CONTENTS RESISTORS

fixed resistors

carbon film

CR16 CR25 CR37
CR52 CR68 CR93

For detailed information
Handbook CM2a

Resistance ranges	from 1 Ω to 10 MΩ; E12 or E24 series				
Resistance tolerance	5 and 10%				
Abs. max. dissipation	CR16	0,2 W	CR52	0,67 W	
at T_{amb} = 70 °C	CR25	0,33 W	CR68	1,15 W	
	CR37	0,5 W	CR93	2 W	
Basic specification	IEC 115-1, 115-2				
Climatic category (IEC 68)	55/155/56				
Stability after load	see nomogram				

colour	first two digits of resistance value	multiplier	tolerance
black	0	1 x	
brown	1	10 x	
red	2	100 x	
orange	3	1 000 x	
yellow	4	10 000 x	
green	5	100 000 x	
blue	6	1 000 000 x	
violet	7		
grey	8		
white	9		
silver			± 10%
gold		0,1 x	± 5%

style	limiting voltage V(r.m.s.)	rated dissipation at 70 °C W	resistance range	tolerance %	series	catalogue no.
CR16	150	**0,2**	10 Ω - 220 kΩ	5	E24	2322 210 13 . . .
			270 kΩ - 1 MΩ	10	E12	2322 210 12 . . .
CR16 on reel			10 Ω - 220 kΩ	5	E24	2322 210 23 . .
			270 kΩ - 1 MΩ	10	E12	2322 210 22 . .
CR25	150	**0,33**	1 Ω - 1 MΩ	5	E24	2322 211 13 . .
			1,2 MΩ - 10 MΩ	10	E12	2322 211 12 . . .
CR25 on reel			1 Ω - 1 MΩ	5	E24	2322 211 23 . .
			1,2 MΩ - 10 MΩ	10	E12	2322 211 22 . .
CR25A	250	**0,33**	1 Ω - 1 MΩ	5	E24	2322 106 33 . .
			1,2 MΩ - 10 MΩ	10	E12	2322 106 32 . .
CR37	350	**0,5**	1 Ω - 1 MΩ	5	E24	2322 212 13 . .
			1,2 MΩ 10 MΩ	10	E12	2322 212 12 . . .
CR37 on reel			1 Ω - 1 MΩ	5	E24	2322 212 23 . .
			1,2 MΩ - 10 MΩ	10	E12	2322 212 22 .
CR52 [1]	500	**0,67**	1 Ω - 1 MΩ	5	E24	2322 213 13 .
CR68 [1]	750	**1,15**	1 Ω 1 MΩ	5	E24	2322 214 13 . .
CR93 [1]	1000	**2**	10 Ω - 1 MΩ	5	E24	2322 215 13 . .

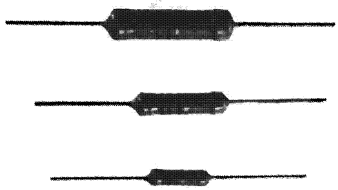
[1] For values > 1 MΩ see high-voltage resistors VR37 and VR68

Composition of the catalogue no.

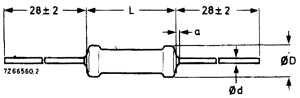
In the above-mentioned catalogue no., replace the first two dots by the first two digits of the resistance value.
Replace the third dot by a figure according to the following table:

1 - 9,1 Ω	8	10 - 91 kΩ	3
10 - 91 Ω	9	100 - 910 kΩ	4
100 - 910 Ω	1	1 - 9,1 MΩ	5
1 - 9,1 kΩ	2	10 MΩ	6

Example
Style CR25 (not on reel) 10 Ω, 5% cat. no. 2322 211 13109

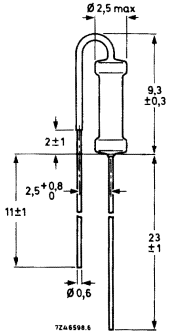


style	D_{max}	L_{max}	d	a_{max}
CR16	1,6	4,0	0,4	1,0
CR25	2,5	6,8	0,6	1,0
CR37	3,7	10	0,7	1,0
CR52	5,2	16,5	0,8	1,2
CR68	6,8	18	0,8	1,2
CR93	9,0	31,7	0,8	1,2



Style CR25A

The bent lead is partly covered with an insulating lacquer having a breakdown voltage of at least 50 V(d.c.)



