PASSIVE COMPONENTS

DATA HANDBOOK

Potentiometers and switches

BOOK PA03 1989

Philips Components

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GENERAL

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 ^{o}C in combinations such as K/W. Also ΔT is in K. Atmospheric pressure is given in kPa instead of millibars, mm Hg etc. 1000 mbar = 100 kPa (= 1000 hPa).

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

Some devices are labelled "MAINTENANCE TYPE". These are available for equipment maintenance but no longer recommended for equipment production.

Devices labelled "OBSOLESCENT TYPE" are available until stocks are exhausted.

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

INTRODUCTION

There are two main styles in our range of potentiometers: **Preset** and **Control.**

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. The preset types are subdivided into **single** and **multiturn** potentiometers. The single turn range includes cermet and carbon versions, **open, enclosed** or **sealed** versions. The multiturn range has carbon open versions and cermet sealed versions. A special series of single turn versions comprises cermet elements combined into networks for high voltage adjustment applications.

Preset:

* OCP10 series, open carbon preset, 0,1 W, dimensions approx. 10 x 10 mm
* OCP14 series, open carbon preset, 0,2 W, dimensions approx. 14 x 17 mm
* OCP18 series, open carbon preset, 0,25 W, dimensions approx. 18 x 20 mm
* OMP10 series, open cermet preset, 0,5 W, dimensions approx. 10 x 12 mm
* ECP10 series, enclosed carbon preset, 0,1 W, dimensions approx. 10 x 12 mm
* EMP10 series, enclosed cermet preset, 0,5 W, dimensions approx. 10 x 12 mm
* EMP06 series, sealed cermet preset, 0,5 W, dimensions approx. 10 x 12 mm
* CMP10/20/40 series, open multiturn carbon preset
* MMP09 series, sealed cermet preset, 0,5 W, dimensions approx. 10 x 10 mm
* MMP20 series, sealed cermet preset, 0,5 W, dimensions approx. 19 x 7 mm

Focus metal glaze preset potentiometers are designed for preset control of focus and screen voltages of picture tubes.

Focus:

* FMP-ST solder tag series, dimensions approx. 29 x 58 mm
* FMP-CR conductive rubber series, dimensions approx. 29 x 60 mm
* FMP-MCS microslot series, dimensions approx. 29 x 48 mm
* FMP-DSB diode split box series, dimensions approx. 29 x 61 mm

Control potentiometers are designed for general, frequent, voltage or resistance adjustment in electronic equipment. They are subdivided into slide, rotary, multiturn types; the rotary versions having carbon or cermet resistance elements.

Control:

* CRC10 series, carbon rotary, 0,1 W (lin), or 0,05 (log), dimensions approx. 10 x 12 mm, single without switch
* CRC12 series, carbon rotary potpack, single and tandem types with or without switch, with or without spindle. Also dual types, dimensions approx. 17 x 22 mm
* CRC16 series, carbon rotary, 0,1 W (lin), or 0,05 (log), diameter approx. 16 mm, single and tandem types, with or without switch.
* CRC17 series, carbon rotary potpack, single and tandem types with or without switch, with or without spindle. Also dual types, dimensions approx. 17 x 22 mm
* CRC23 series, carbon rotary, 0,25 W (lin) or 0,125 (log), diameter approx. 23 mm, single, without switch

* CSC25 series, carbon slide, 25 mm stroke, lin and log single types. dimensions approx. 43,5 x 9 x 5 mm
* CSC40 series, carbon slide, 40 mm stroke, single types. dimensions approx. 68 x 16 x 10,2 mm
* CSC60 series, carbon slide, 60 mm stroke, single types. dimensions approx. 87 x 16 x 10,2 mm
* CMC10/20/40 series, carbon multiturn control (data sheets to follow shortly after publication of this handbook)
* MRC12 series, metal glaze (cermet) rotary potpack, single and tandem types, with or without spindle, dimensions approx. 12 x 13 mm
* MRC17 series, metal glaze (cermet) rotary potpack, single and tandem types, with or without spindle. Also dual types, dimensions approx. 17 x 22 mm
* MRC23 series, metal glaze (cermet) rotary, 5 W, diameter approx. 23 mm, single without switch

SEE ALSO TYPE SELECTION ON PAGE 11

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

Cermet 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.

