

DATA HANDBOOK

Potentiometers

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Philips Components



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Potentiometers

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PREFACE

All dimensions on drawings are in mm unless otherwise indicated. According to the S.I. units the symbol K (kelvin) is used instead of °C in combinations such as K/W. Also ΔT is in K. Atmospheric pressure is given in kPa instead of millibars, mmHg etc. For example 1000 mbar = 100 KPa (= 1000 hPa).

For easy reference, type numbers (such as CRC10) are at the top of each page. Orders should, however, always state the 12 digit catalogue number.

Some devices have been designated "**Maintenance Types**". These are available for equipment maintenance but no longer recommended for equipment production. The data is contained in a separate section at the back of the book.

Some elements are designated "Obsolete". These types or variations are available until stocks are exhausted. They are indicated by shaded areas covering the relevant data.

Besides the types mentioned in this book we may be able to supply special versions. In that respect your supplier should be consulted.

SELECTION GUIDE

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Potentiometers

Selection Guide

HIGH-VOLTAGE FOCUS UNITS AND COMPONENTS

Selection guide by maximum application voltage.

PRODUCT	MAXIMUM APPLICATION VOLTAGE (kV)	RESISTANCE RANGE (M Ω)	TYPE	CATALOGUE NUMBERS	PAGE
Focus metal-glaze preset potentiometers	11.0	69 to 125	FMP-MCS	2322 460 903..	21
				2322 460 913..	21
	13.0	10 to 500	FMP-SLD	2322 460 903..	74
				2322 460 933..	74
	13.0	30 to 300	FMP-PRT-VERT	2322 460 902..	95
	13.0	30 to 300	FMP-PRT-HOR1	2322 460 912..	113
	16.0	69 to 200	FMP-DSB	2322 460 903..	40
				2322 460 923..	40
	17.5	10 to 200	FMP-PRT-DAF	2322 460 916..	126
				2322 460 926..	126
				2322 460 936..	126
	17.5	50 to 500	FMP-PTV	2322 460 90313	158
2322 460 905..				158	
High voltage resistors	-	10 to 1500	HVR	4322 053 79...	174
				4322 053 91...	174

PRESET POTENTIOMETERS

Selection guide by maximum dissipation.

PRODUCT	MAXIMUM DISSIPATION (W)	RESISTANCE RANGE	TYPE	CATALOGUE NUMBERS	PAGE
Carbon preset potentiometers	0.1	47 Ω to 4.7 M Ω	OCP10 (open)	2322 410	199
		100 Ω to 4.7 M Ω	ECP10 (enclosed)	2322 483	209
Cermet preset potentiometers	0.5	100 Ω to 10 M Ω	OMP10 (open)	2322 482	219
		47 Ω to 10 M Ω	EMP10 (enclosed)	2322 484	225

Potentiometers

Selection Guide

CONTROL POTENTIOMETERS

Selection guide by maximum dissipation.

PRODUCT	MAXIMUM DISSIPATION (W)	RESISTANCE RANGE	TYPE (note 3)	CATALOGUE NUMBERS	PAGE		
Carbon rotary control potentiometers	0.05 ⁽¹⁾ 0.1 ⁽²⁾	1 000 Ω to 4.7 MΩ	CRC10	2322 485	353		
	0.1 ⁽¹⁾ 0.2 ⁽²⁾	470 Ω to 4.7 MΩ	CRC12 (without spindle; single)	2322 505	335		
			CRC12 (with spindle; single)	2322 506	347		
			CRC12 (with spindle; tandem)	2322 507	361		
		220 Ω to 2.2 MΩ	CRC17 (without spindle; single)	2322 500	369		
			CRC17 (with spindle; single)	2322 501	373		
Cermet rotary control potentiometers	1.0	220 Ω to 4.7 MΩ	CRC17 (with spindle; tandem)	2322 502	353		
			MRC12 (without spindle; single)	2322 515	335		
			MRC12 (with spindle; single)	2322 516	347		
	3.0	220 Ω to 4.7 MΩ	MRC12 (with spindle; tandem)	2322 517	361		
			MRC17 (without spindle; single)	2322 510	369		
			MRC17 (with spindle; single)	2322 511	373		
			MRC17 (with spindle; tandem)	2322 512	353		
			5.0	47 Ω to 22 MΩ	MRC23 (single)	2322 481	335

Notes

1. Logarithmic.
2. Linear.
3. All types are modular except CRC10 and MRC23.

MAINTENANCE TYPES

Selection guide by resistance range.

PRODUCT	RESISTANCE RANGE	TYPE	CATALOGUE NUMBERS	PAGE
Carbon preset potentiometers	47 Ω to 4.7 MΩ	OCP14	2322 409	353
Carbon rotary control potentiometers	220 Ω to 4.7 MΩ	CRC16	2322 380	335
	220 Ω to 4.7 MΩ	CRC23	2322 350	347
Focus metal-glaze preset potentiometers	24 MΩ and 83 MΩ	FMP-ST	2322 460 900..	361
	24 MΩ to 50 MΩ	FMP-CR	2322 460 901..	369
Test switches	—	switches	2322 136 7....	373

GENERAL

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Potentiometers

General

INTRODUCTION

There are two styles in our range of potentiometers:

- Preset
- Control.

The focus metal-glaze preset potentiometers comprise elements combined into the network for high-voltage adjustment applications and are designed for preset control of focus and screen voltages of picture tubes (high-voltage applications) (see Tables 1, 2 and 3).

Preset potentiometers

Preset potentiometers (trimming potentiometers) are designed for eliminating circuit tolerances during the assembly of electronic equipment or the readjustment of electronic equipment at a later stage.

Table 1 Slot version.

TYPE	DESCRIPTION	MAXIMUM VOLTAGE (kV)	DIMENSIONS (mm)
FMP-MCS	micro slot series	11.0	≈29 × 48
FMP-DSB	diode split box series	16.0	≈29 × 61
FMP-SLD	slide slot series	13.0	≈33 × 57
FMP-CLP ⁽¹⁾	clip slot series	16.0	≈33 × 58

Note

1. Data sheet to follow shortly after publication of this handbook.

Table 2 Print version.

TYPE	DESCRIPTION	MAXIMUM VOLTAGE (kV)	DIMENSIONS (mm)
FMP-ST ⁽¹⁾	solder tag series	10.0	≈29 × 58
FMP-CR ⁽¹⁾	conductive rubber series	13.0	≈29 × 60
FMP-PRT-VERT	print vertical series	13.0	≈32 × 56
FMP-PRT-HOR1	print horizontal series	13.0	≈29 × 60
FMP-PRT-DAF	dynamic astigmatism focus series	17.5	≈47 × 65
FMP-PRT-VRES ⁽²⁾	variable resistor series	4.0	≈23 × 23

Notes

1. Maintenance type.
2. Data sheet to follow shortly after publication of this handbook.

Table 3 Print version for Projection TV.

TYPE	DESCRIPTION	MAXIMUM VOLTAGE (kV)	DIMENSIONS (mm)
FMP-PTV	triple series	17.5	≈68 × 77

Potentiometers

General

Table 4 High-voltage resistors.

Suitable for potentiometers and/or potting applications, bleeder resistors and voltage dividers are available as specials.

TYPE	DESCRIPTION	MAXIMUM VOLTAGE (kV)	DIMENSIONS (mm)
HVR	high-voltage resistor for bleeder and voltage dividers	high-voltage, high-ohmic	several
R-TNM ⁽¹⁾	tube neck mounting series for discharge of EHT voltage	35.0	≈40 × 83

Note

1. Data sheet to follow shortly after publication of this handbook.

Table 5 Carbon and metal-glaze presets with low dissipation (open or enclosed).

TYPE	DESCRIPTION	MAXIMUM DISSIPATION (W)	DIMENSIONS (mm)
OCP10 series	open carbon preset	0.1	≈10 × 10
OCP14 series ⁽¹⁾	open carbon preset	0.2	≈14 × 17
OMP10 series	open cermet preset	0.5	≈10 × 12
ECP10 series	enclosed carbon preset	0.1	≈10 × 12
EMP10 series	enclosed cermet preset	0.5	≈10 × 12

Note

1. Maintenance type.

Control potentiometers

Control potentiometers are designed for general, frequent, voltage or resistance adjustment in electronic equipment. The range includes metal-glaze or carbon resistive elements.

CRC10 series; carbon rotary; 0.1 W (linear) or 0.05 W (logarithmic); dimensions 10 × 12 mm; single types without switch.

CRC12 series; carbon rotary potpack; single and tandem types with or without switch; with or without spindle. Also dual types; dimensions 17 × 22 mm.

CRC16 series; carbon rotary; 0.1 W (linear) or 0.05 W (logarithmic); diameter 16 mm; single and tandem types with or without switch (maintenance).

CRC17 series; carbon rotary potpack; single and tandem types with or without switch; with or without spindle. Also dual types; dimensions 17 × 22 mm.

CRC23 series; carbon rotary; 0.25 W (linear) or 0.125 W (logarithmic); diameter 23 mm; single types without switch (maintenance).

MRC12 series; metal-glaze (cermet) rotary potpack; single types with or without spindle; dimensions 12 × 13 mm.

MRC17 series; metal-glaze (cermet) rotary potpack, single and tandem types with or without spindle. Also dual types; dimensions 17 × 22 mm.

MRC23 series; metal-glaze (cermet) rotary; 5 W; diameter 23 mm; single types without switch.

TERMS AND DEFINITIONS**Preset potentiometers**

Potentiometers of simple construction, either open or enclosed. Designed for a limited number of wiper movements, i.e. for trimming, adjusting or readjusting electronic circuits. Generally an adjusting tool is required. Important characteristics are precise adjustability (settability) and good stability of the set value.

Control potentiometers

Potentiometers of more complicated construction, with or without spindle (rotary types) or with slider (straight line action types). Mechanical and electrical design permit a large number of wiper movements.

Resistive element

The resistance element of a potentiometer.

Carbon potentiometer

Preset or control potentiometers comprising a resistive element of a special carbon composition, fixed to a resin bonded substrate.

Metal-glaze potentiometers

Preset or control potentiometers comprising a metal-glaze resistive element on a ceramic substrate. Designed for high-classed industrial applications.

Rotary type potentiometers

Preset or control potentiometers with a rotary action.

Single potentiometers

Control potentiometers comprising one resistive element.

Tandem potentiometers

Control potentiometers comprising two resistive elements, operated by one spindle or slider.

Dual potentiometers

Rotary type control potentiometers comprising two resistive elements, operated by separate concentric spindles.

Single turn potentiometers

Rotary type preset or control potentiometers with a mechanical angle of rotation smaller than 360° .

Modular potentiometers

Compact rectangular shaped rotary type control potentiometers, custom built from a number of basic elements, either with or without spindle or provided with a snap-in facility for customized operating devices.

Focus potentiometers

Special units with or without V_{g2} control to adjust the focus voltage of picture tubes. Connection is either by soldering or by conductive rubber.

Mains or battery switches

Rotary or push-pull switches fitted to the potentiometers and usually operated by the spindle.

Test switches

Separate switches for screwdriver or knob operation in testing procedures.

Wiper

Moving contact of rotary type potentiometers.

Resistance range

Range of maximum nominal resistances.

Rated resistance (R_r)

The resistance value marked upon the potentiometer.

Change of resistance

The irreversible change of resistance after a specified test, expressed as a percentage of the initial resistance.

Total resistance (R_{ac})

The resistance measured between the end terminals a and c (see Figs 1 and 3). Also R_{tot} or R_{total} .

Nominal resistance (R_{nom})

Nominal value of the resistance between the end terminals a and c (see Fig.1) and the moving contact b at end-stop position.

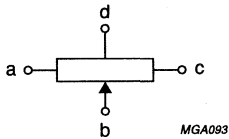


Fig.1 Designation of terminals.

Resistance law

The relationship of the output ratio V_{ab}/V_{ac} to the mechanical position of the moving contact b.

Residual resistance

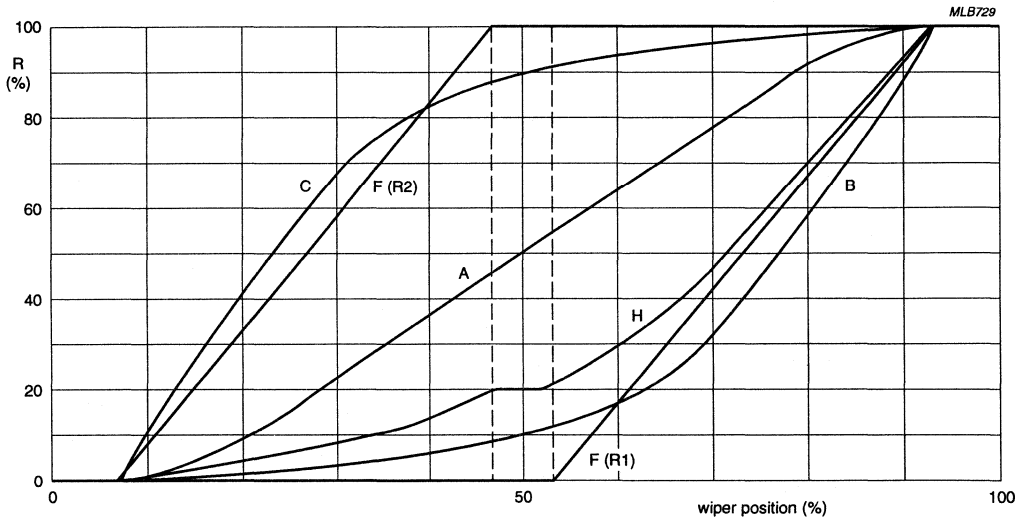
The resistance between either end termination a or c and the termination connected to the moving contact b when the moving contact is set against the relevant end stop (see Fig.3).

Terminal resistance

Minimum resistance which can be obtained between the termination connected to the moving contact b and any other termination (see Fig.3).

Resistance at the tap

Minimum resistance between the tap terminal d and the resistive element.



A = linear.
 B = logarithmic.
 C = inverse logarithmic.
 H = logarithmic with tap.
 F = balance.

Fig.2 Some typical resistance laws.

Contact resistance R_c

Resistance between resistive element and moving contact.

Contact resistance variation (CRV)

Change of resistance between the resistive element and the moving contact when it is moved at a defined speed, expressed as a percentage of R_{nom} .

Contact resistance moving (CRM)

Contact resistance when a moving contact is moved at a defined speed.

Maximum attenuation

Maximum value of the attenuation when the potentiometer is used as an attenuator (see Fig.3).

Attenuation

The reciprocal of the output ratio, in dB.

Maximum dissipation (P_{max})

Maximum amount of power which can be dissipated at a given ambient temperature, when the potentiometer is continuously loaded between the end terminals a and c (see Fig.1) and mounted on a steel panel of $100 \times 100 \times 1.5$ mm by means of a nut (or on a printed-circuit board for types with printed-wiring pins).

Maximum voltage (V_{max})

The maximum voltage that may be applied is calculated from the maximum dissipation (P_{max}) and the nominal resistance (R_{nom})

$$V_{max} = \sqrt{P_{max} \times R_{nom}}$$

provided that the limiting element voltage is not exceeded.

Limiting moving contact current

Maximum current that may be passed between resistance element and moving contact, is usually expressed by:

$$\sqrt{P_{max}/R_{nom}}$$

Insulation resistance

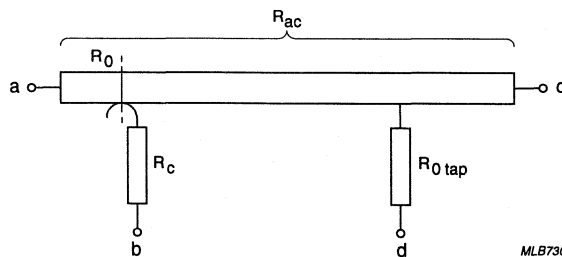
Resistance measured between interconnected terminals and all other external metal parts.

Test voltage

Voltage to be applied for one minute between interconnected terminals and other external metal parts.

Ganging tolerance

Maximum difference between the adjusted resistances of the two sections of a tandem potentiometer (expressed in dB).



MLB730

Residual resistance: $(R_0 + R_c) \Omega$.

Maximum attenuation: $20 \log \frac{V_{ab}}{V_{ac}}$ dB.

The value of R_c is negligible.

Fig.3 Diagram of potentiometers; spindle in fully-clockwise position.

Mechanical angle of rotation

The full extent of the travel of the actuating device of a rotary potentiometer between the end stops (see Fig.4).

Effective angle of rotation

That angle throughout which the resistance law of a rotary potentiometer is applicable (see Fig.4).

Switch angle

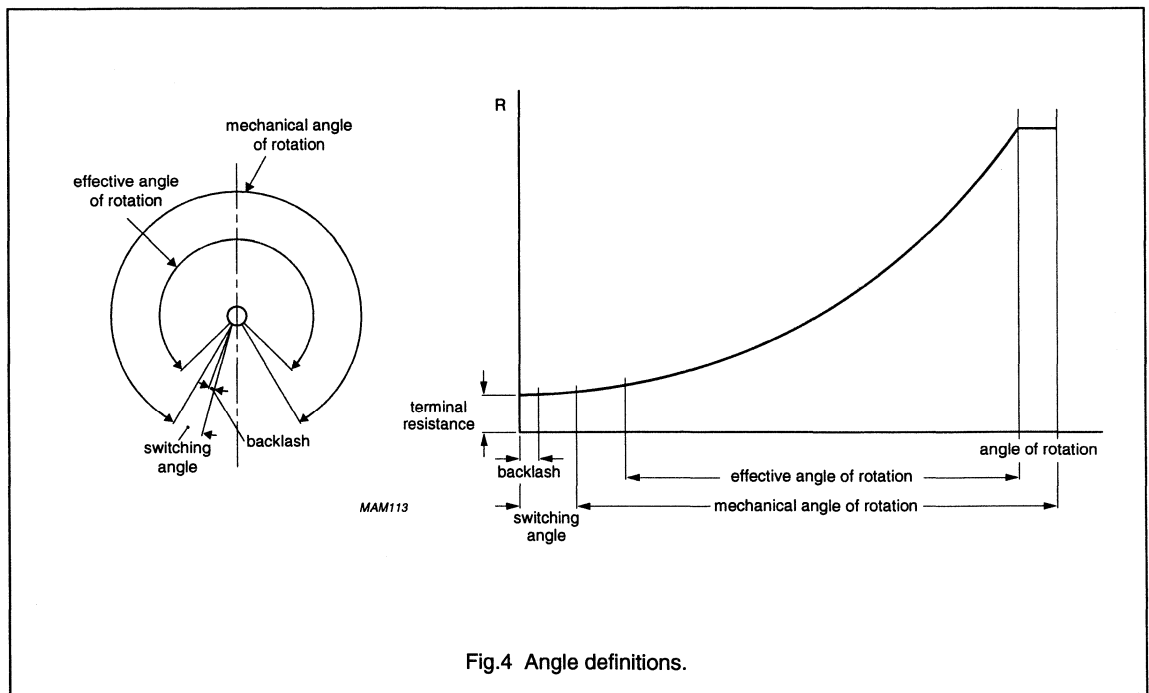
That angle over which the switch of a rotary potentiometer has to be actuated from the off to the on position, or vice versa (see Fig.4).

Backlash of the rotary switch

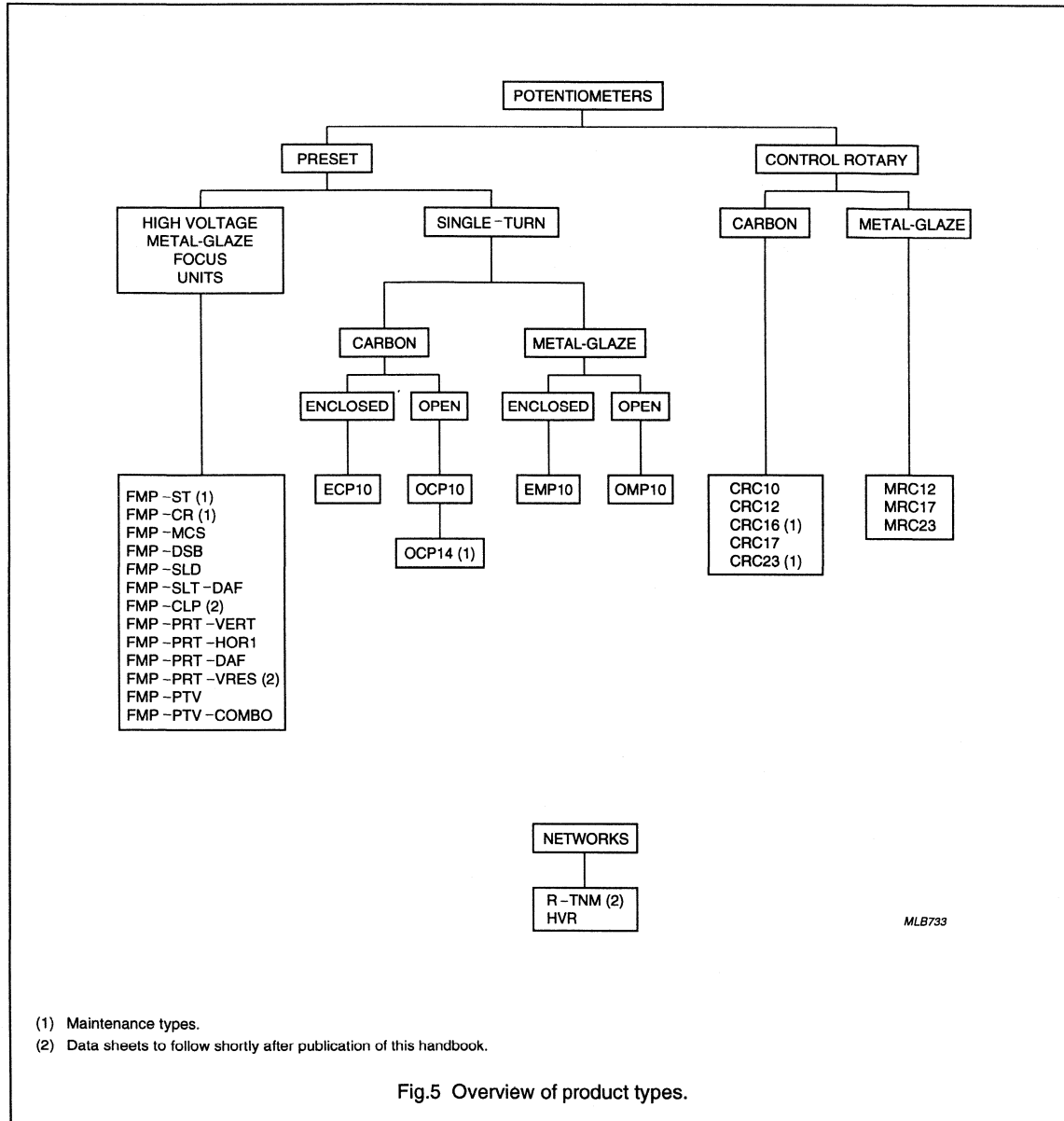
That angle over which the spindle of a rotary potentiometer has to be rotated before actuating the switch from the off to the on position (see Fig.4).

Backlash of potentiometer with push-pull switch

That angle over which the spindle can be rotated before it causes any resistance change.



OVERVIEW OF AVAILABLE PRODUCT TYPES



HIGH-VOLTAGE FOCUS UNITS AND COMPONENTS

	Page
Slot version	
FMP-MCS	21
FMP-DSB	40
FMP-SLD	74
Print version	
FMP-PRT-VERT	95
FMP-PRT-HOR1	113
FMP-PRT-DAF	126
Print version for Projection TV	
FMP-PTV	158
High-Voltage Resistors	
HVR	174

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

FEATURES

- Designed for integration in a high voltage unit
- High temperature and voltage stability
- Wide design freedom.

APPLICATIONS

- Line output transformers
- Diode split transformers.

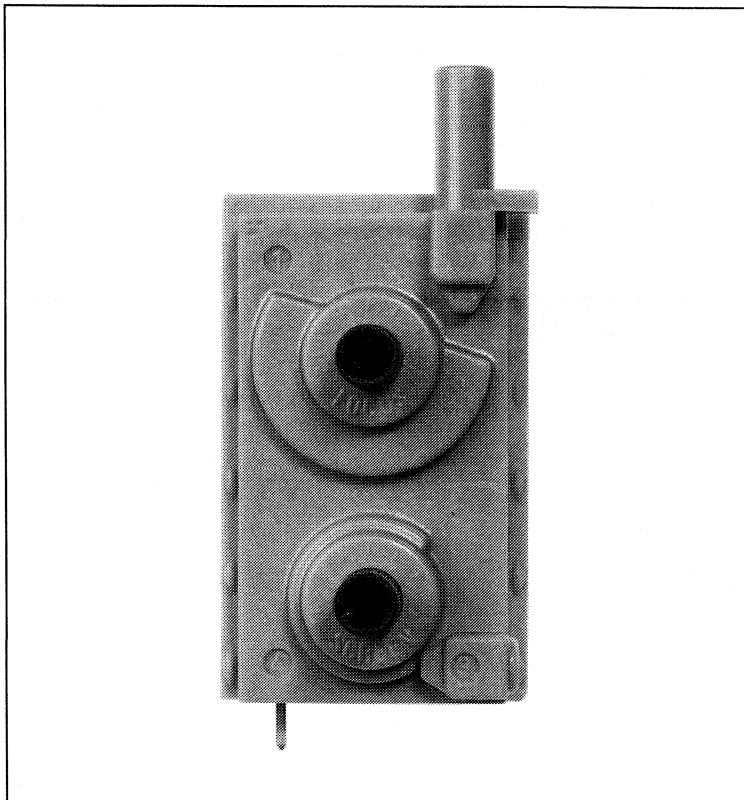
DESCRIPTION

Each unit comprises seven thick film resistance elements on a ceramic (Al_2O_3) substrate, a synthetic (glass reinforced) case and two synthetic (glass reinforced) rotors with multi-wire contacts. Two of the resistance elements are potentiometers.

The product must be mounted into a specially designed slot in the case of the high voltage unit. This provides a complete seal when an epoxy potting agent or other insulation material is used.

A clean and easy method of electrical connection with the high voltage input is made by means of a conductive rubber contact, thereby avoiding the need for soldered joints.

Electrical connection with the focus voltage output (b1) and screen voltage output (b2) (see Figs 8 and 9) is achieved by simply pressing single-core stripped wires into the respective holes. For the recommended cable types see Table 1 and for the stripping length of the recommended wires see Figs 8 and 9. Earth connection is effected through the printed-circuit board with a print tag.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance	69 M Ω to 125 M Ω
Tolerance (% of total resistance)	$\pm 7\%$, $\pm 10\%$, $\pm 15\%$ and $\pm 20\%$
Maximum dissipation at $T_{\text{amb}} = 70\text{ }^{\circ}\text{C}$	1.6 W
Maximum application voltage	11 kV
Setting ability (IEC 393/6.34)	
focus	$\pm 25\text{ V}$; max. 10 s
screen	$\pm 5\text{ V}$; max. 10 s
Temperature characteristic of resistance (20 to 100 $^{\circ}\text{C}$)	$\leq 100 \times 10^{-6}/\text{K}$
Voltage coefficient of resistance	$\leq 2 \times 10^{-6}/\text{V}$
Climatic category	25/070/21

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

DESIGN VARIATIONS

The micro-slot focus units are custom designed. Variations to suit customer requirements are possible on the following:

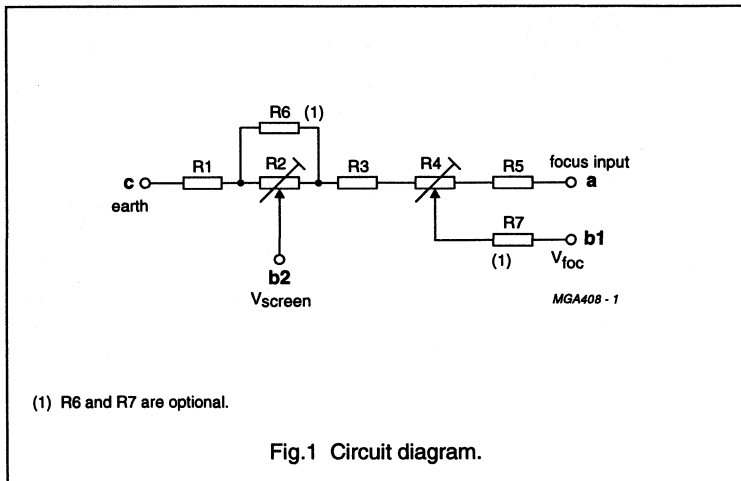
- Total resistance
- Focus and screen voltage ranges
- Location of high voltage connections.

For applications in unfavourable environmental conditions internal shields can be incorporated, thereby giving improved protection against humidity and environmental contamination.

Salt spray and pressure cooker tests can be met.

APPROVAL

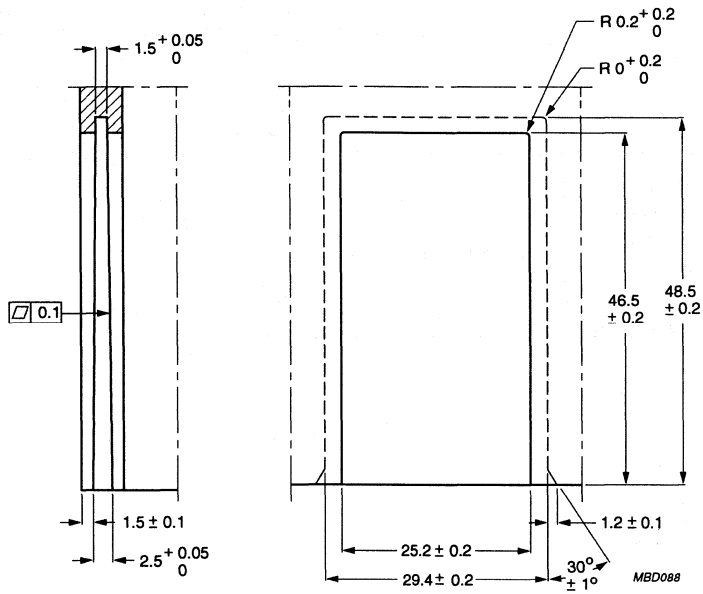
The product is designed for approval (after integration on the high voltage unit) by the major approval institutes. The materials used are UL-VO listed.



Focus Metal-glaze Preset (FMP),
Micro-Slot focus units (MCS)

FMP-MCS

MECHANICAL DATA

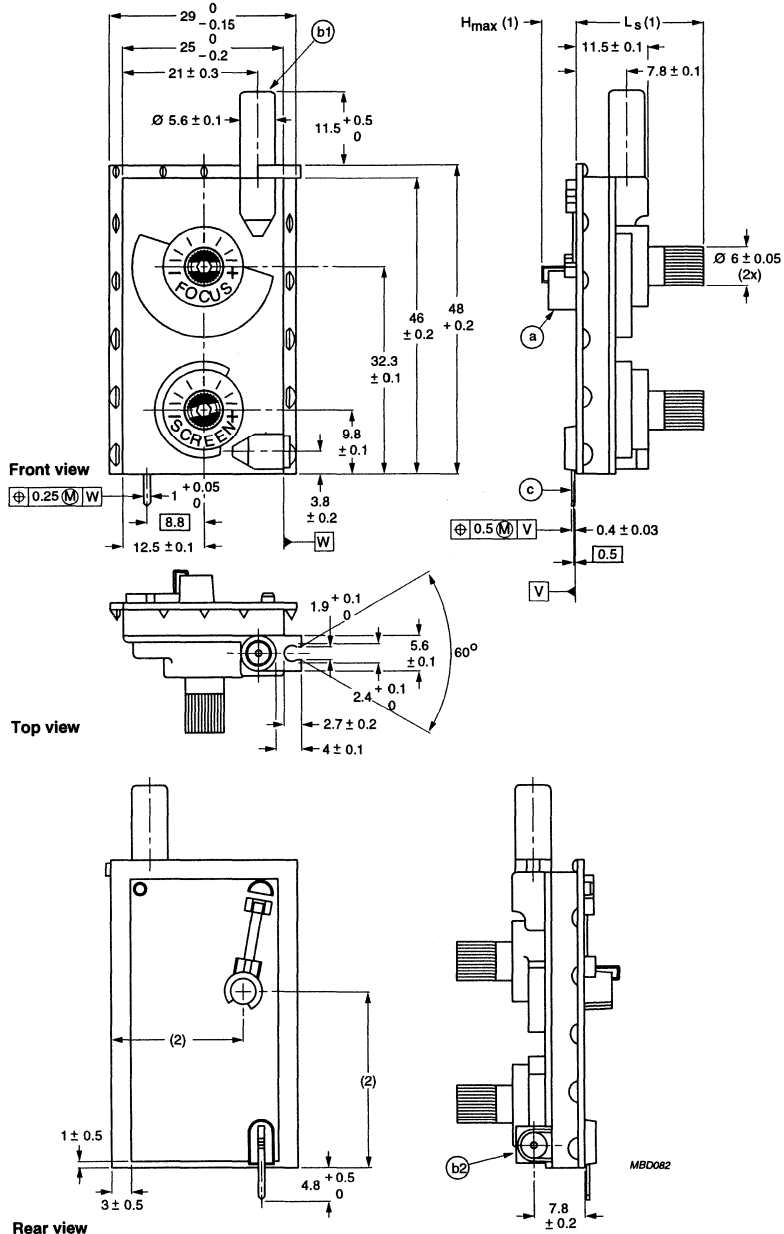


Dimensions in mm.

Fig.2 Slot dimensions.

Focus Metal-glaze Preset (FMP),
Micro-Slot focus units (MCS)

FMP-MCS



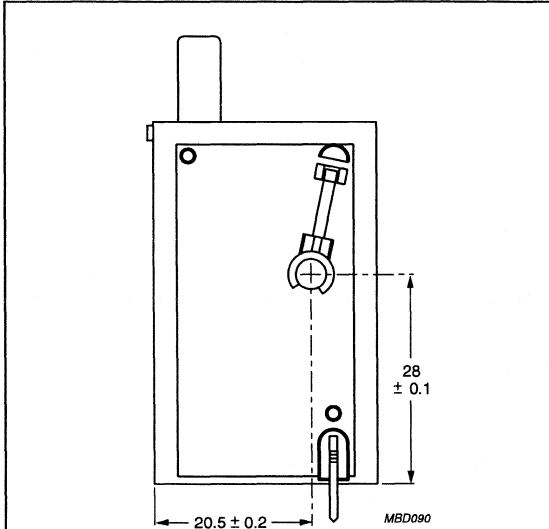
Dimensions in mm.

- (1) See Tables 4, 5, 6, 7 and 8.
- (2) See Figs 4, 5 and 6.

Fig.3 Outline details.

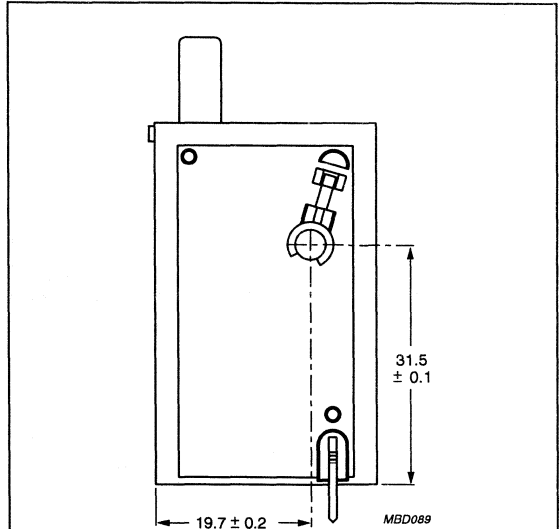
Focus Metal-glaze Preset (FMP),
Micro-Slot focus units (MCS)

FMP-MCS



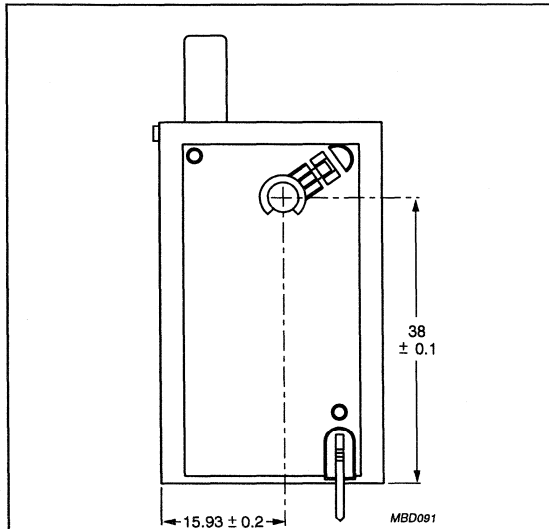
Dimensions in mm.

Fig.4 Rear view of unit showing EHT connecting point (a) for type A.



Dimensions in mm.

Fig.5 Rear view of unit showing EHT connecting point (a) for type B.



Dimensions in mm.

Fig.6 Rear view of unit showing EHT connecting point (a) for type C.

Focus Metal-glaze Preset (FMP),
Micro-Slot focus units (MCS)

FMP-MCS

Connection details

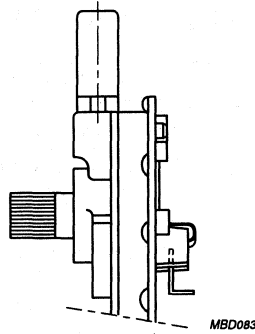
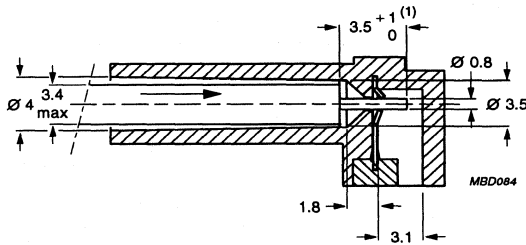


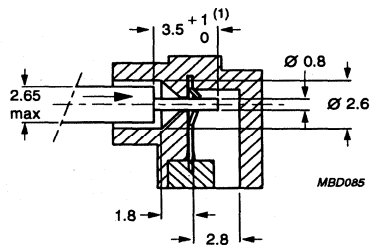
Fig.7 High voltage connection (a).



Dimensions in mm.

(1) Stripping length (under consideration for modification).

Fig.8 Focus connection (b1).



Dimensions in mm.

(1) Stripping length (under consideration for modification).

Fig.9 Screen connection (b2).

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

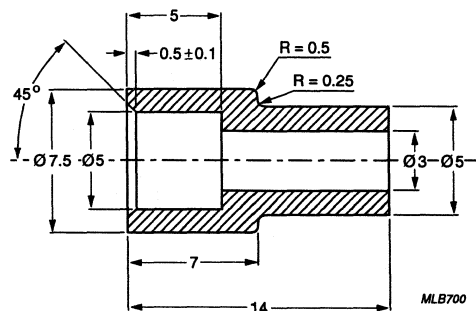
FMP-MCS

Table 1 Recommended connecting wire.

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSULATION MAX. \varnothing (mm)	CATALOGUE NUMBERS
Focus out (b1)	Pope (The Netherlands)	UL758 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.35	0722 388 00005
	Taisho (Japan)	E35688 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00014
	Sumitomo (Japan)	UL3239 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00015
Screen out (b2)	Pope (The Netherlands)	UL1032 VW-1 AWG20 PVC20	2.6	0722 161 00342
	Taisho (Japan)	E35688 AWM 1032 1.2 kV (DC) AWG20 (1/0.83) 90 °C	2.65	0722 158 00547
	Sumitomo (Japan)	UL-style 3476 E41105 (S) 3 kV (DC)	2.51	0722 161 00357
	Tatung (Japan)	UL1032 E54979 1.2 kV (DC) AWG20	2.65	0738 218 00039
	PEWC (Taiwan)	UL1032 E41396 1.2 kV (DC) AWG20 90 °C	2.65	0738 540 00122

Table 2 Recommended rubber boot for focus out connection (b1) (optional).

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSIDE \varnothing (mm)	CATALOGUE NUMBER
Focus out (b1)	Hae Ryong (South Korea)	silicon black HR 7020U UL Ref. E98818	3.0	4322 052 86622



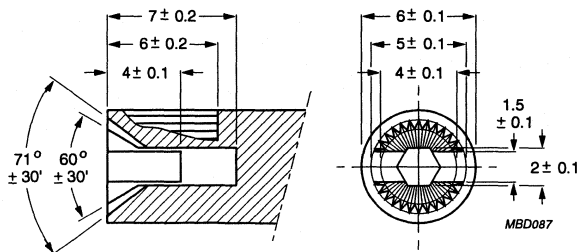
Dimensions in mm.

Fig.10 Rubber boot (4322 052 86622).

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

Shaft style connection details



Dimensions in mm.

Fig.11 Type G shaft style connection.

Table 3 Additional information.

PARAMETER	MIN.	TYP.	MAX.	UNIT
Focus unit				
Climatic category (IEC 68)	25/070/21			
Inflammability of materials	self-extinguishing in accordance with UL94-VO			
Potentiometers				
Angle of rotation				
focus	170	175	180	deg
screen	195	200	205	deg
Starting torque	–	–	30	mNm
Operating torque	3	–	30	mNm
Operating torque ratio	–	–	3	
Permissible end stop torque (adjustment tool)	–	–	150	mNm
Permissible end stop torque (manual)	–	–	300	mNm
Permissible push force on shaft	–	–	50	N
Permissible pull force on shaft	–	–	50	N
Mechanical life; focus/screen	–	50	–	cycles
Weight	–	13	–	g
Connectors b1 and b2				
Insertion force of wire	–	–	25	N
Extraction force of wire	50	–	–	N

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

PRODUCT OVERVIEW**Table 4** Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90311	90314	90315	90323	
Resistances					
Resistance (R_{ac})	70 \pm 10%	76.9 \pm 7%	70 \pm 10%	105 \pm 15%	M Ω
Resistor network (see Fig.1)					
R1	1.01	1.1	1.01	2.26	M Ω
R2/R6	6.9	7.43	6.9	10.34	M Ω
R3	34.09	30.68	34.09	50.4	M Ω
R4	25.38	37.65	25.38	40.95	M Ω
R5	2.62	0.04	2.62	1.05	M Ω
R7	15.0 \pm 20%	15.0 \pm 20%	15.0 \pm 20%	11.4 \pm 20%	M Ω
Voltages					
Maximum application voltage (V_{ac})	9.1	9.9	9.1	9.5	kV
V_{toc} ; note 1					
range	65 to 95	55 to 99.9	65 to 95	65 to 98.6	%
minimum	60.0 \pm 5.0	51.0 \pm 4.0	60.0 \pm 5.0	60.0 \pm 5.0	%
maximum	96.25 \pm 1.25	99.95 \pm 0.05	96.25 \pm 1.25	99.0 \pm 0.4	%
V_{screen} ; note 1					
range	2.2 to 8.8	1.77 to 9.2	2.2 to 8.8	3.3 to 10	%
minimum	1.45 \pm 0.75	1.435 \pm 0.335	1.45 \pm 0.75	2.15 \pm 1.15	%
maximum	11.3 \pm 2.5	11.1 \pm 1.9	11.3 \pm 2.5	12.0 \pm 2.0	%
Dissipation					
Total maximum dissipation	1.2	1.2	1.3	1.0	W
Shaft data					
Length	$L_s = 19.5 \pm 0.3$	$L_s = 19.5 \pm 0.3$	$L_s = 19.5 \pm 0.3$	$L_s = 19.5 \pm 0.3$	mm
Type (see Fig.11)	G	G	G	G	
Colour					
focus	black	black	black	red	
screen	black	black	black	red	
Delivery position					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Dimensions					
Height of high voltage tag	$H_{max} = 5.2$	$H_{max} = 5.2$	$H_{max} = 3.4$	$H_{max} = 5.2$	mm
EHT connections					
Type (see Figs 4 and 5)	A	A	B	A	

Note1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

Table 5 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90327	90334	90338	90341	
Resistances					
Resistance (R_{ac})	105 ±15%	105 ±15%	70 ±15%	105 ±15%	MΩ
Resistor network (see Fig.1)					
R1	2.26	1.65	0.67	2.26	MΩ
R2/R6	15.06	17.77	8.68	10.34	MΩ
R3	45.7	43.58	29.15	43.05	MΩ
R4	39.2	40.95	13.4	38.85	MΩ
R5	2.78	1.05	18.1	10.5	MΩ
R7	11.4 ±20%	15.0 ±20%	15.0 ±20%	11.4 ±20%	MΩ
Voltages					
Maximum application voltage (V_{ac})	9.5	9.5	9.1	9.5	kV
V_{foc} ; note 1					
range	65 to 96.2	65 to 98.6	59.5 to 70.3	58 to 86	%
minimum	60.0 ±5.0	60.0 ±5.0	55.0 ±4.5	53.0 ±5.0	%
maximum	97.35 ±1.15	99.0 ±0.4	74.15 ±3.85	90.0 ±4.0	%
V_{screen} ; note 1					
range	3.3 to 14	2.15 to 16	1.2 to 0.95	3.3 to 10	%
minimum	2.15 ±1.15	1.575 ±0.575	0.95 ±0.25	2.15 ±1.15	%
maximum	16.5 ±2.5	18.5 ±2.5	13.35 ±2.15	12.0 ±2.0	%
Dissipation					
Total maximum dissipation	1.0	1.0	1.4	1.0	W
Shaft data					
Length	$L_s = 19.5 ±0.3$	$L_s = 19.5 ±0.3$	$L_s = 19.5 ±0.3$	$L_s = 19.5 ±0.3$	mm
Type (see Fig.11)	G	G	G	G	
Colour					
focus	green	black	black	blue	
screen	green	black	black	blue	
Delivery position					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Dimensions					
Height of high voltage tag	$H_{max} = 5.2$	$H_{max} = 3.4$	$H_{max} = 5.2$	$H_{max} = 5.2$	mm
EHT connections					
Type (see Figs 4 and 5)	A	B	A	A	

Note1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

Table 6 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90342	90344	90348	90349	
Resistances					
Resistance (R_{ac})	70 ±15%	125 ±15%	105 ±15%	105 ±15%	MΩ
Resistor network (see Fig.1)					
R1	1.5	3.19	1.65	1.65	MΩ
R2/R6	10.05	22.12	17.77	17.77	MΩ
R3	30.45	49.69	43.58	27.82	MΩ
R4	26.15	48.75	40.95	36.76	MΩ
R5	1.85	1.25	1.05	21.0	MΩ
R7	7.6 ±20%	20.0 ±30%	15.0 ±20%	15.0 ±20%	MΩ
Voltages					
Maximum application voltage (V_{ac})	9.5	11.0	9.5	10.0	kV
V_{foc} ; note 1					
range	65 to 96.2	65 to 98.6	65 to 98.6	50 to 75	%
minimum	60.0 ±5.0	60.0 ±5.0	60.0 ±5.0	45.0 ±5.0	%
maximum	97.35 ±1.15	99.0 ±0.4	99.0 ±0.4	80.0 ±5.0	%
V_{screen} ; note 1					
range	3.3 to 14	3.3 to 17.5	2.15 to 16	2.15 to 16	%
minimum	2.15 ±1.15	2.55 ±0.75	1.575 ±0.575	1.575 ±0.575	%
maximum	16.5 ±2.5	20.25 ±2.75	18.5 ±2.5	18.5 ±2.5	%
Dissipation					
Total maximum dissipation	1.5	1.1	1.0	1.1	W
Shaft data					
Length	$L_s = 19.5 ±0.3$	$L_s = 19.5 ±0.3$	$L_s = 19.5 ±0.3$	$L_s = 19.5 ±0.3$	mm
Type (see Fig.11)	G	G	G	G	
Colour					
focus	black	black	black	black	
screen	black	red	black	black	
Delivery position					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Dimensions					
Height of high voltage tag	$H_{max} = 5.2$	$H_{max} = 5.2$	$H_{max} = 5.2$	$H_{max} = 3.4$	mm
EHT connections					
Type (see Figs 4 and 5)	A	A	A	B	

Note1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

Table 7 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90361	90364	90382	90388	
Resistances					
Resistance (R_{ac})	105 \pm 15%	125 \pm 15%	70 \pm 10%	125 \pm 10%	M Ω
Resistor network (see Fig.1)					
R1	2.26	2.19	1.925	0.94	M Ω
R2/R6	10.34	18.12	10.15	14.69	M Ω
R3	50.4	54.69	30.275	41.87	M Ω
R4	40.95	48.75	25.55	43.13	M Ω
R5	1.05	1.25	2.1	24.37	M Ω
R7	11.4 \pm 20%	20.0 \pm 30%	15.0 \pm 20%	20.0 \pm 20%	M Ω
Voltages					
Maximum application voltage (V_{ac})	9.5	11.0	10.0	11.0	kV
V_{foc} ; note 1					
range	65 to 98.6	65 to 98.6	65 to 95	50.5 to 76.5	%
minimum	60.0 \pm 5.0	60.0 \pm 5.0	60.5 \pm 4.5	46.0 \pm 4.5	%
maximum	99.0 \pm 0.4	99.0 \pm 0.4	97.0 \pm 2.0	80.5 \pm 4.0	%
V_{screen} ; note 1					
range	3.3 to 10	2.5 to 13.5	3.3 to 15.5	1.0 to 10.5	%
minimum	2.15 \pm 1.15	1.75 \pm 0.75	2.75 \pm 0.55	0.75 \pm 0.25	%
maximum	12.0 \pm 2.0	16.25 \pm 2.75	17.25 \pm 1.75	12.5 \pm 2.0	%
Dissipation					
Total maximum dissipation	1.0	1.1	1.6	1.1	W
Shaft data					
Length	$L_s = 19.5 \pm 0.3$	$L_s = 19.5 \pm 0.3$	$L_s = 19.5 \pm 0.3$	$L_s = 19.5 \pm 0.3$	mm
Type (see Fig.11)	G	G	G	G	
Colour					
focus	red	black	black	black	
screen	red	green	black	black	
Delivery position					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Dimensions					
Height of high voltage tag	$H_{max} = 5.2$	$H_{max} = 5.2$	$H_{max} = 5.2$	$H_{max} = 4.2$	mm
EHT connections					
Type (see Figs 4 and 6)	A	A	A	C	

Note1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

Table 8 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	91302	91303	91304	91305	
Resistances					
Resistance (R_{ac})	105 \pm 15%	105 \pm 15%	105 \pm 15%	125 \pm 15%	M Ω
Resistor network (see Fig.1)					
R1	2.26	1.65	1.65	3.19	M Ω
R2/R6	10.34	17.77	17.77	22.12	M Ω
R3	50.4	27.82	27.82	49.69	M Ω
R4	40.95	36.76	36.76	48.75	M Ω
R5	1.05	21.0	21.0	1.25	M Ω
R7	11.4 \pm 20%	15.0 \pm 20%	15.0 \pm 20%	20.0 \pm 30%	M Ω
Voltages					
Maximum application voltage (V_{ac})	9.5	10.0	10.0	11.0	kV
V_{foc} ; note 1					
range	65 to 98.6	50 to 75	50 to 75	65 to 98.6	%
minimum	60.0 \pm 5.0	45.0 \pm 5.0	45.0 \pm 5.0	60.0 \pm 5.0	%
maximum	99.0 \pm 0.4	80.0 \pm 5.0	80.0 \pm 5.0	99.0 \pm 0.4	%
V_{screen} ; note 1					
range	3.3 to 10	2.15 to 16	2.15 to 16	3.3 to 17.5	%
minimum	2.15 \pm 1.15	1.575 \pm 0.575	1.575 \pm 0.575	2.55 \pm 0.75	%
maximum	12.0 \pm 2.0	18.5 \pm 2.5	18.5 \pm 2.5	20.25 \pm 2.75	%
Dissipation					
Total maximum dissipation	1.0	1.1	1.1	1.1	W
Shaft data					
Length	$L_s = 19.5 \pm 0.3$	$L_s = 19.5 \pm 0.3$	$L_s = 19.5 \pm 0.3$	$L_s = 19.5 \pm 0.3$	mm
Type (see Fig.11)	G	G	G	G	
Colour					
focus	red	green	red	black	
screen	red	green	red	black	
Delivery position					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Dimensions					
Height of high voltage tag	$H_{max} = 3.4$	$H_{max} = 3.4$	$H_{max} = 5.2$	$H_{max} = 5.2$	mm
EHT connections					
Type (see Figs 4 and 5)	B	B	A	A	

Note1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

SAFETY REQUIREMENTS

In general an area of 10 mm around the focus unit should be free from all conductive parts with sharp edges. Penetration with earthed parts in these areas should be avoided. Full details of these areas are contained in the factory specification related to each catalogue type. The potentiometer parts carrying high voltage should be free from metal particles, solder drops, etc.

RELIABILITY

Maximum cumulative percentage of failures F (n) after n hours (excluding 0 hours rejects)

Percentage rate of failures.

FAILURES	PERCENTAGE
F (300)	≤0.03%
F (10000)	≤0.25%
F (30000)	≤5.0%

LIST OF MATERIALS

NAME OF PART	MATERIAL	TYPE	MANUFACTURER	FLAME CLASS	UL FILE NUMBER
Case	polycarbonate	Lexan 500 R	General Electric	UL-94-VO	E45329
Shaft	modified PPO	Noryl VO-150-B	General Electric	UL-94-VO	E45329
Rubber spring	silicone rubber	K 1238	Philips	UL-94-HB	E45111
Contact plug internal	silicone rubber	K 1764	Philips	UL-94-VO	E45111
Contact plug external	silicone rubber	9274	Philips	UL-94-HB	E45111
Vacuum grease	silicone grease	TKHV-1	Klüber	–	–

ORDERING

Minimum ordering quantity: 360 pieces.

Order by quoting the 12-digit catalogue number of the potentiometer units and the quantity required.

PRODUCT MARKING 2322 460 903..

The unit is marked with the date code (year, week and day of manufacture), the operator code, and the last five digits of the catalogue number.

Example of product marking.

MARKING YWWDX903..	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

PRODUCT MARKING 2322 460 913..

The unit is marked with the date code (year, week and day of manufacture), the operator code, and the last five digits of the catalogue number.

Example of product marking.

MARKING YWWDX913..	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

PACKAGING

Packed as 360 units in 12 polystyrene packaging shells, stacked on a rigid board. An additional empty packaging shell is located on the top together with a cover. The complete package is bound tightly together with polypropylene taping straps.

LABELLING

The label on the package containing the potentiometers is as shown.

<ol style="list-style-type: none"> 1. 2. 3. 4. 5. 6. 7. 8. 		<h4>LINE MARKING EXPLANATION</h4> <ol style="list-style-type: none"> 1. Country of origin 2. Product family and resistance values 3. Product description 4. Customer information 5. Preference origin code and product centre 6. Quantity per standard packing and product code 7. Product description 8. Catalogue number (12NC)
	MRC296	
Fig.12 Packaging label (example).		

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

TESTS AND REQUIREMENTS

In these tables the tests can either be:

D = Destructive

ND = Non-destructive.

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group B1-a	D		
SOLDERABILITY			
Solder iron method in accordance with IEC 68-2-20, Test Ta, method 2: Temperature: 350 °C ±10 °C Solder bit code number: 2622 035 17135 Bit dimensions: 2.5 × 1.5 mm Solder: 60/40 tin/lead Type: Ersin multicore Diameter 1.2 mm with flux 366 Time: 2 ±0.5 s		visual examination	wetting: >95%
Solder bath method in accordance with IEC 68-2-20, Test Ta, method 1: Temperature: 235 °C ±5 °C Immersion time: 2 ±0.5 s		visual examination	wetting: >95%
Sub-group B1-b	ND		
Focus spark gap firing simulation in accordance with PRV-53-8-52/42: R1 = 400 Ω; R2 = 5 MΩ; C1 = 2 nF; P1 = P2 = 600 hPa; V1 = V _{ac} ; V2 = 25 kV; both with shafts FCW; n = 50		visual examination element resistance $\Delta R_{ac}/R_{ac}$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no visible damage $\leq 3\%$ ≤ 25 V ≤ 5 V
Corona in accordance with PRV-53-8-52/43: 1.3 × V _{ac} ; 60 s; standard atmosphere		corona detection	no corona
Breakdown voltage under pressure in accordance with IEC 68-2-13 test M: V _{ac} ; 30 minutes; 600 hPa; 55 °C		flashover detection breakdown detection	no flashover no breakdown
Sub-group C1	ND		
Mechanical travel		focus screen	175° ±5° 200° ±5°
Starting torque		focus screen	3 to 30 mNm; ratio ≤3 3 to 30 mNm; ratio ≤3
Sub-group C2	ND		
Output ratio range		V _{b1c min} /V _{ac} ; V _{b1c max} /V _{ac} ; V _{b2c min} /V _{ac} ; V _{b2c max} /V _{ac}	see Tables 4, 5, 6, 7 and 8
Continuity in accordance with PRV-53-8-52/44			smooth, unidirectional
Settability		focus ±25 V screen ±5 V	≤10 s ≤10 s
Robustness of terminations in accordance with IEC-68-2-21 test Vb, method 1		visual examination	no visible damage

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group C3	D		
Electrical endurance at 70 °C: Temperature: 70 °C ±3 °C Duration: 1000 hours Cyclic load (1.5 hours on and 0.5 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} starting torque	no visual damage $\leq 3\%$ ≤ 25 V ≤ 5 V not specified
Sub-group D1	D		
Damp heat, cyclic in accordance with IEC 68-2-30, Test Db: Upper temperature: 40 °C Number of cycles: 21 (1 cycle = 1 hour on and 23 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no visible damage not specified ≤ 25 V ≤ 5 V
Sub-group D2	D		
Mechanical endurance at room temperature: Number of cycles of operation: 50 Rate: 4 ±1 cycles per minute		visual examination element resistance $\Delta R/R$ starting torque continuity change of output ratios	no visible damage $\leq 3\%$ not specified smooth, unidirectional 0.965 to 1.035 × initial requirements
Sub-group D3	ND		
End - stop torque: Adjustment tool: 150 mNm Manual: 300 mNm Duration: 10 s		visual examination	no visible damage, no deformation
Axial thrust on the shaft: Thrust: 50 N		continuity output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	smooth, unidirectional not specified not specified
Radial thrust on the shaft: Thrust: 150 mNm		visual examination	no visible damage
Sub-group D4-a	D		
Solder iron method in accordance with IEC 68-2-20, Test Ta, method 2: Temperature: 350 °C ±10 °C Solder bit code number: 2622 035 17135 Bit dimensions: 2.5 × 1.5 mm Solder: 60/40 tin/lead Type: Ersin multicore Diameter 1.2 mm with flux 366 Time: 2 ±0.5 s		element resistance $\Delta R/R$ output voltage drift ΔV_{b2}	$\leq 0.2\%$ ≤ 2 V

Focus Metal-glaze Preset (FMP), Micro-Slot focus units (MCS)

FMP-MCS

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group D4-b	D		
Change of temperature in accordance with IEC 68-2-14, Test Na: TA = -25 °C TB = +100 °C Number of cycles: 5 Exposure duration: 30 minutes Shafts: FCCW		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visual damage $\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-c	D		
Vibration in accordance with IEC 68-2-6, Test Fc, Procedure B4: Frequency range: 10 to 55 Hz Amplitude: 0.75 mm or 98m/s ² Sweep endurance: total duration 6 hours Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-d	D		
Shock in accordance with IEC 68-2-27, Test Ea: Pulse duration: 11 ms Acceleration: 490 m/s ² Number of shocks: 3 in each of 6 directions Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-e	D		
Dry heat in accordance with IEC 68-2-2, Test Bb: Temperature: +100 °C Duration: 96 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-f	D		
Cold in accordance with IEC 68-2-1, Test Ab: Temperature: -25 °C Duration: 96 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D5	ND		
Temperature characteristic of resistance: +20 °C to +100 °C		TCR	$\leq 100 \times 10^{-6}/K$
Voltage coefficient of resistance in accordance with HQV-14/001		VCR	$\leq 2 \times 10^{-6}/V$
Dimensions (detail)			in accordance with specification

**Focus Metal-glaze Preset (FMP),
Micro-Slot focus units (MCS)**

FMP-MCS

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group ADD1	ND		
Safety test in accordance with PRV-53-8-52/45: 1.3 × V _{ac} during 3 s Test cover: 8204 115 06560		flashover detection breakdown detection	no flashover no breakdown
Sub-group ADD2	D		
Wire forces		push-in force pull-out force	≤25 N ≥50 N
Sub-group ADD3	ND		
Shaft impact test in accordance with PRV-53-8-52/48			no interruptions, no instability

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

FEATURES

- Designed for integration in a high voltage unit
- High temperature and voltage stability
- Special flash protection
- Wide design freedom.

APPLICATIONS

- Line output transformers
- Diode split transformers.

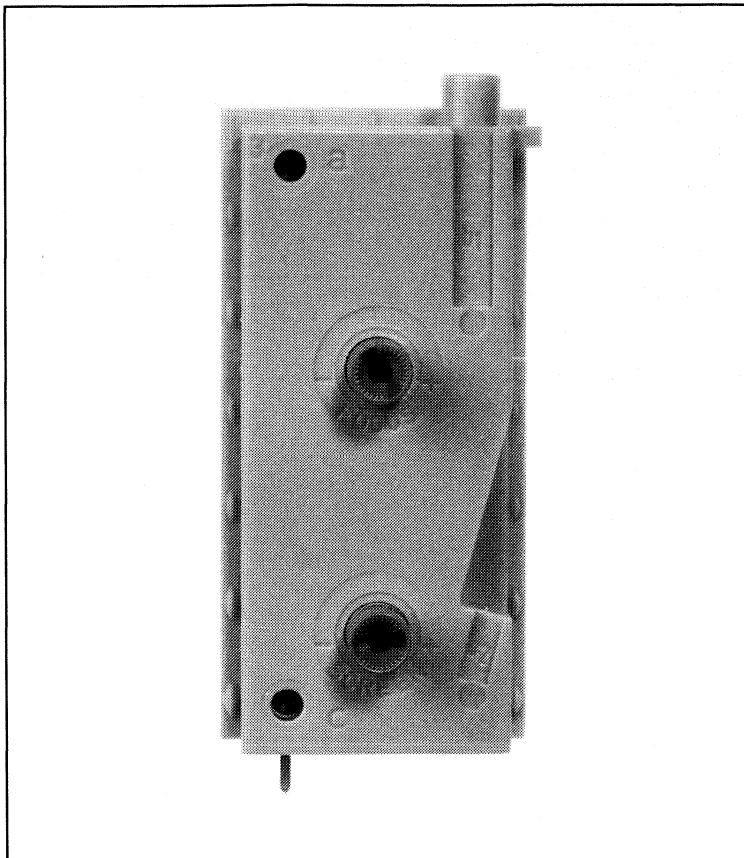
DESCRIPTION

Each unit comprises seven thick film resistance elements on a ceramic (Al_2O_3) substrate, a synthetic (glass reinforced) case and two synthetic (glass reinforced) rotors with multi-wire contacts. Two of the resistance elements are potentiometers.

The product must be mounted into a specially designed slot in the case of the high voltage unit. This provides a complete seal when an epoxy potting agent or other insulation material is used.

A clean and easy method of electrical connection with the high voltage input is made by means of a conductive rubber contact, thereby avoiding the need for soldered joints.

Electrical connection with the focus voltage output (b1) and screen voltage output (b2) (see Figs 5 and 6) is achieved by simply pressing single-core stripped wires into the respective holes. For the recommended cable types see Table 1 and for the stripping length of the recommended wires see Figs 5 and 6. Earth connection is effected through the printed-circuit board with a print tag.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance	69 M Ω to 200 M Ω
Tolerance (% of total resistance)	$\pm 10\%$, $\pm 15\%$ and $\pm 20\%$
Maximum dissipation at $T_{amb} = 70\text{ }^{\circ}\text{C}$	2.0 W
Maximum application voltages	16 kV
Setting ability (IEC 393/6.34)	
focus	$\pm 25\text{ V}$; max. 10 s
screen	$\pm 5\text{ V}$; max. 10 s
Temperature characteristic of resistance (20 to 100 $^{\circ}\text{C}$)	$\leq 100 \times 10^{-6}/\text{K}$
Voltage coefficient of resistance	$\leq 2 \times 10^{-6}/\text{V}$
Climatic category	25/070/21

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

DESIGN VARIATIONS

The DSB focus units are custom designed. Variations to suit customer requirements are possible on the following:

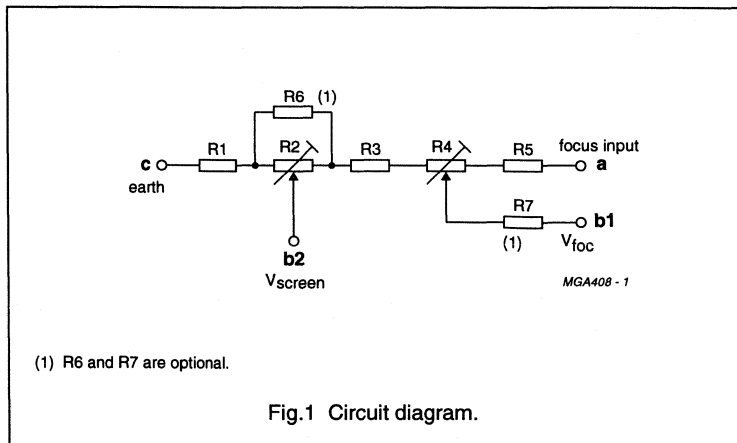
- Total resistance and tolerance
- Focus and screen voltage ranges
- Location of high voltage connections.

For applications in unfavourable environmental conditions, internal shields can be incorporated, thereby giving improved protection against humidity and environmental contamination.

Salt spray and pressure cooker tests can be met.

APPROVAL

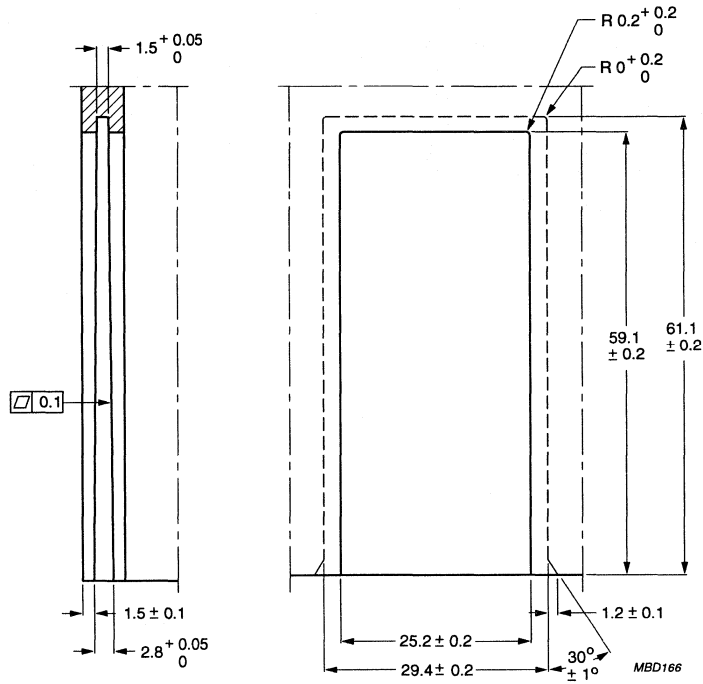
The product is designed for approval (after integration on the high voltage unit) by the major approval institutes. The materials used are UL-VO listed.



Focus Metal-glaze Preset (FMP),
DSB-Slot focus units

FMP-DSB

MECHANICAL DATA

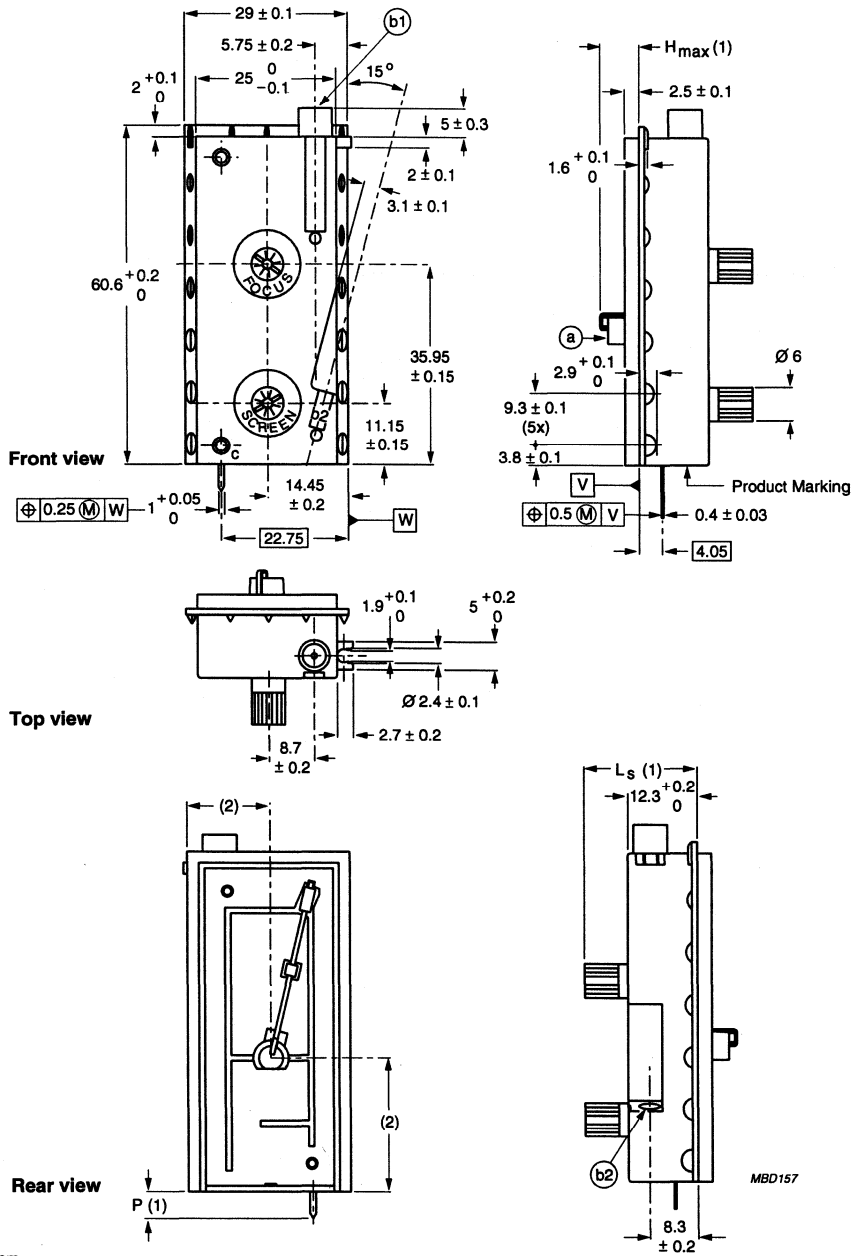


Dimensions in mm.

Fig.2 Slot dimensions.

Focus Metal-glaze Preset (FMP),
DSB-Slot focus units

FMP-DSB



Dimensions in mm.

(1) See Tables 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13.

(2) See Figs 10 to 34.

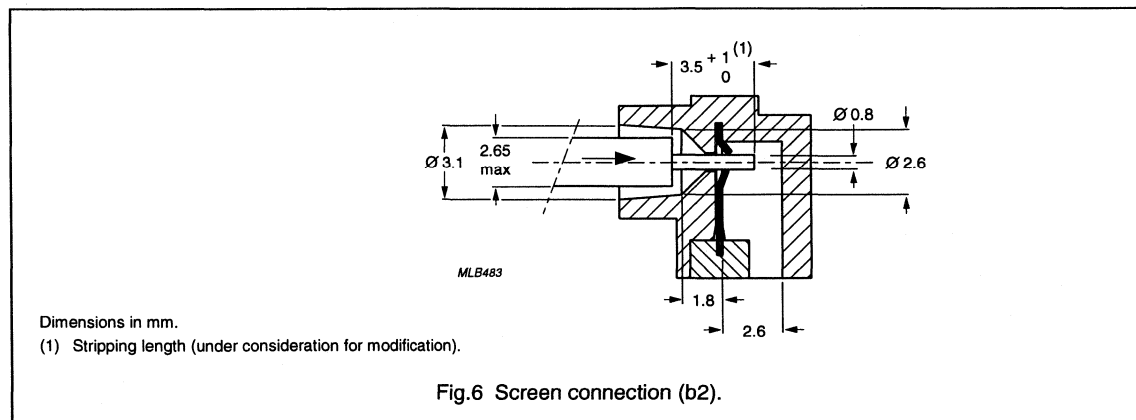
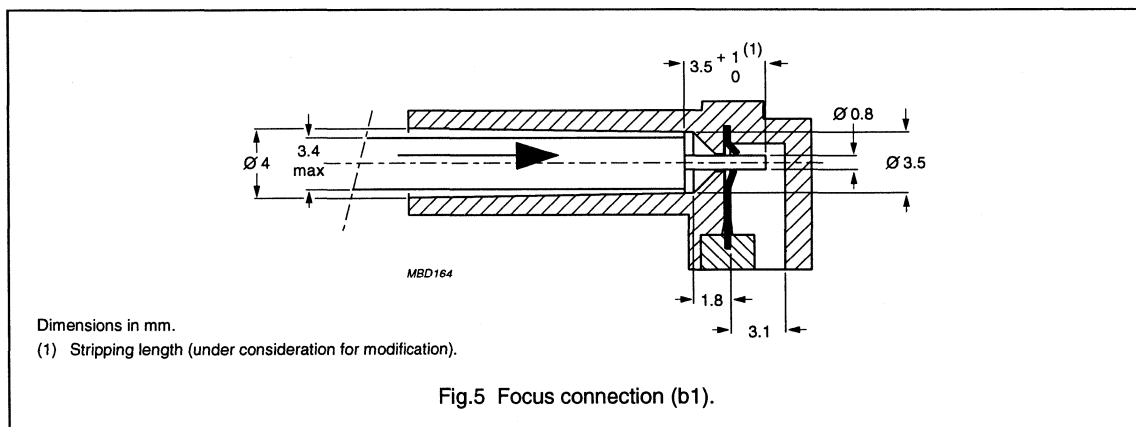
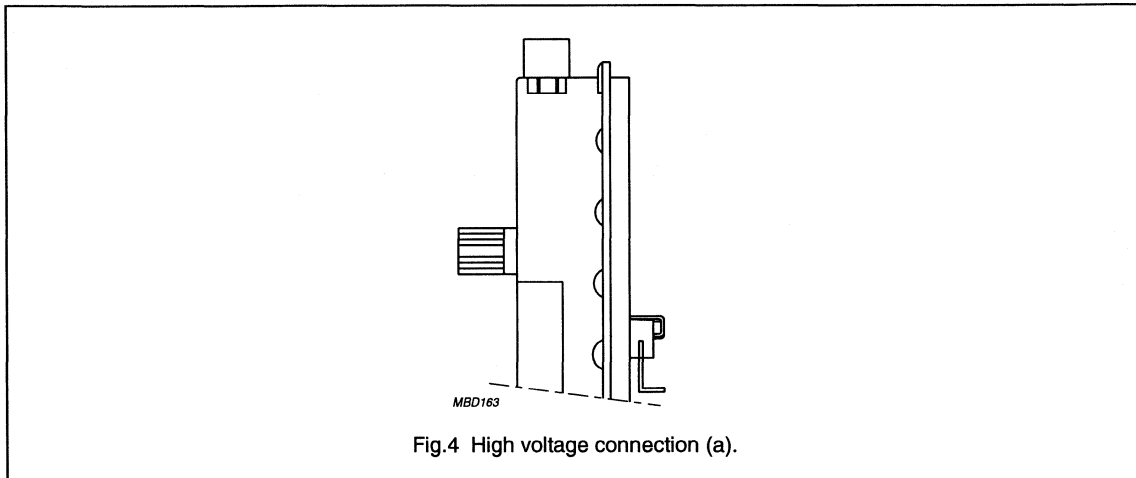
Fig.3 Outline details.

MBD157

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Connection details



Focus Metal-glaze Preset (FMP), DSB-Slot focus units

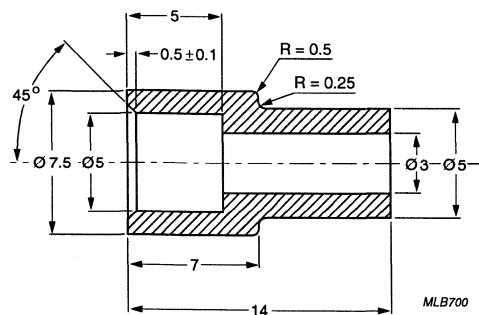
FMP-DSB

Table 1 Recommended connecting wire.

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSULATION MAX. \varnothing (mm)	CATALOGUE NUMBERS
Focus out (b1)	Pope (The Netherlands)	UL758 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.35	0722 388 00005
	Taisho (Japan)	E35688 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00014
	Sumitomo (Japan)	UL3239 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00015
Screen out (b2)	Pope (The Netherlands)	UL1032 VW-1 AWG20 PVC20	2.6	0722 161 00342
	Taisho (Japan)	E35688 AWM 1032 1.2 kV (DC) AWG20 (1/0.83) 90 °C	2.65	0722 158 00547
	Sumitomo (Japan)	UL-style 3476 E41105 (S) 3 kV (DC)	2.51	0722 161 00357
	Tatung (Japan)	UL1032 E54979 1.2 kV (DC) AWG20	2.65	0738 218 00039
	PEWC (Taiwan)	UL1032 E413965 1.2 kV (DC) AWG20 90 °C	2.65	0738 540 00122

Table 2 Recommended rubber boot for focus out connection (b1).

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSIDE \varnothing (mm)	CATALOGUE NUMBER
Focus out (b1)	Hae Ryong (South Korea)	silicon black HR 7020U UL Ref. E98818	3.0	4322 052 86622



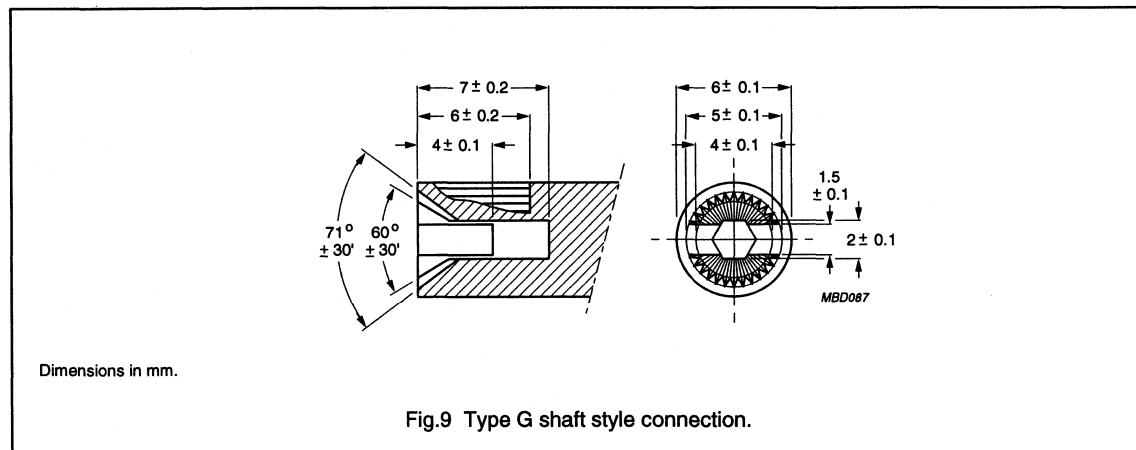
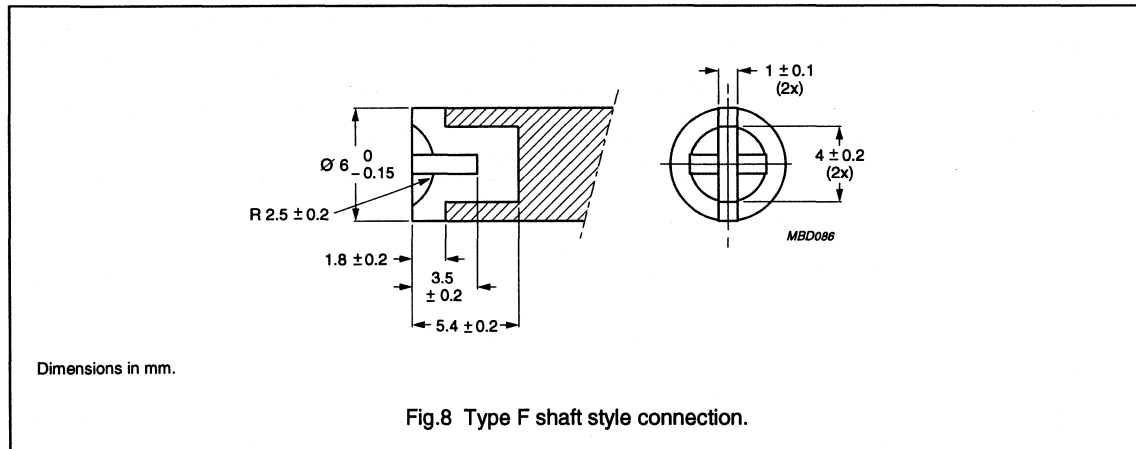
Dimensions in mm.

Fig.7 Rubber boot (4322 052 86622).

Focus Metal-glaze Preset (FMP),
DSB-Slot focus units

FMP-DSB

Shaft style connection details



Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Table 3 Additional information.

PARAMETER	MIN.	TYP.	MAX.	UNIT
Focus unit				
Climatic category (IEC 68)	25/070/21			
Inflammability of materials	self-extinguishing in accordance with UL94-VO			
Potentiometers				
Angle of rotation				
focus	185	190	195	deg
screen	230	235	240	deg
Starting torque	–	–	30	mNm
Operating torque	3	–	30	mNm
Operating torque ratio	–	–	3	
Permissible end stop torque (adjustment tool)	–	–	150	mNm
Permissible end stop torque (manual)	–	–	300	mNm
Permissible push force on shaft	–	–	50	N
Permissible pull force on shaft; note 1	–	–	50	N
Mechanical life; focus/screen	–	50	–	cycles
Weight	–	16	–	g
Connectors b1 and b2				
Insertion force of wire	–	–	25	N
Extraction force of wire	50	–	–	N

Note

1. Not applicable for $L_s \leq 17$ mm.

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

PRODUCT OVERVIEW**Table 4** Overview of product types.

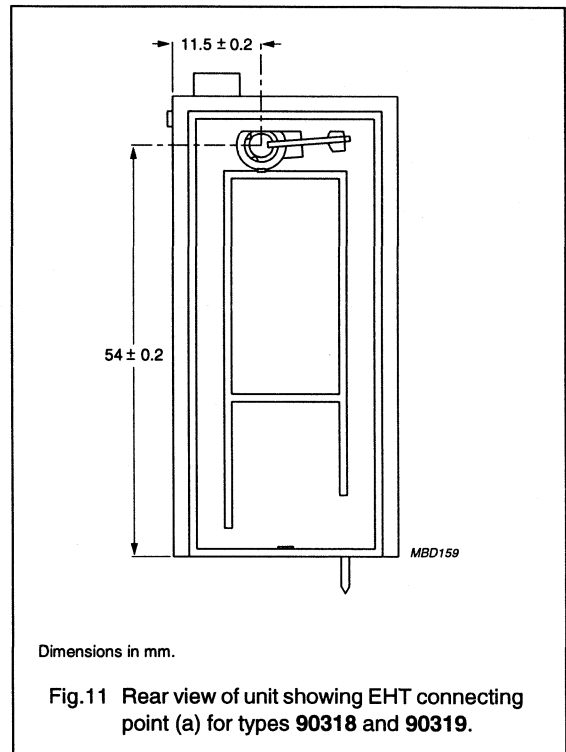
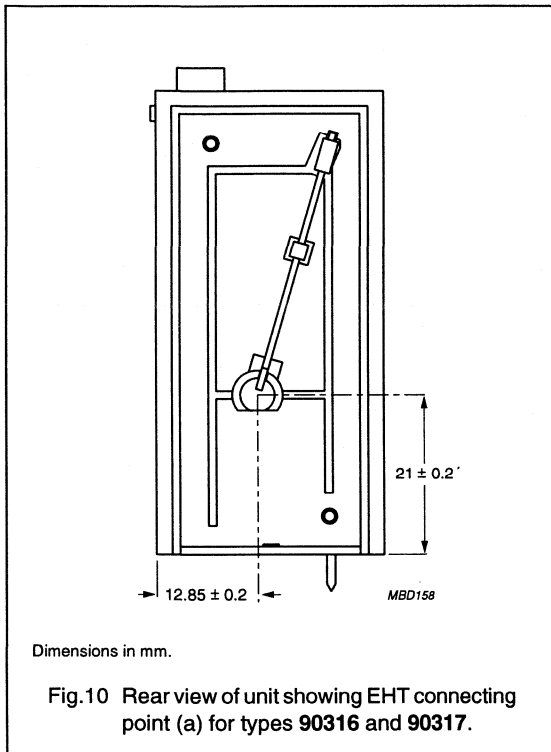
PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90316	90317	90318	90319	
Resistances					
Resistance (R_{ac})	200 \pm 10%	69 \pm 10%	120 \pm 20%	164 \pm 10%	M Ω
Resistor network (see Fig.1)					
R1	2.7	1.48	1.14	1.48	M Ω
R2/R6	15.7	6.8	11.34	14.18	M Ω
R3	61.6	33.12	47.04	36.57	M Ω
R4	50.0	26.91	33.84	38.79	M Ω
R5	70.0	0.69	26.64	72.98	M Ω
R7	–	7.5 \pm 20%	15.0 \pm 30%	15.0 \pm 30%	M Ω
Voltages					
Maximum application voltage (V_{ac})	15.0	9.5	14.0	14.0	kV
V_{toc} ; note 1					
range	44 to 60	65 to 98.6	53.6 to 72.8	35.7 to 50	%
minimum	40.0 \pm 4.0	60.0 \pm 5.0	49.6 \pm 4.0	31.85 \pm 3.85	%
maximum	65.0 \pm 5.0	99.0 \pm 0.4	77.8 \pm 5.0	55.5 \pm 5.5	%
V_{screen} ; note 1					
range	2 to 7.2	3.3 to 10	1.6 to 8.4	1.4 to 7.1	%
minimum	1.35 \pm 0.65	2.15 \pm 1.15	0.95 \pm 0.65	0.9 \pm 0.5	%
maximum	9.2 \pm 2.0	12.0 \pm 2.0	10.4 \pm 2.0	9.55 \pm 2.45	%
Dissipation					
Total maximum dissipation	1.25	1.5	2.0	2.0	W
Shaft data					
Length	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	mm
Type (see Fig.9)	G	G	G	G	
Colour					
focus	black	black	black	black	
screen	black	red	black	black	
Delivery position; note 2					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Special dimensions					
Height of high voltage tag	$H_{max} = 6.9$	$H_{max} = 6.9$	$H_{max} = 6.9$	$H_{max} = 6.9$	mm
Length of earth tag	$P = 4.8 +0.5$	$P = 4.8 +0.5$	$P = 4.8 +0.5$	$P = 4.8 +0.5$	mm

Notes

1. Given in % of V_{ac} .
2. All minimum voltage ratio.

Focus Metal-glaze Preset (FMP),
DSB-Slot focus units

FMP-DSB



Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

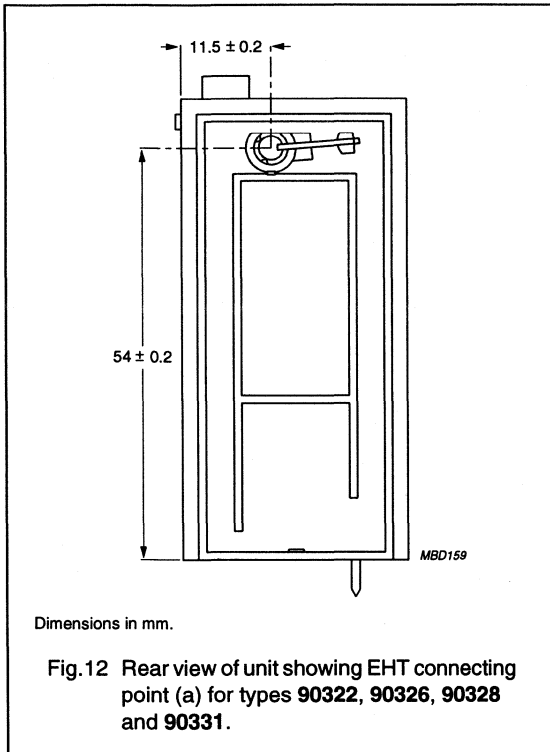
Table 5 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90322	90326	90328	90331	
Resistances					
Resistance (R_{ac})	90 \pm 20%	90 \pm 20%	90 \pm 20%	164 \pm 10%	M Ω
Resistor network (see Fig.1)					
R1	1.35	1.35	1.35	1.64	M Ω
R2/R6	10.66	14.85	14.85	18.45	M Ω
R3	46.4	42.21	42.21	43.79	M Ω
R4	27.9	27.9	27.9	46.33	M Ω
R5	3.69	3.69	3.69	53.79	M Ω
R7	15.0 \pm 30%	15.0 \pm 30%	15.0 \pm 30%	15.0 \pm 30%	M Ω
Voltages					
Maximum application voltage (V_{ac})	9.0	9.0	9.0	14.0	kV
V_{foc} ; note 1					
range	69.4 to 94.4	69.4 to 94.4	69.4 to 94.4	42.9 to 62.7	%
minimum	64.9 \pm 4.5	64.9 \pm 4.5	64.9 \pm 4.5	38.95 \pm 3.95	%
maximum	95.9 \pm 1.5	95.9 \pm 1.5	95.9 \pm 1.5	67.2 \pm 4.5	%
V_{screen} ; note 1					
range	2.2 to 11.1	2.2 to 15.5	2.2 to 15.5	1.4 to 10	%
minimum	1.5 \pm 0.7	1.5 \pm 0.7	1.5 \pm 0.7	1.0 \pm 0.4	%
maximum	13.35 \pm 2.25	18.0 \pm 2.5	18.0 \pm 2.5	12.25 \pm 2.25	%
Dissipation					
Total maximum dissipation	1.2	1.2	1.2	2.0	W
Shaft data					
Length	$L_s = 13.4 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 13.4 \pm 0.3$	$L_s = 20 \pm 0.3$	mm
Type (see Figs 8 and 9)	F	G	F	G	
Colour					
focus	black	green	black	red	
screen	black	green	black	red	
Delivery position; note 2					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Special dimensions					
Height of high voltage tag	$H_{max} = 6.9$	$H_{max} = 6.9$	$H_{max} = 6.9$	$H_{max} = 6.9$	mm
Length of earth tag	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	mm

Notes

1. Given in % of V_{ac} .
2. All minimum voltage ratio.

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Table 6 Overview of product types.

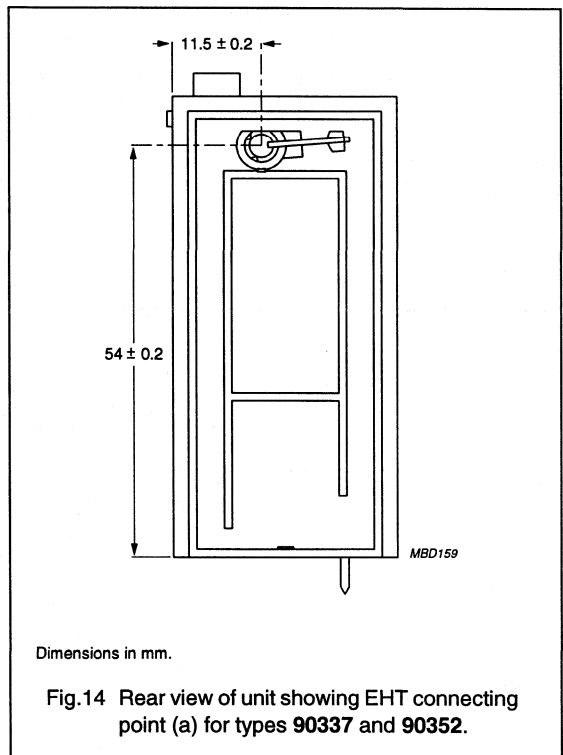
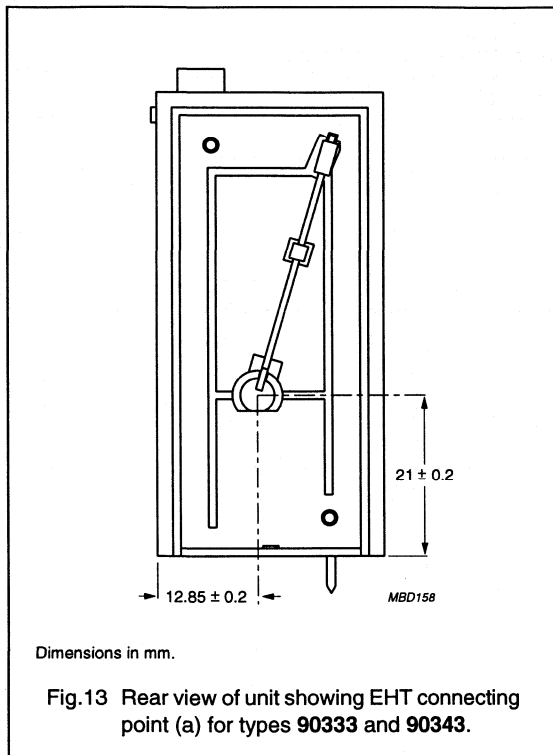
PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90333	90337	90343	90352	
Resistances					
Resistance (R_{ac})	200 \pm 15%	120 \pm 20%	200 \pm 15%	200 \pm 15%	M Ω
Resistor network (see Fig.1)					
R1	7.5	1.8	7.5	1.8	M Ω
R2/R6	14.1	15.24	14.1	16.6	M Ω
R3	68.4	52.26	76.4	61.6	M Ω
R4	70.0	35.4	49.8	50.0	M Ω
R5	60.0	15.3	52.2	70.0	M Ω
R7	20.0 \pm 20%	15.0 \pm 30%	20.0 \pm 20%	20.0 \pm 20%	M Ω
Voltages					
Maximum application voltage (V_{ac})	16.0	12.0	16.0	16.0	kV
V_{foc} ; note 1					
range	50 to 66	62.5 to 85	54 to 70	44 to 60	%
minimum	45.0 \pm 5.0	57.75 \pm 4.75	49.0 \pm 5.0	40.0 \pm 4.0	%
maximum	70.0 \pm 4.0	87.25 \pm 2.25	73.9 \pm 3.9	65.0 \pm 5.0	%
V_{screen} ; note 1					
range	4.6 to 8.8	2 to 11.7	4.6 to 8.8	1.4 to 7.2	%
minimum	3.75 \pm 0.85	1.5 \pm 0.5	3.75 \pm 0.85	0.9 \pm 0.5	%
maximum	10.8 \pm 2.0	14.2 \pm 2.5	10.8 \pm 2.0	9.2 \pm 2.0	%
Dissipation					
Total maximum dissipation	1.5	2.0	1.5	1.5	W
Shaft data					
Length	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	mm
Type (see Fig.9)	G	G	G	G	
Colour					
focus	red	black	black	green	
screen	red	black	green	green	
Delivery position; note 2					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Special dimensions					
Height of high voltage tag	$H_{max} = 6.9$	$H_{max} = 6.9$	$H_{max} = 6.9$	$H_{max} = 6.9$	mm
Length of earth tag	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	mm

Notes

1. Given in % of V_{ac} .
2. All minimum voltage ratio.

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB



Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Table 7 Overview of product types.