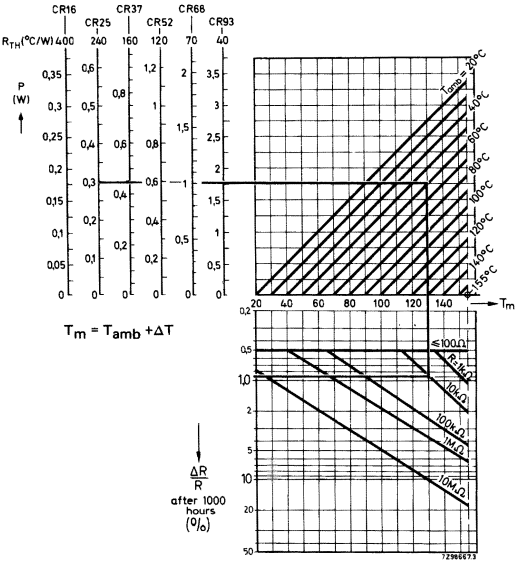
Nomogram to find style or stability

Example
What is the stability of a 10 kΩ resistor, style CR25, operating at
0,3 W in an ambient of 60 °C ?

Find 0,3 W on CR25 style column.

Follow the line right, down, left, to the stability axis. ΔR/R is 1% over 1000 working hours.

Use the reverse procedure to find right style for a given stability and dissipation.



fixed resistors

metal film - lacquered

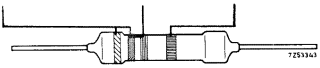
MR25 MR30 MR52

Resistance ranges	from 1 Ω to 1 MΩ E24, E96 and E192 series
Resistance tolerance	± 0,5, ± 1, ± 2, ± 5%
Temperature coefficient	± 50, ± 100, ± 200 ppm/ °C
Abs. max. dissipation at T_{amb} = 70 °C	MR25 0,4 W MR30 0,5 W MR52 0,75W
Basic specification	IEC 115-1
Climatic category (IEC68)	55/155/56
Stability after load	see nomogram

for E96 series
E192 series

colour	first digits of resistance value	multiplier	tolerance
black	0	1 x	
brown	1	10 x	± 1%
red	2	100 x	± 2%
orange	3	1 000 x	
yellow	4	10 000 x	
green	5	100 000 x	± 0,5%
blue	6		
violet	7		
grey	8		
white	9		
silver		0,01 x	
gold		0,1 x	± 5%

for E24 series



style	limiting voltage (r.m.s) V	rated dissipation at 70 °C W	resistance range	tolerance ± %	series	temperature coefficient ± ppm/ °C	catalogue no. 2322 followed by
MR25	250	0,4	4,99 Ω - 681 kΩ	0,5	E192	50 [1]	151 7 .
	250		4,99 Ω - 681 kΩ	1	E96 + E24	50 [1]	151 5 . .
	250		1 Ω - 680 kΩ	2	E24	100	151 4 .
	250		1 Ω - 680 kΩ	5	E24	200	151 6 . . .
MR25	250		4,99 Ω - 681 kΩ	1	E96	50 [1]	151 2 . .
on reel	250		1 Ω - 680 kΩ	2	E24	100	151 1 . .
	250		1 Ω - 680 kΩ	5	E24	200	151 3 . .
MR30	350	0,5	4,99 Ω 1 MΩ	0,5	E192	50 [1]	152 7 .
	350		4,99 Ω 1 MΩ	1	E96 + E24	50 [1]	152 5 .
	350		5,1 Ω 1 MΩ	2	E24	100	152 4 .
	350		5,1 Ω 1 MΩ	5	E24	200	152 6 .
MR30	350		4,99 Ω 1 MΩ	1	E96	50 [1]	152 2 .
on reel	350		5,1 Ω 1 MΩ	2	E24	100	152 1
	350		5,1 Ω 1 MΩ	5	E24	200	152 3 .
MR52	500	0,75	4,99 Ω 1 MΩ	1	E96	100	153 5

[1]) For values ≤ 49,9 Ω. 100 ppm/ °C.

Composition of the catalogue no. 2322 . . .

