at the front of the catalog.

General Specifications

Ball Bearings Ball bearings at both ends of the shaft are offered for all units. They are useful where more precise alignment, more constant torque, and longer life are required. Ball bearings are standard on all motor-driven Variac® autotransformers, and on all 4- to 12-gang types W30, W30H, W50, and W50H manually-operated models.

Connections, Output "Line-voltage connection" refers to the connection of the Variac autotransformer for an output-voltage range of zero to line voltage. "Overvoltage connection" refers to the input-voltage connection for a range of output voltage from 0 to 117% of line voltage.



Current, Maximum Maximum current can be drawn at maximum voltage only when the line-voltage connection is used.

Current, Rated This current can be drawn at any dial setting, independent of overvoltage or line-voltage connection.

Dial Dial plates for single units are reversible. They read 0 to 120 volts output on one side and 0 to 140 volts on the other. H models have similar scale readings of 0 to 240 and 0 to 280. Dial plates are calibrated for mounting on a panel or on the front of a case; output voltage increases with clockwise rotation of the knob. All ganged assemblies are supplied with dials calibrated on one side only, reading 0 to 10.

Frequency, Line W-series units are specified for 50-to-60 Hz service except for the L types which are for 60-Hz service only. However, both of these units can be operated at rated values at line frequencies to 400 Hz. For 350-to-1200 Hz service the M-series units are preferred. Models intended for 240-volt, 60-Hz service can be used at 25 Hz at their normal current rating but at one-half their 60-Hz voltage rating.

kVA Ratings The kVA rating is the maximum load current multiplied by the nominal input line voltage.

Resolution Variac resolution is virtually infinite as the resistive brush always spans 2 or more turns of the autotransformer winding.

Motor-Driven Units All Variac autotransformers, both single and ganged units, can be furnished with motor drive.

Mounting Hardware All models are supplied with the necessary mounting hardware.

Special Designs We welcome requests for modifications of any model. These include different windings, shifting taps, different shafts, or basic new designs to furnish output voltages or voltage ranges differing from standard models. On special order, all W-series Variac autotransformers can be manufactured to conform to military requirements that are standard with the M-series units.

Temperature Rise Ratings are based upon operation at ambient temperatures of up to 50°C. When the ambient temperature exceeds this figure, current ratings should be decreased (see Figure 2).

Terminals All models have combined soldering and screw-type terminals with the exception of the types W30 and W50 which are equipped with clamping terminals. Models for 120-volt lines have five terminals for either 120- or 140-volt maximum output connections: 240-volt units have two extra terminals to provide for either 120- or 240-volt input for 280-volt output.

Military Environmental Specifications Most Variac autotransformers have been tested and do meet some or all of the following Military Specifications: MIL-STD-202, MIL-STD-810, MIL-STD-167, MIL-E-4158, MIL-E-4970, MIL-E-5272, MIL-E-5400, MIL-E-16400, MIL-R-23098, MIL-T-945, and MIL-T-5422. "Certification of Compliance" can be furnished at no charge for units tested. For further information on environmental tests, please contact your local GR District Office.

Overload Protection Today's improved core materials permit the use of higher flux densities than were formerly practical. Under certain conditions of core magnetization and line-voltage phase, an inrush transient or surge having an initial value up to ten times the rated current of the unit may occur. This does no harm except to ordinary "quick-blow" fuses. For this reason, time-current integrating circuit breakers or "slow-blow" fuses are recommended for primary protection. They will hold during transients but will protect against sustained and potentially damaging overloads. Such a protective device on the *input* side of the Variac should be capable of handling a 1000% overload for the duration of one cycle of the power-line frequency.

Overload protection for variable-ratio transformers differs from that used with fixed-ratio transformers, where safe primary and secondary currents are determined by the ratio of secondary to primary turns. For example, in a fixed-ratio transformer having 100 primary turns and 20 secondary turns, if the safe secondary current is 10 amperes, the safe primary

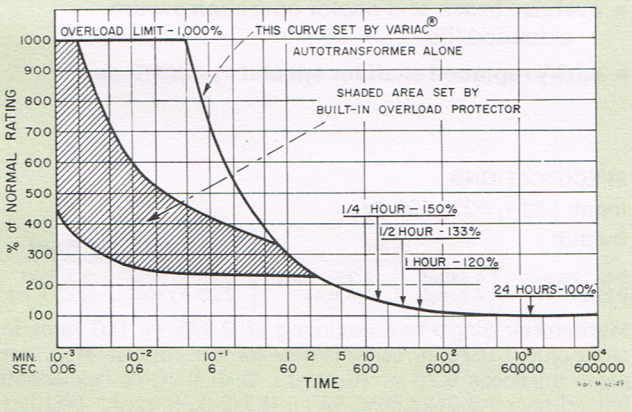


Figure 1. Short-time overload characteristic of Variac autotransformers with line-voltage connection.

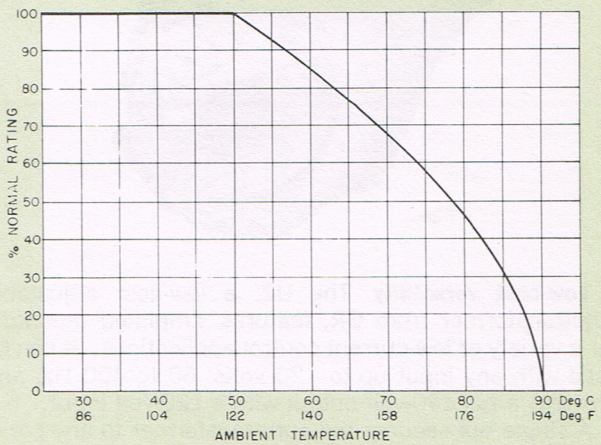


Figure 2. Variac autotransformer derating versus ambient temperature.

General Specifications (Cont'd)

current will be 2 amperes. Equal protection will be provided by a 10-ampere secondary fuse or a 2-ampere primary fuse.

This is not true with Variac autotransformers. As the brush traverses the winding, the transformation ratio continually changes. Under the conditions of a varying transformation ratio, primary protection is of little or no value, but output protection is all important; *it is the output current that must be held within safe limits.* For this reason a Variac autotransformer should be protected by a fuse or circuit breaker in the brush lead, where the load is normally connected.

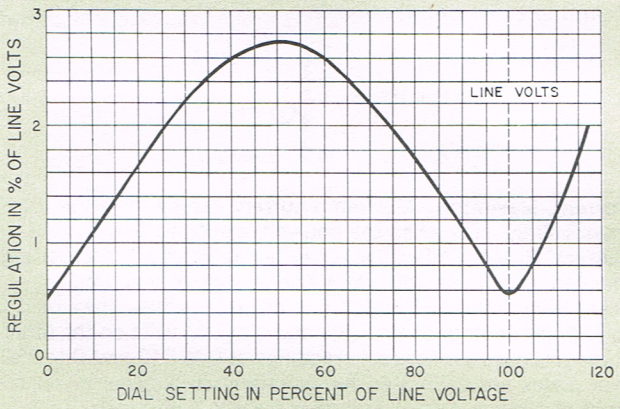
The nature of the protective devices selected should be partially determined by the service requirements. Variac autotransformers have an inherently high short-time overload capacity because temperature is dependent upon time for a given rise. They can safely absorb relatively infrequent short-time overloads (due to motor starting or lamp inrush) without being derated.

The upper curve in Figure 1 applies to units without built-in fuse protection. Models with built-in protection in the brush arm (models W5L, W20H, W30, W30H, W50, and W50H) have overload characteristics corresponding to the shaded area on the curve. The fuse is purposely made inaccessible to guard against careless replacement with fuses of wrong value. Its basic purpose is to provide thermal protection to the autotransformer, and it is not intended to serve as the sole protective device for the unit. It is essential that the user add external overload protection to the output of the variac, that is, between the brush and the load.

To benefit fully from the short-term overload characteristic, the overload capacity must not be unduly limited by the protective device. Since quick-blow fuses cannot withstand surges, their use is discouraged except for loads not subject to inrush. Slow-blow fuses are better; time-current integrating circuit breakers are better still. Thermal breakers are to be preferred, since they automatically derate with increasing ambient temperature. They most nearly conform to the requirements shown in Figure 2. This type of protector is standard in the Type MT (portable, cased) models of the W-series Variac autotransformers.

Regulation Regulation is defined as the change in output voltage from no load to full load current (varying load resistance), with constant input voltage, and is expressed as a percentage of line voltage.

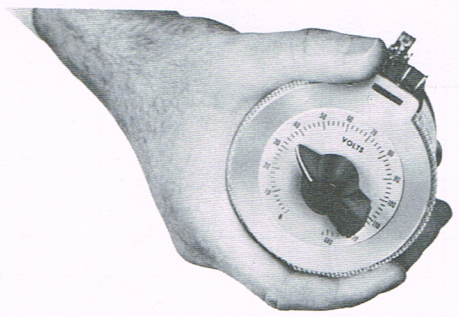
In an autotransformer, regulation varies with dial setting, largely because of IR drop in the winding, and is minimum at transformation ratios of zero and one. Note that, at zero and line-voltage settings, there is some slight regulation attributable to the resistance of the brush. Regulation is also due in part to leakage reactance caused by stray flux that does not link all the turns. While this is a minor factor at low frequencies, it becomes dominant at some higher frequency and actually imposes an upper-frequency limit on the operation of the autotransformer. This limit depends on the load conditions.



Typical regulation curve with normal rated current.

Paralleling Choke, W50-P1 Many of the Variac autotransformers listed on the following pages are indicated to require one or more Type W50-P1 Chokes (catalog number 3150-5016). This unit is used when two or more autotransformer outputs are to be connected in parallel; it impedes the flow of potentially destructive-circulating currents. Instructions for proper interconnecting are included with each unit.

Variac® adjustable autotransformer — U2



- **lowest cost 2-A unit available**
- **highest voltage output — up to 140 V**
- **oversize brush and cooler operation assure extended life**
- **easily replaced shaft for special applications**

Low-cost versatility The U2, a low-cost adjustable autotransformer from GR, features simplified mounting for a variety of low-current control applications. It can be used with any input up to 120 volts, 60 to 400 Hz, and provides a full 140-volt output with a 120-volt input.

A single nut secures the autotransformer to any panel up to ¼-inch thick. The unit's small size allows it to be used on densely packed front-panel configurations — the U2 is a natural for low-current applications in almost any situation.

SPECIFICATIONS

Input: 120 V, 60 to 400 Hz.

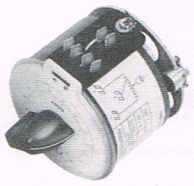
Output:

	In Air		On Aluminum Panel	
0 to 120 V:	2 A rated	2.25 A max	2.25 A rated	3 A max
0 to 140 V:	2 A rated	2 A max	2.25 A rated	2.25 A max

Mechanical: Single-hole mounting of 0.375 in. (10 mm) for shaft plus 0.1875-in. (5-mm) hole for anti-rotation stop, max panel thickness 0.25-in. (6 mm). DIMENSIONS (wxhxdepth behind panel) 3.25x3.69x2.94 in. (83x94x75 mm). WEIGHT: 2.5 lb (1.2 kg) net, 3 lb (1.4 kg) shipping.

Description	Catalog Number
U2 Variac® adjustable autotransformer	**3200-5110**

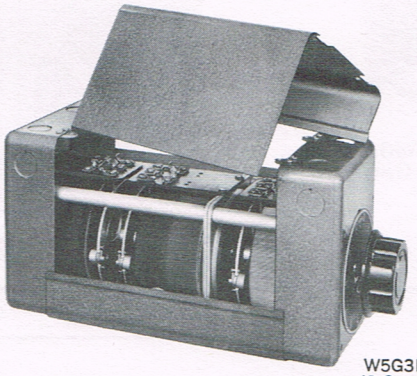
National stock numbers are listed at the back of the catalog.