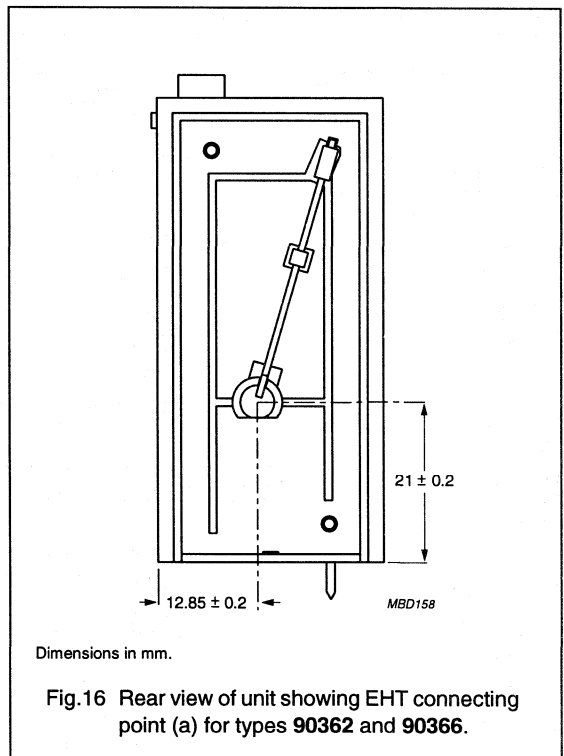
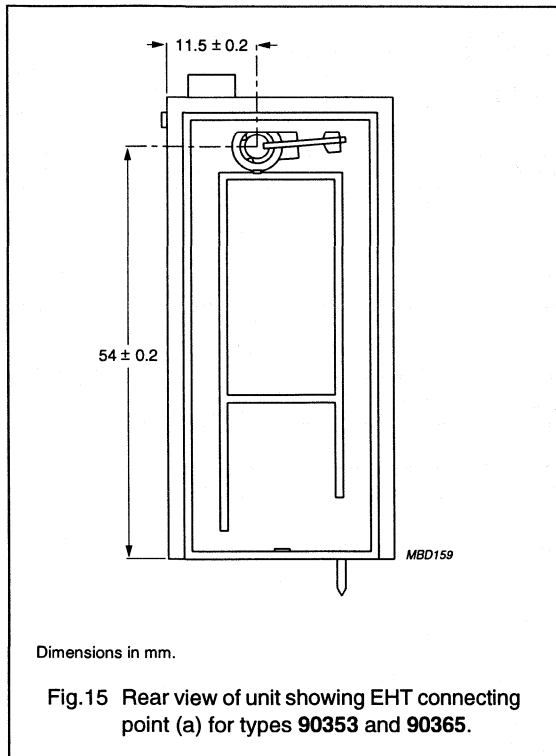
PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90353	90362	90365	90366	
Resistances					
Resistance (R_{ac})	105 \pm 10%	200 \pm 15%	105 \pm 10%	200 \pm 15%	M Ω
Resistor network (see Fig.1)					
R1	1.3	1.8	1.3	1.8	M Ω
R2/R6	17.83	15.6	17.83	16.6	M Ω
R3	46.55	80.6	46.55	71.6	M Ω
R4	37.91	49.8	37.91	50.0	M Ω
R5	1.41	52.2	1.41	60.0	M Ω
R7	15.0 \pm 25%	20.0 \pm 20%	15.0 \pm 25%	20.0 \pm 20%	M Ω
Voltages					
Maximum application voltage (V_{ac})	10.5	16.0	10.5	16.0	kV
V_{foc} ; note 1					
range	66.31 to 98.32	54 to 70	66.31 to 98.32	50 to 66	%
minimum	62.555 \pm 3.755	49.0 \pm 5.0	62.555 \pm 3.755	45.0 \pm 5.0	%
maximum	98.66 \pm 0.34	73.9 \pm 3.9	98.66 \pm 0.34	70.0 \pm 4.0	%
V_{screen} ; note 1					
range	1.57 to 15.44	1.4 to 7.2	1.57 to 15.44	1.4 to 7.2	%
minimum	1.235 \pm 0.335	0.9 \pm 0.5	1.235 \pm 0.335	0.9 \pm 0.5	%
maximum	18.22 \pm 2.78	8.7 \pm 1.5	18.22 \pm 2.78	9.2 \pm 2.0	%
Dissipation					
Total maximum dissipation	1.2	1.5	1.2	1.25	W
Shaft data					
Length	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 13.4 \pm 0.3$	$L_s = 20 \pm 0.3$	mm
Type (see Figs 8 and 9)	G	G	F	G	
Colour					
focus	black	blue	black	red	
screen	black	blue	black	green	
Delivery position; note 2					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Special dimensions					
Height of high voltage tag	$H_{max} = 6.9$	$H_{max} = 6.9$	$H_{max} = 6.9$	$H_{max} = 6.9$	mm
Length of earth tag	$P = 4.8 +0.5$	$P = 4.8 +0.5$	$P = 4.8 +0.5$	$P = 4.8 +0.5$	mm

Notes

1. Given in % of V_{ac} .
2. All minimum voltage ratio.

Focus Metal-glaze Preset (FMP),
DSB-Slot focus units

FMP-DSB



Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Table 8 Overview of product types.

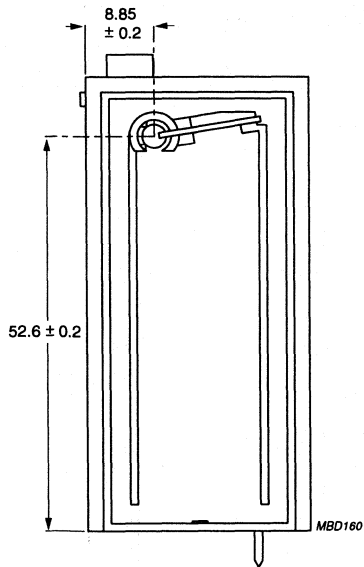
PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90369	90373	90374	90375	
Resistances					
Resistance (R_{ac})	200 \pm 15%	90 \pm 20%	200 \pm 10%	90 \pm 20%	M Ω
Resistor network (see Fig.1)					
R1	5.6	1.35	2.7	1.35	M Ω
R2/R6	20.4	14.85	15.7	14.85	M Ω
R3	78.0	42.21	61.6	42.21	M Ω
R4	60.0	27.9	50.0	27.9	M Ω
R5	36.0	3.69	70.0	3.69	M Ω
R7	10.0 \pm 20%	15.0 \pm 30%	–	15.0 \pm 30%	M Ω
Voltages					
Maximum application voltage (V_{ac})	13.0	9.0	15.0	9.0	kV
V_{foc} ; note 1					
range	56 to 79	69.4 to 94.4	44 to 60	69.4 to 94.4	%
minimum	52.0 \pm 4.0	69.4 \pm 4.5	40.0 \pm 4.0	64.9 \pm 4.5	%
maximum	82.0 \pm 3.0	95.9 \pm 1.5	65.0 \pm 5.0	95.9 \pm 1.5	%
V_{screen} ; note 1					
range	3.8 to 11	2.2 to 15.5	2 to 7.2	2.2 to 15.5	%
minimum	2.8 \pm 1.0	1.5 \pm 0.7	1.35 \pm 0.65	1.5 \pm 0.7	%
maximum	13.0 \pm 2.0	18.0 \pm 2.5	9.2 \pm 2.0	18.0 \pm 2.5	%
Dissipation					
Total maximum dissipation	1.0	1.1	1.3	1.1	W
Shaft data					
Length	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 13.4 \pm 0.3$	mm
Type (see Figs 8 and 9)	G	G	G	F	
Colour					
focus	black	black	black	black	
screen	black	black	black	black	
Delivery position; note 2					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Special dimensions					
Height of high voltage tag	$H_{max} = 4.2$	$H_{max} = 4.7$	$H_{max} = 4.7$	$H_{max} = 4.7$	mm
Length of earth tag	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	mm

Notes

1. Given in % of V_{ac} .
2. All minimum voltage ratio.

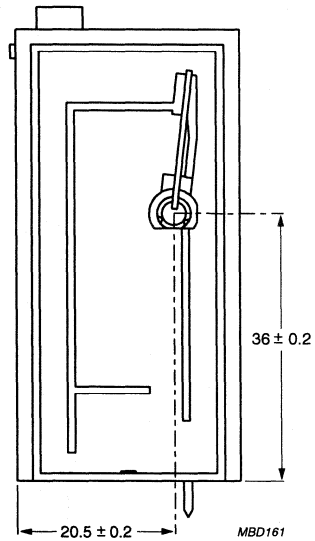
Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB



Dimensions in mm.

Fig.17 Rear view of unit showing EHT connecting point (a) for type 90369.



Dimensions in mm.

Fig.18 Rear view of unit showing EHT connecting point (a) for types 90373, 90374 and 90375.

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Table 9 Overview of product types.

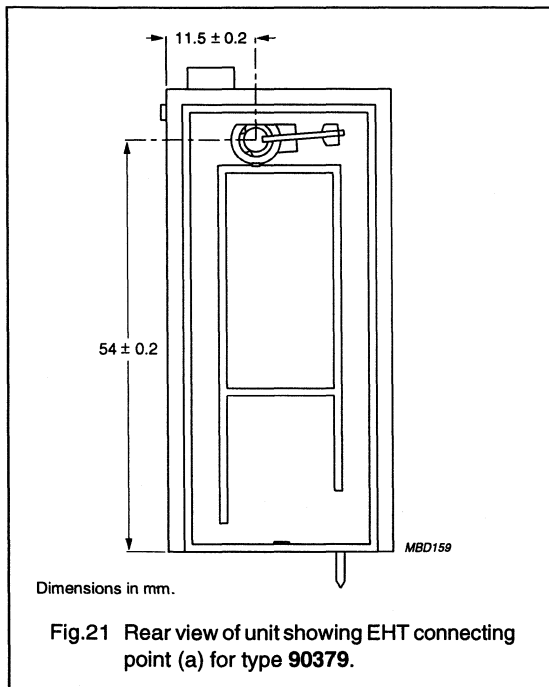
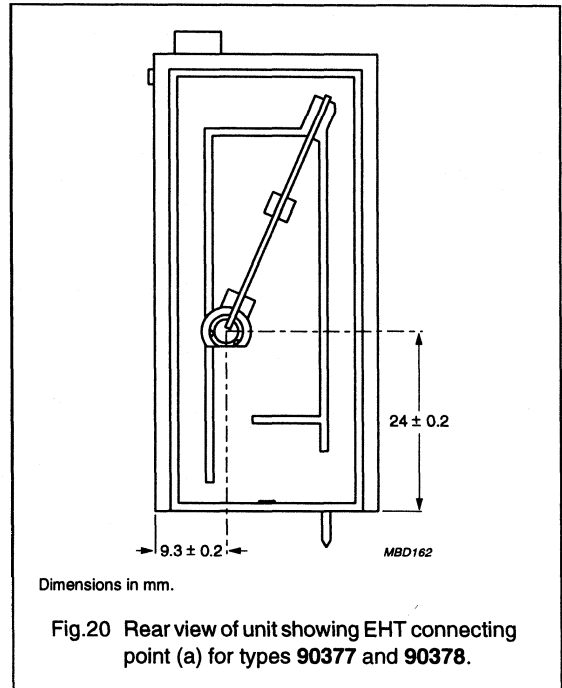
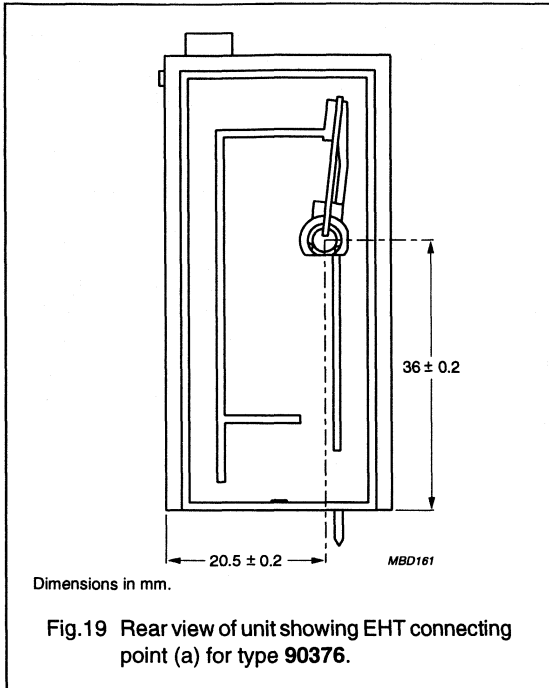
PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90376	90377	90378	90379	
Resistances					
Resistance (R_{ac})	200 \pm 10%	180 \pm 10%	180 \pm 10%	105 \pm 10%	M Ω
Resistor network (see Fig.1)					
R1	2.7	1.8	1.8	1.3	M Ω
R2/R6	15.7	20.7	20.7	17.83	M Ω
R3	61.6	75.06	93.78	46.56	M Ω
R4	50.0	37.98	33.84	37.91	M Ω
R5	70.0	44.46	29.88	1.4	M Ω
R7	–	20.0 \pm 20%	20.0 \pm 20%	15.0 \pm 25%	M Ω
Voltages					
Maximum application voltage (V_{ac})	15.0	13.7	13.7	10.5	kV
V_{foc} ; note 1					
range	44 to 60	58.2 to 72.3	68.6 to 80.4	66.31 to 98.32	%
minimum	40.0 \pm 4.0	54.2 \pm 4.0	64.6 \pm 4.0	62.555 \pm 3.755	%
maximum	65.0 \pm 5.0	75.3 \pm 3.0	83.4 \pm 3.0	98.66 \pm 0.34	%
V_{screen} ; note 1					
range	2 to 7.2	1.5 to 10.5	1.5 to 10.5	1.57 to 15.44	%
minimum	1.35 \pm 0.65	1.0 \pm 0.5	1.0 \pm 0.5	1.235 \pm 0.335	%
maximum	9.2 \pm 2.0	12.5 \pm 2.0	12.5 \pm 2.0	18.22 \pm 2.78	%
Dissipation					
Total maximum dissipation	1.3	1.2	1.2	1.2	W
Shaft data					
Length	$L_s = 13.4 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	mm
Type (see Figs 8 and 9)	F	G	G	G	
Colour					
focus	black	red	red	black	
screen	black	black	black	black	
Delivery position; note 2					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Special dimensions					
Height of high voltage tag	$H_{max} = 4.7$	$H_{max} = 6.2$	$H_{max} = 6.2$	$H_{max} = 6.9$	mm
Length of earth tag	$P = 4.8 + 0.5$	$P = 7.0 + 0.5$	$P = 7.0 + 0.5$	$P = 4.8 + 0.5$	mm

Notes

1. Given in % of V_{ac} .
2. All minimum voltage ratio.

Focus Metal-glaze Preset (FMP),
DSB-Slot focus units

FMP-DSB



Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Table 10 Overview of product types.

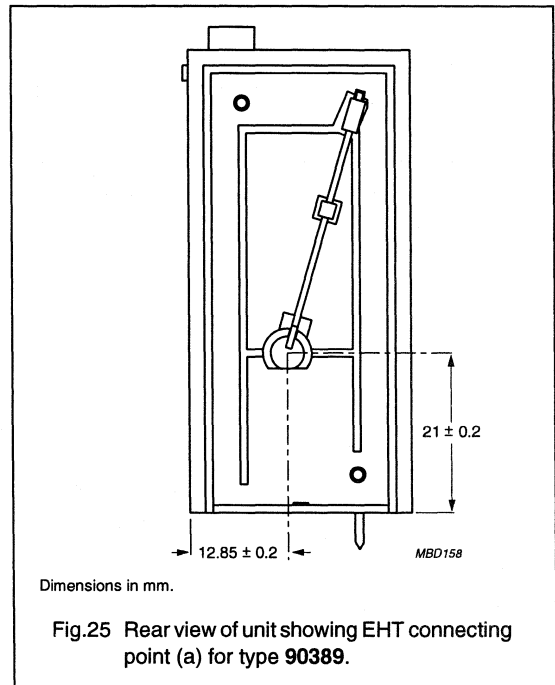
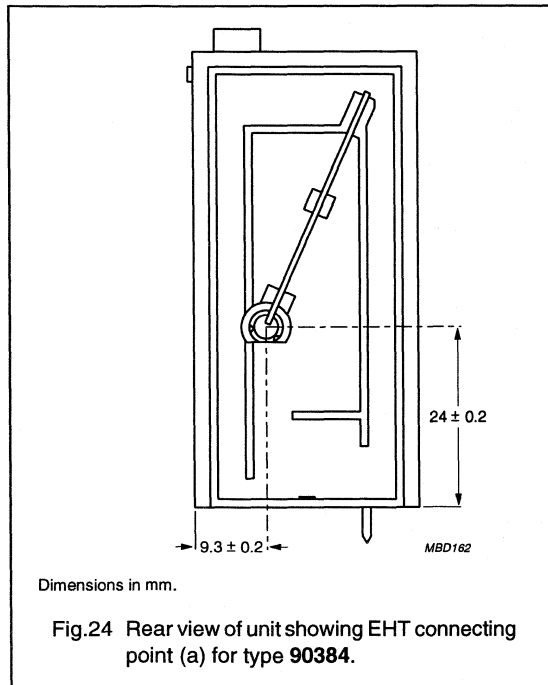
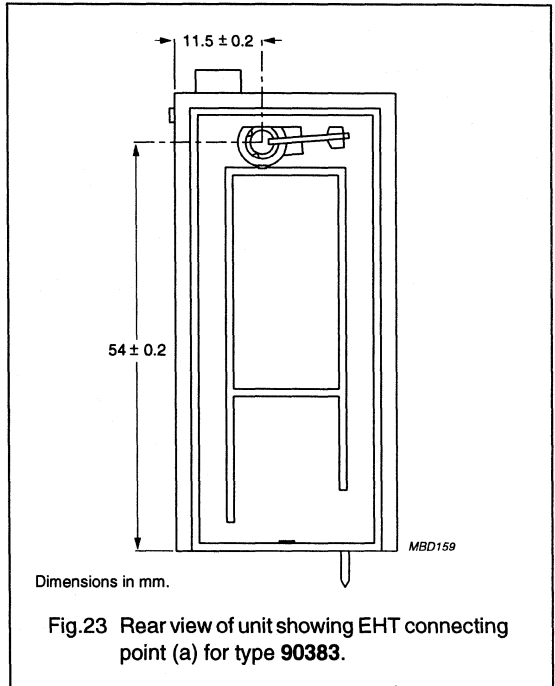
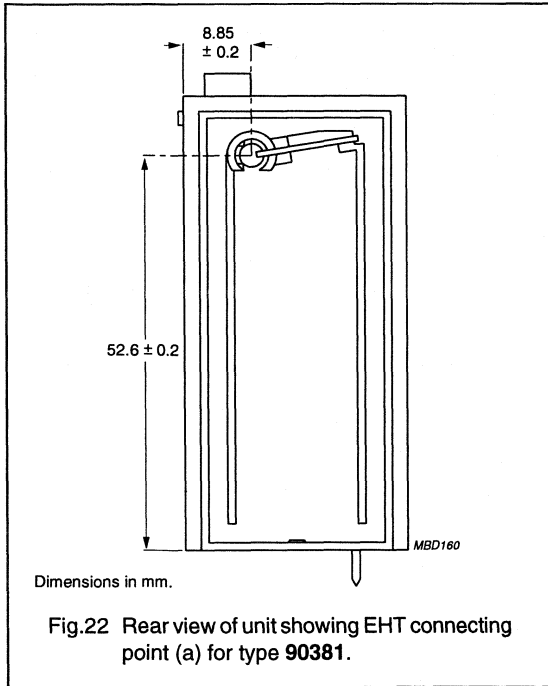
PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90381	90383	90384	90389	
Resistances					
Resistance (R_{ac})	200 \pm 15%	164 \pm 10%	180 \pm 10%	200 \pm 15%	M Ω
Resistor network (see Fig.1)					
R1	6.0	1.48	1.8	6.5	M Ω
R2/R6	20.0	18.61	20.7	15.1	M Ω
R3	89.9	37.39	74.05	65.4	M Ω
R4	55.7	46.0	53.57	56.0	M Ω
R5	28.4	60.52	29.88	57.0	M Ω
R7	15.0 \pm 20%	15.0 \pm 20%	20.0 \pm 20%	20.0 \pm 20%	M Ω
Voltages					
Maximum application voltage (V_{ac})	13.0	14.0	13.7	16.0	kV
V_{foc} ; note 1					
range	61.8 to 83.4	39 to 58.6	57.64 to 80.4	48.5 to 67.5	%
minimum	57.95 \pm 3.85	35.05 \pm 3.95	53.64 \pm 4.0	43.5 \pm 5.0	%
maximum	85.8 \pm 2.4	63.1 \pm 4.5	83.4 \pm 3.0	71.5 \pm 4.0	%
V_{screen} ; note 1					
range	4.15 to 11	1.4 to 10	1.5 to 10.5	4.1 to 8.8	%
minimum	3.0 \pm 1.15	0.9 \pm 0.5	1.0 \pm 0.5	3.25 \pm 0.85	%
maximum	13.0 \pm 2.0	12.25 \pm 2.25	12.5 \pm 2.0	10.8 \pm 2.0	%
Dissipation					
Total maximum dissipation	1.0	1.3	1.2	1.5	W
Shaft data					
Length	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	mm
Type (see Fig.9)	G	G	G	G	
Colour					
focus	red	red	red	black	
screen	red	red	black	blue	
Delivery position; note 2					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Special dimensions					
Height of high voltage tag	$H_{max} = 4.2$	$H_{max} = 6.9$	$H_{max} = 6.2$	$H_{max} = 6.9$	mm
Length of earth tag	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	$P = 7.0 + 0.5$	$P = 4.8 + 0.5$	mm

Notes

1. Given in % of V_{ac} .
2. All minimum voltage ratio.

Focus Metal-glaze Preset (FMP),
DSB-Slot focus units

FMP-DSB



Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Table 11 Overview of product types.

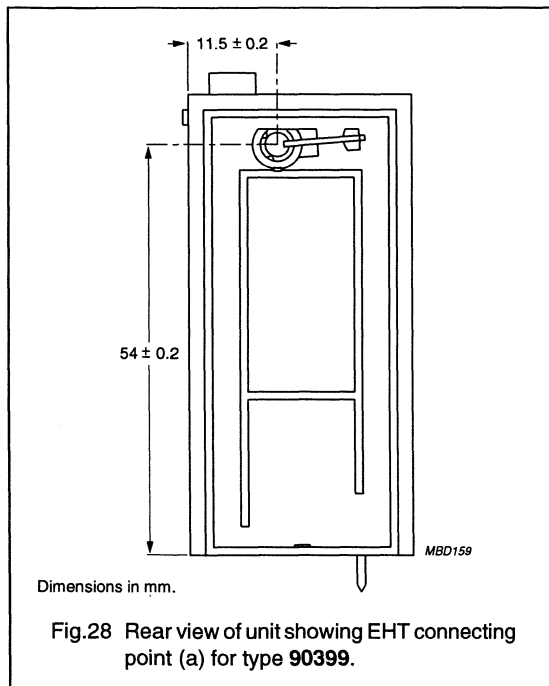
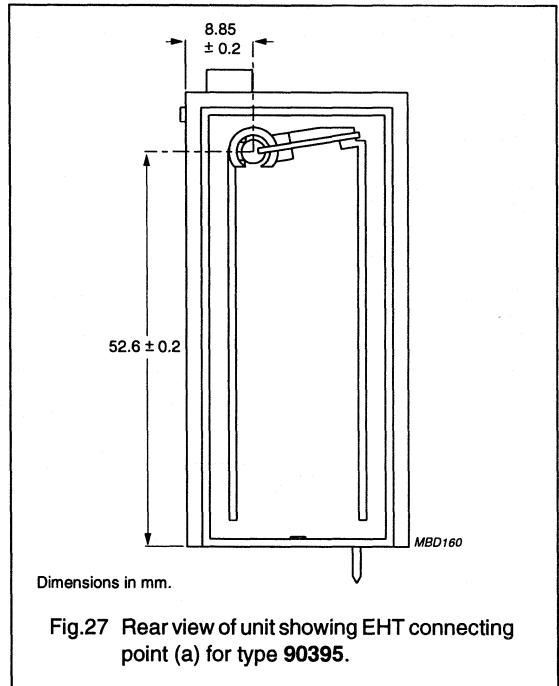
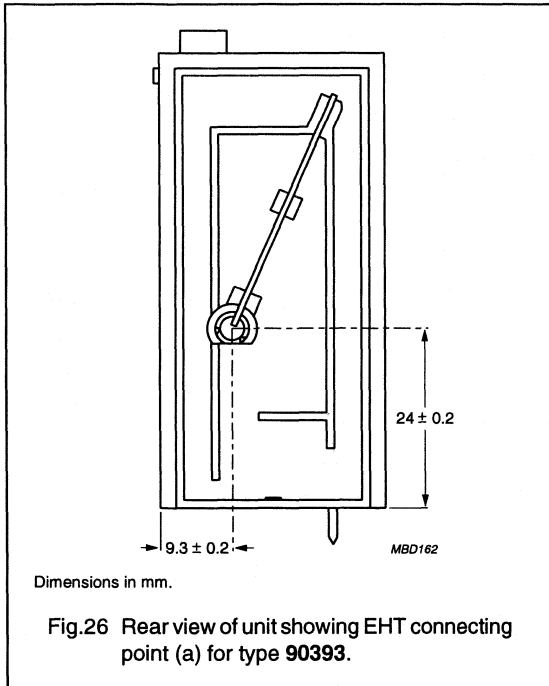
PARAMETERS	CATALOGUE NUMBER 2322 460			UNIT
	90393	90395	90399	
Resistances				
Resistance (R_{ac})	180 \pm 10%	200 \pm 15%	120 \pm 20%	M Ω
Resistor network (see Fig.1)				
R1	1.8	1.3	1.8	M Ω
R2/R6	25.2	9.5	15.24	M Ω
R3	54.0	93.2	52.26	M Ω
R4	51.93	60.0	35.4	M Ω
R5	47.07	36.0	15.3	M Ω
R7	20.0 \pm 20%	10.0 \pm 20%	15.0 \pm 30%	M Ω
Voltages				
Maximum application voltage (V_{ac})	14.2	13.0	12.0	kV
V_{foc} ; note 1				
range	49 to 70	56 to 79	62.5 to 85	%
minimum	45.0 \pm 4.0	52.0 \pm 4.0	57.75 \pm 4.75	%
maximum	73.85 \pm 3.85	82.0 \pm 3.0	87.25 \pm 2.25	%
V_{screen} ; note 1				
range	1.5 to 12.5	0.9 to 4.2	2 to 11.7	%
minimum	1.0 \pm 0.5	0.65 \pm 0.25	1.5 \pm 0.5	%
maximum	15.0 \pm 2.5	5.4 \pm 1.2	14.2 \pm 2.5	%
Dissipation				
Total maximum dissipation	1.2	1.0	2.0	W
Shaft data				
Length	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 13.4 \pm 0.3$	mm
Type (see Figs 8 and 9)	G	G	F	
Colour				
focus	red	green	black	
screen	black	green	black	
Delivery position; note 2				
focus	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	deg
Special dimensions				
Height of high voltage tag	$H_{max} = 6.2$	$H_{max} = 4.2$	$H_{max} = 6.9$	mm
Length of earth tag	$P = 7.0 + 0.5$	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	mm

Notes

1. Given in % of V_{ac} .
2. All minimum voltage ratio.

Focus Metal-glaze Preset (FMP),
DSB-Slot focus units

FMP-DSB



Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Table 12 Overview of product types.

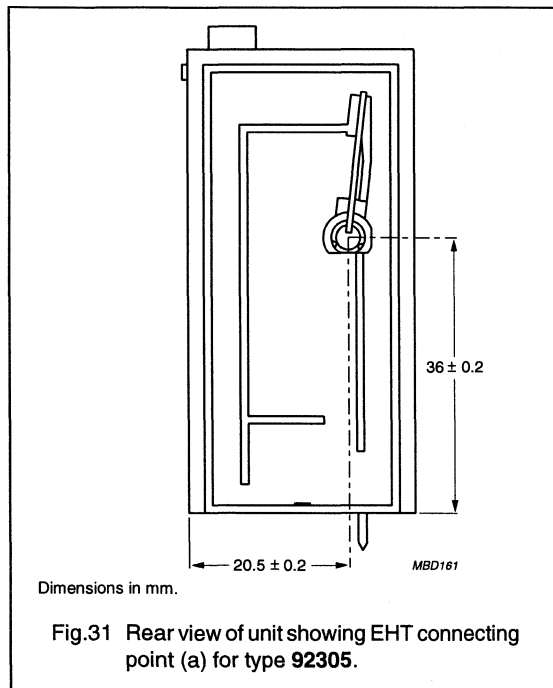
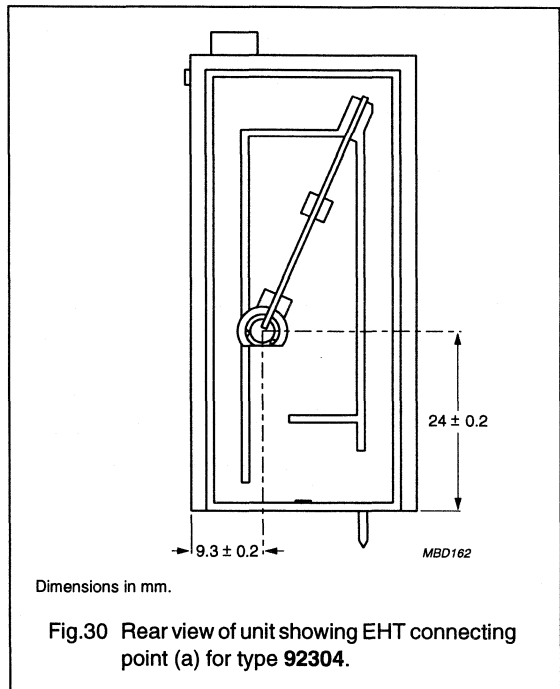
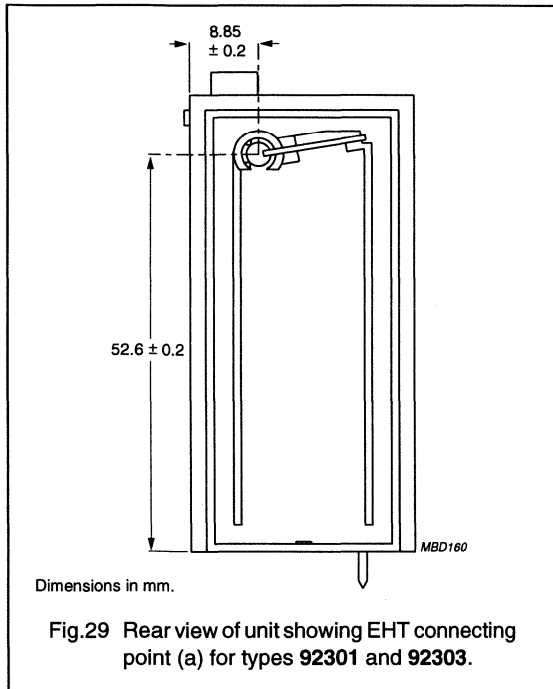
PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	92301	92303	92304	92305	
Resistances					
Resistance (R_{ac})	200 \pm 15%	200 \pm 15%	180 \pm 10%	120 \pm 10%	M Ω
Resistor network (see Fig.1)					
R1	6.5	5.6	1.8	1.65	M Ω
R2/R6	15.1	20.4	24.3	18.15	M Ω
R3	67.9	78.0	90.0	54.0	M Ω
R4	52.5	60.0	63.0	45.0	M Ω
R5	58.0	36.0	0.9	1.2	M Ω
R7	15.0 \pm 20%	10.0 \pm 20%	20.0 \pm 20%	15.0 \pm 20%	M Ω
Voltages					
Maximum application voltage (V_{ac})	16.0	13.0	13.7	11.0	kV
V_{foc} ; note 1					
range	48.5 to 67.5	56 to 79	68.5 to 99	65 to 98	%
minimum	44.75 \pm 3.75	52.0 \pm 4.0	64.5 \pm 4.0	61.5 \pm 3.5	%
maximum	71.0 \pm 3.5	82.0 \pm 3.0	99.5 \pm 0.5	99.0 \pm 1.0	%
V_{screen} ; note 1					
range	4.1 to 8.8	3.8 to 11	1.5 to 12	2 to 14	%
minimum	3.25 \pm 0.85	2.8 \pm 1.0	1.0 \pm 0.5	1.375 \pm 0.625	%
maximum	10.8 \pm 2.0	13.0 \pm 2.0	14.5 \pm 2.5	16.5 \pm 2.5	%
Dissipation					
Total maximum dissipation	1.5	1.0	1.2	1.1	W
Shaft data					
Length	$L_s = 20 \pm 0.3$	$L_s = 13.4 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	mm
Type (see Figs 8 and 9)	G	F	G	G	
Colour					
focus	blue	black	red	black	
screen	blue	black	black	black	
Delivery position; note 2					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg
Special dimensions					
Height of high voltage tag	$H_{max} = 4.2$	$H_{max} = 4.2$	$H_{max} = 6.2$	$H_{max} = 4.7$	mm
Length of earth tag	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	$P = 7.0 + 0.5$	$P = 4.8 + 0.5$	mm

Notes

1. Given in % of V_{ac} .
2. All minimum voltage ratio.

Focus Metal-glaze Preset (FMP),
DSB-Slot focus units

FMP-DSB



Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

Table 13 Overview of product types.

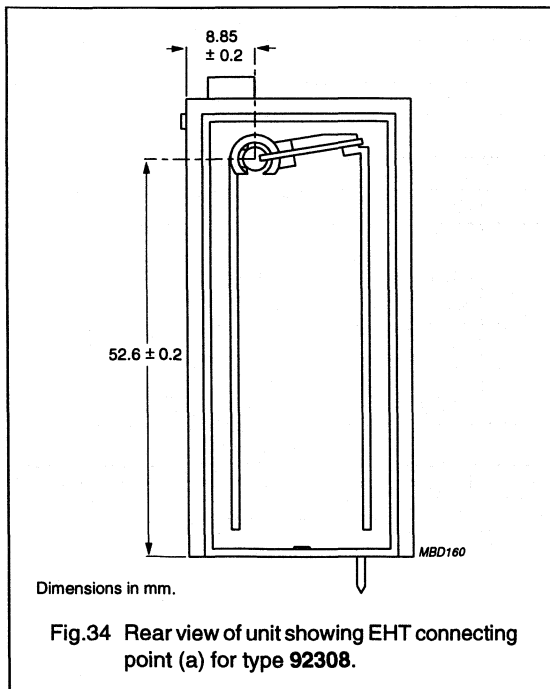
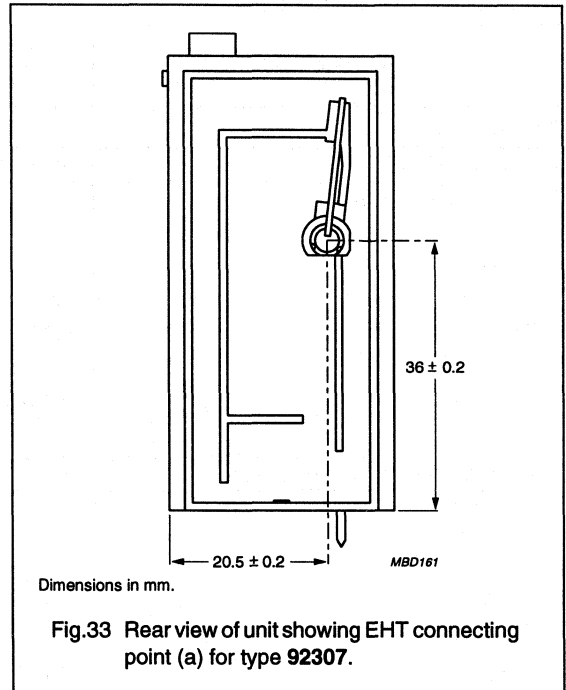
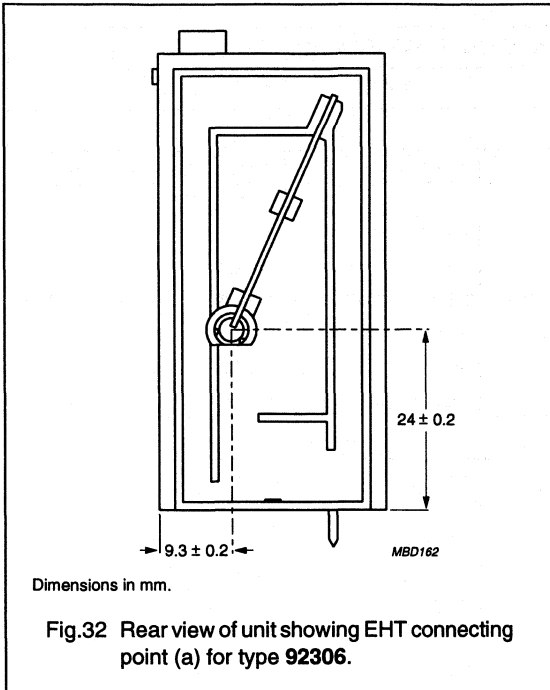
PARAMETERS	CATALOGUE NUMBER 2322 460			UNIT
	92306	92307	92308	
Resistances				
Resistance (R_{ac})	180 \pm 15%	200 \pm 10%	200 \pm 15%	M Ω
Resistor network (see Fig.1)				
R1	1.8	2.7	6.5	M Ω
R2/R6	27.45	19.3	15.1	M Ω
R3	73.8	58.0	67.9	M Ω
R4	58.95	64.0	52.5	M Ω
R5	18.0	56.0	58.0	M Ω
R7	20.0 \pm 20%	15.0 \pm 20%	15.0 \pm 20%	M Ω
Voltages				
Maximum application voltage (V_{ac})	13.5	15.0	16.0	kV
V_{foc} ; note 1				
range	61.25 to 87.5	44 to 68	48.5 to 67.5	%
minimum	57.25 \pm 4.0	40.0 \pm 4.0	44.75 \pm 3.75	%
maximum	90.0 \pm 2.5	72.0 \pm 4.0	71.0 \pm 3.5	%
V_{screen} ; note 1				
range	1.5 to 14	2 to 9	4.1 to 8.8	%
minimum	1.0 \pm 0.5	1.35 \pm 0.65	3.25 \pm 0.85	%
maximum	16.25 \pm 2.25	11.0 \pm 2.0	10.8 \pm 2.0	%
Dissipation				
Total maximum dissipation	1.2	1.3	1.5	W
Shaft data				
Length	$L_s = 20 \pm 0.3$	$L_s = 20 \pm 0.3$	$L_s = 13.4 \pm 0.3$	mm
Type (see Figs 8 and 9)	G	G	F	
Colour				
focus	red	black	blue	
screen	black	black	blue	
Delivery position; note 2				
focus	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	deg
Special dimensions				
Height of high voltage tag	$H_{max} = 6.2$	$H_{max} = 4.7$	$H_{max} = 4.2$	mm
Length of earth tag	$P = 7.0 + 0.5$	$P = 4.8 + 0.5$	$P = 4.8 + 0.5$	mm

Notes

1. Given in % of V_{ac} .
2. All minimum voltage ratio.

Focus Metal-glaze Preset (FMP),
DSB-Slot focus units

FMP-DSB



Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

SAFETY REQUIREMENTS

In general an area of 10 mm around the focus unit should be free from all conductive parts with sharp edges. Penetration with earthed parts in these areas should be avoided. Full details of these areas are contained in the factory specification related to each catalogue type. The potentiometer parts carrying high voltage should be free from metal particles, solder drops, etc.

RELIABILITY

Maximum cumulative percentage of failures F (n) after n hours (excluding 0 hours rejects).

Percentage rate of failures.

FAILURES	PERCENTAGE
F (300)	≤0.03%
F (10000)	≤0.25%
F (30000)	≤5.0%

LIST OF MATERIALS

NAME OF PART	MATERIAL	TYPE	MANUFACTURER	FLAME CLASS	UL FILE
Case	polycarbonate	Lexan 500 R	General Electric	UL-94-VO	E45329
Shaft	modified PPO	Noryl VO-150-B	General Electric	UL-94-VO	E45329
Rubber spring	silicone rubber	K 1238	Philips	UL-94-HB	E45111
Contact plug internal	silicone rubber	K 1764	Philips	UL-94-VO	E45111
Contact plug external	silicone rubber	9274	Philips	UL-94-HB	E45111
Glue	silicone rubber	744 RTV	Dow Corning	LOI 31%	–
Vacuum grease	silicone grease	TKHV-1	Klüber	–	–

ORDERING

Minimum ordering quantity: 360 pieces.

Order by quoting the 12-digit catalogue number of the potentiometer units and the quantity required.

PRODUCT MARKING 2322 460 903..

The unit is marked with the date code (year, week and day of manufacture), the operator code, and the last five digits of the catalogue number.

Example of product marking.

MARKING YWWDX903..	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

PRODUCT MARKING 2322 460 923..

The unit is marked with the date code (year, week and day of manufacture), the operator code, and the last five digits of the catalogue number.

Example of product marking.

MARKING YWWDX923..	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

Focus Metal-glaze Preset (FMP), DSB-Slot focus units





FMP-DSB

PACKAGING

Packed as 360 units in 12 polystyrene packaging shells, stacked on a rigid board. An additional empty packaging shell is located on the top together with a cover. The complete package is bound tightly together with polypropylene taping straps.

LABELLING

The label on the package containing the potentiometers is as shown.

		LINE MARKING EXPLANATION
1.	MADE IN BELGIUM	1. Country of origin
2.	POTENTIOMETERS 200M	2. Product family and resistance values
3.	FMP FOCUS METAL-GLAZE PRESET	3. Product description
4.	FMP-DSB	4. Customer information
5.	 ORIG R170 RPC HQ	5. Preference origin code and product centre
6.	 QTY 360 DATE 9308	6. Quantity per standard packing and product code
7.	 TYPE FMP	7. Product description
8.	 CODENO 2322 460 90389	8. Catalogue number (12NC)

MRC297

Fig.35 Packaging label (example).

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

TESTS AND REQUIREMENTS

In these tables the tests can either be:

D = Destructive

ND = Non-destructive.

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group B1-a	D		
SOLDERABILITY			
Solder iron method in accordance with IEC 68-2-20, Test Ta, method 2: Temperature: 350 °C ±10 °C Solder bit code number: 2622 035 17135 Bit dimensions: 2.5 × 1.5 mm Solder: 60/40 tin/lead Type: Ersin multicore Diameter 1.2 mm with flux 366 Time: 2 ±0.5 s		visual examination	wetting: >95%
Solder bath method in accordance with IEC 68-2-20, Test Ta, method 1: Temperature: 235 °C ±5 °C Immersion time: 2 ±5 s		visual examination	wetting: >95%
Sub-group B1-b	ND		
Focus spark gap firing simulation in accordance with PRV-53-8-52/42: R1 = 400 Ω; R2 = 5 MΩ; C1 = 2 nF; P1 = P2 = 600 hPa; V1 = V _{ac} ; V2 = 30 kV; both with shafts FCW; n = 50		visual examination element resistance $\Delta R_{ac}/R_{ac}$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no visible damage ≤3% ≤25 V ≤5 V
Corona in accordance with PRV-53-8-52/43: 1.3 × V _{ac} ; 60 s; standard atmosphere		corona detection	no corona
Breakdown voltage under pressure in accordance with IEC 68-2-13 test M: V _{ac} ; 30 minutes; 600 hPa; 55 °C		flashover detection breakdown detection	no flashover no breakdown
Sub-group C1	ND		
Mechanical travel		focus screen	195° ±5° 235° ±5°
Starting torque		focus screen	3 to 30 mNm; ratio ≤3 3 to 30 mNm; ratio ≤3
Sub-group C2	ND		
Output ratio range		V _{b1c min} /V _{ac} ; V _{b1c max} /V _{ac} ; V _{b2c min} /V _{ac} ; V _{b2c max} /V _{ac}	see Tables 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13
Continuity in accordance with PRV-53-8-52/44			smooth, unidirectional
Settability		focus ±25 V screen ±5 V	≤10 s ≤10 s
Robustness of terminations in accordance with IEC-68-2-21 test Vb, method 1		visual examination	no visible damage

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group C3	D		
Electrical endurance at 70 °C: Temperature: 70 °C ±3 °C Duration: 1 000 hours Cyclic load (1.5 hours on and 0.5 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} starting torque	no visual damage $\leq 3\%$ ≤ 25 V ≤ 5 V not specified
Sub-group D1	D		
Damp heat, cyclic in accordance with IEC 68-2-30, Test Db: Upper temperature: 40 °C Number of cycles: 21 (1 cycle = 1 hour on and 23 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no visible damage not specified ≤ 25 V ≤ 5 V
Sub-group D2	D		
Mechanical endurance at room temperature: Number of cycles of operation: 50 Rate: 4 ±1 cycles per minute		visual examination element resistance $\Delta R/R$ starting torque continuity change of output ratios	no visible damage $\leq 3\%$ not specified smooth, unidirectional 0.965 to 1.035 × initial requirements
Sub-group D3	ND		
End - stop torque: Adjustment tool: 150 mNm Manual: 300 mNm Duration: 10 s		visual examination	no visible damage, no deformation
Axial thrust on the shaft: Thrust: 50 N		continuity output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	smooth, unidirectional not specified not specified
Radial thrust on the shaft: Thrust: 150 mNm (not applicable for $L_s \leq 17$ mm)		visual examination	no visible damage
Sub-group D4-a	D		
Solder iron method in accordance with IEC 68-2-20, Test Ta, method 2: Temperature: 350 °C ±10 °C Solder bit code number: 2622 035 17135 Bit dimensions: 2.5 × 1.5 mm Solder: 60/40 tin/lead Type: Ersin multicore Diameter 1.2 mm with flux 366 Time: 2 ±0.5 s		element resistance $\Delta R/R$ output voltage drift ΔV_{b2}	$\leq 0.2\%$ ≤ 2 V

Focus Metal-glaze Preset (FMP), DSB-Slot focus units

FMP-DSB

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group D4-b	D		
Change of temperature in accordance with IEC 68-2-14, Test Na: TA = -25 °C TB = +100 °C Number of cycles: 5 Exposure duration: 30 minutes Shafts: FCCW		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visual damage $\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-c	D		
Vibration in accordance with IEC 68-2-6, Test Fc, Procedure B4: Frequency range: 10 to 55 Hz Amplitude: 0.75 mm or 98 m/s ² Sweep endurance: total duration 6 hours Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-d	D		
Shock in accordance with IEC 68-2-27, Test Ea: Pulse duration: 11 ms Acceleration: 490 m/s ² Number of shocks: 3 in each of 6 directions Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-e	D		
Dry heat in accordance with IEC 68-2-2, Test Bb: Temperature: +100 °C Duration: 96 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-f	D		
Cold in accordance with IEC 68-2-1, Test Ab: Temperature: -25 °C Duration: 86 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D5	ND		
Temperature characteristic of resistance: +20 °C to +100 °C		TCR	$\leq 100 \times 10^{-6}/K$
Voltage coefficient of resistance in accordance with HQV-14/001		VCR	$\leq 2 \times 10^{-6}/V$
Dimensions (detail)			in accordance with specification

**Focus Metal-glaze Preset (FMP),
DSB-Slot focus units**
FMP-DSB

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group ADD1	ND		
Safety test in accordance with PRV-53-8-52/45: 1.3 × V _{ac} during 3 s Test cover: 8204 115 31281		flashover detection breakdown detection	no flashover no breakdown
Sub-group ADD2	D		
Wire forces		push-in force pull-out force	≤25 N ≥50 N
Sub-group ADD3	ND		
Shaft impact test in accordance with PRV-53-8-52/48 (not applicable for L _s ≤ 17 mm)			no interruptions, no instability

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

FMP-SLD

FEATURES

- Designed for integration in a high voltage unit
- High temperature and voltage stability
- Wide design freedom.

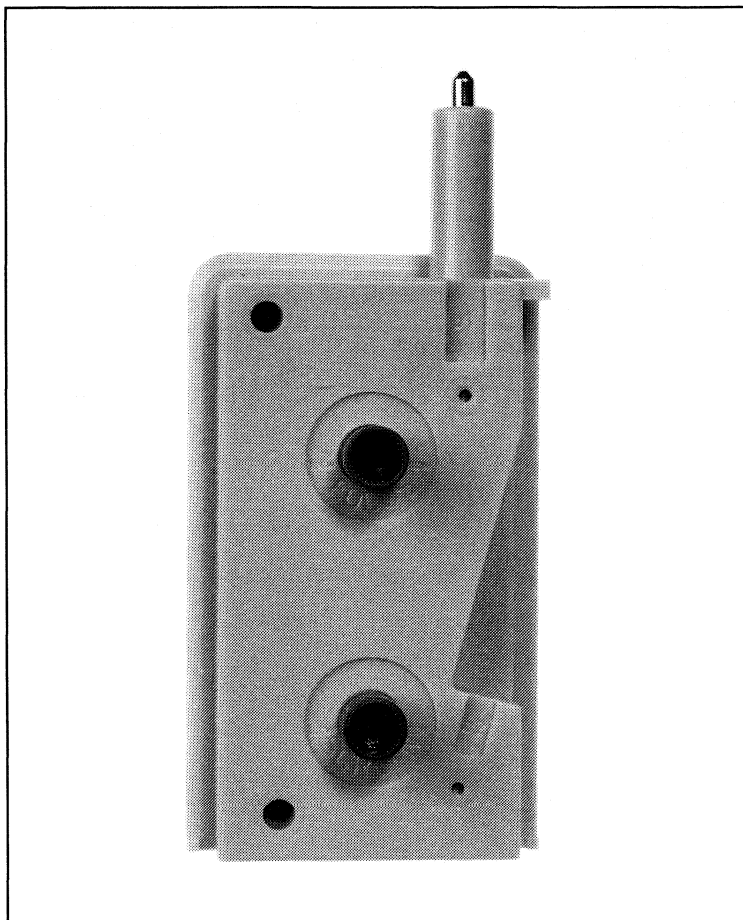
APPLICATIONS

- Focus and screen voltage adjustment in colour televisions and monitors
- Control of any EHT generation source with maximum output of 13 kV.

DESCRIPTION

Each focus unit comprises seven thick film resistance elements on a ceramic (Al_2O_3) substrate, a synthetic (glass reinforced) case and two synthetic (glass reinforced) rotors with multi-wire contacts. Two of the resistance elements are potentiometers, one for focus voltage and one for screen voltage.

The product must be mounted into a specially designed slot in the case of the high voltage unit. This provides a complete seal when an epoxy potting agent or other insulation material is used.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance	120 M Ω
Tolerance (% of total resistance)	$\pm 10\%$ and $\pm 15\%$
Maximum dissipation at $T_{\text{amb}} = 70\text{ }^{\circ}\text{C}$	1.7 W
Maximum application voltage	13 kV
Setting ability (IEC 393/6.34)	
focus	$\pm 25\text{ V}$; max. 10 s
screen	$\pm 5\text{ V}$; max. 10 s
Temperature characteristic of resistance (20 to 100 $^{\circ}\text{C}$)	$\leq 100 \times 10^{-6}/\text{K}$
Voltage coefficient of resistance	$\leq 2 \times 10^{-6}/\text{V}$
Climatic category	25/070/21

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

FMP-SLD

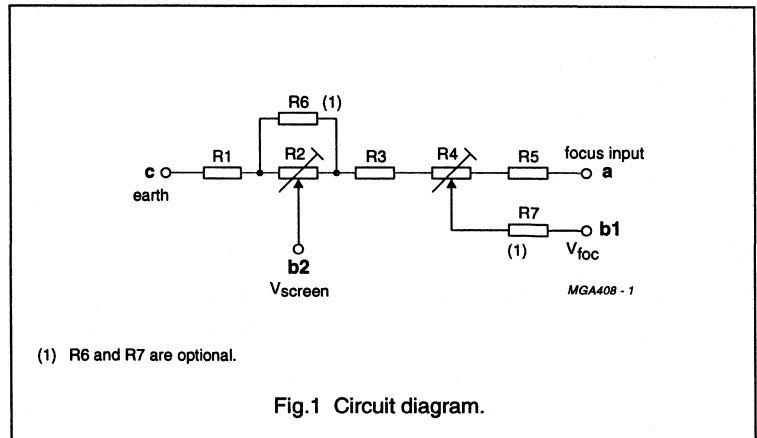
DESIGN VARIATIONS

Variations to suit customer requirements are possible on the following:

- Total resistance
- Focus and screen voltage ranges
- Connections
- Shafts.

APPROVAL

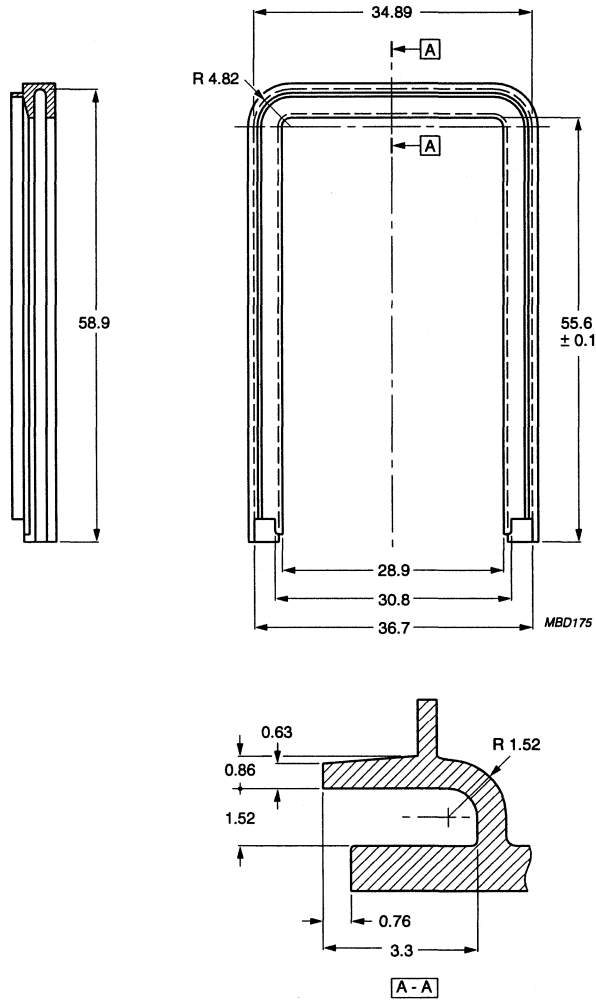
The product is designed for approval (after integration on the high voltage unit) by the major approval institutes. The materials used are UL-VO listed.



Focus Metal-glaze Preset (FMP),
SLD-Slot type focus units

FMP-SLD

MECHANICAL DATA



Dimensions in mm.

Fig.2 Slot dimensions.

Focus Metal-glaze Preset (FMP),
SLD-Slot type focus units

FMP-SLD

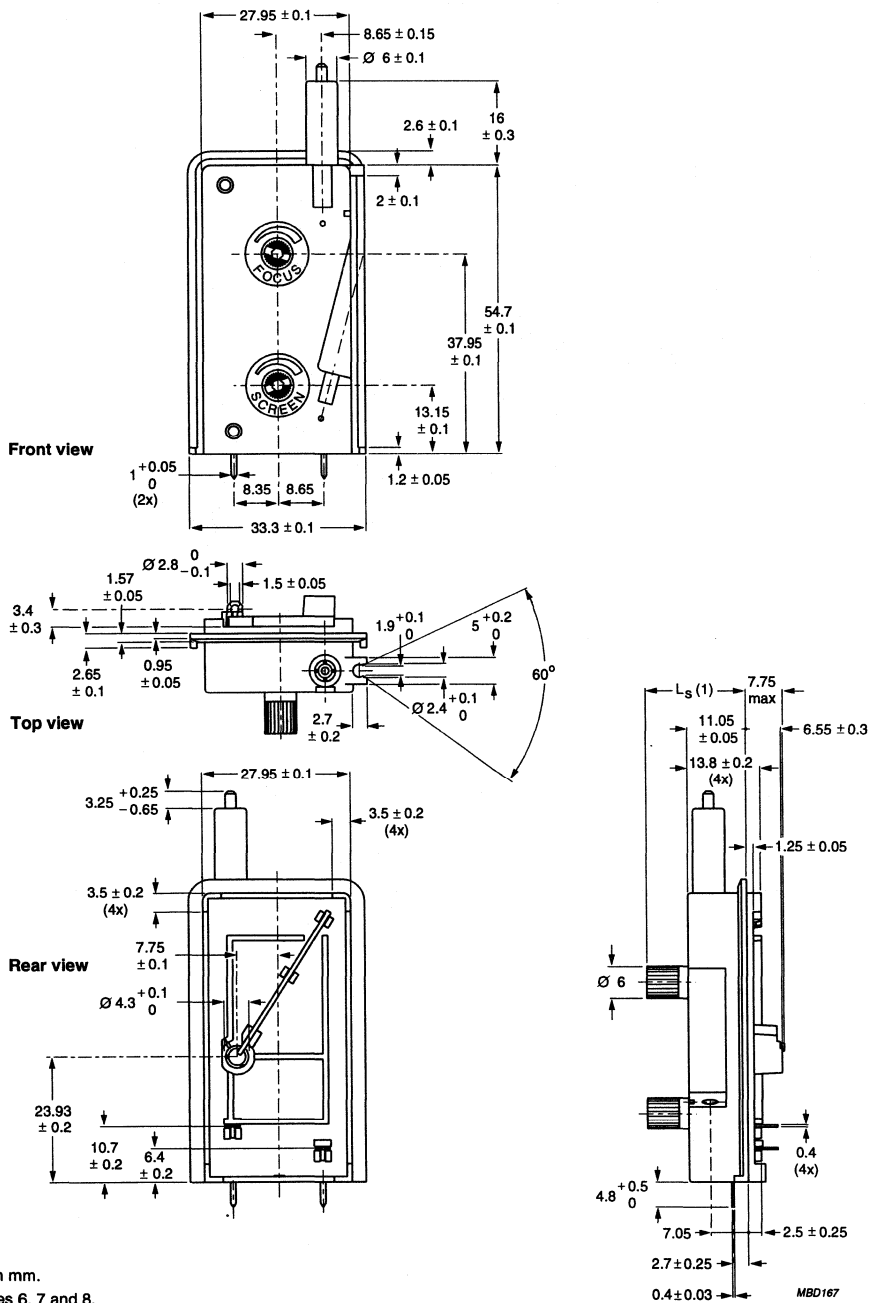
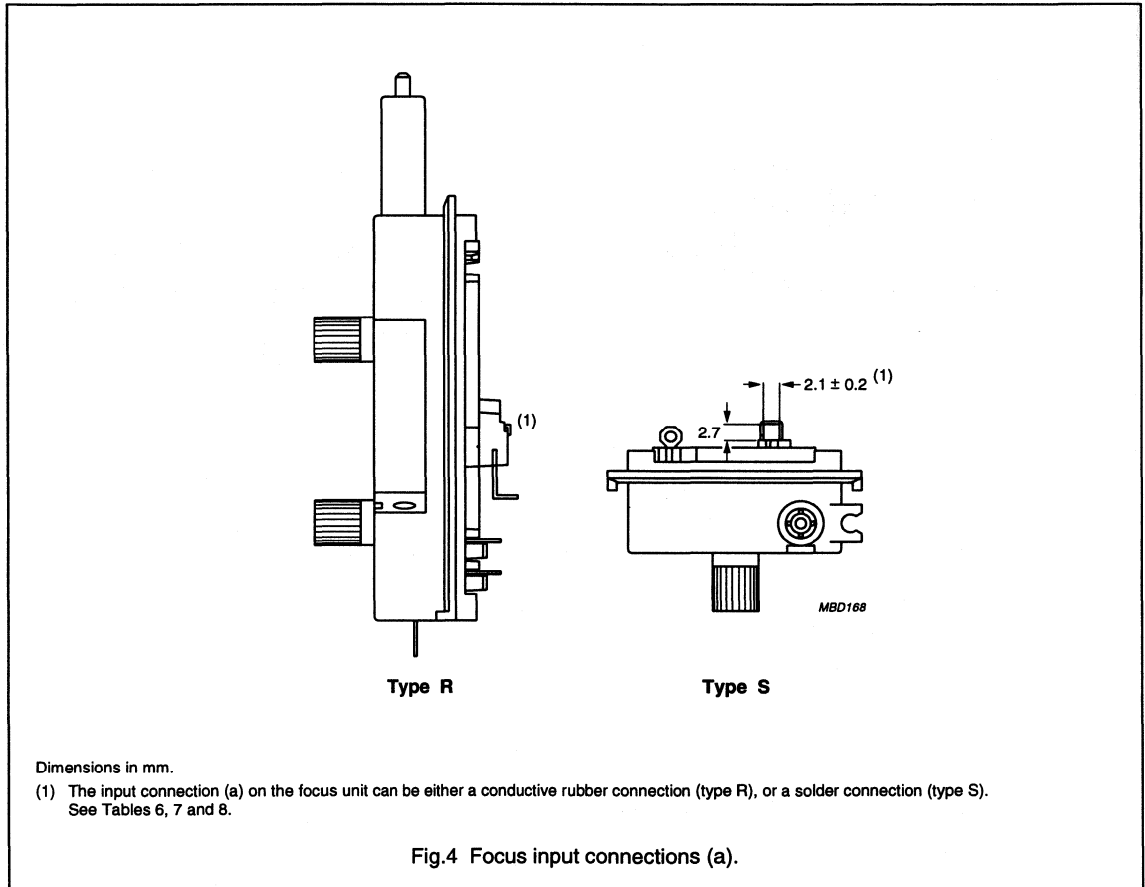


Fig.3 Outline details.

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

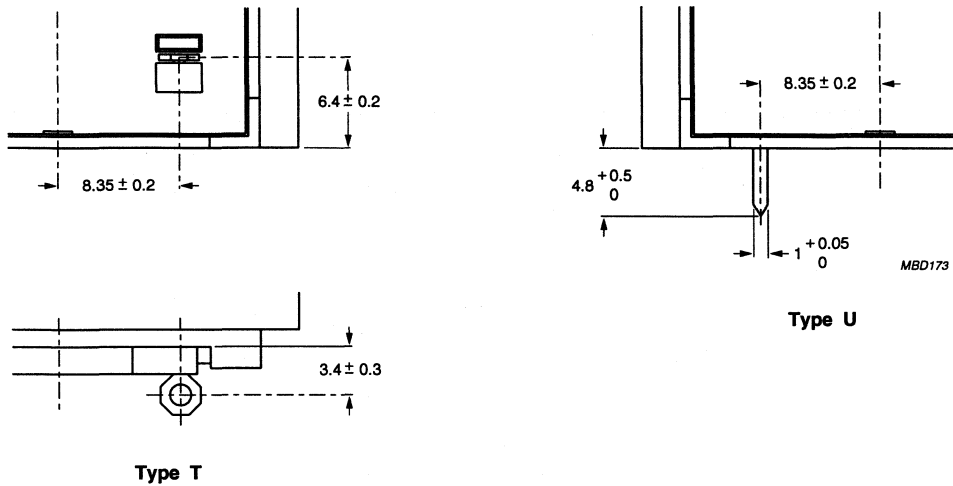
FMP-SLD

Connection details



Focus Metal-glaze Preset (FMP),
SLD-Slot type focus units

FMP-SLD



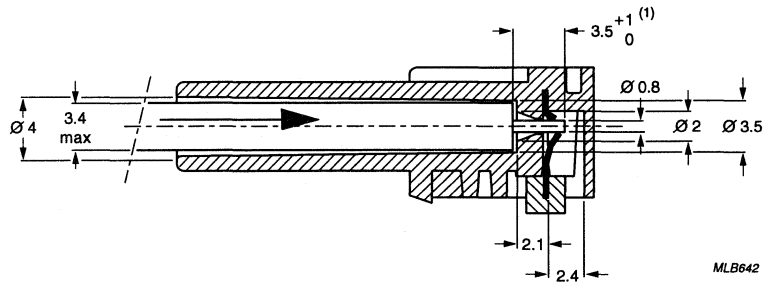
Dimensions in mm.

The earth connection (c) on the focus unit can be either a solder connection (type T), or a print connection (type U). See Tables 6, 7 and 8.

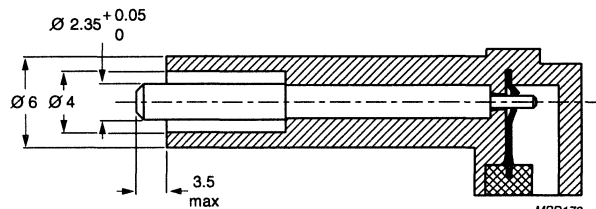
Fig.5 Earth connections (c).

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

FMP-SLD



Type V



Type W

Dimensions in mm.

Type V: wire clamp connection allowing simple press-in connection with 0.8 mm single core stripped wire. This connector is **not** detachable.

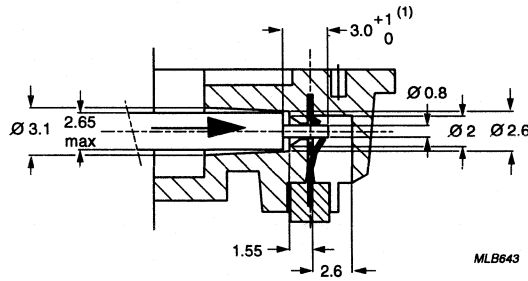
Type W: connection with disconnectable pin.

(1) Stripping length (under consideration for modification).

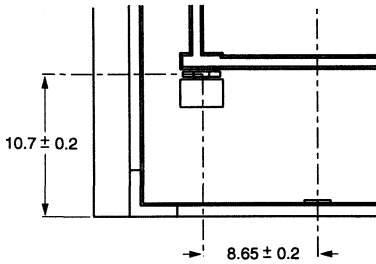
Fig.6 Focus voltage output connections (b1).

Focus Metal-glaze Preset (FMP),
SLD-Slot type focus units

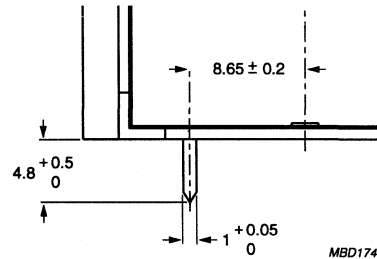
FMP-SLD



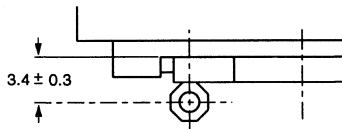
Type X



Type Y



Type Z



Dimensions in mm.

Type X: wire clamp connection.

Type Y: solder connection.

Type Z: print tag connection.

(1) Stripping length (under consideration for modification).

Fig.7 Screen connections (b2).

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

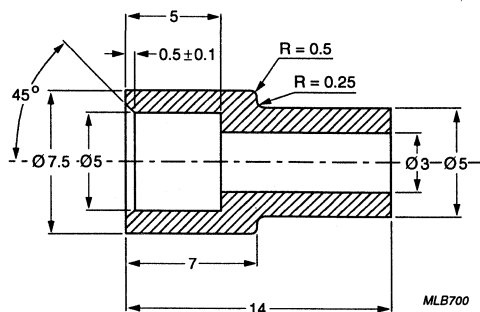
FMP-SLD

Table 1 Recommended connecting wire.

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSULATION MAX. Ø (mm)	CATALOGUE NUMBERS
Focus out (b1)	Pope (The Netherlands)	UL758 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.35	0722 388 00005
	Taisho (Japan)	E35688 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00014
	Sumitomo (Japan)	UL3239 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00015
Screen out (b2)	Pope (The Netherlands)	UL1032 VW-1 AWG20 PVC20	2.6	0722 161 00342
	Taisho (Japan)	E35688 AWM 1032 1.2 kV (DC) AWG20 (1/0.83) 90 °C	2.65	0722 158 00547
	Sumitomo (Japan)	UL-style 3476 E41105 (S) 3 kV (DC)	2.51	0722 161 00357
	Tatung (Japan)	UL1032 E54979 1.2 kV (DC) AWG20	2.65	0738 218 00039
	PEWC (Taiwan)	UL1032 E41396 1.2 kV (DC) AWG20 90 °C	2.65	0738 540 00122

Table 2 Recommended rubber boot for type V (see Fig.6).

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSIDE Ø (mm)	CATALOGUE NUMBER
Focus out (b1)	Hae Ryong (South Korea)	silicon black HR 7020U UL Ref. E98818	3.0	4322 052 86622



Dimensions in mm.

Fig.8 Rubber boot for type V (4322 052 86622).

**Focus Metal-glaze Preset (FMP),
SLD-Slot type focus units**

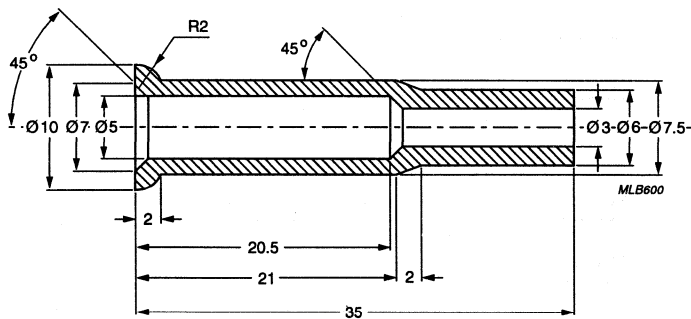
FMP-SLD

Table 3 Recommended connecting contact for type W (see Fig.6).

CONNECTION	MANUFACTURER	STYLE AND TYPE	WIRE SPECIFICATION	CATALOGUE NUMBER
Focus out (b1)	AMP (The Netherlands)	CuZn 030 UN-R311 tin plated article number 160656-2 for pin Ø 2.31 mm	wire range: 0.50 to 0.82 mm ² insulation: Ø 2.3 to 3.3 mm	3104 308 73261

Table 4 Recommended rubber boot for type W (see Fig.6).

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSIDE Ø (mm)	CATALOGUE NUMBER
Focus out (b1)	Hae Ryong (South Korea)	silicon black HR 7020U UL Ref. E98818	3.0	4322 052 86631



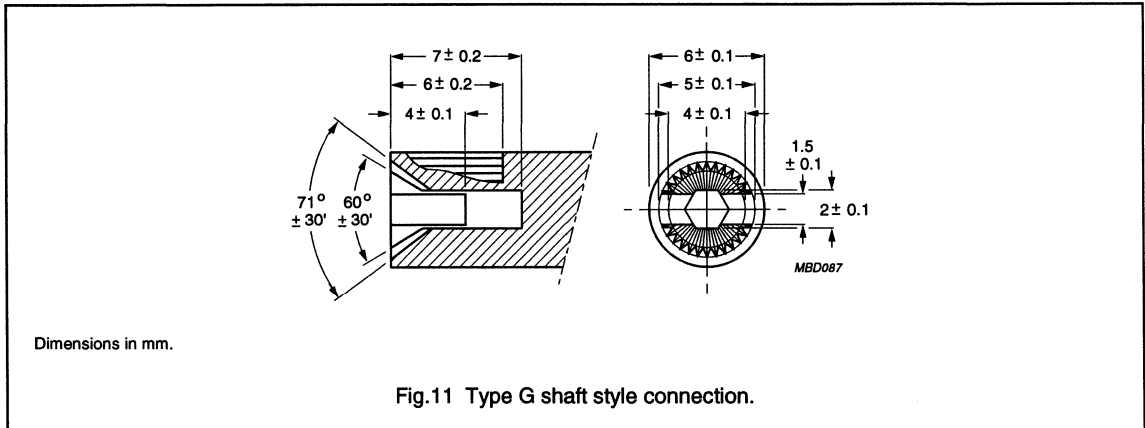
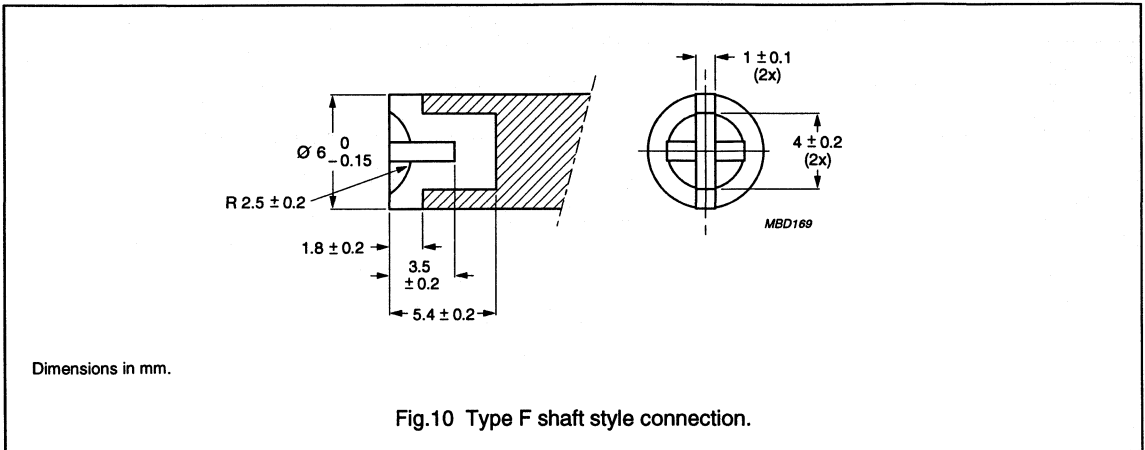
Dimensions in mm.

Fig.9 Rubber boot for type W (4322 052 86631).

Focus Metal-glaze Preset (FMP),
SLD-Slot type focus units

FMP-SLD

Shaft style connection details



Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

FMP-SLD

Table 5 Additional information.

PARAMETER	MIN.	TYP.	MAX.	UNIT
Focus unit				
Climatic category (IEC 68)	25/070/21			
Inflammability of materials	self-extinguishing in accordance with UL94-VO			
Potentiometers				
Angle of rotation				
focus	205	210	215	deg
screen	255	260	265	deg
Starting torque	–	–	30	mNm
Operating torque	3	–	30	mNm
Operating torque ratio	–	–	3	
Permissible end stop torque (adjustment tool)	–	–	150	mNm
Permissible end stop torque (manual)	–	–	300	mNm
Permissible push force on shaft	–	–	50	N
Permissible pull force on shaft; note 1	–	–	50	N
Mechanical life; focus/screen	–	50	–	cycles
Weight	–	19	–	g
Connectors b1 and b2 (for types V and X)				
Insertion force of wire	–	–	25	N
Extraction force of wire	50	–	–	N

Note

1. Not applicable for $L_s \leq 16$ mm.

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

FMP-SLD

PRODUCT OVERVIEW**Table 6** Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460.....				UNIT
	93301	93302	93303	93304	
Resistance					
Resistance (R_{ac})	120 \pm 15%	120 \pm 15%	120 \pm 15%	120 \pm 15%	M Ω
Resistor network (see Fig.1)					
R1	1.5	2.1	2.1	2.1	M Ω
R2/R6	10.2	10.2	10.2	10.2	M Ω
R3	64.5	77.7	77.7	66.3	M Ω
R4	20.4	21.0	21.0	21.6	M Ω
R5	23.4	9.0	9.0	19.8	M Ω
R7	25.0 \pm 20%	10.0 \pm 20%	10.0 \pm 20%	25.0 \pm 20%	M Ω
Voltages					
Maximum application voltage (V_{ac})	13.0	11.0	11.0	13.0	kV
V_{foc} ; note 1					
range	67 to 78	78 to 90	78 to 90	69 to 81	%
minimum	63.5 \pm 3.5	75.0 \pm 3.0	75.0 \pm 3.0	65.5 \pm 3.5	%
maximum	80.5 \pm 2.5	92.5 \pm 2.5	92.5 \pm 2.5	83.5 \pm 2.5	%
V_{screen} ; note 1					
range	2 to 8	3 to 8.5	3 to 8.5	2.5 to 8.5	%
minimum	1.25 \pm 0.75	1.75 \pm 1.25	1.75 \pm 1.25	1.75 \pm 0.75	%
maximum	9.75 \pm 1.75	10.25 \pm 1.75	10.25 \pm 1.75	10.25 \pm 1.75	%
Dissipation					
Total maximum dissipation	1.7	1.2	1.2	1.7	W
Terminal types					
Focus voltage input (a)	type S	type S	type S	type S	
Focus voltage output (b1)	type V	type V	type W	type W	
Screen voltage output (b2)	type X	type X	type Y	type Y	
Earth connection (c)	type T	type T	type T	type T	
Shaft data					
Length	$L_s = 18.85 \pm 0.3$	$L_s = 18.85 \pm 0.3$	$L_s = 18.85 \pm 0.3$	$L_s = 18.85 \pm 0.3$	mm
Type (see Fig.11)	G	G	G	G	
Colour	black	black	black	black	
Delivery position					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	FCCW	deg

Note

1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

FMP-SLD

Table 7 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460.....			UNIT
	93305	90385	90398	
Resistance				
Resistance (R_{ac})	120 \pm 15%	120 \pm 10%	120 \pm 10%	M Ω
Resistor network (see Fig.1)				
R1	5.1	1.65	1.65	M Ω
R2/R6	8.7	18.15	18.15	M Ω
R3	61.2	54.0	54.0	M Ω
R4	24.0	45.0	45.0	M Ω
R5	21.0	1.2	1.2	M Ω
R7	25.0 \pm 20%	15.0 \pm 20%	15.0 \pm 20%	M Ω
Voltages				
Maximum application voltage (V_{ac})	13.0	11.0	11.0	kV
V_{foc} ; note 1				
range	66 to 80	65 to 98	65 to 98	%
minimum	62.5 \pm 3.5	61.5 \pm 3.5	61.5 \pm 3.5	%
maximum	82.5 \pm 2.5	99.0 \pm 1.0	99.0 \pm 0.1	%
V_{screen} ; note 1				
range	5 to 9.5	2 to 14	2 to 14	%
minimum	4.25 \pm 0.75	1.375 \pm 0.625	1.375 \pm 0.625	%
maximum	11.5 \pm 2.0	16.5 \pm 2.5	16.5 \pm 2.5	%
Dissipation				
Total maximum dissipation	1.7	1.2	1.2	W
Terminal types				
Focus voltage input (a)	type S	type R	type R	
Focus voltage output (b1)	type W	type V	type V	
Screen voltage output (b2)	type Y	type X	type X	
Earth connection (c)	type T	type T	type U	
Shaft data				
Length	$L_s = 18.85 \pm 0.3$	$L_s = 18.85 \pm 0.3$	$L_s = 18.85 \pm 0.3$	mm
Type (see Fig.11)	G	G	G	
Colour	black	black	black	
Delivery position				
focus	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	deg

Note1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

FMP-SLD

Table 8 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460.....			UNIT
	93309	93311	93312	
Resistance				
Resistance (R_{ac})	120 \pm 15%	120 \pm 15%	120 \pm 15%	M Ω
Resistor network (see Fig.1)				
R1	2.1	5.1	2.1	M Ω
R2/R6	10.2	8.7	10.2	M Ω
R3	66.3	61.2	77.7	M Ω
R4	21.6	24.0	21.0	M Ω
R5	19.8	21.0	9.0	M Ω
R7	25.0 \pm 20%	25.0 \pm 20%	10.0 \pm 20%	M Ω
Voltages				
Maximum application voltage (V_{ac})	13.0	13.0	11.0	kV
V_{loc} ; note 1				
range	69 to 81	66 to 80	78 to 90	%
minimum	65.5 \pm 3.5	62.5 \pm 3.5	75.0 \pm 3.0	%
maximum	83.5 \pm 2.5	82.5 \pm 2.5	92.5 \pm 2.5	%
V_{screen} ; note 1				
range	2.5 to 8.5	5 to 9.5	3 to 8.5	%
minimum	1.75 \pm 0.75	4.25 \pm 0.75	1.75 \pm 1.25	%
maximum	10.25 \pm 1.75	11.5 \pm 2.0	10.25 \pm 1.75	%
Dissipation				
Total maximum dissipation	1.7	1.7	1.2	W
Terminal types				
Focus voltage input (a)	type S	type S	type S	
Focus voltage output (b1)	type V	type V	type V	
Screen voltage output (b2)	type X	type X	type X	
Earth connection (c)	type T	type T	type T	
Shaft data				
Length	$L_s = 18.85 \pm 0.3$	$L_s = 18.85 \pm 0.3$	$L_s = 18.85 \pm 0.3$	mm
Type (see Fig.11)	G	G	G	
Colour	black	black	black	
Delivery position				
focus	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	deg

Note

- Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

FMP-SLD

SAFETY REQUIREMENTS

In general an area of 10 mm around the focus unit should be free from all conductive parts with sharp edges. Penetration with earthed parts in these areas should be avoided. Full details of these areas are contained in the factory specification related to each catalogue type. The potentiometer parts carrying high voltage should be free from metal particles, solder drops, etc.

RELIABILITY

Maximum cumulative percentage of failures F (n) after n hours (excluding 0 hours rejects).

Percentage rate of failures.

FAILURES	PERCENTAGE
F (300)	≤0.01%
F (10000)	≤0.25%
F (30000)	≤5.0%

LIST OF MATERIALS

NAME OF PART	MATERIAL	TYPE	MANUFACTURER	FLAME CLASS	UL FILE
Case	polycarbonate	Lexan 500 R	General Electric	UL-94-VO	E45329
Shaft	modified PPO	Noryl VO-150-B	General Electric	UL-94-VO	E45329
Rubber spring	silicone rubber	K 1238	Philips	UL-94-HB	E45111
Contact plug internal	silicone rubber	K 1764	Philips	UL-94-VO	E45111
Contact plug external	silicone rubber	9274	Philips	UL-94-HB	E45111
Glue	silicone rubber	744 RTV	Dow Corning	LOI 31%	–
Vacuum grease	silicone grease	TKHV-1	Klüber	–	–

ORDERING

Minimum ordering quantity: 240 pieces.

Order by quoting the 12-digit catalogue number of the potentiometer units and the quantity required.

PRODUCT MARKING

The unit is marked with the date code (year, week and day of manufacture), the operator code, and the last five digits of the catalogue number.

Example of product marking.

MARKING YWWDX933..	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

The catalogue number can be replaced by the customer reference code (see Fig.12).

**Focus Metal-glaze Preset (FMP),
SLD-Slot type focus units**






FMP-SLD

PACKAGING

Packed as 240 units in 12 polystyrene packaging shells, stacked on a rigid board. An additional empty packaging shell is located on the top together with a cover. The complete package is bound tightly together with polypropylene taping straps.

LABELLING

The label on the package containing the potentiometers is as shown.

1. 2. 3. 4. 5. 6. 7. 8.	<p>MADE IN BELGIUM POTENTIOMETERS 120M FMP FOCUS METAL GLAZE PRESET FMP-SLD</p>  CUST. INFO 220491-4  ORIG A170 RPC HQ - -  QTY 240 DATE 9404  TYPE FMP  CODENO 2322 460 90346	<p>LINE MARKING EXPLANATION</p> <p>1. Country of origin 2. Product family and resistance values 3. Product description 4. Customer information 5. Preference origin code and product centre 6. Quantity per standard packing and product code 7. Product description 8. Catalogue number (12NC)</p>
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MRC298

Fig.12 Packaging label with the customer reference code (example).

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

FMP-SLD

TESTS AND REQUIREMENTS

In these tables the tests can either be:

D = Destructive

ND = Non-destructive.

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group B1-a	D		
SOLDERABILITY			
Solder iron method in accordance with IEC 68-2-20, Test Ta, method 2: Temperature: 350 °C ±10 °C Solder bit code number: 2622 035 17135 Bit dimensions: 2.5 × 1.5 mm Solder: 60/40 tin/lead Type: Ersin multicore Diameter 1.2 mm with flux 366 Time: 2 ±0.5 s		visual examination	wetting: >95%
Solder bath method in accordance with IEC 68-2-20, Test Ta, method 1: Temperature: 235 °C ±5 °C Immersion time: 2 ±0.5 s		visual examination	wetting: >95%
Sub-group B1-b	ND		
Focus spark gap firing simulation in accordance with PRV-53-8-52/42: R1 = 400 Ω; R2 = 5 MΩ; C1 = 2 nF; P1 = P2 = 600 hPa; V1 = V _{ac} ; V2 = 25 kV; Shafts V _{b1} and V _{b2} : FCW; n = 50		visual examination element resistance $\Delta R_{ac}/R_{ac}$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no flashover no breakdown ≤3% ≤25 V ≤5 V
Corona in accordance with PRV-53-8-52/43: 1.3 × V _{ac} ; 60 s; standard atmosphere		corona detection	no corona
Breakdown voltage under pressure in accordance with IEC 68-2-13 test M: V _{ac} : 30 minutes; 600 hPa; 55 °C		flashover detection breakdown detection	no flashover no breakdown
Sub-group C1	ND		
Mechanical travel		focus screen	210° ±5° 260° ±5°
Starting torque		focus screen	3 to 30 mNm; ratio ≤3 3 to 30 mNm; ratio ≤3
Sub-group C2	ND		
Output ratio range		V _{b1c min} /V _{ac} ; V _{b1c max} /V _{ac} ; V _{b2c min} /V _{ac} ; V _{b2c max} /V _{ac}	see Tables 6, 7 and 8
Continuity in accordance with PRV-53-8-52/44			smooth, unidirectional
Settability		focus ±25 V screen ±5 V	≤10 s ≤10 s

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

FMP-SLD

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group C3	D		
Electrical endurance at 70 °C: Temperature: 70 °C ±3 °C Duration: 1000 hours Cyclic load (1.5 hours on and 0.5 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} starting torque	no visual damage $\leq 3\%$ ≤ 25 V ≤ 5 V not specified
Sub-group D1	D		
Damp heat, cyclic in accordance with IEC 68-2-30, Test Db: Upper temperature: 40 °C Number of cycles: 21 (1 cycle = 1 hour on and 23 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no visible damage not specified ≤ 25 V ≤ 5 V
Sub-group D2	D		
Mechanical endurance at room temperature: Number of cycles of operation: 50 Rate: 4 ±1 cycles per minute		visual examination element resistance $\Delta R/R$ starting torque continuity change of output ratios	no visible damage $\leq 3\%$ not specified smooth, unidirectional 0.965 to 1.035 × initial requirements
Sub-group D3	ND		
End - stop torque: Adjustment tool: 150 mNm Manual: 300 mNm Duration: 10 s		visual examination	no visible damage, no deformation
Axial thrust on the shaft: Thrust: 50 N		continuity output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	smooth, unidirectional not specified not specified
Radial thrust on the shaft: Thrust: 50 mNm (not applicable for $L_s \leq 16$ mm)		visual examination	no visible damage
Sub-group D4-a	D		
Resistance to soldering heat in accordance with IEC 68-2-20, Test Tb, method 2: Solder iron method Temperature: 350 °C ±10 °C Solder bit code number: 2622 035 17135 Bit dimensions: 2.5 × .5 mm Solder: 60/40 tin/lead Type: Ersin multicore Diameter 1.2 mm with flux 366 Time: 10 ±1 s Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b2}	$\leq 0.2\%$ ≤ 2 V

Focus Metal-glaze Preset (FMP), SLD-Slot type focus units

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TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group D4-b	D		
Change of temperature in accordance with IEC 68-2-14, Test Na: TA = -40 °C TB = +100 °C Number of cycles: 5 Exposure duration: 30 minutes Shafts: FCCW		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visual damage $\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-c	D		
Vibration in accordance with IEC 68-2-6, Test Fc, Procedure B4: Frequency range: 10 to 55 Hz Amplitude: 0.75 mm or 98m/s ² Sweep endurance: total duration 6 hours Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-d	D		
Shock in accordance with IEC 68-2-27, Test Ea: Pulse duration: 11 ms Acceleration: 490 m/s ² Number of shocks: 3 in each of 6 directions Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-e	D		
Dry heat in accordance with IEC 68-2-2, Test Bb: Temperature: +100 °C Duration: 96 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-f	D		
Cold in accordance with IEC 68-2-1, Test Ab: Temperature: -40 °C Duration: 96 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D5	ND		
Temperature characteristic of resistance: +20 °C to +100 °C		TCR	$\leq 100 \times 10^{-6}/K$
Voltage coefficient of resistance in accordance with HQV-14/001		VCR	$\leq 2 \times 10^{-6}/V$
Dimensions (detail)			in accordance with specification

**Focus Metal-glaze Preset (FMP),
SLD-Slot type focus units**
FMP-SLD

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group ADD1	ND		
Safety test in accordance with PRV-53-8-52/45: 1.3 × V _{ac} during 3 s Test cover: 8204 115 31281		flashover detection breakdown detection	no flashover no breakdown
Sub-group ADD2	D		
Wire forces		push-in force pull-out force	≤25 N ≥50 N
Sub-group ADD3	ND		
Shaft impact test in accordance with PRV-53-8-52/48 (not applicable for L _s ≤ 16 mm)			no interruptions, no instability

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

FEATURES

- Designed for mounting on to a printed-circuit board
- High temperature and voltage stability
- Wide design freedom.

APPLICATIONS

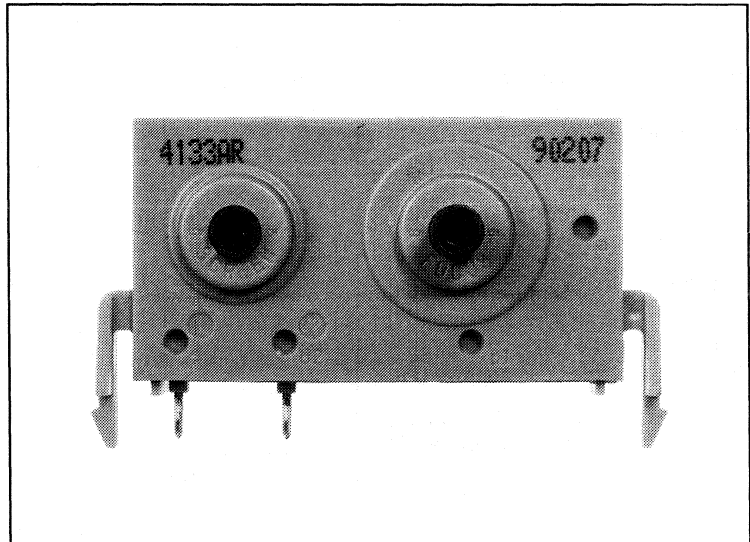
- Focus and screen voltage adjustment in colour televisions and monitors
- Control of any EHT generation source with maximum output of 10 kV.

DESCRIPTION

Each focus unit comprises six thick film resistance elements on a ceramic (Al_2O_3) substrate in a synthetic (glass reinforced) case. Two of the resistance elements are potentiometers, one for focus voltage and one for screen voltage.

Electrical connection with the high voltage input (a) and focus voltage output (b1) (see Fig.1) is achieved by simply pressing single-core stripped wires into the respective holes. For the recommended cable types see Table 1 and for the stripping length of the recommended wires see Fig.4. Connections for screen voltage output (b2) and earth (c) is effected through the printed-circuit board with a print tag.

The focus units are designed to be mounted on to printed-circuit boards, separate from the EHT source. Two snap-lock pins extending from the case provide mechanical support.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance	33 M Ω to 200 M Ω
Tolerance (% of total resistance)	$\pm 7.4\%$, $\pm 10\%$, $\pm 15\%$ and $\pm 20\%$
Maximum dissipation at $T_{amb} = 70^\circ\text{C}$	2.9 W
Maximum application voltage	16 kV
Setting ability (IEC 393/6.34)	
focus	$\pm 25\text{ V}$; max. 10 s
screen	$\pm 5\text{ V}$; max. 10 s
Temperature characteristic of resistance (20 to 100°C)	$\leq 100 \times 10^{-6}/\text{K}$
Voltage coefficient of resistance	$\leq 2 \times 10^{-6}/\text{V}$
Climatic category	25/070/21

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

DESIGN VARIATIONS

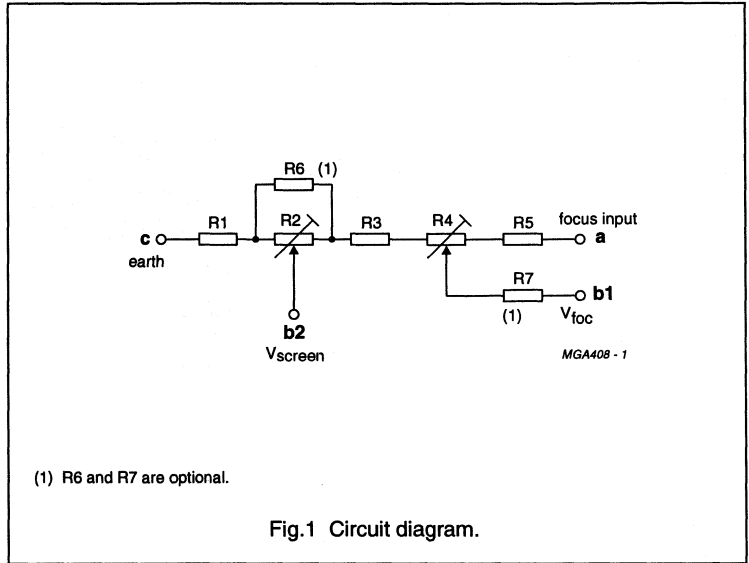
Variations to suit customer requirements are possible on the following:

- Total resistance
- Focus and screen voltage ranges
- Capacitance values
- Connections
- Shafts.

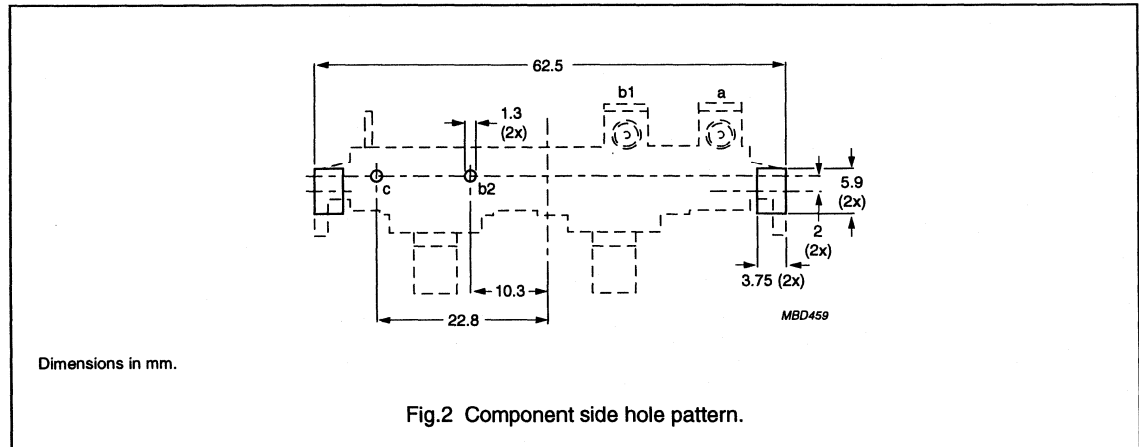
APPROVAL

The products have been approved as a safety product.