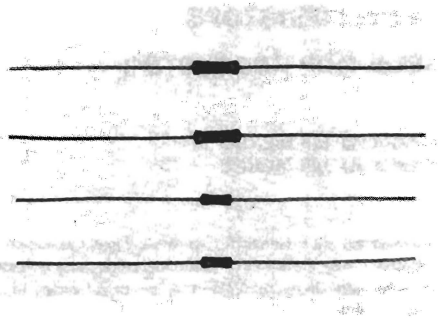
Style code
see table

Tolerance code
7 for ± 0,5%
2 or 5 for ± 1%
1 or 4 for ± 2%
3 or 6 for ± 5%

Resistance code: first three figures of the resistance value followed by

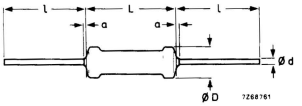
8 for R of 1 to 9,76 Ω
9 for R of 10 to 97,6 Ω
1 for R of 100 to 976 Ω
2 for R of 1 to 9,76 kΩ
3 for R of 10 to 97,6 kΩ
4 for R of 100 to 976 kΩ
5 for R of 1 MΩ

Example
The catalogue no. of an MR30 resistor of 3650 Ω with a tolerance of 1% is 2322 152 53652.



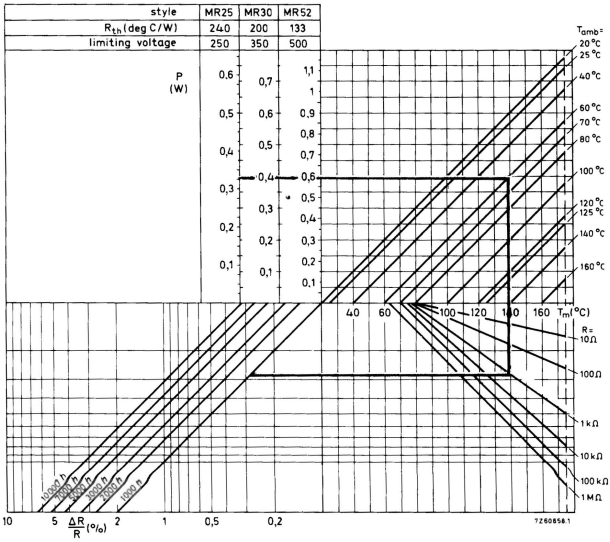
A professional style of resistor that is also widely used in consumer equipment. It meets the high standards required for test and measuring equipment and for communications equipment etc. The lacquer is non-inflammable and is resistant to all the usual cleansing solvents.

style	D_{max}	L_{max}	l	d	a_{max}
MR25	2,5	6,5	28 ± 2	0,6	1
MR30	3	10	28 ± 2	0,6	1
MR52	5,2	16,5	38 ± 3	0,6	1



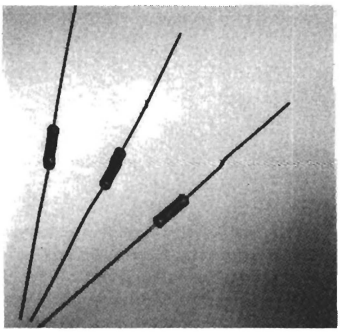
Nomogram to find style or stability

Example
What is the stability of a 1 kΩ metal film resistor, style MR25, operating at 0,33 W in an ambient of 60 °C? Find 0,33 W on MR25 style column. Follow the line right, down, left, to where it intersects the 1000 h line.
ΔR/R is 0,28% over 1000 working hours.
Use the reverse procedure to find right style for a given stability and dissipation.



fixed resistors

metal film-lacquered

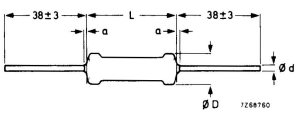


MR24E/C/D MR34E/C/D
MR54E/C/D MR74E/C/D

These resistors are intended for demanding applications where MIL-STD is required. They meet MIL-R-10509F in all respects and can be supplied with tolerances down to 0,1% and, to special order, in non-standard resistance values.

Resistance ranges	from 10 Ω to 1 MΩ, E96, E192 series
Resistance tolerances	0,1 0,25 0,5 1%
Rated dissipation	
at T_{amb} = 125 °C	MR24E/C 0,1 W
	MR34E/C 0,125 W
	MR54E/C 0,25 W
	MR74E/C 0,5 W
at T_{amb} =70 °C	MR24D 0,125 W
	MR34D 0,25 W
	MR54D 0,5 W
	MR74D 0,75 W
Basic specification	MIL-R-10509F
Stability after load	ΔR/R max. 0,5% +0,05 Ω

style	D_{max}	L_{max}	d	a_{max}
MR24 E/C/D	2,5	6,5	0,6	1
MR34 E/C/D	3,1	10,5	0,6	1
MR54 E/C/D	5,2	16,5	0,6	1
MR74 E/C/D	6,8	20,5	0,8	1