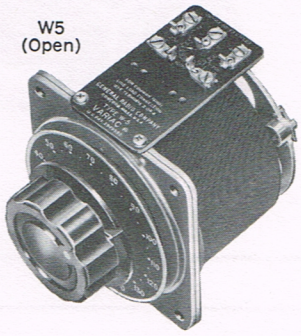
U2



W5M
(Enclosed)



W5G3M
(3-Gang)



W5
(Open)

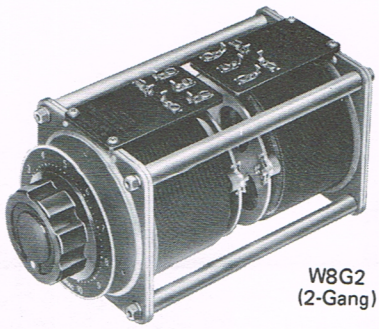
Single-phase, 120-volt input, 50-60 Hz

Output				Description							Outline Dimensions (inches)		
Rated Current Amperes	Max Current Amperes	kVA	Max Output Voltage Range	Type	Mounting	Notes	W50-P1 Chokes Req'd for parallel operation	Catalog Number	Net Weight lb	Shipping Wt lb	W	H	D
2.0	3.0		0-140	**U2**	Open			**3200-5110**	2.5	3	3¼	3 11/16	2 15/16
2.0	2.6	0.31	0-140	**W2M**	Encl			**3010-5111**	4	9	4⅛	5 5/16	4 3/8†
2.4	3.1	0.37	0-140	**W2**	Open			**3010-5110**	3	4	3¼	3 11/16	3 15/16†
5.0	6.5	0.78	0-140	**W5M**	Encl			**3030-5111**	7	13	4⅞	6 5/16	4 3/8*†
6.0	7.8	0.94	0-140	**W5**	Open			**3030-5110**	6	8	4½	4 15/16	3 15/16*†
7.1	9.2	1.1	0-120	**W5LM**	Encl	60 Hz only		**3050-5111**	7	13	4⅞	6 5/16	4 3/8
8.5	11.0	1.32	0-120	**W5L**	Open	60 Hz only		**3050-5110**	7	8	4½	4 15/16	4 11/16*
8.5	11.0	1.32	0-140	**W8**	Open			**3038-5110**	8	9	4½	4 15/16	4 7/16
10.0	13.0	1.56	0-120	**W8L**	Open	60 Hz only		**3058-5110**	8	12	4½	4 15/16	4 7/16
10.0	13.0	1.56	0-140	**W10**	Open			**3060-5110**	12	13	5¾	6 5/16	3 15/16*†
10.0	13.0	1.56	0-140	**W10M**	Encl			**3060-5111**	15	17	6¾	9½	5¼*†
14.2	18.4	2.2	0-120	**W5LG2M**	Encl	60 Hz only	1	**3050-5121**	15	23	5⅛	6¾	8⅛
17.0	22.0	2.6	0-120	**W5LG2**	Open	60 Hz only	1	**3050-5120**	14	16	4½	4 15/16	8
17.0	22.0	2.6	0-140	**W8G2**	Open		1	**3038-5120**	16	19	4½	4 15/16	9 5/16
20.0	26.0	3.12	0-140	**W20**	Open			**3090-5110**	21	24	7½	8 1/16	4 5/8*†
20.0	26.0	3.12	0-140	**W20M**	Encl			**3090-5111**	24	29	8⅝	11 15/16	5 3/8†
20.0	26.0	3.1	0-120	**W8LG2**	Open	60 Hz only	1	**3058-5120**	17	19	4½	4 15/16	9 5/16
21.3	27.6	3.3	0-120	**W5LG3M**	Encl	60 Hz only	3	**3050-5131**	22	32	5⅛	6¾	12¼
25.5	33.0	4.0	0-120	**W5LG3**	Open	60 Hz only	3	**3050-5130**	20	22	4½	4 15/16	12⅛
25.5	33.0	4.0	0-140	**W8G3**	Open		3	**3038-5130**	25	27	4½	4 15/16	13 15/16
28.0	32.0	3.84	0-140	**W30M**	Encl			**3120-5111**	37	47	11	14¾	5¾
30.0	36.0	4.32	0-140	**W30**	Open			**3120-5110**	30	38	10	11 13/16	4⅛
30.0	39.0	4.7	0-120	**W8LG3**	Open	60 Hz only	3	**3058-5130**	25	27	4½	4 15/16	13 15/16
40.0	52.0	6.2	0-140	**W20G2M**	Encl		1	**3090-5121**	48	56	9	12 1/16	9⅜
40.0	52.0	6.2	0-140	**W20G2**	Open		1	**3090-5120**	43	48	7½	8 1/16	9 3/16
40.0	45.0	5.40	0-140	**W50M**	Encl			**3150-5111**	57	74	13 7/16	16⅞	7¼*†
50.0	50.0	6.00	0-140	**W50**	Open			**3150-5110**	50	57	12½	13¾	6¼*†
56.0	64.0	7.7	0-140	**W30G2M**	Encl		1	**3120-5121**	67	90	11⅜	14 15/16	10 1/16
60.0	72.0	8.6	0-140	**W30G2**	Open		1	**3120-5120**	61	80	10	11 13/16	9⅞
60.0	78.0	9.4	0-140	**W20G3M**	Encl		3	**3090-5131**	71	82	9	12 1/16	13 15/16
60.0	78.0	9.4	0-140	**W20G3**	Open		3	**3090-5130**	65	71	7½	8 1/16	13¾
80.0	90.0	10.8	0-140	**W50G2M**	Encl		1	**3150-5121**	123	160	13 13/16	17 1/16	14 11/16
84.0	96.0	11.5	0-140	**W30G3M**	Encl		3	**3120-5131**	99	125	11⅜	14 15/16	14 11/16
90.0	108.0	13.0	0-140	**W30G3**	Open		3	**3120-5130**	93	113	10	11 13/16	20⅞
100.0	100.0	12.0	0-140	**W50G2**	Open		1	**3150-5120**	112	147	12½	13¾	14½
120.0	135.0	16.2	0-140	**W50G3M**	Encl		3	**3150-5131**	179	221	13 13/16	17 1/16	21 1/16
150.0	150.0	18.0	0-140	**W50G3**	Open		3	**3150-5130**	163	206	12½	13¾	20⅞
160.0	180.0	21.6	0-140	**W50G4BBM**	Encl		4	**3150-5241**	240	313	13 13/16	17 1/16	27 1/16
200.0	200.0	24.0	0-140	**W50G4BB**	Open		4	**3150-5240**	215	288	12½	13¾	27¼
240.0	270.0	32.4	0-140	**W50G6BBM**	Encl		6	**3150-5261**	355	430	13 13/16	17 1/16	40 3/16
300.0	300.0	36.0	0-140	**W50G6BB**	Open		6	**3150-5260**	325	400	12½	13¾	40

* Listed under Re-examination Service of the Underwriters' Laboratory.

† Approved by the Canadian Standards Association.

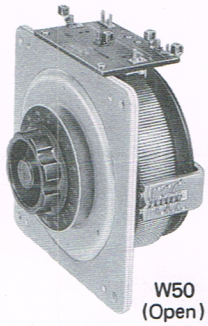
National stock numbers are listed at the back of the catalog.



W8G2
(2-Gang)



W20M
(Enclosed)



W50
(Open)

Single-phase, 240-volt input, 50-60 Hz

Output					Description						Outline Dimensions (inches)		
Rated Current Amperes	Max Current Amperes	kVA	Max Output Voltage Range	Type	Mounting	Connection	W50-P1 Chokes Req'd for parallel operation	Catalog Number	Net Weight lb	Shipping Wt lb	W	H	D
2.0	2.6	0.62	0-280	**W5H**	Open			**3040-5110**	6	8	4½	4 15/16	3 15/16†
2.0	2.6	0.62	0-280	**W5HM**	Encl			**3040-5111**	7	13	4⅞	6⅜	4⅜†
2.4	3.1	0.74	0-280	**W2G2**	Open	Series		**3010-5120**	7	9	3¼	3 11/16	7 15/16
4.0	5.2	1.25	0-280	**W10H**	Open			**3070-5110**	11	12	5¾	6⅜	4 11/16†
4.0	5.2	1.25	0-280	**W10HM**	Encl			**3070-5111**	14	17	6¾	9½	5¼†
5.0	6.5	1.56	0-280	**W5G2M**	Encl	Series		**3030-5121**	15	23	5⅛	6¾	8⅛
6.0	7.8	1.87	0-280	**W5G2**	Open	Series		**3030-5120**	14	15	4½	4 15/16	8
8.0	10.4	2.50	0-280	**W20H**	Open			**3100-5110**	20	23	7½	8 1/16	4⅝*†
8.0	10.4	2.50	0-280	**W20HM**	Encl			**3100-5111**	23	28	8⅝	11 15/16	5⅜*†
8.5	11.0	2.64	0-280	**W8G2**	Open	Series		**3038-5120**	16	19	4½	4 15/16	9 5/16
10.0	13.0	3.12	0-240	**W8LG2**	Open	Series 60 Hz only		**3058-5120**	17	19	4½	4 15/16	9 5/16
10.0	13.0	3.12	0-280	**W10G2**	Open	Series		**3060-5120**	25	27	5¾	6⅜	9 5/16
10.0	13.0	3.12	0-280	**W10G2M**	Encl	Series		**3060-5121**	29	34	7⅛	9 11/16	9½
12.0	15.6	3.74	0-280	**W30H**	Open			**3130-5110**	29	36	10	11 13/16	4⅛
12.0	15.6	3.74	0-280	**W30HM**	Encl			**3130-5111**	36	45	11	14¾	5¾
16.0	20.8	4.99	0-280	**W20HG2**	Open	Parallel	1	**3100-5120**	41	46	7½	8 1/16	9 5/16
16.0	20.8	4.99	0-280	**W20HG2M**	Encl	Parallel	1	**3100-5121**	45	54	9	12 1/16	9⅜
20.0	26.0	6.24	0-280	**W20G2**	Open	Series		**3090-5120**	43	48	7½	8 1/16	9 5/16
20.0	26.0	6.24	0-280	**W20G2M**	Encl	Series		**3090-5121**	48	56	9	12 1/16	9⅜
20.0	31.0	7.45	0-280	**W50HM**	Encl			**3160-5111**	60	76	13 7/16	16⅞	7¼*†
24.0	31.2	7.5	0-280	**W30HG2**	Open	Parallel	1	**3130-5120**	59	76	10	11 13/16	9⅞
24.0	31.2	7.5	0-280	**W30HG2M**	Encl	Parallel	1	**3130-5121**	64	87	11⅜	14 15/16	10 1/16
25.0	32.5	7.80	0-280	**W50H**	Open			**3160-5110**	53	60	12½	13¾	6¼*†
28.0	32.0	7.7	0-280	**W30G2M**	Encl	Series		**3120-5121**	67	90	11⅜	14 15/16	10 1/16
30.0	36.0	8.6	0-280	**W30G2**	Open	Series		**3120-5120**	61	80	10	11 13/16	9⅞
36.0	46.8	11	0-280	**W30HG3**	Open	Parallel	3	**3130-5130**	90	107	10	11 13/16	20⅞
36.0	46.8	11	0-280	**W30HG3M**	Encl	Parallel	3	**3130-5131**	97	120	11⅜	14 15/16	14 1/16
40.0	62.0	14.9	0-280	**W50HG2M**	Encl	Parallel	1	**3160-5121**	126	165	13 13/16	17 1/16	14 1/16
50.0	65.0	15.6	0-280	**W50HG2**	Open	Parallel	1	**3160-5120**	116	153	12½	13¾	14½
60.0	93.0	22.3	0-280	**W50HG3M**	Encl	Parallel	3	**3160-5131**	183	230	13 13/16	17 1/16	21 1/16
75.0	97.5	23.4	0-280	**W50HG3**	Open	Parallel	3	**3160-5130**	167	214	12½	13¾	20⅞
80.0	124.0	29.8	0-280	**W50HG4BBM**	Encl	Parallel	4	**3160-5241**	255	328	13 13/16	17 1/16	27 1/16
100.0	130.0	31.2	0-280	**W50HG4BB**	Open	Parallel	4	**3160-5240**	230	300	12½	13¾	27¼
120.0	186.0	44.6	0-280	**W50HG6BBM**	Encl	Parallel	6	**3160-5261**	385	458	13 13/16	17 1/16	40 5/16
150.0	195.0	46.8	0-280	**W50HG6BB**	Open	Parallel	6	**3160-5260**	355	428	12½	13¾	40

Single-phase, 480-volt input, 50-60Hz

2.0	2.6	1.24	0-560	**W5HG2**	Open	Series		**3040-5120**	13	15	4½	4 15/16	8
2.0	2.6	1.24	0-560	**W5HG2M**	Encl	Series		**3040-5121**	15	23	5⅛	6¾	8⅛
4.0	5.2	2.5	0-560	**W10HG2**	Open	Series		**3070-5120**	24	27	5¾	6⅜	9 5/16
4.0	5.2	2.5	0-560	**W10HG2M**	Encl	Series		**3070-5121**	29	33	7⅛	9 11/16	9½
8.0	10.4	5.0	0-560	**W20HG2**	Open	Series		**3100-5120**	41	46	7½	8 1/16	9 5/16
8.0	10.4	5.0	0-560	**W20HG2M**	Encl	Series		**3100-5121**	45	54	9	12 1/16	9⅜
12.0	15.6	7.48	0-560	**W30HG2**	Open	Series		**3130-5120**	59	76	10	11 13/16	9⅞
12.0	15.6	7.48	0-560	**W30HG2M**	Encl	Series		**3130-5121**	64	87	11⅜	14 15/16	10 1/16
20.0	31.0	14.9	0-560	**W50HG2M**	Encl	Series		**3160-5121**	126	165	13 13/16	17 1/16	14 1/16
25.0	32.5	15.6	0-560	**W50HG2**	Open	Series		**3160-5120**	116	153	12½	13¾	14½
40.0	62.0	29.8	0-560	**W50HG4BBM**	Encl	Parallel	2	**3160-5241**	255	328	13 13/16	17 1/16	27 1/16
50.0	65.0	31.2	0-560	**W50HG4BB**	Open	Parallel	2	**3160-5240**	230	300	12½	13¾	27¼
60.0	91.0	44.7	0-560	**W50HG6BBM**	Encl	Parallel	6	**3160-5261**	385	458	13 13/16	17 1/16	40 5/16
75.0	97.5	46.8	0-560	**W50HG6BB**	Open	Parallel	6	**3160-5260**	355	428	12½	13¾	40

* Listed under Re-examination Service of Underwriters' Laboratory. † Approved by Canadian Standards Association.