AUTHORITY	FILE REFERENCE
UL	UC
VDE	4421
BSI	7637



MECHANICAL DATA



Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

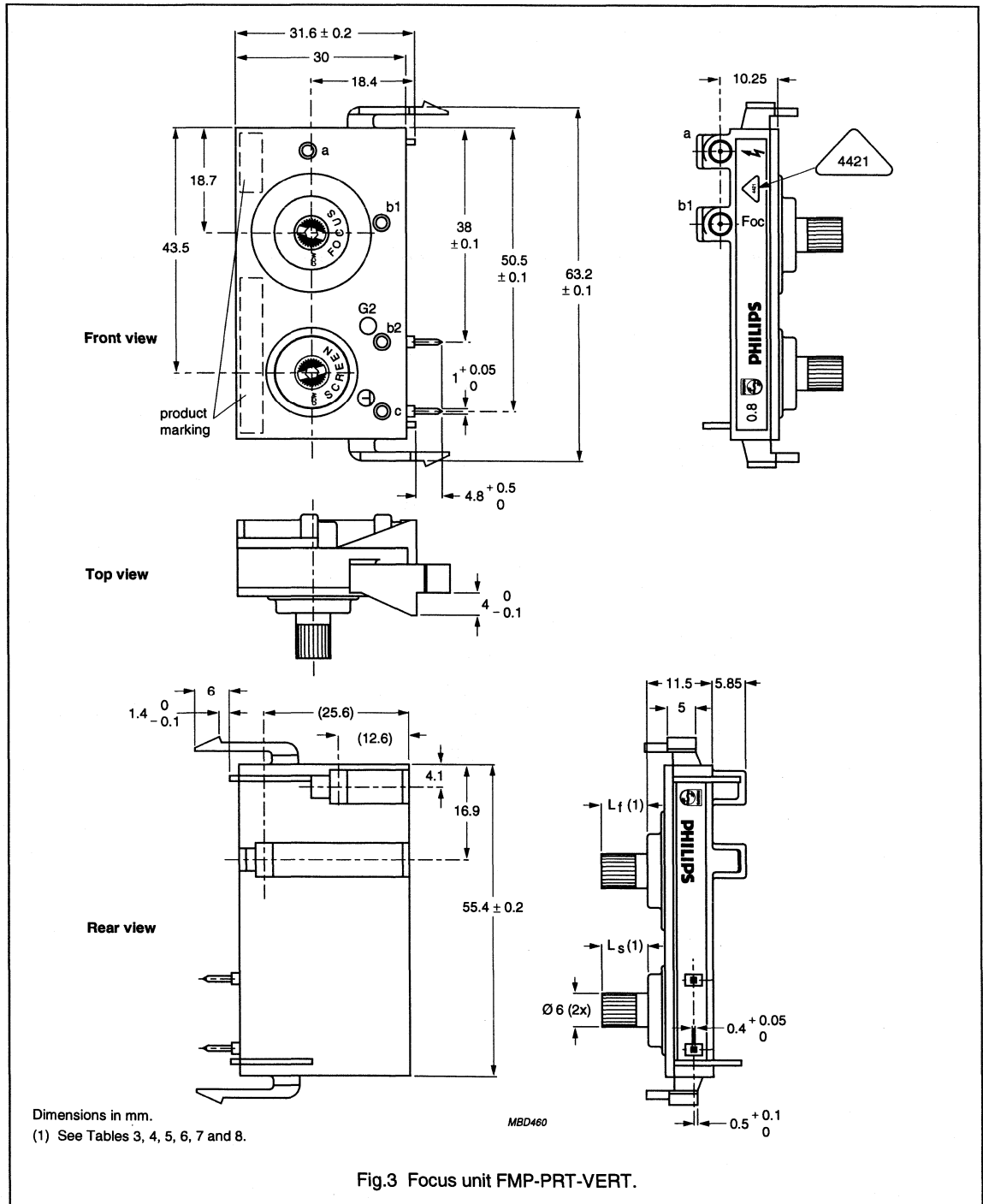
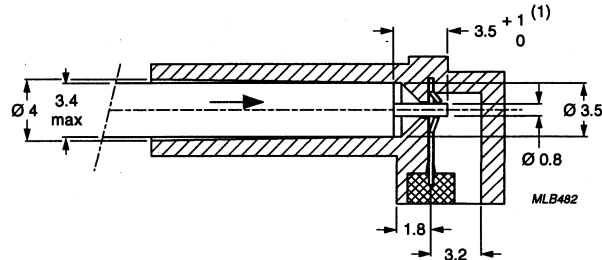


Fig.3 Focus unit FMP-PRT-VERT.

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

Connection details



Dimensions in mm.

(1) Stripping length (under consideration for modification).

Fig.4 Wire clamp connection (a), focus connection (b1).

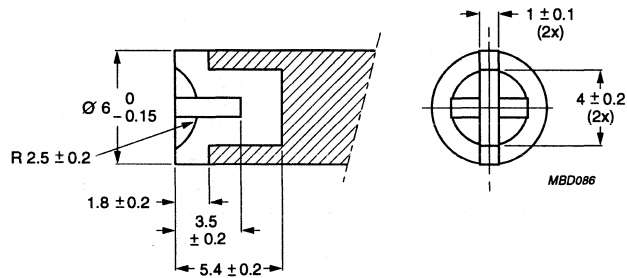
Table 1 Recommended connecting wire.

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSULATION MAX. Ø (mm)	CATALOGUE NUMBERS
Focus in (a) and Focus out (b1)	Pope (The Netherlands)	UL758 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.35	0722 388 00005
	Taisho (Japan)	E35688 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00014
	Sumitomo (Japan)	UL3239 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00015

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

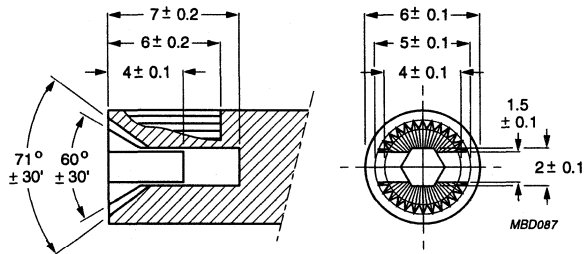
FMP-PRT-VERT

Shaft style connection details



Dimensions in mm.

Fig.5 Type F shaft style connection.



Dimensions in mm.

Fig.6 Type G shaft style connection.

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

Table 2 Additional information.

PARAMETER	MIN.	TYP.	MAX.	UNIT
Focus unit				
Climatic category (IEC 68)	25/070/21			
Inflammability of materials	self-extinguishing in accordance with UL94-VO			
Potentiometers				
Angle of rotation				
focus	225	230	235	deg
screen	255	260	265	deg
Starting torque	–	–	30	mNm
Operating torque	3	–	30	mNm
Operating torque ratio	–	–	3	
Permissible end stop torque (adjustment tool)	–	–	150	mNm
Permissible end stop torque (manual)	–	–	300	mNm
Permissible push force on shaft	–	–	50	N
Permissible pull force on shaft; note 1	–	–	50	N
Mechanical life; focus/screen	–	50	–	cycles
Weight	–	16	–	g
Connectors a and b1				
Insertion force of wire	–	–	25	N
Extraction force of wire	50	–	–	N

Note

1. Not applicable for L_s or $L_f \leq 5$ mm.

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

PRODUCT OVERVIEW**Table 3** Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90207	90208	90209	90211	
Resistances					
Resistance (R_{ac})	40 \pm 15%	40 \pm 15%	50 \pm 10%	200 \pm 20%	M Ω
Resistor network (see Fig.1)					
R1	0.78	1.28	17.0	3.3	M Ω
R2/R6	4.1	4.54	14.0	20.3	M Ω
R3	23.18	20.98	19.0	61.4	M Ω
R4	11.92	13.18	–	59.0	M Ω
R5	0.02	0.02	–	56.0	M Ω
R7	10.0 \pm 25%	10.0 \pm 25%	–	–	M Ω
Voltages					
Maximum application voltage (V_{ac})	10.0	10.0	10.0	16.0	kV
V_{foc} ; note 1					
range	75.3 to 99.9	71 to 99.9	38 to 57	46 to 68	%
minimum	70.15 \pm 5.15	67.0 \pm 4.0	34.0 \pm 4.0	42.5 \pm 3.5	%
maximum	99.95 \pm 0.05	99.95 \pm 0.05	62.0 \pm 5.0	72.0 \pm 4.0	%
V_{screen} ; note 1					
range	2.7 to 9.4	3.8 to 12.8	–	2.3 to 9.6	%
minimum	1.95 \pm 0.75	3.2 \pm 0.6	–	1.65 \pm 0.65	%
maximumLL	12.2 \pm 2.8	14.55 \pm 1.75	–	11.8 \pm 2.2	%
Dissipation					
Total maximum dissipation	2.9	2.6	2.2	1.3	W
Shaft data					
Type and length (see Figs 5 and 6)					
focus; note 2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	mm
screen; note 3	type F: 1.5 \pm 0.2	type F: 1.5 \pm 0.2	–	type G: 8.1 \pm 0.2	mm
Colour					
focus	black	black	black	black	
screen	black	black	–	black	
Delivery position					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	–	FCCW	deg

Notes

1. Given in % of V_{ac} .
2. Length L_f (see Fig.3).
3. Length L_s (see Fig.3).

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

Table 4 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90212	90213	90214	90215	
Resistances					
Resistance (R_{ac})	33.3 \pm 7.4%	120 \pm 15%	120 \pm 15%	120 \pm 15%	M Ω
Resistor network (see Fig.1)					
R1	23.64	2.1	1.5	1.5	M Ω
R2/R6	9.64	10.2	10.2	10.2	M Ω
R3	0.02	77.7	64.5	65.7	M Ω
R4	–	21.0	20.4	25.2	M Ω
R5	–	9.0	23.4	17.4	M Ω
R7	–	17.0 \pm 20%	25.0 \pm 20%	25.0 \pm 20%	M Ω
Voltages					
Maximum application voltage (V_{ac})	10.0	11.0	13.0	13.0	kV
V_{foc} ; note 1					
range	75 to 99.9	78 to 90	67 to 78	68 to 83	%
minimum	71.0 \pm 4.0	75.0 \pm 3.0	63.5 \pm 3.5	64.5 \pm 3.5	%
maximum	99.95 \pm 0.05	92.5 \pm 2.5	80.5 \pm 2.5	85.5 \pm 2.5	%
V_{screen} ; note 1					
range	–	3 to 8.5	2 to 8	2 to 8	%
minimum	–	1.75 \pm 1.25	1.25 \pm 0.75	1.25 \pm 0.75	%
maximum	–	10.25 \pm 1.75	9.75 \pm 1.75	9.75 \pm 1.75	%
Dissipation					
Total maximum dissipation	3.2	1.2	1.7	1.7	W
Shaft data					
Type and length (see Fig.6)					
focus; note 2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	mm
screen; note 3	–	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	mm
Colour					
focus	black	black	black	black	
screen	–	black	black	black	
Delivery position					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	–	FCCW	FCCW	FCCW	deg

Notes

1. Given in % of V_{ac} .
2. Length L_f (see Fig.3).
3. Length L_s (see Fig.3).

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

Table 5 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90216	90217	90219	90221	
Resistances					
Resistance (R_{ac})	120 \pm 15%	180 \pm 15%	33 \pm 10%	33 \pm 10%	M Ω
Resistor network (see Fig.1)					
R1	2.97	5.4	13.86	23.1	M Ω
R2/R6	10.23	47.7	11.88	8.58	M Ω
R3	78.6	126.9	7.26	1.32	M Ω
R4	23.16	–	–	–	M Ω
R5	5.04	–	–	–	M Ω
R7	17.0 \pm 20%	–	–	–	M Ω
Voltages					
Maximum application voltage (V_{ac})	11.0	13.0	8.5	8.5	kV
V_{foc} ; note 1					
range	80 to 93.3	75 to 96	46 to 75	75 to 94	%
minimum	76.5 \pm 3.5	70.5 \pm 4.5	42.0 \pm 4.0	70.0 \pm 5.0	%
maximum	95.8 \pm 2.5	97.0 \pm 1.0	78.0 \pm 3.0	96.0 \pm 2.0	%
V_{screen} ; note 1					
range	3.75 to 9	–	–	–	%
minimum	2.475 \pm 1.275	–	–	–	%
maximum	11.0 \pm 2.0	–	–	–	%
Dissipation					
Total maximum dissipation	1.2	1.1	2.5	2.5	W
Shaft data					
Type and length (see Fig.6)					
focus; note 2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	mm
screen; note 3	type G: 8.1 \pm 0.2	–	–	–	mm
Colour					
focus	black	black	black	black	
screen	black	–	–	–	
Delivery position					
focus	FCCW	FCCW	FCCW	FCCW	deg
screen	FCCW	–	–	–	deg

Notes

1. Given in % of V_{ac} .
2. Length L_f (see Fig.3).
3. Length L_s (see Fig.3).

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

Table 6 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	90222	90223	90224	90225	
Resistances					
Resistance (R_{ac})	100 \pm 15%	100 \pm 15%	80 \pm 15%	40 \pm 10%	M Ω
Resistor network (see Fig.1)					
R1	57.5	72.5	40.4	29.2	M Ω
R2/R6	22.0	24.25	17.6	10.2	M Ω
R3	20.5	3.25	22.0	0.6	M Ω
R7	–	–	3.0 \pm 25%	10.0 \pm 25%	M Ω
Voltages					
Maximum application voltage (V_{ac})	13.0	13.0	13.0	9.5	kV
V_{toc} ; note 1					
range	60 to 78	75 to 96	54 to 70	78 to 98	%
minimum	57.5 \pm 2.5	72.5 \pm 2.5	50.5 \pm 3.5	73.0 \pm 5.0	%
maximum	79.5 \pm 1.5	96.75 \pm 0.75	72.5 \pm 2.5	98.5 \pm 0.5	%
Dissipation					
Total maximum dissipation	2.5	2.0	2.5	2.5	W
Shaft data					
Type and length (see Fig.6) focus; note 2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	mm
Colour focus	black	black	black	black	
Delivery position focus	FCCW	FCCW	FCCW	FCCW	deg

Notes

1. Given in % of V_{ac} .
2. Length L_f (see Fig.3).

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

Table 7 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460			UNIT
	90226	90228	90229	
Resistances				
Resistance (R_{ac})	120 \pm 15%	105 \pm 10%	40 \pm 15%	M Ω
Resistor network (see Fig.1)				
R1	1.52	3.885	0.68	M Ω
R2/R6	10.78	7.035	5.82	M Ω
R3	35.7	48.825	20.3	M Ω
R4	39.0	25.935	13.18	M Ω
R5	33.0	19.32	0.02	M Ω
R7	15.0 \pm 15%	17.5 \pm 20%	10.0 \pm 20%	M Ω
Voltages				
Maximum application voltage (V_{ac})	15.0	14.0	9.3	kV
V_{foc} ; note 1				
range	43 to 70	60.9 to 78.1	2.3 to 14.1	%
minimum	40.0 \pm 3.0	56.9 \pm 4.0	1.7 \pm 0.4	%
maximum	72.5 \pm 2.5	81.6 \pm 3.5	16.25 \pm 2.15	%
V_{screen} ; note 1				
range	1.54 to 8	5.4 to 7.9	71 to 99.9	%
minimum	1.27 \pm 0.27	3.7 \pm 1.7	67.0 \pm 4.0	%
maximum	10.25 \pm 2.25	10.4 \pm 2.5	99.95 \pm 0.05	%
Dissipation				
Total maximum dissipation	2.9	2.1	2.6	W
Shaft data				
Type and length (see Figs 5 and 6)				
focus; note 2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	type G: 8.1 \pm 0.2	mm
screen; note 3	type F: 1.5 \pm 0.2	type F: 1.5 \pm 0.2	type F: 1.5 \pm 0.2	mm
Colour				
focus	black	black	black	
screen	black	black	black	
Delivery position				
focus	FCCW	FCCW	FCCW	deg
screen	FCCW	FCCW	FCCW	deg

Notes

1. Given in % of V_{ac} .
2. Length L_f (see Fig.3).
3. Length L_s (see Fig.3).

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

Table 8 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460		UNIT
	90231	90232	
Resistances			
Resistance (R_{ac})	100 \pm 20%	100 \pm 20%	M Ω
Resistor network (see Fig.1)			
R1	1.2	1.3	M Ω
R2/R6	15.5	7.7	M Ω
R3	37.8	56.0	M Ω
R4	40.0	34.5	M Ω
R5	5.5	0.5	M Ω
R7	20.0 \pm 20%	20.0 \pm 20%	M Ω
Voltages			
Maximum application voltage (V_{ac})	12.0	12.0	kV
V_{foc} ; note 1			
range	59 to 93	69 to 99	%
minimum	54.5 \pm 4.5	65.0 \pm 4.0	%
maximum	94.5 \pm 1.5	99.5 \pm 0.5	%
V_{screen} ; note 1			
range	1.7 to 14.4	1.8 to 7	%
minimum	1.2 \pm 0.5	1.3 \pm 0.5	%
maximum	16.7 \pm 2.3	9.0 \pm 2.0	%
Dissipation			
Total maximum dissipation	1.8	1.8	W
Shaft data			
Type and length (see Figs 5 and 6)			
focus; note 2	type F: 1.5 \pm 0.2	type F: 1.5 \pm 0.2	mm
screen; note 3	type F: 1.5 \pm 0.2	type F: 1.5 \pm 0.2	mm
Colour			
focus	black	black	
screen	black	black	
Delivery position			
focus	FCCW	FCCW	deg
screen	FCCW	FCCW	deg

Notes

1. Given in % of V_{ac} .
2. Length L_f (see Fig.3).
3. Length L_s (see Fig.3).

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

SAFETY REQUIREMENTS

In general an area of 10 mm around the focus unit should be free from all conductive parts with sharp edges. Penetration with earthed parts in these areas should be avoided. Full details of these areas are contained in the factory specification related to each catalogue type. The potentiometer parts carrying high voltage should be free from metal particles, solder drops, etc.

RELIABILITY

Maximum cumulative percentage of failures F (n) after n hours (excluding 0 hours rejects).

Percentage rate of failures.

FAILURES	PERCENTAGE
F (300)	≤0.03%
F (10000)	≤0.25%
F (30000)	≤5.0%

LIST OF MATERIALS

NAME OF PART	MATERIAL	TYPE	MANUFACTURER	FLAME CLASS	UL FILE
Case	polycarbonate	Lexan 500 R	General Electric	UL-94-VO	E45329
Shaft	polycarbonate	Lexan 500 R	General Electric	UL-94-VO	E45329
Rotor	modified PPO	Noryl VO-150-B	General Electric	UL-94-VO	E45329
Rubber spring	silicone rubber	K 1238	Philips	UL-94-HB	E45111
Contact plug	silicone rubber	K 1764	Philips	UL-94-VO	E45111
Vacuum grease	silicone grease	TKHV-1	Klüber	—	—

ORDERING

Minimum ordering quantity: 90 pieces.

Order by quoting the 12-digit catalogue number of the potentiometer units and the quantity required.

PRODUCT MARKING

The unit is marked with the date code (year, week and day of manufacture), the operator code, and the last five digits of the catalogue number.

Example of product marking.

MARKING YWWDX 902..	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

If requested the customer reference code can complete the product marking. The customer code is placed after the operator code.

Focus Metal-glaze Preset (FMP), Vertical type (VERT)






FMP-PRT-VERT

PACKAGING

The units are blister-packed suitable for automatic handling: 30 units per blister, 3 blisters per box.

LABELLING

The label on the package containing the potentiometers is as shown.

LINE	MARKING	EXPLANATION
1.	MADE IN BELGIUM	1. Country of origin
2.	POTENTIOMETERS	2. Product family and resistance values
3.	MFP METAL-GLAZE FOCUS PRESET	3. Product description
	40M	4. Customer information
		5. Preference origin code and product centre
4.	CUST. INFO 2080	6. Quantity per standard packing and product code
		7. Product description
5.	ORIG A170 RPC HQ	8. Catalogue number (12NC)
		
6.	QTY 90 DATE 9404	
		
7.	TYPE FMP	
		
8.	CODENO 2322 460 90202	

MRC294

Fig.7 Packaging label with the customer reference code (example).

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

TESTS AND REQUIREMENTS

In these tables the tests can either be:

D = Destructive

ND = Non-destructive.

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group B1-a	D		
SOLDERABILITY			
Solder iron method in accordance with IEC 68-2-20, Test Ta, method 2: Temperature: 350 °C ±10 °C Solder bit code number: 2622 035 17135 Bit dimensions: 2.5 × 1.5 mm Solder: 60/40 tin/lead Type: Ersin multicore Diameter 1.2 mm with flux 366 Time: 2 ±0.5 s		visual examination	wetting: >95%
Solder bath method in accordance with IEC 68-2-20, Test Ta, method 1: Temperature: 235 °C ±5 °C Immersion time: 2 ±0.5 s		visual examination	wetting: >95%
Sub-group B1-b	ND		
Focus spark gap firing simulation in accordance with PRV-53-8-52/42: R1 = 400 Ω; R2 = 5 MΩ; C1 = 2 nF; P1 = P2 = 600 hPa; V1 = V _{ac} ; V2 = 30 kV; both with shafts FCW; n = 50		visual examination element resistance $\Delta R_{ac}/R_{ac}$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no visible damage ≤3% ≤25 V ≤5 V
Corona in accordance with PRV-53-8-52/43: 1.3 × V _{ac} ; 60 s; standard atmosphere		corona detection	no corona
Breakdown voltage under pressure in accordance with IEC 68-2-13 test M: V _{ac} ; 30 minutes; 600 hPa; 55 °C		flashover detection breakdown detection	no flashover no breakdown
Sub-group C1	ND		
Mechanical travel		focus screen	210° ±5° 260° ±5°
Starting torque		focus screen	3 to 30 mNm; ratio ≤3 3 to 30 mNm; ratio ≤3
Sub-group C2	ND		
Output ratio range		V _{b1c min} /V _{ac} ; V _{b1c max} /V _{ac} V _{b2c min} /V _{ac} ; V _{b2c max} /V _{ac}	see Tables 3, 4, 5, 6, 7 and 8
Continuity in accordance with PRV-53-8-52/44			smooth, unidirectional
Settability		focus ±25 V screen ±5 V	≤10 s ≤10 s
Robustness of terminations in accordance with IEC-68-2-21 test Vb, method 1		visual examination	no visible damage

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group C3	D		
Electrical endurance at 70 °C: Temperature: 70 °C ±3 °C Duration: 1 000 hours Cyclic load (1.5 hours on and 0.5 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} starting torque	no visual damage $\leq 3\%$ ≤ 25 V ≤ 5 V not specified
Sub-group D1	D		
Damp heat, cyclic in accordance with IEC 68-2-30, Test Db: Upper temperature: 40 °C Number of cycles: 21 (1 cycle = 1 hour on and 23 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no visible damage not specified ≤ 25 V ≤ 5 V
Sub-group D2	D		
Mechanical endurance at room temperature: Number of cycles of operation: 50 Rate: 4 ±1 cycles per minute		visual examination element resistance $\Delta R/R$ starting torque continuity change of output ratios	no visible damage $\leq 3\%$ not specified smooth, unidirectional 0.965 to 1.035 × initial requirements
Sub-group D3	ND		
End - stop torque: Adjustment tool: 150 mNm Manual: 300 mNm Duration: 10 s		visual examination	no visible damage, no deformation
Axial thrust on the shaft: Thrust: 50 N		continuity output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	smooth, unidirectional not specified not specified
Radial thrust on the shaft: Thrust: 50 mNm (not applicable for L_s or $L_f \leq 5$ mm)		visual examination	no visible damage
Sub-group D4-a	D		
Resistance to soldering heat in accordance with IEC 68-2-20, Test Tb, method 2: Solder iron method Temperature: 350 °C ±10 °C Solder bit code number: 2622 035 17135 Bit dimensions: 2.5 × .5 mm Solder: 60/40 tin/lead Type: Ersin multicore Diameter 1.2 mm with flux 366 Time: 10 ±1 s Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b2}	$\leq 0.2\%$ ≤ 2 V

Focus Metal-glaze Preset (FMP), Vertical type (VERT)

FMP-PRT-VERT

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group D4-b	D		
Change of temperature in accordance with IEC 68-2-14, Test Na: TA = -25 °C TB = +100 °C Number of cycles: 5 Exposure duration: 30 minutes Shafts: FCCW		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visual damage $\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-c	D		
Vibration in accordance with IEC 68-2-6, Test Fc, Procedure B4: Frequency range: 10 to 55 Hz Amplitude: 0.75 mm or 98m/s ² Sweep endurance: total duration 6 hours Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-d	D		
Shock in accordance with IEC 68-2-27, Test Ea: Pulse duration: 11 ms Acceleration: 490 m/s ² Number of shocks: 3 in each of 6 directions Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-e	D		
Dry heat in accordance with IEC 68-2-2, Test Bb: Temperature: +100 °C Duration: 96 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-f	D		
Cold in accordance with IEC 68-2-1, Test Ab: Temperature: -25 °C Duration: 96 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D5	ND		
Temperature characteristic of resistance: +20 °C to +100 °C		TCR	$\leq 100 \times 10^{-6}/K$
Voltage coefficient of resistance in accordance with HQV-14/001		VCR	$\leq 2 \times 10^{-6}/V$
Dimensions (detail)			in accordance with specification

**Focus Metal-glaze Preset (FMP),
Vertical type (VERT)**

FMP-PRT-VERT

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group ADD1	ND		
Safety test in accordance with PRV-53-8-52/45: 1.3 × V _{ac} during 3 s Test cover: 8204 115 06560		flashover detection breakdown detection	no flashover no breakdown
Sub-group ADD2	D		
Wire forces		push-in force pull-out force	≤25 N ≥50 N
Sub-group ADD3	ND		
Shaft impact test in accordance with PRV-53-8-52/48 (not applicable for L _s or L _f ≤ 5 mm)			no interruptions, no instability

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

FEATURES

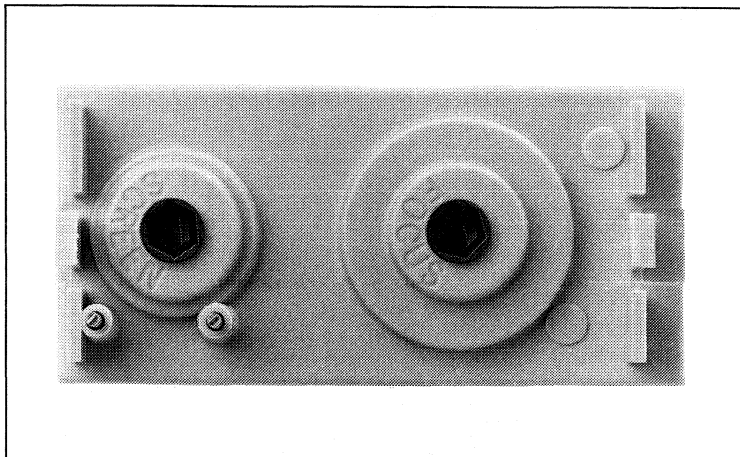
- Single focus and single screen control
- Wire clamp connection for focus voltage in and focus voltage out
- Solder pin for screen control and earth.

APPLICATIONS

- Focus and screen voltage adjustments in colour televisions and monitors.

DESCRIPTION

This unit comprises a thick film network of one focus preset and one screen preset (Fig.1). An optional series resistor may be included in the focus voltage output to protect the focus wiper. Electrical connection to the high voltage input and the focus voltage out (Fig.4) are in each case made by a wire clamp. The connections for screen voltage out and earth are made by soldering the solder pins into the printed-circuit board. The case of the unit is made from synthetic material reinforced with glass-fibre and is self extinguishing. The unit is designed for mounting on to the printed-circuit boards with two snap-locks. The nominal dimensions of the hole pattern for the printed-circuit boards are shown in Fig.2. The shaft design is shown in Fig.5.



QUICK REFERENCE DATA

Resistance	30 M Ω to 300 M Ω
Tolerance (% of total resistance)	$\pm 20\%$
Maximum dissipation at T _{amb} = 70 °C	1.5 W
Maximum application voltage	11 kV
Setting ability (IEC 393/6.34)	
focus	25 V, max. 10 s
screen	5 V, max. 10 s
Temperature characteristic of resistance (20 to 100 °C)	100 $\times 10^{-6}/K$
Voltage coefficient of resistance	
V ₁ = 1 kV	2 $\times 10^{-6}/V$
V ₂ = 10 kV	2 $\times 10^{-6}/V$
Climatic category	25/070/21

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

DESIGN VARIATIONS

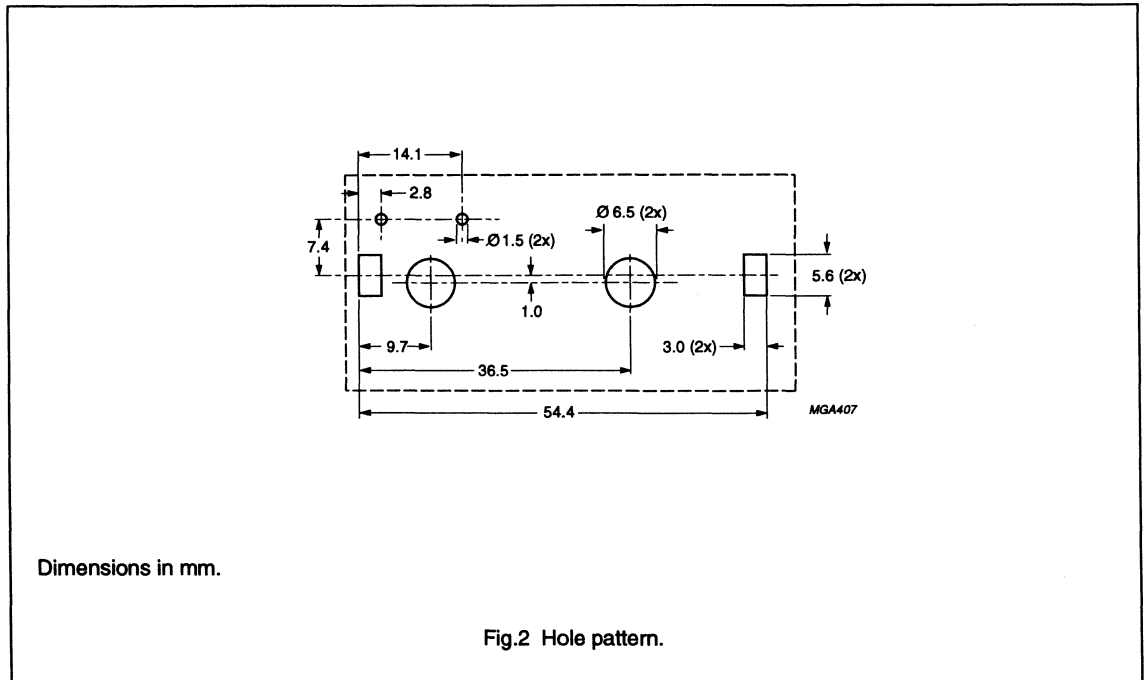
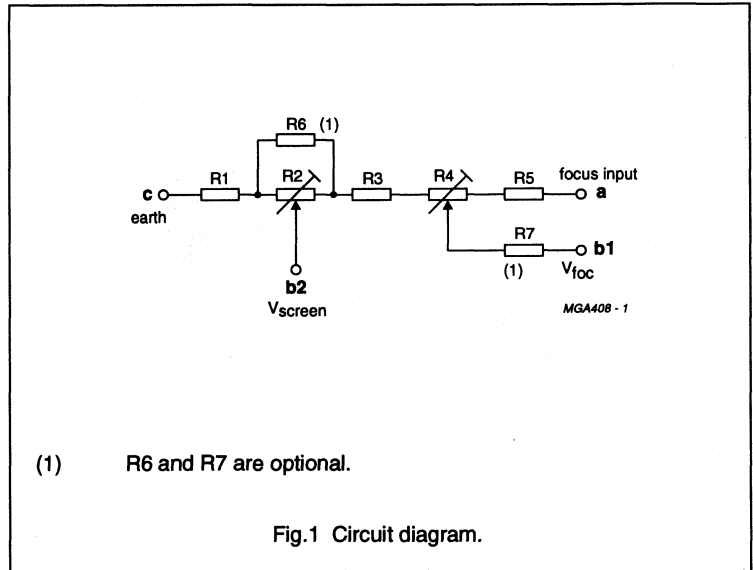
Variations to suit customer requirements are possible on the following:

- Total resistance
- Focus and screen voltage ranges
- Shafts.

APPROVAL

The products have been approved as a safety product.

AUTHORITY	FILE REFERENCE
UL	UC
VDE	4421
BSI	7505



Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

MECHANICAL DATA

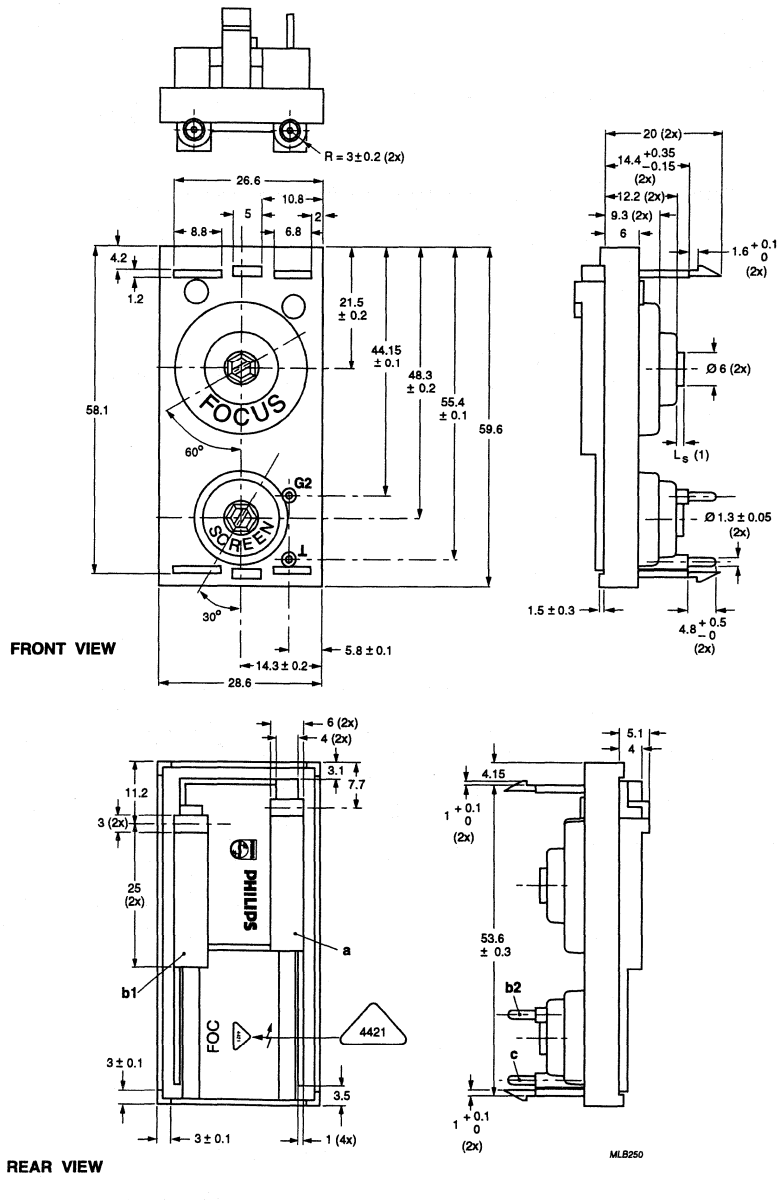
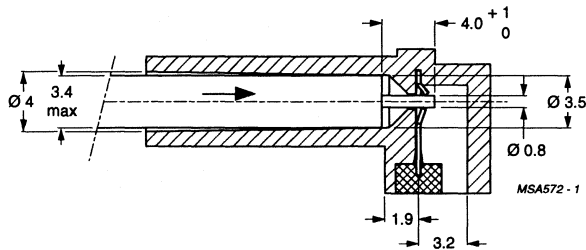


Fig.3 Focus unit FMP-PRT-HOR 1.

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

Connection details



Dimensions in mm.

Fig.4 Wire clamp connection, see Fig.1 for focus input (a) and focus output (b1).

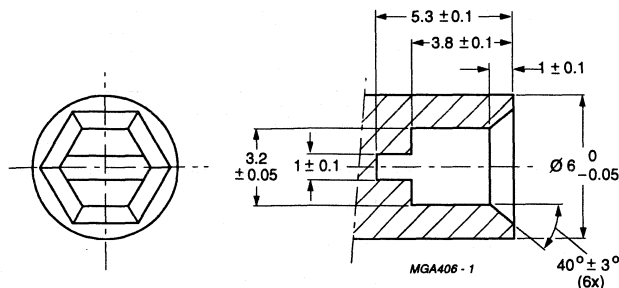
Table 1 Recommended connecting wires for focus voltage input (point a), and focus voltage output (point b1).

MATERIAL	MANUFACTURER	STYLE AND TYPE	INS. MAX. Ø (mm)	FLAME CLASS	UL FILE NUMBER	VDE NUMBER	CATALOGUE NUMBER 0722
PP and Copol 1880	Pope (The Netherlands)	AWM 3239 20 kV (DC) AWG20 CSA TV-20 105 °C	3.35	UL-VW-1	—	—	388 00005
PVC	Sumitomo (Japan)	AWM 3239 20 kV (DC) AWG20 CSA TV-20 105 °C	3.4	UL-VW-1	E41105Y	—	456 00015
PVC	Coroplast (Germany)	VDE 0860/8.86 HS-YV7-3958	3.2	—	—	21039144	—
PVC	Taisho (Japan)	AWM 3239 20 kV (DC) AWG20 CSA TV-20 105 °C	3.4	UL-VW-1	E35688	—	456 00014

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

Shaft data



Dimensions in mm.

Fig.5 Shaft style ($L_s = 1.2 \pm 0.3$ mm; see Fig.3).

Table 2

PARAMETER	MIN.	TYP.	MAX.	UNIT
Focus unit				
Climatic category (IEC-68)	25/070/21			
Inflammability of materials	self-extinguishing in accordance with UL94-VO			
Potentiometers				
Angle of rotation				
focus	265	270	275	deg
screen	175	180	185	deg
Starting torque	–	–	30	mNm
Operating torque	3	–	30	mNm
Operating torque ratio	–	–	3	
Permissible end stop torque (adjustment tool)	–	–	150	mNm
Permissible push force on shaft	–	–	50	N
Permissible pull force on shaft; note 1	–	–	50	N
Mechanical life; focus/screen	–	50	–	cycles
Weight	–	18	–	g
Connectors a and b1				
Insertion force of wire	–	–	25	N
Extraction force of wire	50	–	–	N

Note

1. Not applicable for $L_s \leq 5$ mm.

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

PRODUCT OVERVIEW

Table 3

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT	
	91252	91253	91254	91255		
Resistances						
Resistance (R_{ac})	100 \pm 20%	100 \pm 20%	100 \pm 20%	100 \pm 20%	M Ω	
Resistor network (see Fig.1)						
R1	2.1	1.2	2.0	1.6	M Ω	
R2/R6	14.65	15.5	14.2	15.15	M Ω	
R3	42.25	37.8	24.8	41.25	M Ω	
R4	32.75	40	32.5	34.25	M Ω	
R5	8.25	5.5	26.5	7.75	M Ω	
R7	20 \pm 20%	20 \pm 20%	20 \pm 20%	20 \pm 20%	M Ω	
Voltages						
Maximum application voltage (V_{ac})	10.6	11	11	10	kV	
V_{loc} : note 1	63 to 89.5	59 to 93	45 to 70	62 to 90.5	%	
minimum	59 \pm 4	54.5 \pm 4.5	41 \pm 4	58 \pm 4	%	
maximum	91.75 \pm 2.25	94.5 \pm 1.5	73.5 \pm 3.5	92.25 \pm 1.75	%	
V_{screen} : note 1	2.7 to 14.5	1.7 to 14.4	3 to 14	2.7 to 14.5	%	
minimum	2.1 \pm 0.6	1.2 \pm 0.5	2 \pm 1	1.6 \pm 1.1	%	
maximum	16.75 \pm 2.25	16.7 \pm 2.3	16.2 \pm 2.2	16.75 \pm 2.25	%	
Dissipation						
Total maximum dissipation	1.4	1.5	1.5	1.3	W	
Terminal types						
Focus voltage input (a)	wire clamp	wire clamp	wire clamp	wire clamp		
Focus voltage output (b1)	wire clamp	wire clamp	wire clamp	wire clamp		
Screen voltage output (b2)	solder pin	solder pin	solder pin	solder pin		
Earth connection (c)	solder pin	solder pin	solder pin	solder pin		
Shaft data						
Colour	black	red	red	red		
Length (see Fig.5)	$L_s = 1.2 \pm 0.3$	$L_s = 1.2 \pm 0.3$	$L_s = 1.2 \pm 0.3$	$L_s = 1.2 \pm 0.3$	mm	
Delivery position	focus	FCCW	60 \pm 10; note 2	60 \pm 10; note 2	60 \pm 10; note 2	deg
	screen	FCCW	30 \pm 10; note 3	30 \pm 10; note 3	30 \pm 10; note 3	deg

Notes

1. Given in % of V_{ac} .
2. The mechanical position of the shaft corresponds with 81% of the electrical regulation.
3. The mechanical position of the shaft corresponds with 78% of the electrical regulation.

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

Table 4

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT	
	91256	91257	91258	91259		
Resistances						
Resistance (R_{ac})	100 \pm 20%	100 \pm 20%	100 \pm 20%	100 \pm 20%	M Ω	
Resistor network (see Fig.1)						
R1	0.5	1.75	1.5	1.75	M Ω	
R2/R6	7.5	15.0	8.9	7.75	M Ω	
R3	50.5	33.25	54.6	49.5	M Ω	
R4	33.25	35	30.5	32.75	M Ω	
R5	8.25	15	4.5	8.25	M Ω	
R7	20 \pm 20%	20 \pm 20%	20 \pm 20%	18 \pm 25%	M Ω	
Voltages						
Maximum application voltage (V_{ac})	11	11	11	11	kV	
V_{loc} range; note 1	63 to 89.5	54 to 82.5	69 to 94	63 to 89.5	%	
minimum	58.5 \pm 4.5	50 \pm 4	65 \pm 4	59 \pm 4	%	
maximum	91.75 \pm 2.25	85 \pm 2.5	95.5 \pm 1.5	91.75 \pm 2.25	%	
V_{screen} range; note 1	0.8 to 6	2.7 to 14.5	2.5 to 8.4	2.7 to 7.7	%	
minimum	0.5 \pm 0.3	1.75 \pm 0.95	1.5 \pm 1	1.75 \pm 0.95	%	
maximum	8 \pm 2	16.75 \pm 2.25	10.4 \pm 2	9.5 \pm 1.8	%	
Dissipation						
Total maximum dissipation	1.5	1.5	1.5	1.5	W	
Terminal types						
Focus voltage input (a)	wire clamp	wire clamp	wire clamp	wire clamp		
Focus voltage output (b1)	wire clamp	wire clamp	wire clamp	wire clamp		
Screen voltage output (b2)	solder pin	solder pin	solder pin	solder pin		
Earth connection (c)	solder pin	solder pin	solder pin	solder pin		
Shaft data						
Colour	black	red	red	red		
Length (see Fig.5)	$L_s = 1.2 \pm 0.3$	$L_s = 1.2 \pm 0.3$	$L_s = 1.2 \pm 0.3$	$L_s = 1.2 \pm 0.3$	mm	
Delivery position	focus	60 \pm 10; note 2	60 \pm 10; note 2	60 \pm 10; note 2	60 \pm 10; note 2	deg
	screen	30 \pm 10; note 3	30 \pm 10; note 3	30 \pm 10; note 3	30 \pm 10; note 3	deg

Notes

1. Given in % of V_{ac} .
2. The mechanical position of the shaft corresponds with 81% of the electrical regulation.
3. The mechanical position of the shaft corresponds with 78% of the electrical regulation.

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

RELIABILITY

Maximum cumulative percentage of failures F (n) after n hours (excluding 0 hours rejects):

F (300) ≤0.03%

F (10 000) ≤0.25%

F (30 000) ≤5.0%

LIST OF MATERIALS

NAME OF PART	MATERIAL	TYPE	MANUFACTURER	FLAME CLASS	UL FILE NUMBER
Case	polycarbonate	Lexan 500 R	General Electric	UL-94-VO	E45329
Shaft	modified PPO	Noryl VO-150-B	General Electric	UL-94-VO	E45329
Rubber spring	silicone rubber	K 1238	Philips	UL-94-HB	E45111
Contact plug	silicone rubber	K 1764	Philips	UL-94-VO	E45111
Vacuum grease	silicone grease	TKHV-1	Kluber	–	–

ORDERING

Minimum ordering quantity: 300 pieces.

Order by quoting the 12-digit catalogue number of the potentiometer units and the quantity required.

PRODUCT MARKING

The unit is marked with the date code (year, week and day of manufacture), followed by the operator code, and the last five digits of the catalogue number.

YWWDX912..

Y = year mark e.g. 1992 = 2

WW = week mark e.g. 52

D = day mark e.g. wednesday = 3

XX = operator code

The customer code can complete the product marking.

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

PACKAGING

Packed as 300 units in 10 polystyrene packaging shells, stacked on a rigid board. An additional empty packaging shell is located on the top together with a cover. The complete package is bound tightly together with polypropylene taping straps.

LABELING

The label on the package containing the potentiometers is as shown.





LINE	MARKING EXPLANATION
1. MADE IN BELGIUM	1. Country of origin
2. POTENTIOMETERS 100M	2. Product family and resistance value
3. FMP FOCUS METAL-GLAZE PRESET	3. Product description
4. FMP-PRT-HOR 1	4. Customer information
	5. Preference origin code and production centre
	6. Quantity per standard packaging and production code
	7. Product description
	8. Catalogue number (12NC).
5.  ORIG A170 RPC HQ	
6.  QTY 300 DATE 9320	
7.  TYPE FMP	
8.  CODENO 2322 460 91252	

Fig.6 Packaging label with the customer reference code (example).

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

TESTS AND REQUIREMENTS

In these tables the tests can either be:

D = Destructive

ND = Non-destructive.

TEST / CONDITIONS OF TEST	D or ND	PROCEDURE	PERFORMANCE REQUIREMENTS
Sub-group B1-a	D		
Solderability Solder iron method in accordance with IEC 68-2-20, Test Ta, method 2: Temperature: 350 °C ±10 °C Solder bit code number: 2622 035 17135 Bit dimensions: 2.5 × 1.5 mm Solder: 60/40 tin/lead Type: Ersin multicore Diameter 1.2 mm with flux 366 Time: 2 ±0.5 s		visual examination	wetting: >95%
Solder bath method in accordance with IEC 68-2-20, Test Ta, method 1: Temperature: 235 °C ±5 °C Immersion time: 2 ±0.5 s		visual examination	wetting: >95%
Sub-group B1-b	ND		
Focus spark gap firing simulation in accordance with PRV-53-8-52/42: R1 = 400 Ω; R2 = 5 MΩ; C1 = 2 nF; P1 = P2 = 600 hPa; V1 = V _{ac1} ; V2 = 25 kV; both with shafts FCW; n = 50		visual examination element resistance $\Delta R_{bc}/R_{bc}$ output voltage ΔV_{b1} output voltage ΔV_{b2}	no visible damage ≤3% ≤25 V ≤5 V
Corona in accordance with PRV-53-8-52/43: 1.3 × V _{ac1} ; 60 s; standard atmosphere		corona detection	corona
Breakdown voltage under pressure in accordance with IEC 68-2-13 test M: V _{ac1} ; 30 minutes; 600 hPa; 55 °C		flashover detection breakdown detection	no flashover no breakdown
Sub-group C1	ND		
Mechanical travel		focus screen	270° ±5° 180° ±5°
Starting torque		focus screen	3 to 30 mNm; ratio ≤3 3 to 30 mNm; ratio ≤3

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

TEST / CONDITIONS OF TEST	D or ND	PROCEDURE	PERFORMANCE REQUIREMENTS
Sub-group C2	ND		
Output ratio range		$V_{b1c \min}/V_{ac}; V_{b1c \max}/V_{ac}$ $V_{b2c \min}/V_{ac}; V_{b2c \max}/V_{ac}$	see product overview, Tables 3 and 4
Continuity in accordance with PRV-53-8-52/44			smooth, unidirectional
Settability		focus ± 25 V screen ± 5 V	≤ 10 s ≤ 10 s
Sub-group C3	D		
Electrical endurance at 70 °C: Temperature: $+70 \pm 3$ °C Duration: 1 000 hours Cyclic load (1.5 hours on/0.5 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} starting torque	no visible damage $\leq 3\%$ ≤ 25 V ≤ 5 V not specified
Sub-group D1	D		
Damp heat, cyclic in accordance with IEC 68-2-30, Test Db Upper temperature: 40 °C Number of cycles: 21 (1 cycle = 1 hour on + 23 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no visible damage not specified ≤ 25 V ≤ 5 V
Sub-group D2	D		
Mechanical endurance at room temperature Number of cycles of operation: 50 Rate: 4 ± 1 cycles per minute		visual examination element resistance $\Delta R/R$ starting torque continuity change of output ratios	no visible damage $\leq 3\%$ not specified smooth, unidirectional 0.965 to $1.035 \times$ initial requirements
Sub-group D3	ND		
End - stop torque Torque: 150 mNm Duration: 10 s		visual examination	no visible damage, no deformation
Axial thrust on the shaft Thrust: 50 N		continuity output ratio ΔV_{b1} output ratio ΔV_{b2}	smooth, unidirectional not specified not specified
Radial thrust on the shaft (not applicable for $L_s \leq 5$ mm) Thrust: 50 N		visual examination	no visible damage

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

TEST / CONDITIONS OF TEST	D or ND	PROCEDURE	PERFORMANCE REQUIREMENTS
Sub-group D4-a	D		
Resistance to soldering heat in accordance with IEC 68-2-20, Test Tb, method 2: Solder iron method Temperature: 350 °C ±10 °C Solder bit code number: 2622 035 17135 Bit dimensions: 2.5 × 1.5 mm Solder: 60/40 tin/lead Type: Ersin multicore Diameter 1.2 mm with flux 366 Time: 10 ±1 s Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b2}	$\leq 0.2\%$ ≤ 2 V
Sub-group D4-b	D		
Change of temperature in accordance with IEC 68-2-14, Test Na: TA = -25 °C TB = +100 °C Number of cycles: 5 Exposure duration: 30 minutes Shafts: FCCW		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage $\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-c	D		
Vibration in accordance with IEC 68-2-6, Test Fc, Procedure B4: Frequency range: 10 to 55 Hz Amplitude: 0.75 mm or 98 m/s ² Sweep endurance: total duration: 6 hours Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-d	D		
Shock in accordance with IEC 68-2-27, Test Ea: Pulse duration: 11 ms Acceleration : 490 m/s ² Number of shocks : 3 in each of 6 directions Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm

Focus Metal-glaze Preset (FMP), horizontal types

FMP-PRT-HOR 1

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group D4-e	D		
Dry heat in accordance with IEC 68-2-2, Test Bb: Temperature: +100 °C Duration: 96 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-f	D		
Cold in accordance with IEC 68-2-1, Test Ab: Temperature: -25 °C Duration: 96 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D5	ND		
Temperature characteristic of resistance: +20 °C to +100 °C		TCR	$\leq 100 \times 10^{-6}/K$
Voltage coefficient of resistance in accordance with HQV-14/001		VCR	$\leq 2 \times 10^{-6}/V$
Dimensions (detail)			in accordance with specification
Sub-group ADD1	ND		
Safety test in accordance with PRV-53-8-52/45: $1.3 \times V_{ac}$ during 3 s Test cover: 8204 115 29781		flashover detection breakdown detection	no flashover no breakdown
Sub-group ADD2	D		
Wire forces		push-in force pull-out force	≤ 25 N ≥ 50 N
Sub-group ADD3	ND		
Shaft impact test in accordance with PRV-53-8-52/48 (not applicable for $L_s \leq 5$ mm)			no interruptions, no instability

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

FEATURES

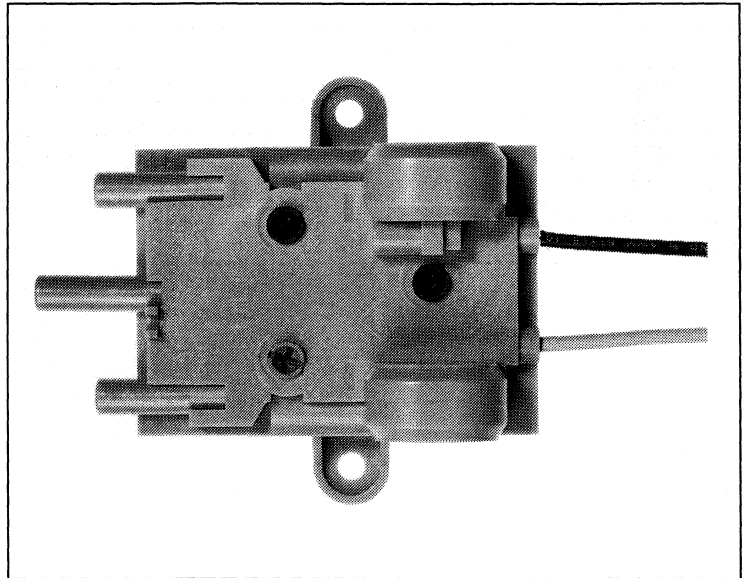
- Integrated dual focus and single screen control
- Integrated dynamic focus correction unit
- Special flash protection circuit
- Wire clamp connections and/or contact pin connections.

APPLICATIONS

- Focus and screen voltage adjustments in colour televisions and monitors, with Dynamic Astigmatism and Focusing guns (DAF).

DESCRIPTION

Each of these units comprises a thick film network of two focus presets and one screen preset (see Fig.1). On both focus wipers a circuit composed of a high voltage capacitor and in series designed protection resistor is available. Additional protection resistors may be included in the focus voltage output connections. The connections with screen (b2), earth and the dynamic correction circuit are made by wire clamps allowing simple press-in connections with 0.8 mm single core stripped wires; these connections are not detachable (see Figs 11, 12, 15, 16, 19 and 20). For earth and dynamic correction, two-fold connectors with wires are available with types K, L and M (see Figs 7, 8 and 9). The case of the unit is made from synthetic material reinforced with glass-fibre, and is self-extinguishing. The discrete components mounted at the back of the substrate are potted with epoxy resin. The unit is designed for mounting on to the chassis with screws. For the stripping length of the recommended wires see Figs 10, 11, 12, 15, 16, 19, 20 and 21.



Types 2322 460 916..

The electrical connections to the high voltage focus input (a) and the focus voltage outputs (b11 and b12) are made by a wire clamp allowing simple press-in connections with 0.8 mm single core stripped wires; these connections are **not** detachable (see Fig.10).

Types 2322 460 926..

The electrical connections to the high voltage focus input (a) and the focus outputs (b11 and b12) are by means of contact terminal pins. These connections are detachable (see Fig.14).

Types 2322 460 936..

The electrical connection to the high focus voltage input (a) is by means of a contact terminal pin. This connection is detachable (see Fig.18). The electrical connections of the focus voltage outputs (b11 and b12) are made by wire clamps, allowing simple press-in connection with 0.8 mm single core

wire; these connections are **not** detachable (see Fig.19).

DESIGN VARIATIONS

Variations to suit customer requirements are possible on the following:

- Total resistance
- Focus and screen voltage ranges
- Capacitance values
- Protection resistors
- Mounting facilities on chassis
- Connections mode for focus in, focus out, screen control, earth connection and dynamic correction.

APPROVALS

The products have been approved as a safety product.

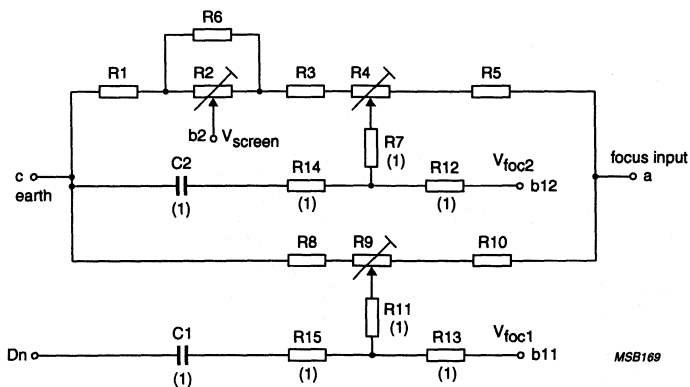
AUTHORITY	FILE REFERENCE
UL	UC
VDE	4453
BSI	UC

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance	10 MΩ to 200 MΩ
Capacitance value (maximum)	1000 pF
Tolerance (% of total resistance)	±10%, ±15% and ±20%
Maximum dissipation at $T_{amb} = 70\text{ °C}$	4 W
Maximum application voltage	17.5 kV
Setting ability (IEC 393/6.34)	
focus	±25 V; max. 10 s
screen	±8 V; max. 10 s
Temperature characteristic of resistance (20 to 100 °C)	$\leq 100 \times 10^{-6}/K$
Voltage coefficient of resistance; $V_{foc1} = 1\text{ kV}$	$\leq 2 \times 10^{-6}/V$
Voltage coefficient of resistance; $V_{foc2} = 10\text{ kV}$	$\leq 2 \times 10^{-6}/V$
Climatic category	40/070/56



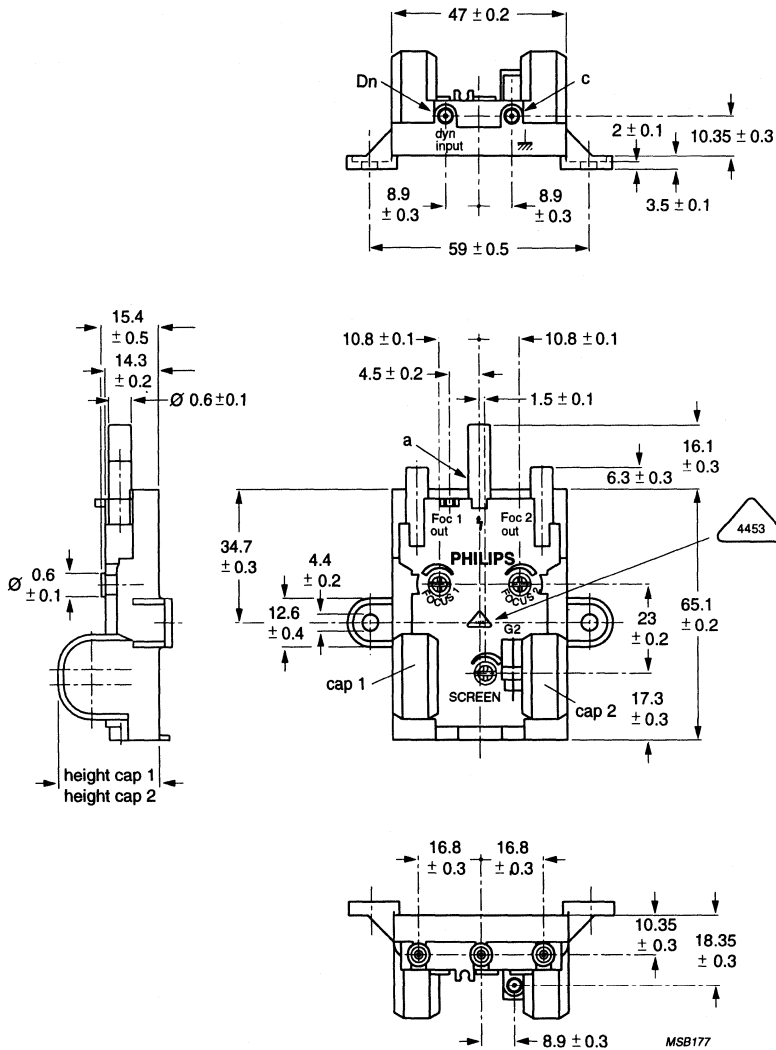
(1) R7, R11, R12, R13, R14, R15, C1 and C2 are optional.

Fig.1 Circuit diagram.

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

MECHANICAL DATA

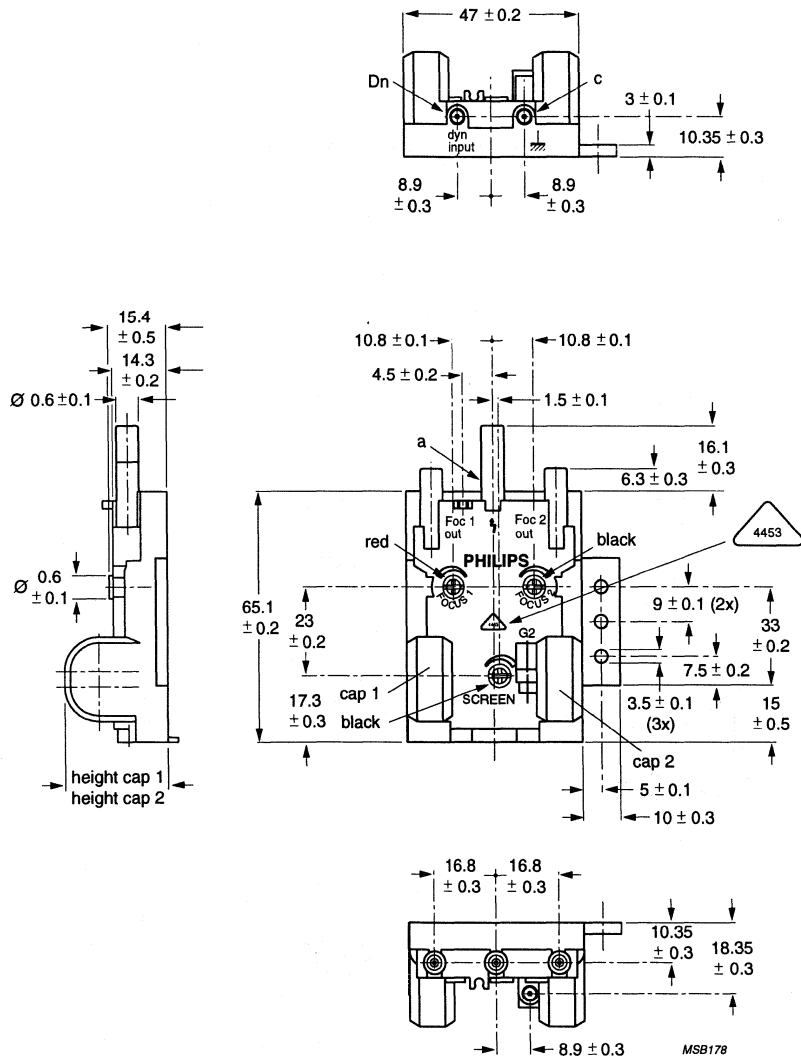


Dimensions in mm.

Fig.2 Housing type A of focus unit group 2322 460 916..

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

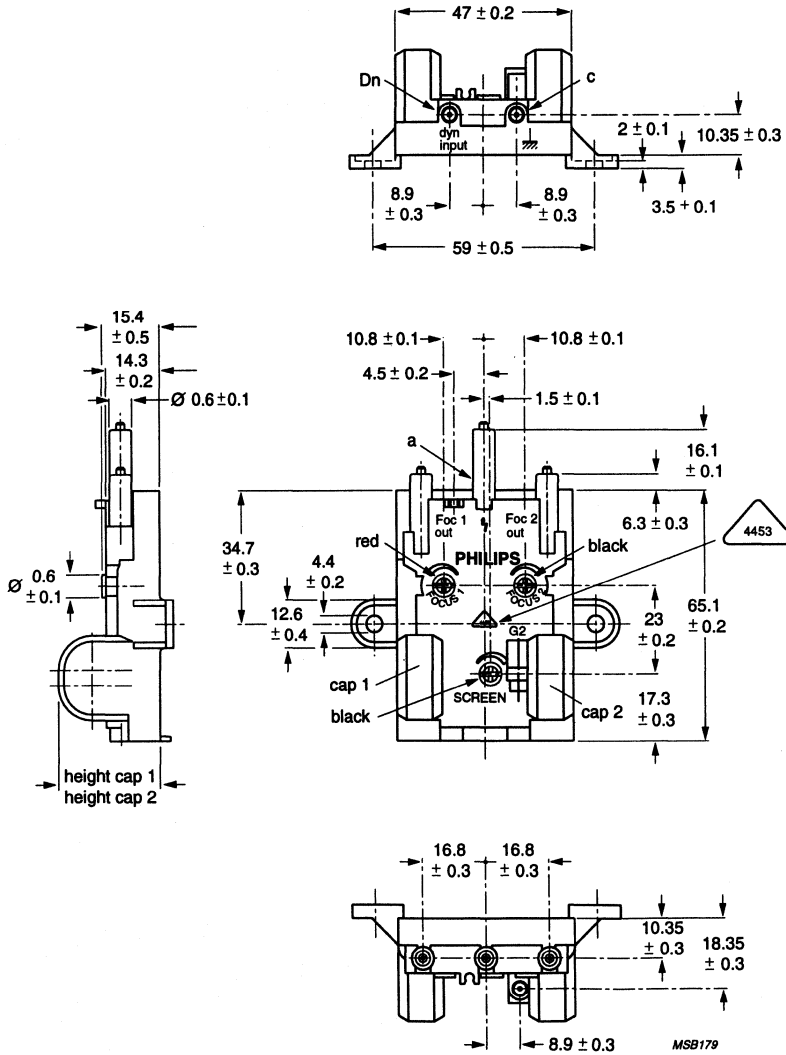


Dimensions in mm.

Fig.3 Housing type B of focus unit group 2322 460 916..

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

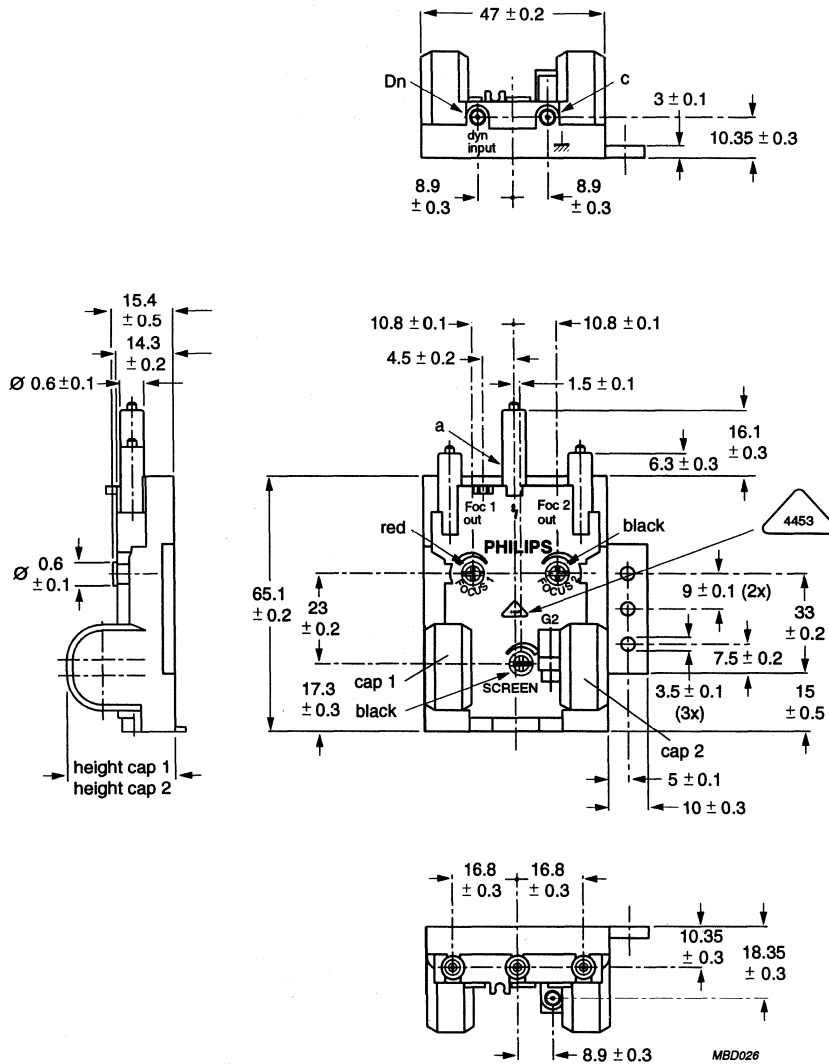


Dimensions in mm.

Fig.4 Housing type A of focus unit group 2322 460 926..

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

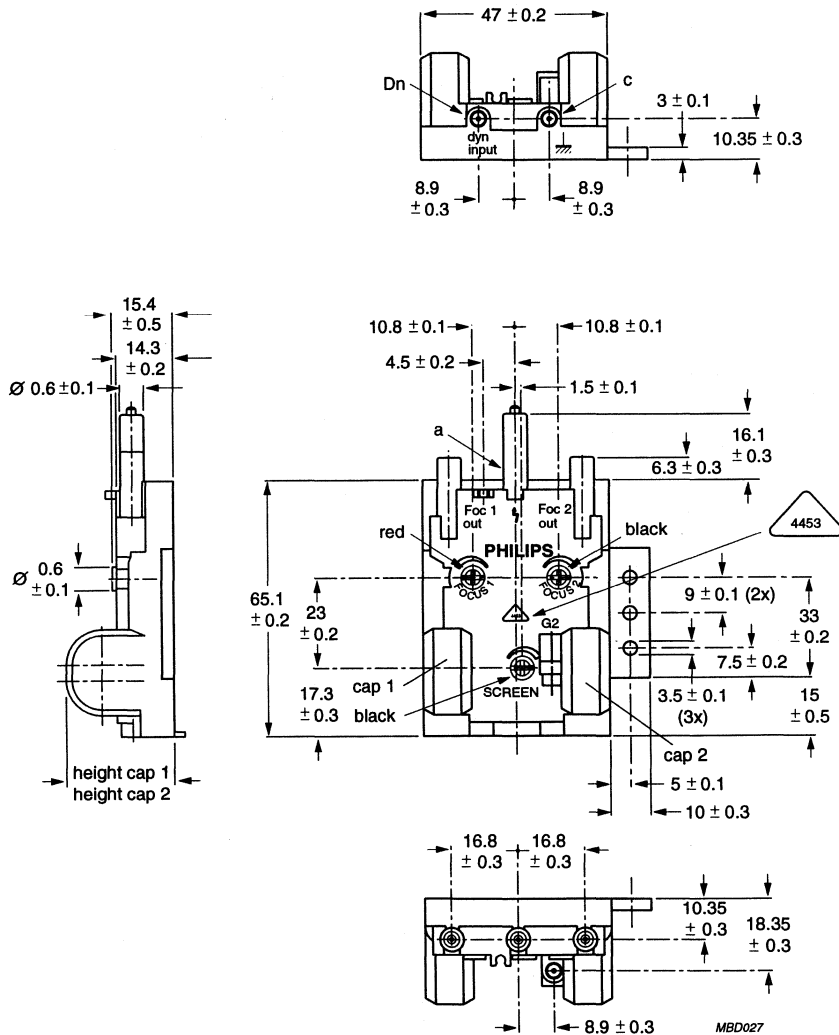


Dimensions in mm.

Fig.5 Housing type B of focus unit group 2322 460 926..

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF



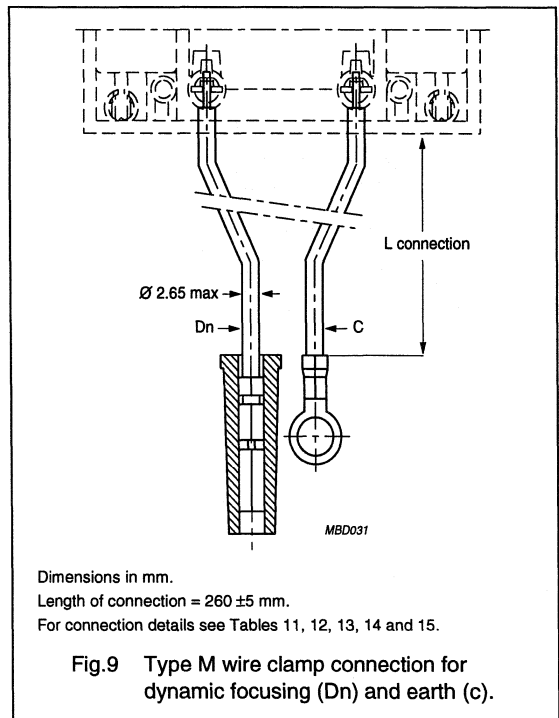
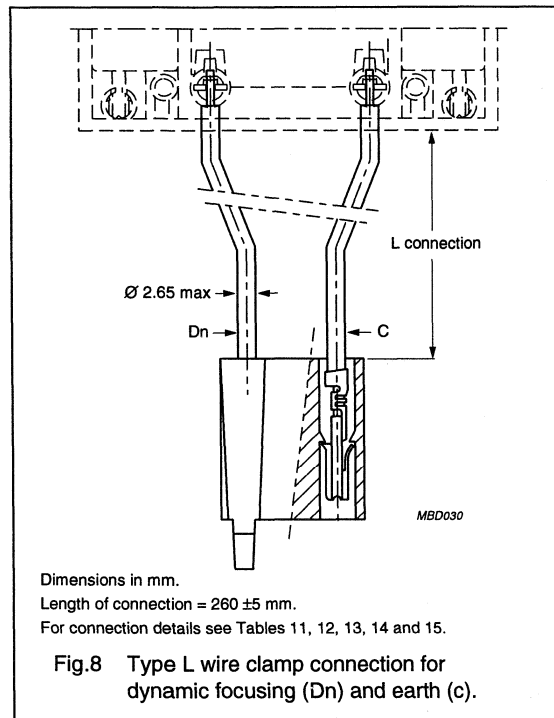
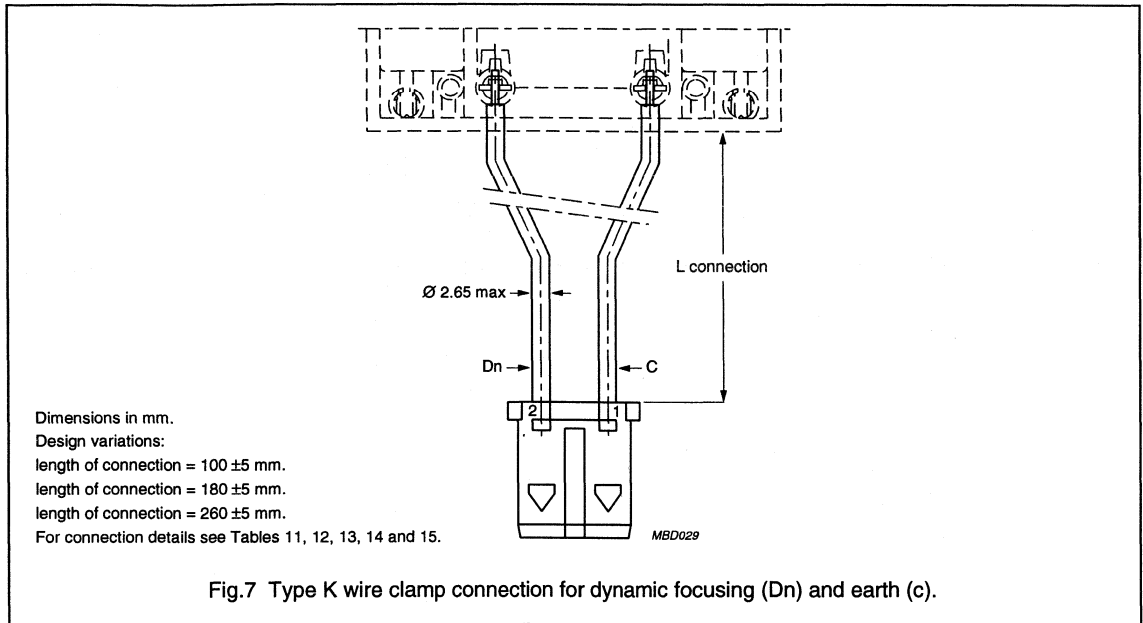
Dimensions in mm.

Fig.6 Housing type B of focus unit group 2322 460 936..

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

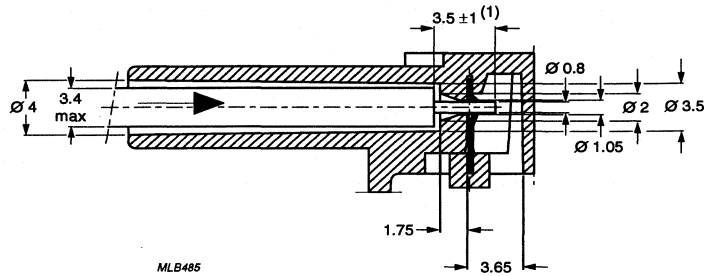
Connections



Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

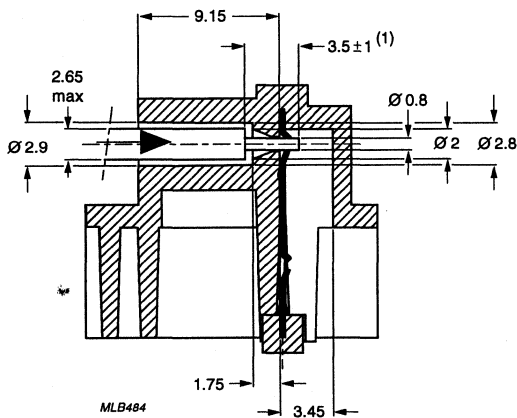
Connections for 2322 460 916..



Dimensions in mm.

(1) Stripping length (under consideration for modification).

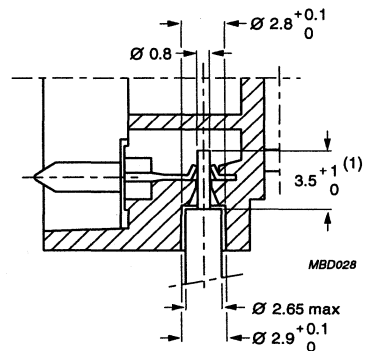
Fig.10 Wire clamp connection for focus input (a) and focus outputs (b11 and b12).



Dimensions in mm.

(1) Stripping length (under consideration for modification).

Fig.11 Wire clamp connection for screen output (b2).



Dimensions in mm.

(1) Stripping length (under consideration for modification).

Fig.12 Wire clamp connection for dynamic focusing (Dn) and earth (c).

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

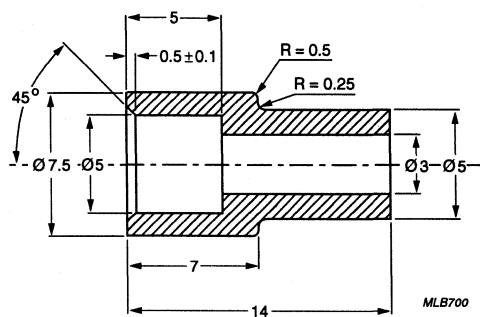
FMP-PRT-DAF

Table 1 Recommended connecting wire for 2322 460 916..

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSULATION MAX. \varnothing (mm)	CATALOGUE NUMBERS
Focus in (a) and Focus out (b11 and b12)	Pope (The Netherlands)	UL758 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.35	0722 388 00005
	Taisho (Japan)	E35688 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00014
	Sumitomo (Japan)	UL3239 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00015
Screen out (b2), Dynamic correction (Dn) and Earth (c)	Pope (The Netherlands)	UL1032 VW-1 AWG20 PVC20	2.6	0722 161 00342
	Taisho (Japan)	E35688 AWM 1032 1.2 kV (DC) AWG20 (1/0.83) 90 °C	2.65	0722 158 00547
	Sumitomo (Japan)	UL-style 3476 E41105 (S) 3 kV (DC)	2.51	0722 161 00357
	Tatung (Japan)	UL1032 E54979 1.2 kV (DC) AWG20	2.65	0738 218 00039
	PEWC (Taiwan)	UL1032 E41396 1.2 kV (DC) AWG20 90 °C	2.65	0738 540 00122

Table 2 Recommended rubber boot for 2322 460 916..

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSIDE \varnothing (mm)	CATALOGUE NUMBER
Focus in (a) and Focus out (b11 and b12)	Hae Ryong (South Korea)	silicon black HR 7020U UL Ref. E98818	3.0	4322 052 86622



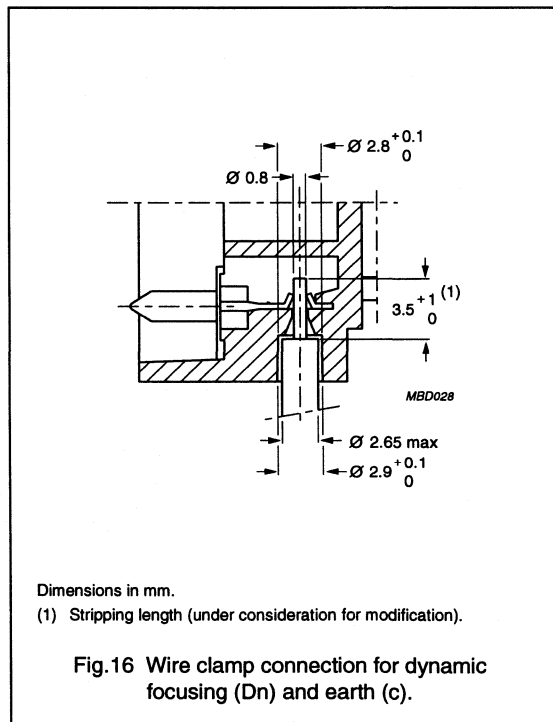
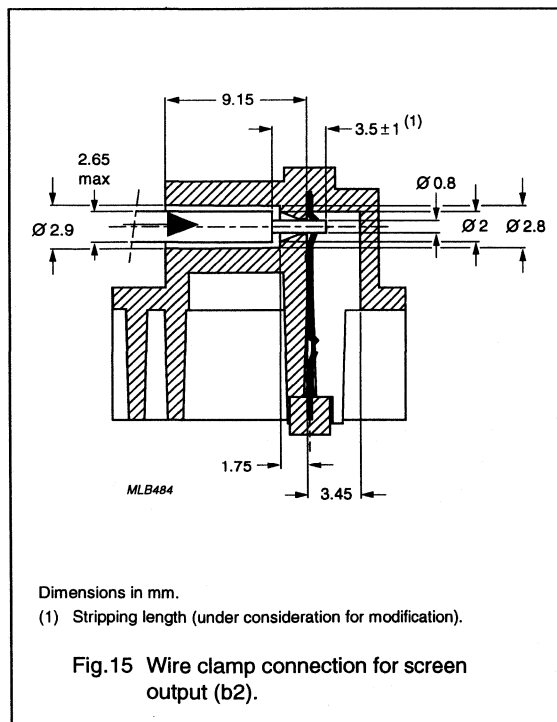
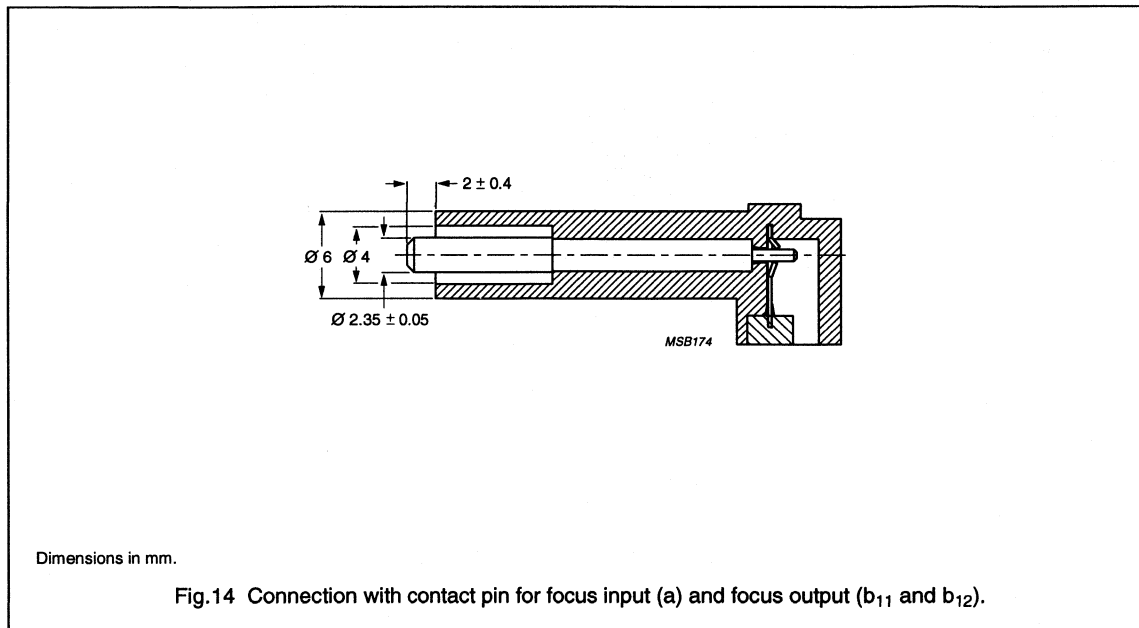
Dimensions in mm.

Fig.13 Rubber boot (4322 052 86622).

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

Connections for 2322 460 926..



Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

Table 3 Recommended connecting wire for 2322 460 926..

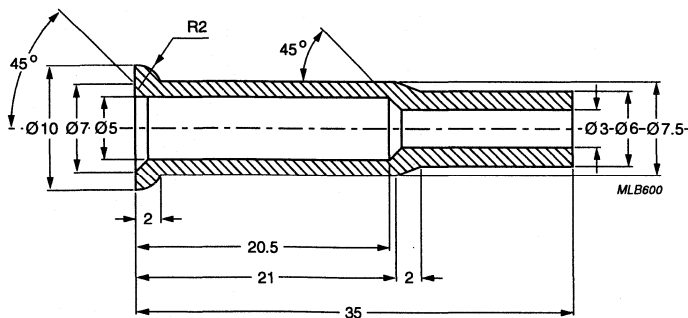
CONNECTION	MANUFACTURER	STYLE AND TYPE	INSULATION MAX. Ø (mm)	CATALOGUE NUMBERS
Screen out (b2), Dynamic correction (Dn) and Earth (c)	Pope (The Netherlands)	UL1032 VW-1 AWG20 PVC20	2.6	0722 161 00342
	Taisho (Japan)	E35688 AWM 1032 1.2 kV (DC) AWG20 (1/0.83) 90 °C	2.65	0722 158 00547
	Sumitomo (Japan)	UL-style 3476 E41105 (S) 3 kV (DC)	2.51	0722 161 00357
	Tatung (Japan)	UL1032 E54979 1.2 kV (DC) AWG20	2.65	0738 218 00039
	PEWC (Taiwan)	UL1032 E41396 1.2 kV (DC) AWG20 90 °C	2.65	0738 540 00122

Table 4 Recommended connecting contact for 2322 460 926..

CONNECTION	MANUFACTURER	STYLE AND TYPE	WIRE SPECIFICATION	CATALOGUE NUMBER
Focus in (a) and Focus out (b11 and b12)	AMP (The Netherlands)	CuZn 030 UN-R311 tin plated article number 160656-2 for pin Ø 2.31 mm	wire range: 0.50 to 0.82 mm ² insulation: Ø 2.3 to 3.3 mm	3104 308 73261

Table 5 Recommended rubber boot for 2322 460 926..

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSIDE Ø (mm)	CATALOGUE NUMBER
Focus in (a) and Focus out (b11 and b12)	Hae Ryong (South Korea)	silicon black HR 7020U UL Ref. E98818	3.0	4322 052 86631



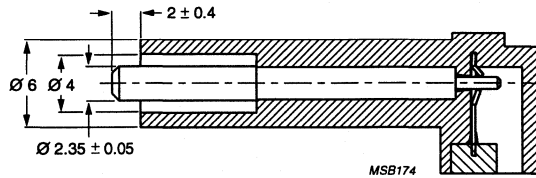
Dimensions in mm.

Fig.17 Rubber boot (4322 052 86631).

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

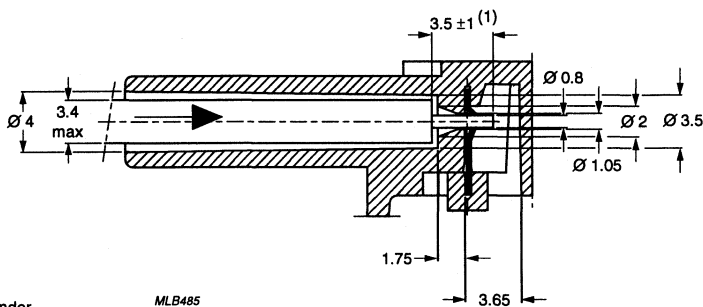
FMP-PRT-DAF

Connections for 2322 460 936..



Dimensions in mm.

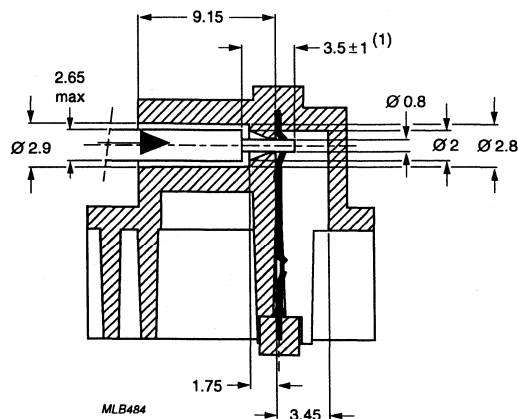
Fig.18 Connection with contact pin for focus input (a).



Dimensions in mm.

(1) Stripping length (under consideration for modification).

Fig.19 Wire clamp connection for focus outputs (b11 and b12).



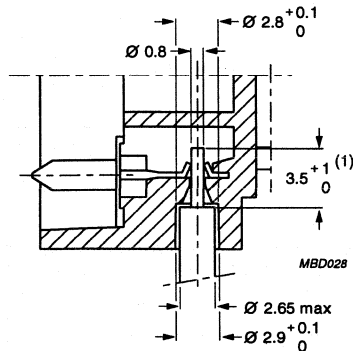
Dimensions in mm.

(1) Stripping length (under consideration for modification).

Fig.20 Wire clamp connection for screen output (b2).

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF



Dimensions in mm.

(1) Stripping length (under consideration for modification).

Fig.21 Wire clamp connection for dynamic focusing (Dn) and earth (c).

Table 6 Recommended connecting wire for 2322 460 936..

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSULATION MAX. Ø (mm)	CATALOGUE NUMBERS
Focus out (b11 and b12)	Pope (The Netherlands)	UL758 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.35	0722 388 00005
	Taisho (Japan)	E35688 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00014
	Sumitomo (Japan)	UL3239 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00015
Screen out (b2), Dynamic correction (Dn) and Earth (c)	Pope (The Netherlands)	UL1032 VW-1 AWG20 PVC20	2.6	0722 161 00342
	Taisho (Japan)	E35688 AWM 1032 1.2 kV (DC) AWG20 (1/0.83) 90 °C	2.65	0722 158 00547
	Sumitomo (Japan)	UL-style 3476 E41105 (S) 3 kV (DC)	2.51	0722 161 00357
	Tatung (Japan)	UL1032 E54979 1.2 kV (DC) AWG20	2.65	0738 218 00039
	PEWC (Taiwan)	UL1032 E41396 1.2 kV (DC) AWG20 90 °C	2.65	0738 540 00122

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

Table 7 Recommended connecting contact for 2322 460 936..

CONNECTION	MANUFACTURER	STYLE AND TYPE	WIRE SPECIFICATION	CATALOGUE NUMBER
Focus in (a)	AMP (The Netherlands)	CuZn 030 UN-R311 tin plated article number 160656-2 for pin \varnothing 2.31 mm	wire range: 0.50 to 0.82 mm ² insulation: \varnothing 2.3 to 3.3 mm	3104 308 73261

Table 8 Recommended rubber boot for 2322 460 936..

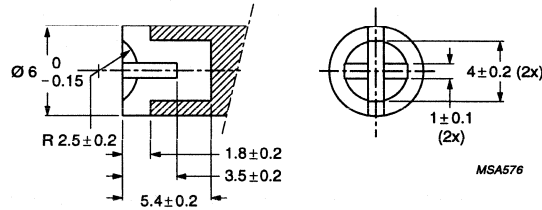
CONNECTION	MANUFACTURER	STYLE AND TYPE	INSIDE \varnothing (mm)	CATALOGUE NUMBERS
Focus in (a) (see Fig.17)	Hae Ryong (South Korea)	silicon black HR 7020U	3.0	4322 052 86631
Focus out (b11 and b12) (see Fig.13)		UL Ref. E98818		4322 052 86622

Table 9 Connecting details for wire clamp connections types K, L and M (see Figs 7, 8 and 9).

CONNECTION	TYPE	STYLE	COLOUR	CATALOGUE NUMBERS
Earth connection wire	type K	AWM 1032 CSA TR-32 VW-1 1 kV 90 °C	black	-
	type L			
	type M			
Dynamic correction wire	type K	AWM 1032 CSA TR-32 VW-1 1 kV 90 °C	grey	-
	type L			
	type M			
Housing	type K	Stocko MKF 2-802-1-0-202	grey	3122 128 73240
	type L	Molex 41456-408		-
	type M	JST SIP-LV		2422 034 19056
Cable tag	type K	-	-	-
	type L (c)	Molex 41050-20	-	8235 043 01490
	type M (c)	AMP 160252-2	-	2422 015 12085
	type M (Dn)	JST SVF-01T-2.36N	-	2422 034 19057

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF



Dimensions in mm.

Fig.22 Design of the shafts.

Table 10 Additional information.