style	max. voltage	rated dissipation	resistance range and tolerance	maximum temperature coefficient ppm/ °C	MIL style	style code
	V(r.m.s.)	W				
		at 125 °C	0,1/0,25/0,5% E192 series ±			
			1% E96 series			
MR24E	200	**0,1**	49,9 Ω–100 kΩ	25	RN55E	160
MR24C	200	**0,1**	49,9 Ω–100 kΩ	50	RN55C	161
MR34E	250	**0,125**	49,9 Ω–499 kΩ	25	RN60E	163
MR34C	250	**0,125**	49,9 Ω–499 kΩ	50	RN60C	164
MR54E	300	**0,25**	49,9 Ω– 1 MΩ	25	RN65E	166
MR54C	300	**0,25**	49,9 Ω– 1 MΩ	50	RN65C	167
MR74E	350	**0,5**	24,9 Ω– 1 MΩ	25	RN70E	169
MR74C	350	**0,5**	24,9 Ω– 1 MΩ	50	RN70C	170
		at 70 °C	1% E96 series	±		
MR24D	200	**0,125**	10 Ω–301 kΩ	100	RN55D	162
MR34D	300	**0,25**	10 Ω– 1 MΩ	100	RN60D	165
MR54D	350	**0,5**	10 Ω– 1 MΩ	100	RN65D	168
MR74D	500	**0,75**	10 Ω– 1 MΩ	100	RN70D	171

Marking: (to MIL-R-10509 F)
Each resistor is marked with:
MIL style
value and tolerance in MIL code
manufacturers' identification symbol

Composition of the catalogue no.

2322 . . . . . .

Style code see table
Tolerance code [1])
1 for ± 1%
2 for ± 0,5%
3 for ± 0,25%
4 for ± 0,1%

Resistance code [1]): first three figures of the resistance value followed by
9 for R of 10 to 98,8 Ω
1 for R of 100 to 988 Ω
2 for R of 1 to 9,88 kΩ
3 for R of 10 to 98,8 kΩ
4 for R of 100 to 988 kΩ
5 for R of 1 MΩ

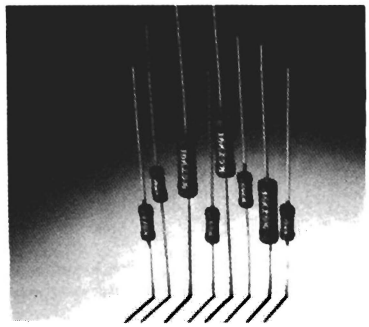
Example
Style MR24E, 261 kΩ, 0,25%; catalogue no. 2322 160 32614.

[1]) Where following values occur, use numbers shown below.

value Ω	last 5 digits of the catalogue no. 0,1%	0,25%	0,5%	1%
29,9	92102	92122		
39,9	92103	92123		
49,9	92104	92124	92134	92144
59,9	92105	92125		
69,9	92106	92126		
79,9	92107	92127		
89,9	92108	92128		
99,9	92109	92129		

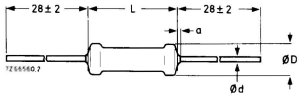
metal film-power

PR37 PR52



Resistance range, PR37	10 Ω to 10 kΩ, E24 series	
PR52	10 Ω to 27 kΩ, E24 series	
Resistance tolerance	± 5%	
Max body temperature (hot spot)	300 °C	
Rated dissipation at T_{amb} = 70 °C	PR37	1,6 W
	PR52	2,5 W
Basic specification	MIL-R-11804/2B, char. G	
Climatic category (IEC 68)	55/200/56	
Stability after:	requirement	typical value
1000 h max load	ΔR ⩽ 5%	ΔR 2,5%

style	L_{max}	D_{max}	a_{max}	d_{max}
PR37	10,0	3,7	1	0,6
PR52	16,7	5,2	1,2	0,6



Marking

Each resistor is marked with:

resistance value (R for Ω, K for kΩ)
tolerance on resistance
e.g. for 27 Ω: 27 R ± 5%
for 3,9 kΩ: 3K9 ± 5%

Composition of the catalogue no.

2322 19. 3 .. 0.