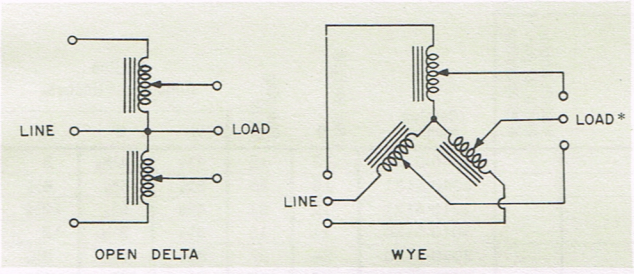
National stock numbers are listed at the back of the catalog.

How to Select a Three-Phase Variac

As discussed in an earlier paragraph, selecting the proper Variac® autotransformer depends on your first knowing the conditions imposed by the power line (frequency, voltage, and phase) and by the load (expressed in current or power).

To determine the needed rating for a three-phase Variac assembly, look at the individual units in the assembly and the line voltage and currents that will be imposed upon them. If the voltages and currents are within rating for the individual units, the assembly will do the job.

To control three-phase power, Variac autotransformers can be connected in either a wye configuration, which requires three units ganged (or 6, 9, or 12 for added capacity), or in an open-delta configuration, which requires two units ganged (or 4, 6, etc).



Consider the simplest cases where a single Variac unit is used in each arm. In the **wye** configuration, the full line-to-line voltage is not imposed on each unit, rather it is $1/\sqrt{3}$ or about 58% of the voltage. Thus a 240-volt line will impose about 138 volts on each unit. However, each unit supplies the full line current to the load through its brush. In the **open delta,** the input to each unit is the full voltage from the line and each unit must supply the full line current.

Line voltage Three-phase Variac assemblies are specified for the more common 208-volt, 240-volt, and 480-volt lines. The **open delta** Variac configuration is limited to the 208- and 240-volt applications and must use the Variac units with a basic rating of 240 volts; the overvoltage connection can be used. If the **wye** is used, the three common line voltages will impose 120, 138, and 277 volts respectively on the individual units in the assembly. So, for 208-volt lines, the Variac units rated for 120 volts can be employed, and the overvoltage connection used, if desired. For 240-volt lines, either 120-volt units can be used (restricted to the line-voltage connection) or 240-volt units can be used (overvoltage permitted). For 480-volt lines, 240-volt units are usable but restricted to line-voltage connection.

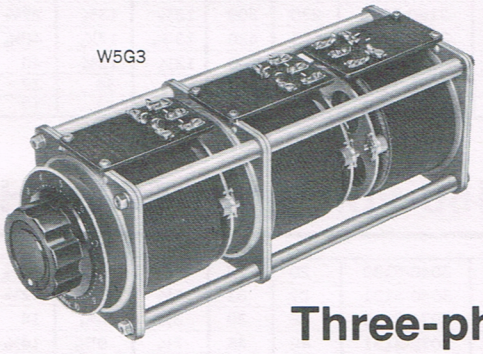
Load current The current rating of the individual Variac autotransformers in the ganged assemblies is the same as the maximum line current to the load. Thus, each leg of the wye or open delta can be selected as though it were a single-phase unit. Each leg can consist of as many units paralleled (with required chokes) as is necessary to handle the current. Standard assemblies are offered with up to 12 ganged-units (a wye with four paralleled units in each leg), and even larger ones can be supplied on special order.

Load power An aid to computing the load power from the voltage and current ratings of individual components of a three-phase load, and the reverse calculations, is given in "Get more out of your Variac," later in this section. However, the kVA ratings of the three-phase Variac autotransformers require an explanation. As with single-phase units, three-phase kVA rating is the product of the maximum current and the line voltage (multiplied by $\sqrt{3}$).** It should not be used in selecting a Variac when the overvoltage connection is employed, when nonlinear loads are used, or when the phase loads may be unbalanced. In those cases, the separate line currents should be calculated and compared against the rated current of the Variac.

Line frequency The selection of a W- or M-series Variac based on line frequency will be governed by the same considerations discussed earlier. Three-phase models for operation at 350 Hz and above are listed later, under 400-Hz operation.

*4-wire 3-phase input preferred. When 3-wire input is used, load must be balanced at all times to prevent damage to Variac.

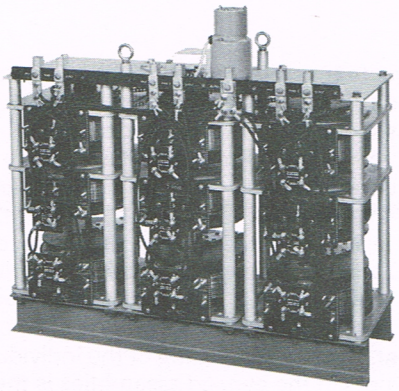
**3 single-phase units, each with $1/\sqrt{3}$ the line voltage.



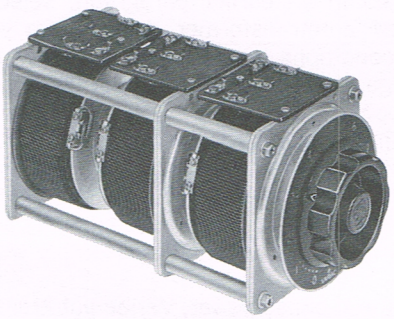
Three-phase, 208-volt input, 60-Hz only

Output				Description							Outline Dimensions (inches)		
Rated Current Amperes	Max Current Amperes	kVA	Max Output Voltage Range	Type	Mounting	Connection	W50-P1 Chokes Req'd for parallel operation	Catalog Number	Net Weight lb	Shipping Wt lb	W	H	D
7.1	9.2	3.31	0-208	**W5LG3M**	Encl	Wye		**3050-5131**	22	32	5⅛	6¾	12¼
8.5	11.0	3.96	0-208	**W5LG3**	Open	Wye		**3050-5130**	20	23	4½	4⅝	12⅛
10.0	13.0	4.68	0-208	**W8LG3**	Open	Wye		**3058-5130**	25	27	4½	4⅝	13⅝

National stock numbers are listed at the back of the catalog.



W50G9



W20G3

Overvoltage may be used on open-delta connection or 208-volt input.

Three-phase, 208-240-volt input, 50-60 Hz

Output				Description							Outline Dimensions (inches)		
Rated Current Amperes	Max Current Amperes	kVA	Max Output Voltage Range	Type	Mounting	Connection	W50-PI Chokes Req'd for parallel operation	Catalog Number	Net Weight lb	Shipping Wt lb	W	H	D
2.0	2.6	1.08	0-280	**W5HG2**	Open	Open Delta		3040-5120	13	15	4½	4 15/16	8
2.0	2.6	1.08	0-280	**W5HG2M**	Encl	Open Delta		3040-5121	15	23	5⅛	6¾	8⅛
2.0	2.6	1.08	0-240	**W2G3M**	Encl	Wye		3010-5131	12	21	4⅜	5¾	12⅛
2.4	3.1	1.29	0-240	**W2G3**	Open	Wye		3010-5130	11	13	3¼	3 1/16	12
4.0	5.2	2.16	0-280	**W10HG2**	Open	Open Delta		3070-5120	24	27	5¾	6 5/16	9 5/16
4.0	5.2	2.16	0-280	**W10HG2M**	Encl	Open Delta		3070-5121	29	33	7⅛	9 1/16	9½
5.0	6.5	2.70	0-240	**W5G3M**	Encl	Wye		3030-5131	22	32	5⅛	6¾	12¼
6.0	7.8	3.24	0-240	**W5G3**	Open	Wye		3030-5130	20	22	4½	4 15/16	12⅛
8.0	10.4	4.32	0-280	**W20HG2**	Open	Open Delta		3100-5120	41	46	7½	8 1/16	9 5/16
8.0	10.4	4.32	0-280	**W20HG2M**	Encl	Open Delta		3100-5121	45	54	9	12 1/16	9⅜
8.5	11.0	4.57	0-240	**W8G3**	Open	Wye		3038-5130	25	27	4½	4 15/16	13 15/16
10.0	13.0	5.40	0-240	**W10G3**	Open	Wye		3060-5130	37	40	5¾	6 5/16	14
10.0	13.0	5.40	0-240	**W10G3M**	Encl	Wye		3060-5131	43	47	7⅛	9 1/16	14 3/16
12.0	15.6	6.48	0-280	**W30HG2**	Open	Open Delta		3130-5120	59	76	10	11 13/16	9⅞
12.0	15.6	6.48	0-280	**W30HG2M**	Encl	Open Delta		3130-5121	64	87	11⅜	14 15/16	10 1/16
20.0	26.0	10.8	0-240	**W20G3**	Open	Wye		3090-5130	65	71	7½	8 1/16	13¾
20.0	26.0	10.8	0-240	**W20G3M**	Encl	Wye		3090-5131	71	82	9	12 1/16	13 15/16
20.0	31.0	12.9	0-280	**W50HG2M**	Encl	Open Delta		3160-5121	126	165	13 13/16	17 1/16	14 1/16
25.0	32.5	13.5	0-280	**W50HG2**	Open	Open Delta		3160-5120	116	153	12½	13¾	14½
28.0	32.0	13.3	0-240	**W30G3M**	Encl	Wye		3120-5131	99	125	11⅜	14 15/16	14 1/16
30.0	36.0	15.0	0-240	**W30G3**	Open	Wye		3120-5130	93	113	12½	13¾	20⅞
40.0	45.0	18.7	0-240	**W50G3M**	Encl	Wye		3150-5131	179	221	13 13/16	17 1/16	21 1/16
50.0	50.0	20.8	0-240	**W50G3**	Open	Wye		3150-5130	163	206	12½	13¾	20⅞
40.0	62.0	25.8	0-280	**W50HG4BBM**	Encl	Open Delta	2	3160-5241	255	328	13 13/16	17 1/16	27 1/16
50.0	65.0	27.0	0-280	**W50HG4BB**	Open	Open Delta	2	3160-5240	230	300	12½	13¾	27¼
80.0	90.0	37.4	0-240	**W50G6BBM**	Encl	Wye	3	3150-5261	355	430	13 13/16	17 1/16	40 5/16
100.0	100.0	41.6	0-240	**W50G6BB**	Open	Wye	3	3150-5260	325	400	12½	13¾	40
*150.0	150.0	62.4	0-240	**W50G9BB**	Open	Wye (chokes included)		3150-5876	600	720	39	35	17
*200.0	200.0	83.2	0-240	**W50G12BB**	Open	Wye (chokes included)		3150-5886	760	880	39	41	17

(Overvoltage connection not recommended)

Three-phase, 480-volt input, 50-60 Hz

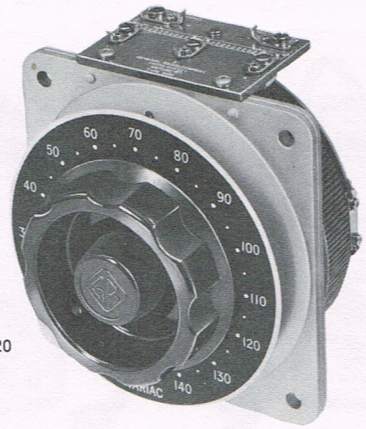
2.0	2.6	2.16	0-480	**W5HG3**	Open	Wye		3040-5130	20	22	4½	4 15/16	12⅛
2.0	2.6	2.16	0-480	**W5HG3M**	Encl	Wye		3040-5131	22	31	5⅛	6¾	12¼
4.0	5.2	4.32	0-480	**W10HG3**	Open	Wye		3070-5130	36	39	5¾	6 5/16	14
4.0	5.2	4.32	0-480	**W10HG3M**	Encl	Wye		3070-5131	42	46	7⅛	9 1/16	14 3/16
8.0	10.4	8.65	0-480	**W20HG3**	Open	Wye		3100-5130	61	68	7½	8 1/16	13¾
8.0	10.4	8.65	0-480	**W20HG3M**	Encl	Wye		3100-5131	67	79	9	12 1/16	13 15/16
12.0	15.6	13.0	0-480	**W30HG3**	Open	Wye		3130-5130	90	107	12½	13¾	20⅞
12.0	15.6	13.0	0-480	**W30HG3M**	Encl	Wye		3130-5131	97	120	11⅜	14 15/16	14 1/16
20.0	31.0	25.8	0-480	**W50HG3M**	Encl	Wye		3160-5131	183	230	13 13/16	17 1/16	21 1/16
25.0	32.5	27.0	0-480	**W50HG3**	Open	Wye		3160-5130	167	214	12½	13¾	20⅞
40.0	62.0	51.5	0-480	**W50HG6BBM**	Encl	Wye	3	3160-5261	385	458	13 13/16	17 1/16	40 5/16
50.0	65.0	54.0	0-480	**W50HG6BB**	Open	Wye	3	3160-5260	355	428	12½	13¾	40
* 75.0	97.5	81.0	0-480	**W50HG9BB**	Open	Wye (chokes included)		3160-5876	610	730	39	35	17
*100.0	130	108.0	0-480	**W50HG12BB**	Open	Wye (chokes included)		3160-5886	806	926	39	41	17

* Motor drive only.

available on request:

Three-phase, 560-volt input, 50-60 Hz

National stock numbers are listed at the back of the catalog.