PARAMETER	MIN.	TYP.	MAX.	UNIT
Focus unit				
Climatic category (IEC-68)	40/070/56			
Inflammability of materials	self-extinguishing in accordance with UL94-VO			
Potentiometers				
Angle of rotation				
focus	185	190	195	deg
screen	225	230	235	deg
Starting torque	–	–	30	mNm
Operating torque	3	–	30	mNm
Operating torque ratio	–	–	3	
Permissible end stop torque (adjustment tool)	–	–	150	mNm
Permissible end stop torque (manual)	–	–	300	mNm
Permissible push force on shaft	–	–	50	N
Permissible pull force on shaft	–	–	–	N
Mechanical life; focus/screen	–	50	–	cycles
Weight	–	60	–	g
Connectors a, b11, b12 and b2				
Insertion force of wire	–	–	25	N
Extraction force of wire	50	–	–	N

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

PRODUCT OVERVIEW**Table 11** Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460					UNIT
	91601	91602	91604	91606	91607	
Resistances						
Resistance (R_{ac})	90 ±15%	90 ±15%	100 ±15%	100 ±15%	120 ±15%	MΩ
Resistor network (see Fig.1)						
R1	1.575	8.235	1.0	1.0	13.44	MΩ
R2/R6	7.605	12.105	14.0	14.0	17.76	MΩ
R3	76.32	58.86	116.0	116.0	93.6	MΩ
R4	45.0	49.5	66.2	66.2	76.8	MΩ
R5	49.5	51.3	2.8	2.8	38.4	MΩ
R7	–	–	–	33 ±30%	–	MΩ
R8	85.5	79.2	131.0	131.0	124.8	MΩ
R9	45.0	49.5	66.2	66.2	76.8	MΩ
R10	49.5	51.3	2.8	2.8	38.4	MΩ
R11	–	–	–	33 ±30%	–	MΩ
R14	22.0 ±20%	22.0 ±20%	22.0 ±20%	22.0 ±20%	22.0 ±20%	KΩ
R15	22.0 ±20%	22.0 ±20%	22.0 ±20%	22.0 ±20%	22.0 ±20%	KΩ
Capacitances						
C1 (15 kV)	220	220	470	470	220	pF
C2 (15 kV)	220	220	470	470	220	pF
Voltages						
Maximum application voltage (V_{ac})	17.5	17.5	11.0	11.0	15.0	kV
V_{foc1} ; note 1						
range	52 to 68	48 to 67	70 to 98.2	70 to 98.2	56 to 79	%
minimum	47.5 ±4.5	44.0 ±4.0	65.5 ±4.5	65.5 ±4.5	52.0 ±4.0	%
maximum	72.5 ±4.5	71.5 ±4.5	98.6 ±0.4	98.6 ±0.4	84.0 ±5.0	%
V_{foc2} ; note 1						
range	52 to 68	48 to 67	70 to 98.2	70 to 98.2	56 to 79	%
minimum	47.5 ±4.5	44.0 ±4.0	65.5 ±4.5	65.5 ±4.5	52.0 ±4.0	%
maximum	72.5 ±4.5	71.5 ±4.5	98.6 ±0.4	98.6 ±0.4	84.0 ±5.0	%
V_{screen} ; note 1						
range	1.25 to 3.2	5.65 to 9.3	0.8 to 5.5	0.8 to 5.5	6.6 to 11	%
minimum	0.875 ±0.375	4.575 ±1.075	0.5 ±0.3	0.5 ±0.3	5.6 ±1.0	%
maximum	5.1 ±1.9	11.3 ±2	7.5 ±2.0	7.5 ±2.0	13 ±2.0	%
Dissipation						
Total maximum dissipation	4.0	4.0	1.5	1.5	2.2	W

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

PARAMETERS	CATALOGUE NUMBER 2322 460					UNIT
	91601	91602	91604	91606	91607	
Terminal types						
Focus voltage input (a)	wire clamp	wire clamp	wire clamp	wire clamp	wire clamp	
Focus voltage output (b11 and b12)	wire clamp	wire clamp	wire clamp	wire clamp	wire clamp	
Screen voltage output (b2)	wire clamp	wire clamp	wire clamp	wire clamp	wire clamp	
Earth connection (c) and dynamic focus voltage input (Dn)	type K	type K	type K	type K	type K	
Dimensions						
Height cap 1 (see Figs 2 and 3)	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	mm
Height cap 1 (see Figs 2 and 3)	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	mm
Length of connection (see Figs 7, 8 and 9)	100 ±5	100 ±5	180 ±5	180 ±5	100 ±5	mm
Housing type	A	A	A	A	A	
Minimum ordering quantity	75	75	75	75	75	
Shaft colour						
Focus 1	red	green	red	red	green	
Focus 2	black	black	black	black	black	
Screen	black	black	black	black	black	

Note

- Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

Table 12 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460					UNIT
	91611	91651	91652	91653	91654	
Resistances						
Resistance (R_{ac})	90 \pm 15%	100 \pm 15%	100 \pm 15%	100 \pm 15%	100 \pm 15%	M Ω
Resistor network (see Fig.1)						
R1	8.235	8.5	1.0	2.8	2.8	M Ω
R2/R6	12.105	16.5	13.5	16.8	16.8	M Ω
R3	58.86	110.0	137.5	111.4	111.4	M Ω
R4	49.5	42.0	41.0	66.2	66.2	M Ω
R5	51.3	23.0	7.0	2.8	2.8	M Ω
R7	–	–	35 \pm 20%	33 \pm 30%	33 \pm 30%	M Ω
R8	79.2	135.0	132.0	131.0	131.0	M Ω
R9	49.5	42.0	65.5	66.2	66.2	M Ω
R10	51.3	23.0	2.5	2.8	2.8	M Ω
R11	–	–	35 \pm 20%	33 \pm 30%	33 \pm 30%	M Ω
R12	–	–	10 \pm 30%	–	–	M Ω
R14	22.0 \pm 20%	22.0 \pm 20%	–	22.0 \pm 20%	22.0 \pm 20%	K Ω
R15	22.0 \pm 20%	22.0 \pm 20%	–	22.0 \pm 20%	22.0 \pm 20%	K Ω
Capacitances						
C1 (15 kV)	220	470	470	470	470	pF
C2 (15 kV)	220	470	330	470	470	pF
Voltages						
Maximum application voltage (V_{ac})	17.5	11.0	12.5	11.0	11.0	kV
V_{foc1} ; note 1						
range	48 to 67	72 to 85	70 to 98	70 to 98.2	70 to 98.2	%
minimum	44.0 \pm 4.0	67.5 \pm 4.5	66.0 \pm 4.0	65.5 \pm 4.5	65.5 \pm 4.5	%
maximum	71.5 \pm 4.5	88.5 \pm 3.5	98.75 \pm 0.75	98.6 \pm 0.4	98.6 \pm 0.4	%
V_{foc2} ; note 1						
range	48 to 67	72 to 85	80 to 95	70 to 98.2	70 to 98.2	%
minimum	44.0 \pm 4.0	67.5 \pm 4.5	76.0 \pm 4.0	65.5 \pm 4.5	65.5 \pm 4.5	%
maximum	71.5 \pm 4.5	88.5 \pm 3.5	96.5 \pm 1.5	98.6 \pm 0.4	98.6 \pm 0.4	%
V_{screen} ; note 1						
range	5.65 to 9.3	5 to 10	0.8 to 6	1.8 to 7.3	1.8 to 7.3	%
minimum	4.575 \pm 1.075	4.25 \pm 0.75	0.5 \pm 0.3	1.4 \pm 0.4	1.4 \pm 0.4	%
maximum	11.3 \pm 2.0	12.5 \pm 2.5	7.25 \pm 1.25	9.8 \pm 2.5	9.8 \pm 2.5	%
Dissipation						
Total maximum dissipation	4.0	1.4	2.0	1.5	1.5	W

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

PARAMETERS	CATALOGUE NUMBER 2322 460					UNIT
	91611	91651	91652	91653	91654	
Terminal types						
Focus voltage input (a)	wire clamp	wire clamp	wire clamp	wire clamp	wire clamp	
Focus voltage output (b11 and b12)	wire clamp	wire clamp	wire clamp	wire clamp	wire clamp	
Screen voltage output (b2)	wire clamp	wire clamp	wire clamp	wire clamp	wire clamp	
Earth connection (c) and dynamic focus voltage input (Dn)	type K	type K	wire clamp	type K	print tags	
Dimensions						
Height cap 1 (see Figs 2 and 3)	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	mm
Height cap 1 (see Figs 2 and 3)	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	mm
Length of connection (see Figs 7, 8 and 9)	200 ±5	180 ±5	–	180 ±5	–	mm
Housing type	A	A	B	A	A	
Minimum ordering quantity	75	75	90	75	90	
Shaft colour						
Focus 1	green	red	red	red	red	
Focus 2	black	black	black	black	black	
Screen	black	black	black	black	black	

Note

1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

Table 13 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	92602	92603	92604	92605	
Resistances					
Resistance (R_{ac})	183 \pm 15%	100 \pm 15%	100 \pm 15%	100 \pm 10%	M Ω
Resistor network (see Fig.1)					
R1	2.93	1.5	1.5	1.5	M Ω
R2/R6	39.16	17.3	17.3	17.3	M Ω
R3	126.27	65.3	61.5	45.5	M Ω
R4	100.65	37.9	30.9	33.2	M Ω
R5	96.99	78.0	88.8	102.5	M Ω
R8	168.36	84.1	80.3	64.3	M Ω
R9	100.65	37.9	30.9	33.2	M Ω
R10	96.99	78.0	88.8	102.5	M Ω
R14	2.2 +36%/-20%	2.2 +36%/-20%	2.2 +36%/-20%	2.2 +36%/-20%	K Ω
R15	2.2 +36%/-20%	2.2 +36%/-20%	2.2 +36%/-20%	2.2 +36%/-20%	K Ω
Capacitance					
C1 (15 kV)	1000	1000	1000	1000	pF
C2 (15 kV)	1000	1000	1000	1000	pF
Voltages					
Maximum application voltage (V_{ac})	14.4	17.5	17.5	17.5	kV
V_{foc1} ; note 1					
range	50 to 69	46.1 to 57	44.3 to 51.2	36.3 to 44.5	%
minimum	46.0 \pm 4.0	42.05 \pm 4.05	40.15 \pm 4.15	32.15 \pm 4.15	%
maximum	73.5 \pm 4.5	61.0 \pm 4.0	55.6 \pm 4.4	48.75 \pm 4.25	%
V_{foc2} ; note 1					
range	50 to 69	46.1 to 57	44.3 to 51.2	36.3 to 44.5	%
minimum	46.0 \pm 4.0	42.05 \pm 4.05	40.15 \pm 4.15	32.15 \pm 4.15	%
maximum	73.5 \pm 4.5	61.0 \pm 4.0	55.6 \pm 4.4	48.75 \pm 4.25	%
V_{screen} ; note 1					
range	1.2 to 8	1.1 to 6.8	1.1 to 6.8	1.1 to 6.8	%
minimum	0.8 \pm 0.4	0.75 \pm 0.35	0.75 \pm 0.35	0.75 \pm 0.35	%
maximum	11.5 \pm 3.5	9.4 \pm 2.6	9.4 \pm 2.6	9.4 \pm 2.6	%
Dissipation					
Total maximum dissipation	1.3	3.6	3.6	3.4	W

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

PARAMETERS	CATALOGUE NUMBER 2322 460				UNIT
	92602	92603	92604	92605	
Terminal types					
Focus voltage input (a)	contacting pin	contacting pin	contacting pin	contacting pin	
Focus voltage output (b11 and b12)	contacting pin	contacting pin	contacting pin	contacting pin	
Screen voltage output (b2)	wire clamp	wire clamp	wire clamp	wire clamp	
Earth connection (c) and dynamic focus voltage input (Dn)	type M	type M	type M	type M	
Dimensions					
Height cap 1 (see Figs 4 and 5)	32.1 ±0.4	32.1 ±0.4	32.1 ±0.4	32.1 ±0.4	mm
Height cap 2 (see Figs 4 and 5)	32.1 ±0.4	32.1 ±0.4	32.1 ±0.4	32.1 ±0.4	mm
Length of connection (see Figs 7, 8 and 9)	260 ±5	260 ±5	260 ±5	260 ±5	mm
Housing type	A	A	A	A	
Minimum ordering quantity	75	75	75	75	

Note

1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

Table 14 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460					UNIT
	92611	92612	92613	92652	92653	
Resistances						
Resistance (R_{ac})	80 \pm 15%	80 \pm 10%	50 \pm 15%	120 \pm 15%	120 \pm 15%	M Ω
Resistor network (see Fig.1)						
R1	1.44	1.44	2.75	10.2	12.12	M Ω
R2/R6	17.12	17.12	10.2	14.4	18.12	M Ω
R3	59.04	42.24	48.55	79.8	74.16	M Ω
R4	40.8	37.6	33.2	55.2	64.8	M Ω
R5	41.6	61.6	5.3	80.4	70.8	M Ω
R8	77.6	60.8	61.5	104.4	104.4	M Ω
R9	40.8	37.6	33.2	55.2	63.6	M Ω
R10	41.6	61.6	5.3	80.4	72.0	M Ω
R11	–	–	–	50 \pm 20%	50 \pm 20%	M Ω
R14	2.2 \pm 36%/-20%	2.2 \pm 36%/-20%	2.2 \pm 36%/-20%	–	22 \pm 20%	K Ω
R15	2.2 \pm 36%/-20%	2.2 \pm 36%/-20%	2.2 \pm 36%/-20%	–	22 \pm 20%	K Ω
Capacitances						
C1 (15 kV)	1000	1000	1000	1000	1000	pF
C2 (15 kV)	1000	1000	470	220	220	pF
Voltages						
Maximum application voltage (V_{ac})	14.2	14.2	9.0	17.5	17.5	kV
V_{foc1} ; note 1						
range	53 to 70	42 to 57.5	66 to 92.4	48 to 62	48 to 65	%
minimum	48.5 \pm 4.5	38.0 \pm 4.0	61.5 \pm 4.5	43.5 \pm 4.5	43.5 \pm 4.5	%
maximum	74.0 \pm 4.0	61.5 \pm 4.0	94.7 \pm 2.3	66.5 \pm 4.5	70.0 \pm 5.0	%
V_{foc2} ; note 1						
range	53 to 70	42 to 57.5	66 to 92.4	48 to 62	48 to 66	%
minimum	48.5 \pm 4.5	38.0 \pm 4.0	61.5 \pm 4.5	43.5 \pm 4.5	43.5 \pm 4.5	%
maximum	74.0 \pm 4.0	61.5 \pm 4.0	94.7 \pm 2.3	66.5 \pm 4.5	70.5 \pm 4.5	%
V_{screen} ; note 1						
range	1.3 to 8.4	1.3 to 8.4	3.5 to 10.9	5 to 9	6 to 10.6	%
minimum	0.9 \pm 0.4	0.9 \pm 0.4	27.5 \pm 0.75	4.25 \pm 0.75	5.05 \pm 0.95	%
maximum	11.6 \pm 3.2	11.6 \pm 3.2	12.95 \pm 2.05	10.25 \pm 1.25	12.6 \pm 2.0	%
Dissipation						
Total maximum dissipation	3.0	3.0	1.9	3.0	3.0	W

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

PARAMETERS	CATALOGUE NUMBER 2322 460					UNIT
	92611	92612	92613	92652	92653	
Terminal types						
Focus voltage input (a)	contacting pin	contacting pin	contacting pin	contacting pin	contacting pin	
Focus voltage output (b11 and b12)	contacting pin	contacting pin	contacting pin	contacting pin	contacting pin	
Screen voltage output (b2)	wire clamp	wire clamp	wire clamp	wire clamp	wire clamp	
Earth connection (c) and dynamic focus voltage input (Dn)	type M	type M	wire clamp	type L	type L	
Dimensions						
Height cap 1 (see Figs 4 and 5)	32.1 ±0.4	32.1 ±0.4	32.1 ±0.4	32.1 ±0.4	32.1 ±0.4	mm
Height cap 2 (see Figs 4 and 5)	32.1 ±0.4	32.1 ±0.4	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	mm
Length of connection (see Figs 7, 8 and 9)	260 ±5	260 ±5	–	260 ±5	260 ±5	mm
Housing type	A	A	A	A	A	
Minimum ordering quantity	75	75	75	75	75	

Note

1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

Table 15 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460			UNIT
	93602	93604	93651	
Resistances				
Resistance (R_{ac})	90 \pm 15%	90 \pm 15%	90 \pm 15%	M Ω
Resistor network (see Fig.1)				
R1	3.6	3.6	6.3	M Ω
R2/R6	27.45	27.45	24.75	M Ω
R3	51.75	76.05	51.75	M Ω
R4	69.3	58.5	69.3	M Ω
R5	27.9	14.4	27.9	M Ω
R8	82.8	107.1	82.8	M Ω
R9	69.3	58.5	69.3	M Ω
R10	27.9	14.4	27.9	M Ω
R14	22.0 \pm 20%	2.2 +36%/-20%	22.0 \pm 20%	K Ω
R15	22.0 \pm 20%	2.2 +36%/-20%	22.0 \pm 20%	K Ω
Capacitances				
C1 (15 kV)	470	470	470	pF
C2 (15 kV)	330	330	330	pF
Voltages				
Maximum application voltage (V_{ac})	12.0	12.0	12.0	kV
V_{foc1} ; note 1				
range	50 to 80	64 to 90	50 to 80	%
minimum	46.0 \pm 4.0	59.5 \pm 4.5	46.0 \pm 4.0	%
maximum	84.5 \pm 4.5	92.0 \pm 2.0	84.5 \pm 4.5	%
V_{foc2} ; note 1				
range	50 to 80	64 to 90	50 to 80	%
minimum	46.0 \pm 4.0	59.5 \pm 4.5	46.0 \pm 4.0	%
maximum	84.5 \pm 4.5	92.0 \pm 2.0	84.5 \pm 4.5	%
V_{screen} ; note 1				
range	3 to 15	3 to 15	4.5 to 15	%
minimum	2.0 \pm 1.0	2.0 \pm 1.0	3.5 \pm 1.0	%
maximum	17.25 \pm 2.25	17.25 \pm 2.25	17.25 \pm 2.25	%
Dissipation				
Total maximum dissipation	1.9	1.9	1.9	W

**Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)**

FMP-PRT-DAF

PARAMETERS	CATALOGUE NUMBER 2322 460			UNIT
	93602	93604	93651	
Terminal types				
Focus voltage input (a)	contacting pin	contacting pin	contacting pin	
Focus voltage output (b11 and b12)	wire clamp	wire clamp	wire clamp	
Screen voltage output (b2)	wire clamp	wire clamp	wire clamp	
Earth connection (c) and dynamic focus voltage input (Dn)	wire clamp	wire clamp	wire clamp	
Dimensions				
Height cap 1 (see Fig.6)	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	mm
Height cap 2 (see Fig.6)	27.1 ±0.4	27.1 ±0.4	27.1 ±0.4	mm
Length of connection (see Figs 7, 8 and 9)	–	–	–	mm
Housing type	B	B	B	
Minimum ordering quantity	90	90	90	

Note

1. Given in % of V_{ac} .

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

SAFETY REQUIREMENTS

In general an area of 10 mm around the focus unit should be free from all conductive parts with sharp edges. Penetration with earthed parts in these areas should be avoided. Full details of these areas are contained in the factory specification related to each catalogue type. The potentiometer parts carrying high voltage should be free from metal particles, solder drops, etc.

RELIABILITY

Maximum cumulative percentage of failures F (n) after n hours (excluding 0 hours rejects).

Percentage rate of failures

FAILURES	PERCENTAGE
F (300)	≤0.03%
F (10000)	≤0.25%
F (30000)	≤5.0%

LIST OF MATERIALS

NAME OF PART	MATERIAL	TYPE	MANUFACTURER	FLAME CLASS	UL FILE
Case	polycarbonate	Lexan 500 R	General Electric	UL-94-VO	E45329
Shaft	modified PPO	Noryl VO-150-B	General Electric	UL-94-VO	E45329
Connecting plug	modified PPO	PX 1751	General Electric	UL-94-VO	E45329
Rubber spring	silicone rubber	K 1238	Philips	UL-94-HB	E45111
Contact plug	silicone rubber	9274	Philips	UL-94-HB	E45111
Glue	silicone rubber	744 RTV	Dow Corning	LOI 31%	–
Potting resin	epoxy resin	CW2122/XB5701-1	Ciba-Geigy	UL-94-VO	E96722
Vacuum grease	silicone grease	TKHV-1	Klüber	–	–
Capacitor	ceramic	DHR	Murata	UL-94-VO	–
Resistor	metal film	EB2235 or EB2225	Allen-Bradley	–	–
Earth (c) and Dynamic focus (Dn)					
Wiring Alternative 1	PVC	CSA TR-32; 90 °C	Pope	UL-VW-1	E28102
Wiring Alternative 2	PVC	CSA TEW; 105 °C; FTI	Sumitomo-Y	UL-VW-1	E41105-Y

ORDERING

Order by quoting the 12-digit catalogue number of the potentiometer units and the quantity required. For Minimum Ordering Quantity (MOQ) see Tables 11, 12, 13, 14 and 15.

POSITION OF SHAFTS ON DELIVERY

The preset angle of the shafts are:

- Dynamic focus; FCW
- Focus; FCCW
- Screen; FCCW
- All minimum voltage ratio.

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

PRODUCT MARKING 2322 460 916..

The unit is marked with the date code (year, week and day of manufacture), the operator code, and the last five digits of the catalogue number.

Example of product marking.

MARKING YWWDX916..	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

The VDE approval mark is moulded on the upper side of the case.

If requested the customer reference code can complete the product marking.

PRODUCT MARKING 2322 460 936..

The unit is marked with the date code (year, week and day of manufacture), the operator code, and the last five digits of the catalogue number.

Example of product marking.

MARKING YWWDX936..	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

The VDE approval mark is moulded on the upper side of the case.

If requested the customer reference code can complete the product marking.

PRODUCT MARKING 2322 460 926..

The unit is marked with the date code (year, week and day of manufacture), the operator code, and the last five digits of the catalogue number.

Example of product marking.

MARKING YWWDX926..	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

The VDE approval mark is moulded on the upper side of the case.

If requested the customer reference code can complete the product marking.

**Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)**

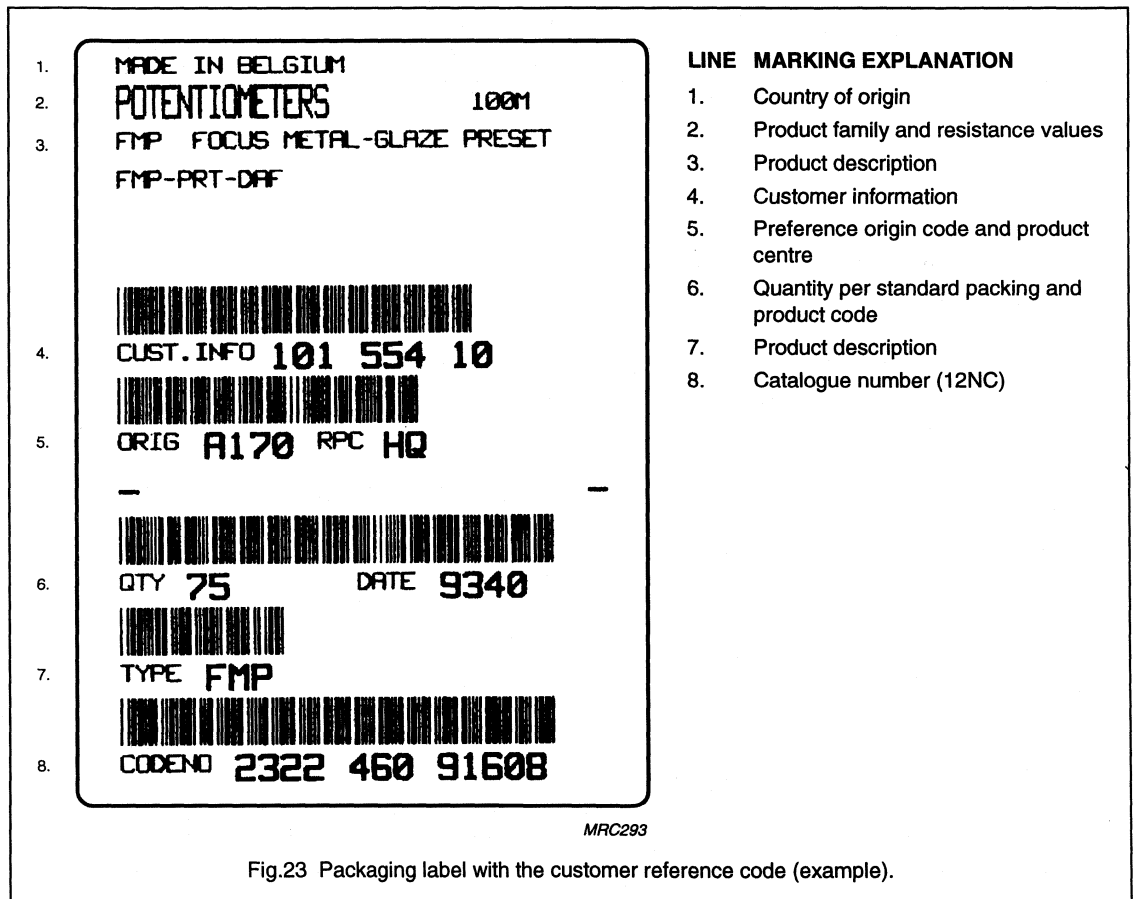
FMP-PRT-DAF

PACKAGING

Packed in polystyrene packaging shells, stacked on a rigid board. An additional empty packaging shell is located on the top together with a cover. The complete package is bound tightly together with polypropylene taping straps.

LABELLING

The label on the package containing the potentiometers is as shown.



Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

TESTS AND REQUIREMENTS

CAUTION

For all tests with applied V_{ac} , all terminals of dynamic focus and earth(s) shall be grounded.

Table 16 Tests and requirements.

In these tables the tests can either be:

D = Destructive

ND = Non-destructive.

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE REQUIREMENTS
Sub-group B1-b	ND		
Focus spark gap firing simulation in accordance with PRV-53-8-52/42: R1 = 400 Ω ; R2 = 5 M Ω ; C1 = 2 nF P1 = P2 = 600 hPa; V1 = V_{ac} ; V2 = 30 kV; Shaft V_{foc2} and V_{screen} : FCW; Shaft V_{foc1} : FCCW; n = 50		visual examination element resistance $\Delta R/R$ output voltage drift $\Delta V_{b11, b12}$ output voltage drift ΔV_{b2}	no visible damage $\leq 3\%$ ≤ 25 V ≤ 8 V
Corona in accordance with PRV-53-8-52/43: $1.3 \times V_{ac}$; 60 s; standard atmosphere		corona detection	no corona
Breakdown voltage under pressure in accordance with IEC 68-2-13 test M: V_{ac} ; 30 minutes; 600 hPa; 55 $^{\circ}$ C		flashover detection breakdown detection	no flashover no breakdown
Sub-group C1	ND		
Mechanical travel		focus 1 and focus 2 screen	$190^{\circ} \pm 5^{\circ}$ $230^{\circ} \pm 5^{\circ}$
Starting torque		focus 1 and focus 2 screen	3 to 30 mNm; ratio ≤ 3 3 to 30 mNm; ratio ≤ 3
Settability		V_{foc1} and V_{foc2} : ± 25 V V_{screen} : ± 8 V	≤ 10 s ≤ 10 s
Sub-group C2	ND		
Output ratio range		$V_{b11c \min}/V_{ac}$; $V_{b11c \max}/V_{ac}$; $V_{b12c \min}/V_{ac}$; $V_{b12c \max}/V_{ac}$ $V_{b2c \min}/V_{ac}$; $V_{b2c \max}/V_{ac}$	see Tables 11, 12, 13, 14 and 15
Continuity in accordance with PRV-53-8-52/44			smooth, unidirectional
Sub-group C1	D		
Electrical endurance at 70 $^{\circ}$ C: Temperature: +70 $^{\circ}$ C ± 3 $^{\circ}$ C Duration: 1000 hours Cyclic load (1.5 hours on and 0.5 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b11} , ΔV_{b12} output voltage drift ΔV_{b2} starting torque	no visual damage $\leq 3\%$ ≤ 25 V ≤ 5 V not specified

Focus Metal-glaze Preset (FMP), Print type, Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE REQUIREMENTS
Sub-group D1	D		
Damp heat, cyclic in accordance with IEC 68-2-30, Test Db: Upper temperature: 40 °C Number of cycles: 56 (1 cycle = 1 hour on and 23 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift $\Delta V_{b11, b12}$ output voltage drift ΔV_{b2}	no visible damage not specified ≤ 25 V ≤ 8 V
Sub-group D2	D		
Mechanical endurance at room temperature: Number of cycles of operation: 50 Rate: 4 ± 1 cycles per minute		visual examination element resistance $\Delta R/R$ starting torque continuity change of output ratios	no visible damage $\leq 3\%$ not specified smooth, unidirectional 0.965 to $1.035 \times$ initial requirements
Sub-group D3	ND		
End - stop torque: Adjustment tool: 150 mNm Manual: 300 mNm Duration: 10 s		visual examination	no visible damage, no deformation
Axial thrust on the shaft: Thrust: 50 N		continuity output voltage drift $\Delta V_{b11, b12}$ output voltage drift ΔV_{b2}	smooth, unidirectional not specified not specified
Sub-group D4-b	D		
Change of temperature in accordance with IEC 68-2-14, Test Nb: TA = -40 °C TB = +100 °C Number of cycles: 5 Exposure duration: 30 minutes Shafts V_{foc2} and V_{screen} : FCCW Shaft V_{foc1} : FCW		visual examination element resistance $\Delta R/R$ output voltage drift $\Delta V_{b11, b12}$ output voltage drift ΔV_{b2} operating torque	no visual damage $\leq 1\%$ ≤ 25 V ≤ 8 V 3 to 30 mNm
Sub-group D4-c	D		
Vibration in accordance with IEC 68-2-6, Test Fc, Procedure B4: Frequency range: 10 to 55 Hz Amplitude: 0.75 mm or 98 m/s^2 Sweep endurance: total duration 6 hours Shafts: mid position		visual examination output voltage drift $\Delta V_{b11, b12}$ output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 8 V 3 to 30 mNm

Focus Metal-glaze Preset (FMP), Print type,
Dynamic Astigmatism and Focusing (DAF)

FMP-PRT-DAF

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE REQUIREMENTS
Sub-group D4-d	D		
Shock in accordance with IEC 68-2-27, Test Ea: Pulse duration: 11 ms Acceleration: 490 m/s ² Number of shocks: 3 in each of 6 directions Shafts: mid position		visual examination output voltage drift ΔV_{b11} , ΔV_{b12} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 8 V 3 to 30 mNm
Sub-group D4-e	D		
Dry heat in accordance with IEC 68-2-2, Test Bb: Temperature: +100 °C Duration: 96 hours Shafts V_{foc2} and V_{screen} : FCCW Shaft V_{foc1} : FCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b11} , ΔV_{b12} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 8 V 3 to 30 mNm
Sub-group D4-f	D		
Cold in accordance with IEC 68-2-1, Test Ab: Temperature: -40 °C Duration: 96 hours Shafts V_{foc2} and V_{screen} : FCCW Shaft V_{foc1} : FCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b11} , ΔV_{b12} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D5	ND		
Temperature characteristic of resistance: +20 °C to +100 °C		TCR	$\leq 100 \times 10^{-6}/K$
Voltage coefficient of resistance in accordance with HQV-14/001		VCR	$\leq 2 \times 10^{-6}/V$
Dimensions (detail)			in accordance with specification
Sub-group ADD1	ND		
Safety test in accordance with PRV-53-8-52/45: $1.3 \times V_{ac}$ during 3 s Test cover: 8204 115 06560		flashover detection breakdown detection	no flashover no breakdown
Sub-group ADD2	D		
Wire forces		push-in force pull-out force	≤ 25 N ≥ 50 N

Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)

FMP-PTV

FEATURES

- Integrated focus and g_2 control
- Special dynamic focus correction circuit
- Wire clamp connections and/or contact pin connections.

APPLICATIONS

- Focus and screen voltage adjustments in television receivers.

DESCRIPTION

Each unit comprises three parallel thick film circuits on a ceramic (Al_2O_3) substrate, with focus and screen (g_2) potentiometers, and integrated circuit for dynamic focusing.

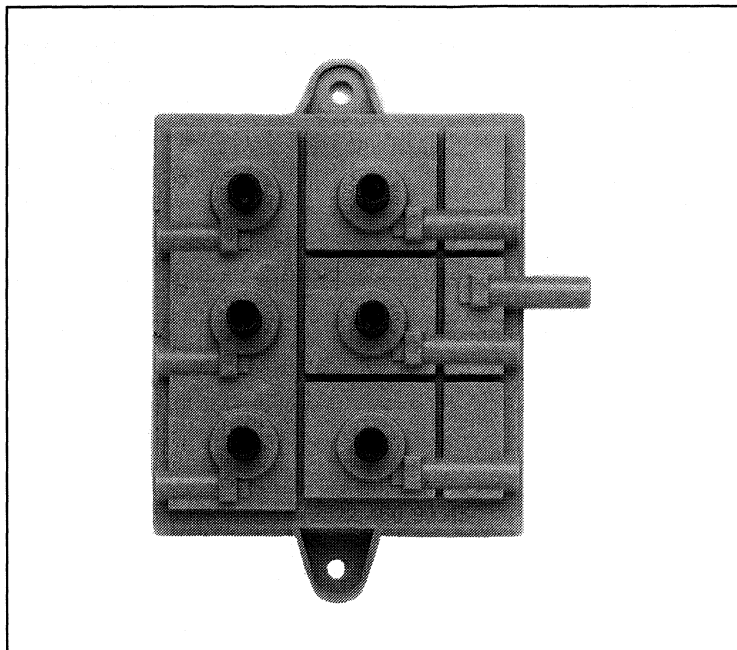
The units are designed for mounting on the chassis with screws (M4).

Electrical connections of the high voltage (a), focus out (b_{1R} - b_{1G} - b_{1B}) and screen (g_2) out (b_{2R} - b_{2G} - b_{2B}) (see Fig.1) are made by simply pressing 0.8 mm single core, stripped wires in to the respective holes.

These connections are **not** detachable. For the recommended cable types see Table 3 and for the stripping length of the recommended wires see Figs 3 and 4.

The electrical connections to the high voltage focus input (a) and the focus voltage outputs (b_{1R} - b_{1G} - b_{1B}) contact pins can be designed in (see Fig.1).

Earth connection (black wire) and dynamic focus input (brown wire) can be effected by a two-fold 'Stocko' plug (see Fig.5).



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance	22.7 M Ω to 73 M Ω
Tolerance (% of total resistance)	$\pm 10\%$ and $\pm 20\%$
Maximum dissipation at $T_{amb} = 70\text{ }^{\circ}\text{C}$	4.3 W
Maximum application voltages	11.7 kV
Setting ability (IEC 393/6.34)	
focus	$\pm 25\text{ V}$; max. 10 s
screen	$\pm 8\text{ V}$; max. 10 s
Temperature characteristic of resistance (20 to 100 $^{\circ}\text{C}$)	$\leq 100 \times 10^{-6}/\text{K}$
Voltage coefficient of resistance	$\leq 2 \times 10^{-6}/\text{V}$
Climatic category	25/070/21

Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)

FMP-PTV

DESIGN VARIATIONS

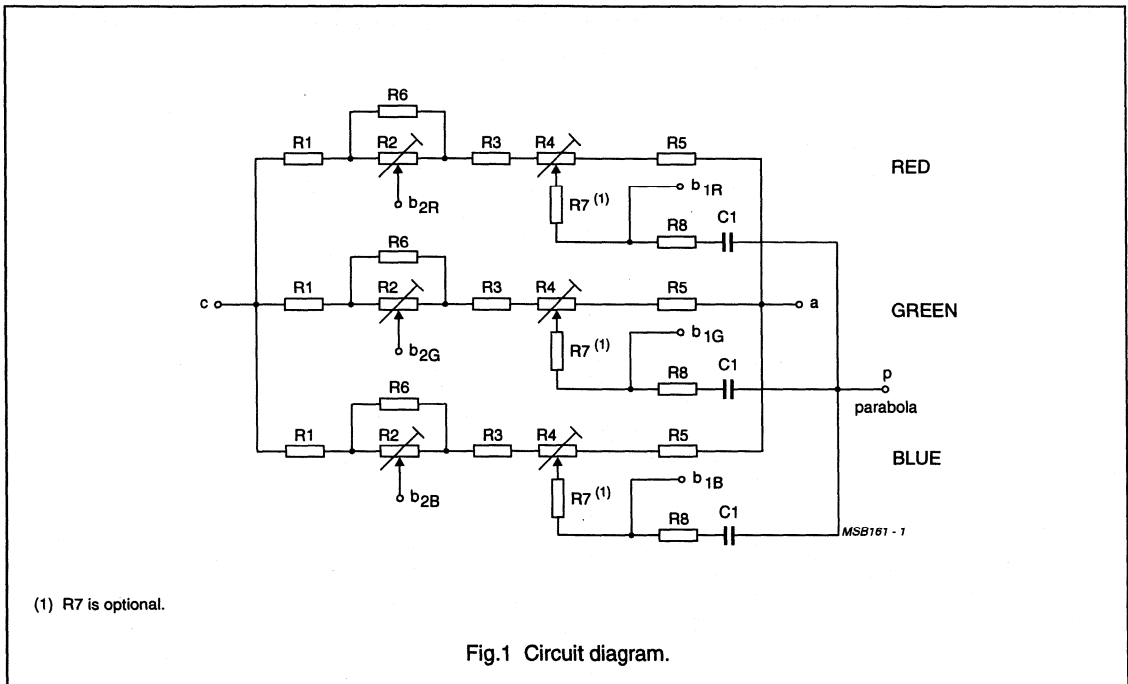
Variations to suit customer requirements are possible on the following:

- Total resistance
- Focus and screen voltage ranges
- Connections
- Shafts.

APPROVALS

The products have been approved as a safety product.

AUTHORITY	FILE REFERENCE
VL	UC
VDE	2599 (only for 2322 460 90313)
BSI	UC



Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)

FMP-PTV

MECHANICAL DATA

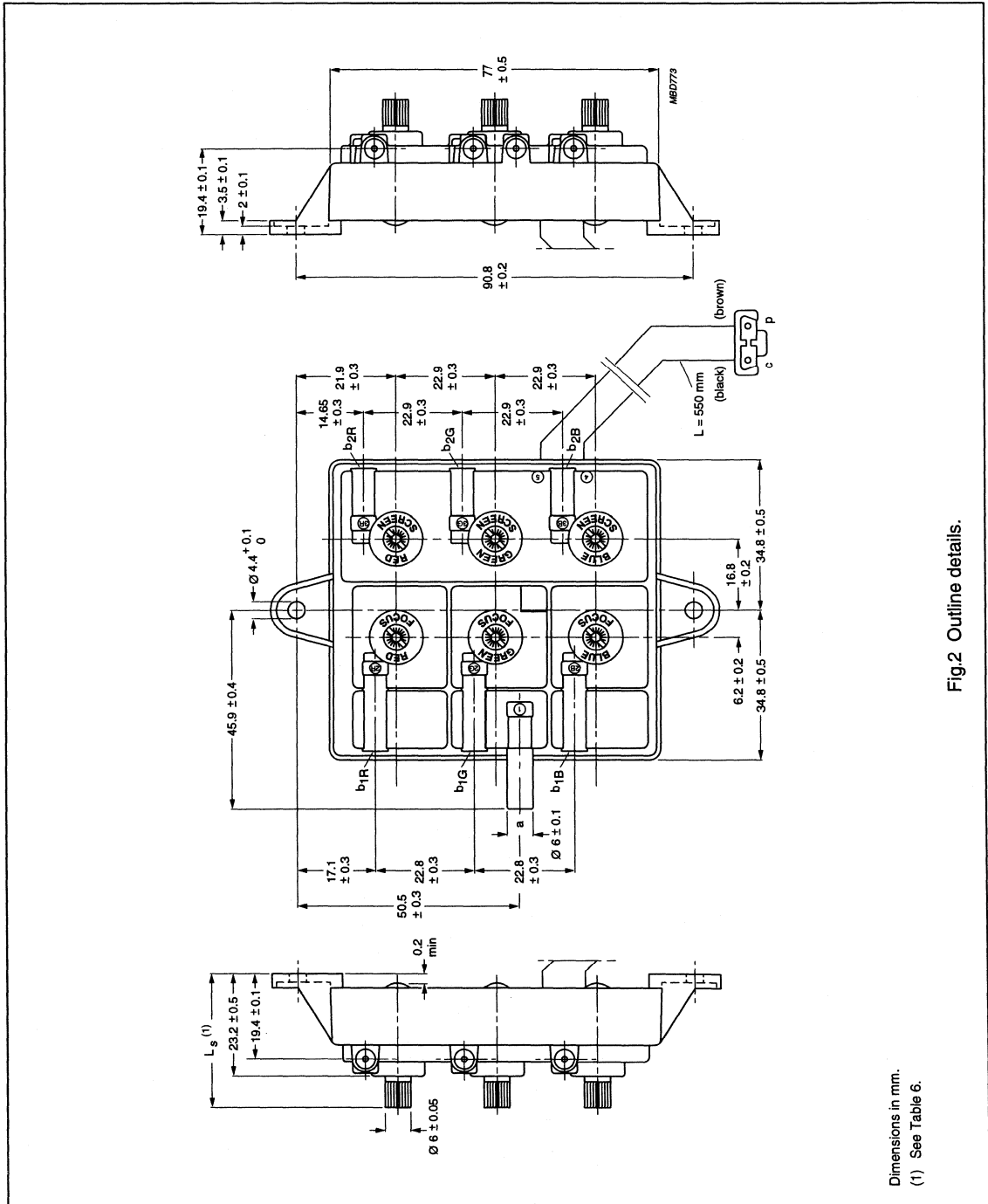
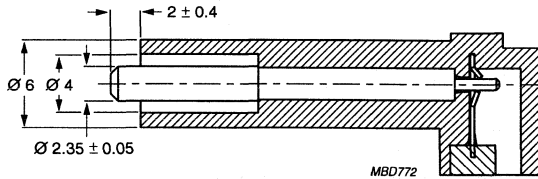


Fig.2 Outline details.

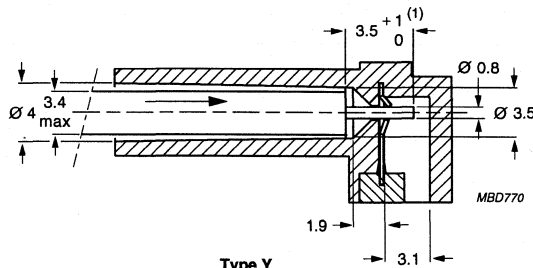
Focus Metal-glaze Preset (FMP),
triple Projection TV type (PTV)

FMP-PTV

Connection details



Type X

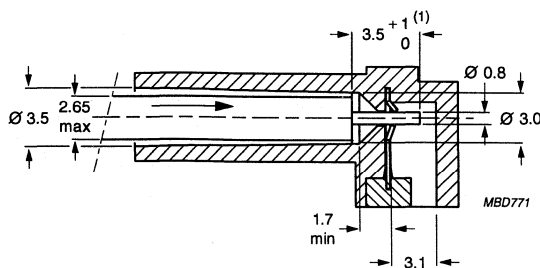


Type Y

Dimensions in mm.

(1) Stripping length (under consideration for modification).

Fig.3 Connections for focus input (a) and focus outputs (b_{1R}-b_{1G}-b_{1B}).



Dimensions in mm.

(1) Stripping length (under consideration for modification).

Fig.4 Wire clamp connections for screen output (b_{2R}-b_{2G}-b_{2B}).

Focus Metal-glaze Preset (FMP),
triple Projection TV type (PTV)

FMP-PTV

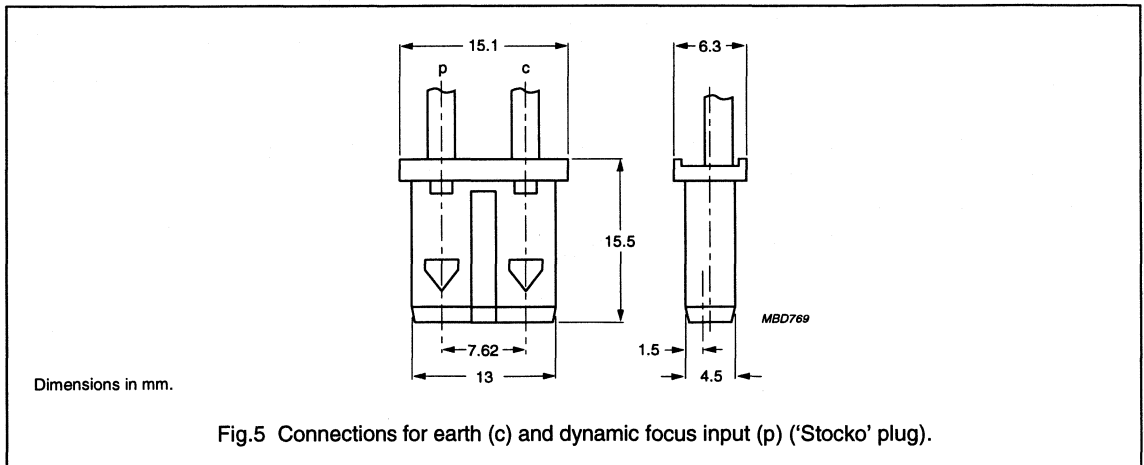
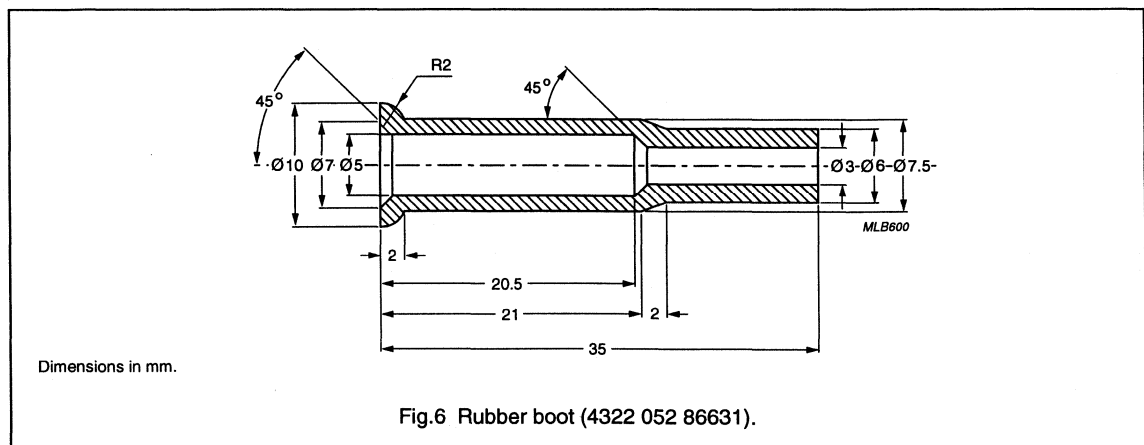


Table 1 Recommended connecting contact for type X (see Fig.3).

CONNECTION	MANUFACTURER	STYLE AND TYPE	WIRE SPECIFICATION	CATALOGUE NUMBER
Focus in (a) and Focus out (b _{1R} -b _{1G} -b _{1B}) (see Fig.1)	AMP (The Netherlands)	CuZn 030 UN-R311 tin plated article number 160656-2 for pin Ø 2.31 mm	wire range: 0.50 to 0.82 mm ² insulation: Ø 2.3 to 3.3 mm	3104 308 73261

Table 2 Recommended rubber boot for type X (see Fig.3).

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSIDE Ø (mm)	CATALOGUE NUMBER
Focus in (a) and Focus out (b _{1R} -b _{1G} -b _{1B}) (see Fig.1)	Hae Ryong (South Korea)	silicon black HR 7020U UL Ref. E98818	3.0	4322 052 86631



Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)

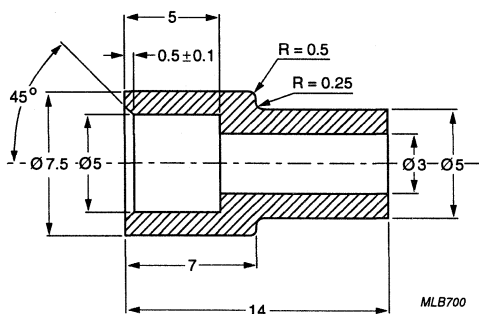
FMP-PTV

Table 3 Recommended connecting wire.

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSULATION MAX. \varnothing (mm)	CATALOGUE NUMBERS
Focus in (a) and Focus out (b _{1R} -b _{1G} -b _{1B}) (see Fig.1)	Pope (The Netherlands)	UL758 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.35	0722 388 00005
	Taisho (Japan)	E35688 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00014
	Sumitomo (Japan)	UL3239 AWM 3239 CSA 20 kV (DC) AWG20 VW-1 105 °C	3.4	0722 456 00015
Screen out (b _{2R} -b _{2G} -b _{2B}), Dynamic correction (Dn) and Earth (c) (see Fig.1)	Pope (The Netherlands)	UL1032 VW-1 AWG20 PVC20	2.6	0722 161 00342
	Taisho (Japan)	E35688 AWM 1032 1.2 kV (DC) AWG20 (1/0.83) 90 °C	2.65	0722 158 00547
	Sumitomo (Japan)	UL-style 3476 E41105 (S) 3 kV (DC)	2.51	0722 161 00357
	Tatung (Japan)	UL 1032 E54979 1.2 kV (DC) AWG20	2.65	0738 218 00039
	PEWC (Taiwan)	UL 1032 E41396 1.2 kV (DC) AWG20 90 °C	2.65	0738 540 00122

Table 4 Recommended rubber boot for type Y (see Fig.3).

CONNECTION	MANUFACTURER	STYLE AND TYPE	INSIDE \varnothing (mm)	CATALOGUE NUMBER
Focus in (a)	Hae Ryong (South Korea)	silicon black HR 7020U UL Ref. E98818	3.0	4322 052 86622



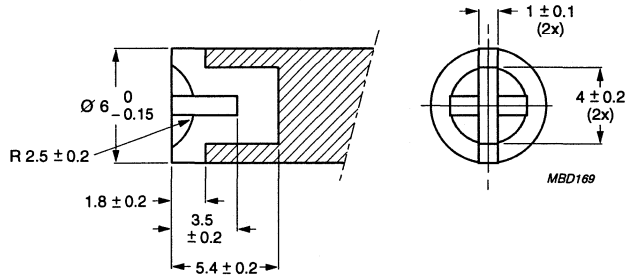
Dimensions in mm.

Fig.7 Rubber boot (4322 052 86622).

Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)

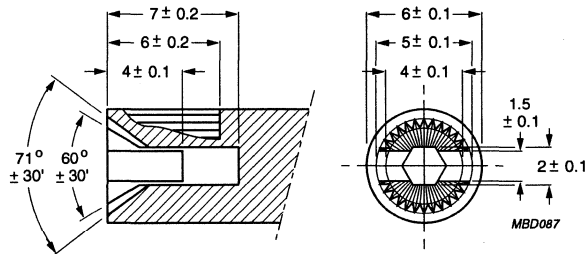
FMP-PTV

Shaft style connection details



Dimensions in mm.

Fig.8 Type F shaft style connection.



Dimensions in mm.

Fig.9 Type G shaft style connection.

**Focus Metal-glaze Preset (FMP),
triple Projection TV type (PTV)**
FMP-PTV
Table 5 Additional information.

PARAMETER	MIN.	TYP.	MAX.	UNIT
Focus unit				
Climatic category (IEC 68)	25/070/21			
Inflammability of materials	self-extinguishing in accordance with UL94-VO			
Potentiometers				
Angle of rotation				
focus	195	200	205	deg
screen	225	230	235	deg
Starting torque	–	–	30	mNm
Operating torque	3	–	30	mNm
Operating torque ratio	–	–	3	
Permissible end stop torque (adjustment tool)	–	–	150	mNm
Permissible end stop torque (manual)	–	–	300	mNm
Permissible push force on shaft	–	–	50	N
Permissible pull force on shaft; note 1	–	–	50	N
Mechanical life; focus/screen	–	50	–	cycles
Weight	–	135	–	g
Connectors a, b₁ and b₂				
Insertion force of wire	–	–	25	N
Extraction force of wire	50	–	–	N

Note

1. Not applicable for $L_s \leq 27$ mm.

Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)

FMP-PTV

PRODUCT OVERVIEW

Table 6 Overview of product types.

PARAMETERS	CATALOGUE NUMBER 2322 460			UNIT
	90313	90506	90507	
Resistances				
Resistance (R_{ac})	22.7 \pm 20%	73 \pm 10%	40 \pm 20%	M Ω
Resistor network (see Fig.1)				
R1 (3x)	2.67	5.04	2.14	M Ω
R2/R6 (3x)	4.53	14.12	11.42	M Ω
R3 (3x)	33.57	168.52	72.36	M Ω
R4 (3x)	20.37	31.32	29.76	M Ω
R5 (3x)	6.96	–	4.32	M Ω
R7 (3x)	23.0 \pm 20%	4200 \pm 20%	–	k Ω
R8 (3x)	–	–	23.0 \pm 20%	k Ω
Voltagess				
Maximum application voltage (V_{ac})	8.6	11.0	11.7	kV
V_{foc} ; note 1				
range	64.4 to 87.6	88.2 to 99.9	75.2 to 95.3	%
minimum	59.9 \pm 4.5	85.7 \pm 2.5	71.6 \pm 3.6	%
maximum	89.8 \pm 2.2	99.95 \pm 0.05	96.4 \pm 1.1	%
V_{screen} ; note 1				
range	4.9 to 8.2	2.73 to 7.3	2.56 to 9.3	%
minimum	3.95 \pm 0.95	2.08 \pm 0.65	1.78 \pm 0.78	%
maximum	10.6 \pm 2.4	9.3 \pm 2.0	11.3 \pm 2.0	%
Capacitance				
Capacitor C1 (3x) (see Fig.1)	220 \pm 20%	2500 \pm 20%	220 \pm 20%	pF
Dissipation				
Total maximum dissipation	3.9	1.9	4.3	W
Shaft data				
Length	$L_s = 31 \pm 0.6$	$L_s = 24.3 \pm 0.5$	$L_s = 31 \pm 0.6$	mm
Type (see Figs 8 and 9)	G	F	G	
Colour				
focus	black	black, green, red	blue, green, red	
screen	black	black	blue, green, red	
Delivery position				
focus	midway	FCCW	FCCW	deg
screen	midway	FCCW	FCCW	deg

**Focus Metal-glaze Preset (FMP),
triple Projection TV type (PTV)**
FMP-PTV

PARAMETERS	CATALOGUE NUMBER 2322 460			UNIT
	90313	90506	90507	
Terminal types				
Focus voltage input (a) (see Fig.3)	type Y	type X	type X	
Focus voltage output (b _{1R} -b _{1G} -b _{1B}) (see Fig.3)	type Y	type X	type X	
Screen voltage output (b _{2R} -b _{2G} -b _{2B}) (see Fig.4)	wire clamp	wire clamp	wire clamp	
Earth connection (c) and dynamic focus correction (p) (see Fig.5)	Stocko plug	wire clamp	Stocko plug	

Note

1. Given in % of V_{ac}.

Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)

FMP-PTV

SAFETY REQUIREMENTS

In general an area of 10 mm around the focus unit should be free from all conductive parts with sharp edges. Penetration with earthed parts in these areas should be avoided. Full details of these areas are contained in the factory specification related to each catalogue type. The potentiometer parts carrying high voltage should be free from metal particles, solder drops, etc.

RELIABILITY

Maximum cumulative percentage of failures F (n) after n hours (excluding 0 hours rejects).

Percentage rate of failures.

FAILURES	PERCENTAGE
F (300)	≤0.03%
F (10000)	≤0.25%
F (30000)	≤5.0%

LIST OF MATERIALS

NAME OF PART	MATERIAL	TYPE	MANUFACTURER	FLAME CLASS	UL FILE
Case	polycarbonate	Lexan 500 R	General Electric	UL-94-VO	E45329
Shaft	modified PPO	Noryl VO-150-B	General Electric	UL-94-VO	E45329
Connecting plug	modified PPO	PX 1751	General Electric	UL-94-VO	E45329
Rubber spring	silicone rubber	K 1238	Philips	UL-94-HB	E45111
Contact plug	silicone rubber	K1764	Philips	UL-94-VO	E45111
Glue	silicone rubber	744 RTV	Dow Corning	LOI 31%	–
Potting resin	epoxy resin	CW2122/XB5701-1	Ciba-Geigy	UL-94-VO	E96722
Vacuum grease	silicone grease	TKHV-1	Klüber	–	–
Capacitor	ceramic	DHR	Murata	UL-94-VO	–
	film foil	MKT1816-225	ERO	–	–
Resistor	metal film	EK4	Resista	–	–
Earth (c) and Dynamic focus (Dn)					
Wiring Alternative 1	PVC	1032 AWG20 number 41106	Pope	UL-1032 VW-1	E41105-Y
Wiring Alternative 2	PVC	TEW; 105 °C; FTI	Sumitomo-Y	UL-VW-1	E41105-Y

ORDERING

Minimum ordering quantity: 16 pieces.

Order by quoting the 12-digit catalogue number of the potentiometer units and the quantity required.

Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)

FMP-PTV

PRODUCT MARKING 2322 460 90313

The unit is marked with the date code (year, week and day of manufacture), the operator code, the last five digits of the catalogue number and VDE-Reg.-Nr.2599.

Example of product marking.

MARKING YWWDXX90313 VDE-Reg.-Nr.2599	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

PRODUCT MARKING 2322 460 905..

The unit is marked with the date code (year, week and day of manufacture), the operator code, and the last five digits of the catalogue number.

Example of product marking.

MARKING YWWDXX905..	DESCRIPTION
Y	year mark e.g. 1993 = 3
WW	week mark e.g. 52
D	day mark e.g. Wednesday = 3
XX	operator code

Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)





FMP-PTV

PACKAGING

Packed as 16 units in expanded polystyrene packaging shells.

LABELLING

The label on the package containing the potentiometers is as shown.

		LINE MARKING EXPLANATION
1.	MADE IN BELGIUM	1. Country of origin
2.	POTENTIOMETERS 22.7M	2. Product family and resistance values
3.	FMP FOCUS METAL GLAZE PRESET	3. Product description
4.	FMP-PTV	4. Customer information
5.	 ORIG A170 RPC HQ	5. Preference origin code and product centre
6.	 QTY 16 DATE 9408	6. Quantity per standard packing and product code
7.	 TYPE FMP	7. Product description
8.	 CODENO 2322 460 90313	8. Catalogue number (12NC)

MRC300

Fig.10 Packaging label (example).

Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)

FMP-PTV

TESTS AND REQUIREMENTS

In these tables the tests can either be:

D = Destructive

ND = Non-destructive.

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group B1-b	ND		
Focus spark gap firing simulation in accordance with PRV-53-8-52/42: R1 = 400 Ω ; R2 = 5 M Ω ; C1 = 2 nF; P1 = P2 = 600 hPa; V1 = V _{ac} ; V2 = 30 kV; both with shafts FCW; n = 50		visual examination element resistance $\Delta R_{ac}/R_{ac}$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no visible damage $\leq 3\%$ ≤ 25 V ≤ 5 V
Corona in accordance with PRV-53-8-52/43: 1.3 \times V _{ac} ; 60 s; standard atmosphere		corona detection	no corona
Breakdown voltage under pressure in accordance with IEC 68-2-13 test M: V _{ac} ; 30 minutes; 600 hPa; 55 $^{\circ}$ C		flashover detection breakdown detection	no flashover no breakdown
Sub-group C1	ND		
Mechanical travel		focus screen	200 $^{\circ}$ \pm 5 $^{\circ}$ 230 $^{\circ}$ \pm 5 $^{\circ}$
Starting torque		focus screen	3 to 30 mNm; ratio ≤ 3 3 to 30 mNm; ratio ≤ 3
Sub-group C2	ND		
Output ratio range		V _{b1c min} /V _{ac} ; V _{b1c max} /V _{ac} ; V _{b2c min} /V _{ac} ; V _{b2c max} /V _{ac}	see Table 6
Continuity in accordance with PRV-53-8-52/44			smooth, unidirectional
Settability		focus ± 25 V screen ± 5 V	≤ 10 s ≤ 10 s
Sub-group C3	D		
Electrical endurance at 70 $^{\circ}$ C: Temperature: 70 $^{\circ}$ C \pm 3 $^{\circ}$ C Duration: 1000 hours Cyclic load (1.5 hours on and 0.5 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} starting torque	no visual damage $\leq 3\%$ ≤ 25 V ≤ 5 V not specified

**Focus Metal-glaze Preset (FMP),
triple Projection TV type (PTV)**

FMP-PTV

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group D1	D		
Damp heat, cyclic in accordance with IEC 68-2-30, Test Db: Upper temperature: 40 °C Number of cycles: 21 (1 cycle = 1 hour on and 23 hours off) Shafts: mid position		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	no visible damage not specified ≤ 25 V ≤ 5 V
Sub-group D2	D		
Mechanical endurance at room temperature: Number of cycles of operation: 50 Rate: 4 \pm 1 cycles per minute		visual examination element resistance $\Delta R/R$ starting torque continuity change of output ratios	no visible damage $\leq 3\%$ not specified smooth, unidirectional 0.965 to 1.035 \times initial requirements
Sub-group D3	ND		
End - stop torque: Adjustment tool: 150 mNm Manual: 300 mNm Duration: 10 s		visual examination	no visible damage, no deformation
Axial thrust on the shaft: Thrust: 50 N		continuity output voltage drift ΔV_{b1} output voltage drift ΔV_{b2}	smooth, unidirectional not specified not specified
Radial thrust on the shaft: Thrust: 50 mNm (not applicable for $L_s \leq 27$ mm)		visual examination	no visible damage
Sub-group D4-b	D		
Change of temperature in accordance with IEC 68-2-14, Test Na: TA = -25 °C TB = +100 °C Number of cycles: 5 Exposure duration: 30 minutes Shafts: FCCW		visual examination element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visual damage $\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-c	D		
Vibration in accordance with IEC 68-2-6, Test Fc, Procedure B4: Frequency range: 10 to 55 Hz Amplitude: 0.75 mm or 98 m/s ² Sweep endurance: total duration 6 hours Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm

Focus Metal-glaze Preset (FMP), triple Projection TV type (PTV)

FMP-PTV

TEST / CONDITIONS OF TEST	D OR ND	PROCEDURE	PERFORMANCE
Sub-group D4-d	D		
Shock in accordance with IEC 68-2-27, Test Ea: Pulse duration: 11 ms Acceleration: 490 m/s ² Number of shocks: 3 in each of 6 directions Shafts: mid position		visual examination output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	no visible damage ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-e	D		
Dry heat in accordance with IEC 68-2-2, Test Bb: Temperature: +100 °C Duration: 96 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D4-f	D		
Cold in accordance with IEC 68-2-1, Test Ab: Temperature: -25 °C Duration: 86 hours Shafts: FCCW		element resistance $\Delta R/R$ output voltage drift ΔV_{b1} output voltage drift ΔV_{b2} operating torque	$\leq 1\%$ ≤ 25 V ≤ 5 V 3 to 30 mNm
Sub-group D5	ND		
Temperature characteristic of resistance: +20 °C to +100 °C		TCR	$\leq 100 \times 10^{-6}/K$
Voltage coefficient of resistance in accordance with HQV-14/001		VCR	$\leq 2 \times 10^{-6}/V$
Dimensions (detail)			in accordance with specification
Sub-group ADD1	ND		
Safety test in accordance with PRV-53-8-52/45: $1.3 \times V_{ac}$ during 3 s Test cover: 8204 115 09160		flashover detection breakdown detection	no flashover no breakdown
Sub-group ADD2	D		
Wire forces		push-in force pull-out force	≤ 25 N ≥ 50 N
Sub-group ADD3	ND		
Shaft impact test in accordance with PRV-53-8-52/48 (not applicable for $L_s \leq 27$ mm)			no interruptions, no instability

High voltage - high value - thick film resistors

HVR

FEATURES

- High temperature and voltage stability
- Suitable for potentiometer and/or potting applications
- Wide design freedom.

APPLICATIONS

- Bleeder resistors
- Voltage dividers
- Focus/screen potentiometer substrates.

DESCRIPTION

Resistor tracks (metal glaze) are screen-printed on to a 96% alumina substrate. The contact patterns (metal glaze) are solderable in case of soldering applications, or non-solderable for connector or conductive rubber applications.

Polymer or glaze resistor-protection layers are available for encapsulation or potting with epoxy or other materials.

The resistor surface is suitable for trimmer-potentiometer applications.

Voltage dividers can be precision trimmed.

MARKING

The resistors are not individually marked. For some series the

QUICK REFERENCE DATA

PARAMETER	VALUE
Rated resistance range (see specification per type)	10 - 1500 M Ω
Tolerance on rated resistance (see specification per type)	$\pm 20\%$; $\pm 10\%$; $\pm 5\%$
Maximum application temperature (temperature on substrate surface)	125 °C
Maximum dissipation (dependent on encapsulation)	0.4 W/cm ²
Maximum voltage rating (per mm length of the resistor track)	400 V/mm
Temperature coefficient (-40 to +20 °C) Dependent on encapsulation (+20 to +100 °C)	$\pm 150 \times 10^{-6}$ °C
Voltage coefficient (dependent on resistor track and voltage gradient)	2×10^{-6} V
Long-term stability (2000 hours maximum loading at 70 °C)	DR $\leq 2\%$
Climatic category	40/125/21

resistor protection layer is colour coded in relation to the resistor value.

PACKAGING

The resistor substrates are stacked and packed in blisters. The blister package is marked with code number, production date and quantity. See specification per type for packing quantities.

ORDERING INFORMATION

The resistor substrates are ordered by quoting the relevant code number

(see specification per type).
Minimum ordering quantity = packing quantity.

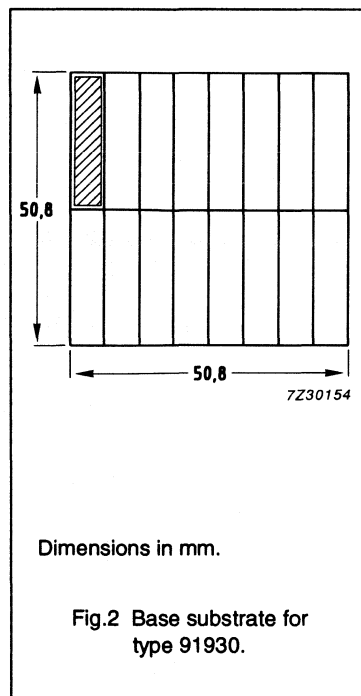
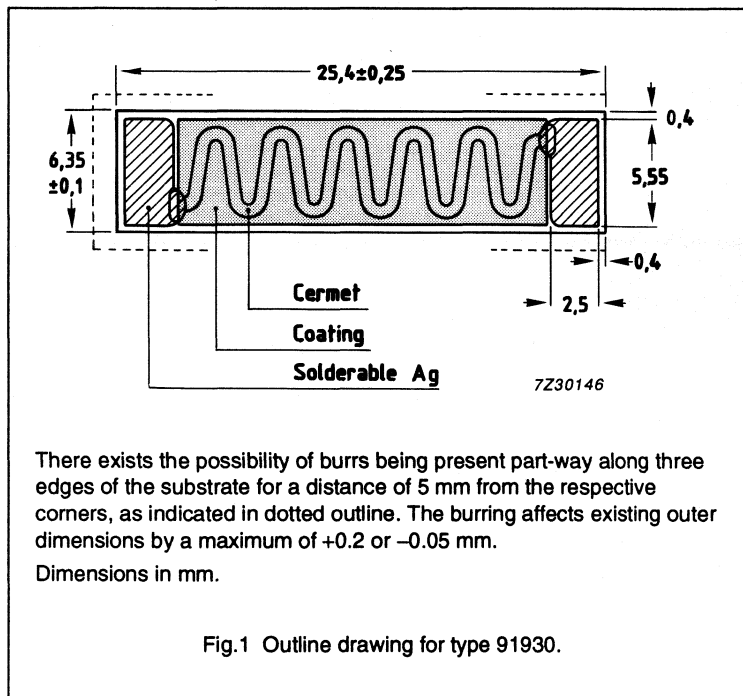
RELATED DOCUMENTS

- IEC 68 basic environmental testing procedures for electronic components and electronic testing.
- IEC 410 sampling procedures and tables for inspection by attributes for electronic components and assessed quality.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 35 x 0.635
Dissipation	encapsulated, at 70 °C	W	-	-	0.6
Operating voltage	encapsulated	kV	-	11	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91930	blue polymer	40 MΩ	±10%	5 kV

PACKAGING

Details to be defined.

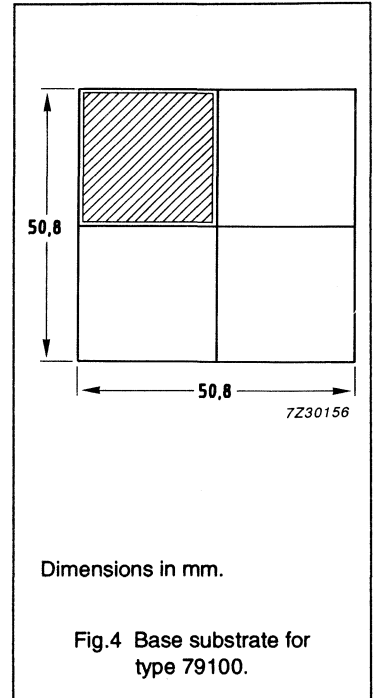
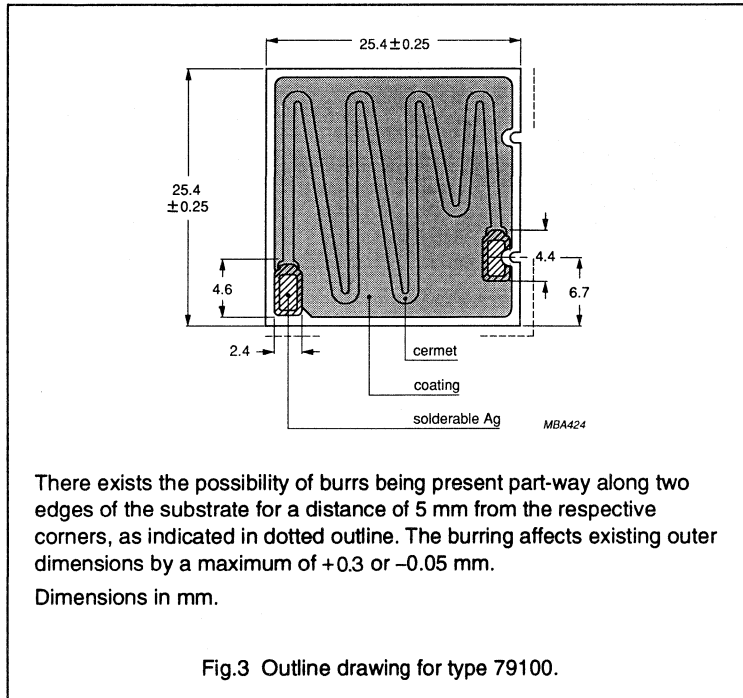
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 25.4 x 1
Dissipation	encapsulated, at 70 °C	W	-	-	2.5
Operating voltage	encapsulated	kV	-	25	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 79100	blue polymer	400 MΩ	±20%	20 kV

PACKAGING

Details to be defined.

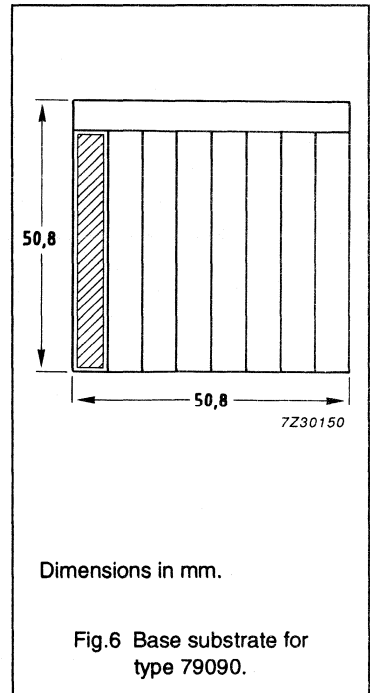
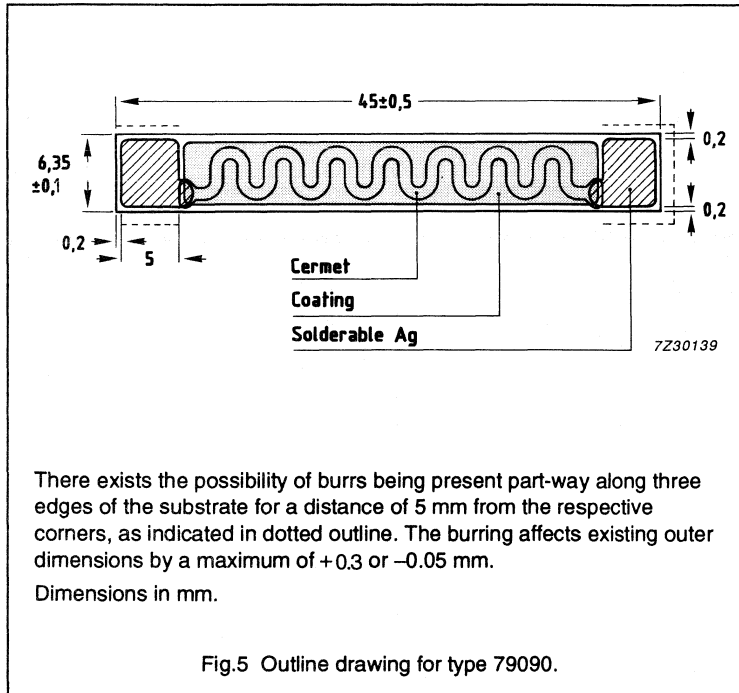
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	45 x 6.35 x 1
Dissipation	encapsulated, at 70 °C	W	-	-	1.1
Operating voltage	encapsulated	kV	-	30	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 79090	blue polymer	700 MΩ	+10%	27.5 kV

PACKAGING

Details to be defined.

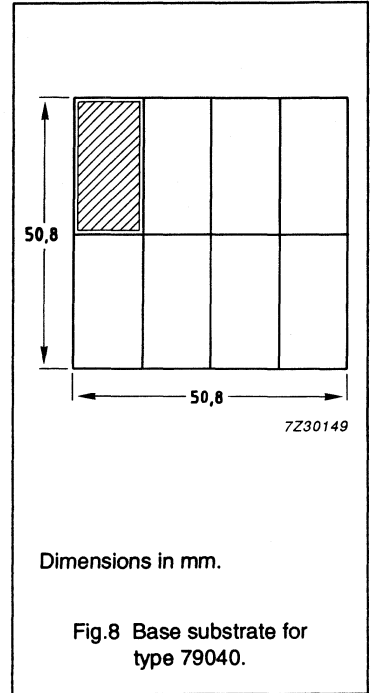
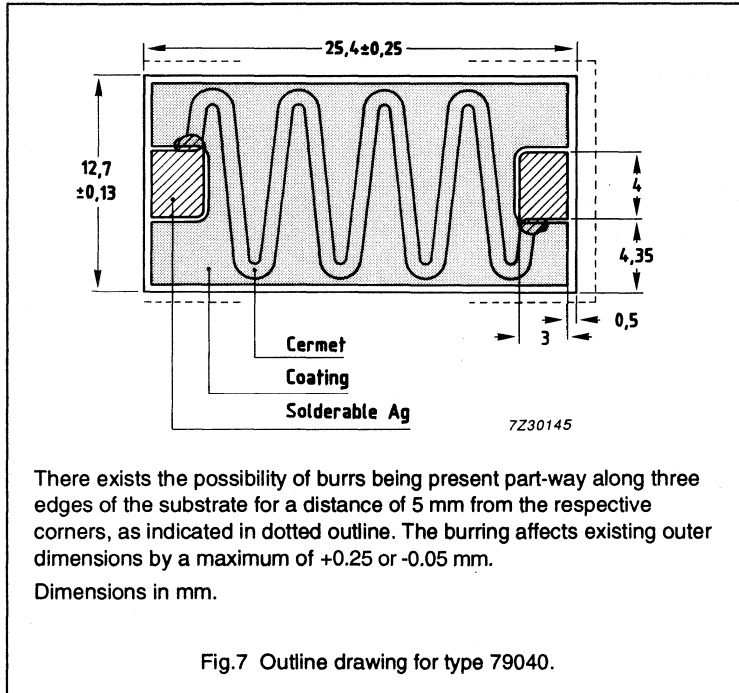
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 12.7 x 0.76
Dissipation	encapsulated, at 70 °C	W	-	-	1.3
Operating voltage	encapsulated	kV	-	22	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 79040	blue polymer	500 MΩ	±20%	22 kV

PACKAGING

Details to be defined.

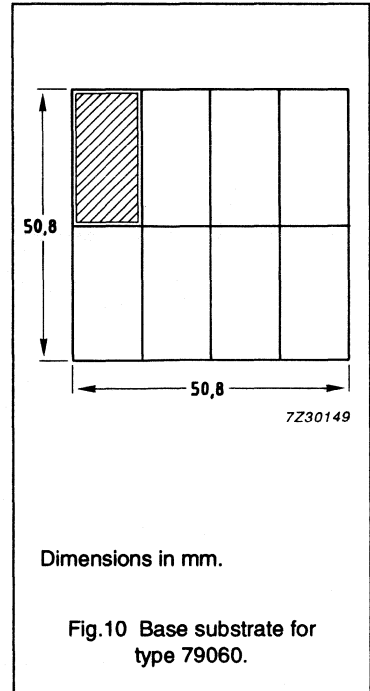
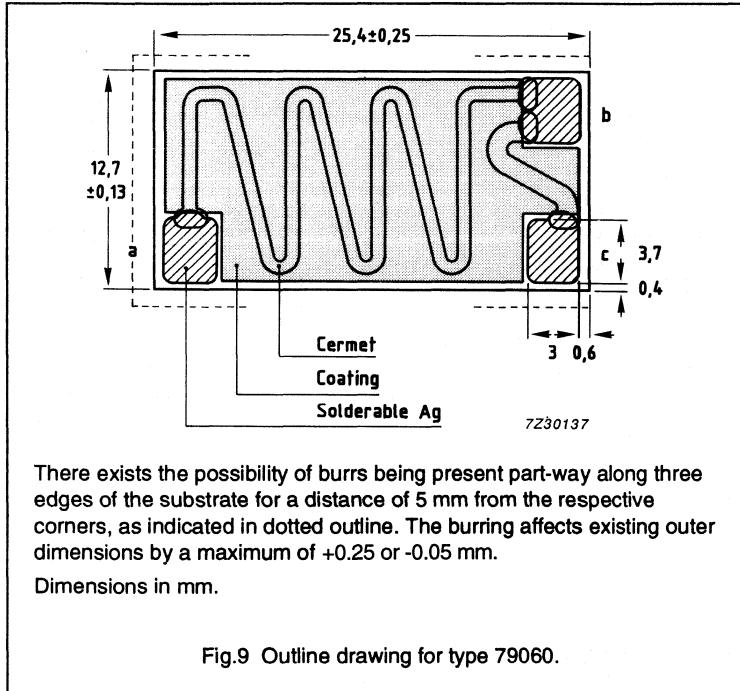
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL	
					Rab	Rbc
Dimensions		mm	-	-	25.4 x 12.7 x 0.76	
Dissipation	encapsulated, at 70 °C	W	-	-	1.3	
Operating voltage	encapsulated	kV	-	-	Vab 26 kV	Vbc 2.8 kV

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE		RESISTOR TOLERANCE		APPLICATION VOLTAGE	
		Rab	Rbc	Rab	Rbc	Rab	Rbc
4322 053 79060	blue polymer	400 MΩ	25 MΩ	±20%	±10%	20 kV	2.8 kV

PACKAGING

Details to be defined.

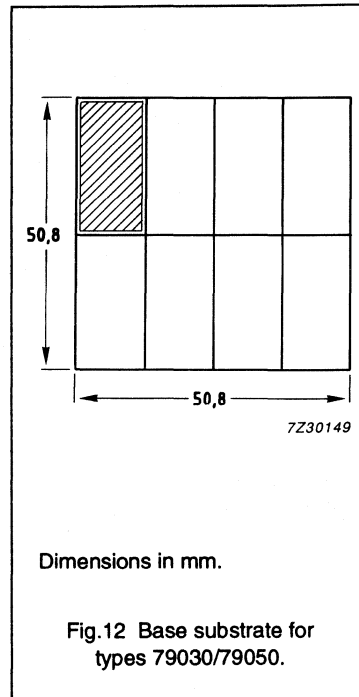
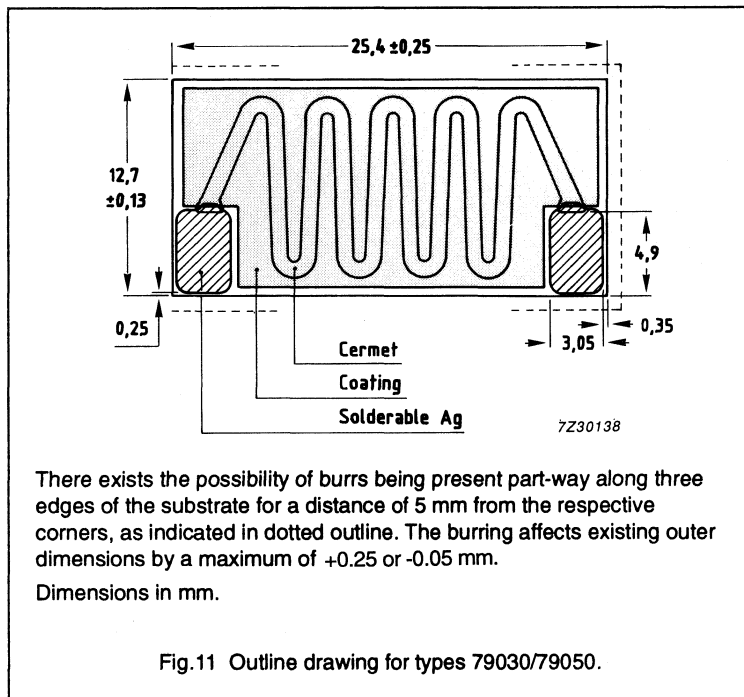
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 12.7 x 0.76
Dissipation	encapsulated, at 70 °C	W	-	-	1.3
Operating voltage	encapsulated	kV	-	17	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 79030	blue polymer	400 MΩ	±20%	17 kV
4322 053 79050	blue polymer	130 MΩ	±10%	12.5 kV

PACKAGING

Details to be defined.

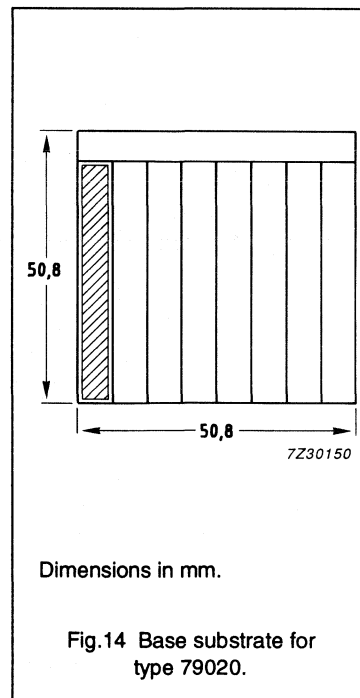
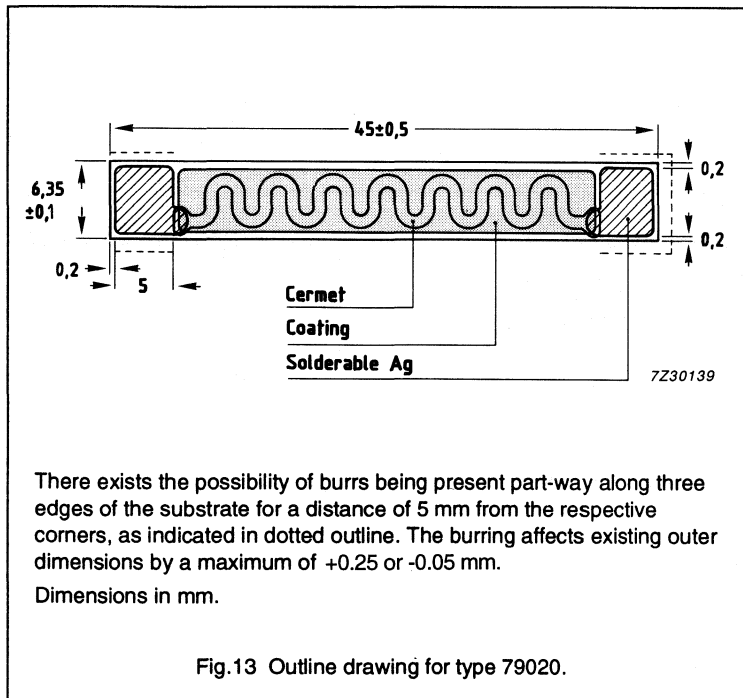
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	45 x 6.35 x 0.76
Dissipation	encapsulated, at 70 °C	W	-	-	1.1
Operating voltage	encapsulated	kV	-	20	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 79020	blue polymer	330 MΩ	±20%	17 kV
4322 053 79200	blue polymer	400 MΩ	±20%	19 kV

PACKAGING

Data to be defined.

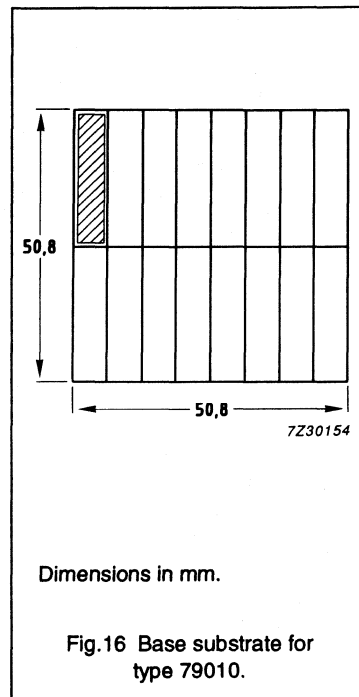
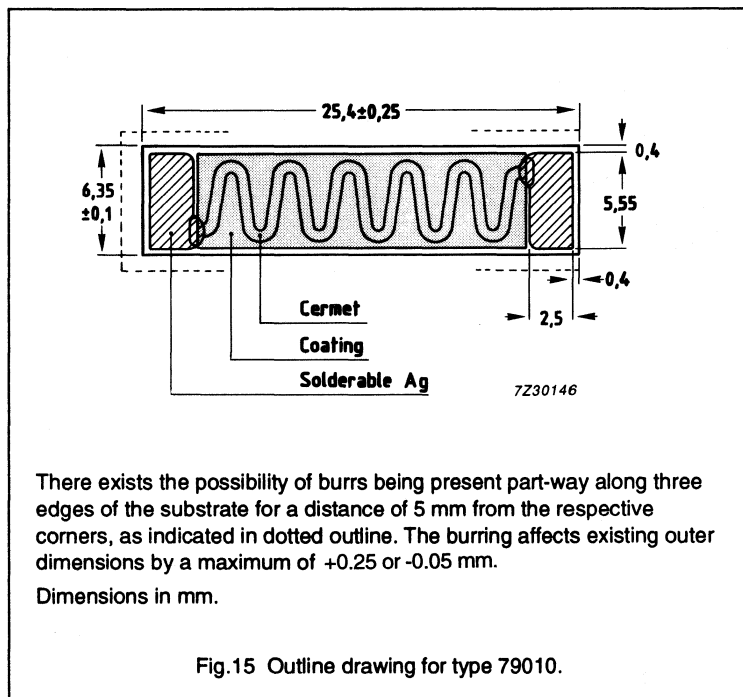
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 6.35 x 0.76
Dissipation	encapsulated, at 70 °C	W	-	-	0.6
Operating voltage	encapsulated	kV	-	18	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 79010	blue polymer	500 MΩ	±20%	16 kV

PACKAGING

Details to be defined.

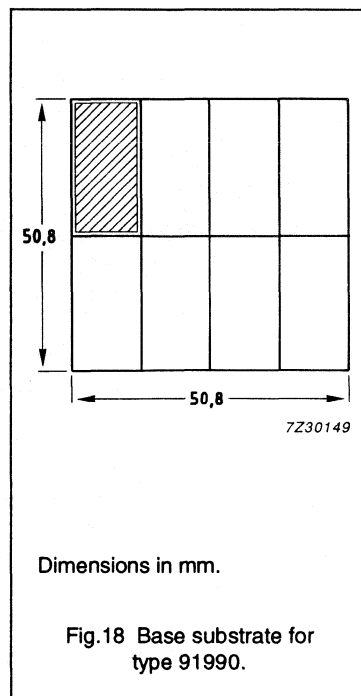
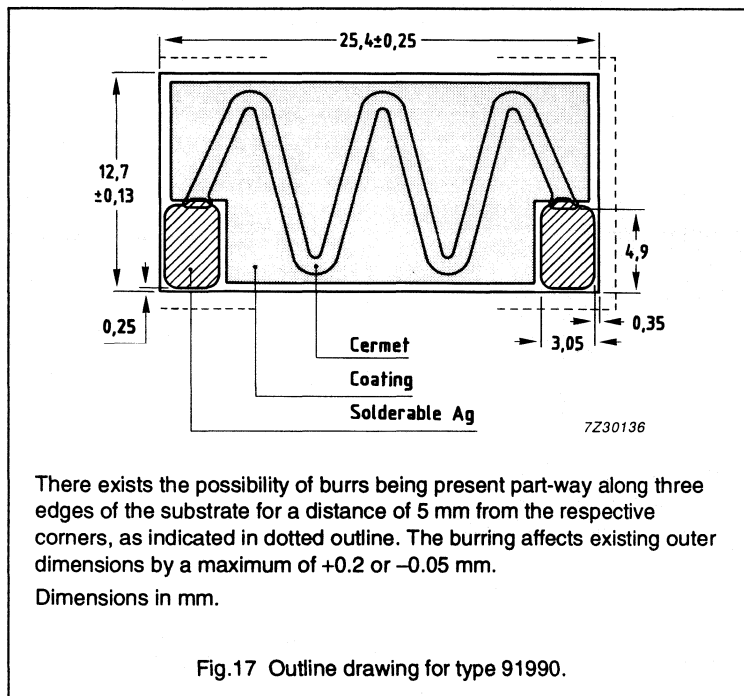
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 12.7 x 0.635
Dissipation	encapsulated, at 70 °C	W	-	-	1.3
Operating voltage	encapsulated	kV	-	21	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91990	blue polymer	400 MΩ	±20%	20 kV
4322 053 79260	blue polymer	400 MΩ	±5%	20 kV
4322 053 79340	blue polymer	600 MΩ	±20%	20 kV

PACKAGING

Details to be defined.

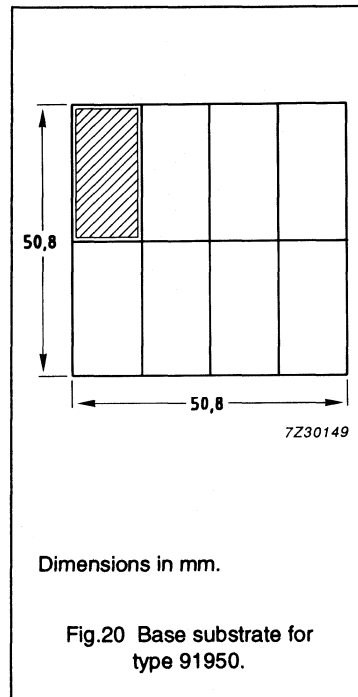
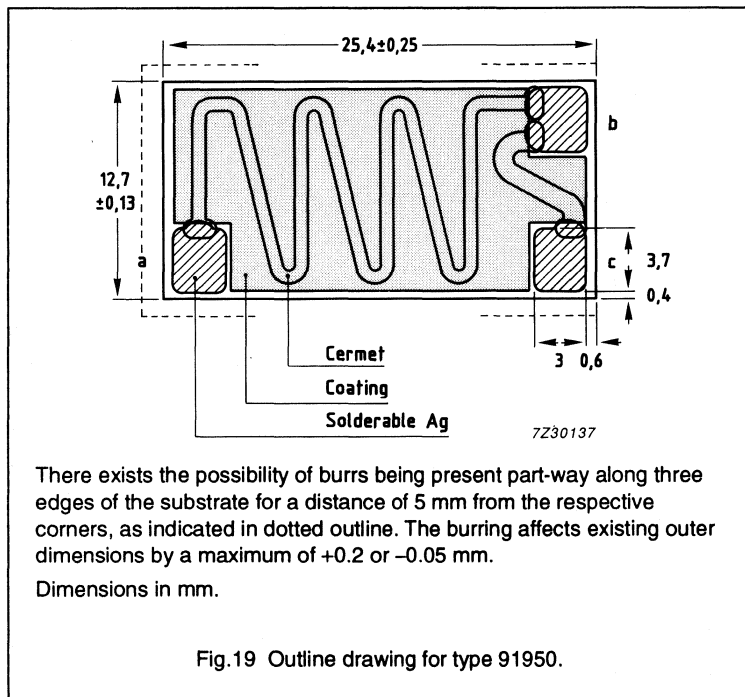
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL	
					Rab	Rbc
Dimensions		mm	-	-	25.4 x 12.7 x 0.635	
Dissipation	encapsulated, at 70 °C	W	-	-	1.3	
Operating voltage	encapsulated	kV	-	-	Vab 26 kV	Vbc 2.8 kV

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE		RESISTOR TOLERANCE		APPLICATION VOLTAGE	
		Rab	Rbc	Rab	Rbc	Rab	Rbc
4322 053 91950	blue polymer	400 MΩ	25 MΩ	±20%	±10%	20 kV	2.8 kV

PACKAGING

Details to be defined.

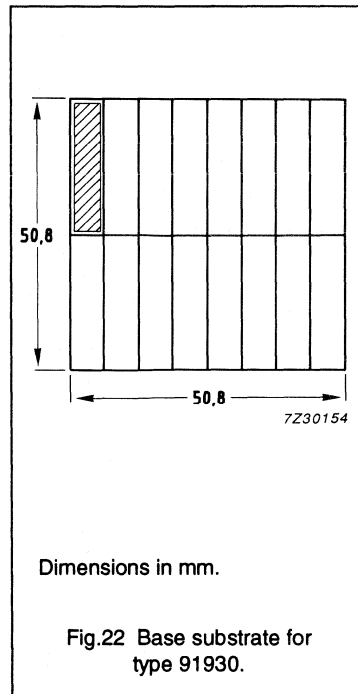
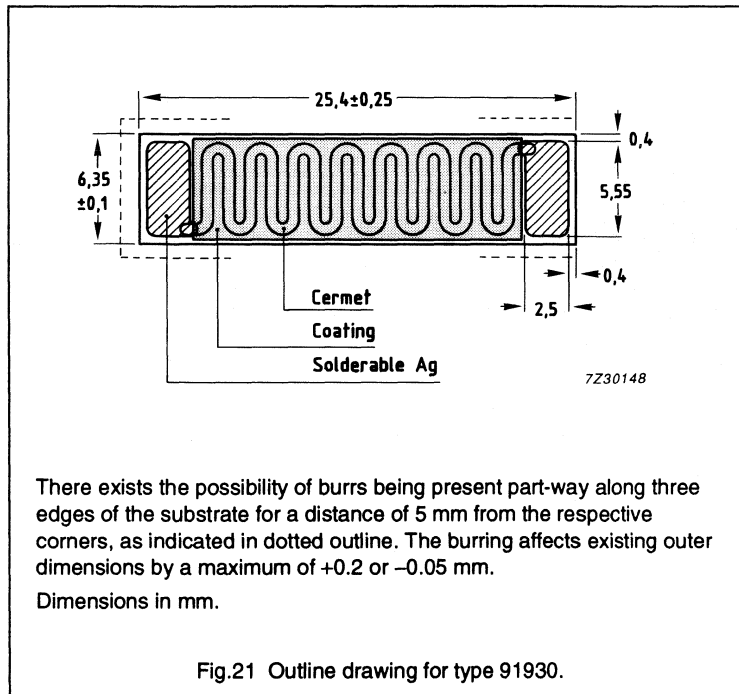
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 6.35 x 0.635
Dissipation	encapsulated, at 70 °C	W	-	-	0.6
Operating voltage	encapsulated	kV	-	11	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91930	blue polymer	40 MΩ	±10%	5 kV

PACKAGING

Details to be defined.

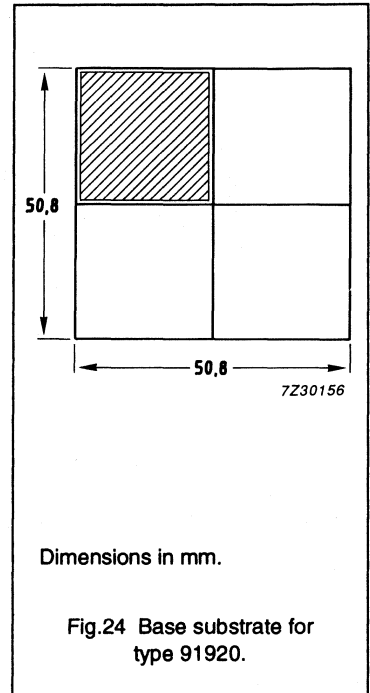
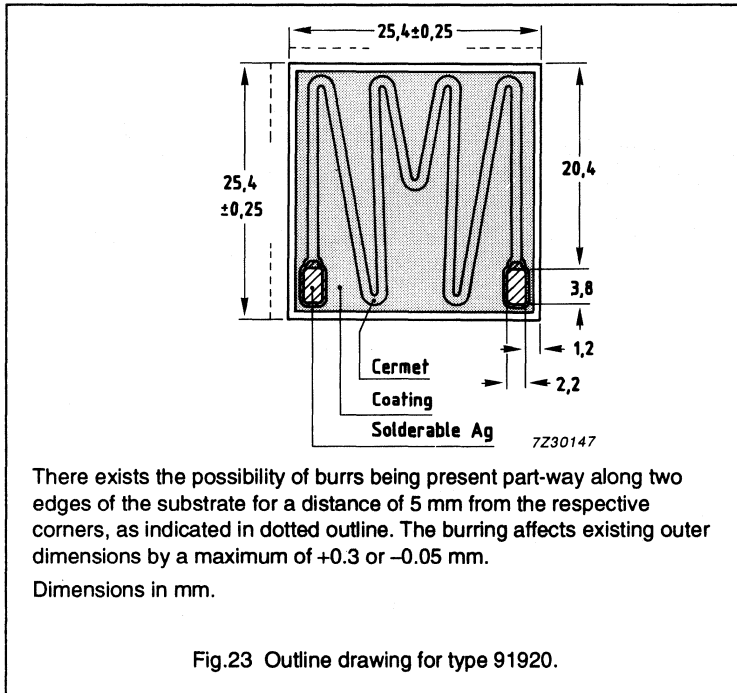
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 25.4 x 1
Dissipation	encapsulated, at 70 °C	W	-	-	2.5
Operating voltage	encapsulated	kV	-	25	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91920	blue polymer	240 MΩ	±10%	23 kV

PACKAGING

Details to be defined.