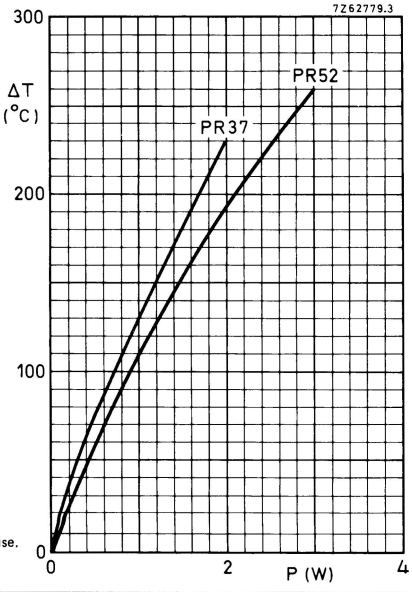
Style code
191 for PR37
192 for PR52

Tolerance code
3 for 5%

9 for R of 10 to 91 Ω
1 for R of 100 to 910 Ω
2 for R of 1000 to 9100 Ω
3 for R of 10000 to 27000 Ω

First two digits of the resistance value (E24 series)

Example:
PR52, 240 Ω, 5%
catalogue no. 2322 192 32401



ΔT = hot-spot temperature rise.

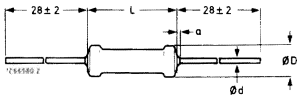
fixed resistors
high voltage

VR37 VR68

A range of metal glazed resistors especially intended for stability and reliability at high voltages. They are commonly used as protection resistors in tv and radio touch control systems.

Resistance range, VR37	1 MΩ to 33 MΩ, E24 and E96
VR68	1 MΩ to 68 MΩ, E24 and E96
Resistance tolerance	± 1% (E96) and ± 5% (E24)
Max body temperature (hot spot)	155 °C
Temperature coefficient	± 200 ppm/ °C
Rated dissipation at T_{amb} = 70 °C	VR37 0,5 W
	VR68 1,0 W
Limiting voltage, VR37	3500 V(d.c.) or 2500 V(r.m.s.)
VR68	10000 V(d.c.) or 7000 V(r.m.s.)
Dielectric withstanding voltage of the insulation for 1 minute	min 700 V(r.m.s.)
Basic specification	IEC 115, type 1B
Climatic category (IEC 68)	55/155/56
Noise	0,5 μV/V
Stability after:	VR37 VR68
1000 h max load	ΔR 0,5% ΔR 1%

style	L_{max}	D_{max}	a_{max}	d
VR37	10	3,7	1,0	0,7
VR68	18	6,8	1,2	0,8



Composition of the catalogue no.

2322 ... .

style code
242 for VR37
244 for VR68

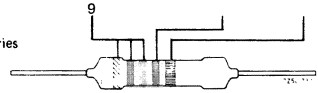
5 for R of 1 MΩ to 9,1 MΩ
6 for R of 10 MΩ to 68 MΩ

E24: 13 + first two digits of the resistance value
E96: 8 + first three digits of the resistance value

E24 series

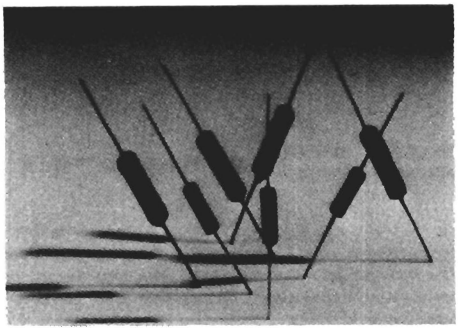
colour	first digits of resistance value	multiplier	tolerance
black	0		
brown	1		± 1%
red	2		
orange	3		
yellow	4		± 5%
green	5	100 000 x	
blue	6	1 000 000 x	
violet	7		
grey	8		
white	9		

E96 series



cemented wirewound

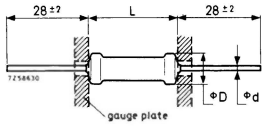
AC04 AC05 AC07
AC10 AC15 AC20



These wirewound resistors are specially designed to dissipate high loads in a small volume.
The resistor is coated with a green silicon cement which is non-inflammable and cannot drip at high overloads.