Slide carbon potentiometers — Slider type control potentiometers with a straight line 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°.

Multiturn potentiometers – Rotary type preset or control potentiometers with a rotary operation up to 40 rotations. Preset types comprise a straight line resistive element operated by knob or gear wheel. Control types comprise a reduction gear on the rotary action. Designed for fine resistance adjustment.

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 unit 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.

Bandswitches – For bandswitching, in combination with preset multiturn carbon potentiometers.

Wiper – Moving contact of rotary type potentiometers.

Slider – Moving contact of slider 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 (Fig. 1). Also R_{tot} or R_{total}.

Nominal resistance (R_{nom}) – Nominal value of the resistance between the end terminals a and c (Fig. 1), the moving contact b at end-stop position.

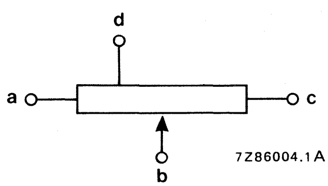


Fig. 1 Designation of terminals.

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

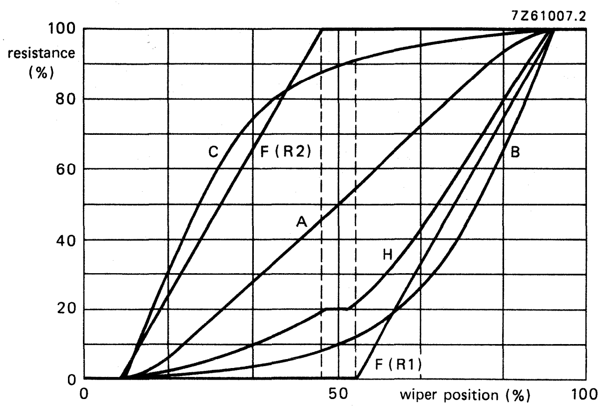


Fig. 2 Some typical resistance laws.

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

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

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. (Fig. 3).

Resistance at the tap — Minimum resistance between the tap terminal d and the resistive element.

Contact resistance CR — 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.

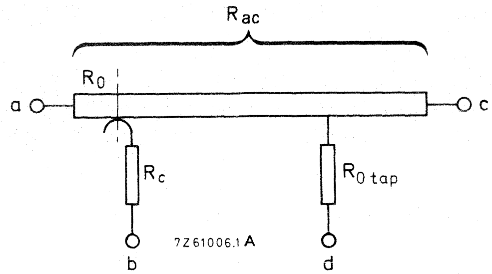


Fig. 3 Diagram of potentiometer; spindle in fully counter-clockwise position.

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

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

(The value of R_c is negligible.)

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 (Fig. 1) and mounted on a steel panel of 100 x 100 x 1,5 mm by means of a nut (or on a printed circuit board for types with printed-wiring pins).

Maximum voltage (E_{max}) – The maximum voltage that may be applied is calculated from maximum dissipation (P_{max}) and nominal resistance (R_{nom}):
$E_{max} = \sqrt{P_{max} \times R_{nom}}$, 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, 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).

Mechanical angle of rotation – The full extent of the travel of the actuating device of a rotary potentiometer between the end stops (Fig. 4).

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

Switching 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 (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 (Fig. 4).

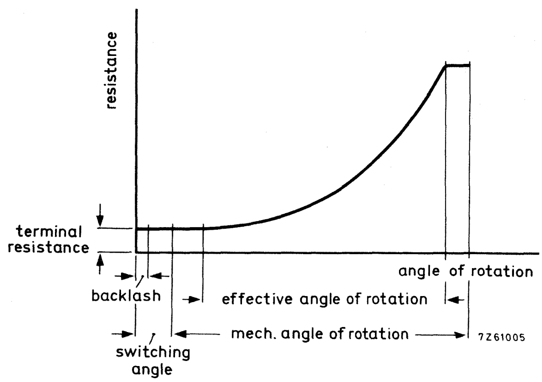


Fig. 4a.

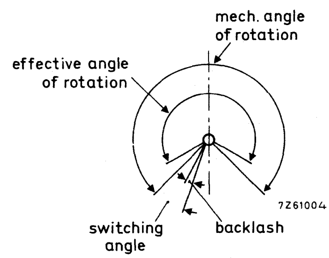


Fig. 4b.