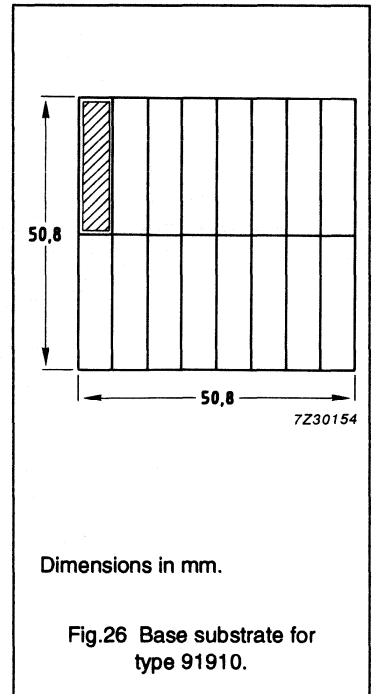
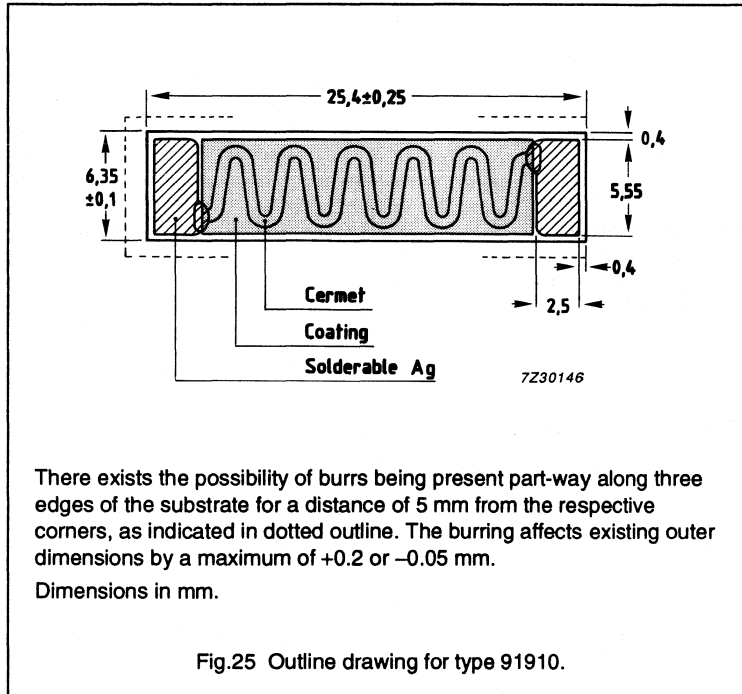
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 6.36 x 0.635
Dissipation	encapsulated, at 70 °C	W	-	-	0.6
Operating voltage	encapsulated	kV	-	18	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91910	blue polymer	500 MΩ	±20%	16 kV

PACKAGING

Details to be defined.

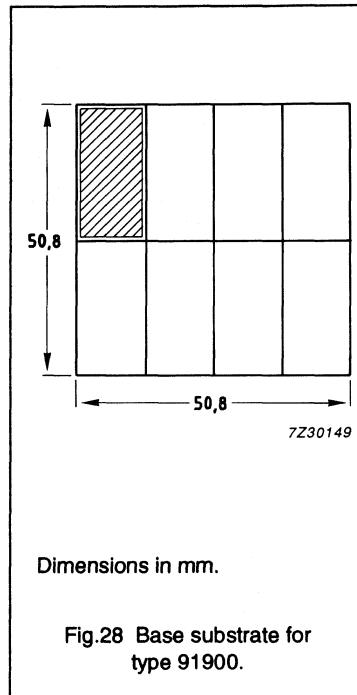
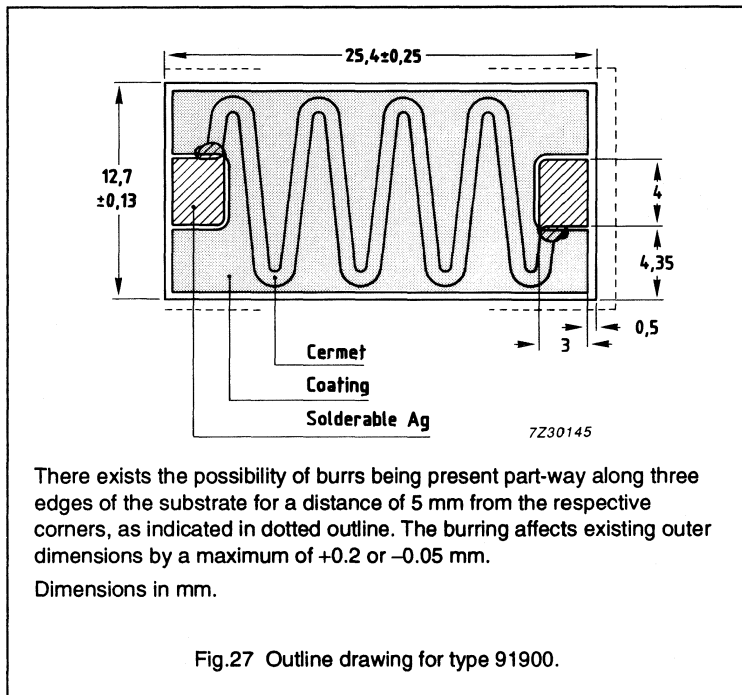
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 12.7 x 0.635
Dissipation	encapsulated, at 70 °C	W	-	-	1.3
Operating voltage	encapsulated	kV	-	22	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91900	blue polymer	500 MΩ	±20%	22 kV

PACKAGING

Details to be defined.

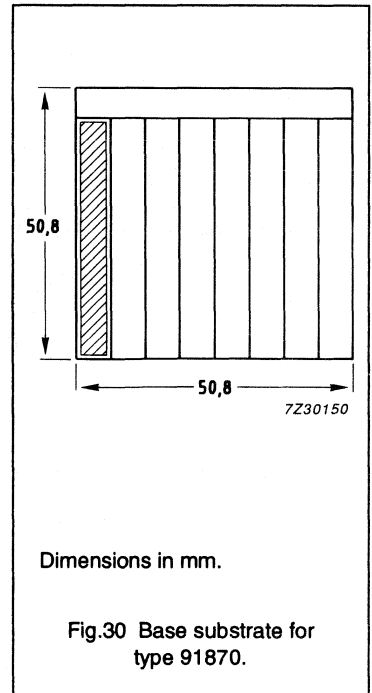
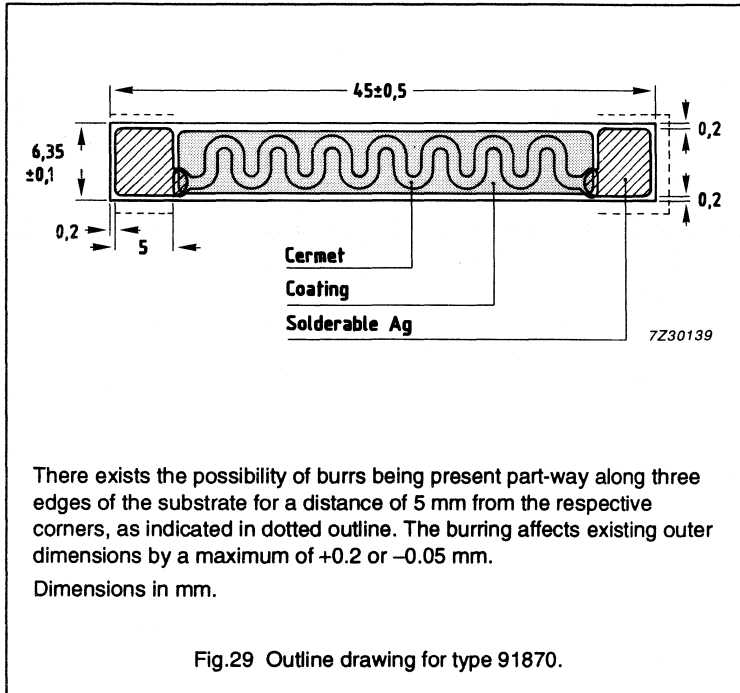
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	45 x 6.35 x 0.635
Dissipation	encapsulated, at 70 °C	W	-	-	1.1
Operating voltage	encapsulated	kV	-	20	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91870	blue polymer	330 MΩ	±20%	17 kV

PACKAGING

Details to be defined.

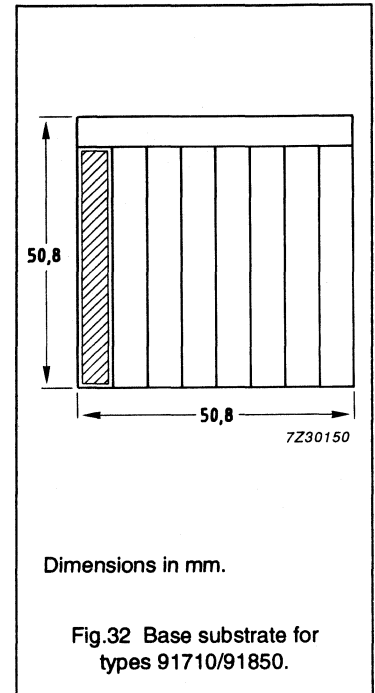
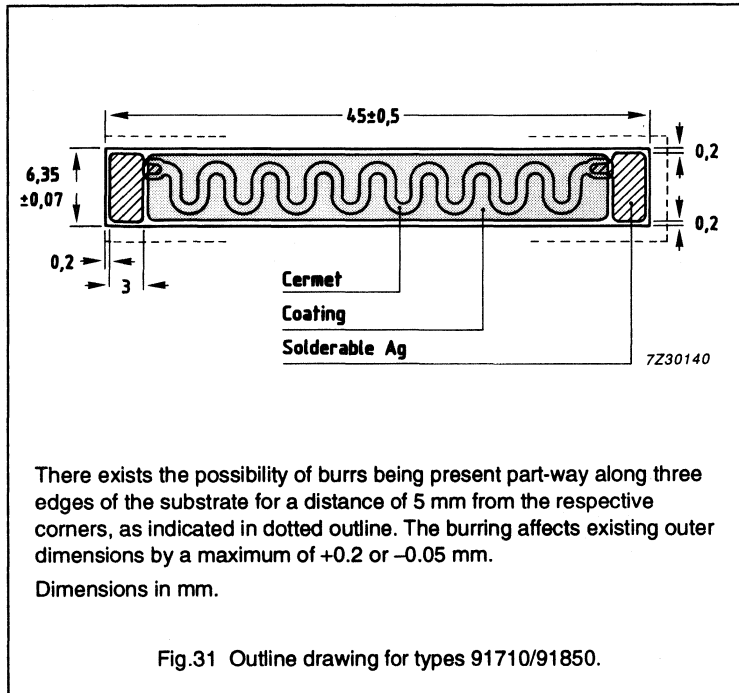
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	45 x 6.35 x 0.635
Dissipation	encapsulated, at 70 °C	W	-	-	1.1
Operating voltage	encapsulated	kV	-	24	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91710	blue polymer	330 MΩ	±10%	18 kV
4322 053 91850	blue polymer	330 MΩ	±20%	17 kV

PACKAGING

Details to be defined.

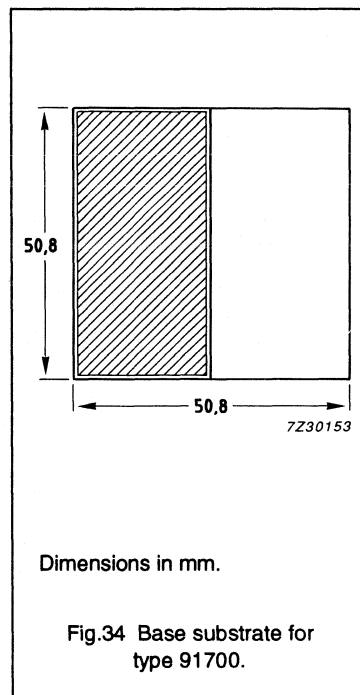
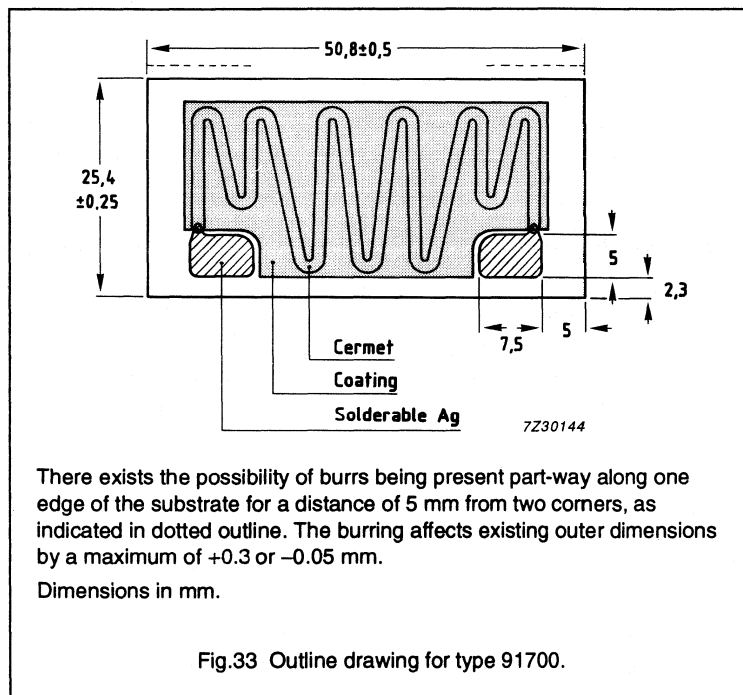
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	50.8 x 25.4 x 1
Dissipation	encapsulated, at 70 °C	W	-	-	5.1
Operating voltage	encapsulated	kV	-	30	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91700	blue polymer	140 MΩ	±10%	25 kV

PACKAGING

Details to be defined.

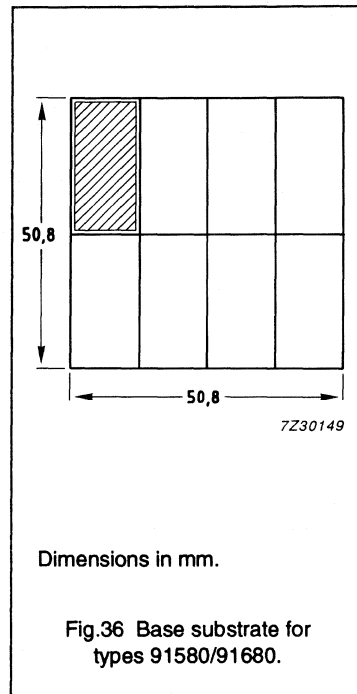
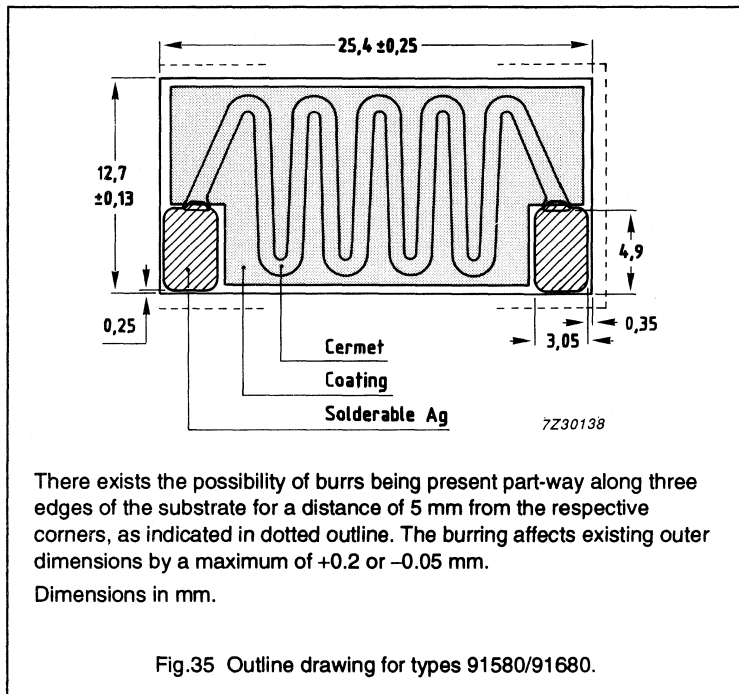
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 12.7 x 0.635
Dissipation	encapsulated, at 70 °C	W	-	-	1.3
Operating voltage	encapsulated	kV	-	17	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91580	blue polymer	330 MΩ	±20%	17 kV
4322 053 91680	blue polymer	130 MΩ	±10%	12 kV

PACKAGING

Details to be defined.

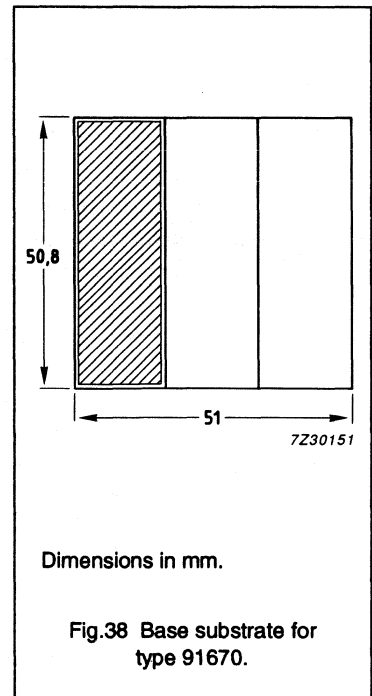
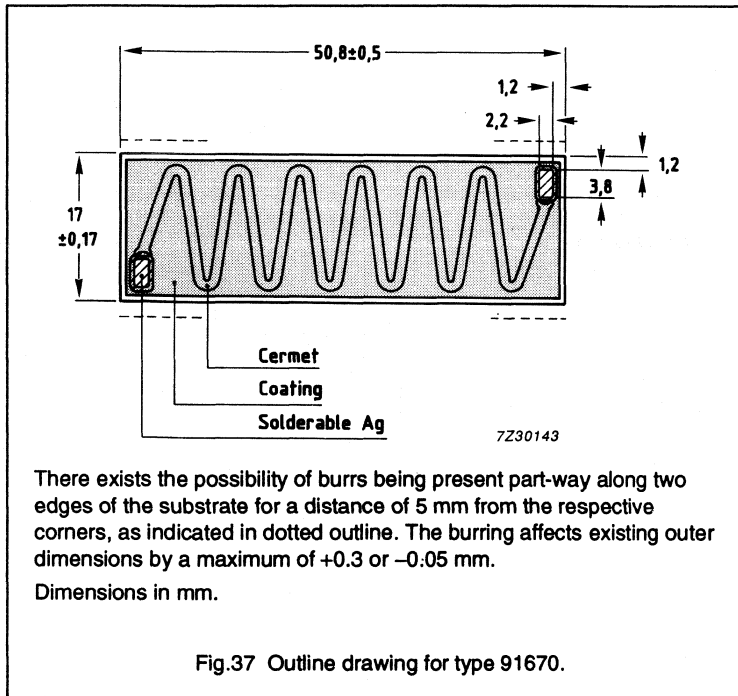
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	50.8 x 17 x 1
Dissipation	encapsulated, at 70 °C	W	-	-	3.4
Operating voltage	encapsulated	kV	-	35	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91670	blue polymer	1.5 GΩ	±30%	35 kV

PACKAGING

Details to be defined.

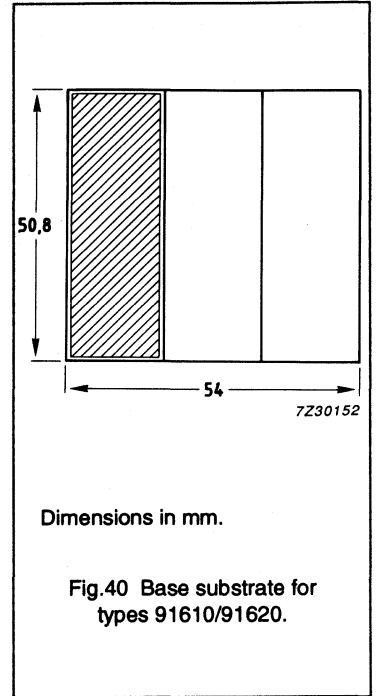
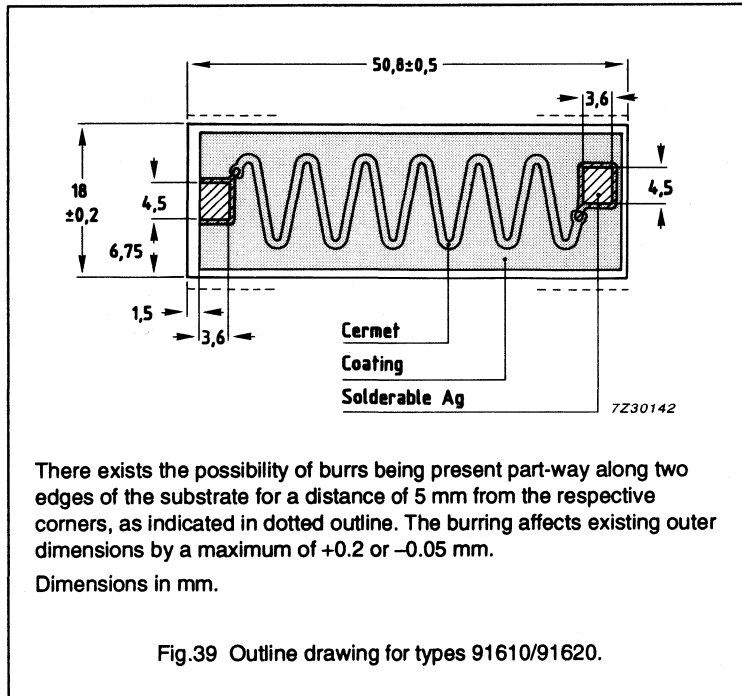
ORDERING INFORMATION

The minimum ordering quantity = the packing quantity.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	50.8 x 18 x 0.635
Dissipation	encapsulated,, at 70 °C	W	-	-	3.6
Operating voltage	encapsulated	kV	-	35	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91610	blue polymer	140 MΩ	±10%	20 kV
4322 053 91620	blue polymer	550 MΩ	±10%	35 kV

PACKAGING

To be supplied.

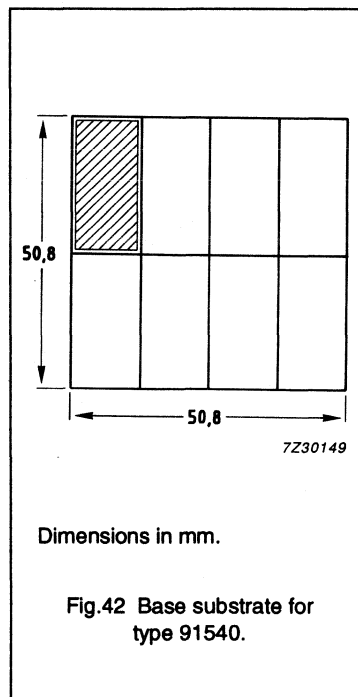
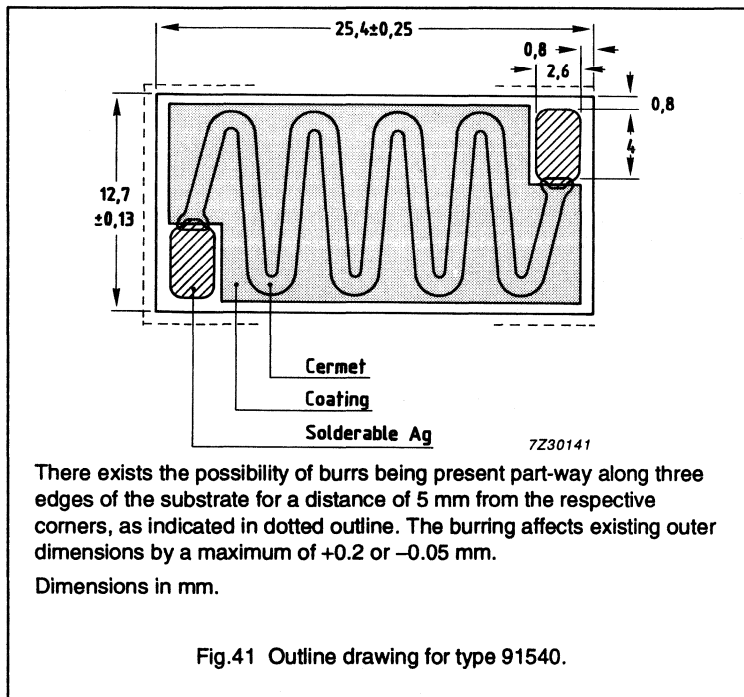
ORDERING INFORMATION

To be supplied.

High voltage - high value - thick film resistors

HVR

OUTLINE DRAWINGS



TECHNICAL DATA

PARAMETER	CONDITIONS	UNIT	MIN.	MAX.	TYPICAL
Dimensions		mm	-	-	25.4 x 12.7 x 0.635
Dissipation	encapsulated, at 70 °C	W	-	-	1.3
Operating voltage	encapsulated	kV	-	22	-

STANDARD AVAILABLE

CODE NUMBER	COATING	RESISTOR VALUE	RESISTOR TOLERANCE	APPLICATION VOLTAGE
4322 053 91540	blue polymer	300 MΩ	±10%	18 kV

PACKAGING

Details to be defined.

ORDERING INFORMATION

The minimum order quantity = the packing quantity.

PRESET POTENTIOMETERS

	Page
OCP10	199
ECP10	209
OMP10	219
EMP10	225

10mm OPEN CARBON PRESET

QUICK REFERENCE DATA

Resistance range (E3-series), linear law	47 Ω – 4,7 M Ω
Maximum dissipation at 40 °C	0,1 W
Climatic category, IEC 68	25/070/21

APPLICATION

These potentiometers are for preset resistance control with provision for re-adjustment. They are particularly suitable for use in radio and television receivers.

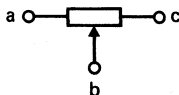
DESCRIPTION

These potentiometers have a resistance element of a special carbon composition with a low temperature coefficient. The element is riveted to a base plate of resin bonded paper.

The potentiometers are provided with printing-wiring pins; pins a and c (see drawings) are connected to the ends of the carbon track, pin b is connected to the wiper. The wiper, which is provided with a double contact, has a screwdriver slot or a plastic knob for adjustment.

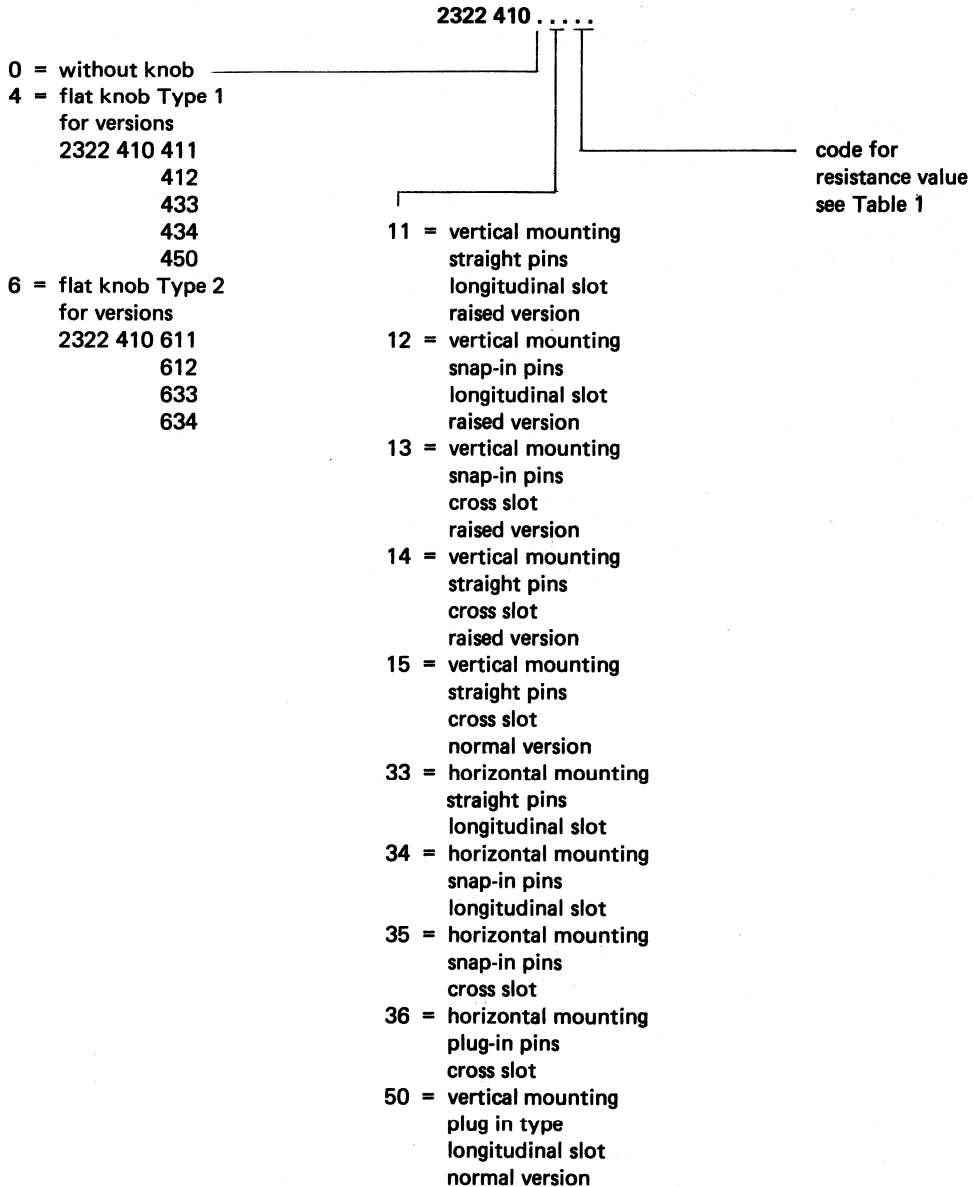
This potentiometer series includes types for vertical and for horizontal mounting on printed-wiring boards. The resistance law is linear and the tolerance on the nominal resistance is $\pm 20\%$, however log. versions and 10% tolerance versions are also available.

Note: The potentiometers are supplied with the wiper positioned at 50% of the angle of rotation.



7Z85818

COMPOSITION OF THE CATALOGUE NUMBER



Note: catalogue number of knob type 1 (Figs 4, 5, 9): 4322 047 00190;
catalogue number of knob type 2 (Figs 6, 10): 4322 047 27740.

MARKING

The potentiometers are marked with the nominal resistance value punched on the wiper.

Outlines

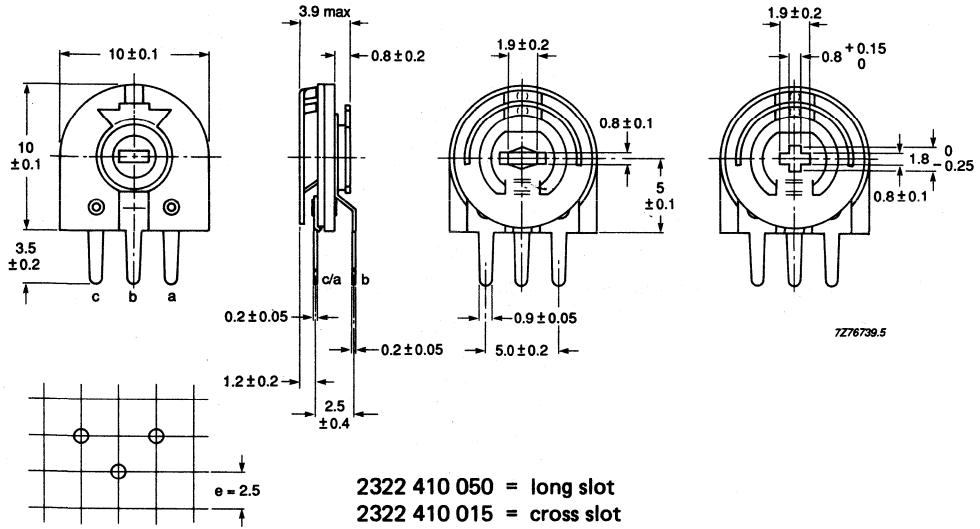


Fig.1 Potentiometers for vertical mounting; straight pins.

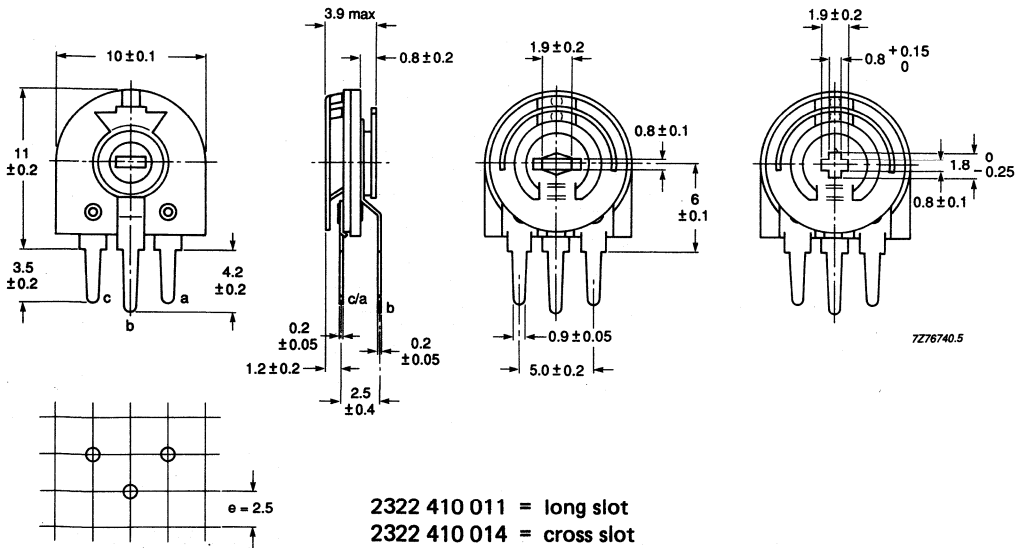


Fig.2 Potentiometers for vertical mounting: straight pins (raised version).

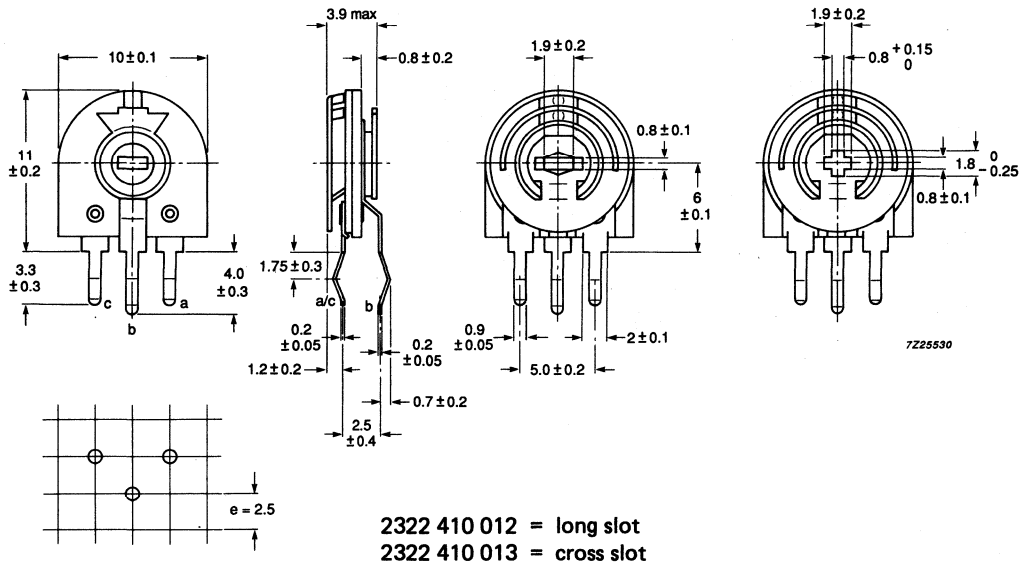


Fig.3 Potentiometers for vertical mounting: snap-in pins (raised version).

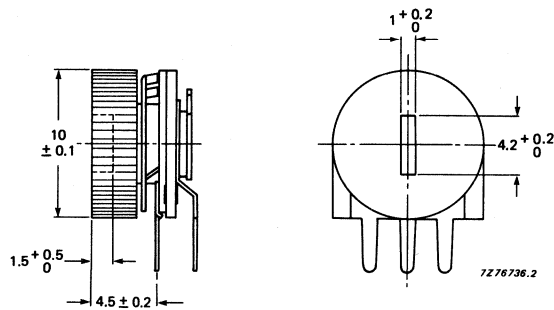
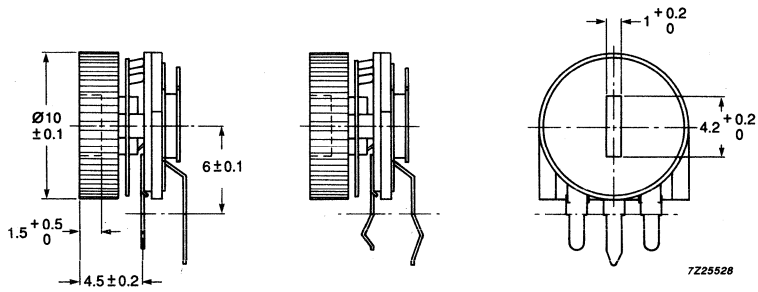
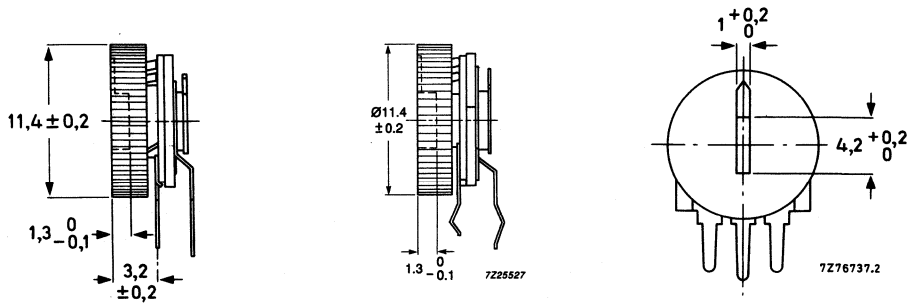


Fig.4 Potentiometers for vertical mounting, with knob type 1: straight pins, 2322 410 450.



2322 410 411 = straight pins
 2322 410 412 = snap-in pins

Fig.5 Potentiometers for vertical mounting, with knob type 1: (raised version).



2322 410 611 = straight pins
 2322 410 612 = snap-in pins

Fig.6 Potentiometers for vertical mounting, with knob type 2: (raised version).

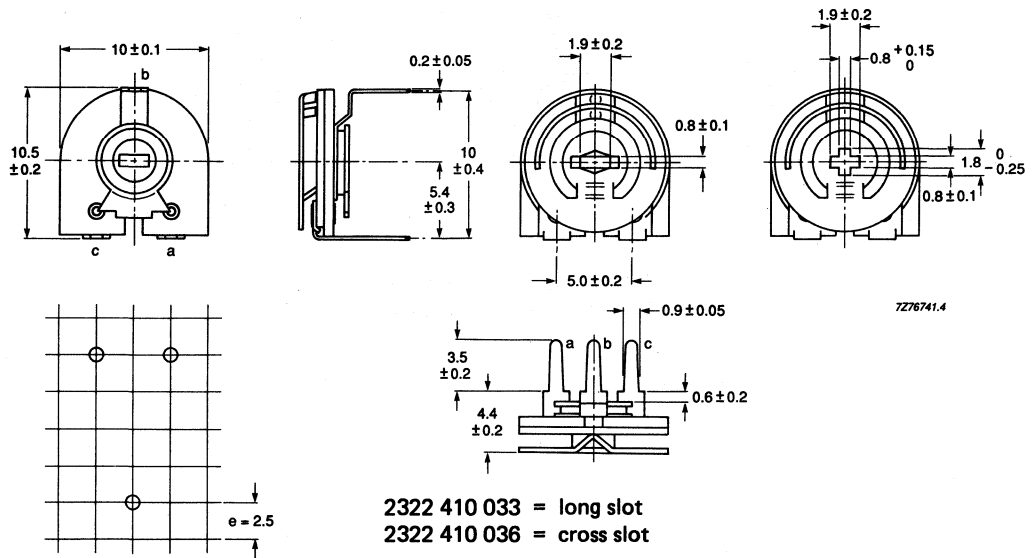


Fig.7 Potentiometers for horizontal mounting: straight pins.

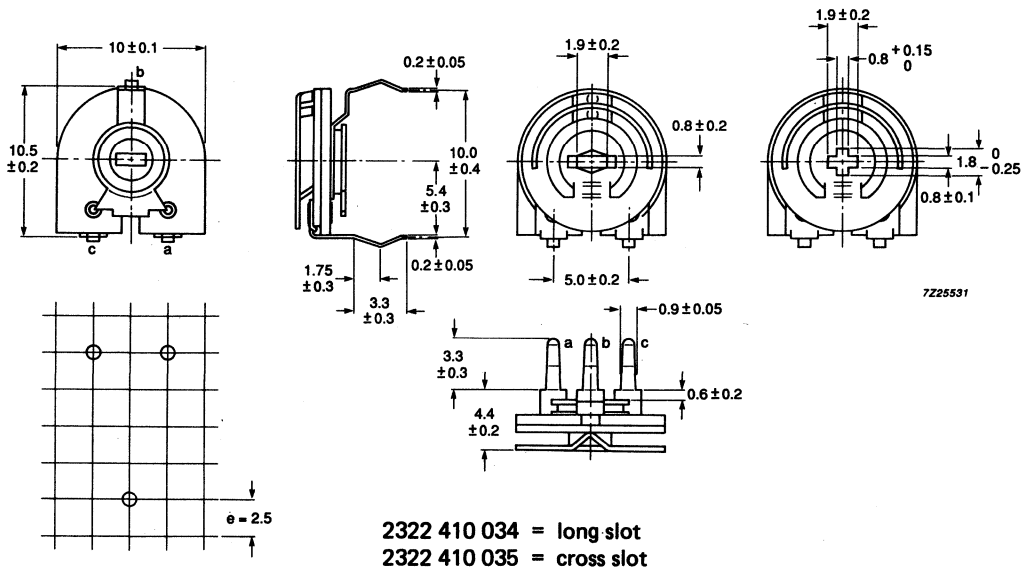
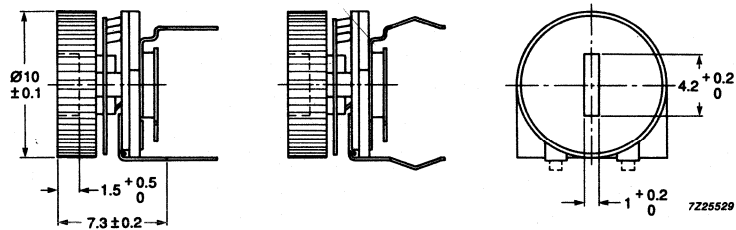
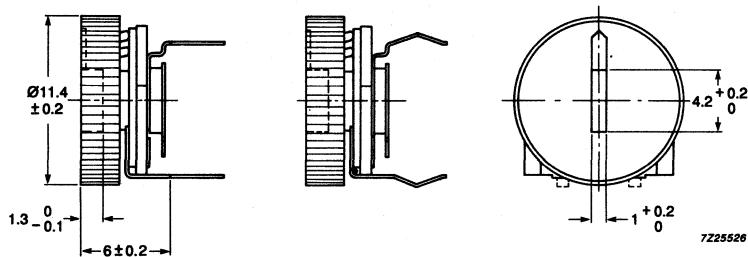


Fig.8 Potentiometers for horizontal mounting: snap-in pins.



2322 410 433 = straight pins
 2322 410 434 = snap-in pins

Fig.9 Potentiometers for horizontal mounting, with knob type 1.



2322 410 633 = straight pins
 2322 410 634 = snap-in pins

Fig.10 Potentiometers for horizontal mounting, with knob type 2.

TECHNICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Table 1

nom. resistance R_{nom}	max. voltage (V) at 40 °C	max. terminal resistance Ω	limiting wiper current (mA) at 40 °C	code in catalogue number
47 Ω	2,2	10	46	91
100 Ω	3,2	10	32	51
220 Ω	4,7	10	21	52
330 Ω	5,7	10	17	69
470 Ω	6,9	10	15	53
1 k Ω	10	20	10	54
2,2 k Ω	14,8	40	6,7	55
4,7 k Ω	21,7	100	4,6	56
10 k Ω	32	200	3,2	57
22 k Ω	47	400	2,1	58
47 k Ω	69	1 000	1,5	59
100 k Ω	100	2 000	1,0	61
220 k Ω	148	4 000	0,7	62
470 k Ω	150	10 000	0,32	63
1 M Ω	150	20 000	0,15	64
2,2 M Ω	150	40 000	0,068	65
4,7 M Ω	150	100 000	0,032	66

Tolerance on the nominal resistance

$\pm 20\%$

Resistance law

linear

Maximum dissipation (P_{max}),

at 40 °C

0,1 W

at 70 °C

0,05 W

Maximum voltage

$\sqrt{P_{max} R_{nom}}$; maximum 200 V
(DC or AC) (see table above)

Ambient temperature range

-25 to + 70 °C

Climatic category, IEC 68

25/070/21

Temperature coefficient

-500 to + 300 $\cdot 10^{-6}/K$

Operating torque

3,5 to 25 mNm

Maximum end stop torque

50 mNm

Effective angle of rotation

$200 \pm 10^\circ$

Mechanical angle of rotation

$260 \pm 5^\circ$

Mechanical endurance (200 cycles)

$\frac{\Delta R_{ac}}{R_{ac}} \leq 5\%$

Mass

potentiometer without knob

0,40 g

potentiometer with knob

0,60 g

TESTS AND REQUIREMENTS

Clause numbers of tests and conditions of test refer to IEC 393-1 (potentiometers; part 1: terms and methods of test).

The potentiometers have been tested whilst mounted by their terminations on a printed wiring board. When drying is called for, procedure 1 of IEC 393-1, sub. 5.2 is used (24 ± 4 h, sub. 55 ± 2 °C, R.H. $\leq 20\%$). When the contact resistance variation (CRV) is measured, the wiper is rotated in both directions over 90% of the effective resistance.

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.22.3	Ta	Solderability	solder bath: $235^{\circ} \pm 5$ °C, $2 \pm 0,5$ s	good tinning
6.22.4	Tb	Resistance to heat	solder bath: 260 ± 5 °C 5 ± 1 s	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0,5\%$
6.25	Eb	Bump	acceleration 40g number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$
6.24	F	Vibration	frequency: 10 to 500 Hz amplitude: 0,75 mm or 10g, 3 directions, 2 h per direction	$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$ $\frac{\Delta V_{ab}}{V_{ab}} \leq 0,3\%$
6.13	—	Temperature characteristics of resistance	temp. cycle: +20 °C; −25 °C; +20 °C; +70 °C; +20 °C	$-500 < TC < +300 \cdot 10^{-6} / K$
6.26 6.26.2 6.26.3 6.26.4 6.26.6	— Ba Db Aa Db	Climatic sequence Dry heat Damp heat acc. 1st cycle Cold Damp heat, remaining cycle	16 h at 70 ± 2 °C 24 h at 55 ± 2 °C $95 - 100\%$ R.H. 2 h at -55 ± 3 °C 24 h at 55 ± 2 °C $95 - 100\%$ R.H.	$\frac{\Delta R_{ac}}{R_{ac}} \leq 5\%$ operating torque ≤ 25 mNm
6.30	—	Electrical endurance	T_{amb} : 70 °C, 1000 h, cycle (1,5 h on and 0,5 h off, b at 0,67 a – c) Load: 0,05 W between a and c Load: 0,033 W between a and b	$CRV < 1\%$ of R_{ac} $\frac{\Delta R_{ac}}{R_{ac}} \leq 10\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0,5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leq 10\%$

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.29	—	Mechanical endurance	200 cycles, 4 cycles/min, no load	$\frac{\Delta R_{ac}}{R_{ac}} \leq 3\%$ $CRV < 0,5\% \text{ of } R_{ac}$
6.27	Ca	Damp heat steady state	slider at 0,67 a - c load via a - c recovery 24 h 22 ± 1 °C, 50% R.H. ± 5%	$CRV < 0,5\% \text{ of } R_{ac}$ $\frac{\Delta R_{ac}}{R_{ac}} \leq 5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leq 5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0,5\%$

10mm ENCLOSED CARBON PRESET

QUICK REFERENCE DATA

Resistance range (E3-series), linear law, log law on request	100 Ω to 4,7 M Ω *
Maximum dissipation	
at 40 °C	0,1 W
at 70 °C	0,05 W
at 85 °C	0,025 W
Temperature coefficient (range 1 k Ω to 2,2 M Ω)	$\pm 300 \cdot 10^{-6} / K$
Climatic category, IEC 68-2	25/085/10

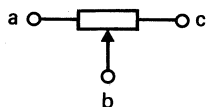
DESCRIPTION

These preset potentiometers comprise a carbon resistive element on a phenolic paper base. The actuating device is a plastic rotor or a metal wiper. Adjustment is by means of cross or hexagonal slots. The overall width of 9,8 mm allows for high density use with air-gap isolation on a 2,5 mm grid; either horizontal or vertical mounting. The black glass-filled synthetic resin housing is fire resistant. The potentiometers, which are manufactured and tested fully automatically, offer stable, high quality performance and can be mounted by automatic insertion machines.

They are designed for video, audio and industrial applications and are especially suited for equipment in which automatic placement and adjustment is practised. Versions are available with a hexagonal slotted plastic rotor, which can accept a knob to facilitate manual adjustment.

The terminals a and c are the end terminals; b is the central terminal connected to the slider. All terminals are either straight or snap-in pins for mounting on printed-wiring boards of nominal 1,0 to 1,6 mm thickness, grid pitch 2,5 or 2,54 mm.

Special straight terminals are available for automatic insertion.



Terminal designation.

7Z85818

* 33 Ω and 47 Ω on request.

MECHANICAL DATA

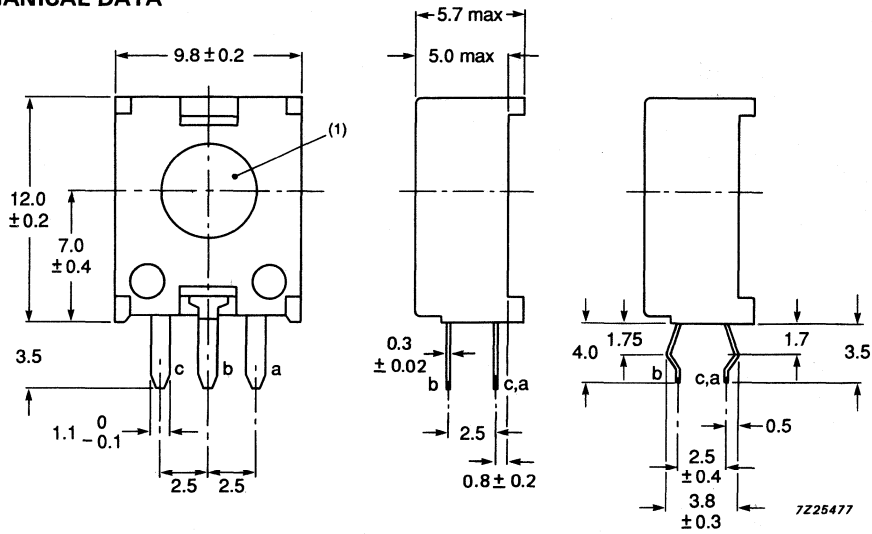


Fig. 1 Vertical mounting.

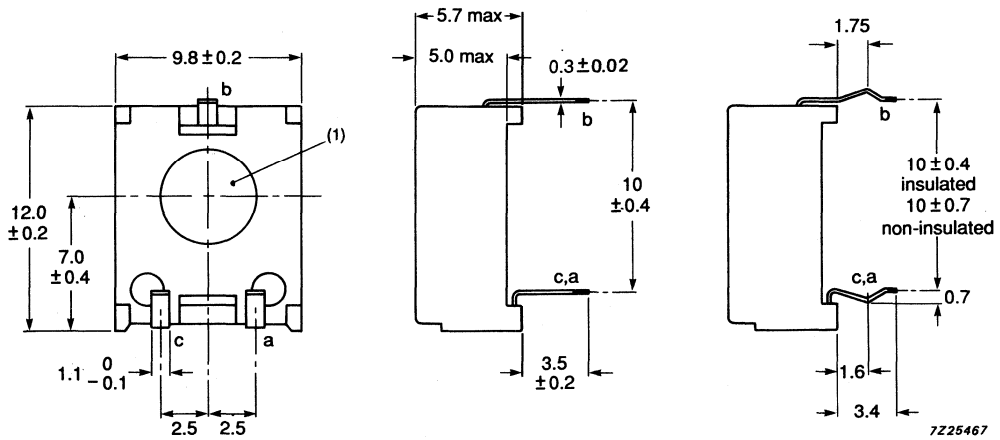


Fig. 2 Horizontal mounting.

Note: Snap-in terminals are designed for 1,6 mm PC boards.

Note to mechanical data

1. For details of available slots (cross, hexagonal, insulated or non-insulated wiper), see Figs 3, 4 and 5.

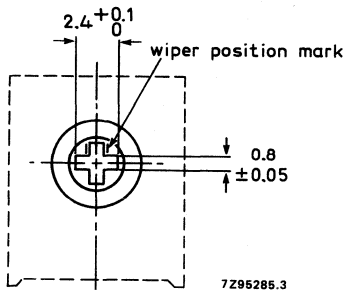


Fig. 3 Cross slot, non-insulated wiper for vertical and horizontal versions; straight pins only.

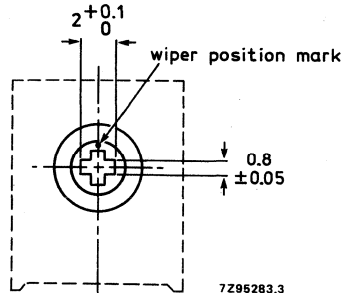


Fig. 4 Cross slot, insulated wiper for vertical and horizontal versions.

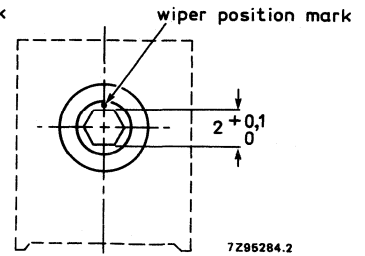


Fig. 5 Hexagonal slot, insulated wiper for vertical and horizontal versions.

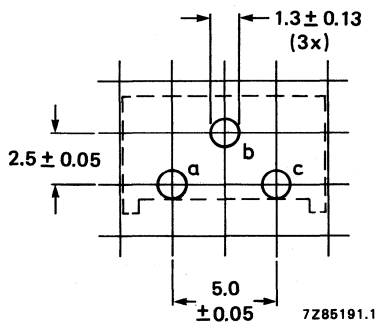


Fig. 6 Hole pattern for vertical versions, viewed from component side.

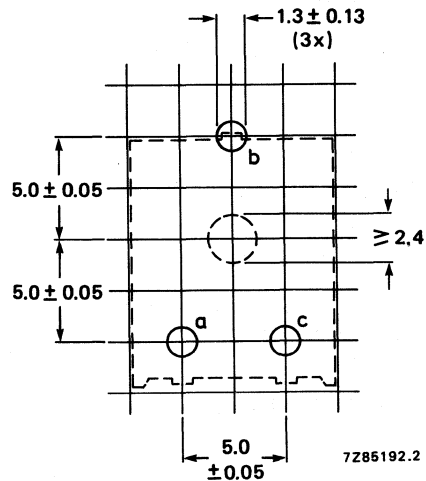


Fig. 7 Hole pattern for horizontal versions, viewed from component side.

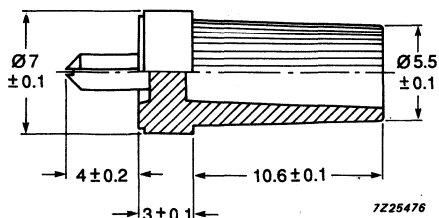


Fig. 8 Example of a knob for versions with a hexagonal slot and coloured black (cat. no. 4322 052 70720). Other colours are available on request.

TECHNICAL DATA

Mass		~ 0,6 g
Resistance range (E3-series)		100 Ω to 4,7 M Ω
Standard tolerance		$\pm 20\%$ and $\pm 10\%$
Resistance law		linear, see Fig. 9
Rated dissipation at 40 $^{\circ}\text{C}$ (P_{max})		0,1 W, see Fig. 8
Limiting element voltage		200 V (DC or AC)
Limiting wiper current (DC or AC)		$\sqrt{\frac{P_{\text{max}}}{R_{\text{nom}}}}$
Minimum effective resistance		$\leq 2\%$ of R_{ac} or 10 Ω , whichever is greater
Rotational noise limits (contact resistance variation)		$\leq 1,0\%$ of R_{nom} (0 to top)
Operating torque		2 to 10 mNm
Permissible end-stop torque		max. 50 mNm
Total mechanical angle of rotation		300 $\pm 5^{\circ}$
Effective angle of rotation		285 $\pm 10^{\circ}$
Settability		0,2% within 20 s
Climatic category according to IEC 68-2		25/085/10
Climatic sequence	$\frac{\Delta R_{\text{ac}}}{R_{\text{ac}}}$	$\leq \pm 10\%$
Damp heat, steady state, with or without load, between a and c, 10 days	$\frac{\Delta R_{\text{ac}}}{R_{\text{ac}}}$	$\leq 10\%$
Mechanical endurance (200 cycles)	$\frac{\Delta R_{\text{ac}}}{R_{\text{ac}}}$	$\leq 10\%$
Electrical endurance (1000 hours at 70 $^{\circ}\text{C}$, cyclic, loaded between a and c)	$\frac{\Delta R_{\text{ac}}}{R_{\text{ac}}}$	$\leq \pm 10\%$
Resistance to soldering heat	$\frac{\Delta R_{\text{ac}}}{R_{\text{ac}}}$	$\leq \pm 2\%$
Bump	$\frac{\Delta R_{\text{ac}}}{R_{\text{ac}}}$	$\leq \pm 2\%$
Vibration	$\frac{\Delta R_{\text{ac}}}{R_{\text{ac}}}$	$\leq \pm 2\%$
	$\frac{\Delta V_{\text{ab}}}{V_{\text{ac}}}$	$\leq 0,5\%$

DERATING

Potentiometers covered by this specification are derated from 100% rated dissipation at 40 °C to 25% dissipation at 85 °C. The dissipation below 40 °C is the rated dissipation.

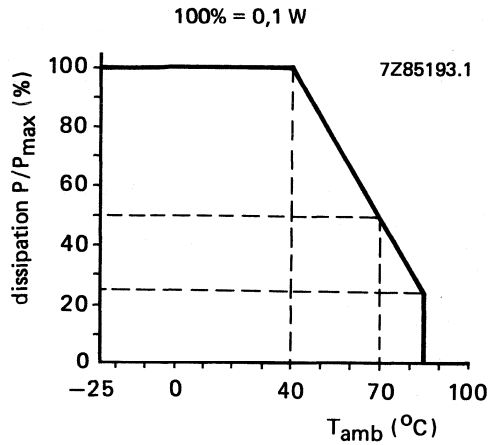


Fig. 9 Dissipation as a function of ambient temperature.

RESISTANCE

Potentiometers covered by this specification are linear. Logarithmic and inverse logarithmic law on request.

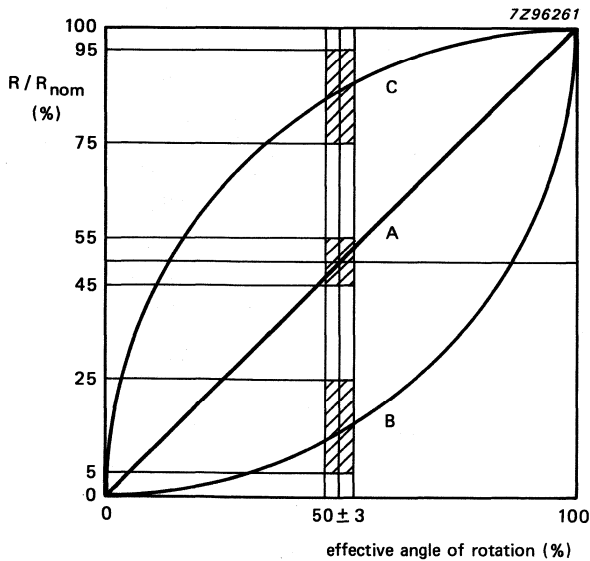


Fig. 10 Linear resistance law.

PRODUCT MARKING

The potentiometers are marked with the rated resistance, according to IEC 62, e.g. $220 \Omega = 220 R$; $10 k\Omega = 10K$; $1 M\Omega = 1MO$.

PACKAGING

The potentiometers can be supplied in bulk packaging of 1000 in a cardboard box or, especially for automatic insertion, in anti-static rail packaging of 50 per rail, 20 rails in a box. The outside dimensions of the rails, which have rubber stops at both ends, one grey and one black, are given in Fig. 11.

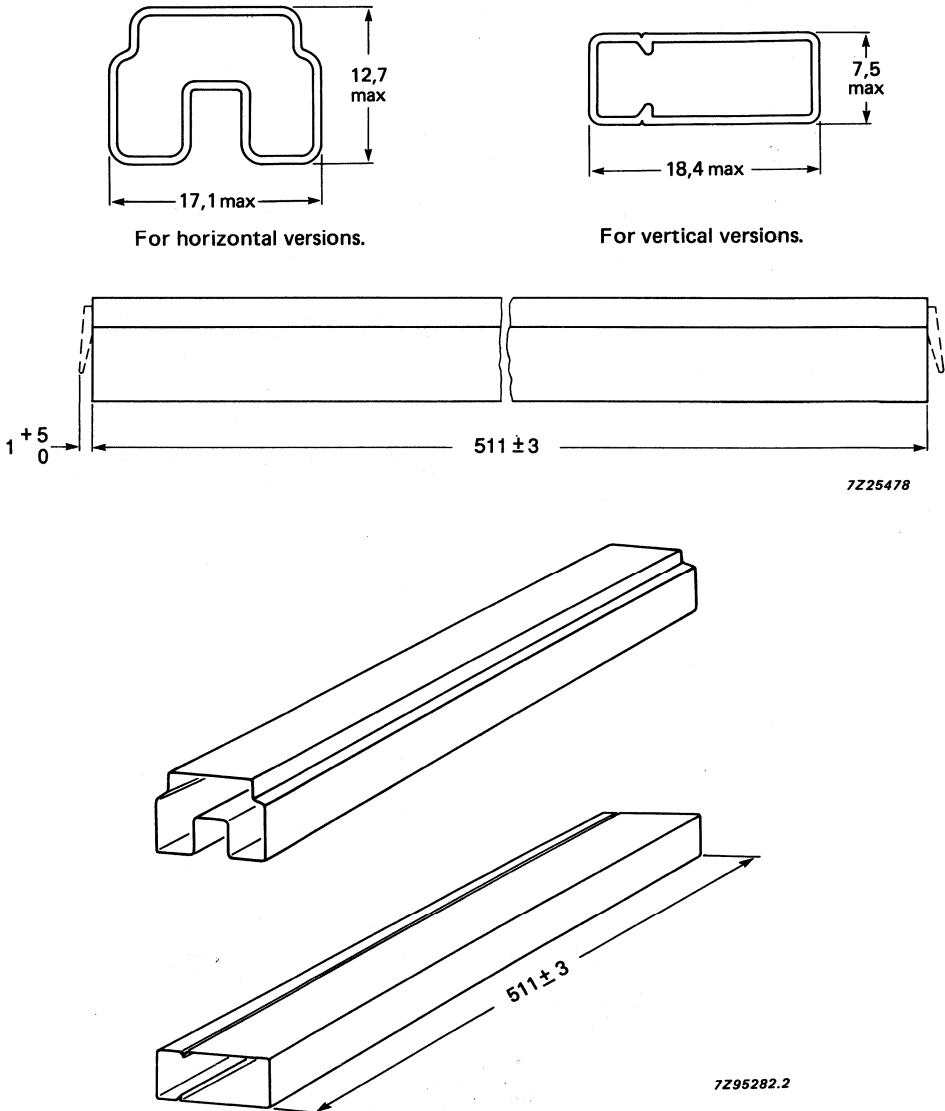


Fig. 11 Outlines of the rail packaging.

PACKAGING MARKING

The package containing the potentiometer has a main label as shown in Fig. 12.

Data on the main label is as follows:

- Field 1 : Country of origin
- Field 2: Product family and Resistance value
- Field 3: Product description (30 positions)

MADE IN BELGIUM
POTENTIOMETERS 47K A
ECP10 ENCLOSED CARBON PRESET

- Field 4: Customer code (on request)

- Field 5: Preference origin code and production centre


ORIG A170 RPC HQ

- Field 6: Quantity per PC and Production code


QTY 1000 DATE 9118

- Field 7: Product description (5 positions)

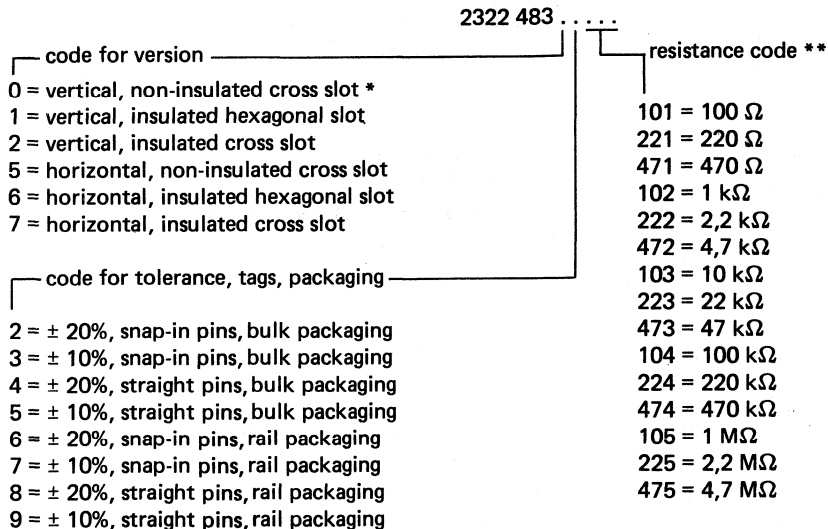

TYPE ECP10

- Field 8: Code number


CODEN0 2322 483 12473

Fig. 12 Package label.

COMPOSITION OF THE CATALOGUE NUMBER



* Snap in terminals on request
 ** log versions on request.

TESTS AND REQUIREMENTS

Clause numbers of tests and conditions of test refer to IEC 393-1 (potentiometers, part 1: terms and methods of test).

The potentiometers have been tested whilst mounted by their terminations on a printed wiring board. When drying is called for procedure I of IEC 393-1, sub. 5.2. is used (24 ± 4 h, 55 ± 2 °C, R.H. 20%).

When the contact resistance variation (CRV) is measured, the wiper is rotated in both directions over 90% of the effective resistance for a total of 6 cycles. The maximum deviations in the last 3 cycles are taken into account. Wiper speed: 2 cycles/minute; bandwidth 10 Hz to 5 kHz.

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.22.3	T	Solderability	solder bath: 235 ± 5 °C 2 ± 0,5 s	good tinning
6.22.4	Tb	Resistance to heat	solder bath: 350 ± 10 °C 3,5 ± 0,5 s	$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$ (typ. value $\leq 0,5\%$)
6.25	Eb	Bump	acceleration: 390 m/s ² number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.24	Fc	Vibration	frequency: 10 - 500 Hz amplitude: 0,75 mm or 98 m/s ² , 6 h	$\frac{\Delta R_{ac}}{R_{ac}} \leq \pm 2\%$ (typ. value $\leq 0,5\%$) $\frac{\Delta V_{ab}}{V_{ac}} \leq 0,5\%$ (typ. value $\leq 0,3\%$)
6.13		Temperature characteristic of resistance	temp. cycle: + 20 °C; -25 °C; + 20 °C; + 70 °C + 85 °C; + 20 °C	$\pm 500 \cdot 10^{-6}/K$ (100 Ω up to 470 Ω) $\pm 300 \cdot 10^{-6}/K$ (1 kΩ up to 2 MΩ) $\pm 1000 \cdot 10^{-6}/K$ (4,7 MΩ)
6.26	—	Climatic sequence		} $\frac{\Delta R_{ac}}{R_{ac}} \leq \pm 10\%$
6.26.2	Ba	Dry heat	16 h at 85 °C	
6.26.3	D	Damp heat, accel. 1st cycle	24 h at 55 °C 95 - 100% R.H.	
6.26.4	Aa	Cold	2 h at -25 °C	
6.26.6	D	Damp heat remaining cycle	24 h at 55 °C 95 - 100% R.H.	
(6.30)	—	Electrical endurance	T _{amb} : 70 °C, 1000 h cycle (1,5 h on and 0,5 h off, b at 0,67 a - c) Load: 0,05 W between a and c	CRV < 2% of R _{nom} $\frac{\Delta R_{ac}}{R_{ac}} \leq \pm 10\%$ $R_{ac} \leq \pm 20\%$ up to 4,7 MΩ
6.29	—	Mechanical endurance	200 cycles, 4 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leq 10\%$ (typ. value $\leq 5\%$) CRV < 1,0% of R _{nom}
(6.27)	C	Damp heat steady state	10 days; recovery 24 h, 22 ± 1 °C, 50% R.H. ± 5%	CRV < 1,0% of R _{nom} $\frac{\Delta R_{ac}}{R_{ac}} \leq 10\%$ (typ. value $\leq 5\%$) $\frac{\Delta V_{ab}}{V_{ac}} \leq 1\%$ (typ. value $\leq 0,2\%$)

10 mm OPEN METAL-GLAZE PRESET

QUICK REFERENCE DATA

Resistance range (E6-series), linear law	100 Ω to 10 M Ω
Maximum dissipation at 70 °C	0,5 W
Climatic category, IEC 68	55/125/56

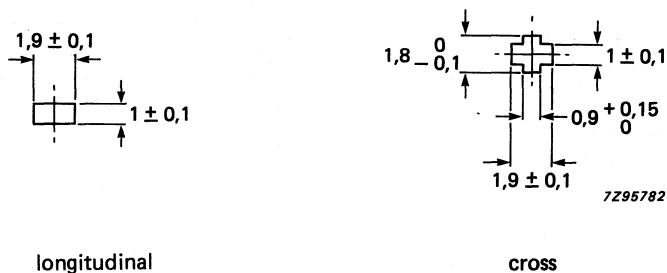
APPLICATION

These potentiometers are for preset resistance control with provision for re-adjustments. They are particularly suitable for use in professional apparatus and/or in those applications where stability is of extreme importance.

DESCRIPTION

These potentiometers comprise a resistance element of thick film, with particles of conductive metal dispersed in it. The element is supported by a non-conductive temperature-resistant ceramic base. The terminals a and c (see Figs 1 to 3) are connected to the ends of the resistance element; terminal b is connected to the wiper.

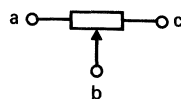
The actuating slot is either longitudinal or cross shaped:



longitudinal

cross

The potentiometers are available in versions for horizontal and vertical mounting on printed-wiring boards.



7285818

Fig. 1 Terminal allocations.

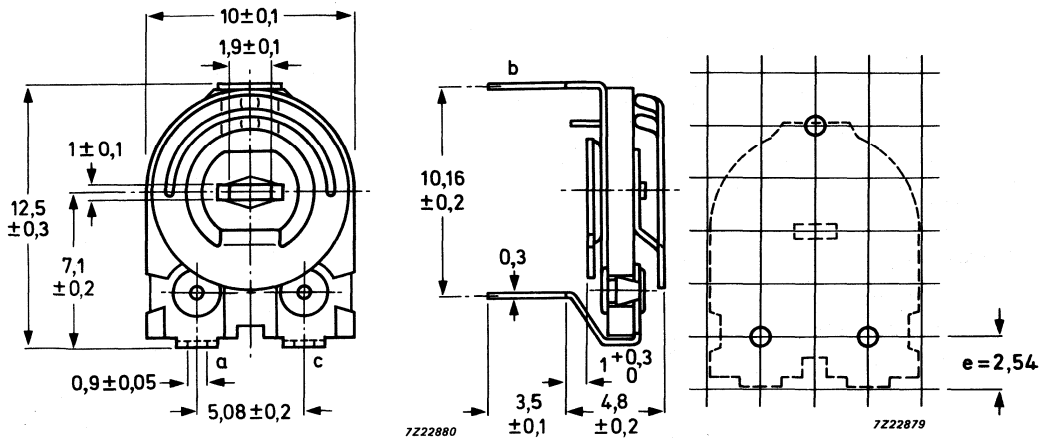


Fig. 2 Potentiometer for horizontal mounting, 2322 482 4 . . .

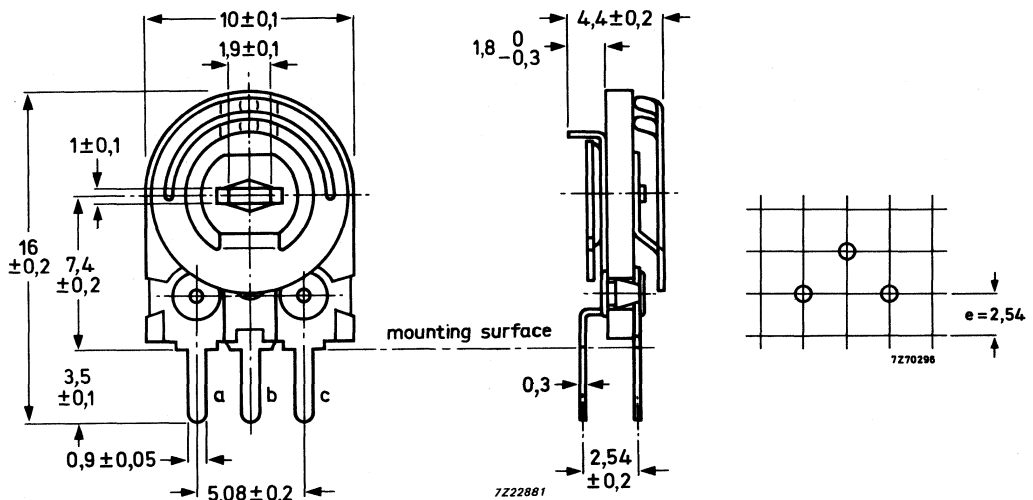


Fig. 3 Potentiometer for vertical mounting, 2322 482 3 . . .

TECHNICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 35 °C, an air pressure of 860 to 1060 hPa and a relative humidity of 45 to 75%. For terms and test methods see IEC publication 393-1.

Nominal resistance (R_{nom})

100 Ω to 10 M Ω , see Table 1

Tolerance on the nominal resistance

$\pm 20\%$ and $\pm 10\%$

Resistance law and tolerances

linear, see Fig. 4

Terminal resistance

$\leq 0.5\%$ of R_{ac} or 2 Ω , whichever is the greater

Contact resistance variation (CRV)

$\leq 0.5\%$ of R_{ac}

Maximum dissipation (P_{max}) at 70 °C

0.5 W, see Fig. 5

Limiting voltage (AC)	500 V
Limiting wiper current	$\sqrt{\left(\frac{P_{max}}{R_{ac}}\right)}$
Operating temperature range	-55 to + 125 °C
Temperature coefficient	
$R_{nom} \leq 1 M\Omega$	$\pm 50 \cdot 10^{-6}/K$
$R_{nom} > 1 M\Omega$	$\pm 100 \cdot 10^{-6}/K$
Operating torque	4 to 30 mNm
Permissible end stop torque	≤ 50 mNm
Effective angle of rotation	$220 \pm 5^\circ$
Mechanical angle of rotation	$235 \pm 5^\circ$
Rotational life	200 cycles
Settability	0.1% of R_{ac} within 10 s
Mass	approx. 0.8 g

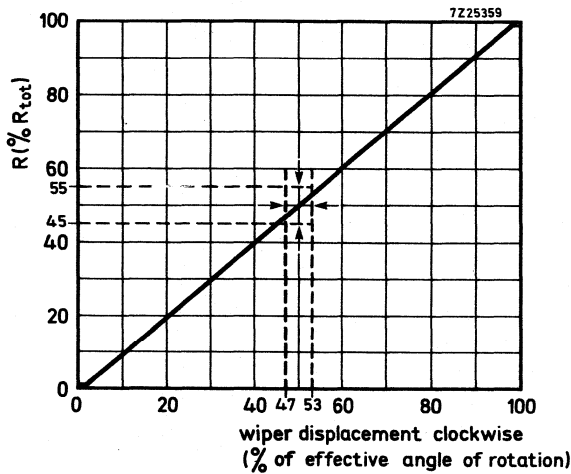


Fig. 4 Linear law.

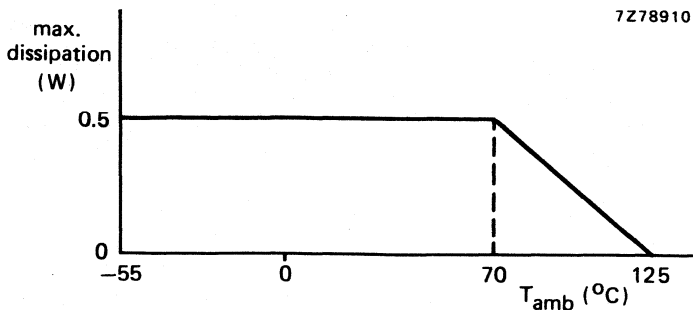
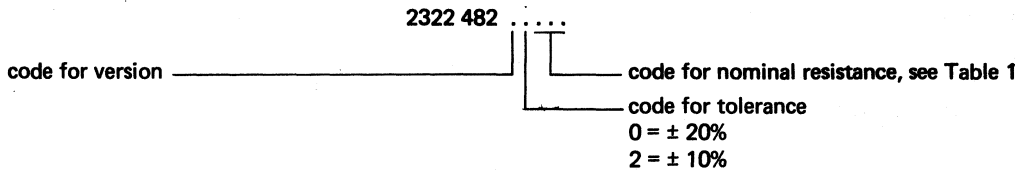


Fig. 5 Maximum dissipation as a function of ambient temperature.

COMPOSITION OF THE CATALOGUE NUMBER



- 2 = horizontal mounting (assymmetric), longitudinal slot
- 3 = vertical mounting, longitudinal slot
- 4 = horizontal mounting (symmetric), longitudinal slot
- 6 = horizontal mounting (assymmetric), cross slot
- 7 = vertical mounting, cross slot
- 8 = horizontal mounting (symmetric), cross slot

Table 1 Code for nominal resistance

nominal resistance	code in cat. number	nominal resistance	code in cat. number
100 Ω	101	33 kΩ	333
150 Ω	151	47 kΩ	473
220 Ω	221	68 kΩ	683
330 Ω	331	100 kΩ	104
470 Ω	471	150 kΩ	154
680 Ω	681	220 kΩ	224
1 kΩ	102	330 kΩ	334
1.5 kΩ	152	470 kΩ	474
2.2 kΩ	222	680 kΩ	684
3.3 kΩ	332	1 MΩ	105
4.7 kΩ	472	1.5 MΩ	155
6.8 kΩ	682	2.2 MΩ	225
10 kΩ	103	3.3 MΩ	335
15 kΩ	153	4.7 MΩ	475
22 kΩ	223	6.8 MΩ	685
		10 MΩ	106

TESTS AND REQUIREMENTS

Clause numbers of tests and conditions of test refer to IEC 393-1 (potentiometers, part 1: terms and methods of test).

The potentiometers have been tested whilst mounting by their terminations on a printed-wiring board.

When drying is called for, procedure I of IEC 393-1, sub. 5.2. is used (24 ± 4 h, 55 ± 2 °C, R.H. 20%).

When the contact resistance variation (CRV) is measured, the wiper is rotated in both directions over 90% of the effective resistance for a total of 6 cycles. The maximum deviations in the last 3 cycles are taken into account. Wiper speed: 2 cycles/minute; bandwidth 10 Hz to 5 kHz.

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.22.3	T	Solderability	solder bath: 230 ± 10 °C, 2 ± 0.5 s	good tinning
6.22.4	Tb	Resistance to heat	solder bath: 350 ± 10 °C 3.5 ± 0.5 s	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0.1\%$
6.25	Eb	Bump	acceleration: 40g number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0.1\%$
6.24	Fc	Vibration	frequency: 10 - 500 Hz amplitude: 0.75 mm or 10g, 3 directions, 2h per direction	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0.1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0.2\%$
6.13		Temperature characteristic of resistance	temp. cycle: + 20 °C; -25 °C; + 20 °C; + 70 °C + 20 °C	$-50 < TC < + 50 \cdot 10^{-6} / K$
6.23	Na	Change of temperature	-55 °C and + 125 °C; 5 cycles, ½ h	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0.5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0.2\%$
6.26	—	Climatic sequence		$\frac{\Delta R_{ac}}{R_{ac}} \leq 0.5\%$ operating torque $\leq 36 \text{ mNm}$
6.26.2	Ba	Dry heat	16 h at 70 °C	
6.26.3	Db	Damp heat accel. 1st cycle	24 h at 55 ± 2 °C 95 - 100% R.H.	
6.26.4	Aa	Cold	2 h at -55 ± 3 °C	
6.26.6	D	Damp heat, remaining cycle	24 h at 55 ± 2 °C 95 - 100% R.H.	
6.30	—	Electrical endurance	T _{amb} : 70 °C, 1000 h cyclic (1.5 h on and 0.5 h off, b at 0.67 ac) Load: 0.5 W between a and c Load: 0.33 W between a and b	CRV < 1% of R _{nom} $\frac{\Delta R_{ac}}{R_{ac}} \leq 1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0.2\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leq 3\%$

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.29	—	Mechanical endurance	200 cycles, 4 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$ CRV < 0.5% of R_{nom}
6.27	Ca	Damp heat steady state	b at 0.67 a - c no load; 56 days	CRV < 0.5% of R_{nom} $\frac{\Delta R_{ac}}{R_{ac}} \leq 0.5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leq 1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0.2\%$
			load a - c 0.05 W	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0.5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0.2\%$
			load a - c 0.03 W	$\frac{\Delta R_{ab}}{R_{ab}} \leq 2\%$
Immersion in cleaning solvents		Immersion in boiling mixture of 1.1.2. trichlorotrifluoroethane and isopropanol (75%/25%) for 5 ± 0.5 min., followed by 5 min drying (rubbing or wrapping excluded).		Marking legible, no damage. $\Delta R_{ac}/R_{ac} \leq 0.5\%$; CRV $\leq 0.5\%$; operating torque: 2 to 10 mNm.

PACKAGING

50 items per blister
1000 per box.

10 mm ENCLOSED CERMET PRESET POTENTIOMETERS

QUICK REFERENCE DATA

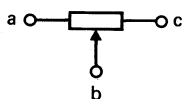
Resistance range (E6-series), linear law	47 Ω to 10 M Ω
Maximum dissipation at 70 $^{\circ}$ C	0,5 W
Climatic category, IEC 68-2	55/125/56

DESCRIPTION

These preset potentiometers comprise a metal-glaze resistive element on a ceramic base. The actuating device is a plastic rotor. Adjustment is by means of insulated hexagonal or cross slots. The overall width of 9,8 mm allows for high density use with air-gap isolation on a 2,5 mm grid; either horizontal or vertical mounting. The glass-filled synthetic resin housing is fire resistant. The potentiometers, which are manufactured fully automatically, offer stable high quality performance and can be mounted by automatic insertion machines.

They are designed for video, audio and industrial applications and are especially suited for equipment in which automatic adjustment is practised. Versions with a hexagonal slot are available that can be provided with a knob to facilitate manual adjustment.

The terminals a and c are the end terminals; b is the central terminal connected to the slider. All terminals are either straight or snap-in pins for mounting on printed-wiring boards of nominal 1,0 to 1,6 mm thickness, grid pitch 2,5 or 2,54 mm.



Terminal designation.

7Z85818

MECHANICAL DATA

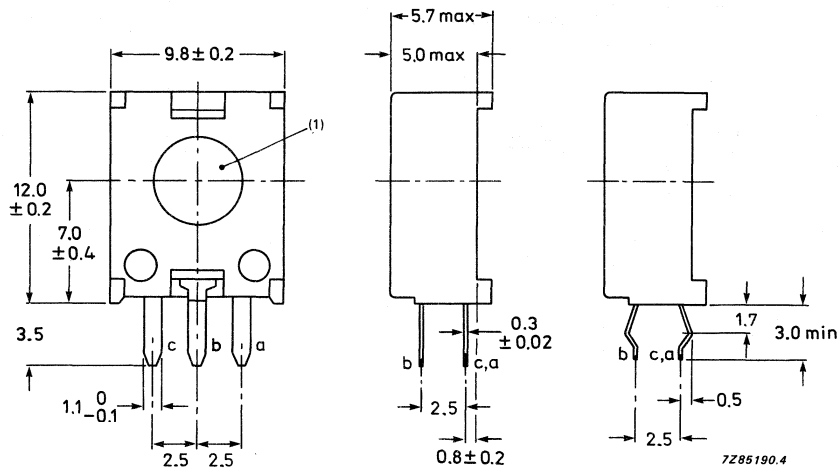


Fig. 1 Vertical mounting version.

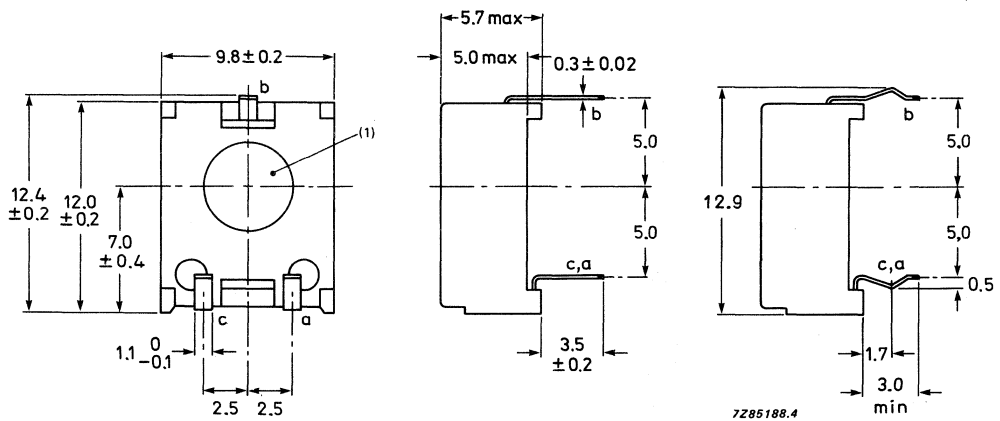


Fig. 2 Horizontal mounting.

Note to mechanical data

1. For details of available slots see Figs 3 and 4.

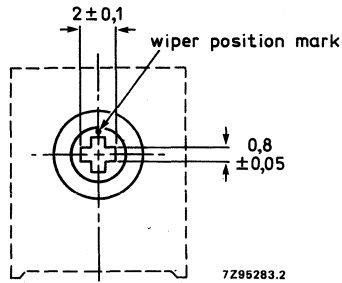


Fig. 3 Cross slot.

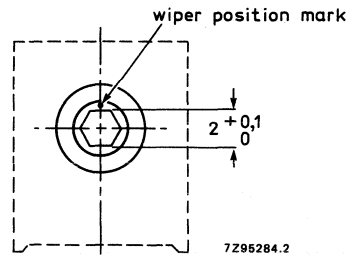


Fig. 4 Hexagonal slot.

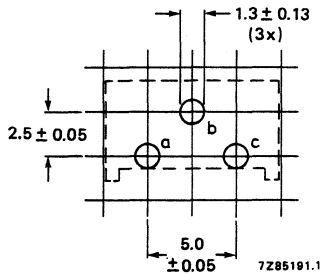


Fig. 5 Hole pattern for vertical versions, viewed from component side.

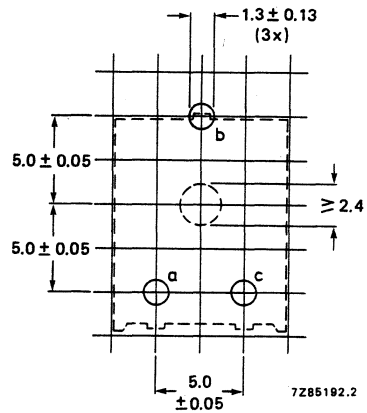


Fig. 6 Hole pattern for horizontal versions, viewed from component side.

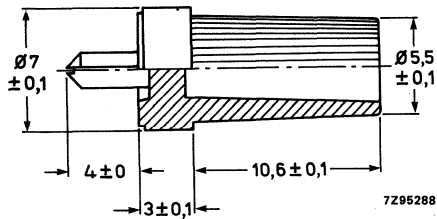


Fig. 7 Example of a knob for versions with a hexagonal slot and coloured black. (cat. no. 4322 052 70720).

TECHNICAL DATA

Mass	~ 0,8 g
Resistance range (E6-series)	47 Ω to 10 MΩ
Standard tolerance	± 20% and ± 10%
Resistance law	linear, see Fig. 9
Rated dissipation at 40 °C (P _{max})	0,5 W, see Fig. 8
Limiting element voltage	250 V (DC)
Limiting wiper current	$\sqrt{\frac{P_{max}}{R_{nom}}}$
Minimum effective resistance	≤ 0,5% of R _{ac} or 2 Ω, whichever is greater
Rotational noise limits (contact resistance variation)	≤ 1,0% of R _{nom}
Temperature coefficient in the range -55 °C to + 125 °C	
R _{nom} ≤ 100 Ω	± 200 · 10 ⁻⁶ /K
100 < R _{nom} < 1 MΩ	± 50 · 10 ⁻⁶ /K
R _{nom} ≤ 1 MΩ	± 100 · 10 ⁻⁶ /K
Operating torque	3 to 20 mNm
Permissible end-stop torque	max. 50 mNm
Total mechanical angle of rotation	300 ± 5°
Effective angle of rotation	285 ± 10°
Settability	0,1% within 10 s
Climatic category according to IEC 68-2	55/125/56
Climatic sequence	$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$
Damp heat, steady state	$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$
Mechanical endurance (200 cycles)	$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$
Electrical endurance (1000 h at 70 °C, cyclic)	$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$
Change of temperature (between -55 °C and + 125 °C)	$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$
	$\frac{\Delta V_{ab}}{V_{ac}} \leq 1\%$
Resistance to soldering heat	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0,5\%$
Bump	$\frac{\Delta R_{ac}}{R_{ac}} \leq 1\%$
Vibration	$\frac{\Delta R_{ac}}{R_{ac}} \leq 1\%$
	$\frac{\Delta V_{ab}}{V_{ac}} \leq 0,5\%$

DERATING

Potentiometers covered by this specification are derated from 100% rated dissipation at 40 °C to zero dissipation at 125 °C. The dissipation below 40 °C is the rated dissipation.

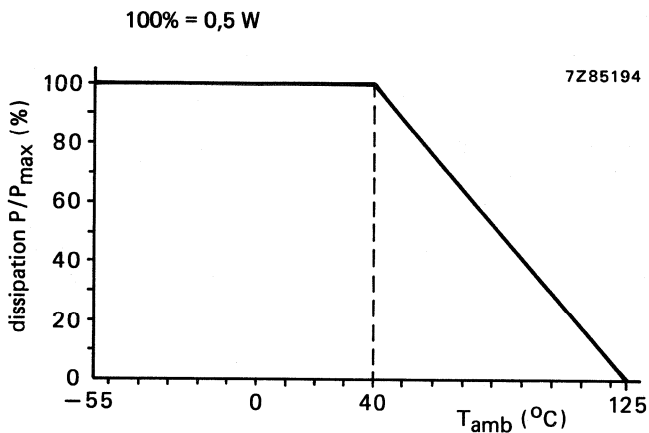


Fig. 8 Dissipation as a function of ambient temperature.

RESISTANCE LAW

Potentiometers covered by this specification are linear.

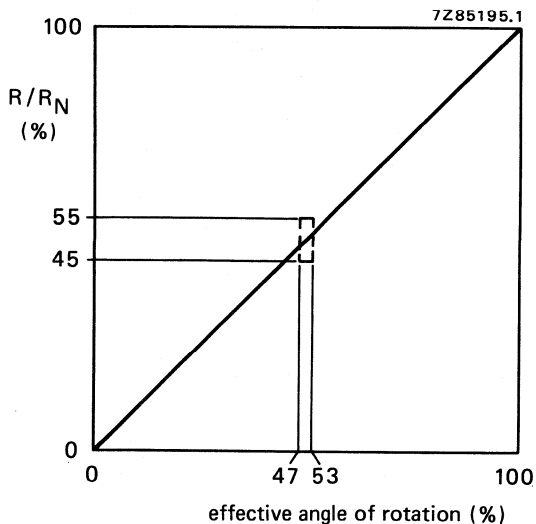


Fig. 9 Linear resistance law.

MARKING

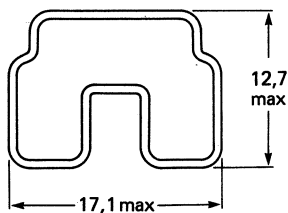
The potentiometers are marked with the rated resistance, according to IEC 62, e.g. $220 \Omega = 220 R$; $10 \text{ k}\Omega = 10 \text{ k}$; $1 \text{ M}\Omega = 1 \text{ MO}$.

The package is marked with:

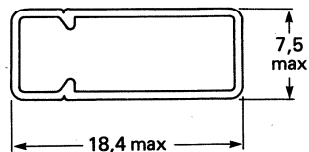
- catalogue number,
- date of production,
- quantity.

PACKAGING

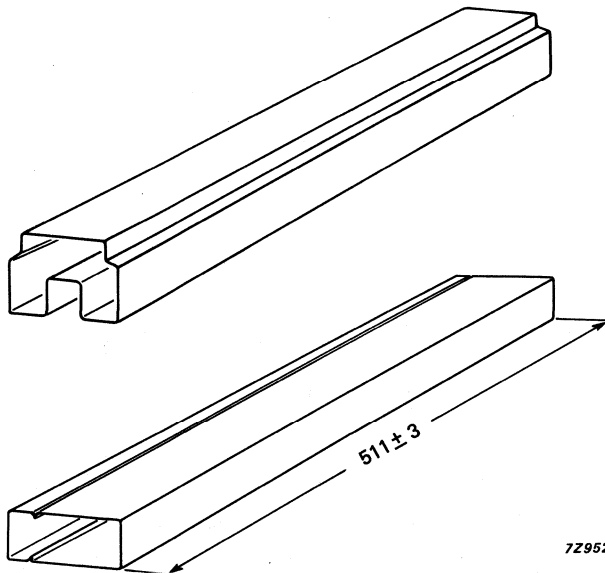
The potentiometers can be supplied in bulk packaging of 1000 in a cardboard box or, especially for automatic insertion, in anti-static rail packaging of 50 per rail, 20 rails in a box. The outside dimensions of the rails, which have rubber stops at both ends, one grey and one black, are given in Fig. 10



For horizontal versions.



For vertical versions.



7Z95282.2

Fig. 10 Outlines of the rail packaging.

PACKAGING MARKING

The package containing the potentiometer has a main label as shown in Fig. 11.