Resistance range	from 0,1 Ω to 33 kΩ E24 series
Resistance tolerances	5% and 10%
Maximum body temperature	350 °C
Rated dissipation at T_{amb} = 40 °C	AC04 4 W, AC10 10 W AC05 5 W, AC15 15 W AC07 7 W, AC20 20 W
Basic specification	IEC 266
Climatic category (IEC 68)	40/200/56
Stability after load	ΔR/R max 5%

style	D_{max}	L_{max}	d
AC04	6	19	0,6
AC05	8	19	0,8
AC07	8	27	0,8
AC10	8	44	0,8
AC15	10	51	0,8
AC20	10	67	0,8

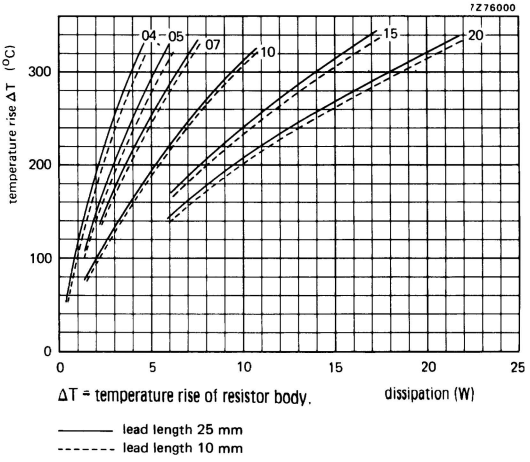


style	rated dissipation (W) T_{amb} = 40 °C	T_{amb} = 70 °C	resistance range Ω	tol. %	series	catalogue no. 2322 329
AC04	4	3,5	0,18 – 8,2	10	E12	34 . . .
			10 – 4700	5	E24	04 . . .
AC05	5	4,7	0,18 – 8,2	10	E12	35 . . .
			10 – 5600	5	E24	05 . . .
AC07	7	5,8	0,10 – 8,2	10	E12	37 . .
			10 – 10 000	5	E24	07 . . .
AC10	10	8,4	0,68 – 8,2	10	E12	40 . . .
			10 – 15 000	5	E24	10 . . .
AC15	15	12,5	0,82 – 8,2	10	E12	45 . . .
			10 – 22 000	5	E24	15 . . .
AC20	20	16	1,2 – 8,2	10	E12	50 . . .
			10 – 33 000	5	E24	20 . . .

Composition of the catalogue no.

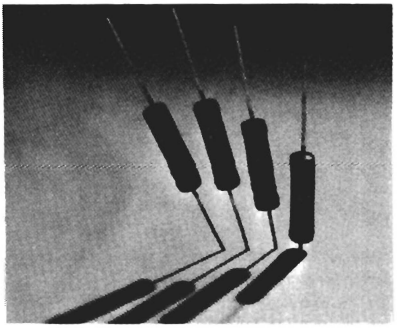
In the catalogue no. (table above) replace the first two dots by the first two digits of the resistance value. Replace the third dot by a figure according to the following table:

0,1 - 0,82	Ω: 7
1 - 8,2	Ω: 8
10 - 91	Ω: 9
100 - 910	Ω: 1
1 000 - 9 100	Ω: 2
10 000 - 33 000	Ω: 3



fixed resistors

enamelled wirewound

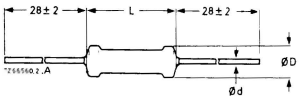


WR0617E WR0825E
WR0842E WR0865E **MAINTENANCE TYPES**

These resistors have a permissible hot-spot temperature of 400 °C. The leads are of a special material with high thermal resistance to counter temperature effects of the solder joint. The coating is a high quality vitreous enamel.

Resistance range	from 4,7 Ω to 100 kΩ E24 series
Resistance tolerance	± 5%
Max. body temperature (hot spot)	400 °C
Rated dissipation at T_{amb} = 70 °C	WR0617 E 4,2 W WR0825 E 7 W WR0842 E 11 W WR0865 E 17 W
Basic specification	IEC 266, type 2
Climatic category (IEC 68)	55/200/56
Stability after 1000 h max. load	ΔR/R max. 5%

style	D_{max}	L_{max}	d
WR0617E	6	19	0,7
WR0825E	8	27	0,8
WR0842E	8	44	0,8
WR0865E	8	67	0,8



style	rated dissipation at T_{amb} = 70 °C W	resistance range Ω	catalogue no.
WR0617E	4,2	4,7 - 4 700	2322 330 22 . . .
WR0825E	7	6,8 - 27 000	2322 330 32 . . .
WR0842E	11	10 - 56 000	2322 330 42 . . .
WR0865E	17	15 - 100 000	2322 330 52 . . .