M20

400-Hz Operation

- **small, light, excellent regulation**
- **high- and low-temperature lubrication**
- **iridite-treated aluminum parts**
- **fungicidal treatment of all phenolic parts**
- **special nickel-plated brush holders**

The M-series models are designed for use at frequencies between 350 and 1200 Hz. They are electrically the high-frequency equivalents of the standard W series but are much smaller and lighter than the 60-Hz models. At 400 Hz, the regulation obtained with the M-series is considerably better than with the 60-Hz models.

All M-series units conform to most military specifications for shock, vibration, salt spray, tropicalization, altitude, humidity, and temperature. See General Specifications section for further information regarding military environmental specifications. Operation of the M-series models is possible at 60 Hz if the input is limited to 60 volts. The output current remains the same and the output voltage range is 0 to 70 volts.

Single-phase, 120-volt input, 400-Hz

Output				Description						Outline Dimensions (inches)		
Rated Current Amperes	Max Current Amperes	kVA	Max Output Voltage Range	Type	Mounting	Connection	Catalog Number	Net Weight lb	Shipping Wt lb	W	H	D
2.4	3.1	0.37	0-140	**M2**	Open		**3410-5110**	2	3	3¼	3 11/16	2 11/16†
6.0	7.8	0.94	0-140	**M5**	Open		**3430-5110**	3	4	4½	4 15/16	2 11/16†
10.0	13.0	1.56	0-140	**M10**	Open		**3460-5110**	6	8	5¾	6 5/16	3 7/16†
20.0	26.0	3.12	0-140	**M20**	Open		**3490-5110**	13	15	7½	8 1/16	3 5/8†

Three-phase, 120-volt input, 400-Hz

2.4	3.1	0.65	0-140	**M2G2**	Open	Open Delta	**3410-5120**	4	5	3¼	3 11/16	5 7/16
6.0	7.8	1.62	0-140	**M5G2**	Open	Open Delta	**3430-5120**	7	8	4½	4 15/16	5½
10.0	13.0	2.7	0-140	**M10G2**	Open	Open Delta	**3460-5120**	12	16	5¾	6 5/16	6 13/16
20.0	26.0	5.4	0-140	**M20G2**	Open	Open Delta	**3490-5120**	26	30	7	8 1/16	7 3/16

Three-phase, 120-208-240-volt, 400-Hz

2.4	3.1	1.30	0-240*	**M2G3**	Open	Wye	**3410-5130**	5	7	3½	3 11/16	8¼
6.0	7.8	3.24	0-240*	**M5G3**	Open	Wye	**3430-5130**	10	12	4½	4 15/16	8⅜
10.0	13.0	5.4	0-240*	**M10G3**	Open	Wye	**3460-5130**	19	23	5¾	6 15/16	10¼
20.0	26.0	10.8	0-240*	**M20G3**	Open	Wye	**3490-5130**	38	43	7½	8 1/16	10¾

* 17% overvoltage connection is permitted on 120/208, three-phase lines.

National stock numbers are listed at the back of the catalog.



W8MT3VM



W8MT3

Portable Variac® Autotransformers

Portable, metered, cased units are available in twenty models for use in the laboratory and on the test bench. Each consists of a Variac autotransformer and an overload protector. Some models have a voltmeter, ammeter, and wattmeter in different configurations.

Adequate meter shielding is provided to reduce stray fields sufficiently to give over-all meter accuracy of 3% of full scale (5% of full scale for the powerful W20HMT3A).

The output circuit is protected by either a Klixon* thermal overload breaker, resettable from the panel, or by easily accessible and replaceable fuses.

A double-pole on-off switch disconnects both sides of the line. Where dual-range meters are used, make-before-break range switches permit switching under load. All have convenient carrying handles. Some models come in both 2- and 3-wire versions.

* Registered trademark of Texas Instruments Inc.

Single-phase, 120-volt input, 50-60 Hz

Output				Meter Ranges (full scale)							Outline Dimensions (inches)		
Rated Current Amperes	Max Current Amperes	Max Output Voltage Range	Type	Amperes	Watts	Volts	2- or 3-wire cord and receptacle	Catalog Number	Net Weight lb	Shipping Wt lb	W	H	D
5.0	—	0-140	**W5MT**	—	—	—	2	**3030-5118**	8	15	4⅞	6⅜₁₆	4⅜*†
5.0	—	0-140	**W5MT3**	—	—	—	3	**3030-5119**	8	15	4⅞	6⅜₁₆	4⅜*†
5.0	—	0-140	**W5MT3VM**	—	—	150	3	**3030-5015**	8	19	4⅞	6⅜₁₆	4⅜
5.0	—	0-140	**W5MT3A**	1/5	—	150	3	**3030-5012**	11	19	6¾	9½	5¼
5.0	—	0-140	**W5MT3W**	—	150/750	150	3	**3030-5013**	12	19	6¾	9½	5¼
5.0	—	0-140	**W5MT3AW**	1/5	150/750	150	3	**3030-5014**	12	21	11⁵⁄₁₆	8⅝	5⅜
7.1	—	0-120	**W5LMT3**[1]	—	—	—	3	**3050-5119**	8	18	4⅞	6⅜₁₆	4⅜
10.0	—	0-140	**W8MT3**	—	—	—	3	**3038-5119**	10	16	5⅜	7	6⅛
10.0	—	0-140	**W8MT3VM**	—	—	150	3	**3038-5015**	10	16	5⅜	7	6⅛
10.0	—	0-140	**W10MT**	—	—	—	2	**3060-5118**	16	24	6¾	9½	5¼†
10.0	—	0-140	**W10MT3**	—	—	—	3	**3060-5119**	16	24	6¾	9½	5¼†
10.0	—	0-140	**W10MT3A**	2/10	—	150	3	**3060-5012**	18	30	8⅝	11⁵⁄₁₆	5⅜
10.0	—	0-140	**W10MT3W**	—	300/1500	150	3	**3060-5013**	18	30	8⅝	11⁵⁄₁₆	5⅜
18.0	—	0-140	**W20MT3A**	20	—	150	3	**3090-5012**	27	34	8⅝	11⁵⁄₁₆	5⅜
18.0	—	0-140	**W20MT3**	—	—	—	3	**3090-5119**	20	23	8⅝	11⁵⁄₁₆	5⅜†

[1] 60 Hz only

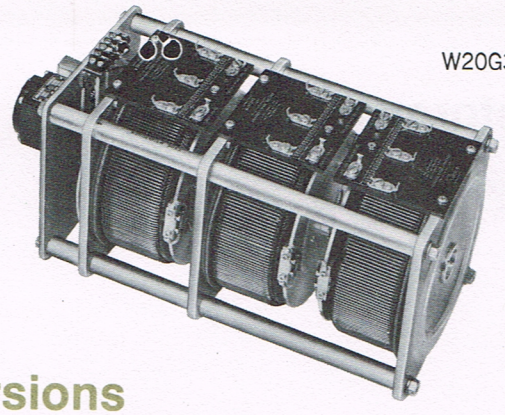
Single-phase, 240-volt input, 50-60 Hz

2.0	—	0-280	**W5HMT**	—	—	—	2	**3040-5118**	8	15	4⅞	6⅜₁₆	4⅜†
4.0	—	0-280	**W10HMT**	—	—	—	2	**3070-5118**	15	24	6¾	9½	5¼
4.0	—	0-280	**W10HMT3**	—	—	—	3	**3070-5119**	15	24	6¾	9½	5¼
8.0	—	0-280	**W20HMT3**	—	—	—	3	**3100-5119**	27	35	8⅝	11⁵⁄₁₆	5⅜†
8.0	—	0-280	**W20HMT3A**	10	—	300	3	**3100-5012**	25	31	8⅝	11⁵⁄₁₆	5⅜

Types MT and MT3 have overvoltage connections and corresponding dial scales, but can be supplied on special order with line-voltage connections and dial scales.

* Listed under Re-examination Service of Underwriters' Laboratory. † Approved by Canadian Standards Association.

National stock numbers are listed at the back of the catalog.



W20G3D8CK

Motor-Drive Versions

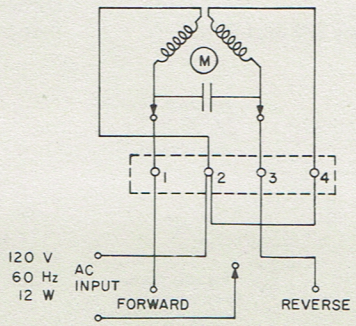
ORDERING INFORMATION

From table: yes = available from stock
so = available on special order

Establishing correct type number:

1. Select basic Variac type number; e.g., W5G2 (a 2-gang W5-series Variac)
2. Select time desired for full 320° traverse and insert time in "D–CK"
3. Arrange in following order:
   W5G2D8CK (a 2-gang W5-series Variac with motor drive, 8-second traverse)
4. If fully enclosed case is desired, add "M", e.g., W5G2D8CKM.

Dimensions: Width and height are same as for component Variac. Depth is approx 6 inches greater than that of equivalent manually operated model.



Schematic diagram of motor circuit

Seconds for full 320° Traverse*	2	4	8	16	32	64	128	Shipping Weight (lb) Cased	Uncased
M2	yes	yes	yes	yes	yes	yes	...	9	...
M2G2	yes	yes	yes	yes	yes	yes	...	11	...
M2G3	...	yes	yes	yes	yes	yes	...	14	...
M5	yes	yes	yes	yes	yes	yes	...	14	...
M5G2	yes	yes	yes	yes	yes	yes	...	16	...
M5G3	...	yes	yes	yes	yes	yes	...	19	...
M10	yes	yes	yes	yes	yes	yes	yes	16	...
M10G2	so	yes	yes	yes	yes	yes	yes	22	...
M10G3	so	so	yes	yes	yes	yes	yes	29	...
M20	...	yes	yes	yes	yes	yes	yes	27	...
M20G2	so	so	yes	yes	yes	yes	yes	47	...
M20G3	so	so	yes	yes	yes	yes	yes	58	...
W2	yes	yes	yes	yes	yes	yes	...	13	15
W2G2	yes	yes	yes	yes	yes	yes	...	15	17
W2G3	...	yes	yes	yes	yes	yes	...	17	20
W5	yes	yes	yes	yes	yes	yes	...	17	20
W5G2	yes	yes	yes	yes	yes	yes	...	23	26
W5G3	...	yes	yes	yes	yes	yes	...	33	39
W5H	yes	yes	yes	yes	yes	yes	...	18	20
W5HG2	yes	yes	yes	yes	yes	yes	...	25	28
W5HG3	...	yes	yes	yes	yes	yes	...	34	38
W5L	yes	yes	yes	yes	yes	yes	...	17	20
W5LG2	yes	yes	yes	yes	yes	yes	...	24	29
W5LG3	...	yes	yes	yes	yes	yes	...	27	32
W8	yes	yes	yes	yes	yes	yes	...	19	...
W8G2	yes	yes	yes	yes	yes	yes	...	28	...
W8G3	...	yes	yes	yes	yes	yes	...	37	...
W8L	yes	yes	yes	yes	yes	yes	...	19	...
W8LG2	yes	yes	yes	yes	yes	yes	...	28	...
W8LG3	...	yes	yes	yes	yes	yes	...	37	...