Data on the main label is as follows:

- Field 1 : Country of origin
- Field 2: Product family and Resistance value
- Field 3: Product description (30 positions)

MADE IN BELGIUM
 POTENTIOMETERS 47K A
 EMP10 ENCLOSED METAL-GLAZE PRESET

- Field 4: Customer code (on request)

- Field 5: Preference origin code and production centre


 ORIG A170 RPC HQ

- Field 6: Quantity per PC and Production code

—

 QTY 1000 DATE 9118

- Field 7: Product description (5 positions)


 TYPE EMP10

- Field 8: Code number


 CODENO 2322 484 12473

Fig. 11 Package label

COMPOSITION OF THE CATALOGUE NUMBER

		2322 484		
└─ code for version ─┘		└─ resistance code ─┘		
1 = vertical, hexagonal slot		479 = 47 Ω	333 = 33 kΩ	
2 = vertical, cross slot		689 = 68 Ω	473 = 47 kΩ	
6 = horizontal, hexagonal slot		101 = 100 Ω	683 = 68 kΩ	
7 = horizontal, cross slot		151 = 150 Ω	104 = 100 kΩ	
		221 = 220 Ω	154 = 150 kΩ	
└─ code for tolerance, tags, packaging ─┘		331 = 330 Ω	224 = 220 kΩ	
2 = ± 20%, snap-in pins, bulk packaging		471 = 470 Ω	334 = 330 kΩ	
3 = ± 10%, snap-in pins, bulk packaging		681 = 680 Ω	474 = 470 kΩ	
4 = ± 20%, straight pins, bulk packaging		102 = 1 kΩ	684 = 680 kΩ	
5 = ± 10%, straight pins, bulk packaging		152 = 1,5 kΩ	105 = 1 MΩ	
6 = ± 20%, snap-in pins, rail packaging		222 = 2,2 kΩ	155 = 1,5 MΩ	
7 = ± 10%, snap-in pins, rail packaging		332 = 3,3 kΩ	225 = 2,2 MΩ	
8 = ± 20%, straight pins, rail packaging		472 = 4,7 kΩ	335 = 3,3 MΩ	
9 = ± 10%, straight pins, rail packaging		682 = 6,8 kΩ	475 = 4,7 MΩ	
		103 = 10 kΩ	685 = 6,8 MΩ	
		153 = 15 kΩ	106 = 10 MΩ	
		223 = 22 kΩ		

TESTS AND REQUIREMENTS

Clause numbers of tests and conditions of test refer to IEC 393-1 (potentiometers, part 1: terms and methods of test).

The potentiometers have been tested whilst mounted by their terminations on a printed wiring board.

When drying is called for procedure I of IEC 393-1, sub 5.2. is used (24 ± 4 h, 55 ± 2 °C, R.H. 20%).

When the contact resistance variation (CRV) is measured, the wiper is rotated in both directions over 90% of the effective resistance for a total of 6 cycles. The maximum deviations in the last 3 cycles are taken into account. Wiper speed: 2 cycles/minute; bandwidth 10 Hz to 5 kHz.

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.22.3	T	Solderability	solder bath: 230 ± 10 °C, 2 ± 0,5 s	good tinning
6.22.4	Tb	Resistance to heat	solder bath: 350 ± 10 °C, 3,5 ± 0,5 s	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0,1\%$
6.25	Eb	Bump	acceleration: 390 m/s ² number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0,1\%$
6.24	Fc	Vibration	frequency: 10 - 500 Hz amplitude: 0,75 mm or 98 m/s ² , 6 h	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0,5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0,3\%$

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.13		Temperature characteristic of resistance	temp. cycle: + 20 °C; -25 °C; + 20 °C; + 70 °C; + 20 °C	$-50 < TC < + 50 \cdot 10^{-6}/K$
6.23	Na	Change of temperature	-55 °C and + 125 °C; 5 cycles	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0,5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0,2\%$
6.26	—	Climatic sequence		} $\frac{\Delta R_{ac}}{R_{ac}} \leq 0,5\%$
6.26.2	Ba	Dry heat	16 h at 125 °C	
6.26.3	D	Damp heat accel. 1st cycle	24 h at 55 °C 95 - 100% R.H.	
6.26.4	Aa	Cold	2 h at -55 °C	
6.26.6	D	Damp heat, remaining cycle	24 h at 55 °C 95 - 100% R.H.	
(6.30)	—	Electrical endurance	T _{amb} : 40 °C, 1000 h, cyclic (1,5 h on and 0,5 h off, b at 0,67 ac) Load: 0,5 W between a and c Load: 0,33 W between a and b	CRV < 1% of R _{nom} $\frac{\Delta R_{ac}}{R_{ac}} \leq 1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0,5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leq 5\%$
6.29	—	Mechanical endurance	200 cycles, 4 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leq 1\%$ CRV < 1% of R _{nom}
(6.27)	C	Damp heat steady state	wiper at 0,67 a - c no load; recovery 24 h at 22 ± 1 °C, 50% R.H. ± 5%	CRV < 1% of R _{nom} $\frac{\Delta R_{ac}}{R_{ac}} \leq 1\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leq 2\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0,2\%$

CONTROL POTENTIOMETERS

	Page
CRC10	237
CRC12; MRC12	245
CRC17; MRC17	283
MRC23	327

10 mm CARBON CONTROL POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E3-series)	
linear law	1 k Ω to 4,7 M Ω
logarithmic/inverse log. law	2,2 k Ω to 2,2 M Ω
Maximum dissipation at 40 °C	
linear law	0,1 W
logarithmic/inverse log. law	0,05 W
Temperature coefficient	$\pm 500 \times 10^{-6}/K$
Climatic category, IEC 68-2	25/85/10

DESCRIPTION

These control potentiometers comprise a carbon resistive element on a phenolic paper base. The actuating device is operated by a custom made plastic knob which can be pressed into an hexagonal slot in the rotor. The overall width of 9,8 mm allows for high density use with air-gap isolation on a 2,5 mm grid; either horizontal or vertical mounting. The black glass-filled synthetic resin housing is fire resistant. The potentiometers, which are manufactured and tested fully automatically, offer stable, high quality performance and can be mounted by automatic insertion machines.

They are designed for video, audio and industrial applications where mechanical and electrical requirements are not severe and low price is important.

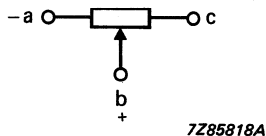


Fig. 1 Terminal designation.

MECHANICAL DATA

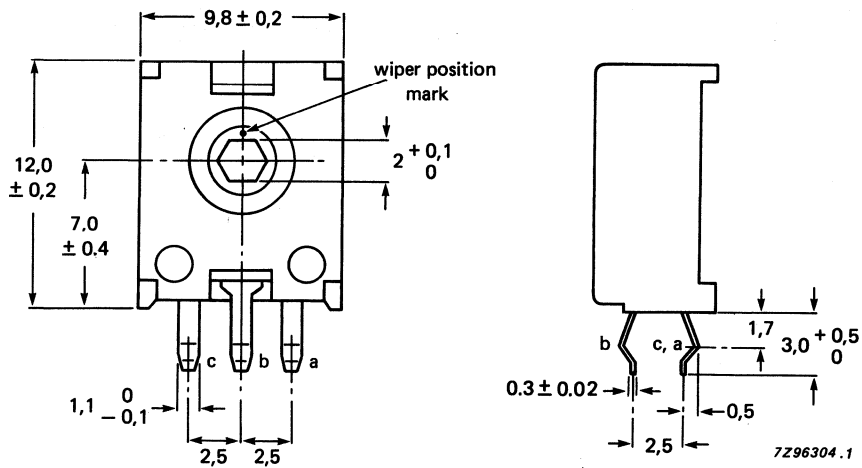


Fig. 2 Vertical mounting.

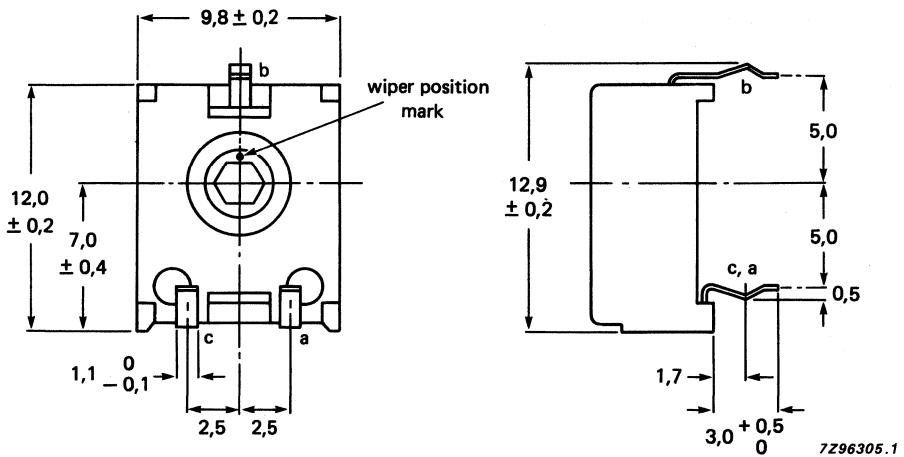


Fig. 3 Horizontal mounting.

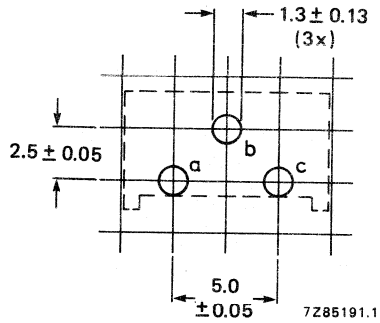


Fig. 4 Hole pattern for vertical versions, viewed from component side.

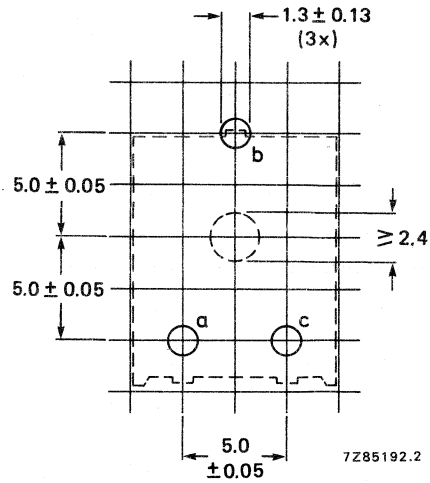


Fig. 5 Hole pattern for horizontal versions, viewed from component side.

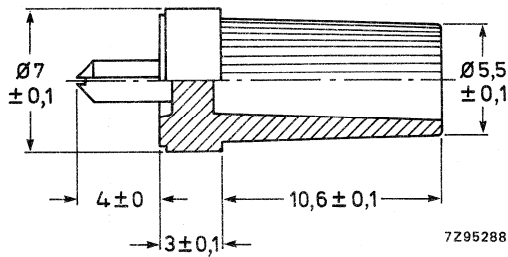


Fig. 6 Example of a knob for versions with a hexagonal slot (cat. no. 4322 052 70710).

TECHNICAL DATA

Resistance law

Resistance range (E3-series)

Standard tolerance

Rated dissipation at 40 °C (P_{max}) (see Fig. 7)

CRV, initial and after 10 000 cycles

Limiting element voltage (d.c.)

Limiting wiper current

Minimum effective resistance

Mass

Temperature coefficient in the range -25 °C to 85 °C

Operating torque, ratio max./min. < 3

Permissible end-stop torque

Permissible axial load on adjustment slot during 20 s

horizontal versions

vertical versions

Total mechanical angle of rotation

Effective angle of rotation

Settability

Climatic category according to IEC 68-2

Climatic sequence

Damp heat, steady state, with or without load, between a and c, 10 days

Mechanical endurance (10 000 cycles)

Electrical endurance
(1000 h at 70 °C, cyclic)

Resistance to soldering heat

Bump and vibration

linear	log./inv. log.
1 k Ω to 4,7 M Ω	2,2 k Ω to 2,2 M Ω
$\pm 20\%$	$\pm 20\%$
0,1 W	0,05 W
$\leq 1\%$	$\leq 2\%$

150 V

$$\sqrt{\frac{P_{max}}{R_{nom}}}$$

$\leq 2\%$ of R_{ac} or 10 Ω ,
whichever is greater

0,6 g

$\pm 500 \times 10^{-6}/K$

2 to 10 mNm

max. 75 mNm

< 20 N

< 10 N

300 $\pm 5^\circ$

285 $\pm 10^\circ$

25/85/10

$$\frac{\Delta R_{ac}}{R_{ac}} \leq 10\%$$

$$\frac{\Delta R_{ac}}{R_{ac}} \leq 10\%$$

$$\frac{\Delta R_{ac}}{R_{ac}} \leq 10\%$$

$$\frac{\Delta R_{ac}}{R_{ac}} \leq 10\%$$

$$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$$

$$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$$

$$\frac{\Delta V_{ab}}{V_{ac}} \leq 1\%$$

DERATING

Potentiometers covered by this specification are derated from 100% rated dissipation at 40 °C to zero dissipation at 85 °C. The dissipation below 40 °C is the rated dissipation.

linear:

100% = 0,1 W

logarithmic and

inverse logarithmic:

100% = 0,05 W

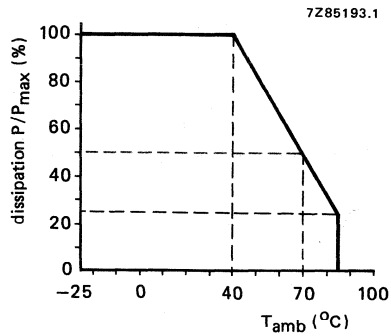


Fig. 7 Dissipation as a function of ambient temperature.

RESISTANCE

Potentiometers covered by this specification are linear, logarithmic and inverse logarithmic.

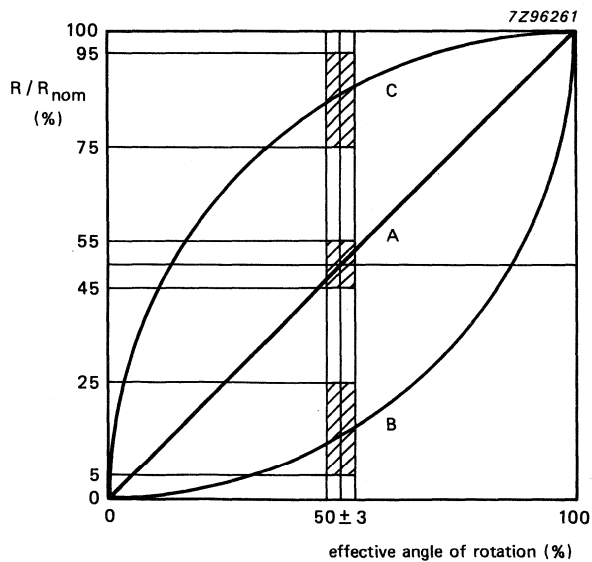


Fig. 8 Resistance laws: A = linear; B = logarithmic; C = inverse logarithmic.

MARKING

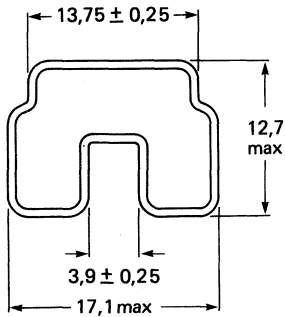
The potentiometers are marked with the rated resistance, according to IEC 62, e.g. $10\text{ k}\Omega = 10\text{ k}$;
 $1\text{ M}\Omega = 1\text{ MO}$.

The package is marked with:

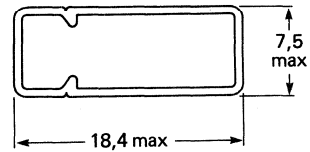
- catalogue number,
- date of production,
- quantity.

PACKAGING

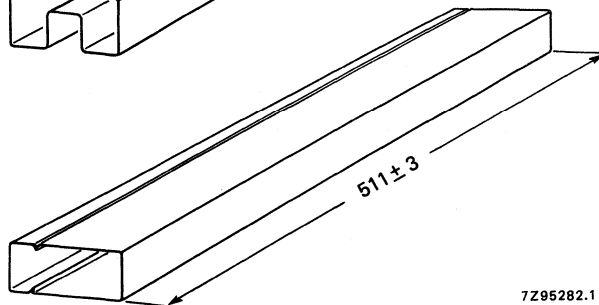
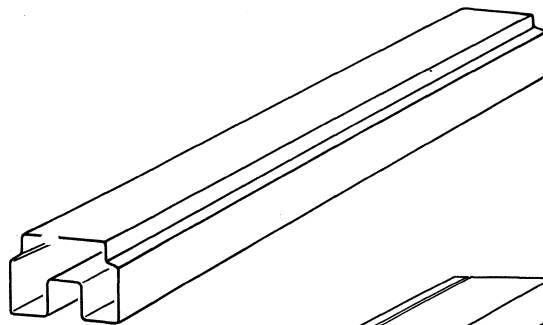
The potentiometers can be supplied in bulk packaging of 1000 in a cardboard box or, especially for automatic insertion, in anti-static rail packaging of 50 per rail, 20 rails in a box. The outside dimensions of the rails, which have rubber stops at both ends, are given in Fig. 9.



For horizontal versions.



For vertical versions.



7Z95282.1

Fig. 9 Outlines of the rail packaging.

COMPOSITION OF THE CATALOGUE NUMBER -

2322 485

code for version

- 0 = vertical, insulated hexagonal slot
- 5 = horizontal, insulated hexagonal slot

code tags, packaging

- 00 = snap-in pins, bulk packaging
- 20 = snap-in pins, rail packaging

resistance code			
linear	log.	inv. log.	
04			= 1 kΩ
05	25	45	= 2,2 kΩ
06	26	46	= 4,7 kΩ
07	27	47	= 10 kΩ
08	28	48	= 22 kΩ
09	29	49	= 47 kΩ
11	31	51	= 100 kΩ
12	32	52	= 220 kΩ
13	33	53	= 470 kΩ
14	34	54	= 1 MΩ
15	35	55	= 2,2 MΩ
16			= 4,7 MΩ

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

The PP12 series includes resistance elements (linear and logarithmic), battery switches, mounting brackets, detents, and shielding, which can be efficiently assembled to customer's order to form an almost infinite variety of carbon and cermet control potentiometers. All types of these rectangular potentiometers are custom built from standard stock parts and are therefore available within comparatively short delivery times. The surveys on the following pages show the most probable combinations of items. The various modular elements are then described, and the electrical and mechanical details of complete units are given. The resistance elements can also be supplied separately.

DESCRIPTION

The potentiometer family can be divided into two groups:

- versions without spindle, to be activated by snap-in devices of customer (survey 1);
- versions with spindle types (survey 2).

All versions have the same type of resistance element (carbon or cermet).

The resistance element is a carbon track on a phenolic paper base, or a metal-glass track on a ceramic Al_2O_3 base, fixed in a plastic housing. The metallic slider has a multi-finger wiper and is mounted in a plastic rotor. Terminals are designated as shown in Fig.1 in accordance with IEC 393-1, sub-clause 4.5.

QUICK REFERENCE DATA

PARAMETER	VALUE
Resistance range (E3 series)	
carbon, linear law	470 Ω to 4.7 M Ω
carbon, logarithmic/reverse logarithmic law	2.2 k Ω to 470 k Ω
cermet, linear law	220 Ω to 4.7 M Ω
Maximum dissipation at $T_{amb} = 40^\circ C$	
carbon, linear law	0.2 W
carbon, logarithmic law	0.1 W
cermet, linear law	1.0 W
Climatic category (IEC 68)	
carbon	25/070/10
cermet	25/070/56

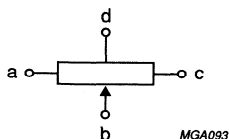


Fig.1 Terminal designation: carbon types.

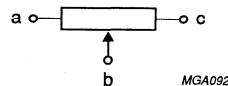

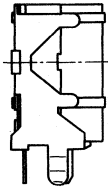


Fig.1 Terminal designation for carbon and cermet types.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

SURVEY 1, VERSIONS WITHOUT SPINDLE

VERSIONS				SINGLE VERTICAL	
				with bracket	with bracket and battery switch
					
		snap-in rotor		•	X
terminal configuration		in-line		•	X
type of terminal	vertical versions	spindle height	10 mm	X	X
			12.5 mm	•	X
		solder tag			
		horizontal versions			
detent		none		•	X
		at 50%		X	

Notes

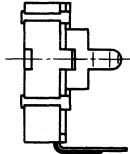
X = available

• = recommended

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

SURVEY 1, VERSIONS WITHOUT SPINDLE (CONTINUED)

VERSIONS			SINGLE HORIZONTAL
			
		snap-in rotor	•
terminal configuration		in-line	•
type of terminal	vertical versions	spindle height	
		10 mm	
	12.5 mm		
		solder tag	
		horizontal versions	•
detent		none	•
		at 50%	X

Notes

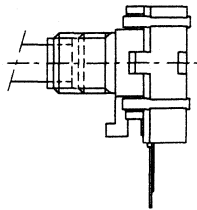
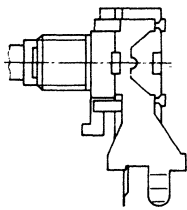
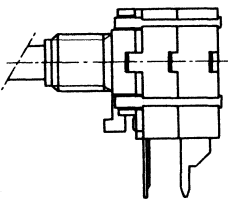
X = available

• = recommended

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

SURVEY 2, VERSIONS WITH SPINDLE

VERSIONS				SINGLE VERTICAL		
				standard	with bracket	with battery switch
						
bushing L = 8 mm	M7	spindle dia. 4 mm	plastic	•	•	•
			metal	•	•	•
		spindle dia. 6 mm	plastic	X	X	X
			metal	X	X	X
type of terminal	vertical versions	spindle height	12.5 mm	•	•	•
			10 mm	X	X	X
		solder tag	X	X		
	horizontal version					
optional	bracket			X	X	
	centre detent (3)		X	X		

Notes

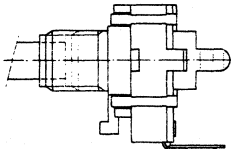
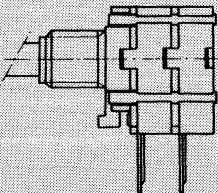
X = available

• = recommended

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

SURVEY 2, VERSIONS WITH SPINDLE (CONTINUED)

VERSIONS				SINGLE HORIZONTAL with bracket	TANDEM VERTICAL
					
bushing L = 8 mm	M7	spindle dia. 4 mm	plastic	•	•
			metal	•	•
		spindle dia. 6 mm	plastic	X	X
			metal	X	X
type of terminal	vertical versions	spindle height	12.5 mm		•
			10 mm		X
		solder tag		X	
	horizontal version		•		
optional	bracket			X	
	centre detent (3)		X	X	

Notes

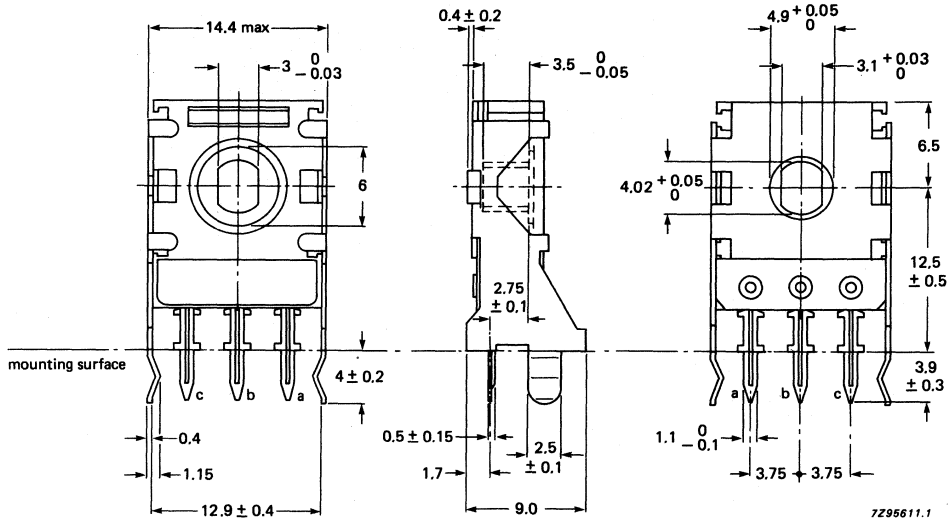
X = available

• = recommended

PP12 Series modular carbon and cermet potentiometers

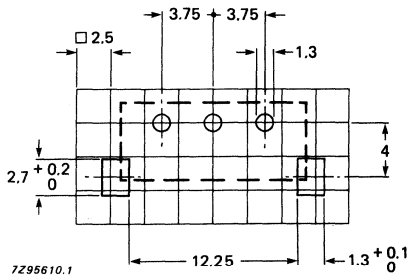
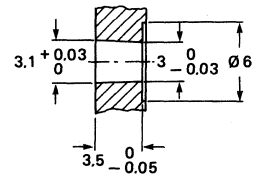
CRC12; MRC12

VERSION WITHOUT SPINDLE, SINGLE VERTICAL WITH BRACKET



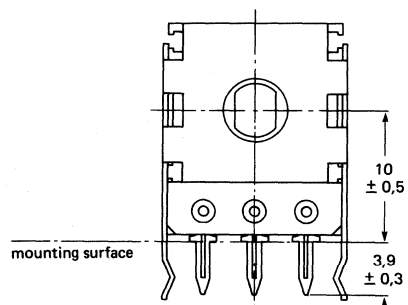
7Z95611.1

Rotor drawn at mid position, long p.w. tags.



7Z95610.1

Hole pattern in printed wiring board, viewed from component side.



7Z95675

Version with spindle height of 10 mm, short p.w. tags.

Dimensions in mm.

Fig.3 Version without spindle, single vertical with bracket.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Table 1 Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series carbon, linear carbon, log/reverse log cermet, linear	470 Ω to 4.7 M Ω ; tolerance 20% 2.2 k Ω to 470 k Ω ; tolerance 20% 220 Ω to 4.7 M Ω ; tolerance 10 or 20%
Resistance law	carbon, types A,B,C (Figs 18, 19, 20) cermet, type A (Fig.18)
Maximum dissipation at $T_{amb} = 40\text{ }^{\circ}\text{C}$ carbon, linear carbon, non-linear cermet, linear	0.2 W 0.1 W 1.0 W
Test voltage (for 1 minute)	350 V, 50 Hz 500 V (DC)
For further information see Electrical Data and Mechanical Data.	

Composition of the catalogue number, PP12 without spindle, single, vertical

2322 5	x	5 00	x	xx
	Code for element: 0 = carbon 1 = cermet		code for tags and detent: 0 = short p.w. tags, no detent 1 = long p.w. tags, no detent 5 = short p.w. tags, detent 50% 6 = long p.w. tags, detent 50%	resistance code (see Table 2)

Table 2 Resistance code

VALUE	UNIT	LAW			
		LINEAR		LOG.*	REV. LOG.*
		See Notes	20%	20%	
220**	Ω	02	52	-	-
470	Ω	03	53	-	-
1	k Ω	04	54	-	-
2.2	k Ω	05	55	25	45
4.7	k Ω	06	56	26	46
10	k Ω	07	57	27	47
22	k Ω	08	58	28	48
47	k Ω	09	59	29	49
100	k Ω	11	61	31	51
220	k Ω	12	62	32	52
470	k Ω	13	63	33	53
1	M Ω	14	64	-	-
2.2	M Ω	15	65	-	-
4.7	M Ω	16	66	-	-

Notes

Codes in linear law columns as follows:

First column - applicable for 10% tolerance cermet or 20% tolerance carbon values.

Second column - applicable for 20% tolerance cermet values only.

For log and reverse log resistance laws attention should be paid to the actuating side as indicated on the outline drawings.

Catalogue numbers for other versions are available on request.

* = carbon only

** = cermet only

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

VERSION WITHOUT SPINDLE, SINGLE HORIZONTAL

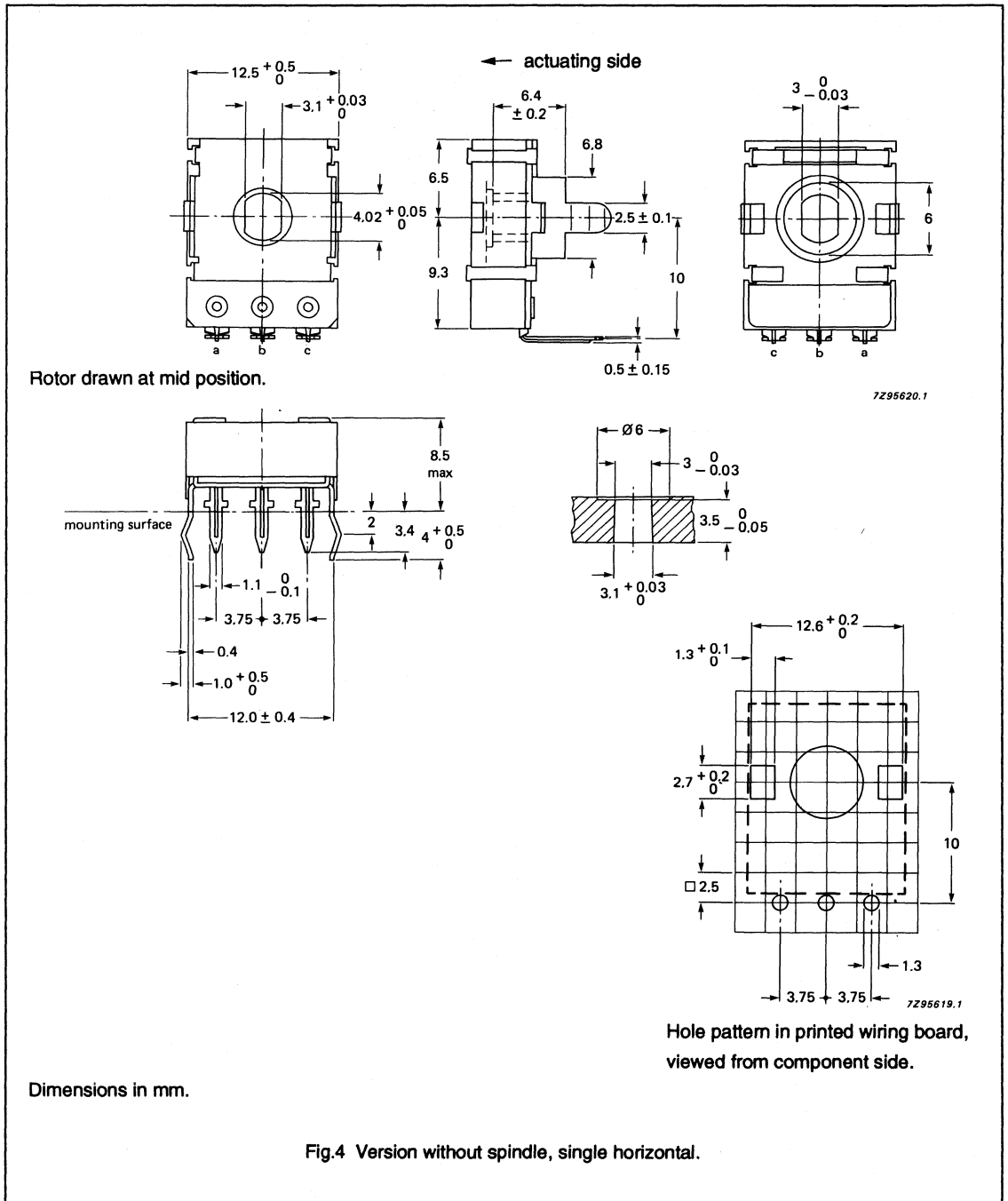


Fig.4 Version without spindle, single horizontal.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Table 3 Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series carbon, linear carbon, log/reverse log cermet, linear	470 Ω to 4.7 MΩ; tolerance 20% 2.2 kΩ to 470 kΩ; tolerance 20% 220 Ω to 4.7 MΩ; tolerance 10 or 20%
Resistance law	carbon, types A,B,C (Figs 18, 19, 20) cermet, type A (Fig.18)
Maximum dissipation at T _{amb} = 40 °C carbon, linear carbon, non-linear cermet, linear	0.2 W 0.1 W 1.0 W
Test voltage (for 1 minute)	350 V, 50 Hz 500 V (DC)
For further information see Electrical Data and Mechanical Data and Battery Switch.	

Composition of the catalogue number, PP12 without spindle, single, horizontal

2322 5	x	5 00	x	xx
	Code for element: 0 = carbon 1 = cermet		code for tags and detent: 3 = p.w. tags, no detent 8 = p.w. tags, detent 50%	resistance code (see Table 4)

Table 4 Resistance code

VALUE	UNIT	LAW			
		LINEAR		LOG.*	REV.LOG.*
		See Notes	20%	20%	
220**	Ω	02	52	-	-
470	Ω	03	53	-	-
1	kΩ	04	54	-	-
2.2	kΩ	05	55	25	45
4.7	kΩ	06	56	26	46
10	kΩ	07	57	27	47
22	kΩ	08	58	28	48
47	kΩ	09	59	29	49
100	kΩ	11	61	31	51
220	kΩ	12	62	32	52
470	kΩ	13	63	33	53
1	MΩ	14	64	-	-
2.2	MΩ	15	65	-	-
4.7	MΩ	16	66	-	-

Notes

Codes in linear law columns as follows:

- First column - applicable for 10% tolerance cermet or 20% tolerance carbon values.
- Second column - applicable for 20% tolerance cermet values only.

For log and reverse log resistance laws attention should be paid to the actuating side as indicated on the outline drawings.

Catalogue numbers for other versions are available on request.

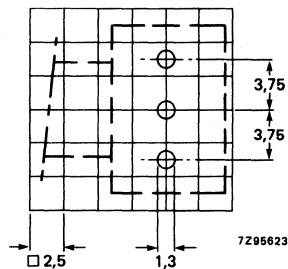
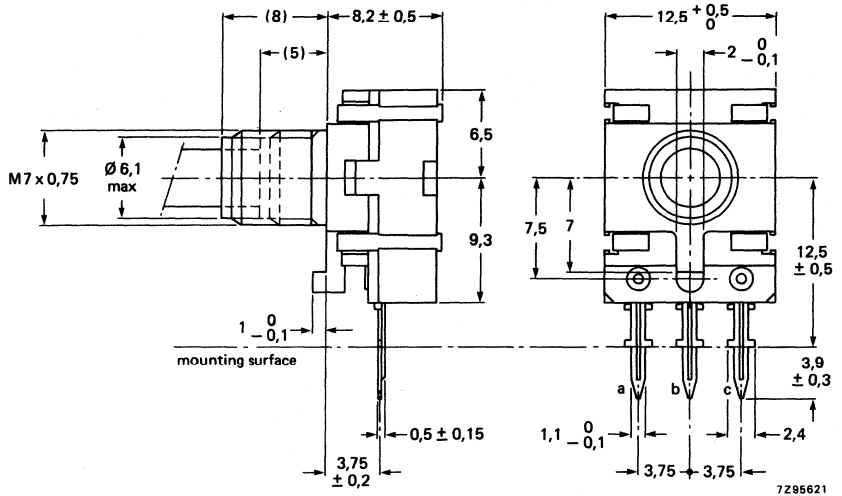
* = carbon only

** = cermet only

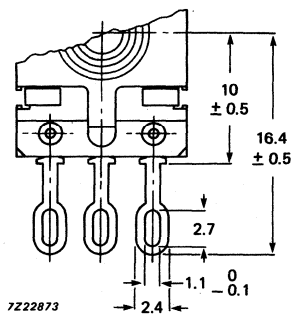
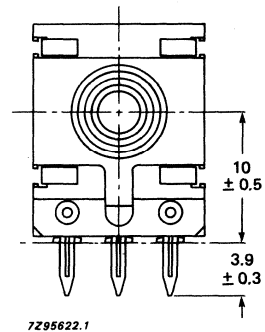
PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

VERSION WITH SPINDLE, SINGLE VERTICAL



Hole pattern in printed wiring board, viewed from component side.



Dimensions in mm.

Fig.5 Version with spindle, single vertical.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Table 5 Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series carbon, linear carbon, log/reverse log cermet, linear	470 Ω to 4.7 M Ω ; tolerance 20% 2.2 k Ω to 470 k Ω ; tolerance 20% 220 Ω to 4.7 M Ω ; tolerance 10 or 20%
Resistance law	carbon, types A,B,C (Figs 18, 19, 20) cermet A type A (Fig.18)
Max. dissip. at $T_{amb} = 40\text{ }^{\circ}\text{C}$ carbon, linear carbon, non-linear cermet, linear	0.2 W 0.1 W 1.0 W
Test voltage (for 1 minute)	500 V, 50 Hz
For further information see Electrical Data and Mechanical Data	

Notes

Codes in linear law columns as follows:

First column - applicable for 10% tolerance cermet or 20% tolerance carbon values.

Second column - applicable for 20% tolerance cermet values only.

Catalogue numbers for other versions are available on request.

* = carbon only

** = cermet only

Composition of the catalogue number, PP12 with spindle, single, vertical

2322 5	x	6	xx	x	xx
	Code for element: 0 = carbon 1 = cermet		code for bushing (see Table 6)	code for tags and detent: 0 = short tags, no detent 1 = long tags, no detent 4 = solder tags, no detent 5 = short tags, detent 50% 6 = long tags, detent 50% 9 = solder tags, detent 50%	resistance code (see Table 7)

Table 6 Bushing and material code

CODE	BUSHING LENGTH	SPINDLE L = 20		
		TYPE	MATERIAL	DIAMETER
00	5	plain	metal	6
01	5	flat	metal	6
02	5	plain	metal	4
03	5	flat	metal	4
04	5	plain	plastic	4
05	8	plain	metal	6
06	8	flat	metal	6
07	8	plain	metal	4
08	8	flat	metal	4
09	8	plain	plastic	4
SPINDLE L = 30				
20	5	plain	metal	6
24	5	plain	plastic	6
25	8	plain	metal	6
29	8	plain	plastic	6

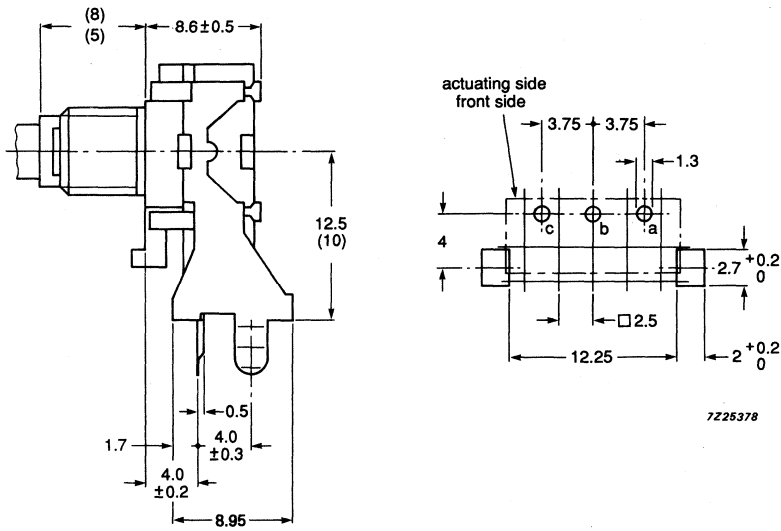
Table 7 Resistance code

VALUE	UNIT	LAW			
		LINEAR		LOG.*	REV. LOG.*
		See Notes		20%	20%
220**	Ω	02	52	-	-
470	Ω	03	53	-	-
1	k Ω	04	54	-	-
2.2	k Ω	05	55	25	45
4.7	k Ω	06	56	26	46
10	k Ω	07	57	27	47
22	k Ω	08	58	28	48
47	k Ω	09	59	29	49
100	k Ω	11	61	31	51
220	k Ω	12	62	32	52
470	k Ω	13	63	33	53
1	M Ω	14	64	-	-
2.2	M Ω	15	65	-	-
4.7	M Ω	16	66	-	-

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

SPECIAL SINGLE VERSION WITH VERTICAL BRACKET



7225378

Dimensions in mm.

Fig.6 Outline and hole pattern for bracket version.

PP12 Series modular carbon and
cermet potentiometers

CRC12; MRC12

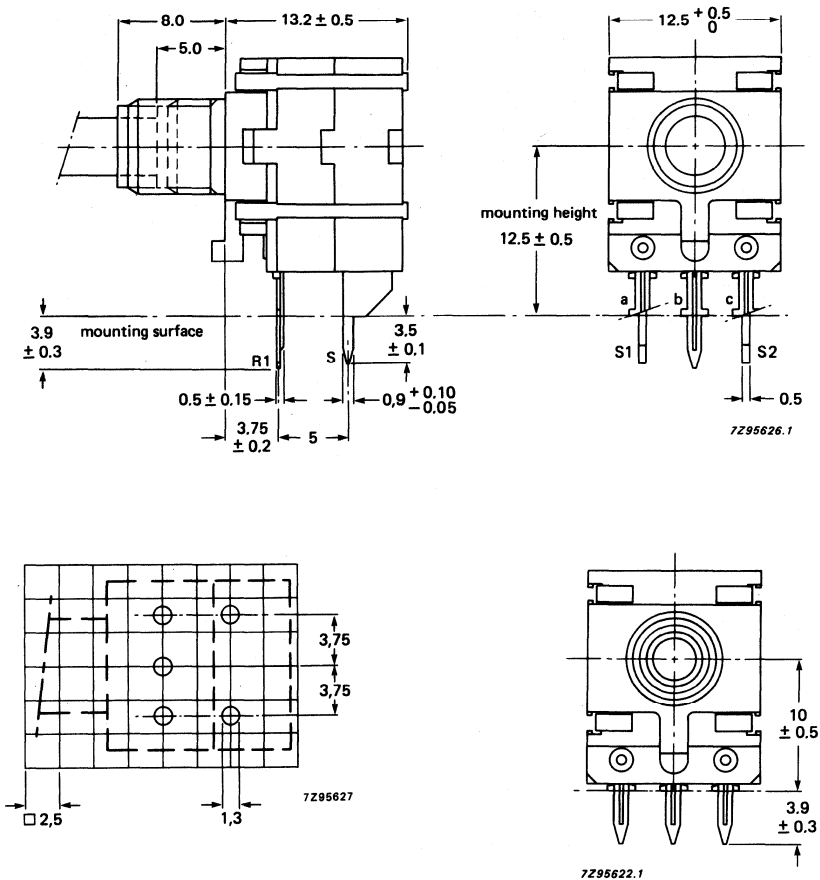
Table 8 Catalogue numbers for PP12 with spindle, single, vertical, with bracket

RESISTANCE			SPINDLE				BUSHING LENGTH	CATALOGUE NUMBER 2322 506
VALUE	UNIT	LAW	TYPE	MATERIAL	LENGTH	DIA.		
1	k Ω	lin	plain	metal	20	4	8	90189
4.7	k Ω	lin	plain	metal	20	4	8	90191
10	k Ω	lin	flat	metal	17	4	8	90153
10	k Ω	lin	slot	metal	18	4	8	90071
10	k Ω	lin	flat	metal	26	4	8	90049
47	k Ω	lin	flat	metal	26	4	8	90051
100	k Ω	lin	plain	metal	38	4	8	90192
470	k Ω	lin	flat	plastic	26	4	8	90052
1	M Ω	log	plain	metal	38	4	8	90193

PP12 Series modular carbon and
cermet potentiometers

CRC12; MRC12

VERSION WITH SPINDLE, SINGLE VERTICAL, WITH BATTERY SWITCH



Hole pattern in printed wiring board,
viewed from component side.

Dimensions in mm.

Fig.7 Version with spindle, single vertical, with battery switch.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Table 9 Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series carbon, linear carbon, log/reverse log cermet, linear	470 Ω to 4.7 M Ω ; tolerance 20% 2.2 k Ω to 470 k Ω ; tolerance 20% 220 Ω to 4.7 M Ω ; tolerance 10 or 20%
Resistance law	carbon, types A,B,C (Figs 18, 19, 20) cermet, type A (Fig.18)
Maximum dissipation at $T_{amb} = 40\text{ }^{\circ}\text{C}$ carbon, linear carbon, non-linear cermet, linear	0.2 W 0.1 W 1.0 W
Test voltage (for 1 minute)	500 V, 50 Hz
For further information see Electrical Data, Mechanical Data and Battery Switch.	

Notes

Codes in linear law columns as follows:

First column - applicable for 10% tolerance cermet or 20% tolerance carbon values.

Second column - applicable for 20% tolerance cermet values only.

Catalogue numbers for other versions are available on request.

* = carbon only

** = cermet only

Composition of the catalogue number, PP12 with spindle, single, vertical, with battery switch

2322 5	x	6	xx	x	xx
	Code for element: 0 = carbon 1 = cermet		code for bushing (see Table 10)	code for tags and detent: 0 = short tags, no detent 1 = long tags, no detent 5 = short tags, detent 50% 6 = long tags, detent 50%	resistance code (see Table 11)

Table 10 Bushing and material code

CODE	BUSHING LENGTH	SPINDLE L = 20		
		TYPE	MATERIAL	DIAMETER
10	5	plain	metal	6
11	5	flat	metal	6
12	5	plain	metal	4
13	5	flat	metal	4
14	5	plain	plastic	4
15	8	plain	metal	6
16	8	flat	metal	6
17	8	plain	metal	4
18	8	flat	metal	4
19	8	plain	plastic	4
SPINDLE L = 30				
30	5	plain	metal	6
34	5	plain	plastic	6
35	8	plain	metal	6
39	8	plain	plastic	6

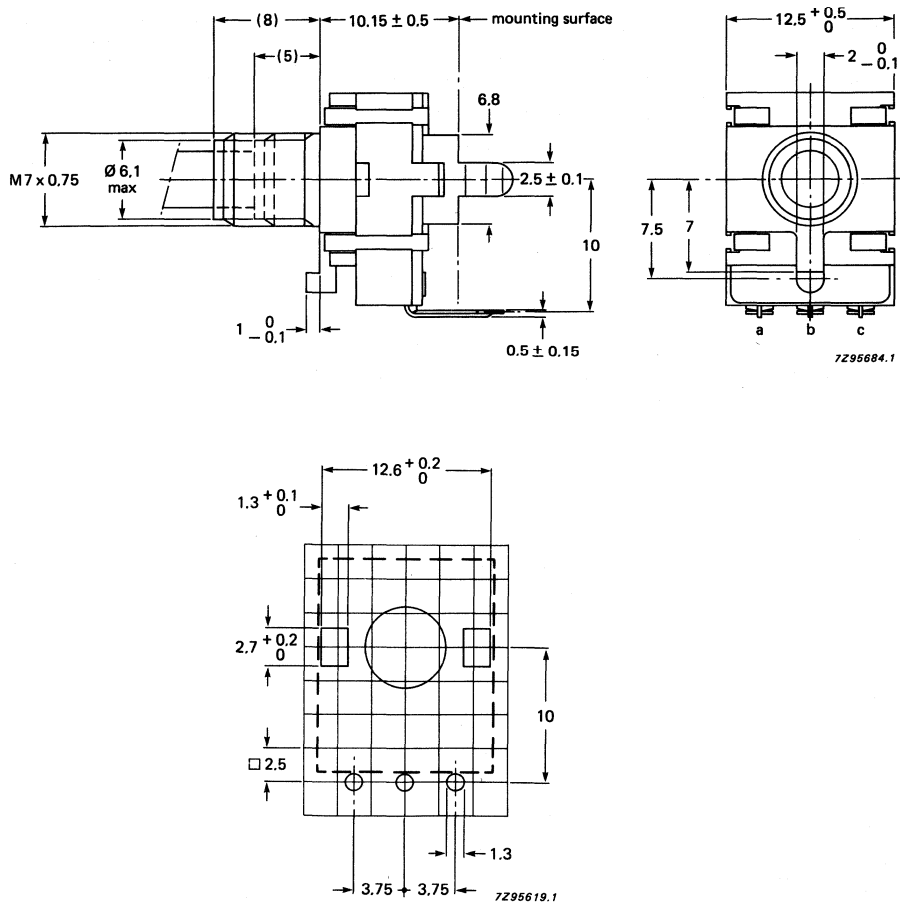
Table 11 Resistance code

VALUE	UNIT	LAW			
		LINEAR		LOG.*	REV. LOG.*
		See Notes		20%	20%
220**	Ω	02	52	-	-
470	Ω	03	53	-	-
1	k Ω	04	54	-	-
2.2	k Ω	05	55	25	45
4.7	k Ω	06	56	26	46
10	k Ω	07	57	27	47
22	k Ω	08	58	28	48
47	k Ω	09	59	29	49
100	k Ω	11	61	31	51
220	k Ω	12	62	32	52
470	k Ω	13	63	33	53
1	M Ω	14	64	-	-
2.2	M Ω	15	65	-	-
4.7	M Ω	16	66	-	-

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

VERSION WITH SPINDLE, SINGLE HORIZONTAL



Hole pattern in printed wiring board, viewed from component side.

Dimensions in mm.

Fig.8 Version with spindle, single horizontal.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Table 12 Main properties

Climatic category	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series carbon, linear carbon, log/reverse log cermet, linear	470 Ω to 4.7 M Ω ; tolerance 20% 2.2 k Ω to 470 k Ω ; tolerance 20% 220 Ω to 4.7 M Ω ; tolerance 10 or 20%
Resistance law	carbon, types A,B,C (Figs 18, 19, 20) cermet, type A (Fig.18)
Maximum dissipation at $T_{amb} = 40\text{ }^{\circ}\text{C}$ carbon, linear carbon, non-linear cermet, linear	0.2 W 0.1 W 1.0 W
Test voltage (for 1 minute)	500 V, 50 Hz
For further information see Electrical Data and Mechanical Data.	

Notes

Codes in linear law columns as follows:

First column - applicable for 10% tolerance cermet or 20% tolerance carbon values.

Second column - applicable for 20% tolerance cermet values only.

Catalogue numbers for other versions are available on request.

* = carbon only

** = cermet only

Composition of the catalogue number, PP12 with spindle, single, horizontal

2322 5	x	6	xx	x	xx
	Code for element: 0 = carbon 1 = cermet		code for bushing (see Table 13)	code for detent: 3 = no detent 8 = detent at 50%	resistance code (see Table 14)

Table 13 Bushing and material code

CODE	BUSHING LENGTH	SPINDLE L = 20		
		TYPE	MATERIAL	DIAMETER
00	5	plain	metal	6
01	5	flat	metal	6
02	5	plain	metal	4
03	5	flat	metal	4
04	5	plain	plastic	4
05	8	plain	metal	6
06	8	flat	metal	6
07	8	plain	metal	4
08	8	flat	metal	4
09	8	plain	plastic	4
SPINDLE L = 30				
20	5	plain	metal	6
24	5	plain	plastic	6
25	8	plain	metal	6
29	8	plain	plastic	6

Table 14 Resistance code

VALUE	UNIT	LAW			
		LINEAR		LOG.*	REV. LOG.*
		See Notes		20%	20%
220**	Ω	02	52	-	-
470	Ω	03	53	-	-
1	k Ω	04	54	-	-
2.2	k Ω	05	55	25	45
4.7	k Ω	06	56	26	46
10	k Ω	07	57	27	47
22	k Ω	08	58	28	48
47	k Ω	09	59	29	49
100	k Ω	11	61	31	51
220	k Ω	12	62	32	52
470	k Ω	13	63	33	53
1	M Ω	14	64	-	-
2.2	M Ω	15	65	-	-
4.7	M Ω	16	66	-	-

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Table 15 Catalogue numbers for PP12 with spindle, single, horizontal, with bracket

RESISTANCE			SPINDLE				BUSHING LENGTH	CATALOGUE NUMBER 2322 506
VALUE	UNIT	LAW	TYPE	MATERIAL	LENGTH	DIA.		
470	Ω	lin	flat	metal	15	4	5	90162
470	Ω	lin	knurl+slot	metal	15	6	5	90172
1	$k\Omega$	lin	flat	metal	15	4	5	90151
1	$k\Omega$	lin	flat	metal	15.3	4	5	90175
1	$k\Omega$	lin	flat	metal	15.3	4	5	90176
1	$k\Omega$	lin	flat	plastic	19.8	6	8	90156
1	$k\Omega$	lin	flat	plastic	20	4	8	90187
2.2	$k\Omega$	lin	flat	metal	15	4	5	90163
2.2	$k\Omega$	lin	flat	plastic	20	4	8	90171
4.7	$k\Omega$	lin	knurl+slot	metal	13	6	5	90166
10	$k\Omega$	log	knurl+slot	metal	13	6	5	90164
10	$k\Omega$	lin	flat	metal	15	4	5	90047
10	$k\Omega$	lin	flat	metal	15.3	4	5	90065
10	$k\Omega$	lin	flat	metal	15.3	4	5	90069
10	$k\Omega$	lin	flat	plastic	19.8	6	8	90157
10	$k\Omega$	lin	plain	plastic	40	6	8	90099
22	$k\Omega$	log	plain	metal	12	4	5	90184
22	$k\Omega$	log	knurl+slot	metal	13	6	5	90198
22	$k\Omega$	lin	flat	metal	15	4	5	90152
22	$k\Omega$	lin	flat	metal	15.3	4	5	90066
47	$k\Omega$	lin	plain	metal	12	4	5	90183
47	$k\Omega$	log	knurl+slot	metal	13	6	5	90165
47	$k\Omega$	lin	flat	plastic	19.8	6	8	90158
100	$k\Omega$	lin	flat	metal	15	4	5	90149
100	$k\Omega$	lin	knurl+slot	metal	15	6	5	90173
100	$k\Omega$	lin	flat	metal	15.3	4	5	90068
220	$k\Omega$	lin	flat	metal	15	4	5	90169
470	$k\Omega$	lin	flat	metal	15	4	5	90067
2.2	$M\Omega$	lin	knurl+slot	metal	13	6	5	90167

PP12 Series modular carbon and
cermet potentiometers

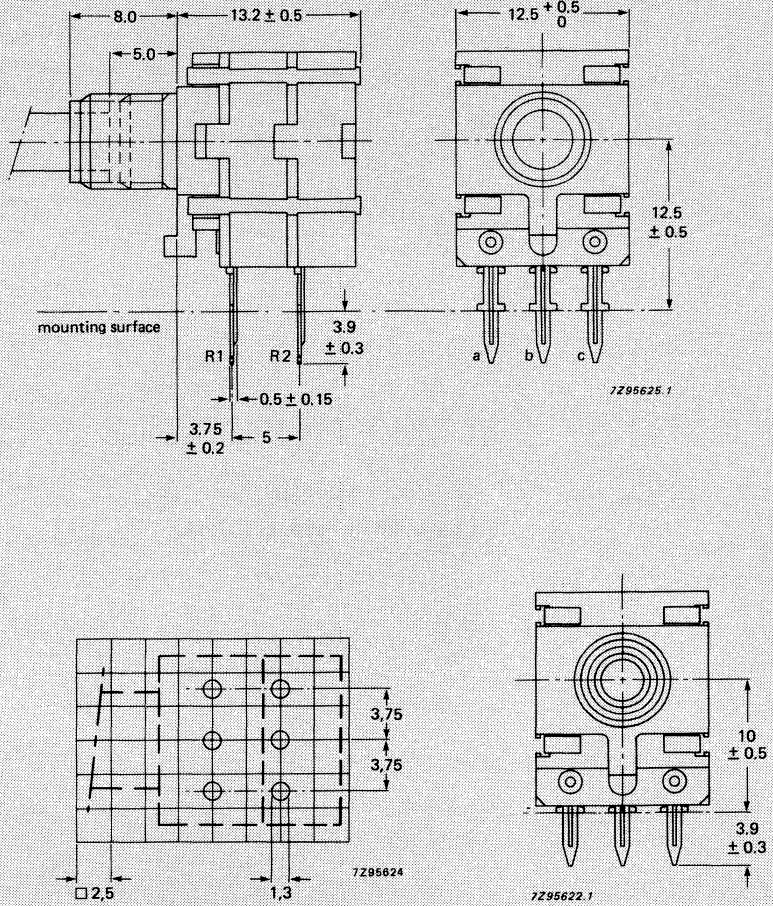
CRC12; MRC12

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PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

VERSION WITH SPINDLE, TANDEM, VERTICAL



Hole pattern in printed wiring board, viewed from component side.

Dimensions in mm.

Fig.9 Version with spindle, tandem vertical.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Table 16 Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series	
carbon, linear	470 Ω to 4.7 MΩ; tolerance 20%
carbon, log/reverse log	2.2 kΩ to 470 kΩ; tolerance 20%
cermet, linear	220 Ω to 4.7 MΩ; tolerance 10 or 20%
Resistance law	carbon, types A,B,C (Figs 18, 19, 20) cermet, type A (Fig.18)
Maximum dissipation at T _{amb} = 40 °C	
carbon, linear	0.2 + 0.2 W
carbon, non-linear	0.1 + 0.1 W
cermet, linear	1.0 + 1.0 W
Test voltage for 1 minute	500 V, 50 Hz
For further information see Electrical Data and Mechanical Data.	

Notes

Codes in linear law columns as follows:

First column - applicable for 10% tolerance cermet or 20% tolerance carbon values.
Second column - applicable for 20% tolerance cermet values only.

Catalogue numbers for other versions are available on request.

* = carbon only

** = cermet only

Composition of the catalogue number, PP12 with spindle, tandem, vertical

2322 5	x	7	xx	x	xx
	Code for element: 0 = carbon 1 = cermet		code for bushing (see Table 17)	code for tags and detent: 0 = short tags, no detent 1 = long tags, no detent 5 = short tags, detent 50% 6 = long tags, detent 50%	resistance code (see Table 18)

Table 17 Bushing and material code

CODE	BUSHING LENGTH	SPINDLE L = 20		
		TYPE	MATERIAL	DIAMETER
00	5	plain	metal	6
01	5	flat	metal	6
02	5	plain	metal	4
03	5	flat	metal	4
04	5	plain	plastic	4
05	8	plain	metal	6
06	8	flat	metal	6
07	8	plain	metal	4
08	8	flat	metal	4
09	8	plain	plastic	4
		SPINDLE L = 30		
20	5	plain	metal	6
24	5	plain	plastic	6
25	8	plain	metal	6
29	8	plain	plastic	6

Table 18 Resistance code

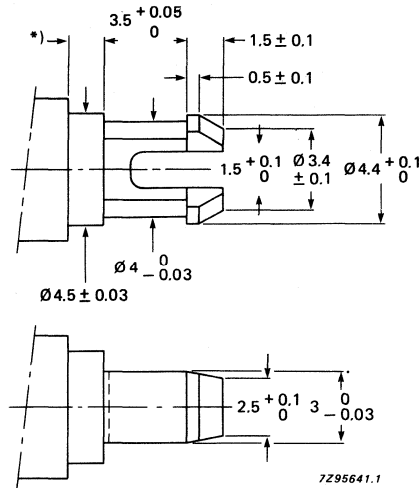
VALUE	UNIT	LAW			
		LINEAR		LOG.*	REV. LOG.*
		See Notes			
220**	Ω	02	52	-	-
470	Ω	03	53	-	-
1	kΩ	04	54	-	-
2.2	kΩ	05	55	25	45
4.7	kΩ	06	56	26	46
10	kΩ	07	57	27	47
22	kΩ	08	58	28	48
47	kΩ	09	59	29	49
100	kΩ	11	61	31	51
220	kΩ	12	62	32	52
470	kΩ	13	63	33	53
1	MΩ	14	64	-	-
2.2	MΩ	15	65	-	-
4.7	MΩ	16	66	-	-

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

ACTUATING DEVICE FOR POTENTIOMETERS WITHOUT SPINDLE

Fig.10 shows the snap-in part of a plastic actuating device for a single module.



* See Figs 11 and 12.
Dimensions in mm.

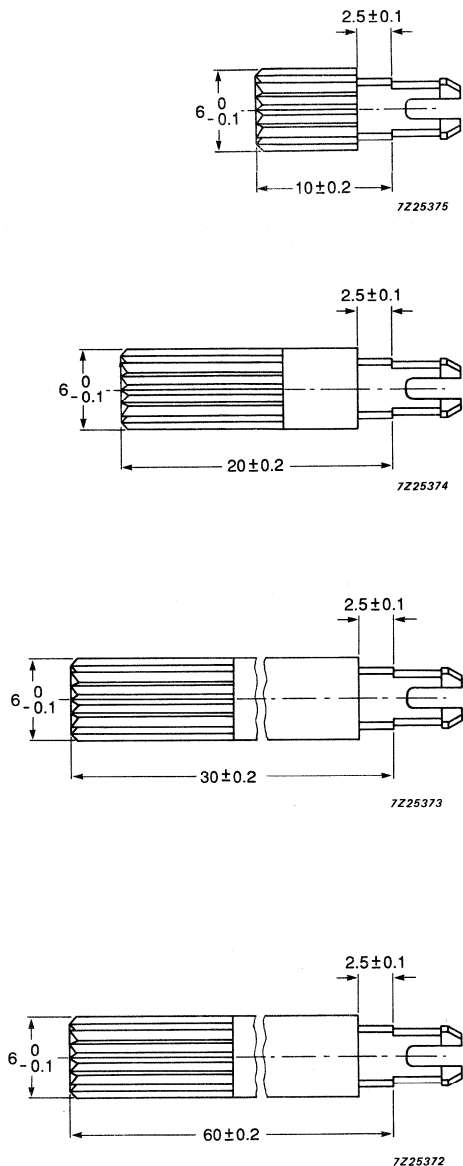
Fig.10 Dimensions for snap-in section of actuating device.

Table 19 Snap-in device codes (see Figs.11 and 12)

LENGTH	CODE NUMBER 4322 046	COLOUR	TYPE
10 mm	20081	black	shaft ϕ 6 mm
20 mm	20091	black	shaft ϕ 6 mm
30 mm	20101	black	shaft ϕ 6 mm
60 mm	20111	black	shaft ϕ 6 mm
25 mm	20121	black	thumbwheel
30.7 mm	20131	black	thumbwheel

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

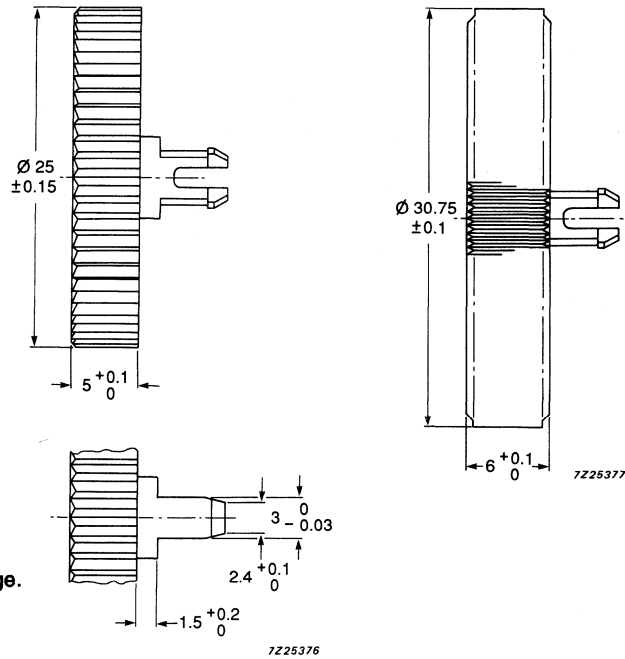


Available in black only.
Dimensions in mm.

Fig.11 Small diameter plastic actuating devices.

PP12 Series modular carbon and
cermet potentiometers

CRC12; MRC12



Available in black, grey or beige.
Dimensions in mm.

Fig.12 Thumbwheel actuating devices.

PP12 Series modular carbon and cermet potentiometers

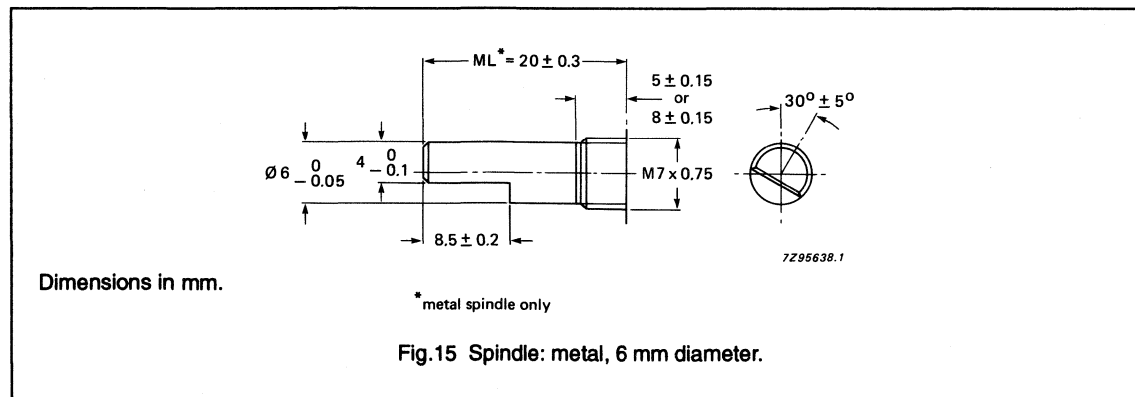
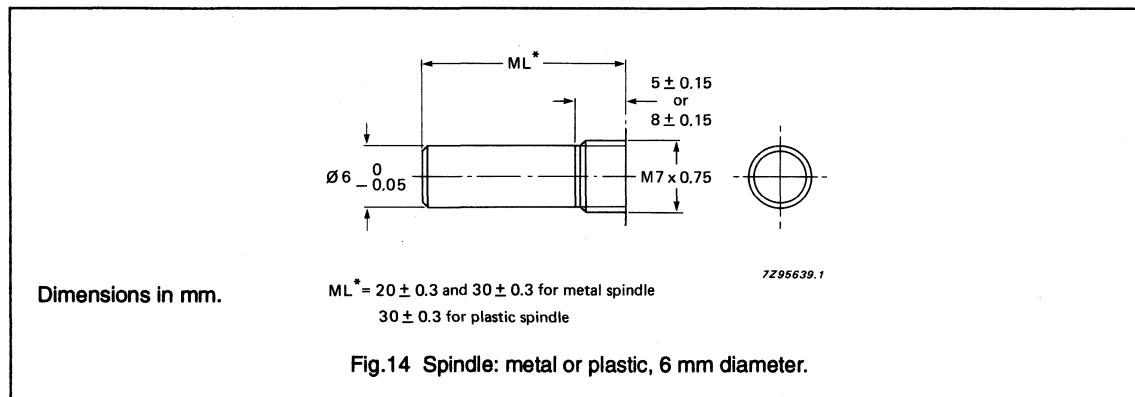
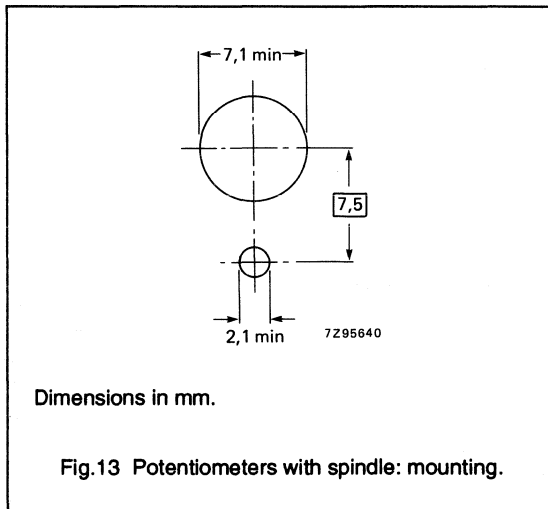
CRC12; MRC12

MOUNTING HOLES FOR POTENTIOMETERS WITH SPINDLE

These details apply to single and tandem potentiometers. The potentiometer is to be mounted with the supplied mounting nut, together with an M7 x 0.75 mm bush. The maximum tightening torque is 1 Nm and the minimum thickness of mounting plate is 1 mm. Fig.13 shows the dimensions of the chassis mounting holes.

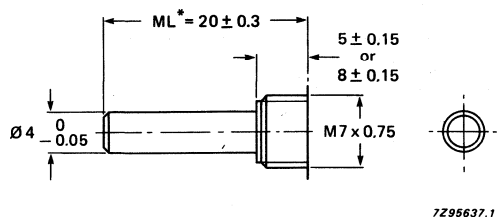
SPINDLES, METAL OR PLASTIC, M7 BUSHING

Figs 14 to 17 are shown at the counter-clockwise position.



PP12 Series modular carbon and
cermet potentiometers

CRC12; MRC12

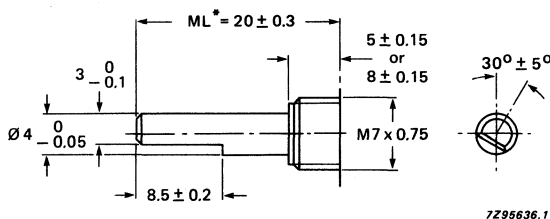


7Z95637.1

Dimensions in mm.

* metal and plastic spindles

Fig.16 Spindle: metal or plastic, 4 mm diameter.



7Z95636.1

Dimensions in mm.

* metal spindle only

Fig.17 Spindle: metal, 4 mm diameter.

ELECTRICAL DATA

Unless otherwise specified, all values are valid at an ambient temperature of 18 to 22 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

For measuring and test methods, see IEC publications 393-1 and 68. The terms used are explained in the Glossary of terms.

Note

The requirements are valid for most of the nominal resistance values. The lowest and highest can deviate from specification.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

PARAMETER	RESISTANCE ELEMENT	
	CARBON	CERMET
Resistance range, E3 series: potentiometers without spindle linear law log/reverse log law potentiometers with spindle linear law log/reverse log law	470 Ω to 4.7 M Ω 2.2 k Ω to 470 k Ω	220 Ω to 4.7 M Ω 220 Ω to 4.7 M Ω
Tolerance on resistance	$\pm 20\%$	$\pm 10\%$ or $\pm 20\%$
Resistance law and tolerances	A,B,C: Figs 18, 19, 20	A: Fig. 18
Ganging tolerance (tandem potentiometers)	standard	special
linear law at values between 10 and 90% of R_{total}	<2 dB	
(reserved) logarithmic law at attenuations between 0 and 20 dB at attenuations between 20 and 40 dB at attenuations between 40 and 60 dB	<2 dB <3 dB <6 dB	
with a tap at 10% of R_{total} , tap load 1% of R_{total} or with a tap at 20% of R_{total} , tap load 6.2% of R_{total} at attenuations between 0 and 20 dB at attenuations between 20 and 40 dB at attenuations between 40 and 60 dB at attenuations between 60 and 70 dB	<2 dB <3 dB <4 dB <6 dB	<2 dB <3 dB <3 dB <3 dB
Terminal resistance, (residual)	$\leq 10 \Omega$	$\leq 1\%$ or R_n or 1 Ω
Contact resistance moving (CRM) linear law log/reverse log law	$\leq 2\%$ of R_{ac} $\leq 4\%$ of R_{ac}	$\leq 2.5\%$ of R_{ac}
Contact resistance variation (CRV), (acc. to IEC 393-1, sub. clause 4.17) initially, linear law log/reverse log law	$\leq 1\%$ $\leq 2\%$	$\leq 1\%$ of R_{ac}
Temperature coefficient of resistance type A,B,C; 1 M Ω to 4.7 M Ω (note 1)	$\pm 500 \times 10^{-6}/K$ $\pm 1000 \times 10^{-6}/K$	$\pm 100 \times 10^{-6}/K$
Insulation resistance after damp heat test (IEC 68, test C)	after 10 days: $\geq 100 \text{ M}\Omega$	after 56 days: $\geq 100 \text{ M}\Omega$

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

PARAMETER	RESISTANCE ELEMENT	
	CARBON	CERMET
Maximum attenuation $R_{tot} \geq 22 \text{ k}\Omega$, type A,B,C $R_{tot} < 22 \text{ k}\Omega$, type A $R_{tot} < 22 \text{ k}\Omega$, type B,C	$\geq 90 \text{ dB}$ $\geq 55 \text{ dB}$ $\geq 75 \text{ dB}$	
Maximum dissipation at $T_{amb} = 40 \text{ }^\circ\text{C}$ (P_{max}) (note 1) linear law log/reverse log law	0.2 W 0.1 W	1.0 W
Rated element voltage, see Table 20 or 21, 500 VDC or 350 VAC never to be exceeded	$\sqrt{P_{max} \times R_{nom}}$	$\sqrt{P_{max} \times R_{nom}}$
Limiting slider current, see Table 20 or 21	$\sqrt{P_{max}/R_{nom}}$	$\sqrt{P_{max}/R_{nom}}$
Test voltage for 1 minute	500 V, 50Hz	500 V, 50Hz
Operating temperature range	-25 to +70 °C	-25 to +70 °C
Storage temperature range	-40 to +85 °C	-40 to +85 °C
Climatic category (IEC 68)	25/070/10	25/070/56

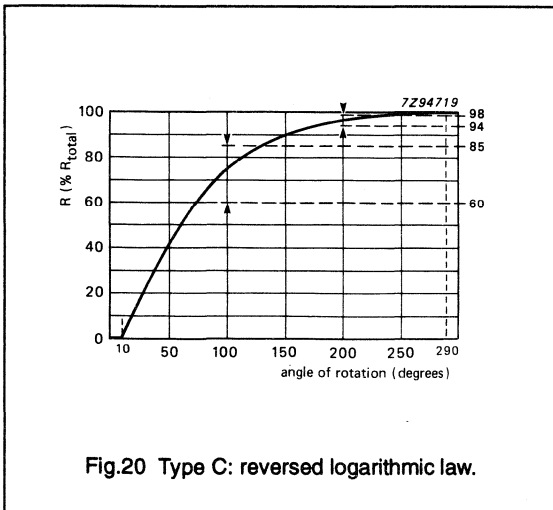
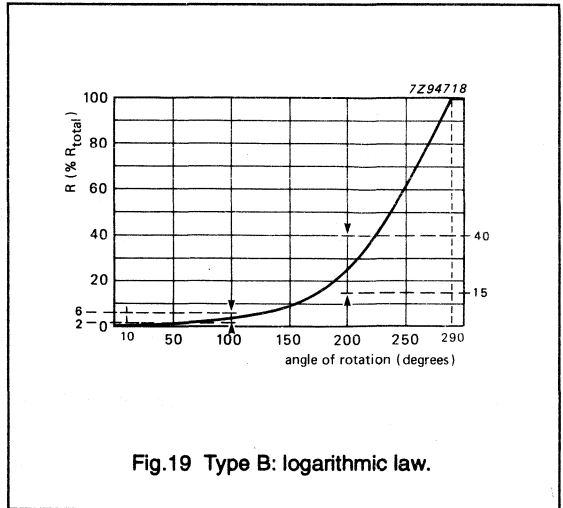
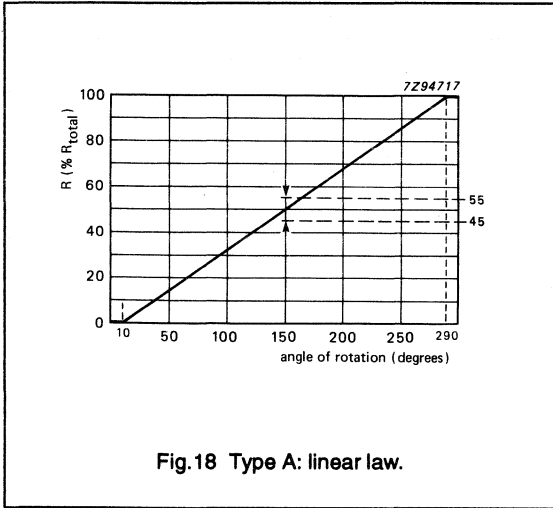
Note

1. See Fig.22 for derating.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Characteristics of potentiometers without switch



PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

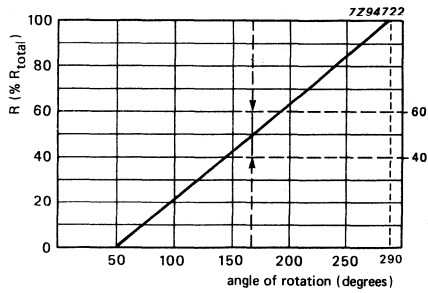


Fig.21 Type A: linear law (potentiometer with switch).

Characteristics of potentiometers with switch

The curves of Figs 18 to 20 have to be adapted since the effective angle of rotation is from 50° to 290°. An example for linear law is given in Fig.21.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Table 20 Rated element voltage: carbon types A to C

VALUE	UNIT	RESISTANCE LAW	RATED ELEMENT VOLTAGE DC		LIMITING SLIDER CURRENT	
			AT 40 °C (V)	AT 70 °C (V)	AT 40 °C mA	AT 70 °C mA
470	Ω	lin	9	6	20	14
1	k Ω	lin	14	10	14	10
2.2	k Ω	lin	21	14	9.5	6.7
4.7	k Ω	lin	30	21	6.5	4.6
10	k Ω	lin	44	31	4.5	3.2
22	k Ω	lin	66	47	3.0	2.1
47	k Ω	lin	97	68	2.0	1.5
100	k Ω	lin	141	100	1.4	1.0
220	k Ω	lin	210	148	1.0	0.7
470	k Ω	lin	306	216	0.7	0.5
1	M Ω	lin	447	316	0.4	0.3
2.2	M Ω	lin	500	470	0.3	0.2
4.7	M Ω	lin	500	500	0.2	0.15
2.2	k Ω	log/rev.log.	14	21	6.5	4.6
4.7	k Ω	log/rev.log.	21	15	4.6	3.3
10	k Ω	log/rev.log.	31	22	3.2	2.2
22	k Ω	log/rev.log.	47	33	2.1	1.5
47	k Ω	log/rev.log.	68	48	1.5	1.0
100	k Ω	log/rev.log.	100	70	1.0	0.7
220	k Ω	log/rev.log.	148	104	0.7	0.5
470	k Ω	log/rev.log.	216	153	0.5	0.3

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Table 21 Rated element voltage: cermet, type A only

VALUE	UNIT	RESISTANCE LAW	RATED ELEMENT VOLTAGE DC		LIMITING SLIDER CURRENT	
			AT 40 °C (V)	AT 70 °C (V)	AT 40 °C mA	AT 70 °C (mA)
220	Ω	lin	14.8	10.5	67.4	47.7
470	Ω	lin	21.7	15.3	46.1	32.6
1	kΩ	lin	31.6	22.4	31.6	22.4
2.2	kΩ	lin	46.9	33.2	21.3	15.1
4.7	kΩ	lin	50	48.5	10.6	10.3
10	kΩ	lin	50	50	5	5
22	kΩ	lin	50	50	2.3	2.3
47	kΩ	lin	50	50	1.1	1.1
100	kΩ	lin	50	50	0.5	0.5
220	kΩ	lin	50	50	0.2	0.2
470	kΩ	lin	50	50	0.1	0.1
1	MΩ	lin	50	50	0.1	0.1
2.2	MΩ	lin	50	50		
4.7	MΩ	lin	50	50		

Derating

Modules covered by this specification are derated from 100% rated dissipation at 40 °C to zero dissipation at 100 °C. This dissipation below 40 °C is the rated dissipation.

Linear law 100% = 0.2 W	carbon versions
Non-linear law 100% = 0.1 W	carbon versions
100% = 1W	cermet versions

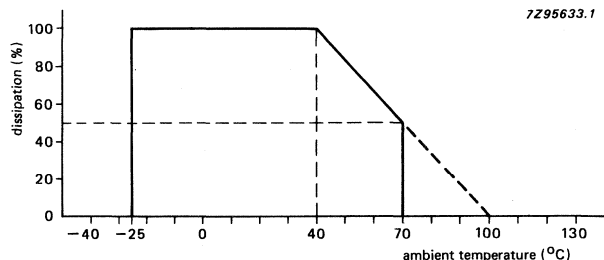


Fig.22 Maximum permissible dissipation as a function of ambient temperature.

**PP12 Series modular carbon and
cermet potentiometers**

CRC12; MRC12**MARKING**

The potentiometers are marked according to IEC 62 as follows:

- nominal resistance (in RKM code)
- resistance law
- code for year and month of manufacture.

PACKAGING

Modules: vertical and horizontal:

- 200 items in blister pack - 200 per box
- or -
- 200 items in blister pack - 1000 per box.

Spindle types:

- 100 items per box in expanded polystyrene shells.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

MECHANICAL DATA

PARAMETER	VALUE FOR TYPE				UNIT
	VERSION WITHOUT SPINDLE		VERSION WITH SPINDLE		
	SINGLE	TANDEM	SINGLE	TANDEM	
Maximum axial force	60	60	80	80	N
Operating torque initial	3 to 10	3 to 16	3 to 12	3 to 18	mNm
Operating torque initial (with switch)	3 to 14	3 to 18	3 to 18	5 to 20	mNm
Operating torque of switch	10 to 30	10 to 30	10 to 30	10 to 30	mNm
Maximum permissible end-stop torque	400	400	600*	600*	mNm
Angle of rotation	300 ±2	300 ±2	300 ±2	300 ±2	deg
Effective angle of rotation	280 ±5	280 ±5	280 ±5	280 ±5	deg
Effective angle of rotation (with switch)	240 ±8.5	240 ±8.5	240 ±8.5	240 ±8.5	deg
Axial rotor/spindle play			≤0.2	≤0.2	mm
Radial rotor/spindle play			≤0.2 per 10 mm	≤0.2 per 10 mm	mm

Note

*For metal spindles; 400 mNm for plastic spindles.

PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

Angle of rotation

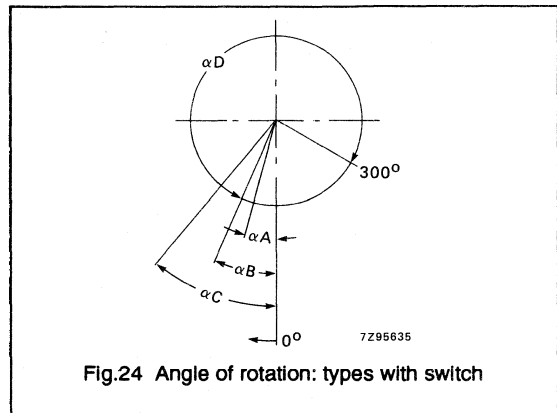
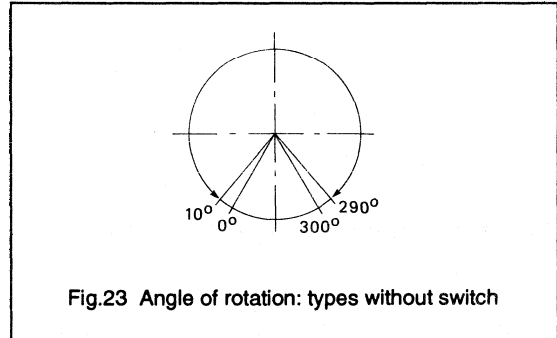
Types without switch (see Fig.23):	
Total mechanical angle	0° to $300^\circ \pm 2^\circ$
Effective R-angle	10° to 290°
Types with switch (see Fig.24):	
Total mechanical angle	0° to $300^\circ \pm 5^\circ$
Effective angle	50° to $290^\circ \pm 5^\circ$
αA : switch angle (Switch at "on" position and rotor at leftmost off position (CCW))	$15^\circ \pm 10^\circ$ (CCW)
αB : switch-off angle	$23^\circ \pm 10^\circ$ (CW off to on position)
αC : effective resistance starting angle	$50^\circ \pm 5^\circ$
αD : switch-on angle	$277^\circ \pm 10^\circ$ (CW in on position)

Mounting

The potentiometers with printed-wiring terminals are intended for PC board mounting with a grid pitch of 1e (2.54 mm). The holes in the board should be 1.3 mm; the board thickness not over 2 mm. Potentiometers with bushing should be mounted as shown in Fig.13.

The switch

The spring actuated switch is specially designed for the modular PP12 potentiometer system. The terminals must be soldered with the switch in 'off' position.



PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

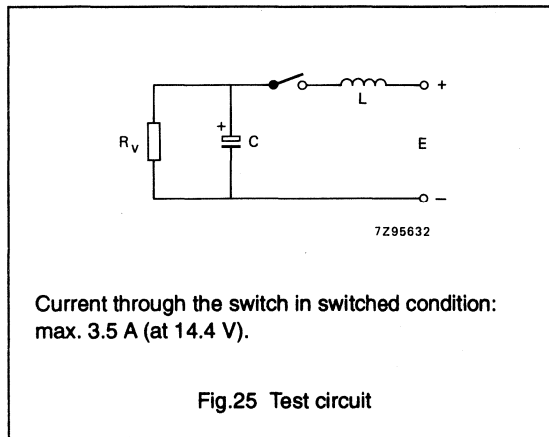
ELECTRICAL RATINGS AND CHARACTERISTICS

Unless otherwise specified, all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

PARAMETER	VALUE	UNIT
DC voltage rating (note 1)	14.4	V
DC current rating (note 1)	3.5	A
Isolation voltage, DC, for 1 minute		
initial	500	V
after 21 days humidity test to IEC58	100	V
Contact resistance (C.R.) at max. 20 mV (DC or AC) and 100 mA	≤20	mΩ
Insulation resistance (note 2)		
initial	≥100	MΩ
after 21 days humidity test to IEC 68	≥2	MΩ
Climatic sequence	ΔCR ≤30	mΩ
Damp heat, steady state	ΔCR ≤30	mΩ
Electrical endurance, 1000 h at 70 °C, 3.5 A, AC	ΔCR ≤30	mΩ
Bump and vibration (no interruption during test)	ΔCR ≤30	mΩ

Notes

- The specification holds for the switch being used as depicted in Fig.25. Connection of the plus pole: under consideration.
During the switching action the current through the switch is determined by:
 $E = 16 \text{ V (DC)}$; $L = 250 \text{ } \mu\text{H}$ ($R = 150 \text{ m}\Omega$); $C = 1000 \text{ } \mu\text{F}$; $R_v = 32 \text{ } \Omega$.
- Measured between the switch terminals and measured between the interconnected terminals and other metal parts.



PP12 Series modular carbon and cermet potentiometers

CRC12; MRC12

ENVIRONMENTAL TESTS

The requirements are valid for most of the nominal resistance values. The lowest and highest can deviate from specification.

TEST	CONDITION	REQUIREMENTS	
		CARBON	CERMET
Climatic sequence	$\Delta R_{ac}/R_{ac}$	$\leq 10\%$	$\leq 2\%$
Damp heat, steady state	$\Delta R_{ac}/R_{ac}$	15%	$\leq 2\%$
Mechanical endurance			
10 000 cycles	$\Delta R_{ac}/R_{ac}$	$\leq 10\%$	
50 000 cycles	$\Delta R_{ac}/R_{ac}$		$\leq 2\%$
Electrical endurance			
1000 h at 70 °C, cyclic	$\Delta R_{ac}/R_{ac}$	$\leq 10\%$	$\leq 2\%$
Resistance to soldering heat (IEC68-2, test T _b)	$\Delta R_{ac}/R_{ac}$	$\leq 2\%$	$\leq 0.5\%$
Change of temperature			
	$\Delta R_{ac}/R_{ac}$	$\leq 3\%$	$\leq 1\%$
	$\Delta V_{ab}/V_{ac}$	$\leq 1\%$	$\leq 0.5\%$
Bump and vibration			
	$\Delta R_{ac}/R_{ac}$	$\leq 2\%$	$\leq 2\%$
	$\Delta V_{ab}/V_{ac}$	$\leq 1\%$	$\leq 1\%$

MODULAR CARBON AND CERMET POTENTIOMETERS

The PP17 series includes resistance elements (linear and logarithmic), battery switches, drive units, mounting brackets, detents, shielding, cover, and heatsink, which can be efficiently assembled to customer's order to form an almost infinite variety of carbon and cermet control potentiometers. All types of these rectangular potentiometers are custom built from standard stock parts and are therefore available within comparatively short delivery times. The surveys on the following pages show the most probable combinations of items. The various modular elements are then described, and the electrical and mechanical details of complete units are given. The resistance elements can also be supplied separately.

QUICK REFERENCE DATA

Resistance range (E3 series)	
carbon, linear law	220 Ω to 2,2 M Ω
carbon, logarithmic law	2200 Ω to 2,2 M Ω
cermet, linear law	220 Ω to 4,7 M Ω
Maximum dissipation at $T_{amb} = 40\text{ }^{\circ}\text{C}$	
carbon, linear law	0,2 W
carbon, logarithmic law	0,1 W
cermet, linear law	1 to 3 W
Climatic category (IEC 68)	
carbon	25/070/10
cermet, versions with metal spindle	40/100/56
cermet, versions with plastic spindle or without spindle	25/070/56

DESCRIPTION

The potentiometer family can be divided into two groups:

- versions without spindle, to be activated by customized snap-in devices (survey 1);
- versions with one of many available spindle types (survey 2);

All versions can be supplied with either carbon or cermet resistance elements, fixed in a self extinguishing glass-fibre filled polycarbonate housing (black).

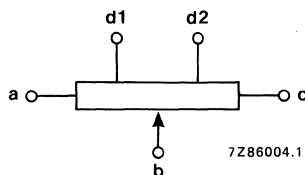

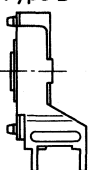
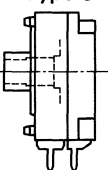
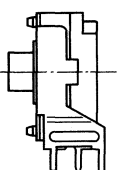


Fig. 1 Designation of terminals.

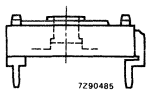
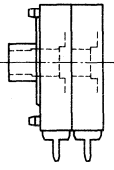
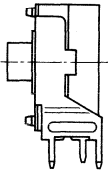
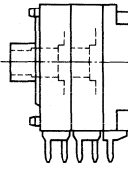
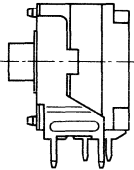
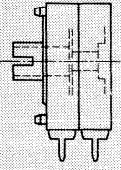
The carbon resistance element is a carbon track on a phenolic paper substrate; the cermet resistance element is Al_2O_3 substrate. The metallic multi-finger wiper is mounted in a plastic rotor. Terminals are designated as shown in Fig. 1 in accordance with IEC 393-1, sub-clause 4.5.

SURVEY 1, VERSIONS WITHOUT SPINDLE

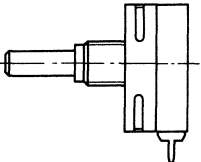
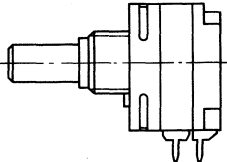
version		single vertical			
		Type A 	Type B 	Type C 	
			with bracket	with battery switch	with bracket and battery switch
Catalogue numbers		2322 5.0 0....	2322 5.0 0....	2322 5.0 100..	2322 5.0 120..
rotor	flat, snap-in		•	•	
	protruding, snap-in		•	•	•
	flat, slotted		X (1)		
terminal configuration	in-line		•	•	•
	staggered		•	•	• tap version
type of terminal	vertical versions	spindle height	12,5 mm	•	•
			18,0 mm	X	
	solder tag		X		
	horizontal version				
optional	metal shield		X		
	plastic cover		X		

X = available
• = preferred.

(1) Used in versions with spindle.

single horizontal	tandem vertical				dual vertical
Type D					Type E
 <p>7290485</p>		 <p>with bracket</p>	 <p>with battery switch</p>	 <p>with bracket and battery switch</p>	
2322 5.0 0.5..	2322 5.0 05...	2322 5.0 07...	2322 5.0 150..	2322 5.0 170..	2322 5.0 9....
•					
•	•	•	•	•	X
X (1)					
•	•	•	•	•	X
	•	•	• tap versions	X tap versions	X
	•	•	•	•	X
	X				X
	X				X
•					
	X	X			X
	X	X			X

SURVEY 2, VERSIONS WITH SPINDLE

				single vertical	
				Type F	Type G
version					 with battery switch
Catalogue numbers				2322 5.1 0....	2322 5.1 1....
bushing L = 8 mm (1)	M7	spindle dia. 4 mm	plastic	● (10)	● (10)
			metal	● (9)	● (9)
	M10	spindle dia. 6 mm	plastic	● (10)	● (10)
			metal	● (9)	● (9)
type of terminal (2)	vertical versions	spindle height	12,5 mm	●	●
			18,0 mm	X	
	solder tag			X	X
horizontal version					
optional	slow-motion drive 4, 6: 1			X	
	centre detent (3), carbon only			X	
	metal shield			X	
	plastic cover			X	
	heatsink, cermet only			X	

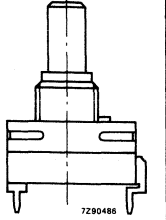
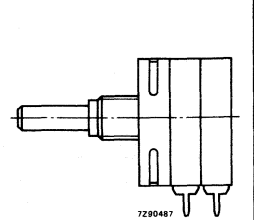
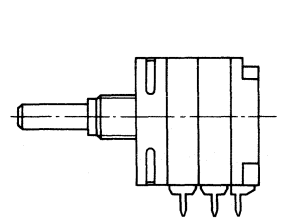
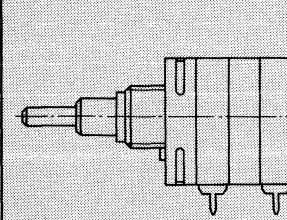
X = available.

● = preferred.

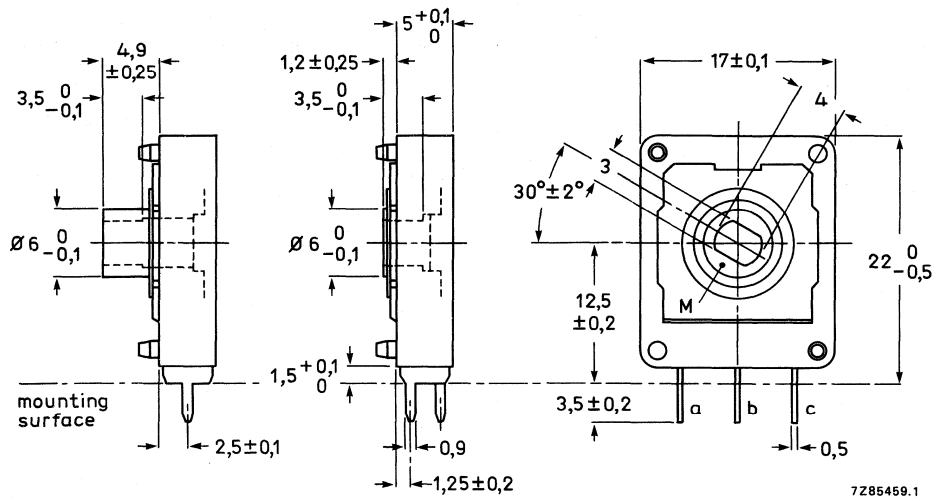
(1) The figures between brackets give the number of spindle types.

(2) See sheet of relevant version for terminal configuration.

(3) More detents on request.

single horizontal	tandem vertical		dual vertical
Type H	Type I	Type H	Type J
 <p>7290486</p>	 <p>7290487</p>	 <p>with battery switch</p>	
2322 5.1 9....	2322 5.2 0....	2322 5.2 1....	2322 5.3
● (10)	● (10)	● (10)	
● (9)	● (9)	● (9)	X (1)
● (10)	● (10)	● (10)	
● (9)	● (9)	● (9)	X (1)
	●	●	X
	X	X	X
	X	X	X
●			
X	X		
X	X		X
	X		X
	X		X
	X		X

VERSION WITHOUT SPINDLE, SINGLE VERTICAL (TYPE A)



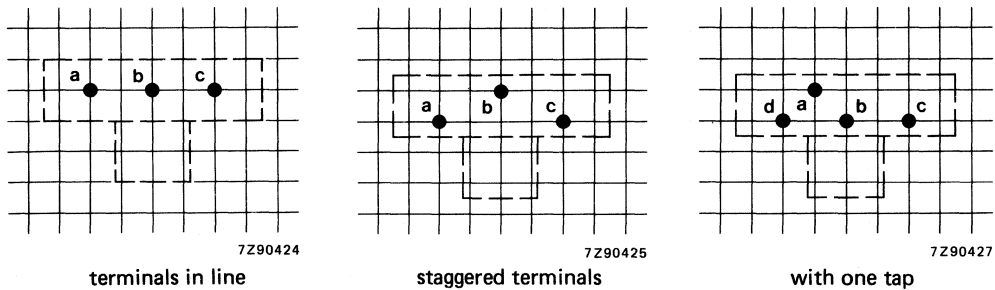
7285459.1

Rotor drawn at fully counter-clockwise position. M = mark for position of slider.
For other terminals see Fig.34.

Fig.2 Version without spindle, single vertical.

Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side.
Hole diameter $1,3 \pm 0,05$ mm.



terminals in line

staggered terminals

with one tap

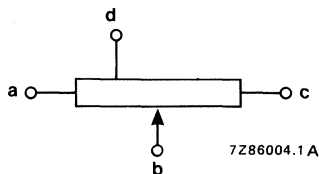


Fig.3 Version without spindle, single vertical: hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series	
carbon, linear (linearity 4%)	220 Ω to 2,2 MΩ, tolerance 20%
carbon, non-linear	2200 Ω to 2,2 MΩ, tolerance 20%
cermet, linear (linearity 4%)	220 Ω to 4,7 MΩ, tolerance 10%
Resistance law (see Fig.35)	carbon A, B, C, H cermet A
Maximum dissipation at T _{amb} = 40 °C	
carbon, linear	0,2 W
carbon, non-linear	0,1 W
cermet, linear	1,25 W
Test voltage for 1 minute	500 V, 50 Hz
with plastic cover	1000 V, 50 Hz

For further information see Electrical Data and Mechanical Data.