Marking

Each resistor is marked with:

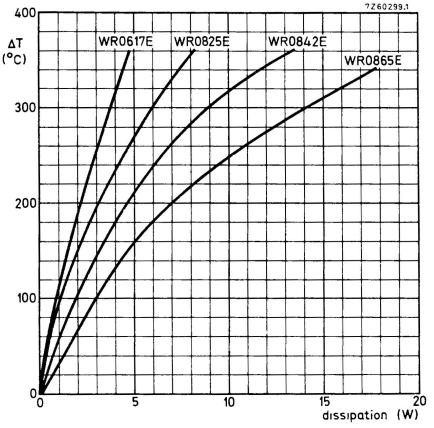
resistance value (R for Ω, K for kΩ)
e.g. 27 Ω = 27R
27 kΩ = 27K

tolerance
style

Composition of the catalogue no.

In the above-mentioned catalogue no. replace the first two dots by the first two digits of the resistance value. Replace the third dot by a figure according to the following table:

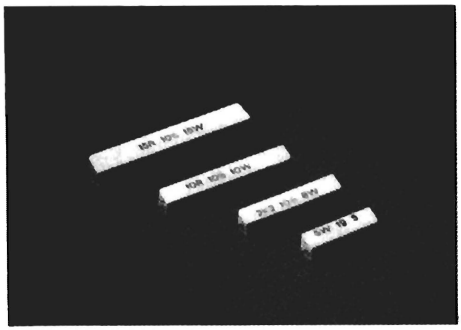
4,7	-	9,1 Ω	: 8
10	-	91 Ω	: 9
100	-	910 Ω	: 1
1 000	-	9 100 Ω	: 2
10 000	-	91 000 Ω	: 3
		100 000 Ω	: 4



ΔT = temperature rise of resistor body.

rectangular wirewound

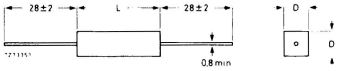
EH05 EH08
EH10 EH15



Resistors especially designed for high dissipation in a small volume. The rectangular package makes mounting quick and simple. Maximum hot-spot temperature of the resistors is 350 °C.

Resistance ranges	from 0,15 Ω to 12 kΩ E12 and E24 series
Resistance tolerance	± 5% or ± 10%
Max. body temperature (hot spot)	350 °C
Rated dissipation at T_{amb} = 70 °C	EH05 5 W EH08 7 W EH10 9 W EH15 17 W
Basic specification	IEC 266
Climatic category (IEC 68)	40/200/56
Stability after 1000 h rated dissipation	ΔR/R max. 5%

style	D_{max}	L_{max}
EH05	7,2	26
EH08	7,2	36
EH10	7,2	46
EH15	10,2	62



style	rated dissipation (W) at T_{amb} = 70 °C W	resistance range Ω	tol. ± % %	series	catalogue no.
EH05	**5**	0,15 9,1	10	E12	2306 330 02 .
		10 4700	5	E24	2306 330 03 . .
EH08	**7**	0,27 - 9,1	10	E12	2306 331 02 .
		10 - 8200	5	E24	2306 331 03 .
EH10	**9**	0,33 - 9,1	10	E12	2306 332 02 . .
		10 - 10000	5	E24	2306 332 03 .
EH15	**17**	0,47 9,1	10	E12	2306 333 02 .
		10 - 12000	5	E24	2306 333 03 . .

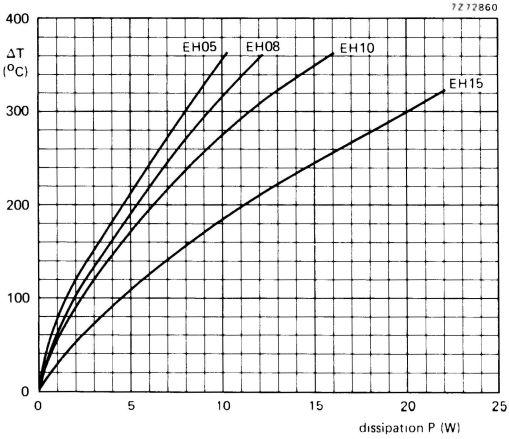
Marking

Each resistor is marked with:
- resistance value (R for Ω, K for kΩ)
  e.g. 27 Ω = 27R
  15 kΩ = 15K
- tolerance on resistance in ± %
- rated dissipation at T_{amb} = 40 °C
- date of manufacture

Composition of the catalogue no.