Seconds for full 320° Traverse*	2	4	8	16	32	64	128	Shipping Weight (lb) Cased	Uncased
W10	yes	yes	yes	yes	yes	yes	yes	23	30
W10G2	so	so	yes	yes	yes	yes	yes	35	43
W10G3	so	so	yes	yes	yes	yes	yes	47	56
W10H	yes	yes	yes	yes	yes	yes	yes	23	30
W10HG2	so	yes	yes	yes	yes	yes	yes	35	43
W10HG3	so	so	yes	yes	yes	yes	yes	47	56
W20	so	yes	yes	yes	yes	yes	yes	35	50
W20G2	so	so	yes	yes	yes	yes	yes	54	71
W20G3	so	so	yes	yes	yes	yes	yes	78	97
W20H	so	yes	yes	yes	yes	yes	yes	35	47
W20HG2	so	so	yes	yes	yes	yes	yes	54	69
W20HG3	so	so	yes	yes	yes	yes	yes	77	93
W30	so	yes	yes	yes	yes	yes	yes	57	79
W30G2	...	so	so	yes	yes	yes	yes	89	98
W30G3	...	...	so	so	yes	yes	yes	120	120
W30H	so	yes	yes	yes	yes	yes	yes	55	78
W30HG2	...	so	so	yes	yes	yes	yes	88	98
W30HG3	...	...	so	so	yes	yes	yes	120	120
W50	...	so	so	yes	yes	yes	yes	95	125
W50G2	...	...	so	so	yes	yes	yes	162	194
W50G3	...	...	so	so	yes	yes	yes	220	242
W50G4	...	...	so	so	so	so	yes	295	330
W50G6	...	...	so	so	so	so	yes	411	454
W50G9	...	...	...	...	...	yes	...	...	...
W50G12	...	...	...	...	...	yes	...	...	...
W50H	...	so	so	yes	yes	yes	yes	100	130
W50HG2	...	...	so	so	yes	yes	yes	167	201
W50HG3	...	...	so	so	yes	yes	yes	222	246
W50HG4	...	...	so	so	so	so	yes	302	334
W50HG6	...	...	so	so	so	so	yes	480	526
W50HG9	...	...	...	...	...	yes	...	...	...
W50HG12	...	...	...	...	...	yes	...	...	...

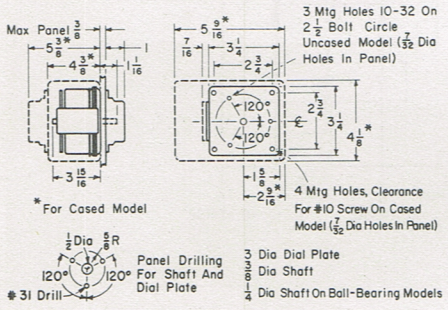
* Motor times given for 60-Hz operation. Add 20% more time for 50-Hz operation.

National stock numbers are listed at the back of the catalog.

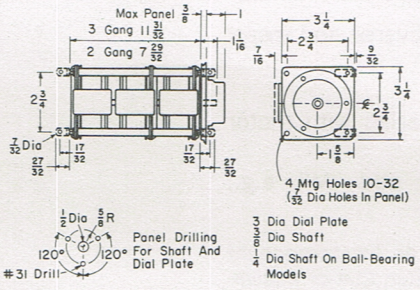
W2 Variac® Autotransformer

Basic data for single section:	
Input	120 V, 50 to 60 Hz
Output as % of input	0 to 117%
Rated Current	2.4 A
Maximum Current	3.1 A
No-Load Loss at 60 Hz	3.5 W
Number of Turns	403
DC Resistance of Winding	10.35 Ω
Drive Torque (ounce-inches)	5 to 10
Replacement Brush	VB-1

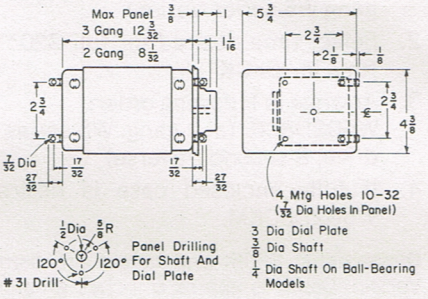
Dimensions Types W2 and W2M



Dimensions Ganged Uncased Types W2G2 and W2G3



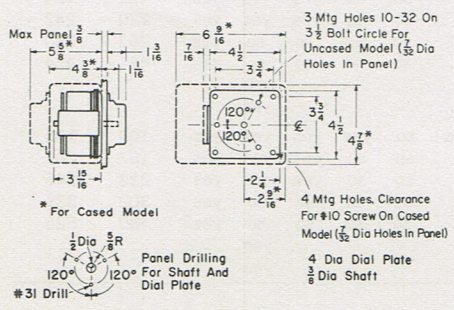
Dimensions Ganged Cased Types W2G2M and W2G3M



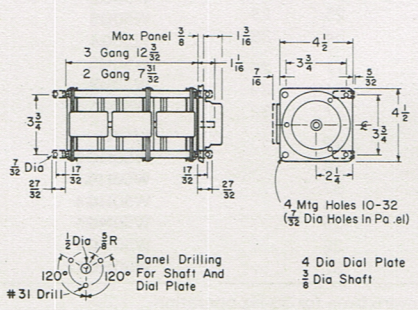
W5 Variac® Autotransformer

Basic data for single section:	W5	W5L	W5H
Input	120 V, 50 to 60 Hz	120 V, 60 Hz	240 V, 50 to 60 Hz
Output as % of input	0 to 117%	0 to 100%	0 to 117%
Rated Current	6 A	8.5 A	2 A
Maximum Current	7.8 A	11 A	2.6 A
No-Load Loss at 60 Hz	9 W	12 W	9 W
Number of Turns	293	235	590
DC Resistance of Winding	1.85 Ω	0.92 Ω	17 Ω
Drive Torque (ounce-inches)	10 to 20	10 to 20	10 to 20
Replacement Brush	VB-2	VB-2	VB-1

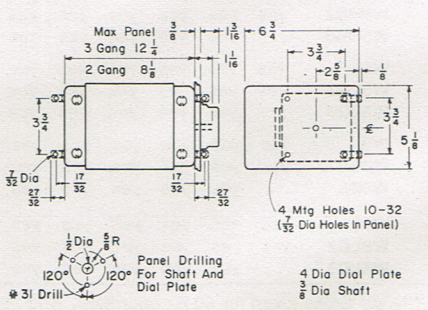
Dimensions Types W5, W5L, W5M, W5LM, W5MT, W5MT3, W5LMT3, W5H, W5HM, and W5HMT



Dimensions Ganged (Uncased) Types W5G2, W5G3, W5HG2, W5HG3, W5LG2 and W5LG3



Dimensions Ganged Cased Types W5G2M, W5G3M, W5HG2M, W5HG3M, W5LG2M, and W5LG3M

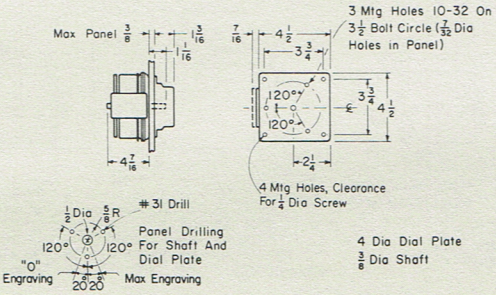


National stock numbers are listed at the back of the catalog.

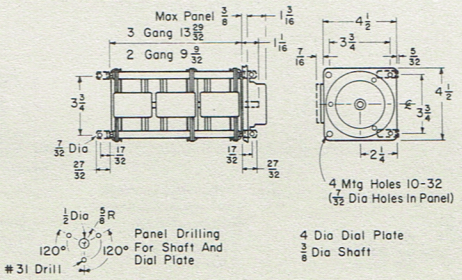
W8 Variac® Autotransformer

Basic data for single section:	W8	W8L
Input	120 V, 50 to 60 Hz	120 V, 60 Hz
Output as % of input	0 to 117%	0 to 100%
Rated Current	8.5 A	10 A
Maximum Current	11 A	13 A
No-Load Loss at 60 Hz	12 W	12 W
Number of Turns	236	184
DC Resistance of Winding	1 Ω	0.5 Ω
Drive Torque (ounce-inches)	10 to 20	10 to 20
Replacement Brush	VB-3	VB-3

Dimensions Types W8 and W8L



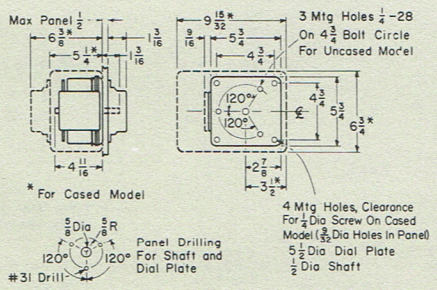
Dimensions Ganged Types W8G2, W8G3, W8LG2, and W8LG3



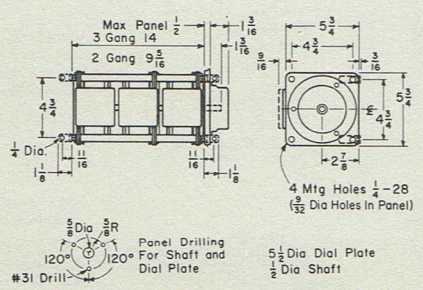
W10 Variac® Autotransformer

Basic data for single section:	W10	W10H
Input	120 V, 50 to 60 Hz	240 V, 50 to 60 Hz
Output as % of Input	0 to 117%	0 to 117%
Rated Current	10 A	4 A
Maximum Current	13 A	5.2 A
No-Load Loss at 60 Hz	17 W	17 W
Number of Turns	212	430
DC Resistance of Winding	0.58 Ω	4.85 Ω
Drive Torque (ounce-inches)	15 to 30	15 to 30
Replacement Brush	VBT-10	VBT-11

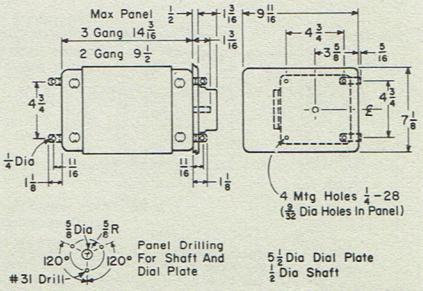
Dimensions Types W10, W10M, W10MT, W10MT3, W10H, W10HM, W10HMT, and W10HMT3.



Dimensions Ganged Uncased Types W10G2, W10G3, W10HG2, and W10HG3



Dimensions Cased Types W10G2M, W10G3M, W10HG2M, and W10HG3M

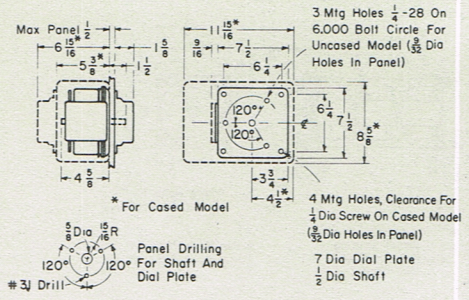


National stock numbers are listed at the back of the catalog.

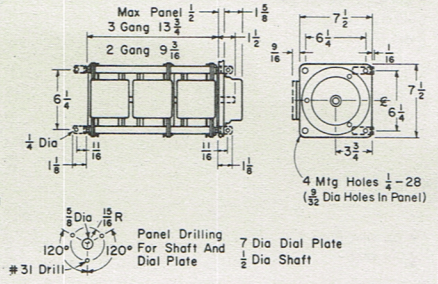
W20 Variac® Autotransformer

Basic data for single section:	W20	W20H
Input	120 V, 50 to 60 Hz	240 V, 50 to 60 Hz
Output as % of Input	0 to 117%	0 to 117%
Rated Current	20 A	8 A
Maximum Current	26 A	10.4 A
No-Load Loss at 60 Hz	27 W	27 W
Number of Turns	169	339
DC Resistance of Winding	0.21 Ω	1.6 Ω
Drive Torque (ounce-inches)	45 to 90	45 to 90
Replacement Brush	VBT-8	VBT-12

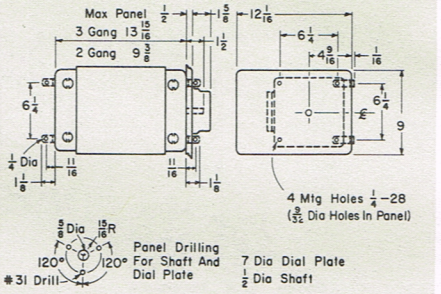
Dimensions Types W20, W20M, W20MT3, W20H, W20HM and W20HMT3.