Composition of the catalogue number, PP17 without spindle, single, vertical

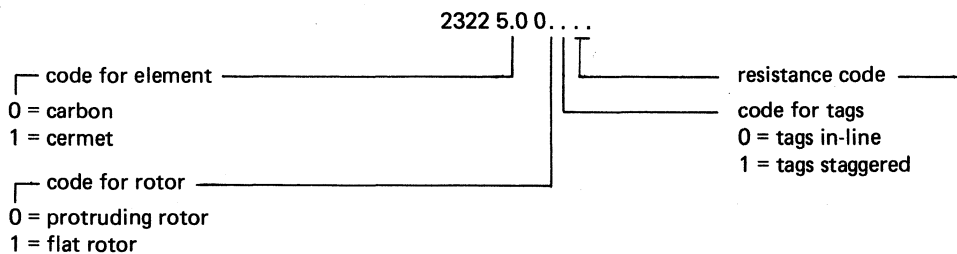


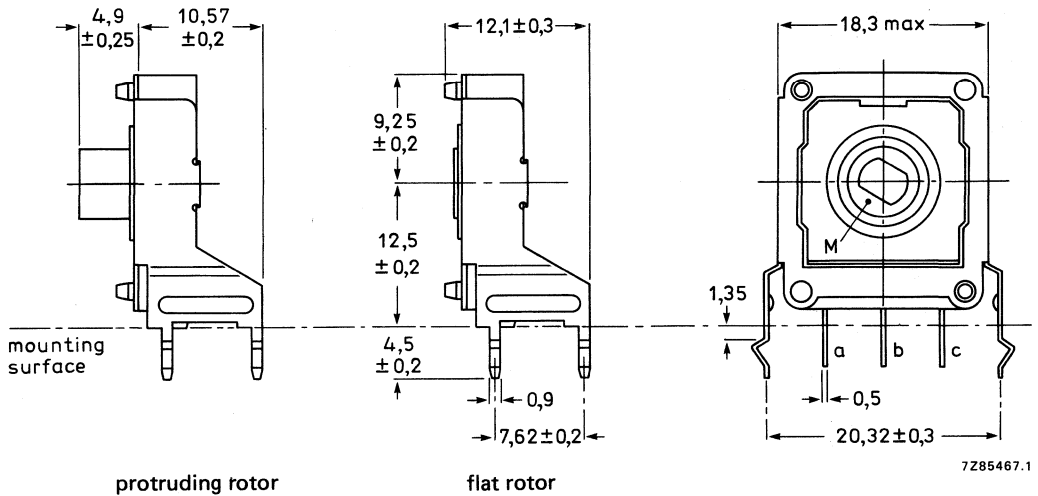
Table for R_{nom}

R \ law	linear	logarithmic*	rev. logarithmic*	log. with tap
220 Ω	02	—	—	—
470 Ω	03	—	—	—
1 kΩ	04	—	—	—
2,2 kΩ	05	25	45	—
4,7 kΩ	06	26	46	—
10 kΩ	07	27	47	—
22 kΩ	08	28	48	—
47 kΩ	09	29	49	—
100 kΩ	11	31	51	—
220 kΩ	12	32	52	—
470 kΩ	13	33	53	—
1 MΩ	14	34	—	—
2,2 MΩ	15	35	—	—
4,7 MΩ	16	—	—	—

* carbon only.

Catalogue numbers for other versions on request.

VERSION WITHOUT SPINDLE, SINGLE VERTICAL WITH BRACKET (TYPE B)



Rotor drawn at fully counter-clockwise position. M = mark for position of slider.

Fig.4 Version without spindle, single vertical with bracket.

Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side.
Hole diameter $1,3 \pm 0,05$ mm.

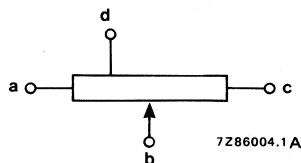
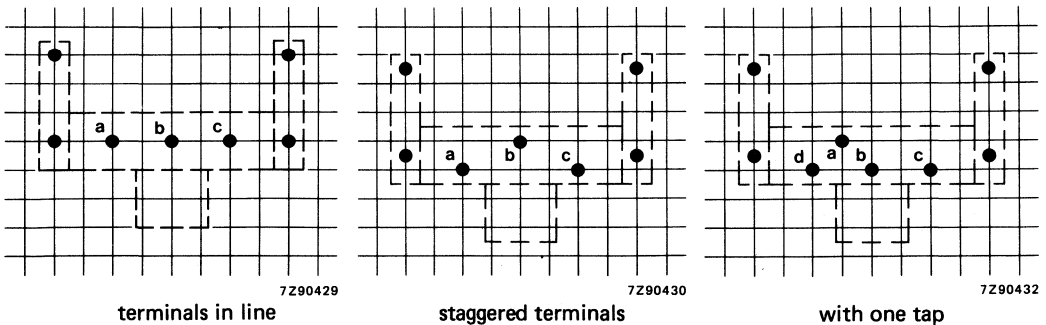


Fig.5 Version without spindle, single vertical with bracket: hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series	
carbon, linear (linearity 4%)	220 Ω to 2,2 MΩ, tolerance 20%
carbon, non-linear	2200 Ω to 2,2 MΩ, tolerance 20%
cermet, linear (linearity 4%)	220 Ω to 4,7 MΩ, tolerance 10%
Resistance law (see Fig.35)	carbon A, B, C, H cermet A
Maximum dissipation at $T_{amb} = 40\text{ °C}$	
carbon, linear	0,2 W
carbon, non-linear	0,1 W
cermet, linear	1,25 W
Test voltage for 1 minute	500 V, 50 Hz
with plastic cover	1000 V, 50 Hz

For further information see Electrical Data and Mechanical Data.

Composition of the catalogue number, PP17 without spindle, single, vertical, with bracket

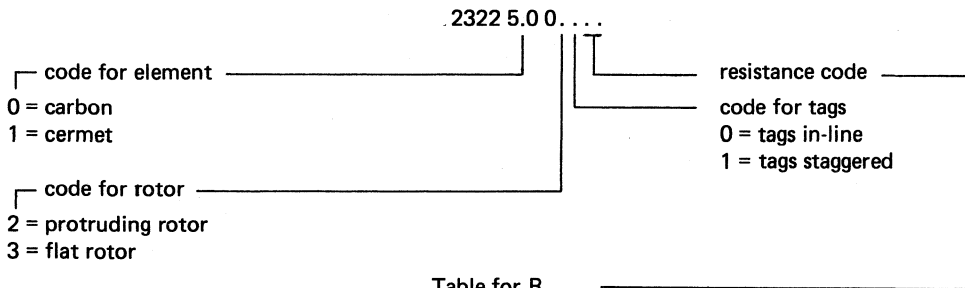


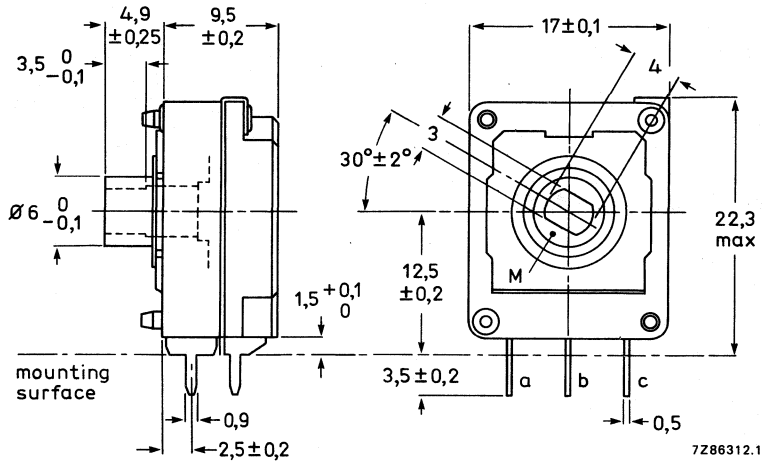
Table for R_{nom}

R \ law	linear	logarithmic*	rev. logarithmic*	log. with tap
220 Ω	02	—	—	—
470 Ω	03	—	—	—
1 kΩ	04	—	—	—
2,2 kΩ	05	25	45	—
4,7 kΩ	06	26	46	—
10 kΩ	07	27	47	—
22 kΩ	08	28	48	—
47 kΩ	09	29	49	—
100 kΩ	11	31	51	—
220 kΩ	12	32	52	—
470 kΩ	13	33	53	—
1 MΩ	14	34	—	—
2,2 MΩ	15	35	—	—
4,7 MΩ	16	—	—	—

* carbon only.

Catalogue numbers for other versions on request.

VERSION WITHOUT SPINDLE, SINGLE VERTICAL WITH BATTERY SWITCH (TYPE C)

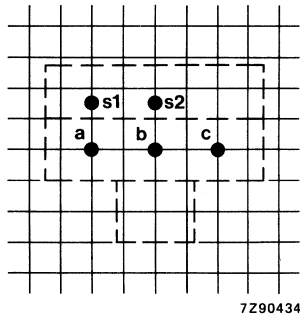


Rotor drawn at fully counter-clockwise position. M = mark for position of slider.

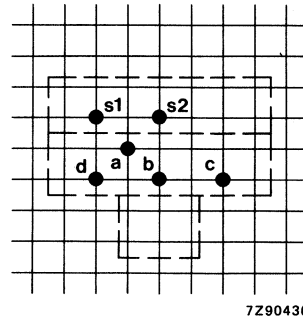
Fig.6 Version without spindle, single vertical with battery switch.

Hole patterns

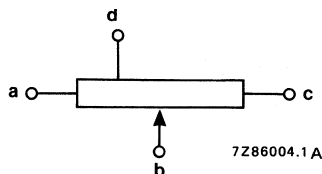
For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side. Hole diameter 1,3 ± 0,05 mm.



terminals in line



with one tap



7Z86004.1 A

Fig.7 Version without spindle, single vertical with battery switch: hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series	
carbon, linear (linearity 4%)	220 Ω to 2,2 MΩ, tolerance 20%
carbon, non-linear	2200 Ω to 2,2 MΩ, tolerance 20%
cermet, linear (linearity 4%)	220 Ω to 4,7 MΩ, tolerance 10%
Resistance law (see Fig.35)	carbon A, B, C, H cermet A
Maximum dissipation at $T_{amb} = 40\text{ °C}$	
carbon, linear	0,2 W
carbon, non-linear	0,1 W
cermet, linear	1,25 W
Test voltage for 1 minute	500 V, 50 Hz

For further information see Electrical Data, Mechanical Data and Battery Switch.

Composition of the catalogue number, PP17 without spindle, single, vertical with switch

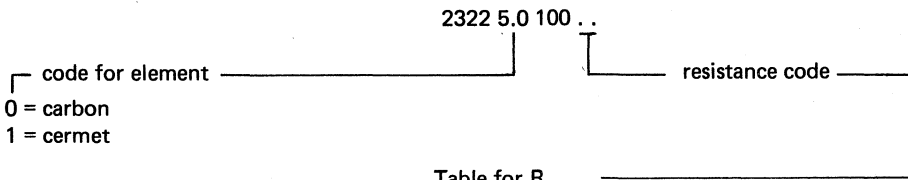


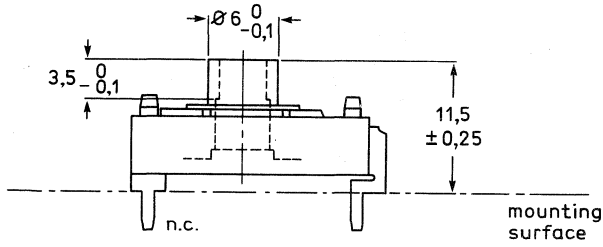
Table for R_{nom}

R \ law	linear	logarithmic*	rev. logarithmic*	log. with tap
220 Ω	02	—	—	—
470 Ω	03	—	—	—
1 kΩ	04	—	—	—
2,2 kΩ	05	25	45	—
4,7 kΩ	06	26	46	—
10 kΩ	07	27	47	—
22 kΩ	08	28	48	—
47 kΩ	09	29	49	—
100 kΩ	11	31	51	—
220 kΩ	12	32	52	—
470 kΩ	13	33	53	—
1 MΩ	14	34	—	—
2,2 MΩ	15	35	—	—
4,7 MΩ	16	—	—	—

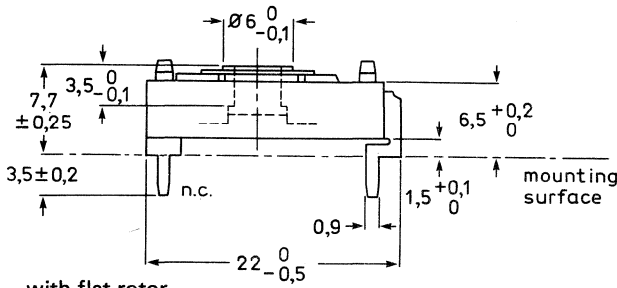
* carbon only.

Catalogue numbers for other versions on request.

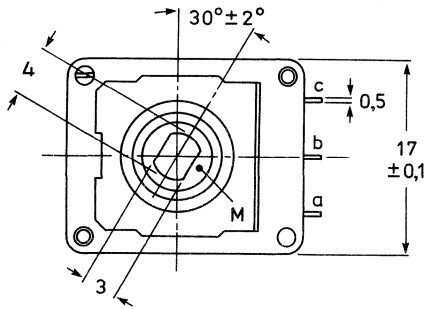
VERSION WITHOUT SPINDLE, SINGLE HORIZONTAL (TYPE D)



with protruding rotor

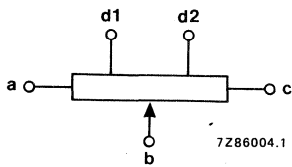


with flat rotor



7Z85460.1

Rotor drawn at fully counter-clockwise position.
M = mark for position of slider.

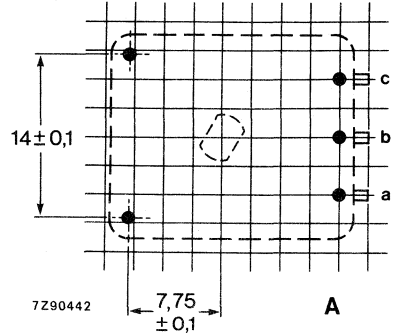


7Z86004.1

designation of terminals

Hole patterns

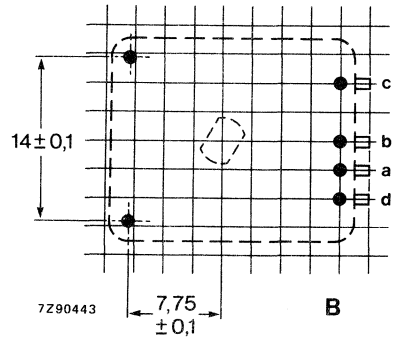
For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side. Hole dia. $1,3 \pm 0,05$ mm.



7Z90442

A

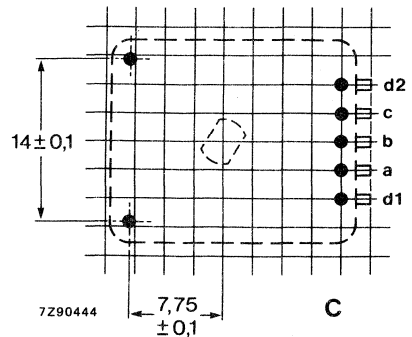
no tap



7Z90443

B

one tap



7Z90444

C

two taps

Fig.8 Version without spindle, single horizontal.

Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series	
carbon, linear (linearity 4%)	220 Ω to 2,2 MΩ, tolerance 20%
carbon, non-linear	2200 Ω to 2,2 MΩ, tolerance 20%
cermet, linear (linearity 4%)	220 Ω to 4,7 MΩ, tolerance 10%
Resistance law (see Fig.35)	carbon, A, B, C, H cermet A
Maximum dissipation at T _{amb} = 40 °C	
carbon, linear	0,2 W
carbon, non-linear	0,1 W
cermet, linear	1,25 W
Test voltage for 1 minute	500 V, 50 Hz

For further information see Electrical Data and Mechanical Data.

Composition of the catalogue number, PP17 without spindle, single, horizontal

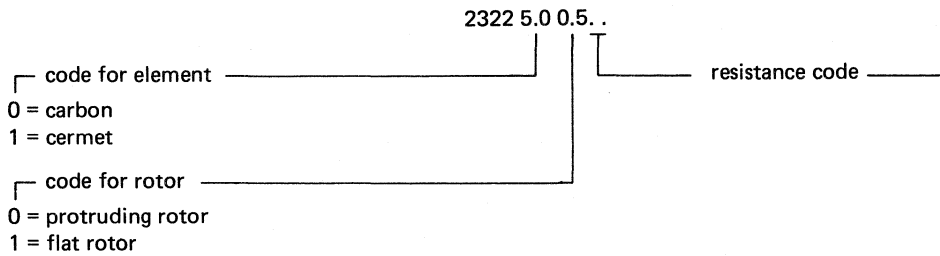


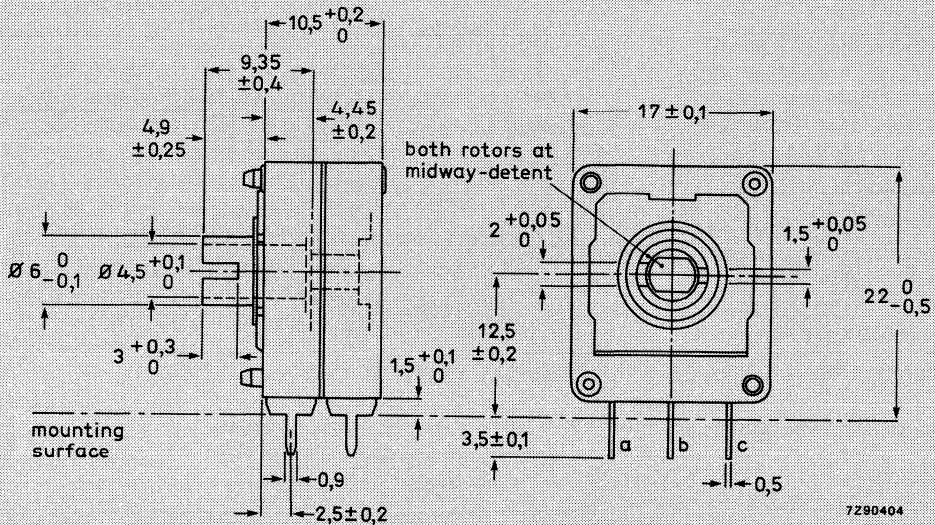
Table for R_{nom}

R \ law	linear	logarithmic*	rev. logarithmic*	log. with tap
220 Ω	02	—	—	—
470 Ω	03	—	—	—
1 kΩ	04	—	—	—
2,2 kΩ	05	25	45	—
4,7 kΩ	06	26	46	—
10 kΩ	07	27	47	—
22 kΩ	08	28	48	—
47 kΩ	09	29	49	—
100 kΩ	11	31	51	—
220 kΩ	12	32	52	—
470 kΩ	13	33	53	—
1 MΩ	14	34	—	—
2,2 MΩ	15	35	—	—
4,7 MΩ	16	—	—	—

* carbon only.

Catalogue numbers for other versions on request.

VERSION WITHOUT SPINDLE, DUAL VERTICAL (TYPE E)

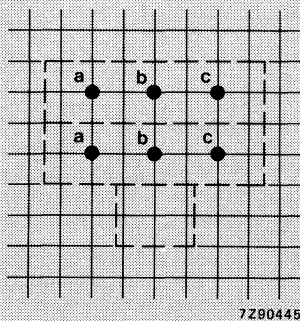


Both rotors at mid-position.

Fig.9 Version without spindle, dual vertical.

Hole pattern

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side. Hole diameter $1,3 \pm 0,05$ mm.



terminals in line

Dual potentiometers with tap on request.

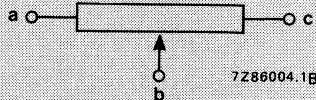


Fig.10 Version without spindle, dual vertical: hole pattern and terminal designation.

Main properties

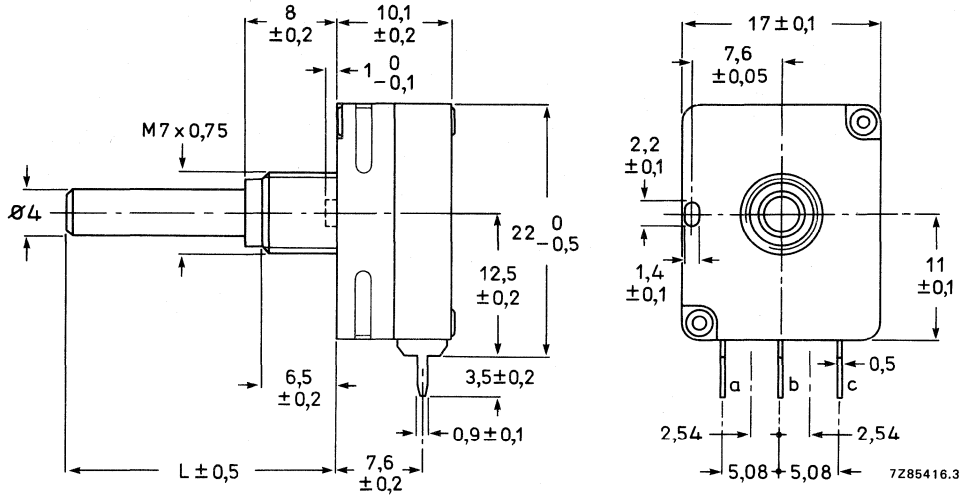
Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series	
carbon, linear (independent linearity 4%)	220 Ω to 2,2 M Ω , tolerance 20%
carbon, non-linear	2200 Ω to 2,2 M Ω , tolerance 20%
cermet, linear (independent linearity 4%)	220 Ω to 4,7 M Ω , tolerance 10%
Resistance law (see Fig.35)	carbon, A, B, C, H cermet A
Maximum dissipation at $T_{amb} = 40^{\circ}C$	
carbon, linear	0,2 + 0,2 W
carbon, non-linear	0,1 + 0,1 W
cermet, linear	1,25 + 1,25 W
Test voltage for 1 minute	500 V, 50 Hz

For further information see Electrical Data and Mechanical Data.

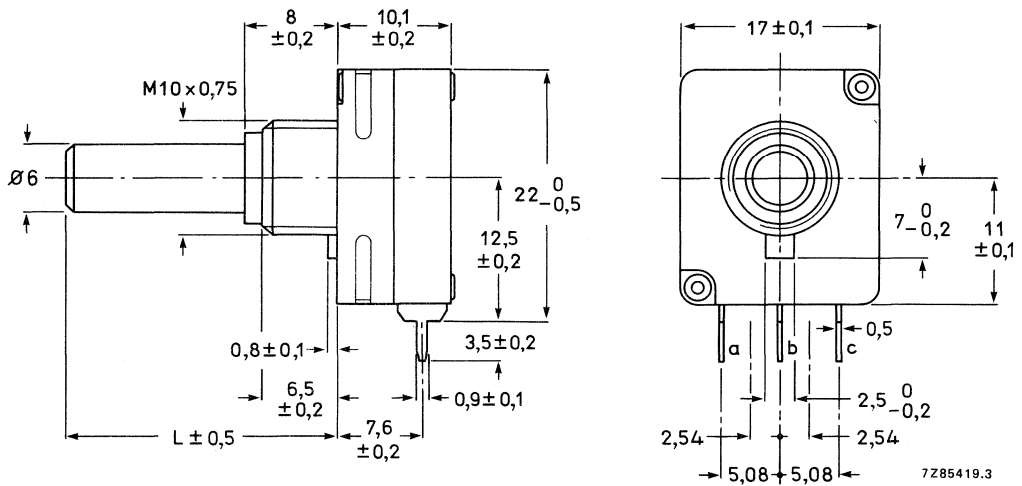
Catalogue number

On request.

VERSION WITH SPINDLE, SINGLE VERTICAL (TYPE F)



with mounting bush M7 x 0,75 mm.



with mounting bush M10 x 0,75 mm.

For dimension L see under Spindles. For other terminals see Fig.34.

Fig.11 Version with spindle, single vertical.

Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side.
Hole diameter $1,3 \pm 0,05$ mm.

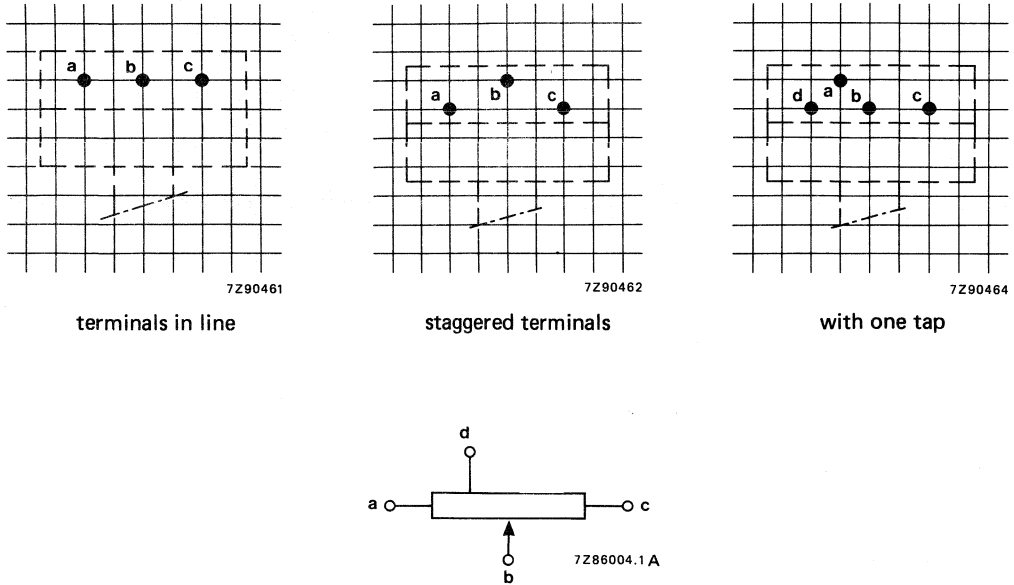


Fig. 12 Version with spindle, single vertical: hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)

metal spindle
metal spindle
plastic spindle

cermet and heatsink 40/125/56
carbon 25/070/10, cermet 40/100/56
carbon 25/070/10, cermet 25/070/56

Resistance range, E3 series

carbon, linear (linearity 4%)
carbon, non-linear
cermet, linear (linearity 4%)

220 Ω to 2,2 MΩ, tolerance 20%
2200 Ω to 2,2 MΩ, tolerance 20%
220 Ω to 4,7 MΩ, tolerance 10%

Resistance law (see Fig.35)

carbon A, B, C, H
cermet A

Maximum dissipation at $T_{amb} = 40$ °C

carbon, linear
carbon, non-linear
cermet, linear
cermet, with heatsink

0,2 W
0,1 W
2 W } metal spindle, 1 W } plastic spindle
3 W } 2 W }

Test voltage for 1 minute
with plastic cover

500 V, 50 Hz
1000 V, 50 Hz

For further information see Electrical Data and Mechanical Data.

Composition of the catalogue number, PP17 with spindle, single, vertical

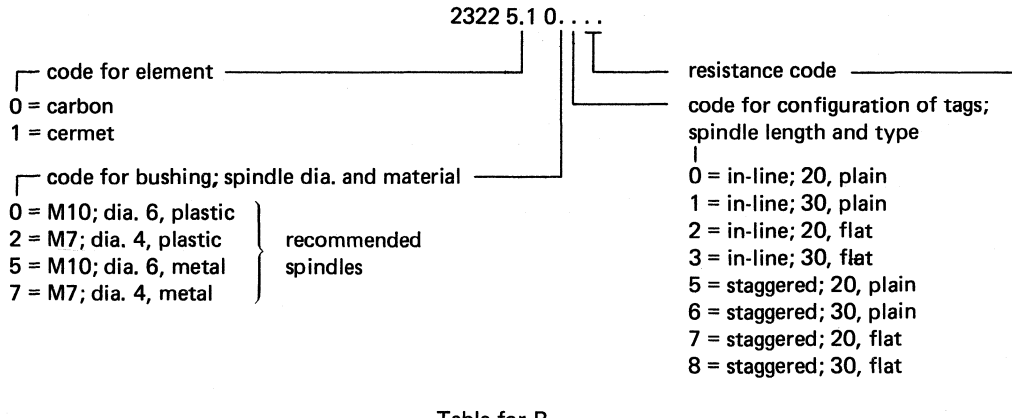


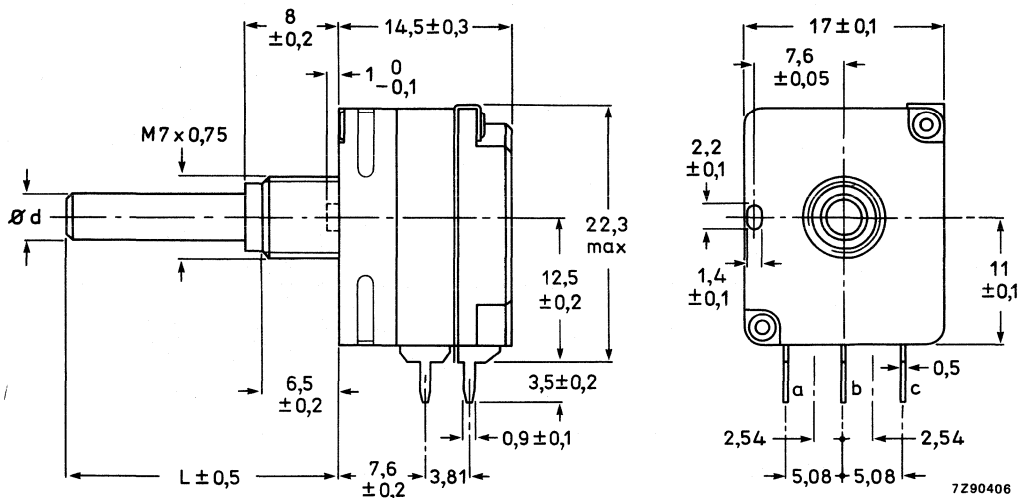
Table for R_{nom}

R \ law	linear	logarithmic*	rev. logarithmic*	log. with tap*
220 Ω	02	—	—	—
470 Ω	03	—	—	—
1 k Ω	04	—	—	—
2,2 k Ω	05	25	45	—
4,7 k Ω	06	26	46	—
10 k Ω	07	27	47	—
22 k Ω	08	28	48	—
47 k Ω	09	29	49	—
100 k Ω	11	31	51	—
220 k Ω	12	32	52	—
470 k Ω	13	33	53	—
1 M Ω	14	34	—	—
2,2 M Ω	15	35	—	—
4,7 M Ω	16	—	—	—

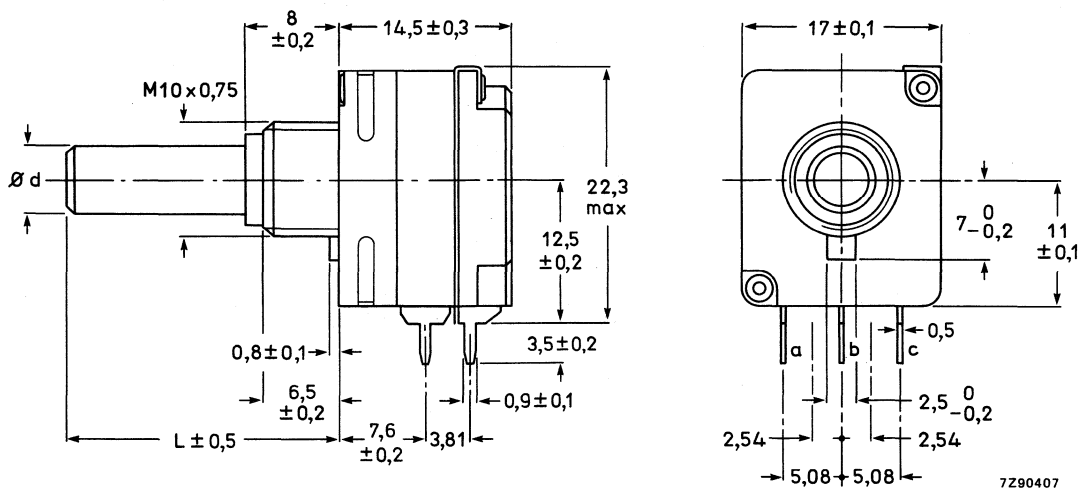
* carbon only.

Catalogue numbers for other versions on request.

VERSION WITH SPINDLE, SINGLE VERTICAL WITH BATTERY SWITCH (TYPE G)



with mounting bush M7 x 0,75 mm.



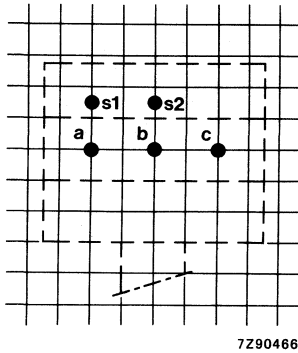
with mounting bush M10 x 0,75 mm.

For dimensions d and L see under Spindles. For other terminals see Fig.34.

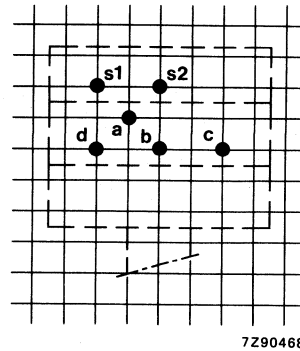
Fig.13 Version with spindle, single vertical with battery switch.

Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side.
Hole diameter $1,3 \pm 0,05$ mm.



without tap



with one tap

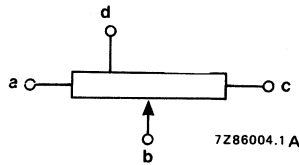


Fig.14 Version with spindle, single vertical with battery switch:
hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)	metal spindle plastic spindle	carbon 25/070/10, cermet 40/125/56 carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series		
carbon, linear (linearity 4%)		220 Ω to 2,2 M Ω , tolerance 20%
carbon, non-linear		2200 Ω to 2,2 M Ω , tolerance 20%
cermet, linear (linearity 4%)		220 Ω to 4,7 M Ω , tolerance 10%
Resistance law (see Fig.35)		carbon A, B, C, H cermet A
Maximum dissipation at $T_{amb} = 40$ °C		
carbon, linear		0,2 W
carbon, non-linear		0,1 W
cermet, linear		1,25 W (metal spindle), 1 W (plastic spindle)
Test voltage for 1 minute		500 V, 50 Hz
For extended data see under Electrical Data, Mechanical Data and Battery Switch.		

Composition of the catalogue number, PP17 with spindle, single, vertical with switch

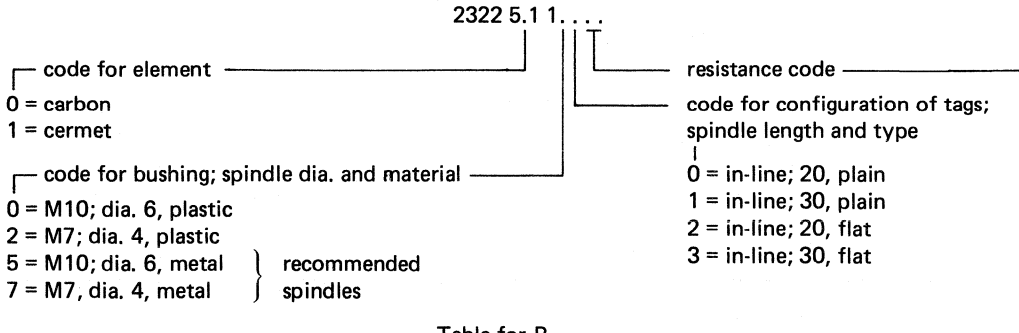


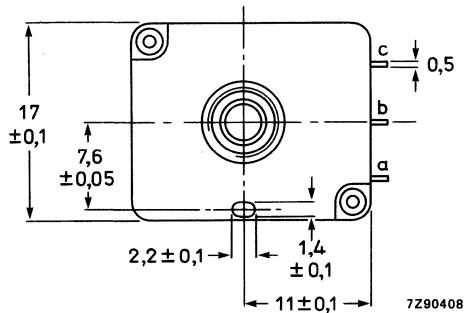
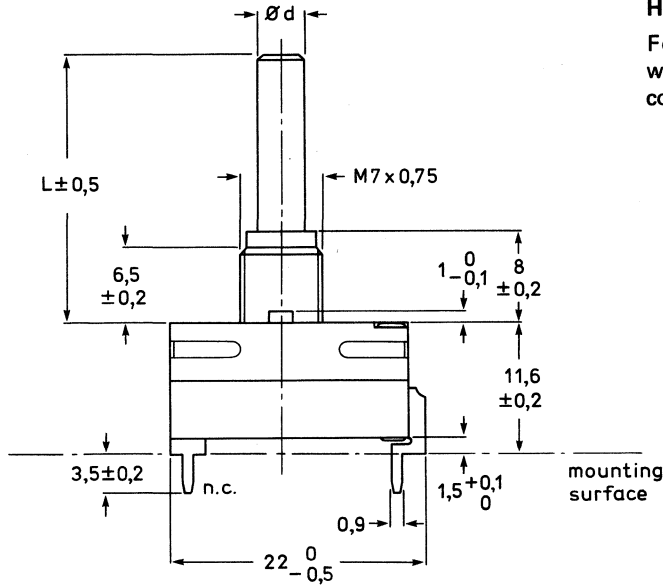
Table for R_{nom}

R \ law	linear	logarithmic*	rev. logarithmic*	log. with tap*
220 Ω	02	—	—	—
470 Ω	03	—	—	—
1 k Ω	04	—	—	—
2,2 k Ω	05	25	45	—
4,7 k Ω	06	26	46	—
10 k Ω	07	27	47	—
22 k Ω	08	28	48	—
47 k Ω	09	29	49	—
100 k Ω	11	31	51	—
220 k Ω	12	32	52	—
470 k Ω	13	33	53	—
1 M Ω	14	34	—	—
2,2 M Ω	15	35	—	—
4,7 M Ω	16	—	—	—

* carbon only.

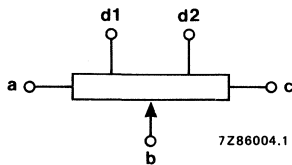
Catalogue numbers for other versions on request.

VERSION WITH SPINDLE, SINGLE HORIZONTAL (TYPE H)



with mounting bush M7 x 0,75 mm.

For dimensions d and L see under Spindles.



designation of terminals

Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side. Hole dia. $1,3 \pm 0,05$ mm.

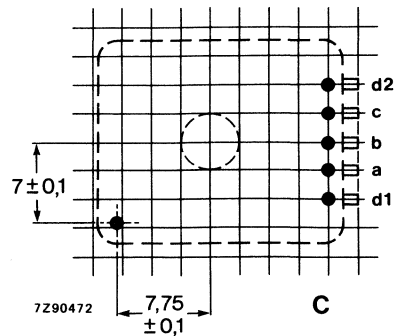
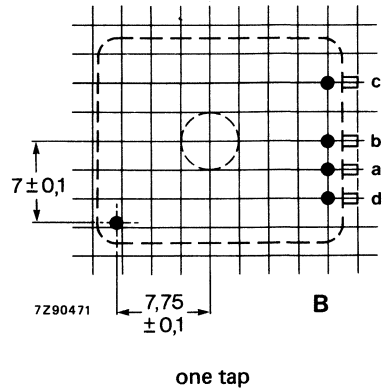
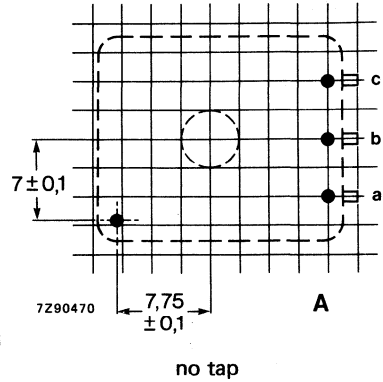
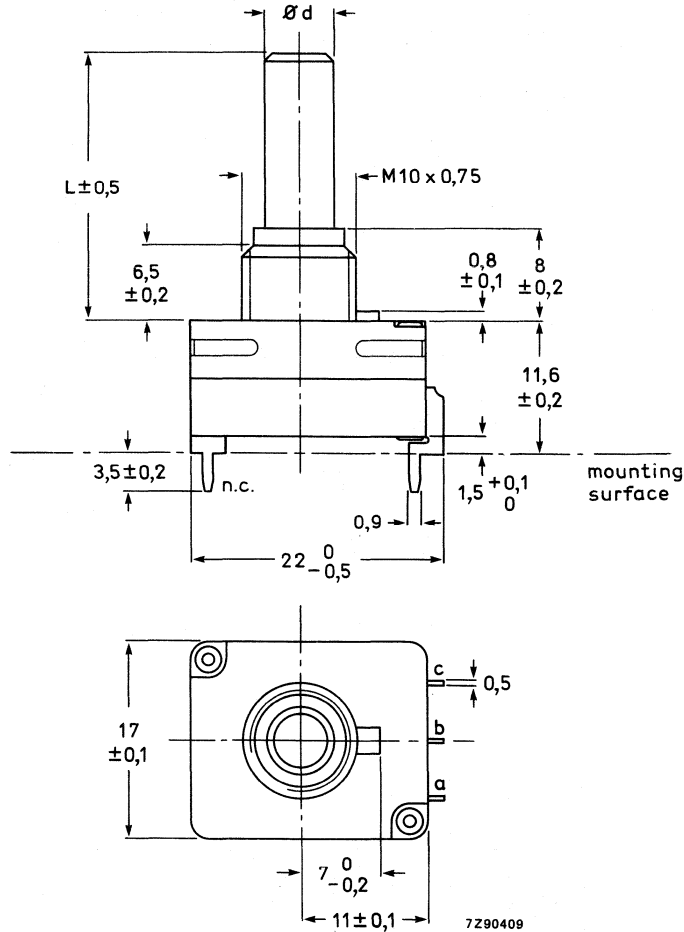


Fig. 15 Version with spindle, single horizontal.



with mounting bush
M10 x 0,75 mm.

Fig.15 Version with spindle, single horizontal (continued).

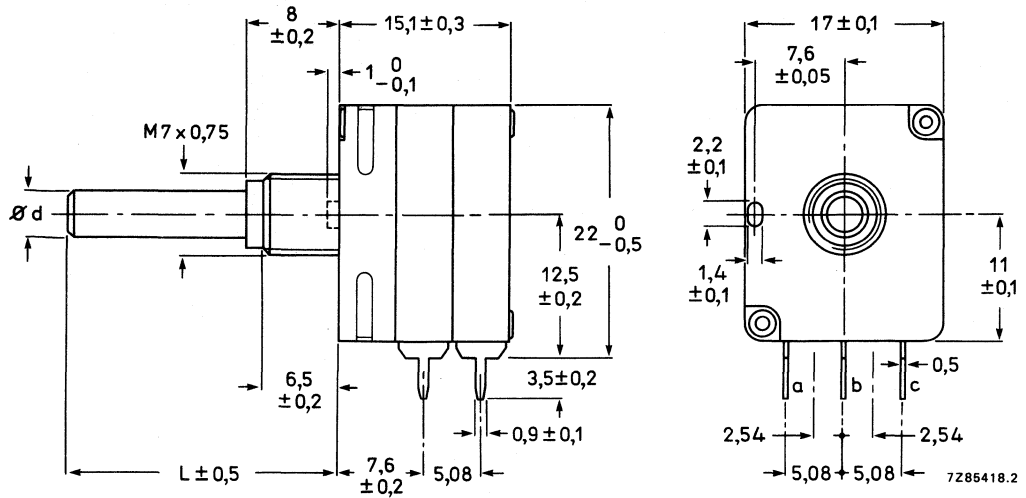
Main properties

Climatic category	metal spindle plastic spindle	carbon 25/070/10, cermet 40/100/56 carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series		
carbon, linear (linearity 4%)		220 Ω to 2,2 M Ω , tolerance 20%
carbon, non-linear		2200 Ω to 2,2 M Ω , tolerance 20%
cermet, linear (linearity 4%)		220 Ω to 4,7 M Ω , tolerance 10%
Resistance law (see Fig.35)		carbon A, B, C, H cermet A
Maximum dissipation at $T_{amb} = 40 \text{ }^\circ\text{C}$		
carbon, linear		0,2 W
carbon, non-linear		0,1 W
cermet, linear		2 W (metal spindle), 1 W (plastic spindle)
Test voltage for 1 minute		500 V, 50 Hz

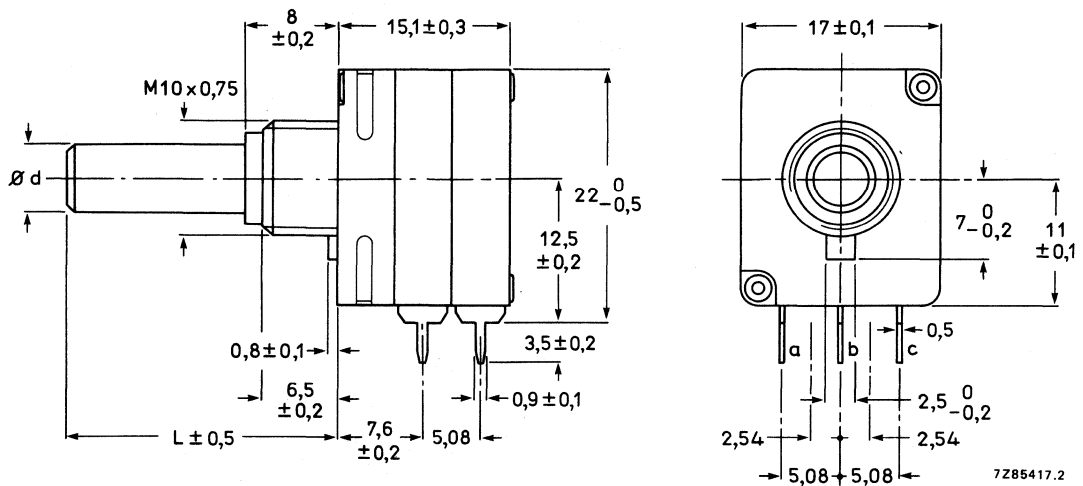
For further information see Electrical Data and Mechanical Data.

Catalogue numbers: On request.

VERSIONS WITH SPINDLE, TANDEM VERTICAL (TYPE I)



with mounting bush M7 x 0,75 mm.



with mounting bush M10 x 0,75 mm.

For dimensions d and L see under Spindles.

Fig.16 Version with spindle, tandem vertical.

Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side.
Hole diameter $1,3 \pm 0,05$ mm.

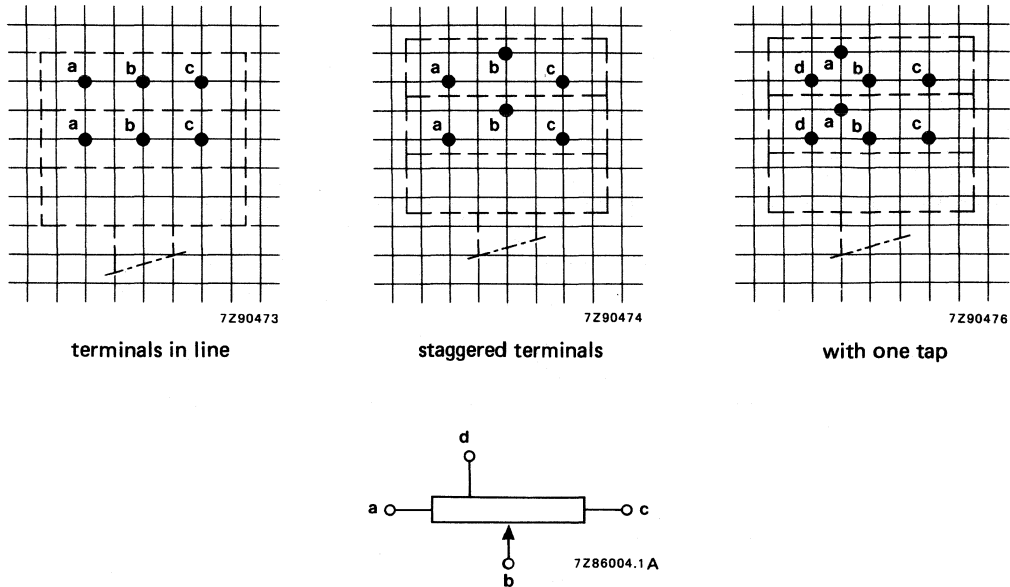


Fig.17 Version with spindle, tandem vertical: hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)	metal spindle	carbon 25/070/10, cermet 40/100/56
	plastic spindle	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series		
carbon, linear (linearity 4%)		220 Ω to 2,2 MΩ, tolerance 20%
carbon, non-linear		2200 Ω to 2,2 MΩ, tolerance 20%
cermet, linear (linearity 4%)		220 Ω to 4,7 MΩ, tolerance 10%
Resistance law (see Fig.35)		carbon A, B, C, H
		cermet A
Maximum dissipation at T _{amb} = 40 °C		
carbon, linear		0,2 + 0,2 W
carbon, non-linear		0,1 + 0,1 W
cermet, linear		1,25 + 1,25 W
cermet, with heatsink		2 + 2 W
		} metal 1 + 1 W } plastic
		} spindle, 1,5 + 1,5 W } spindle
Test voltage for 1 minute		500 V, 50 Hz

For further information see Electrical Data and Mechanical Data.

Composition of the catalogue number, PP17 with spindle, tandem, vertical

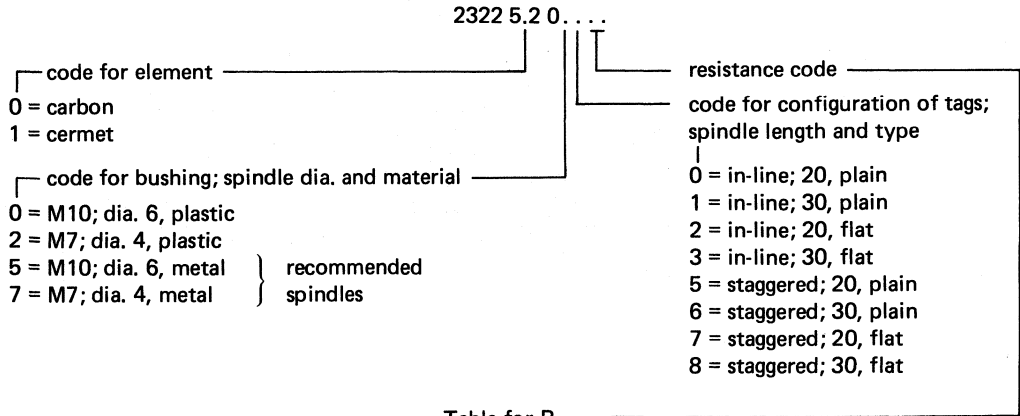


Table for R_{nom}

R \ law	linear	logarithmic*	rev. logarithmic*	log. with tap*
220 Ω	02	—	—	—
470 Ω	03	—	—	—
1 kΩ	04	—	—	—
2,2 kΩ	05	25	45	—
4,7 kΩ	06	26	46	—
10 kΩ	07	27	47	—
22 kΩ	08	28	48	—
47 kΩ	09	29	49	—
100 kΩ	11	31	51	—
220 kΩ	12	32	52	—
470 kΩ	13	33	53	—
1 MΩ	14	34	—	—
2,2 MΩ	15	35	—	—
4,7 MΩ	16	—	—	—

* carbon only.

Catalogue numbers for other versions on request.

VERSION WITH SPINDLE, DUAL VERTICAL (TYPE J)

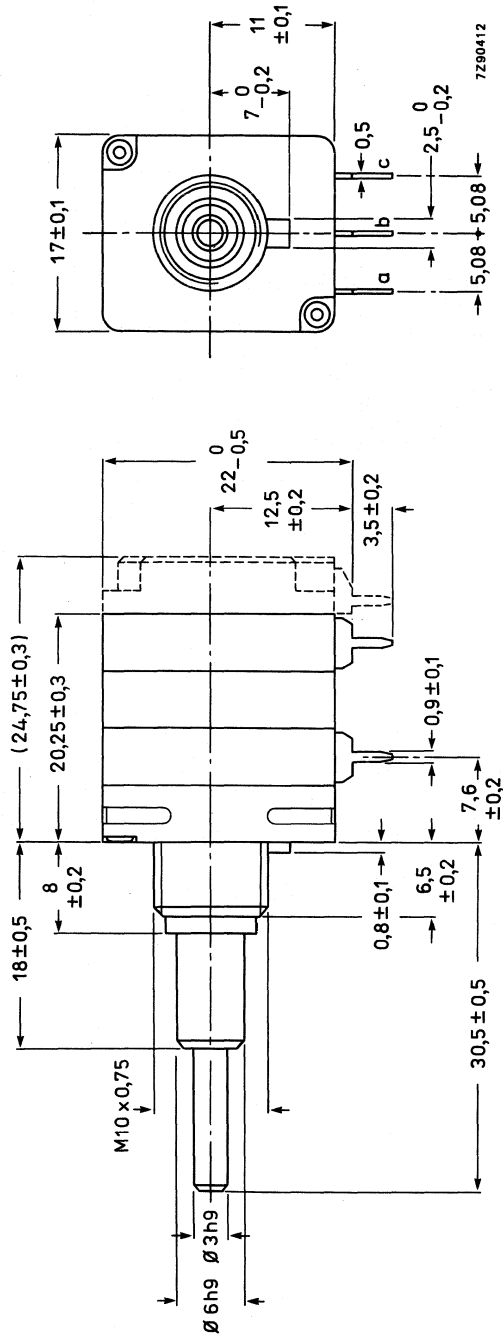
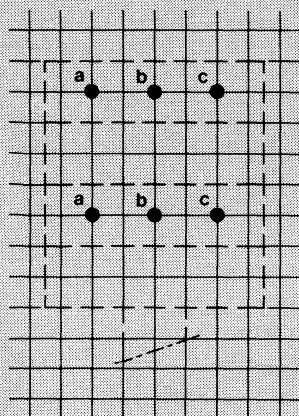


Fig.18 Version with spindle, dual vertical.

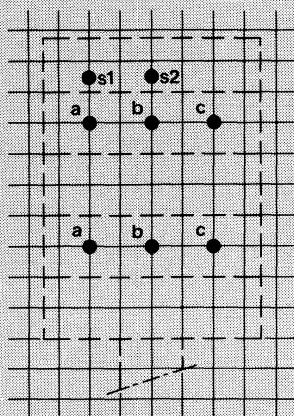
Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side.
Hole diameter $1,3 \pm 0,05$ mm.



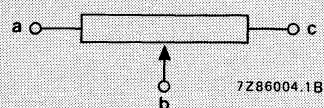
7290482

without switch



7290483

with switch



designation of terminals

Fig.19 Version with spindle, dual vertical: hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)

carbon 25/070/10, cermet 25/070/56

Resistance range, E3 series

carbon, linear (linearity 4%)

220 Ω to 2,2 M Ω , tolerance 20%

carbon, non-linear

2200 Ω to 2,2 M Ω , tolerance 20%

cermet, linear (linearity 4%)

220 Ω to 4,7 M Ω , tolerance 10%

Resistance law (see Fig.35)

carbon A, B, C, H

cermet A

Maximum dissipation at $T_{amb} = 40$ °C

carbon, linear

0,2 + 0,2 W

carbon, non-linear

0,1 + 0,1 W

cermet, linear

1,25 + 1,25 W (metal spindle),

1 + 1 W (plastic spindle)

Test voltage for 1 minute

500 V, 50 Hz

For further information see Electrical Data, Mechanical Data and Battery Switch.

Catalogue number

On request.

BUILDING ELEMENTS FOR POTENTIOMETERS WITHOUT SPINDLE (Survey 1)

Potentiometer with flat rotor, snap-in type

To be used with snap-in actuating devices, see Fig.22. Cannot be combined with other PP17 potentiometers and switches.

Maximum axial force	20 N
if mechanically supported, e.g. by mounting bracket	80 N

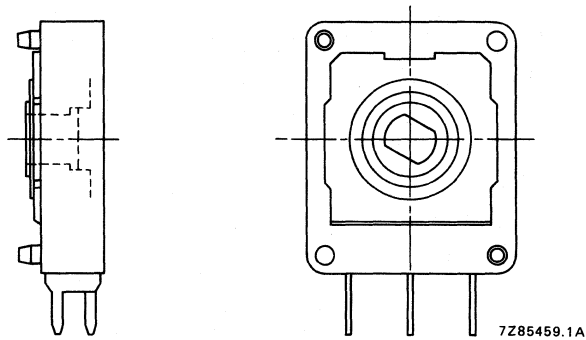


Fig.20 Flat rotor, snap-in type.

Potentiometer with protruding rotor, snap-in type

To be used with snap-in actuating devices, see Fig.22. Can be combined with another PP17 potentiometer and/or switch.

Maximum axial force	20 N
if mechanically supported, e.g. by mounting bracket	80 N

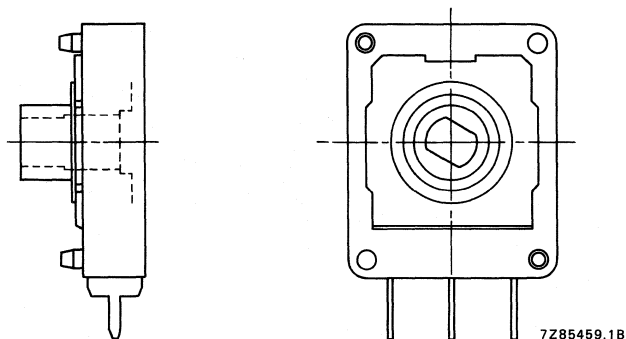


Fig.21 Protruding rotor, snap-in type.

Actuating device

Figure 22 shows the snap-in part of a plastic actuating device. A limited range of actuating devices is available – see PP12 series.

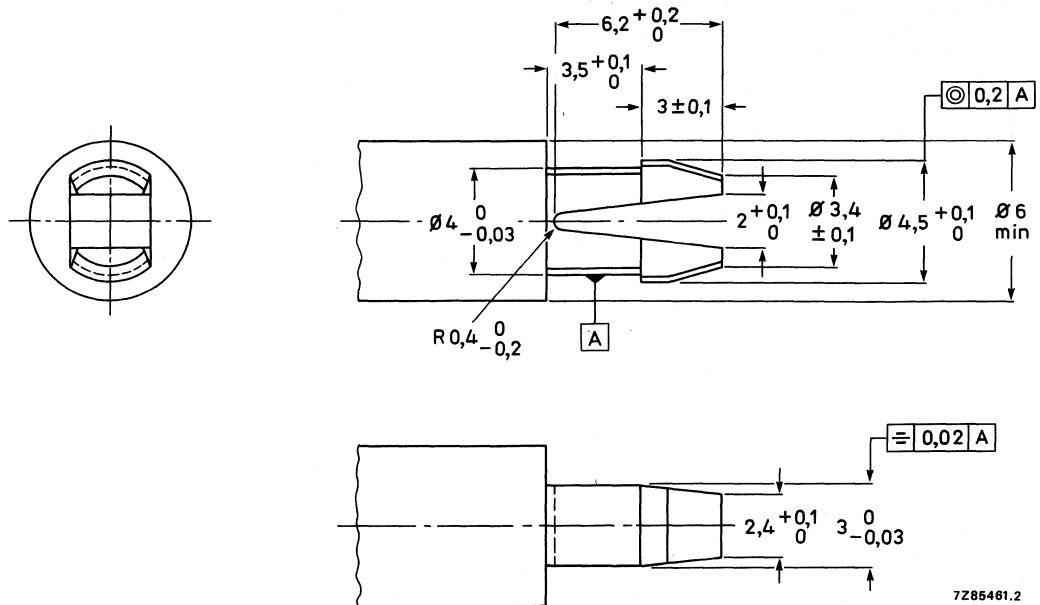


Fig.22 Actuating device.

Mounting bracket

For extra stability of single vertical or tandem vertical potentiometers. Use of this bracket permits an axial force of maximum 80 N to the potentiometers opposite.

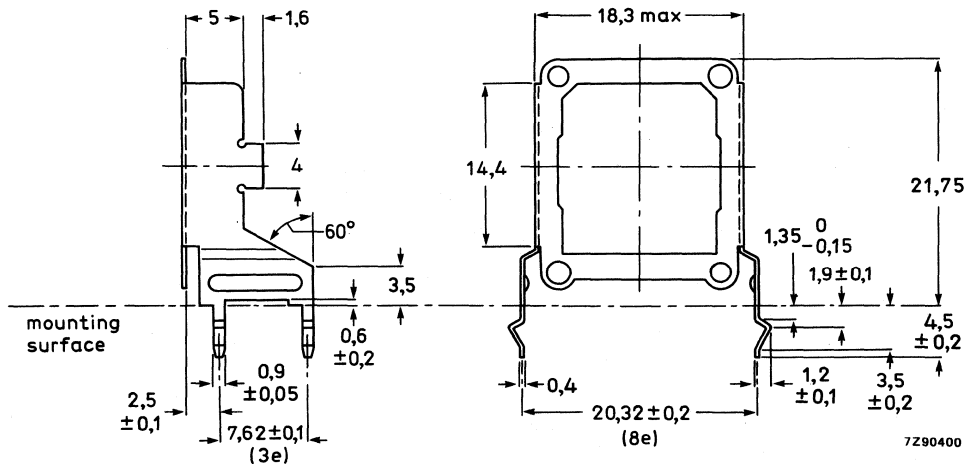


Fig.23 Mounting bracket.

BUILDING ELEMENTS FOR POTENTIOMETERS WITH SPINDLE (Survey 2)

Potentiometer with flat rotor, slotted type

To be used with spindle as single or tandem potentiometer. Cannot be combined with a switch.

Maximum axial force 20 N

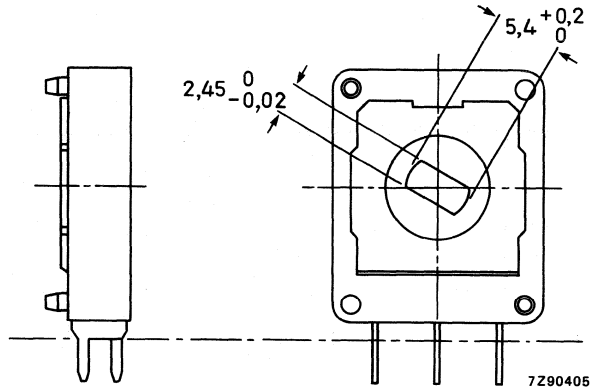


Fig.24 Flat rotor, slotted type.

Heatsink

Zinc heatsinks are available to increase the maximum permissible dissipation of cermet potentiometers. They can be added to single potentiometers and to both potentiometers of a tandem version.

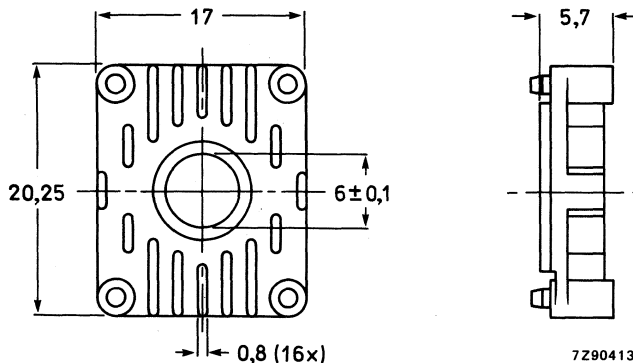
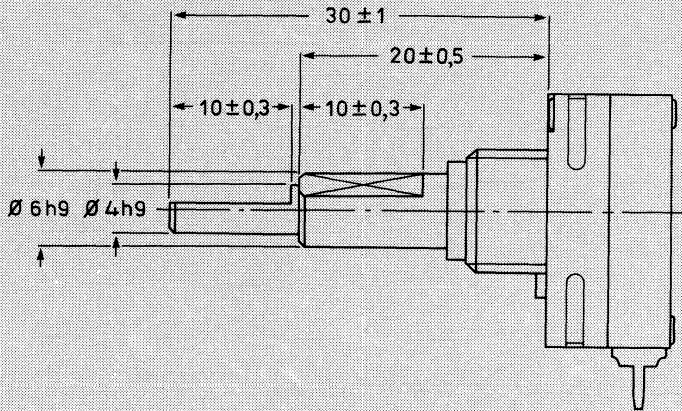


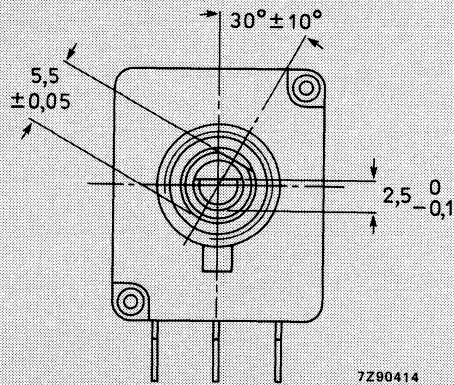
Fig.25 Heatsink.

Slow-motion drive

For fine adjustment. Gear ratio 4,6 : 1 and 7 : 1. (Other spindles on request.)



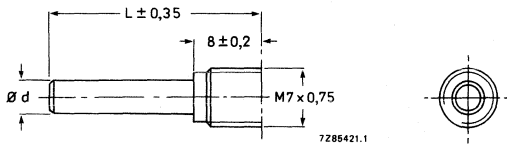
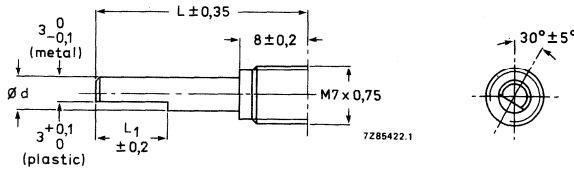
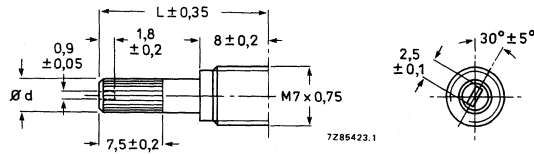
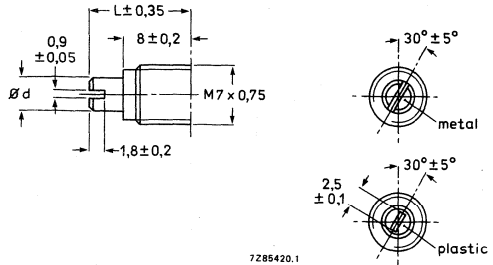
side view



front view

Fig.26 Slow-motion drive.

Spindles, metal or plastic, M7 bushing

	CCW position	L mm	L ₁ mm	d metal	d plastic
 <p>Fig. 27a.</p>		15		4h9	4 ⁰ _{-0,1}
		20		*4h9	*4 ⁰ _{-0,1}
		25		4h9	4 ⁰ _{-0,1}
		30		*4h9	*4 ⁰ _{-0,1}
 <p>Fig. 27b.</p>		15	3,0	4h9	4 ⁰ _{-0,1}
		20	7,5	*4h9	*4 ⁰ _{-0,1}
		25	8,5	4h9	4 ⁰ _{-0,1}
		30	8,5	*4h9	*4 ⁰ _{-0,1}
 <p>Fig. 27c.</p>		20			4 ⁰ _{-0,1}
 <p>Fig. 27d.</p>		12		4h9	4 ⁰ _{-0,1}

* Recommended spindle types in metal for all versions and in plastic only for single versions without switch.

Spindles, metal or plastic, M10 bushing

		CCW position	L mm	L ₁ mm	d metal	d plastic
<p>Fig. 28a.</p>			20		*6h9	*6 ⁰ _{-0,1}
			30		*6h9	*6 ⁰ _{-0,1}
			40		6h9	6 ⁰ _{-0,1}
			60		6h9	6 ⁰ _{-0,1}
<p>Fig. 28b.</p>			20	7,5	*6h9	*6 ⁰ _{-0,1}
			30	13,5	*6h9	*6 ⁰ _{-0,1}
			60	13,5	6h9	6 ⁰ _{-0,1}
<p>Fig. 28c.</p>			30			6 ⁰ _{-0,1}
<p>Fig. 28d.</p>			12		6h9	6 ⁰ _{-0,1}

* Recommended spindle types in metal for all versions and in plastic only for single versions without switch.

Mounting holes for potentiometers with spindle

for single and tandem potentiometers

required mounting holes in chassis

fixing of potentiometer

with mounting bush
M7 x 0,75 mm

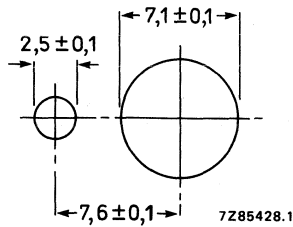


Fig.29.

with supplied mounting nut;
max. torque for tightening = 1 Nm;
minimum thickness of mounting plate = 1 mm

with mounting bush
M10 x 0,75 mm

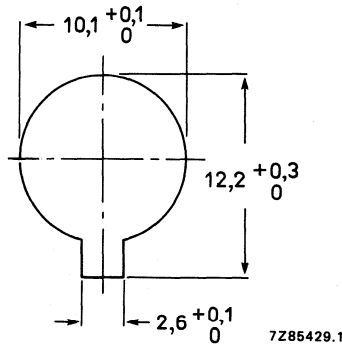


Fig.30.

with supplied mounting nut;
max. torque for tightening = 3,5 Nm;
minimum thickness of mounting plate = 1 mm

**BUILDING ELEMENTS FOR POTENTIOMETERS WITHOUT SPINDLE (Survey 1)
AND WITH SPINDLE (Survey 2)**

Battery switch (s.p.s.t.)

Operating torque, initial	25 to 75 mNm
Mechanical endurance	≥ 16 000 cycles
DC voltage/current rating	14,4 V/3,5 A
Test voltage	
initial	500 V DC for 1 minute
after 21 days humidity test IEC 68-C	100 V DC for 1 minute
Contact resistance	
initial	≤ 20 mΩ
after 16 000 cycles (under load)	≤ 50 mΩ
Insulation resistance, between switch contacts, and between interconnected contacts and housing	
initial	≥ 100 MΩ
after 21 days humidity test IEC 68-C	≥ 2 MΩ

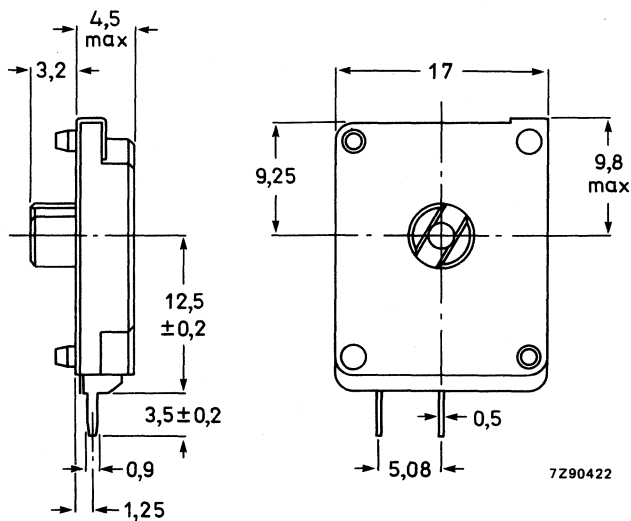


Fig.31 Battery switch (s.p.s.t.).

Metal shield

For the suppression of hum, crosstalk and noise. Provided with earth tag. Can be mounted at the rear of the potentiometers. Material: finished steel. Potentiometers with a switch do not need this shield (the switch already has one).

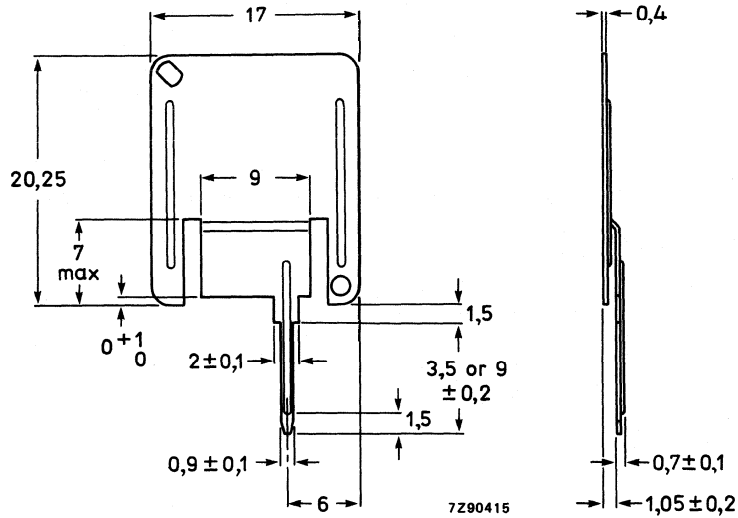


Fig.32 Metal shield.

Plastic cover

Can be mounted at the rear of the potentiometer. Use is necessary if a test voltage of 1000 V AC must be withstood for 1 minute. (Vertical types only).

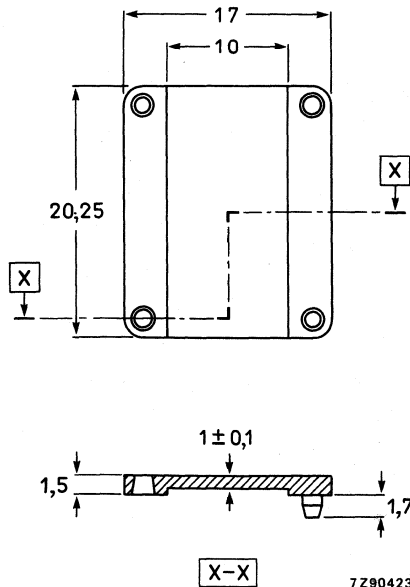


Fig.33 Plastic cover.

Terminals

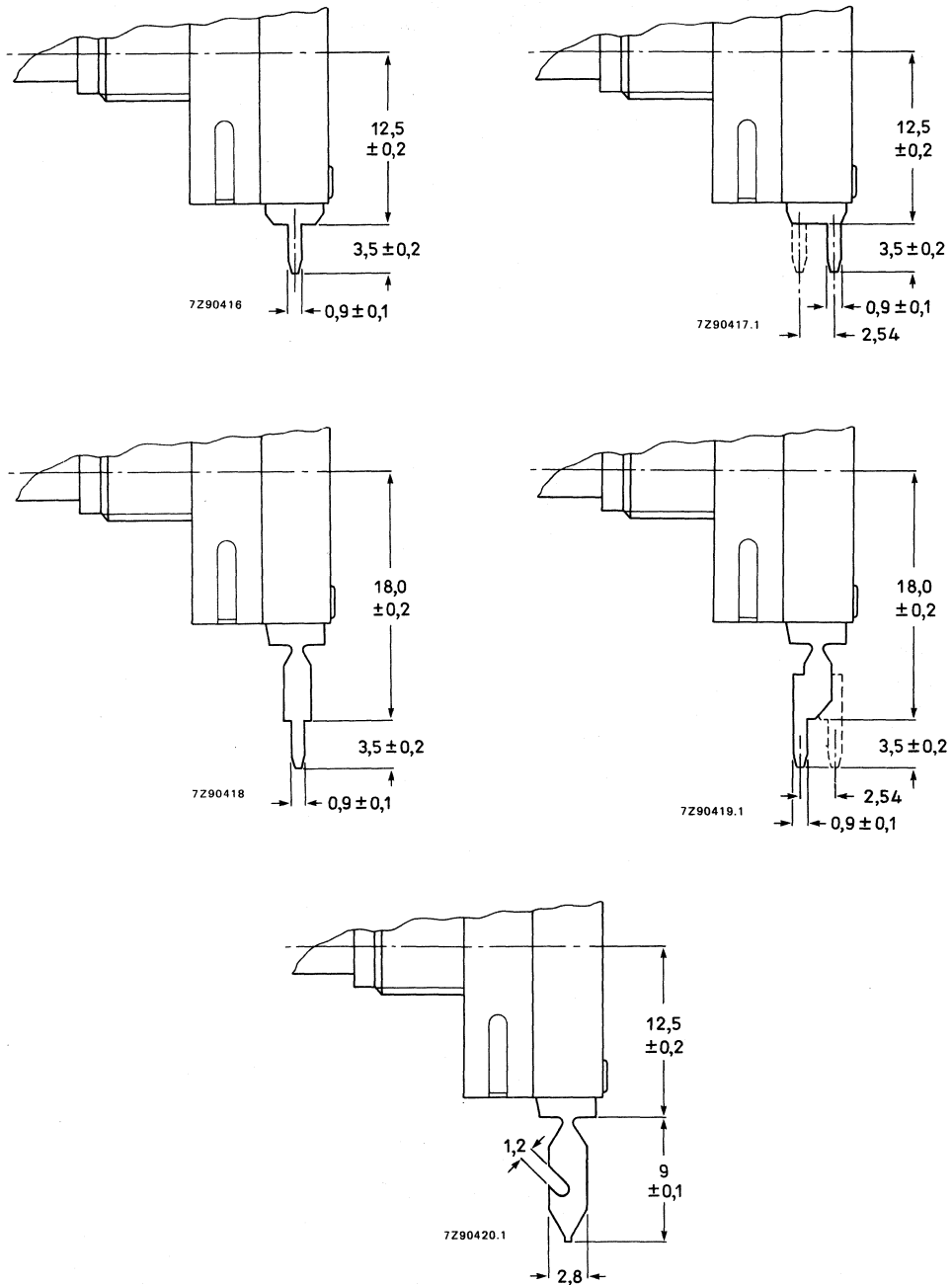


Fig.34 Terminals.

ELECTRICAL DATA

Unless otherwise specified, all values are valid at an ambient temperature of 18 to 22 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

For measuring and test methods, see IEC publications 393-1 and 68. The terms used are explained in general section Terms and Definitions.

	carbon	cermet
Resistance range, E3 series* potentiometers without spindle		
linear law	220 Ω to 2,2 MΩ	220 Ω to 2,2 MΩ
logarithmic law	2200 Ω to 2,2 MΩ	—
potentiometers with spindle		
linear law	220 Ω to 2,2 MΩ	220 Ω to 2,2 MΩ
logarithmic law	2200 Ω to 2,2 MΩ	—
Tolerance on resistance	± 20%*	± 10%
Resistance law and tolerances (see Fig.35)	type A, B, C, H	type A
Ganging tolerance (tandem potentiometers)		
linear law	standard	special
at values between 10 and 90% of R _{ac} (reversed) logarithmic law	< 2 dB	
at attenuations between 0 and 20 dB	< 2 dB	
at attenuations between 20 and 40 dB	< 3 dB	
at attenuations between 40 and 60 dB	< 4 dB	
with a tap at 10% of R _{total} , tap load 1% of R _{ac}		
at attenuations between 0 and 20 dB	< 2 dB	< 2 dB
at attenuations between 20 and 40 dB	< 3 dB	< 3 dB
at attenuations between 40 and 60 dB	< 4 dB	< 3 dB
at attenuations between 60 and 70 dB	< 6 dB	< 3 dB
at attenuations between 70 and 80 dB	< 8 dB	< 8 dB
Terminal resistance, (residual)	≤ 2% of R _{nom} or 10 Ω	≤ 1% of R _{nom} or 10 Ω
Resistance at the tap	≤ 1,5% or R _{nom} or 10 Ω	
Contact resistance moving, initially,		
linear law	≤ 4% of R _{ac}	≤ 2,5% of R _{ac}
logarithmic law	≤ 8% of R _{ac}	—
Contact resistance variation (CRV), (acc. to IEC 393-1, sub. clause 4.17) initially,		
linear law	≤ 1%	≤ 1% of R _{ac}
logarithmic law	≤ 2%	—
Temperature coefficient of resistance	± 500 × 10 ⁻⁶ /K	± 100 × 10 ⁻⁶
Insulation resistance		
after damp heat test (IEC 68, test C)	after 21 days > 100 MΩ	after 56 days > 100 MΩ

* 10% on request.

ELECTRICAL DATA (continued)

	carbon	cermet
Maximum attenuation		
$R_{ac} \geq 22 \text{ k}\Omega$, logarithmic law	$\geq 90 \text{ dB}$	
$R_{ac} < 22 \text{ k}\Omega$, logarithmic law	$\geq 75 \text{ dB}$	
$R_{ac} < 22 \text{ k}\Omega$, linear law	$\geq 55 \text{ dB}$	$\geq 60 \text{ dB}$
Maximum dissipation at $T_{amb} = 40 \text{ }^\circ\text{C}$ (P_{max})*		
linear law	0,2 W	1,25 W **
logarithmic law	0,1 W	
linear law, using a heatsink		3 W **
Test voltage for 1 minute with cover	500 V, 50 Hz 1000 V, 50 Hz	500 V, 50 Hz 1000 V, 50 Hz
Working temperature range		
versions without spindle	-25 to + 70 $^\circ\text{C}$	-25 to + 70 $^\circ\text{C}$
versions with spindle	-25 to + 70 $^\circ\text{C}$	-40 to + 125 $^\circ\text{C}$
Storage temperature range		
without switch, versions without spindle	-40 to + 90 $^\circ\text{C}$	-40 to + 90 $^\circ\text{C}$
without switch, versions with spindle		-40 to + 100 $^\circ\text{C}$
with switch	-40 to + 85 $^\circ\text{C}$	
Climatic category (IEC 68)		
versions without spindle	25/070/10	25/070/56
versions with metal spindle	25/070/10	25/100/56
versions with plastic spindle	25/070/10	25/070/56

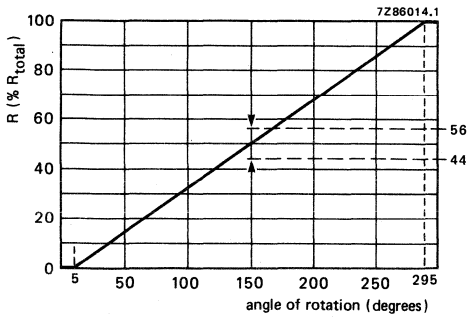
ENVIRONMENTAL TESTS

tests	requirements		
		carbon	cermet
Climatic sequence	$\Delta R_{ac}/R_{ac}$	$\leq 10\%$	$\leq 2\%$
Damp heat, steady state			
$R \leq 100 \text{ k}\Omega$	$\Delta R_{ac}/R_{ac}$	$\leq 15\%$	$\leq 2\%$
$R > 100 \text{ k}\Omega$		$\leq 20\%$	$\leq 2\%$
Mechanical endurance			
25 000 cycles	$\Delta R_{ac}/R_{ac}$	$\leq 10\%$	$\leq 2\%$
Electrical endurance			
1000 h at 70 $^\circ\text{C}$, cyclic	$\Delta R_{ac}/R_{ac}$	$\leq 10\%$	$\leq 2\%$
Resistance to soldering heat (IEC 68-2, test T)	$\Delta R_{ac}/R_{ac}$	$\leq 2\%$	$\leq 1\%$
Change of temperature	$\Delta R_{ac}/R_{ac}$	$\leq 3\%$	$\leq 1\%$
	$\Delta V_{ab}/V_{ac}$	$\leq 1\%$	$\leq 0,5\%$
Bump and vibration	$\Delta R_{ac}/R_{ac}$	$\leq 2\%$	$\leq 0,5\%$
	$\Delta V_{ab}/V_{ac}$	$\leq 1\%$	$\leq 0,5\%$

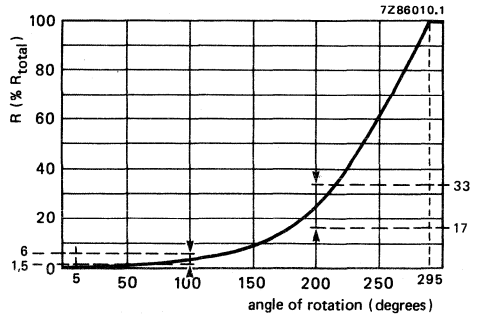
* For derating see Fig.36.

** For versions with metal spindle. The max. dissipation of cermet types with plastic spindle is 1 W (lin. law) and 2 W (lin. law with heatsink).

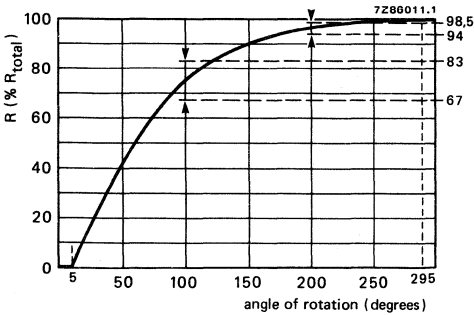
Characteristics of potentiometers without switch



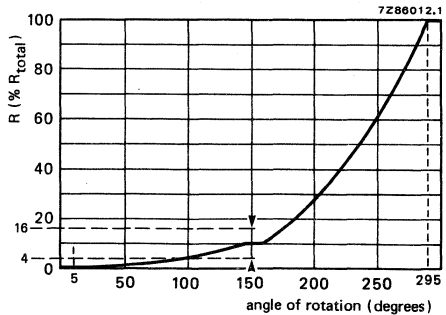
Type A
Fig.35a Linear law.



Type B
Fig.35b Logarithmic law.



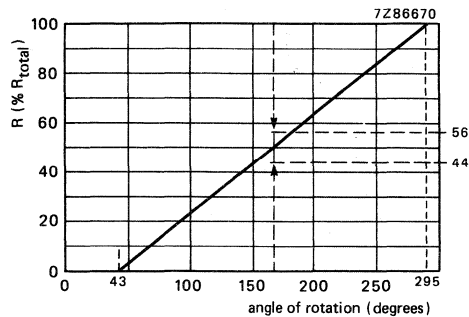
Type C
Fig.35c Reversed logarithmic law.



Type H
Fig.35d Logarithmic law, tap at 10%.

Characteristics of potentiometers with switch

The curves of Fig.35a to d have to be adapted since the effective angle of rotation is from 43° to 295°. An example for linear law is given in Fig.35e.



Type A
Fig.35e Linear law.

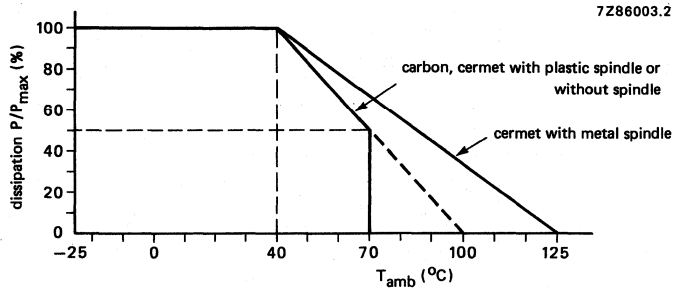


Fig.36 Maximum permissible dissipation as a function of ambient temperature.

MARKING

The potentiometers are marked according to IEC 62 as follows:

- nominal resistance (in RKM code)
- resistance law
- code for year and month of manufacture.

MECHANICAL DATA

	versions without spindle		versions with spindle		unit
	single duo	tandem	single duo	tandem	
Max. axial force	80*	80*	100	100	N
Operating torque initial	4 to 16	4 to 20	5 to 20	5 to 30	mNm
Operating torque of switch	25 to 75	25 to 75	25 to 75	25 to 75	mNm
Max. permissible end-stop torque			4φ: 600 6φ: 800	4φ: 600 6φ: 800	mNm
Angle of rotation	300 ± 2	300 ± 2	300 ± 2	300 ± 2	deg
Effective angle of rotation with switch	290 ± 2,5 252 ± 2,5	290 ± 2,5 252 ± 2,5	290 ± 2,5 252 ± 2,5	290 ± 2,5 252 ± 2,5	deg deg
Axial rotor/spindle play	≤ 0,2	≤ 0,2	≤ 0,3	≤ 0,3	mm
Radial rotor/spindle play	≤ 0,2	≤ 0,2	≤ 0,1 per 10 mm	≤ 0,1 per 10 mm	mm

Angle of rotation

- Types without switch
total mechanical angle
effective R-angle

For performance see

- Types with switch
total mechanical angle
O to A; radial spindle play in "off" position (c.c.w.)
O to B; switch angle
B to C; effective R-angle

For performance see

0° to 300°
5° to 295°
Fig.37a

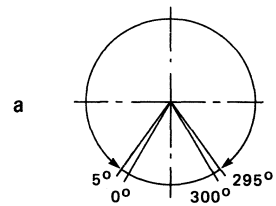
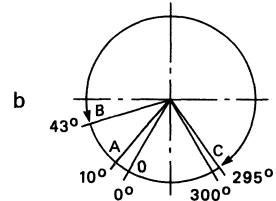


Fig.37a.

0° to 300°
10° max.
43° max.
43° to 295°
Fig.37b



7286309.1
Fig.37b.

MOUNTING

The potentiometers with printed-wiring terminals are intended for p.c. board mounting with a grid pitch of 1e (2,54 mm). The holes in the board should be 1,3 ± 0,5 mm; the board thickness not over 2 mm. Potentiometers with bushing should be mounted as described in Figs 29 and 30.

* If not supported: 20 N.

23 mm METAL-GLAZE ROTARY CONTROL

QUICK REFERENCE DATA

Resistance range (E3 series), linear law	47 Ω to 22 M Ω
Maximum dissipation at 40 °C	5 W
Climatic category, IEC 68	55/125/56

APPLICATION

These potentiometers are for control functions where high dissipation and high stability are necessary, e.g. in industrial control functions.

DESCRIPTION

These potentiometers have a metal-glaze resistive element on a ceramic base. The actuating device is an isolated rotor with a multiple wiper, operated by a metal spindle. For applications, up to 70 °C, potentiometers with a plastic spindle are also available. The resistance element is shielded by a metal housing. The bushing is profiled to act as a heatsink.

The terminals a and c (see Fig. 1) are the end terminals; b is the central terminal connected to the slider. All terminals are either solder tags (also suitable for snap-on connection), or printed wiring pins.

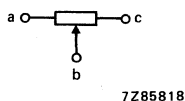


Fig. 1.

MOUNTING

The potentiometers can be mounted on a panel with a hexagonal nut which is supplied with each potentiometer (catalogue number of nut 4322 047 00350). The maximum tightening torque is 3.5 Nm.

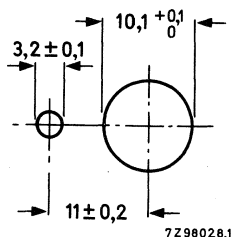


Fig. 2.

MARKING

The potentiometers are marked with:

- nominal resistance (in RKM code according to IEC 62)
- resistance law (LIN)
- code for period and year of manufacture.

Outline drawings.

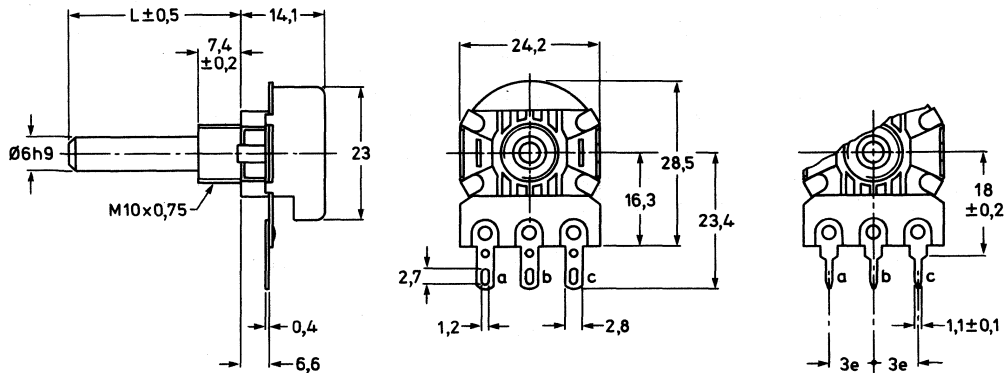


Fig. 3.

Dimension L: 18, 30 or 60

TECHNICAL DATA

Unless otherwise specified, all values have been determined at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 96 to 106 kPa and a relative humidity of 45 to 75%. The 47 Ω and the 100 Ω versions deviate slightly from the specified data.

Resistance range (E3 series), linear law

47 Ω to 22 MΩ

Tolerance on nominal resistance

± 10%, ± 20% (standard)
± 5% on request

Maximum dissipation at 40 °C (P_{max})

5 W

Test voltage between interconnected terminals and chassis during 1 minute, AC or DC

1000 V

Rated element voltage

$\sqrt{P_{max} \cdot R_{nom}}$
 $\geq 10^5 \text{ M}\Omega$

Insulation resistance after damp heat test IEC 68, c 56 days

$\leq 100 \cdot 10^{-6}/K$

Temperature coefficient

CRM (contact resistance moving), initial

$\leq 4\%$ of R_{ac}

CRV (contact resistance variation), initial

$\leq 2\%$ of R_{ac}

Climatic category according to IEC 68-2

metal spindle

55/125/56

plastic spindle

25/70/56

Operating torque (max./min. ≤ 2)

3 to 20 mNm

Permissible end-stop torque

$\leq 800 \text{ mNm}$

Permissible axial spindle load

$\leq 100 \text{ N}$

Effective angle of rotation

$270^\circ \pm 2^\circ$

Mechanical angle of rotation

$300^\circ \pm 5^\circ$

Rotation life

25 000 cycles

RESISTANCE

Potentiometers covered by this specification are linear, see Fig. 4.

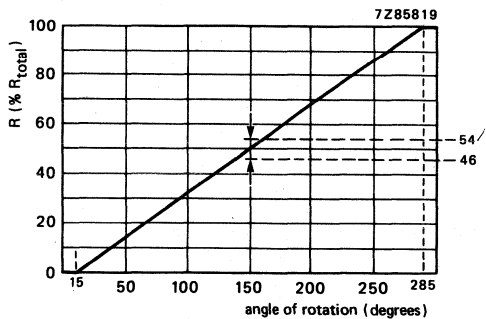


Fig. 4.

DERATING

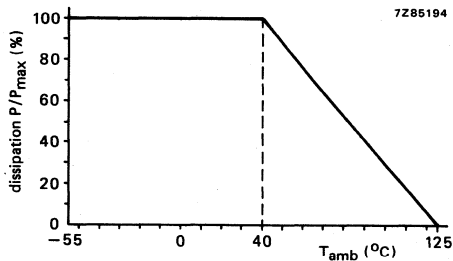


Fig. 5.

COMPOSITION OF THE CATALOGUE NUMBER

2322 481

code for terminals
and spindle material

0 = solder tags, metal spindle
 1 = p.w. tags, metal spindle
 7 = solder tags, plastic spindle
 6 = p.w. tags, plastic spindle

code for spindle length

06 = 18 mm length
 03 = 30 mm length
 07 = 60 mm length

Table for R_{nom}

R	law	10%	20%
47 Ω		41	91
100 Ω		01	51
220 Ω		02	52
470 Ω		03	53
1 k Ω		04	54
2.2 k Ω		05	55
4.7 k Ω		06	56
10 k Ω		07	57
22 k Ω		08	58
47 k Ω		09	59
100 k Ω		11	61
220 k Ω		12	62
470 k Ω		13	63
1 M Ω		14	64
2.2 M Ω		15	65
47 M Ω		16	66
10 M Ω		17	67
22 M Ω		18	68

Note

E6 values available on request.

ENVIRONMENTAL TESTS

tests	requirements	
Climatic sequence	$\Delta R_{ac}/R_{ac}$	$\leq 2\%$
Damp heat, steady state	$\Delta R_{ac}/R_{ac}$	$\leq 2\%$
Mechanical endurance 25 000 cycles	$\Delta R_{ac}/R_{ac}$	$\leq 2\%$
CRV (contact resistance variation) initial	CRV	$\leq 1.5\%$
after 25 000 cycles	CRV	$\leq 1.5\%$
Electrical endurance 1000 h at 70 °C, cyclic	$\Delta R_{ac}/R_{ac}$	$\leq 2\%$
Resistance to soldering heat (IEC 68-2, test T)	$\Delta R_{ac}/R_{ac}$	$\leq 0.5\%$
Change of temperature	$\Delta R_{ac}/R_{ac}$	$\leq 1\%$
	$\Delta V_{ab}/V_{ac}$	$\leq 0.5\%$
Bump and vibration	$\Delta R_{ac}/R_{ac}$	$\leq 0.5\%$

PACKAGING

50 items per box.