Backlash of potentiometer with push-pull switch — That angle over which the spindle can be rotated before it causes any resistance change.

- potentiometers
  - preset
    - focus
      - cermet
        - FMP-ST
        - FMP-CR
        - FMP-MCS
        - FMP-DSB
    - multi-turn
      - carbon
        - open
          - CMP-10
          - CMP-20
          - CMP-40
      - cermet
        - sealed
          - MMP-09
          - MMP-20
    - single-turn
      - carbon
        - enclosed
          - ECP10 *
        - open
          - OCP10 *
          - OCP14
          - OCP18
      - cermet
        - sealed
          - EMP06
        - enclosed
          - EMP10
        - open
          - OMP10
  - control
    - slide
      - carbon
        - CSC25
        - CSC40
        - CSC60
    - rotary
      - carbon
        - CRC10
        - CRC12
        - CRC16
        - CRC17
        - CRC23
        - CMC10 **
        - CMC20 **
        - CMC40 **
      - cermet
        - MRC12
        - MRC17
        - MRC23

* Release of new loose leaf data sheets imminent.

** Not included in this handbook. At time of publication release of loose leaf data sheets imminent.

CONTROL POTENTIOMETERS

10 mm CARBON CONTROL POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E3-series)	
linear law	1 kΩ to 4,7 MΩ
logarithmic/inverse log. law	2,2 kΩ to 2,2 MΩ
Maximum dissipation at 40 °C	
linear law	0,1 W
logarithmic/inverse log. law	0,05 W
Temperature coefficient	$\pm$ 500 x 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.

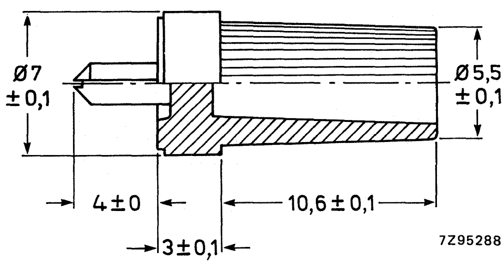


Fig. 1 Example of a knob for versions with a hexagonal slot (cat. no. 4322 052 70710).

The terminals a and c are the end terminals; b is the central terminal connected to the wiper. All terminals are 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.

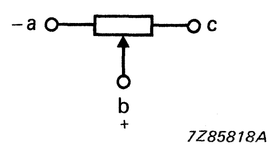


Fig. 2 Terminal designation.

MECHANICAL DATA

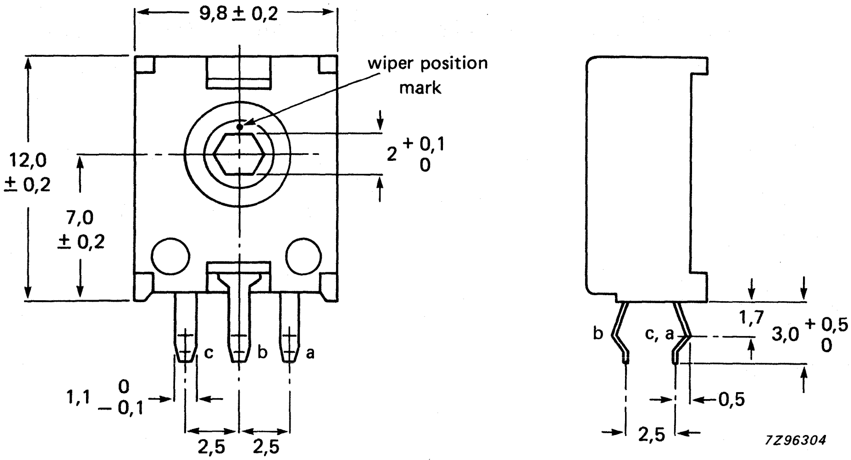


Fig. 3 Vertical mounting.