Dimensions Ganged Uncased Types W20G2, W20G3, W20HG2 and W20HG3



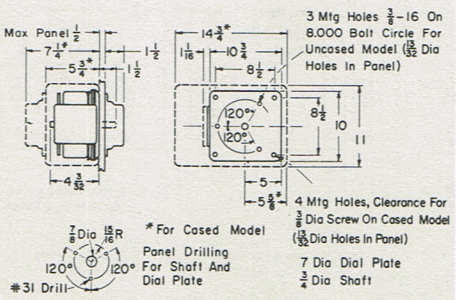
Dimensions Ganged Cased Types W20G2M, W20G3M, W20HG2M, and W20HG3M



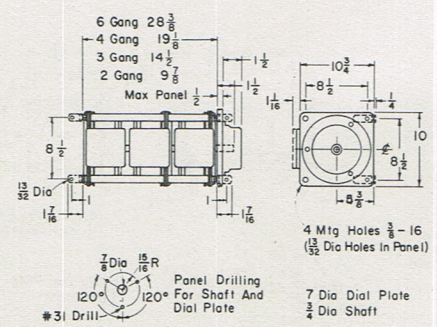
W30 Variac® Autotransformer

Basic data for single section:	W30	W30H
Input	120 V, 50 to 60 Hz	240 V, 50 to 60 Hz
Output as % of Input	0 to 117%	0 to 117%
Rated Current	30 A	12 A
Maximum Current	36 A	15.6 A
No-Load Loss at 60 Hz	35 W	35 W
Number of Turns	184	367
DC Resistance of Winding	0.14 Ω	1.17 Ω
Drive Torque (ounce-inches)	50 to 100	50 to 100
Replacement Brush	VBT-13	VBT-14

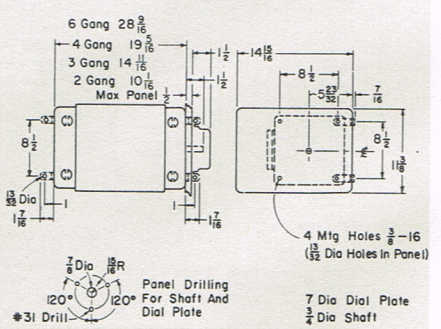
Dimensions Types W30, W30M, W30H, and W30HM



Dimensions Ganged Uncased Types W30G2, W30G3, W30G4, W30G6, W30HG2, W30HG3, W30HG4, and W30HG6



Dimensions Ganged Cased Types W30G2M, W30G3M, W30G4M, W30G6M, W30HG2M, W30HG3M, W30HG4M, and W30HG6M

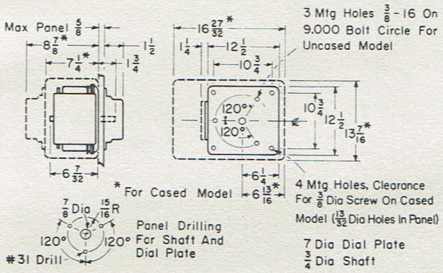


National stock numbers are listed at the back of the catalog.

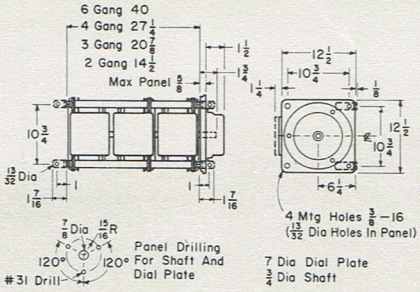
W50 Variac® Autotransformer

Basic data for single section:	W50	W50H
Input	120 V, 50 to 60 Hz	240 V, 50 to 60 Hz
Output as % of Input	0 to 117%	0 to 117%
Rated Current	50 A	25 A
Maximum Current	50 A	32.5 A
No-Load Loss at 60 Hz	50 W	50 W
Number of Turns	186	294
DC Resistance of Winding	0.08 Ω	0.3 Ω
Drive Torque (ounce-inches)	150 to 300	150 to 300
Replacement Brush	VBT-6	VBT-7

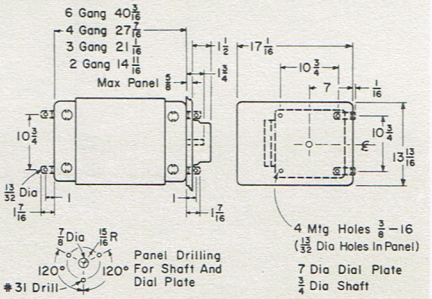
Dimensions Types W50, W50M, W50H and W50HM



Dimensions Ganged Uncased Types W50G2, W50G3, W50G4, W50G6, W50HG2, W50HG3, W50HG4 and W50HG6



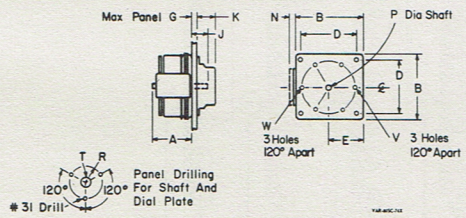
Dimensions Ganged Cased Types W50G2M, W50G3M, W50G4M, W50G6M, W50HG2M, W50HG3M, W50HG4M, and W50HG6M



M-Series Variac® Autotransformer

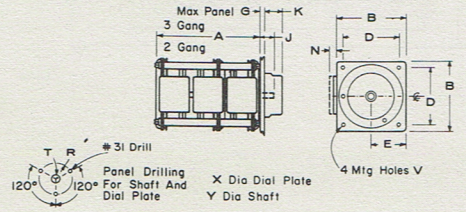
Basic data for single section:	M2	M5	M10	M20
Input	120 V, 350 to 1200 Hz	120 V, 350 to 1200 Hz	120 V, 350 to 1200 Hz	120 V, 350 to 1200 Hz
Output as % of Input	0 to 117%	0 to 117%	0 to 117%	0 to 117%
Rated Current	2.4A	6 A	10 A	20 A
Maximum Current	3.1 A	7.8 A	13 A	26 A
No-Load Loss at 400 Hz	3.5 W	9 W	17 W	27 W
Number of Turns	403	294	212	169
DC Resistance of Winding	6.25 Ω	1.2 Ω	0.36 Ω	0.15 Ω
Drive Torque (ounce-inches)	5 to 10	10 to 20	15 to 30	45 to 90
Replacement Brush	VB-1	VB-2	VBT-10	VBT-8

Dimensions Type M Variacs



TYPE	A	B	D	E	G	J	K	N	P	R	T	V	W
M2	2 1/16″	3 1/4″	2 3/4″	1 5/8″	3/8″	1 1/16″	1″	7/16″	3/8″	5/8″	1/2″	10-32	—
M5	2 1/16″	4 1/2″	3 3/4″	2 1/4″	3/8″	1 1/16″	1 3/16″	7/16″	3/8″	5/8″	1/2″	—	10-32
M10	3 7/16″	5 3/4″	4 3/4″	2 7/8″	1/2″	1 13/16″	1 3/16″	9/16″	1/2″	5/8″	5/8″	—	1/4-28
M20	3 5/8″	7 1/2″	6 1/4″	3 3/4″	1/2″	1 1/2″	1 5/8″	9/16″	1/2″	15/16″	5/8″	—	1/4-28

Dimensions Type M Ganged Variacs



TYPE	A	B	D	E	G	J	K	N	R	T	V	X	Y
M2G2	5 13/32″	3 1/4″	2 3/4″	1 5/8″	3/8″	1 1/16″	1″	7/16″	5/8″	1/2″	10-32	3″	3/8″
M2G3	8 1/32″	3 1/4″	2 3/4″	1 5/8″	3/8″	1 1/16″	1″	7/16″	5/8″	1/2″	10-32	3″	3/8″
M5G2	5 15/32″	4 1/2″	3 3/4″	2 1/4″	3/8″	1 1/16″	1 3/16″	7/16″	5/8″	1/2″	10-32	4″	3/8″
M5G3	8 11/32″	4 1/2″	3 3/4″	2 1/4″	3/8″	1 1/16″	1 3/16″	7/16″	5/8″	1/2″	10-32	4″	3/8″
M10G2	6 13/16″	5 3/4″	4 3/4″	2 7/8″	1/2″	1 3/16″	1 3/16″	9/16″	5/8″	5/8″	1/4-28	5 1/2″	1/2″
M10G3	10 1/4″	5 3/4″	4 3/4″	2 7/8″	1/2″	1 3/16″	1 3/16″	9/16″	5/8″	5/8″	1/4-28	5 1/2″	1/2″
M20G2	7 3/16″	7 1/2″	6 1/4″	3 3/4″	1/2″	1 1/2″	1 5/8″	9/16″	15/16″	5/8″	1/4-28	7″	1/2″
M20G3	10 3/4″	7 1/2″	6 1/4″	3 3/4″	1/2″	1 1/2″	1 5/8″	9/16″	15/16″	5/8″	1/4-28	7″	1/2″

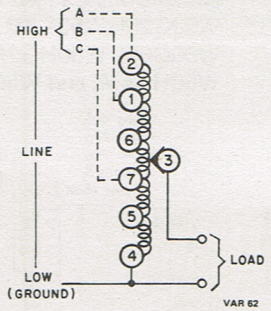
National stock numbers are listed at the back of the catalog.

Wiring Diagrams

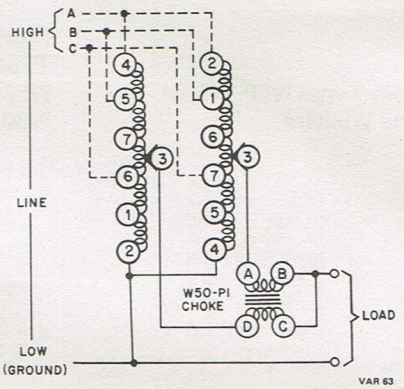
Note: A = line-voltage connection, B = overvoltage connection, C = voltage-doubling connection (terminals 6 and 7 exist on H models only).

Single phase, single unit;

if ground is necessary, it must connect to low load terminal.

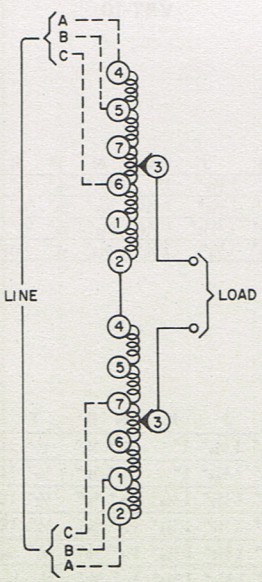


Single phase, two gang; parallel wired.

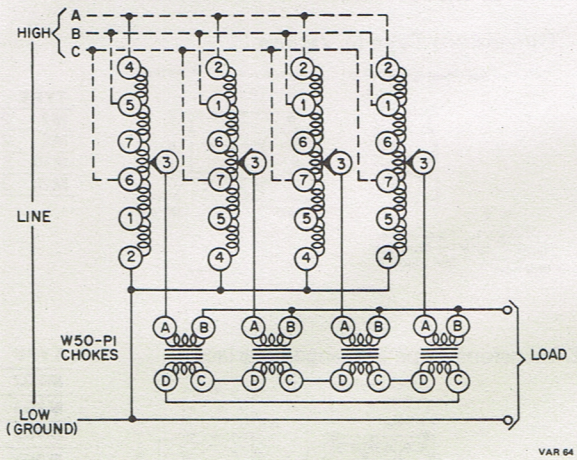


Single phase, two gang; series wired,

load must not be grounded.



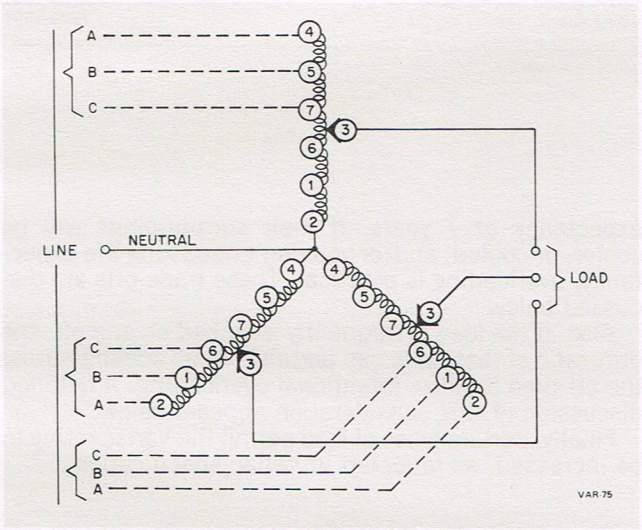
Single phase, four gang; parallel wired.



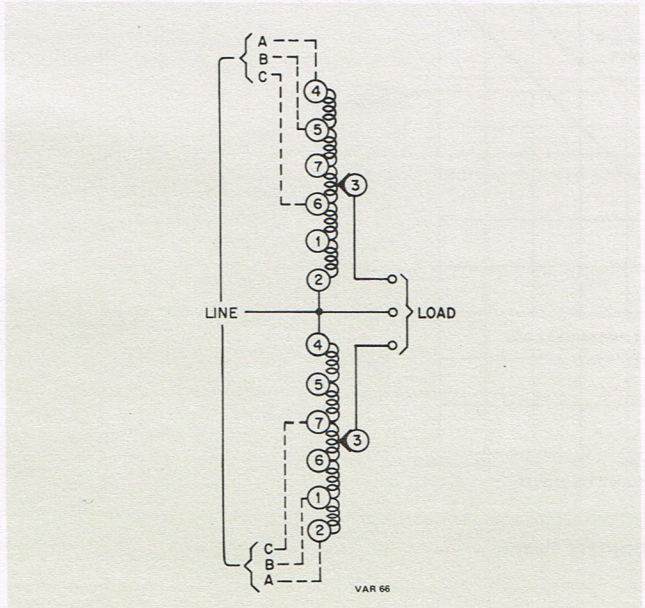
Wiring Diagrams

Note: A = line-voltage connection, B = overvoltage connection, C = voltage-doubling connection (terminals 6 and 7 exist on H models only).