In the above-mentioned catalogue no. replace the first two dots by the first two digits of the resistance value. Replace the third dot by a figure according to the following table:

0,15	0,91	Ω : 7
1	9,1	Ω : 8
10	91	Ω : 9
100	910	Ω : 1
1 000	- 9 100	Ω : 2
10 000	16 000	Ω : 3

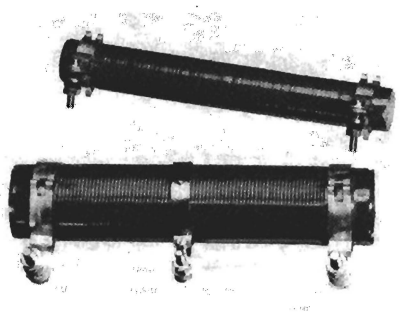


ΔT = temperature rise of resistor body

fixed resistors

wirewound

2322 321 to 324 MAINTENANCE TYPES
fixed or adjustable, with side terminals



Rated dissipation; T_{amb} = 40 °C	P, see table
mounted on metal plate	1,2 P
Temperature coefficient	−50 to +140 ppm/ °C
Climatic category IEC 68	55/155/56

P	coating	resistance range	tolerance	catalogue no. 2322 followed by	
W			%	fixed	adjustable
8	cement	1 Ω – 100 Ω	10	323 14 . . .	-
		110 Ω – 150 Ω	5	323 34 . .	-
	enamel	160 Ω – 6,8 kΩ	5	321 34 .	-
10	cement	1,2 Ω – 27 Ω	10	323 12 .	324 12 .
		30 Ω – 300 Ω	5	323 32	324 32 . .
	enamel	330 Ω – 12 kΩ	5	321 32 .	-
		330 Ω – 3,3 kΩ	5	-	322 32 .
16	cement	1,5 Ω – 2,7 Ω	10	323 10	324 10 . .
		3 Ω – 620 Ω	5	323 30 .	324 30 .
	enamel	680 Ω – 24 kΩ	5	321 30 . .	-
		680 Ω – 6,8 kΩ	5	-	322 30 .
25	cement	2,7 Ω – 15 Ω	10	323 08 . .	324 08 .
		16 Ω – 820 Ω	5	323 28 .	324 28 . .
	enamel	1 kΩ – 39 kΩ	5	321 28 .	
		1 kΩ – 9,1 kΩ	5	-	322 28 .
40	cement	4,7 Ω – 1,6 kΩ	5	323 26	324 26 .
	enamel	1,8 kΩ – 75 kΩ	5	321 26 . .	-
		1,8 kΩ – 18 kΩ	5		322 26 .
60	cement	3 Ω – 2,2 kΩ	5	323 24 .	324 24 .
	enamel	2,4 kΩ – 68 kΩ	5	321 24 .	-
		2,4 kΩ – 24 kΩ	5	-	322 24 .
100	cement	6,8 Ω – 4,3 kΩ	5	323 23	324 23 .
	enamel	4,7 kΩ – 120 kΩ	5	321 23	-
		4,7 kΩ – 47 kΩ	5	-	322 23 .
160	cement	10 Ω – 47 kΩ	5	323 22 .	324 22 . .
250	cement	16 Ω – 11 kΩ	5	323 21 .	324 21

Composition of the catalogue no.

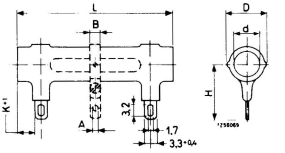
2322 . . . .

See table

The first two digits of the resistance value.

8 for R of 1 to 8,2 Ω
9 for R of 10 to 82 Ω
1 for R of 100 to 820 Ω
2 for R of 1 to 8,2 kΩ
3 for R of 10 to 82 kΩ
4 for R of 100 to 120 kΩ

P ⩽ 40 W



P	L_{max}	D_{max}	d_{min}	K	H	E	B	A	thread
W									
8	26	11,5	5	2,5	14	-	-	-	-
10	41	11,5	4,2	4	14	-	5	2,8	-
16	62	11,5	4,2	4	14		5	2,8	-
25	64	16	7,2	4	20		6	3,2	-
40	103	16	7,2	4	20	-	6	3,2	
60	103	32	12,5	6	33	8,5	6	-	M4
100	165	32	12,5	6	33	8,5	6	-	M4
160	165	44	20	8	40	10	8	-	M5
250	256	44	20	8	40	10	8	-	M5

P ⩾ 60 W