MAINTENANCE TYPES

	Page
CRC16 SERIES	335
CRC23 SERIES	347
OCP14	353
FMP-ST	361
FMP-CR	369
2422 136 7....	373

16 mm CARBON ROTARY CONTROL

QUICK REFERENCE DATA

Resistance range (E3 series)	
linear law	220 Ω to 4.7 MΩ
logarithmic law	1 kΩ to 2.2 MΩ
Maximum dissipation at 40 °C	
linear law	0.1 W
logarithmic law	0.05 W
Climatic category (IEC 68)	10/070/21

DESCRIPTION

The CP16 carbon control potentiometer is a single type for general purposes. It comprises a carbon track fitted on to a base plate of resin-bonded paper, all of which is housed in a metal case. The terminals a and c (see Types) are connected to the ends of the carbon track; terminal b is connected via a contact ring to the wiper contact. The spindle is constructed of plastic.

The potentiometer can be delivered either without a switch or with a rotary switch. It is available with a choice of different connecting terminals, mounting facilities and spindles (see the following figures).

Shaded data indicates that these are obsolete items.

Types

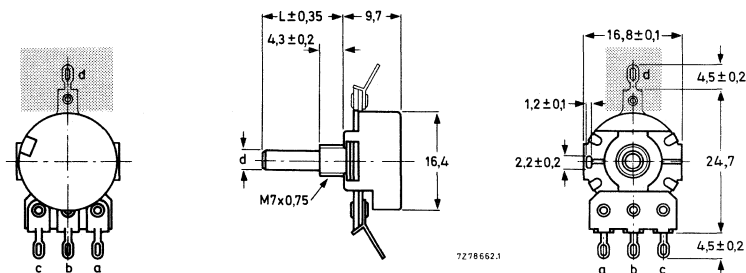
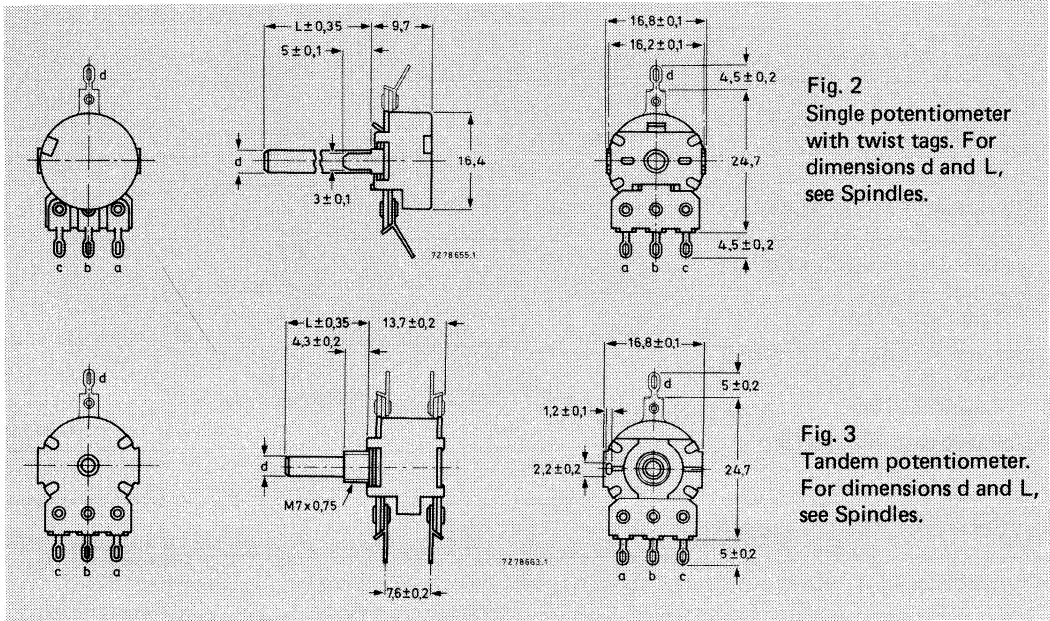
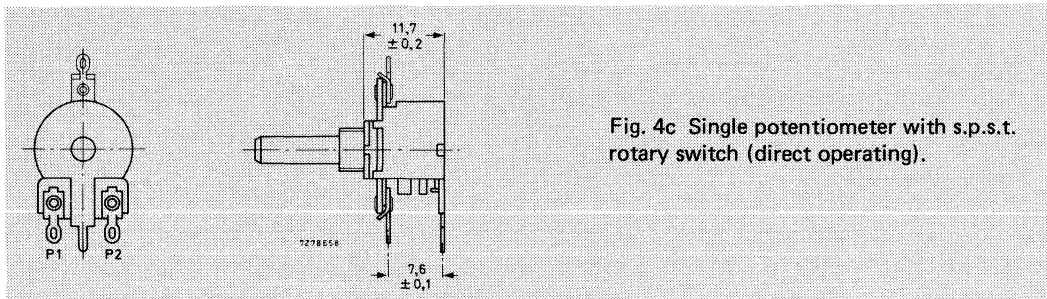
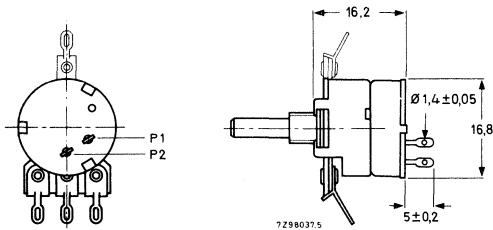
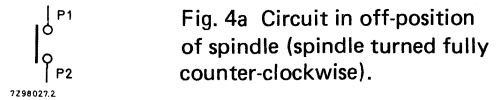


Fig. 1 Single potentiometer with mounting bushing. For dimensions d and L, see Spindles.



Switches

Single-pole, single-throw, rotary switch (s.p.s.t.).



Connecting terminals

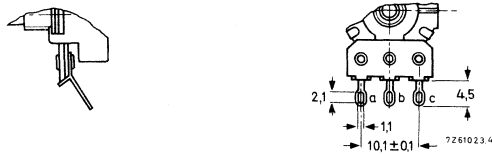


Fig. 5 Solder tags.

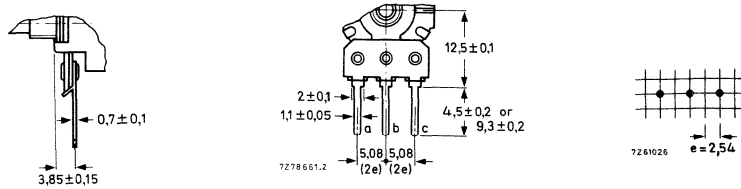


Fig. 6 Long or short printed-wiring pins (single potentiometer).

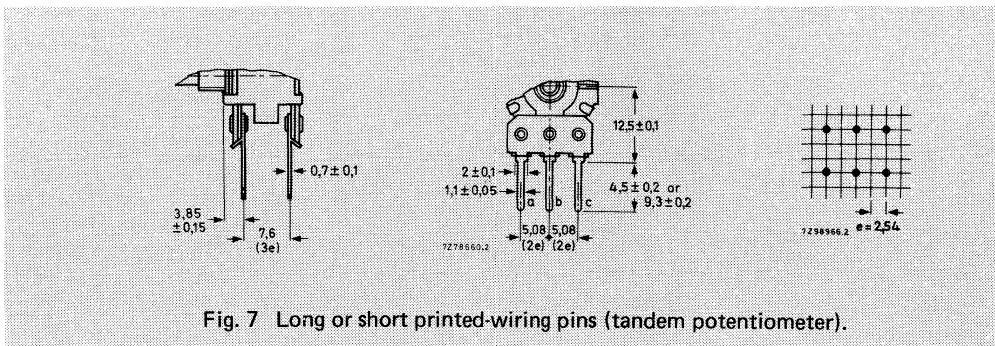


Fig. 7 Long or short printed-wiring pins (tandem potentiometer).

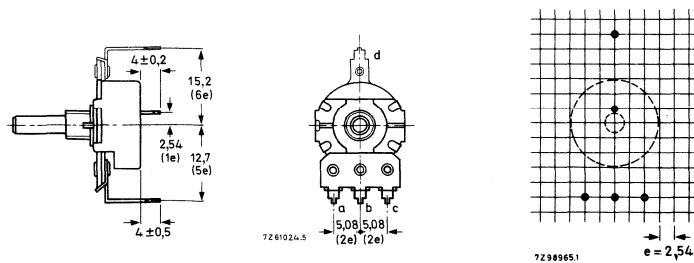
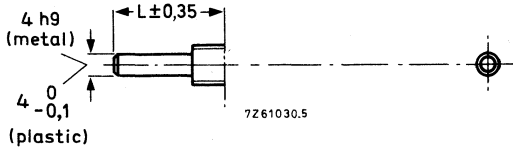


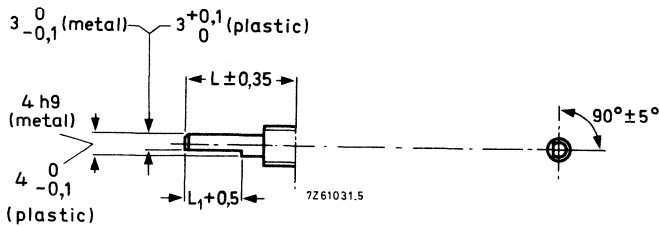
Fig. 8 Printed-wiring pins, bent backwards.

Spindles

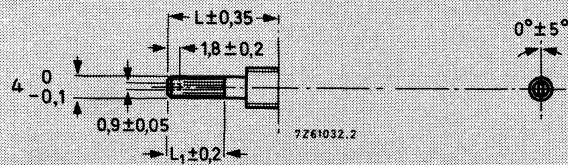
type	off position	L mm	L ₁ mm	material
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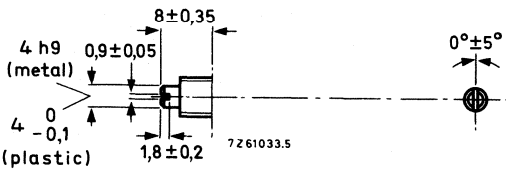
10		
20		plastic
30		



10	3.5	
15	8.5	plastic
20	8.5	
20	13.5	

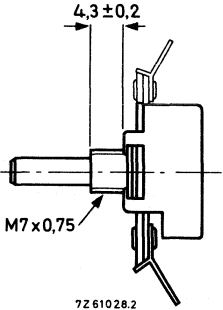
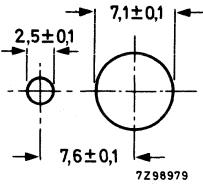


10	5	
15	9	plastic
20	9	



plastic

Mounting facilities

	required mounting holes in chassis	fixing of potentiometer
<p>mounting bushing M7 x 0.75</p> 		<p>with supplied mounting nut;* max. torque for tightening = 1 Nm; min. thickness of chassis = 1 mm</p>

MARKING

The potentiometers are marked with nominal resistance, resistance law, period and year of manufacture.

PACKAGING

150 per box for standard versions.

100 per box for special versions.

* Catalogue number of mounting nut: 4322 047 00370.

TECHNICAL DATA

Unless otherwise specified, all values have been determined at an ambient temperature of 15 to 35 °C, at atmospheric pressure of 96 to 106 kPa and a relative humidity of 45 to 75%.
For measuring methods, see IEC publications 190 and 68.

nominal resistance R_{nom}^*	resistance law according to Figs 9 and 10	max. voltage at 40 °C V	max. terminal resistance	max. attenuation dB	max. contact resistance % R_{nom}	limiting wiper current at 40 °C mA
220 Ω	a	4.7	10 Ω	—	4	21
470 Ω	a	6.8	10 Ω	—	4	14.5
1 k Ω	a	10	25 Ω	—	4	10
2.2 k Ω	a	14	25 Ω	—	4	7
4.7 k Ω	a	22	25 Ω	—	4	5
10 k Ω	a	31	35 Ω	—	4	3.2
22 k Ω	a	45	35 Ω	—	4	2.2
47 k Ω	a	70	35 Ω	—	4	1.5
100 k Ω	a	100	100 Ω	—	4	1.0
220 k Ω	a	140	125 Ω	—	4	0.7
470 k Ω	a	220	250 Ω	—	4	0.5
1 M Ω	a	310	1 k Ω	—	4	0.32
2.2 M Ω	a	460	2 k Ω	—	4	0.22
4.7 M Ω	a	500	5 k Ω	—	4	0.14
1 k Ω	b	7	5 Ω	50	6	7
2.2 k Ω	b	10	5 Ω	50	6	5
4.7 k Ω	b	15	5 Ω	60	6	3.2
10 k Ω	b	22	10 Ω	60	6	2.2
22 k Ω	b	31	20 Ω	60	6	1.5
47 k Ω	b	50	35 Ω	60	6	1.0
100 k Ω	b	70	50 Ω	70	6	0.7
220 k Ω	b	100	50 Ω	80	6	0.5
470 k Ω	b	155	100 Ω	80	6	0.32
1 M Ω	b	220	200 Ω	80	6	0.22
2.2 M Ω	b	310	500 Ω	80	6	0.15
5 + 42 k Ω	d	50	40 Ω	60	6	1.0
20 + 200 k Ω	d	100	50 Ω	80	6	0.5
50 + 420 k Ω	d	155	470 Ω	80	6	0.32
100 + 900 k Ω	d	220	200 Ω	80	6	0.22

* Measured between terminals a and c; for potentiometers with a tap, between terminals a and d and between c and d.

** Measured between terminals a and b; spindle turned fully counter-clockwise.

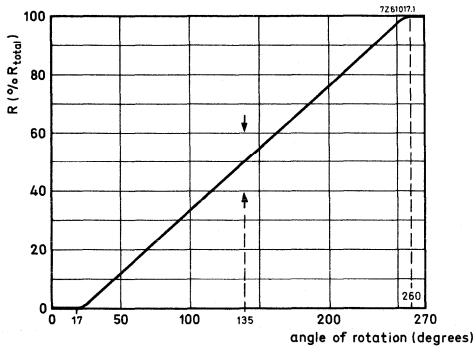


Fig. 9a Linear law, single potentiometers.

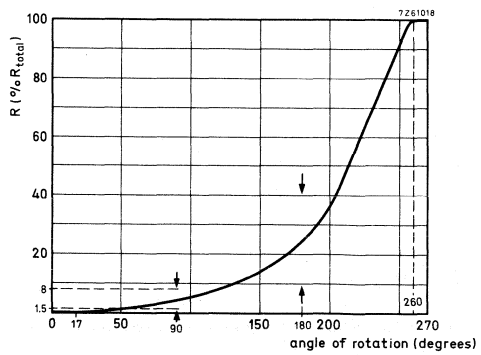


Fig. 9b Logarithmic law, single potentiometers.

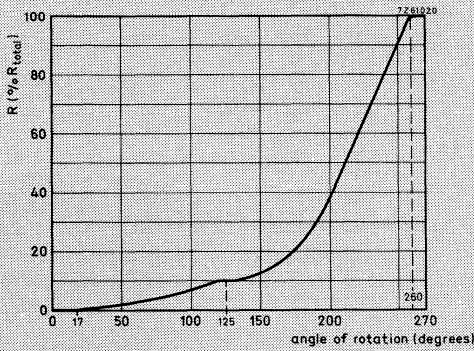


Fig. 9c Semi-logarithmic law, tap at 10%, single potentiometers.

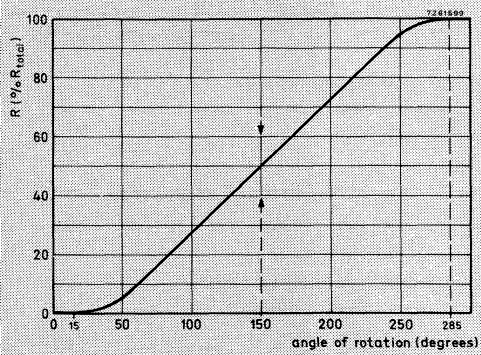


Fig. 10a Linear law, tandem potentiometers.

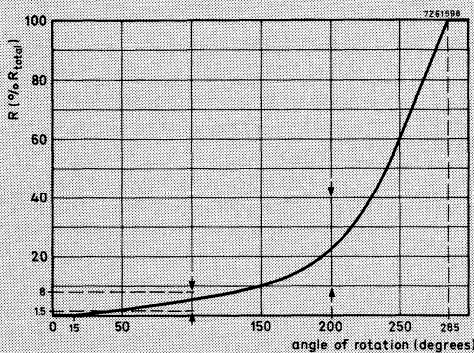


Fig. 10b Logarithmic law, tandem potentiometers.

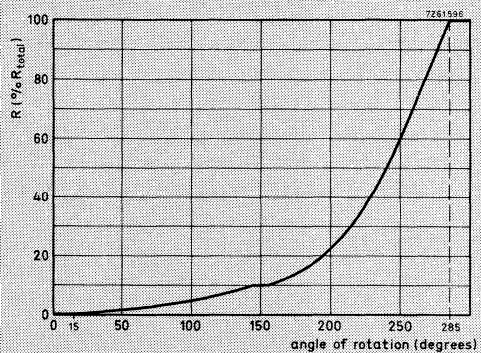


Fig. 10c Logarithmic law, tap at 10%, tandem potentiometers.

Tolerance on the nominal resistance	± 20% (note 1)	
Resistance law and tolerances	see Figs 9 and 10	
Ganging tolerance (note 2)		
linear law		
at values between 10 and 90% of R_{total}	< 2 dB	
(reversed) logarithmic law		
at attenuations between 0 and -20 dB	< 2 dB	
at attenuations between -20 and -30 dB	< 3 dB	
at attenuations between -30 and -40 dB	< 4 dB	
with a tap		
at attenuations between 0 and -20 dB	< 2 dB	
at attenuations between -20 and -30 dB	< 3 dB	
at attenuations between -30 and -34 dB	< 4 dB	
Minimum resistance at the tap	< 1,5% of R_{nom}	
Insulation resistance,		
initially	> 1000 M Ω	
after damp heat test (IEC 68, test C, 21 days)	> 25 M Ω	
Maximum dissipation at 40 °C		
linear law, acc. to Figs 9a, 10a	0.1 W	
resistance law, acc. to Figs 9b, 9c and 10b, 10c	0.05 W	
Test voltage	1000 V, 50 Hz	
Working temperature range	-10 to +70 °C	
Storage temperature range	-25 to +70 °C	
Category (IEC 68)	10/070/21	
Operating torque	5 to 20 mNm	
Permissible torque with wiper at end stop		
plain spindles	≤ 500 mNm	metal ≤ 600 mNm
spindles with flat face	≤ 400 mNm	≤ 600 mNm
spindles with screwdriver slot	≤ 250 mNm	≤ 600 mNm
Permissible axial spindle load		
single potentiometers	≤ 100 N	} pull ≤ 100 N } ≤ 60 N } push
tandem potentiometers	≤ 100 N	
Axial spindle play	< 0.8 mm	
Radial spindle play, measured with 2.5 N		
at 10 mm from the mounting plane		
potentiometers with mounting bushing	≤ 0.2 mm	
potentiometers with twist tags	≤ 0.5 mm	
Effective angle of rotation		
single	235 – 250°	
tandem	265 – 275°	
balance	range of balance, half the effective angle of rotation: 20 ± 10° R ₂ : 125 ± 10° (counter-clockwise) R ₁ : 125 ± 10° (clockwise)	

Notes to Technical Data

1. For potentiometers with a tap the tolerance on R_{ad} as well as $R_{dc} = \pm 20\%$.
2. For tandem potentiometers only.

Mechanical angle of rotation single potentiometers

without switch

with switch

tandem potentiometers

 $270 \pm 5^\circ$ $292 \pm 5^\circ$ $300 \pm 5^\circ$

Life

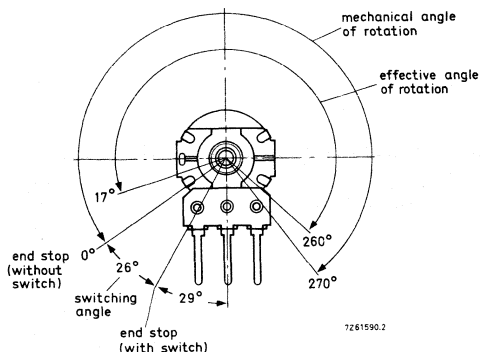
after 10 000 cycles ΔR_{ac}
< 25% of R_{ac} 

Fig. 11a Angles of rotation of single potentiometers with or without switch.

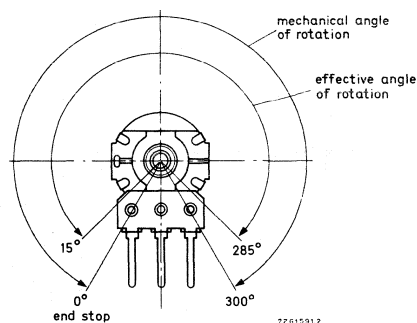


Fig. 11b Angles of rotation of tandem potentiometers.

	switch type	
	s.p.s.t. rotary spring actuated	s.p.s.t. rotary direct operating
Breaking capacity	12 V DC, 2A	12 V DC, 2A
Contact resistance, initially after 10 000 on-off switching operations at breaking capacity	< 10 mΩ < 50 mΩ*	< 10 mΩ < 50 mΩ*
Insulation resistance** initially after damp heat test (IEC 68, test Ca, 21 days)	> 10 MΩ > 2 MΩ	> 10 MΩ > 2 MΩ
Test voltage for 1 min**, initially after damp heat test (IEC 68, test Ca, 21 days)	500 V (DC) 100 V (DC)	500 V (DC) 100 V (DC)
Switching torque	15 to 40 mNm	12 to 30 mNm
Switching angle	$26 \pm 2^\circ$	$26 \pm 2^\circ$
Total mechanical angle of rotation	$295 \pm 5^\circ$	$295 \pm 5^\circ$
Backlash	$\leq 10^\circ$	$\leq 10^\circ$
Permissible axial spindle load	≤ 100 N	≤ 100 N

* Averaged over 10 measurements: < 25 mΩ.

** Measured between the terminals, and between interconnected terminals and the case or other metal parts.

COMPOSITION OF THE CATALOGUE NUMBER

Table 1 16 mm carbon rotary control

2322

code for type and switch	code for terminals, mounting facility, spindle type and length		code for resistance law and nominal resistance, see Table 2	
without switch { single = 380 tandem = 390	p.w. pins, length 4.5 mm		p.w. pins, length 9.3 mm	
single, with s.p.s.t. rotary switch (spring actuated)* = 381	solder tags		mounting bushing	
single, with s.p.s.t. rotary switch (direct operating) = 387	metal spindle		metal spindle	plastic spindle
single, without switch, with p.w. pins bent backwards** = 389	0..		0..	7..
	mounting bushing		mounting bushing	
	plastic spindle		plastic spindle	
	7..		7..	
	10 mm = .11 12 mm = .09 15 mm = .12 17 mm = .13 19 mm = .14 20 mm = .15 22 mm = .17 24 mm = .19 25 mm = .01 28 mm = .02 30 mm = .03		10 mm = .61 12 mm = .59 15 mm = .62 17 mm = .63 19 mm = .64 20 mm = .65 22 mm = .67 24 mm = .69 25 mm = .51 28 mm = .52 30 mm = .53	
	plain		plain	
	with flat face { 10 (L ₁ = 3.5) mm = .42 15 (L ₁ = 8.5) mm = .44 20 (L ₁ = 8.5) mm = .45 20 (L ₁ = 13.5) mm = .46		with flat face { 10 (L ₁ = 3.5) mm = .92 15 (L ₁ = 8.5) mm = .94 20 (L ₁ = 8.5) mm = .95 20 (L ₁ = 13.5) mm = .96	
	knurled (only plastic) { 10 mm = .26 15 mm = .27 20 mm = .28		knurled (only plastic) { 10 mm = .76 15 mm = .77 20 mm = .78	
	with screwdriver slot = .10		with screwdriver slot = .60	

* Only available with mounting bushing.
** Only available with mounting bushing and p.w. pins of 9.3 mm length.

Table 2 Resistance law and nominal resistance codes

nominal resistance	code in catalogue number		
	linear law Fig. 9a, 10a	log. law Fig. 9b, 10b	log. law tap at 10% Figs 9c, 10c
220 Ω	02		
470 Ω	03		
1 k Ω	04	24	
2.2 k Ω	05	25	
4.7 k Ω	06	26	
10 k Ω	07	27	
22 k Ω	08	28	
47 k Ω	09	29	
100 k Ω	11	31	
220 k Ω	12	32	
470 k Ω	13	33	
1 M Ω	14	34	
2.2 M Ω	15	35	
4.7 M Ω	16		
5 + 42 k Ω			72
20 + 200 k Ω			67
50 + 420 k Ω			73
100 + 900 k Ω			64

23mm CARBON ROTARY CONTROL

QUICK REFERENCE DATA

Resistance range (E3 series)	
linear law	220 Ω to 4,7 MΩ
logarithmic law	1 kΩ to 4,7 MΩ
Maximum dissipation at 40 °C	
linear law	0,25 W
logarithmic law	0,125 W
Climatic category (IEC 68)	10/070/21

APPLICATION

The potentiometers are widely used in electronic equipment.

DESCRIPTION

These single potentiometers consist of a carbon track, which is fitted on to a base plate of resin bonded paper and housed in a metal case. The terminals a and c (see Types) are connected to the ends of the carbon track; terminal b is connected via a contact ring to the wiper contact. The material of the spindle is plastic. The potentiometers are provided with solder tag terminals.

MARKING

The potentiometers are marked with nominal resistance, resistance law, period and year of manufacture.

Types

For dimensions d, L and L1, see Spindles.

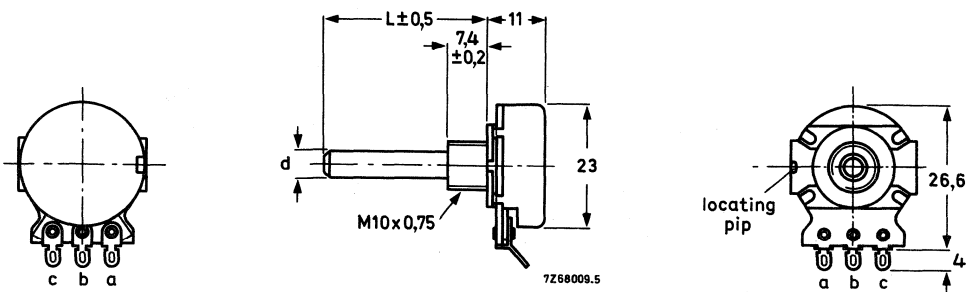


Fig. 1 Single potentiometer.

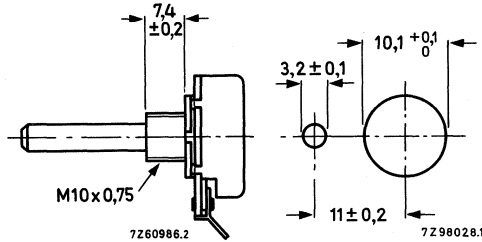
Mounting facilities

method

required mounting
holes in chassis

fixing of
potentiometer

mounting bushing
M10 x 0,75



with supplied mounting
nut (catalogue number
4322 047 00350)
max. torque for
tightening = 3,5 Nm;
min. thickness of
chassis = 1,5 mm

Fig. 2.

Connecting terminals

solder tags

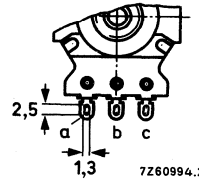
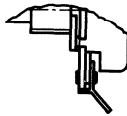


Fig. 3.

Spindles

type

L
mm

L₁
mm

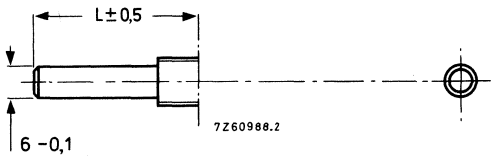


Fig. 4.

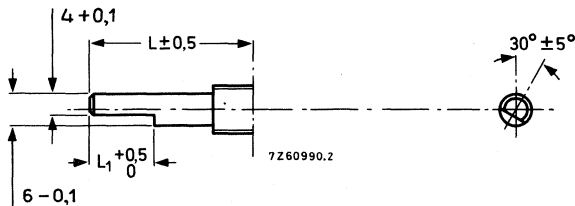


Fig. 5.

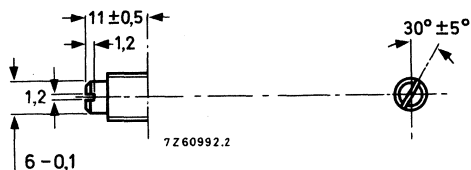


Fig. 6.

17	—
18	8,5
19	—
20	—
22	—
25	13,5
30	—
35	—
40	13,5
60	13,5
70	—
90	—

TECHNICAL DATA

Unless otherwise specified, all values have been determined at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

For measuring methods, see IEC publications 190 and 68.

nominal resistance R_{nom}^*	resistance law according to Fig. 11	max. voltage (V)		max. terminal resistance	max. attenuation dB	max. contact resist. % R_{nom}	limiting wiper current at 40 °C mA
		at 40 °C	at 70 °C				
220 Ω	a	7,4	5,7	10 Ω	—	3	40
330 Ω	a	8,7	6,7	10 Ω	—	3	30
470 Ω	a	11	8,4	10 Ω	—	3	22
1 k Ω	a	16	12	25 Ω	—	3	16
2,2 k Ω	a	23	18	25 Ω	—	3	11
4,7 k Ω	a	34	26	25 Ω	—	3	7
10 k Ω	a	50	39	35 Ω	—	2,5	5
22 k Ω	a	74	57	35 Ω	—	2,5	3,5
47 k Ω	a	110	84	35 Ω	—	2,5	2,2
100 k Ω	a	160	120	100 Ω	—	2,5	1,4
220 k Ω	a	230	180	125 Ω	—	2,5	1,0
470 k Ω	a	340	265	250 Ω	—	2,5	0,65
1 M Ω	a	500	390	1 k Ω	—	2,5	0,45
2,2 M Ω	a	500	500	2,2 k Ω	—	2,5	0,32
4,7 M Ω	a	500	500	4,7 k Ω	—	2,5	0,22
470 Ω	b	8,4	6,9	5 Ω	—	6	14
1 k Ω	b	12	10	5 Ω	50	4	10
2,2 k Ω	b	18	15	5 Ω	60	4	7
4,7 k Ω	b	26	22	5 Ω	60	4	4,5
10 k Ω	b	39	32	10 Ω	60	4	3,2
22 k Ω	b	57	47	22 Ω	60	4	2,2
47 k Ω	b	84	69	35 Ω	** 70	** 4	1,4
100 k Ω	b	120	100	50 Ω	70	4	1,0
220 k Ω	b	180	150	50 Ω	80	4	0,7
470 k Ω	b	265	220	100 Ω	80	4	0,45
1 M Ω	b	390	320	500 Ω	80	4	0,32
2,2 M Ω	b	500	470	2,2 k Ω	80	4	0,22

* Measured between terminals a and c.

** Measured between terminals a and b; spindle turned fully counter-clockwise.

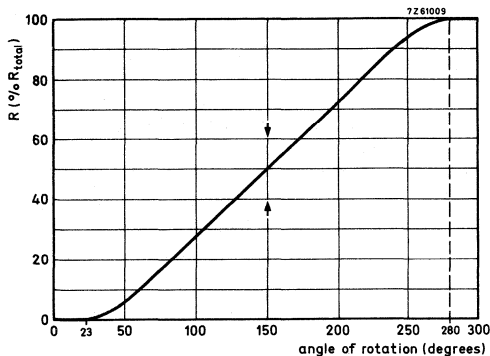


Fig. 11a Linear law.

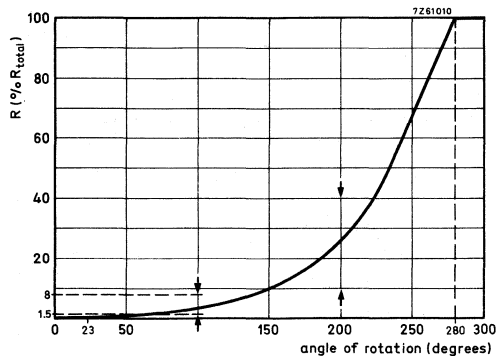


Fig. 11b Logarithmic law.

Tolerance on the nominal resistance

Resistance law and tolerances

Minimum resistance at the tap

Insulation resistance after damp heat test
(IEC 68, test C, 21 days)

Maximum dissipation

linear law, acc. to Fig. 11a

at 40 °C

at 70 °C

resistance law, acc. to Fig. 11b

at 40 °C

at 70 °C

Test voltage

Working temperature range

Category (IEC 68)

Operating torque

Permissible torque with wiper at end stop

Permissible axial spindle load

Effective angle of rotation

Mechanical angle of rotation

Life, $\Delta R_{ac}/R_{ac}$

$\pm 20\%$

see Figs 11a and 11b

$\leq 1\%$ of R_{nom}

$> 100 \text{ M}\Omega$

0,25 W

0,125 W

0,125 W

0,0625 W

1000 V, 50 Hz

-10 to + 70 °C

10/070/21

3 to 20 mNm

$\leq 0,8 \text{ Nm}$

$\leq 100 \text{ N}$

250-265°

300 \pm 5°

after 10 000 rotations

$< 25\%$

Packaging

150 items per box for standard types.

100 items per box for specials.

COMPOSITION OF THE CATALOGUE NUMBER

2322 350 7

code for type, and length of spindle

slotted = .10			
plain	17 mm = 13	flat faced	18 mm = .40
	18 mm = 06		25 mm = .41
	19 mm = 14		30 mm = .43
	20 mm = 15		40 mm = .45
	22 mm = 17		60 mm = .47
	25 mm = 01		
	30 mm = 03		
	35 mm = 04		
	40 mm = 05		
	60 mm = 07		
70 mm = 08			
90 mm = 09			

code for resistance law and nominal resistance

nominal resistance	lin law	log law
220 Ω	= 02	
330 Ω	= 19	
470 Ω	= 03	23
1 kΩ	= 04	24
2,2 kΩ	= 05	25
4,7 kΩ	= 06	26
10 kΩ	= 07	27
22 kΩ	= 08	28
47 kΩ	= 09	29
100 kΩ	= 11	31
220 kΩ	= 12	32
470 kΩ	= 13	33
1 MΩ	= 14	34
2,2 MΩ	= 15	35
4,7 MΩ	= 16	

14 mm OPEN CARBON PRESET

QUICK REFERENCE DATA

Resistance range (E3-series), linear law	47 Ω – 4,7 M Ω
Maximum dissipation at 40 $^{\circ}\text{C}$	0,3 W
Climatic category, IEC 68	55/100/10
Dimensions based upon spec.	DIN 44150

APPLICATION

These potentiometers are for preset resistance control with provision for re-adjustments. They are particularly suitable for use in radio and television receivers.

DESCRIPTION

These preset potentiometers comprise a carbon track, which is riveted on to a base plate of resin-bonded paper. They are provided with snap-in printed-wiring pins, which hold them firmly in place on the board before soldering. They are also available with straight printed-wiring pins.

The pins a and c (see drawings) are connected to the ends of the carbon track; pin b is connected to the wiper, which has a central screwdriver slot. This potentiometer series includes two types: one for vertical and one for horizontal mounting on printed-wiring boards.

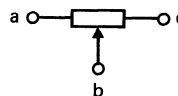
COMPOSITION OF THE CATALOGUE NUMBER

2322 409

0 = without knob

* Versions with knob available on request.

- 02 = straight pins, vertical mounting
- 13 = straight pins, horizontal mounting
- 22 = snap-in pins, vertical mounting
- 33 = snap-in pins horizontal mounting



7Z85818

code for resistance value

- 91 = 47 Ω
- 51 = 100 Ω
- 52 = 220 Ω
- 69 = 330 Ω
- 53 = 470 Ω
- 54 = 1 k Ω
- 55 = 2,2 k Ω
- 56 = 4,7 k Ω
- 57 = 10 k Ω
- 58 = 22 k Ω
- 59 = 47 k Ω
- 61 = 100 k Ω
- 62 = 220 k Ω
- 63 = 470 k Ω
- 64 = 1 M Ω
- 65 = 2,2 M Ω
- 66 = 4,7 M Ω

MARKING

The potentiometers are marked with the rated resistance value, by letter punches on the wiper.

Outlines

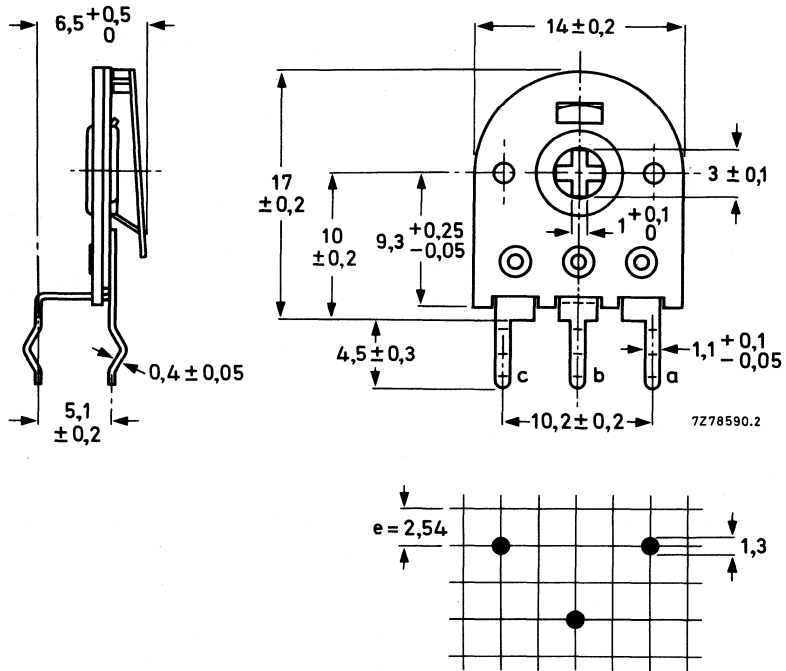


Fig.1 Potentiometer for vertical mounting, with snap-in printed-wiring pins, 2322 409 022.

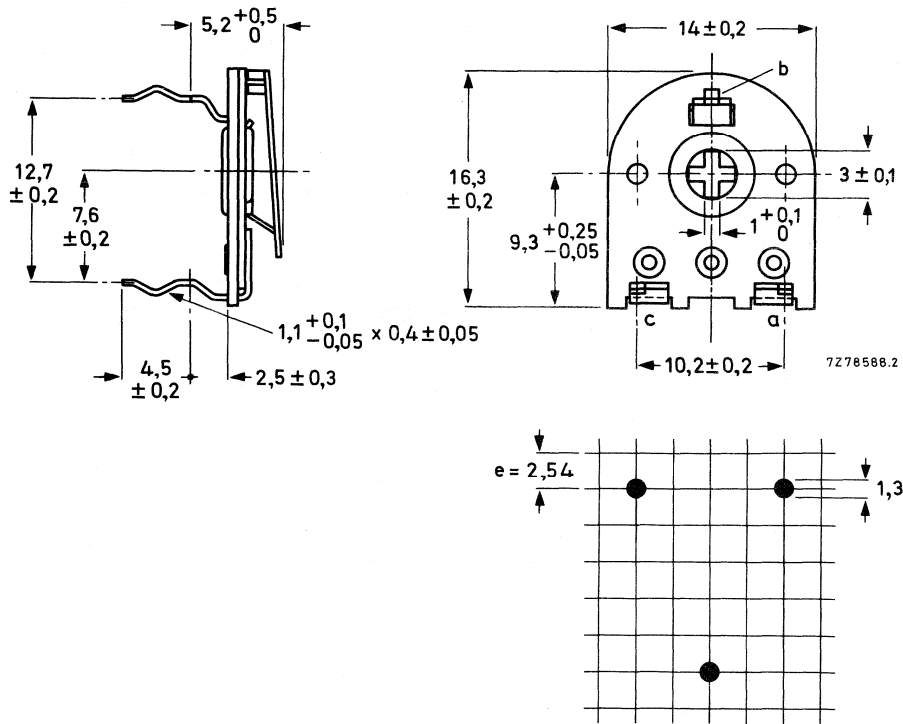


Fig.2 Potentiometer for horizontal mounting, with snap-in printed-wiring pins, 2322 409 033..

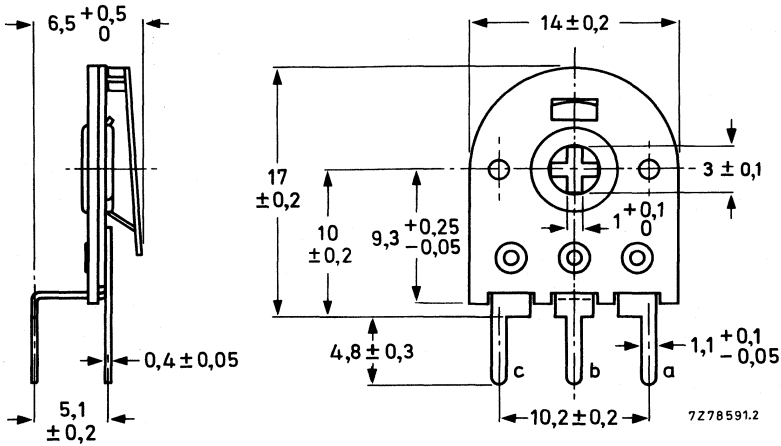


Fig.3 Potentiometer for vertical mounting, with straight printed-wiring pins, 2322 409 002..

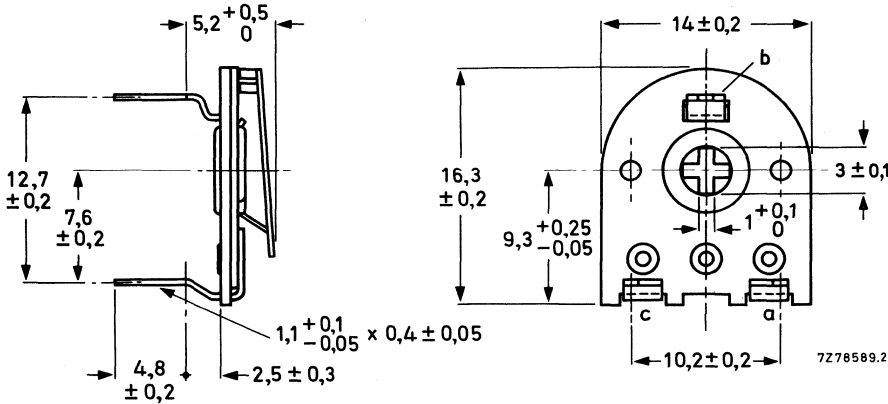
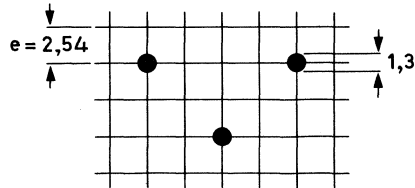
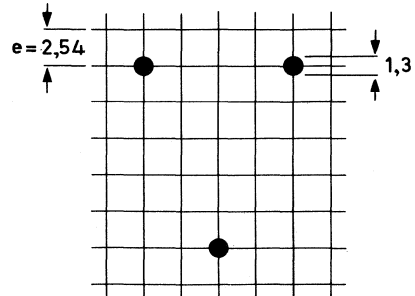


Fig.4 Potentiometer for horizontal mounting, with straight printed-wiring pins, 2322 409 013..



Note

For dimensions of knob or wheel versions see relevant drawing of snap-in-pin counterpart.

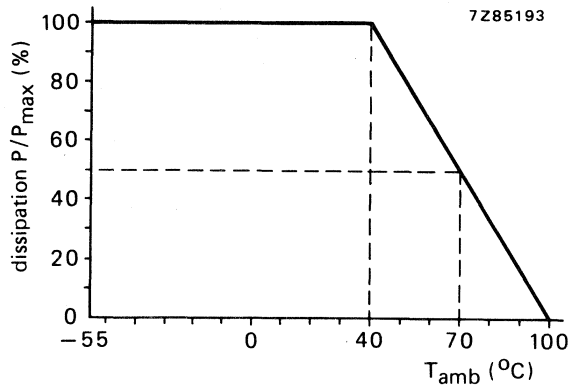
TECHNICAL DATA

Mass, per 100		72 g
Resistance range (E3-series)		47 Ω to 4,7 M Ω
Standard tolerance		$\pm 20\%$
Resistance law		linear, see Fig. 6
Rated dissipation		0,15 W, see Fig. 5
at 70 °C (P_{max})		0,3 W
at 40 °C		500 V (DC)
Limiting element voltage		
Limiting wiper current		$\sqrt{\frac{P_{max}}{R_{nom}}}$
Terminal resistance		$\leq 2\%$ of R_{nom}
Contact resistance variation (CRV)		$\leq 1\%$ of R_{ac}
Temperature coefficient in the range -55 °C to $+100$ °C		-500 to $+300 \cdot 10^{-6}/K$
Starting torque		≤ 25 mNm
Operating torque		3,5 to 25 mNm
Permissible end-stop torque		max. 100 mNm
Total mechanical angle of rotation		$230 \pm 5^\circ$
Effective angle of rotation		$210 \pm 10^\circ$
Settability		0,1% within 10 s
Climatic category according to IEC 68-2		55/100/10
Climatic sequence		$\frac{\Delta R_{ac}}{R_{ac}} \leq 10\%$
Damp heat, steady state, 10 days max.	$R_{nom} \leq 100 K$	$\frac{\Delta R_{ac}}{R_{ac}} \leq 15\%$
	$R_{nom} > 100 K$	$\frac{\Delta R_{ac}}{R_{ac}} \leq 20\%$
Mechanical endurance (200 cycles)		$\frac{\Delta R_{ac}}{R_{ac}} \leq 5\%$
Electrical endurance (1000 h at 70 °C, cyclic)		$\frac{\Delta R_{ac}}{R_{ac}} \leq 10\%$
Resistance to soldering heat		$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$
Bump		$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$
Vibration		$\frac{\Delta R_{ac}}{R_{ac}} \leq 2\%$
		$\frac{\Delta V_{ab}}{V_{ab}} \leq 0,5\%$

DERATING

Potentiometers covered by this specification are derated from 100% rated dissipation at 40 °C to zero dissipation at 100 °C. The dissipation below 40 °C is the rated dissipation.

100% = 0,3 W



For $\Delta R_{ac} \leq 10\%$

Fig. 5 Dissipation as a function of ambient temperature.

RESISTANCE LAW

Potentiometers covered by this specification are linear.

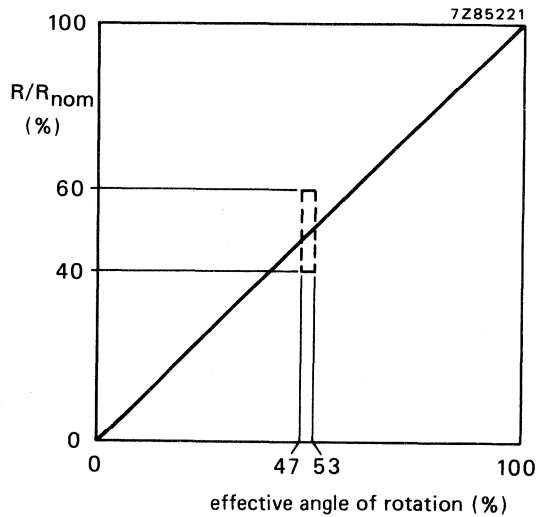


Fig. 6 Linear resistance law.

TESTS AND REQUIREMENTS

Clause numbers of tests and conditions of test refer to IEC 393-1 (potentiometers; part 1: terms and methods of test).

The potentiometers have been tested whilst mounted by their terminations on a printed wiring board. When drying is called for, procedure l of IEC 393-1, sub. 5,2 is used (24 ± 4 h, 55 ± 2 °C, R.H. $\leq 20\%$). When the contact resistance variation (CRV) is measured, the wiper is rotated in both directions over 90% of the effective resistance.

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.22.3	T _a	Solderability	solder bath: $235^{\circ} \pm 5$ °C, $2 \pm 0,5$ s	good tinning
6.22.4	T _b	Resistance to heat	solder bath: 350 ± 10 °C, $3,5 \pm 0,5$ s	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0,5\%$
6.25	E _b	Bump	acceleration: 390 m/s ² number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0,5\%$
6.24	E _c	Vibration	frequency: 10 to 500 Hz amplitude: 0,75 mm or 98 m/s ² , 6 h	$\frac{\Delta R_{ac}}{R_{ac}} \leq 1\%$ $\frac{\Delta V_{ab}}{V_{ab}} \leq 0,1\%$
6.13	—	Temperature characteristics of resistance	temp. cycle: $+20$ °C; -55 °C; $+20$ °C; $+100$ °C; $+20$ °C	$-300 < TC < +300 \cdot 10^{-6}/K$
6.26 6.26.2 6.26.3 6.26.4 6.26.6	— Ba Db Aa Db	Climatic sequence Dry heat Damp heat accel. 1st cycle Cold Damp heat, remaining cycle	16 h at 100 °C 24 h at 55 °C $95 - 100\%$ R.H. 2 h at -55 °C 24 h at 55 °C $95 - 100\%$ R.H.	$\frac{\Delta R_{ac}}{R_{ac}} \leq 5\%$ operating torque ≤ 30 mNm
6.30	—	Electrical endurance	T _{amb} : 70 °C, 1000 h, cyclic (1,5 h on and 0,5 h off, b at 0,67 a - c) Load: 0,15 W between a and c Load: 0,1 W between a and b	CRV $< 1\%$ of R _{ac} $\frac{\Delta R_{ac}}{R_{ac}} \leq 10\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0,5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leq 10\%$

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.29	—	Mechanical endurance	200 cycles, 4 cycles/min, no load	$\frac{\Delta R_{ac}}{R_{ac}} \leq 3\%$ CRV < 0,5% of R_{ac}
6.27	C	Damp heat steady state	slider at 0,67 a - c load via a - c recovery 24 h 22 ± 1 °C, 50% R.H. ± 5% (CECC 41 000 clause 4.29)	CRV < 0,5% of R_{ac} $\frac{\Delta R_{ac}}{R_{ac}} \leq 5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leq 5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leq 0,2\%$

FOCUS METAL-GLAZE PRESET solder tag version

- For colour picture tubes, focusing voltage approx. 4,5 kV and 7 kV
- In conjunction with triplers or diode-split line output transformers

QUICK REFERENCE DATA

Nominal resistance	24 M Ω \pm 20% and 83 M Ω \pm 15%*
Maximum dissipation at 70 °C	3,8 W
Climatic category, IEC 68	20/070/21

APPLICATION

These focus potentiometer units are for adjustment of the focusing voltage for colour picture tubes.

DESCRIPTION

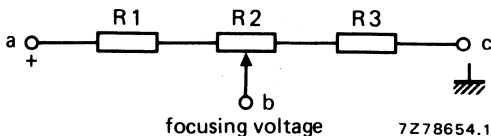
The units comprise three resistive elements which are connected in series, see Fig. 1. The centre element is a potentiometer. The resistive elements are of the thick-film, metal glaze type; they are printed on an Al₂O₃ substrate. The housing of the units is self-extinguishing, glass-fibre filled thermoplastic material. The units have two snap-in clasps for board mounting.

The electrical connections are solder tags or faston receptables of 2,8 x 0,5 mm or 4,8 x 0,5 mm. The focus units can be used with or without a bleeder resistor.

For a stable focus output voltage the types 2322 460 90028 and 2322 460 90029 are provided with an extra input terminal d.

Fig. 1. Designation of terminals

- a = focus output voltage or tripler unit;
- b = focusing voltage;
- c = earth.



* Other values on request.

MECHANICAL DATA

Outlines

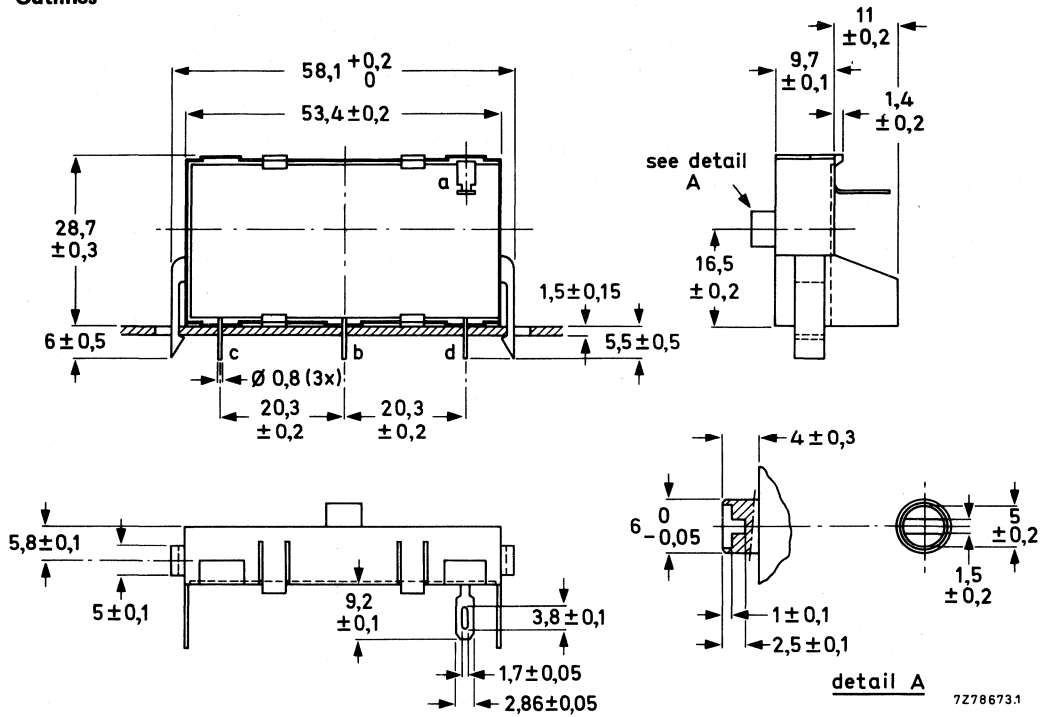


Fig. 2 Potentiometer unit 2322 460 90016. The indication of the terminals corresponds to those shown in Fig. 1; terminal d serves for mechanical fitting of the unit. Solder tag a fits Faston receptacles (2,8 x 0,5).

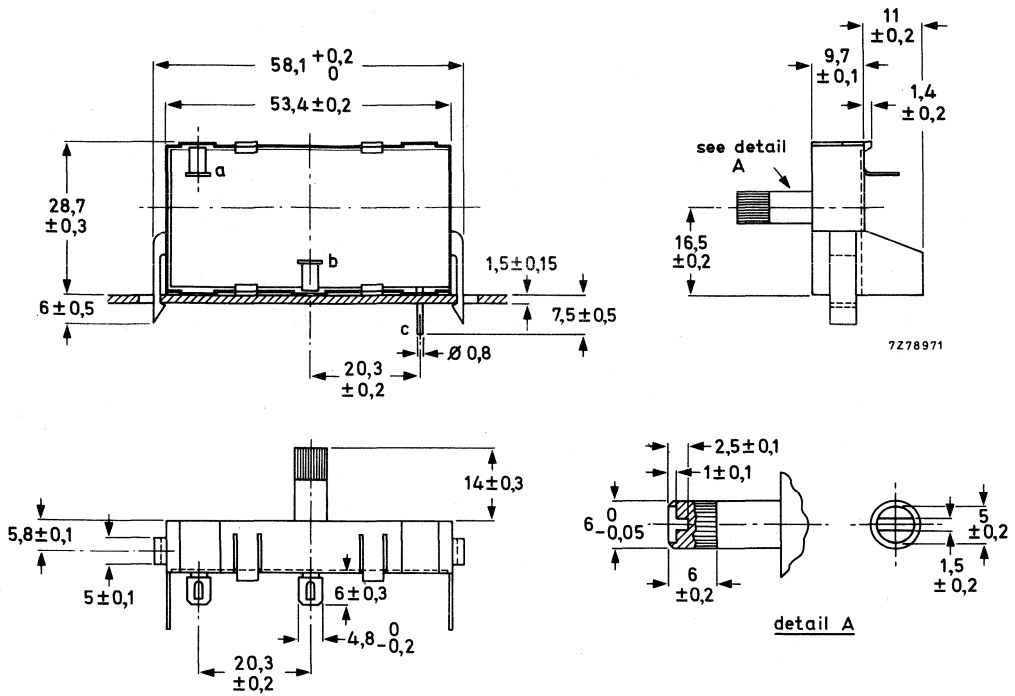


Fig. 3 Potentiometer unit **2322 460 90022**. The indication of the terminals corresponds to those shown in Fig. 1. The solder tags fit on Faston receptacles (4,8 x 0,5).

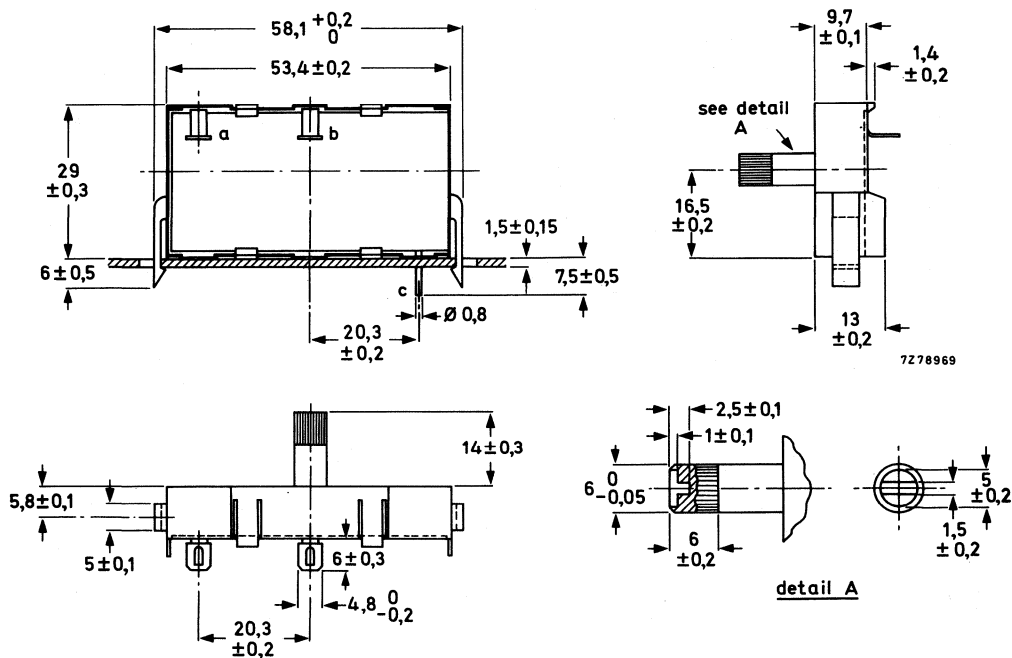


Fig. 4 Potentiometer unit **2322 460 90027**. The indication of the terminals corresponds to those shown in Fig. 1. The solder tags fit on Faston receptacles (4,8 x 0,5).

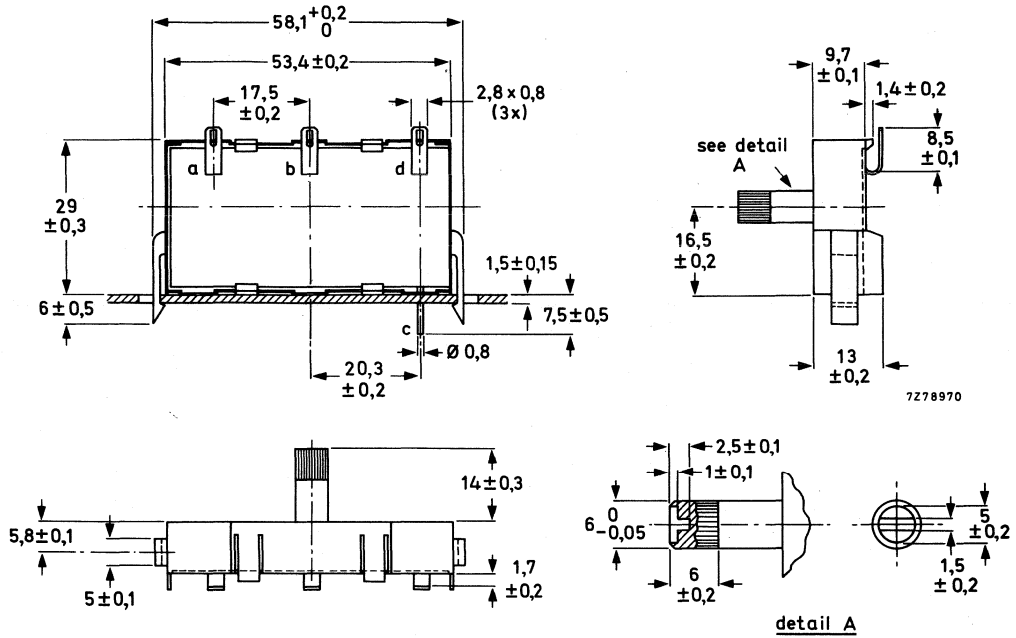


Fig. 5 Potentiometer unit **2322 460 90028**. The indication of the terminals corresponds to those shown in Fig. 6. The solder tags fit on Faston receptacles (2,8 x 0,8).

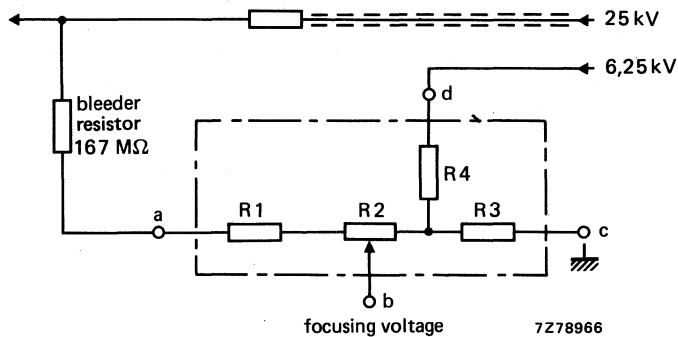


Fig. 6 Diagram of potentiometer unit **2322 460 90028**.

- a = EHT voltage via bleeder resistor;
- b = focusing voltage;
- c = earth;
- d = 6,25 kV connection.

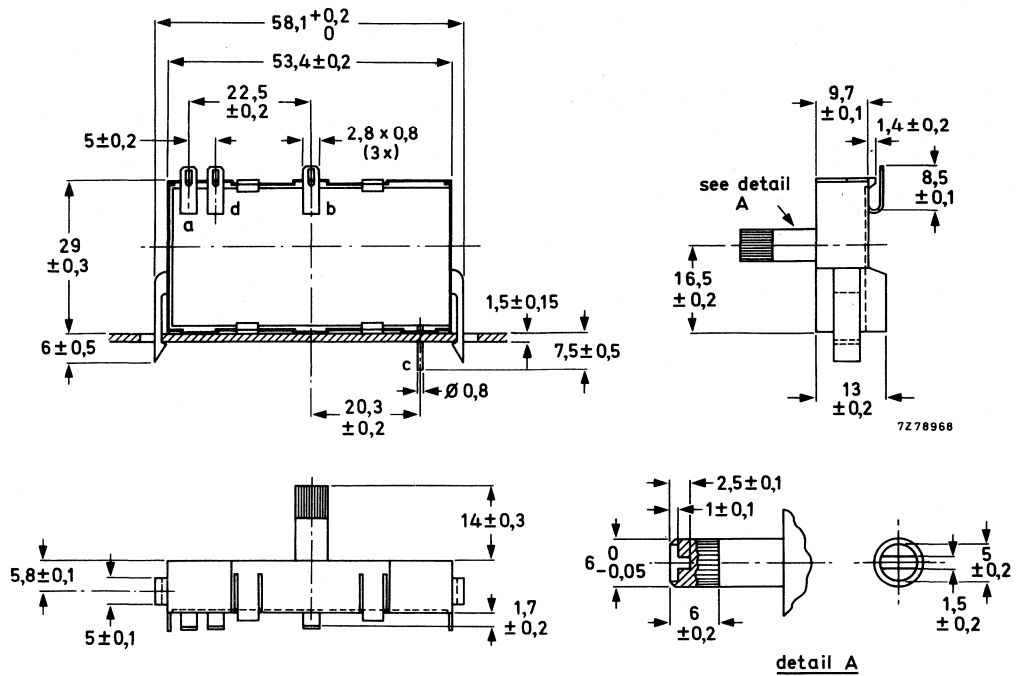


Fig. 7 Potentiometer unit **2322 460 90029**. The indication of the terminals corresponds to those shown in Fig. 8. The solder tags fit on Faston receptacles (2,8 x 0,8).

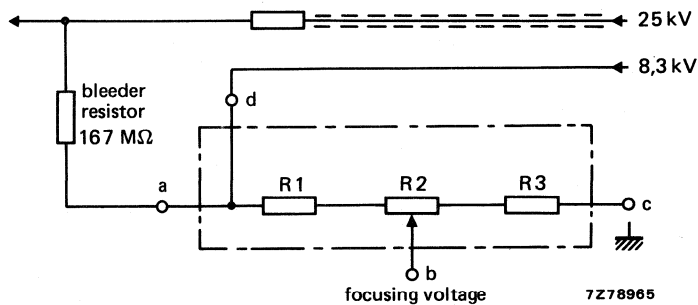


Fig. 8 Diagram of potentiometer unit **2322 460 90029**.

- a = EHT voltage via bleeder resistor;
- b = focusing voltage;
- c = earth;
- d = 8,3 kV connection.

TECHNICAL DATA

	2322 460 900 . .					
	16	22	27	28	29	
Nominal resistance value (R1 + R2 + R3, Figs 1, 6 and 8)	24	24	24	83	83	MΩ
Tolerance on nominal resistance	± 20	± 10	± 10	± 15	± 15	%
Resistance ratio at 25 °C (focusing voltage range)						
$\frac{R3 + R2}{R_{tot}}$	≥ 0,73	≥ 0,73	≥ 0,94	≥ 0,94	0,94	
$\frac{R3}{R_{tot}}$	≤ 0,50	≤ 0,50	≤ 0,75	≤ 0,75	≤ 0,75	
Variation in resistance ratios at 70 °C	≤ 3	≤ 3	≤ 3	≤ 3	≤ 3	%
Resistance law of R2	lin.	lin.	lin.	lin.	lin.	
Contact resistance	≤ 250	≤ 250	≤ 350	≤ 750	≤ 750	kΩ
Maximum dissipation at 70 °C	3,8	3,8	3,8	3,8	3,8	W
Limiting element voltage	8,5	8,5	9	10	10	kV
Insulation resistance between interconnected terminals and mounting base at 500 V (DC)			> 10 ³			MΩ
Test voltage between interconnected terminals and mounting base for 1 min			10			kV
Operation temperature range			-20 to + 70			°C
Climatic category, IEC 68			20/070/21			
Operating torque			3,5 to 30			mNm
Permissible end stop torque			≤ 80			mNm
Permissible axial spindle load			12			N

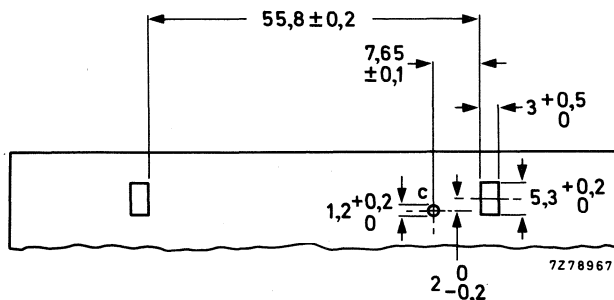
Note

Potentiometer units with different resistance values and resistance ratios, connecting terminals and spindles are available on request.

MOUNTING

Fig. 9.

Piercing diagram for board mounting (component side).



MARKING

The potentiometer units are marked with last five digits of the catalogue number, and period and year of manufacture.

TESTS AND REQUIREMENTS

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical results
6.30	—	Electrical endurance	$T_{amb} = 70\text{ }^{\circ}\text{C}$; 1000 h load: 9,5 kV (DC) at $80 \pm 5\%$ of V_{ac}	$\frac{\Delta R_{ac}}{R_{ac}} \leq 3\%$ $\frac{\Delta V_{bc}}{V_{bc}} \leq 0,3\%$
6.27	Ca	Damp heat steady state	b at $0,80 V_{ac}$ no load, 21 days, $T_{amb} = 40\text{ }^{\circ}\text{C}$, 93% R.H.	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0,5\%$
6.24	Fc	Vibration	frequency 50 Hz, amplitude 1 mm, 3 directions, 2 h per direction	$\frac{\Delta V_{bc}}{V_{bc}} \leq 0,1\%$
6.29	—	Mechanical endurance	50 cycles, 10 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leq 3\%$
9	—	Insulation resistance	500 V (DC)	min. $10^3\text{ M}\Omega$
—	Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. $235\text{ }^{\circ}\text{C}$, dwell time 2 s.	good tinning

FOCUS METAL-GLAZE PRESET conductive rubber versions

- For hi-bi and lo-bi colour picture tubes, focus voltage range 3.9 to 9.3 kV
- Simple mounting and connection by conductive rubber

QUICK REFERENCE DATA

Nominal resistance	24 to 50 MΩ
Maximum dissipation	3 W
Climatic category, IEC 68	20/70/21

DESCRIPTION

The units comprise three resistance elements which are connected in series, see Fig.1. The centre element is a potentiometer. The resistance elements are of the thick-film, metal glaze type; they are printed on an Al₂O₃ substrate. The housing of the units is of self-extinguishing, glass-fibre filled thermoplastic material. The units have two snap-in clasps for p.c. board mounting. Electrical connections are by means of conductive rubber.

For direct connections to the p.c. board, appropriate pins, mounted on the p.c. board, are plugged into the conductive rubber pads when mounting the unit. For wire connections, stripped wires, fitted in wire carriers, are plugged in the relevant channels in the housing, thus piercing into conductive rubber pads.

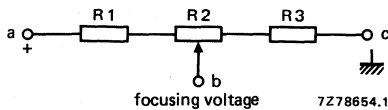


Fig.1 Diagram of potentiometer unit.

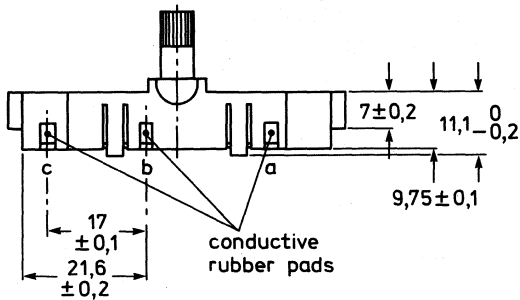
- a = focus input voltage of EHT device
- b = focusing voltage;
- c = earth.

MECHANICAL DATA

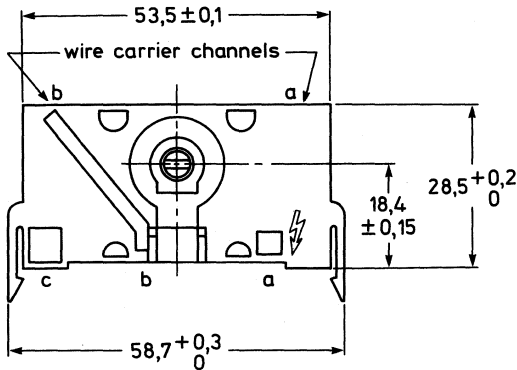
Outlines (see Fig.2)

Mechanical angle of rotation	252 ± 5°
Operating torque	3.5 to 30 mNm
Torque against end stop	≪ 800 mNm
Permissible axial spindle load	≪ 120 N
Pull-out force of wires	t.b.f.
Push-in force of wires	t.b.f.
Inflammability	according to IEC 50 c
Climatic category, IEC 68	20/70/21

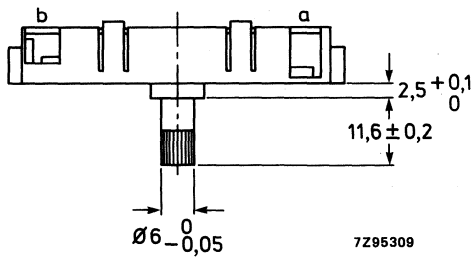
Outlines



Holes b and c are designed for pre-mounted contact pins, dia. 1 mm x 6 mm, cat. number 3122 121 63560.



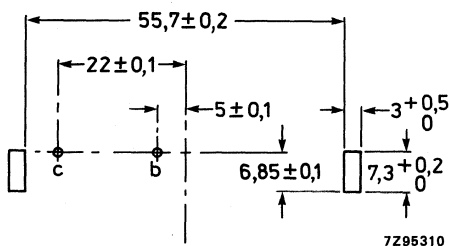
a, b and c are conductive rubber pads.



Channel a is designed for mounting wire carrier 4322 052 88750 for wire, dia. 1.8 ± 0.2 mm, stripped over a length of 7 ± 0.5 mm.

Channel b is designed for mounting wire carrier 4322 052 88730 for wire, dia. 1.8 ± 0.06 mm, stripped over a length of 6 ± 0.5 mm.

The wire carriers must be ordered extra.



Piercing diagram. Position of oblong mounting holes for snap-in clasps and of the contact pins b and c.

ELECTRICAL DATA

Nominal resistance (R_{nom})	See table below
Tolerance on R_{nom}	$\pm 10\%$
Resistance ratio at 25 °C $\frac{R2+R3}{R_{ac}}$	See table below
$\frac{R_s}{R_{ac}}$	See table below
Variation in resistance ratio at 70 °C	$\leq 1\%$
Resistance law of R2	linear
Contact resistance	$\leq 2\%$ of R_{nom}
Maximum dissipation at 70 °C	3 W
Limiting element voltage	10 kV
Insulation resistance between interconnected terminals and mounting base at 500 V (DC)	$\geq 10^3$ M Ω
Test voltage between interconnected terminals and mounting base for 1 minute (DC)	10 kV

MARKING

The units are marked 460 followed by the last five digits of the cat. no., source code and date code (year + month of manufacture).

AVAILABLE TYPES

catalogue number	R_{ac} M Ω	EHT voltage kV	focus voltage kV	$\frac{R2+R3}{R_{ac}}$	$\frac{R3}{R_{ac}}$
				%	%
2322 460 90105	28	7.3	5.2 to 7.3	> 71	—
2322 460 90106	24	8.5	3.9 to 6.4	> 75	< 46
2322 460 90107	24	8.5	6.0 to 8.0	> 93	< 70
2322 460 90108	40	8.5	4.2 to 6.2	> 73	< 50
2322 460 90111	50	9.5	6.7 to 8.8	> 93	< 70
2322 460 90115	50	9.5	4.4 to 7.1	> 75	< 46
2322 460 90119	24	8.5	3.9 to 6.4	> 75	< 46
2322 460 90122	40	8.5	4.2 to 6.2	> 73	< 50
2322 460 90123	50	9.5	6.7 to 8.8	> 93	< 70
2322 460 90124	50	9.5	4.4 to 7.1	> 75	< 46
2322 460 90127	33	9.5	7.4 to 9.3	> 98	< 78

TESTS AND REQUIREMENTS

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical results
6.30	—	Electrical endurance	$T_{amb} = 70\text{ }^{\circ}\text{C}$; 1000 h load: 9.5 kV (DC) at $80 \pm 5\%$ of V_{ac}	$\frac{\Delta R_{ac}}{R_{ac}} \leq 3\%$ $\frac{\Delta V_{bc}}{V_{bc}} \leq 0.3\%$
6.27	Ca	Damp heat steady state	b at $0.80 V_{ac}$ no load, 21 days, $T_{amb} = 40\text{ }^{\circ}\text{C}$, 93% R.H.	$\frac{\Delta R_{ac}}{R_{ac}} \leq 0.5\%$
6.24	Fc	Vibration	frequency 50 Hz, amplitude 1 mm, 3 directions, 2h per direction	$\frac{\Delta V_{bc}}{V_{bc}} \leq 0.1\%$
6.29	—	Mechanical endurance	50 cycles, 10 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leq 3\%$
9	—	Insulation resistance	500 V (DC)	min. $10^3\text{ M}\Omega$

PACKAGING

100 items per box.

TEST SWITCHES

APPLICATION

These switches are designed to simplify the testing of any electronic circuit by providing a swift means of changing over from "normal working" to "test" conditions. They are often used for testing a particular section of a circuit immediately after set assembly or later during service.

DESCRIPTION

Three types of switch are available designed for mounting on printed-wiring boards. All types can be supplied for horizontal or vertical mounting.

The basic switch consists of a rotatable selector contact and two or three switch connections, mounted on an insulating plate. By turning the selector contact one of the switch connections can be connected to the centre contact. The contacts are of the "break before make" type.

One switch type is provided with two active switch connections and a "centre-off" position. The second type has three active switch connections; the third type has two active switch connections (without "centre-off" position).

Switches are available for screwdriver-control (allowing the "flatness" of printed-wiring circuitry to be maintained), or finger-control by means of a plastic knob.

OUTLINES

Dimensions in mm

Fig. 1 Test switch for horizontal mounting, with two active switch connections:
 a. with "centre-off" position,
 b. without "centre-off" position,
 c. hole pattern for mounting on a printed-wiring board (solder side).

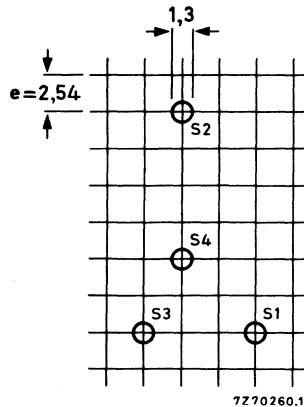
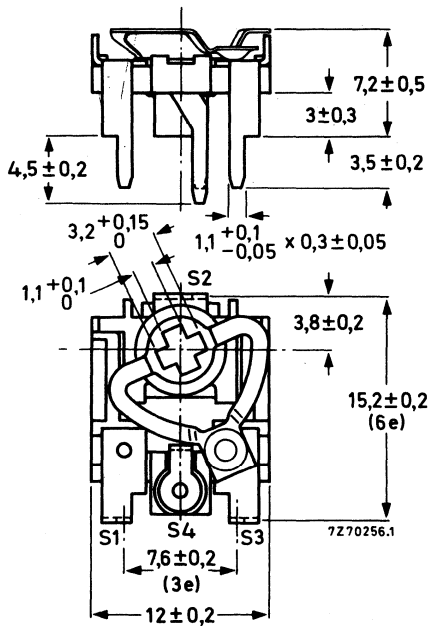
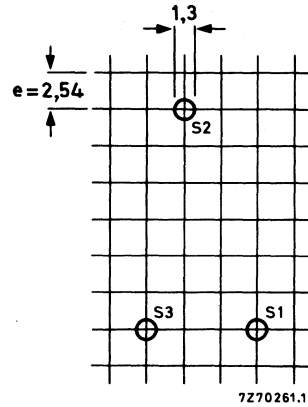
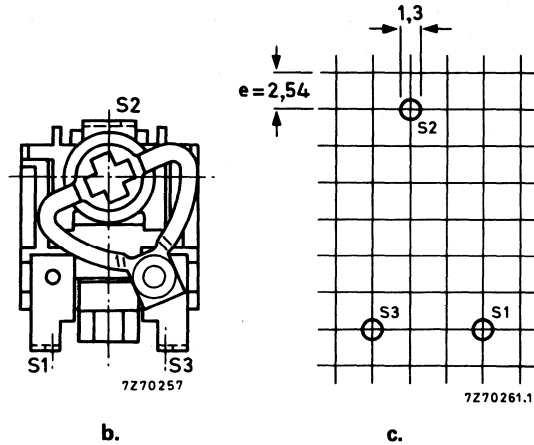
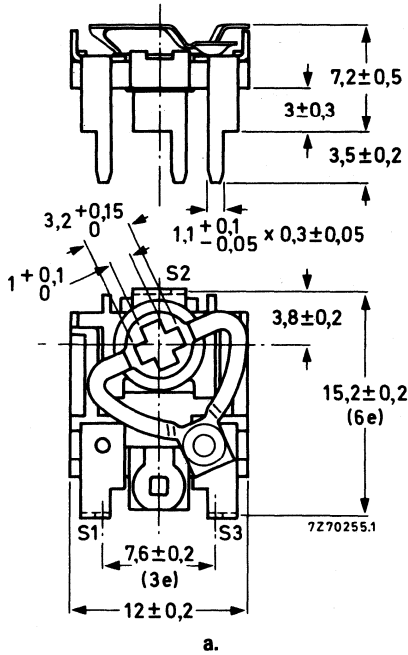


Fig. 2a Test switch for horizontal mounting, with three active switch connections.

Fig. 2b Hole pattern for mounting on a printed-wiring board (solder side).

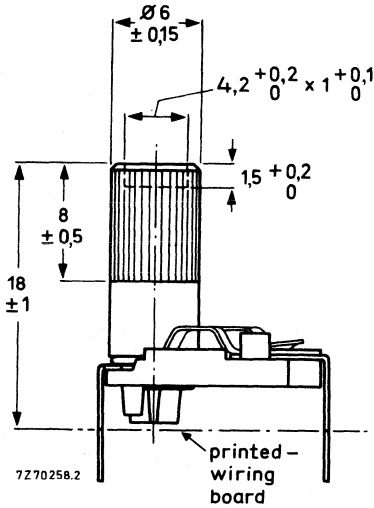


Fig. 3 Test switch for horizontal mounting with adjustment knob at the side of the selector contact.

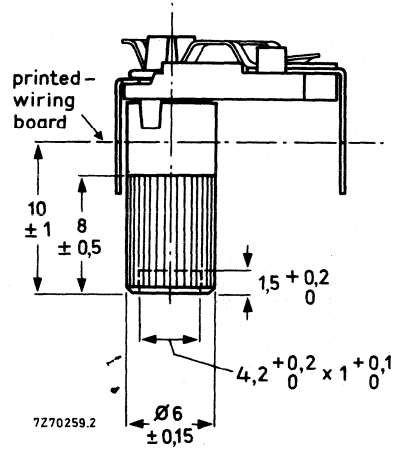
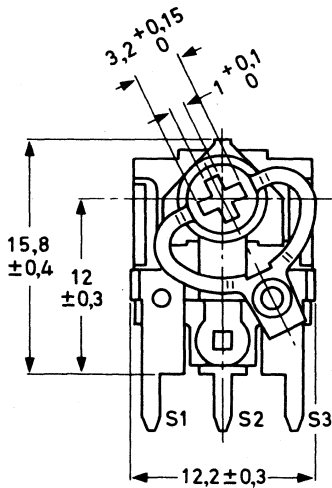
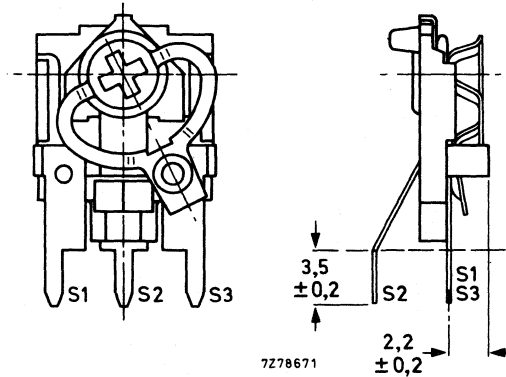


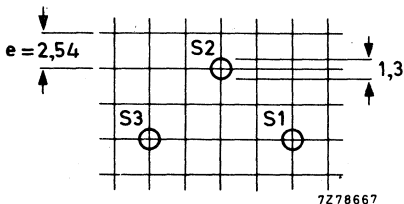
Fig. 4 Test switch for horizontal mounting with adjustment knob at the side of the base plate.



a.



b.



c.

Fig. 5 Test switch for vertical mounting, with two active switch connections;
a. with "centre-off" position,
b. without "centre-off" position,
c. hole pattern for mounting on a printed-wiring board (solder side).

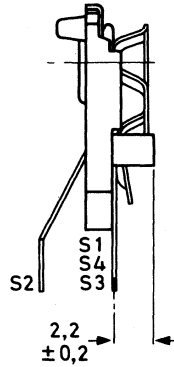
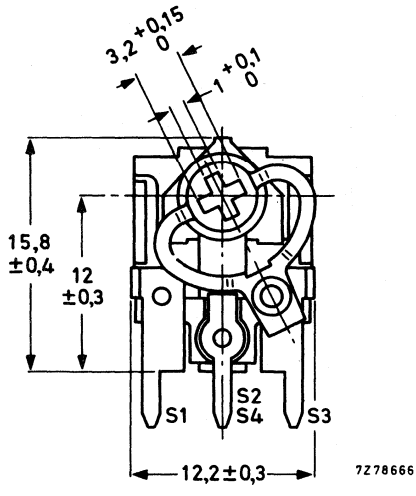


Fig. 6a Test switch for vertical mounting, with three active switch conditions.

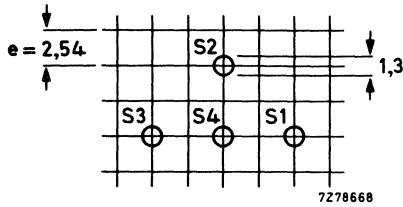


Fig. 6b Hole pattern for mounting on a printed-wiring board (solder side).

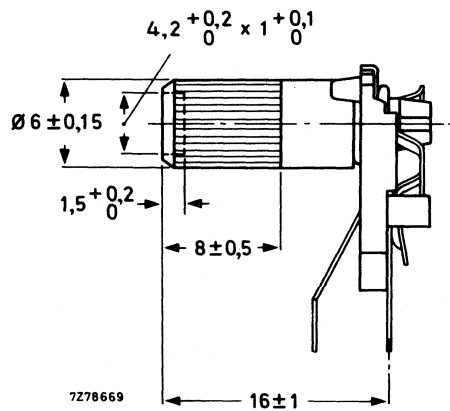
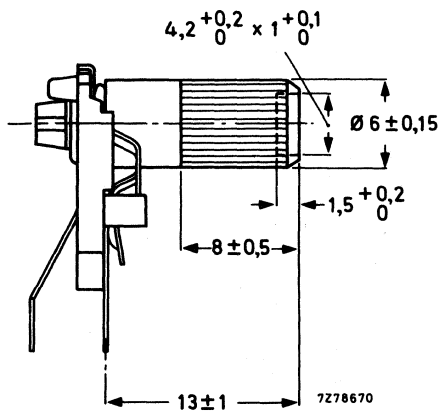


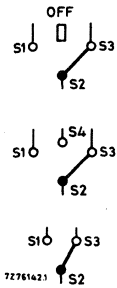
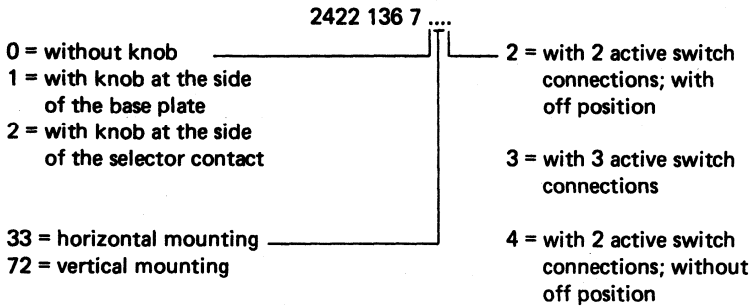
Fig. 7 Test switch for vertical mounting with adjustment knob at the side of the selector contact.

Fig. 8 Test switch for vertical mounting, with adjustment knob at the side of the base plate.

TECHNICAL DATA

<p>Contact resistance initially $\leq 20 \text{ m}\Omega$ after 50 switching operations at $\leq 10 \text{ mA}$, $\leq 500 \text{ V}$ $\leq 200 \text{ m}\Omega$</p>	
<p>Operating torque 5 to 50 mNm</p>	
<p>End stop torque $\leq 100 \text{ mNm}$</p>	
<p>Life ≥ 50 switching operations</p>	
<p>Mass switch without knob approx. 1 g switch with knob approx. 1,5 g</p>	

COMPOSITION OF THE CATALOGUE NUMBER



The catalogue number of a loose knob, such as used with CTP14, is 4322 047 08280.

DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

Philips Components data handbooks are available for selected product ranges and contain all relevant data available at the time of publication and each is revised and updated regularly.

Loose data sheets are sent to subscribers to keep them up-to-date on additions or alterations made during the lifetime of each edition.

Our data handbook titles are listed here.

Display components

Book Title

- DC01 Colour Display Components
Colour TV Picture Tubes and Assemblies
Colour Monitor Tube Assemblies
- DC02 Monochrome Monitor Tubes and Deflection Units
- DC03 Television Tuners, Coaxial Aerial Input Assemblies
- DC05 Flyback Transformers, Mains Transformers and General-purpose FXC Assemblies

magnetic products

- MA01 Soft Ferrites
- MA03 Piezoelectric Ceramics and Specialty Ferrites
- MA04 Dry-reed Switches

Passive components

- PA01 Electrolytic Capacitors
- PA02 Varistors, Thermistors and Sensors
- PA03 Potentiometers
- PA04 Variable Capacitors
- PA05 Film Capacitors
- PA06 Ceramic Capacitors
- PA07 Quartz Crystals for Special and Industrial Applications
- PA08 Fixed Resistors
- PA10 Quartz Crystals for Automotive and Standard Applications
- PA11 Quartz Oscillators

professional components

- PC04 Photo Multipliers
- PC05 Plumbicon Camera Tubes and Accessories
- PC07 Vidicon and Newvicon Camera Tubes and Deflection Units
- PC08 Image Intensifiers
- PC12 Electron Multipliers

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Integrated circuits

<i>Book</i>	<i>Title</i>
IC01	Semiconductors for Radio and Audio Systems
IC02	Semiconductors for Television and Video Systems
IC03	Semiconductors for Telecom Systems
IC04	CMOS HE4000B Logic Family
IC05	Advanced Low-power Schottky (ALS) Logic Series
IC06	High-speed CMOS Logic Family
IC08	100K ECL Logic Family
IC10	Memories
IC11	General-purpose/Linear ICs
IC12	Display Drivers and Microcontroller Peripherals (planned)
IC13	Programmable Logic Devices (PLD)
IC14	8048-based 8-bit Microcontrollers
IC15	FAST TTL Logic Series
IC16	ICs for Clocks and Watches
IC17	RF/Wireless Communications
IC18	Semiconductors for In-car Electronics and General Industrial Applications (planned)
IC19	Semiconductors for Datacom: LANs, UARTs, Multi-protocol Controllers and Fibre Optics
IC20	8051-based 8-bit Microcontrollers
IC21	68000-based 16-bit Microcontrollers (planned)
IC22	ICs for Multi-Media Systems (planned)
IC23	QUBIC Advanced BiCMOS Interface Logic ABT, MULTIBYTE™
IC24	Low Voltage Logic

Discrete semiconductors

SC01	Diodes
SC02	Power Diodes
SC03	Thyristors and Triacs
SC04	Small-signal Transistors
SC05	Low-frequency Power Transistors and Hybrid IC Power Modules
SC06	High-voltage and Switching NPN Power Transistors
SC07	Small-signal Field-effect Transistors
SC08a	RF Power Bipolar Transistors
SC08b	RF Power MOS Transistors

Discrete semiconductors (continued)

SC09	RF Power Modules
SC10	Surface Mounted Semiconductors
SC13	PowerMOS Transistors including TOPFETs and IGBTs
SC14	RF Wideband Transistors, Video Transistors and Modules
SC15	Microwave Transistors
SC16	Wideband Hybrid IC Modules
SC17	Semiconductor Sensors

Professional components

PC01	High-power Klystrons and Accessories
PC06	Circulators and Isolators

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Indonesia:	JAKARTA, Tel. (021)5201 122, Fax. (021)5205 189
Ireland:	DUBLIN, Tel. (01)640 000, Fax. (01)640 200
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	Discrete Semiconductors - RIVIERA BEACH, Tel. (800)447-3762 and (407)881-3200, Fax. (407)881-3300
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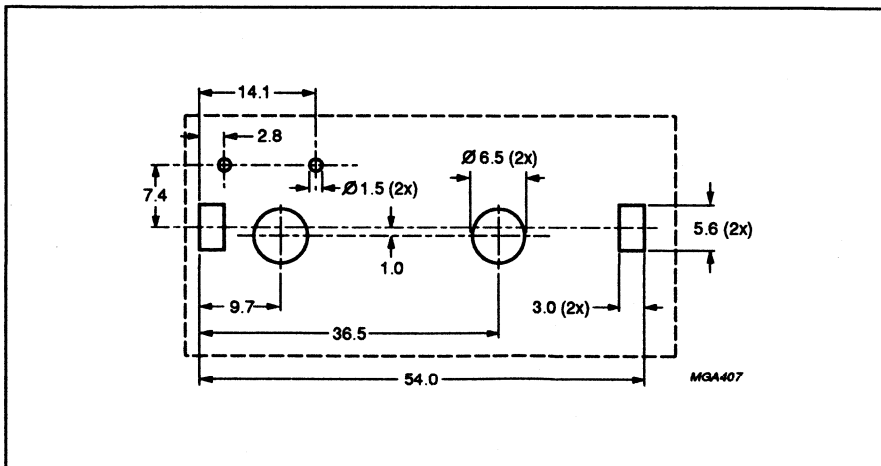
PHILIPS

Philips Components

ERRATA

Some errors have been detected in the 1994 edition of Data Handbook PA03. Please note the following:

1. Page 7 'Control Potentiometers'. The page reference in the table is incorrect. The section 'Control Potentiometers' actually starts on Page 237.
2. Page 7 'Maintenance types'. The 'Test switches' catalogue number is 2422 1367 and not 2322 1367 as quoted in the table.
3. Page 114. Fig.2 is incorrect. The correct figure is shown below.



4. Page 245. The left figure at the bottom of this page is not applicable and should be disregarded.

STANDARD SERIES OF VALUES IN A DECADE

for resistances and capacitances

according to IEC publication 63

E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48	
100	100	100	169	169	169	287	287	287	487	487	487	825	825	825	
101			172			291			493			835			
102	102		174	174		294	294		499	499		845	845		
104			176			298			505			856			
105	105	105	178	178	178	301	301	301	511	511	511	866	866	866	
106			180			305			517			876			
107	107		182	182		309	309		523	523		887	887		
109			184			312			530			898			
110	110	110	187	187	187	316	316	316	536	536	536	909	909	909	
111			189			320			542			920			
113	113		191	191		324	324		549	549		931	931		
114			193			328			556			942			
115	115	115	196	196	196	332	332	332	562	562	562	953	953	953	
117			198			336			569			965			
118	118		200	200		340	340		576	576		976	976		
120			203			344			583			988			
121	121	121	205	205	205	348	348	348	590	590	590				
123			208			352			597						
124	124		210	210		357	357		604	604					
126			213			361			612			E24	E12	E6	E3
127	127	127	215	215	215	365	365	365	619	619	619	10	10	10	10
129			218			370			626			11			
130	130		221	221		374	374		634	634		12	12		
132			223			379			642			13			
133	133	133	226	226	226	383	383	383	649	649	649	15	15	15	
135			229			388			657			16			
137	137		232	232		392	392		665	665		18	18		
138			234			397			673			20			
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142			240			407			690			24			
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145			246			417			706			30			
147	147	147	249	249	249	422	422	422	715	715	715	33	33	33	
149			252			427			723			36			
150	150		255	255		432	432		732	732		39	39		
152			258			437			741			43			
154	154	154	261	261	261	442	442	442	750	750	750	47	47	47	47
156			264			448			759			51			
158	158		267	267		453	453		768	768		56	56		
160			271			459			777			62			
162	162	162	274	274	274	464	464	464	787	787	787	68	68	68	
164			277			470			796			75			
165	165		280	280		475	475		806	806		82	82		
167			284			481			816			91			

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