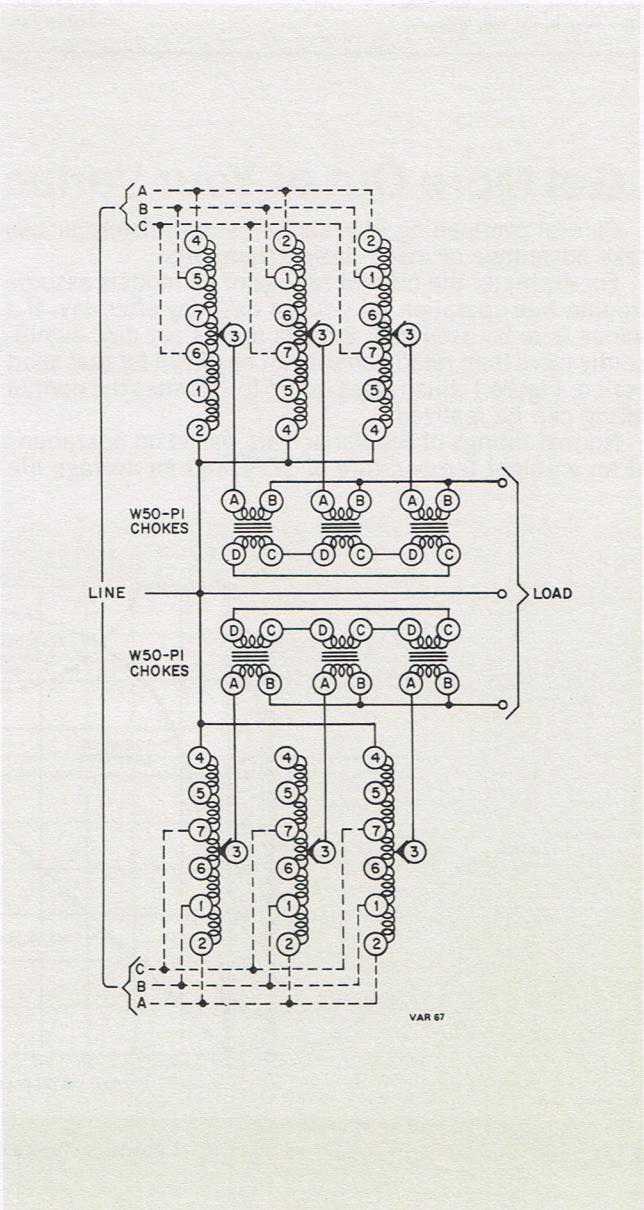
Three phase, three gang; wye.



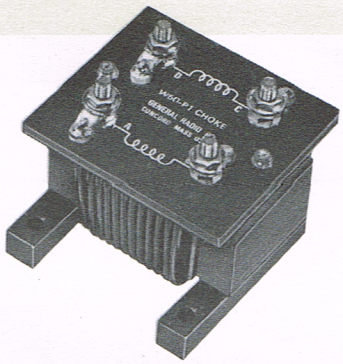
Three phase, two gang; open delta.



Three phase, six gang; open delta.



W50-P1 Paralleling Choke



Many of the Variac® autotransformers listed on the preceding pages are indicated to require one or more Type W50-P1 Chokes. This unit is used when two or more autotransformer outputs are to be connected in parallel; it prevents the flow of potentially damaging currents from one unit to the other. Instructions for proper interconnecting are included with each unit.

Description	Catalog Number
W50-P1 Choke	**3150-5016**

Replacement Brushes

Occasionally, as a result of accident or excessive wear or current, it may be necessary to replace the autotransformer's carbon brush or brushes. They may be ordered from the table below.

Description	Catalog Number
VB-1 Brush, for M2, W2, W5H	**3200-5901**
VB-2 Brush, for M5, W5, W5L	**3200-5900**
VB-3 Brush, for W8, W8L	**3200-5923**

Description	Catalog Number
VBT-10 Brush, forM10, W10	**3200-5910**
VBT-11 Brush, for W10H	**3200-5911**
VBT-8 Brush Set, for M20, W20	**3200-5908**
VBT-12 Brush Set, for W20H	**3200-5912**
VBT-13 Brush Set, for W30	**3200-5913**
VBT-14 Brush Set, for W30H	**3200-5914**
VBT-6 Brush Set, for W50	**3200-5906**
VBT-7 Brush Set, for W50H	**3200-5907**

Get More Out of Your Variac

Careful overloading of a Variac® autotransformer can take advantage of many design trade-offs.

For example, the current ratings of all models assume trouble-free operation 24 hours a day, day after day. If a Variac is to be used only 2 hours or less per day, significantly more than rated current can be drawn for that short period. Figure 1 illustrates how up to 10 times the normal rating can be realized.

Normal ratings of the Variacs are based on operations at an ambient temperature of 50°C and an average life expectancy of 7 years. If their surroundings will be cooler, or cooled, and/or you don't need long life expectancy, overloading is practical. These trade-offs are discussed below.

Also, if the load is frequently switched on and off, the duty ratio of that cycle can permit enough cooling during the off time to allow intentional overloading. A detailed discussion of this consideration appears below.

Finally, certain types of load permit the Variac rating to be increased, as reflected in Variac specifications.

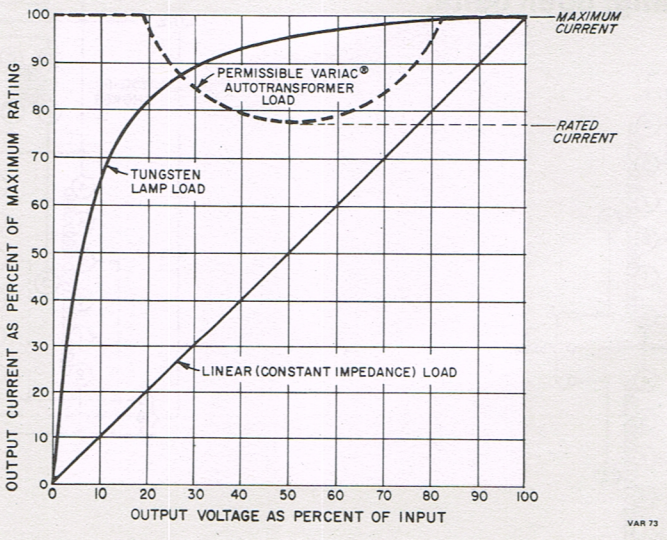


Figure 3. Typical load-current curves.

National stock numbers are listed at the back of the catalog.

Match the Variac to the load To enable the user to get the most out of a Variac autotransformer, GenRad specifies the current rating with two different numbers, rated current and maximum current. Briefly, remember that maximum current can be drawn from the autotransformer only when the output voltage is set near line voltage. Rated current, on the other hand, can be drawn at any setting of the Variac and is the only rating applicable when the overvoltage connection of the Variac is employed.

The two ratings exist because there are two basic categories of load (linear and nonlinear) and because the Variac cannot supply as much current at a mid-range setting as it can near the extremes without overheating. In Figure 3, the sagging dashed line plots the reduction in the current capacity at mid-range. With an output of 50% of line voltage, the greatest current is flowing through the Variac winding causing the greatest heating. The straight black line shows the current that a well-behaved constant-impedance load will draw through the Variac as the voltage is decreased from maximum. Note that, even though maximum current is drawn at maximum voltage, the line stays well below the reduced capacity level at mid-range. Typical of this kind of load is a heating element.

Unfortunately, all loads don't behave so well, incandescent lights in particular. They react to a decreasing voltage much as shown by the curved solid line. The current they draw drops very little even as the voltage is cut to 50% of maximum. If a load of this type is permitted to draw maximum current at maximum voltage, it will obviously exceed the Variac capacity at mid-range, causing overheating and reduced life. A Variac with larger current capacity must be chosen so the load will not exceed its rated current and thus remain within bounds at mid-range.

So, for many loads, the maximum current rating permits greater performance without risk, while for other common loads, the rated current specification is a necessary guard against overheating. To limit the specification to but one number would mean either unnecessary caution or undesirable risk; neither would permit full utilization of the Variac capability.

Effect of duty cycle When the duty-cycle operation is continuous, the rating should be determined as follows: The duty-cycle ratio is defined as the ratio of "off-plus-on" time to "on" time; the rated current can be multiplied by the square root of this ratio to obtain the allowable uprated current. The following examples will illustrate the calculation of permissible overloads for the W5 model, whose rated current is 6 amperes.

Example 1: *The load is on for 15 seconds out of every 4 minutes (240 seconds).*

$$\text{duty cycle} = \sqrt{\frac{240}{15}} = 4$$

duty-cycle uprated current = 6 A × 4 = 24 A

From Figure 1, a 15-second overload uprates the current by 500% so that

short-term overload current = 6 A × 5 = 30 A

Since the lower rating takes precedence, the 24-A limitation imposed by the duty ratio is the maximum current permissible. Note, on the overload curve of Figure 1, the lower curve must be used for models with built-in fuses.

Example 2: *The load is on for 6 seconds out of each minute (60 seconds) over a duration of one-half hour.*

$$\text{duty cycle} = \sqrt{\frac{60}{6}} = 3.16$$

short-term overload for 30 minutes = 133%

from duty-cycle and 30-minute short-term overload considerations:

uprated current = 6 A × 3.16 × 1.33 = 24.6 A

short-term overload current = 6 A × 7.25 = 42.7 A

Since the lower rating takes precedence, the 24.6-A limitation imposed by the duty-cycle and 30-minute short-term overload is the maximum current permissible.

A trade off—life vs increased rating When the effects of temperature upon rating and upon insulation life are combined, a new life-load-ambient relationship is obtained; Figure 4 illustrates this relationship.

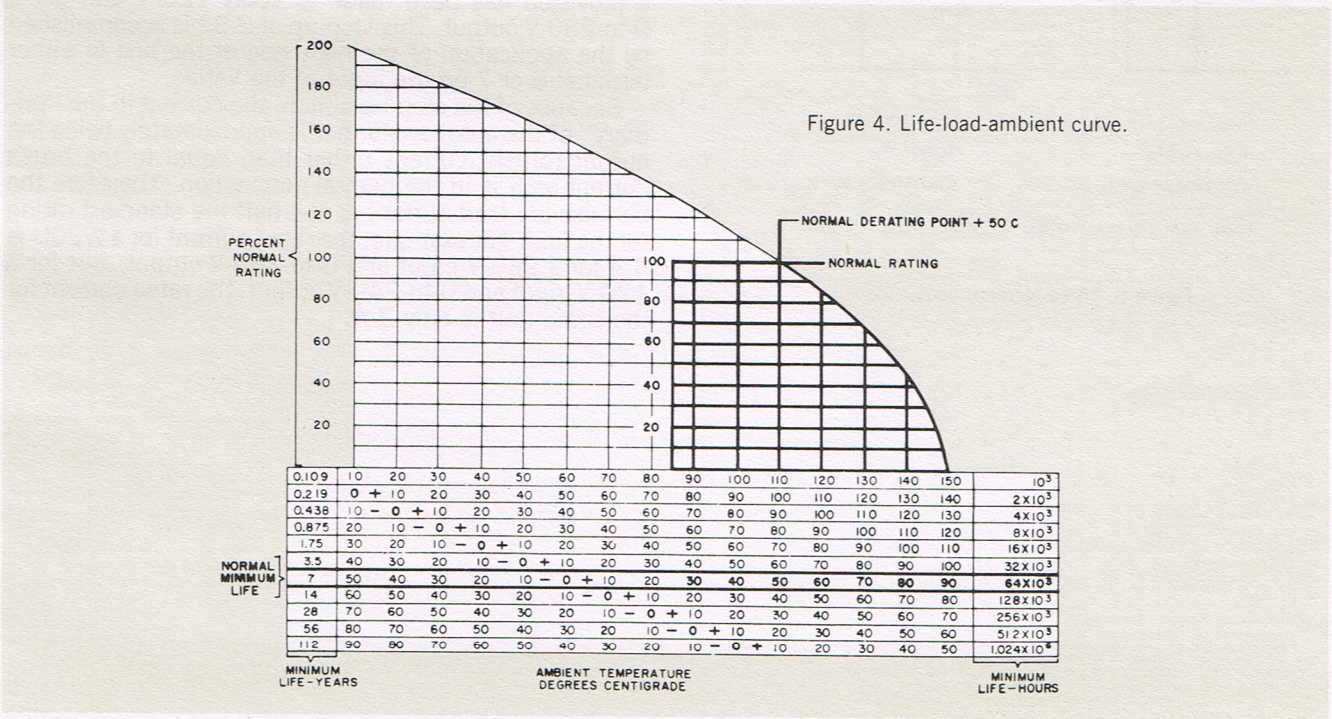


Figure 4. Life-load-ambient curve.

Except for a reference to the effects of duty cycle, all previous rating methods have been based on a steady-state, 24-hours-a-day operation for a calculated minimum seven-year life. However, with these data one can trade minimum life for increased rating or vice-versa. You can do this by following the life-load-ambient curve and uprating or derating as desired. It should be noted that the limit of ten times rated current should *never,* under any circumstance, be exceeded.

As another example, consider the W5 model previously described. In this case, the rating is further modified by a requirement of a 4000-hour minimum life at a 30°C ambient temperature:

Uprating for 30°C ambient, 4000-hour life	1.65
Duty cycle	× 4
Resultant uprating factor	6.60
W5 rating	× 6 A
Allowable current from duty cycle	**39.6 A**
Uprating for 30°C ambient, 4000-hour life	1.65
15-second short-term overload factor	× 5
Resultant uprating	8.25
W5 rating	× 6 A
Allowable current from short-term overload	**49.5 A**

Since 39.6 is the smaller, it is the limiting value; thus the allowable current is 39.6 amperes.

Three-phase load calculations If the three-phase-load unit is marked with rated line-voltage and current or load-power (kVA), you can easily select a Variac.

If, however, the ratings are known only for the individual three elements of the load, you must do some figuring to arrive at the values needed to use the selection tables.

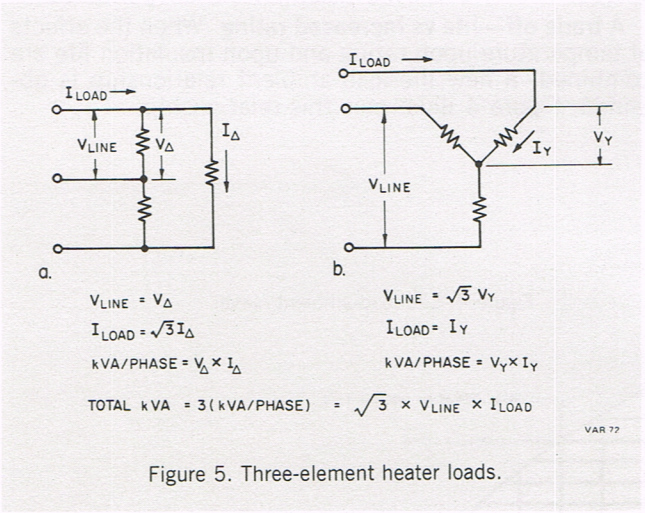


Figure 5. Three-element heater loads.

Consider, for example, three heater elements, each rated at 1.4 kVA and 240 V, which are connected in a delta configuration as in Figure 5a. To deliver full power, they must be connected, through a Variac to provide control, to a 240-V line. The current each Variac must supply, I_{load}, is $\sqrt{3}$ times larger than the current in each element to a delta load:

$$I_{load} = \sqrt{3}\,\frac{1400\ (VA)}{240\ V} = 10.1\ A$$

In the table of 3-phase, 240-V models, the first model listed with adequate "maximum current" rating is the W20HG2. It has two drawbacks, however: It cannot supply overvoltage output (since that means limiting the output to the "rated current" value), and it is not the most economical selection. The W8G3 Variac is considerably less expensive but cannot supply overvoltage either, for a different reason: It must be wired in a wye configuration in which the maximum voltage allowed, 140 V, will be applied to each unit in the assembly, thus preventing added voltage from being developed for the load. To get over-voltage capability, find, in the table, the next model that is wired in an open delta and has adequate "maximum current" rating: The W30HG2. A quick look at larger open-delta assemblies confirms that this is the least expensive choice.

Now consider three heater elements, each rated at 1.0 kVA and 120 V, which are connected in a wye as in Figure 5b. To deliver full power, each element must have 120 V applied. Since the line voltage across a wye is $\sqrt{3}$ times that across each arm, the needed line voltage is 208 V. Each arm will draw 1000 VA/120 V or 8.3 A from each Variac. From the specifications for 3-phase units, select the W5LG3 as having adequate "maximum current" rating. However, the W5LG3 cannot supply over-voltage. If you want the overvoltage feature, you need a W8G3, based on its rated current.

Note that the configuration, open-delta or wye, of the load and the Variac do not have to match.

Voltage doubling In normal use, a Variac supplies an output of from 0 to line voltage (or slightly higher when the overvoltage connection is used). On the 240-V (H) models, a provision has been made to apply 120 V and get a 0-to-280-V output. This step-up of 2.33 is accomplished by the application of the high side of the line to either terminal 6 or 7 on the input of the Variac.

Because of the step-up action, the current in the "primary" of the autotransformer is approximately twice the output (brush) current rather than equal to the brush current as it is in the normal connection. Therefore the permissible load current is one half the standard rating for the unit. For example, the rated current for a W20H is 4 A for a 240-V input and 0-to-280-V output. But for a 120-V input and 0-to-240-V output, the rated current for the same unit is only 2 A.

Narrow-Range Voltage Adjustment Circuits

The Variac® autotransformer is inherently a wide-range device. If the required range of voltage adjustment is narrow, it can most effectively be used with a supplementary transformer (available from any power-transformer manufacturer) having a ratio determined by the ratio of the normal Variac autotransformer range to the required range of adjustment. In this way the whole traverse is used to effect the necessary adjustment, improving resolution and multiplying the available current by the transformation ratio of the supplementary transformer. Such narrow-range operation generally falls into one of two classifications, low voltage or line voltage.

In the *low-voltage* case, either an isolation transformer or a fixed-ratio autotransformer can be used as shown in Figure 6. It is interesting to note that the supplementary transformer in this example allows the use of a unit of about 1/20th the current rating that would be required where the load operated directly from the autotransformer. Furthermore, the resolution or fineness of adjustment is greatly improved by two factors—the control range is spread over the whole traverse and the smaller Variac has more turns per volt.

Line-Voltage Adjustment

Buck *OR* Boost For many applications a lower-rated model can be used in conjunction with other transformers to provide better resolution at lower or equal cost. The following examples represent a few of the many possibilities.

If the application requires that the voltage should be varied ±30% or less, one of the best solutions is probably to use a buck or boost transformer in conjunction with a Variac, as shown in Figure 7. In such a configuration the load voltage is equal to the line voltage plus or minus the voltage across the fixed-turn-ratio transformer.

For example: What size fixed transformer and Variac are necessary to provide 96 to 120 V from a 120-V line into a 50-A load? The maximum voltage required across the secondary of the fixed transformer is 120 − 96 = 24 V. This would occur when it receives the full voltage (120 V) from the Variac. Hence the turns ratio of the fixed transformer is 24/120 = 1/5. The current in the secondary is the load current (50 A). Therefore the current in the primary is 50 A divided by the turns ratio or 10 A. This would require a Variac rated at 10 A and 120 V, i.e., a W10.

By the reversal of the connections on the primary or secondary of the fixed transformer, the phase of its voltage will be reversed and its output will *boost* rather than buck the line voltage so that the voltage across the load will be 120 to 144 V.

Where the regulated line is always high or always low, an autotransformer can also be used as shown in Figures 8 and 9. In the step-down case, the transformation ratio allows a 6-A unit to control a load of 6 × 13 × 120 = 9.4 kVA; in the step-up case, 6 × 11 × 120 = 7.9 kVA.

Buck *AND* Boost A similar problem is that of being able both to increase or decrease the voltage from the nominal line-voltage input. This can be accomplished by the circuit in Figure 10. The problem in this case is to provide a variable voltage of 110 to 130 V at 50 A from a 120-V supply.

The voltage needs to be varied ±10 V and we have 0 to 120 V or ±60 V available. Therefore a 6:1 fixed transformer is required, having a primary rating of 60 V and 8.3 A (50 A/6) and a secondary rating of 10 V and 50 A. The Variac would be a W10 specially ordered with a center tap.

This technique can be extended so that you can obtain a constant voltage output from a varying input. For example, if the input varies from 110 to 130 V and it is desired to maintain an output of 120 V into 50-A load, then the circuit of Figure 11 can be employed.

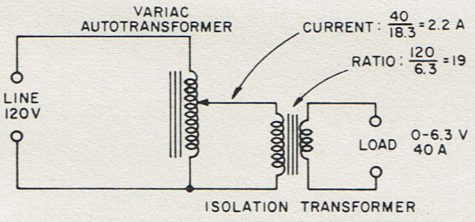


Figure 6. Low-voltage output.

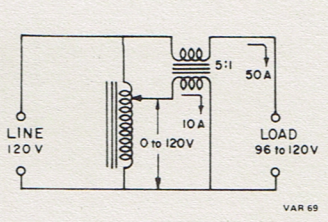


Figure 7. Line-voltage output.

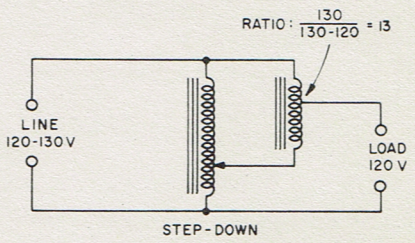


Figure 8. Step-down circuit for high line voltage

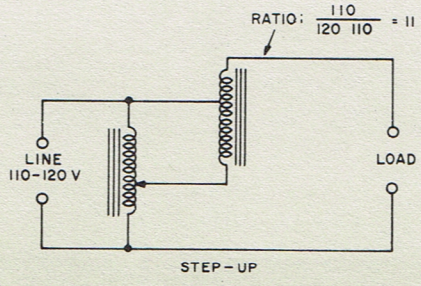


Figure 9. Step-up circuit for low line voltage.

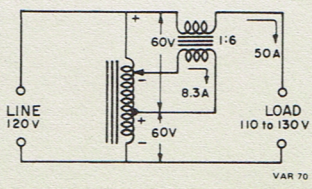


Figure 10. Overvoltage output.

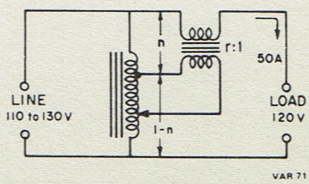


Figure 11. Constant-voltage output.

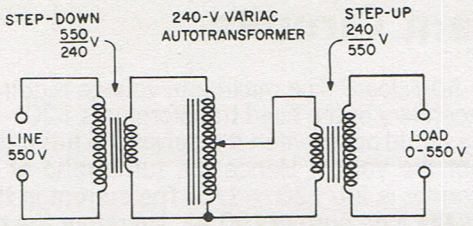


Figure 12. Line-voltage adjustment circuit when line and load voltages are beyond the range of the Variac autotransformer.

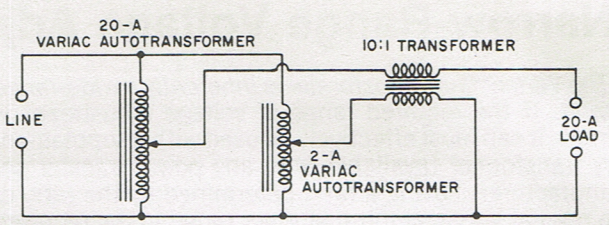


Figure 13. Line-voltage adjustment with a coarse/fine control.

The 110-V input requires an addition of 10 V, and the 130-V input requires a subtraction of 10 V. If we arbitrarily assign the fixed transformer a ratio of r then the output from the Variac will be 10r in volts. If the Variac is center tapped, the maximum available voltage would be 55 V for a 110-V input and 65 V for a 130-V input. The Variac can be tapped on special order so that 130 n = 110 (1-n), where n is the location of the tap as a ratio of the total winding. In this example, n is equal to 55/120 or 0.458. In the case of 240-V systems, H models have a tap at the 0.429 position (120 V/280 V), and this tap satisfies most requirements without necessitating a special order. In the example, the voltage available from the Variac would be 0.458 × 65 V = 60.8 V. Since a 10-V correction is required, the buck-boost transformer ratio should be 6:1, its primary rating would be 61 V at 8.3 A, and its secondary rating would be 10 V at 50 A. The proper Variac to use would be a W10 with a tap at the 0.458 position.

Where the line and load voltages are vastly dissimilar from the Variac operating voltage, a Variac unit or assembly may be inserted between transformers as shown in Figure 12. The transformers may be either isolation transformers, as shown, or autotransformers. There is, of course, no current gain in this case. In fact, current rating of the Variac autotransformers must be 55/24 of the load-current requirement.

Two Variac autotransformers can be combined with a supplementary transformer to give a coarse/fine control as shown in Figure 13. The two-ampere model and supplementary transformer make an effective vernier adjustment.