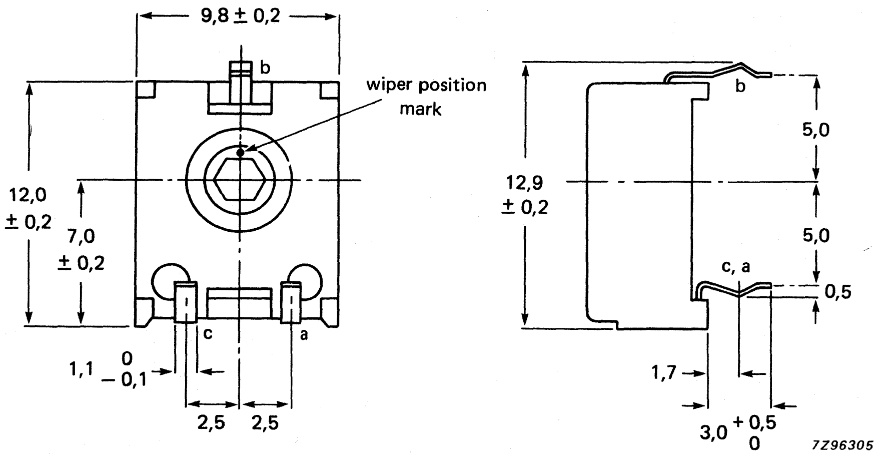


Fig. 4 Horizontal mounting.

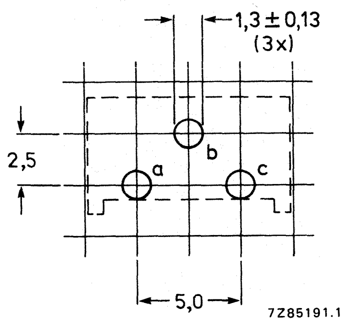


Fig. 5 Hole pattern for vertical versions, viewed from component side.

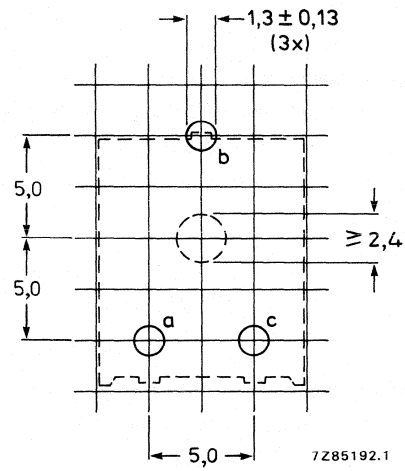


Fig. 6 Hole pattern for horizontal versions, viewed from component side.

TECHNICAL DATA

	linear	log./inv. log.
Resistance law	linear	log./inv. log.
Resistance range (E3-series)	1 kΩ to 4,7 MΩ	2,2 kΩ to 2,2 MΩ
Standard tolerance	± 20%	± 20%
Rated dissipation at 40 °C (P_{max}) (see Fig. 7)	0,1 W	0,05 W
CRV, initial and after 10 000 cycles	⩽ 1%	⩽ 2%
Limiting element voltage (d.c.)	150 V	
Limiting wiper current	$\frac{P_{max}}{R_{nom}}$	
Minimum effective resistance	⩽ 2% of R_{ac} or 10 Ω, whichever is greater	
Mass	0,6 g	
Temperature coefficient in the range −25 °C to 85 °C	± 500 x 10^{-6}/K	
Operating torque, ratio max./min. < 3	2 to 10 mNm	
Permissible end-stop torque	max. 75 mNm	
Permissible axial load on adjustment slot during 20 s		
horizontal versions	< 20 N	
vertical versions	< 10 N	
Total mechanical angle of rotation	300 ± 5°	
Effective angle of rotation	285 ± 5°	
Settability		
Climatic category according to IEC 68-2	25/85/10	
Climatic sequence	$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 10%	
Damp heat, steady state, with or without load, between a and c, 10 days	$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 10%	
Mechanical endurance (10 000 cycles)	$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 10%	
Electrical endurance (1000 h at 70 °C, cyclic)	$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 10%	
Resistance to soldering heat	$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 2%	
Bump and vibration	$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 2%	
	$\frac{\Delta V_{ab}}{V_{ac}}$ ⩽ 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

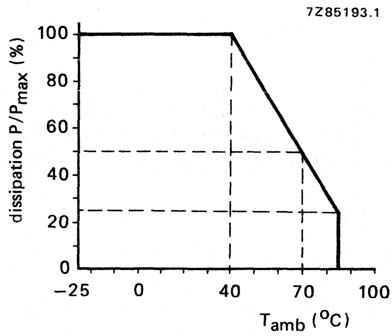


Fig. 7 Dissipation as a function of ambient temperature.

RESISTANCE

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

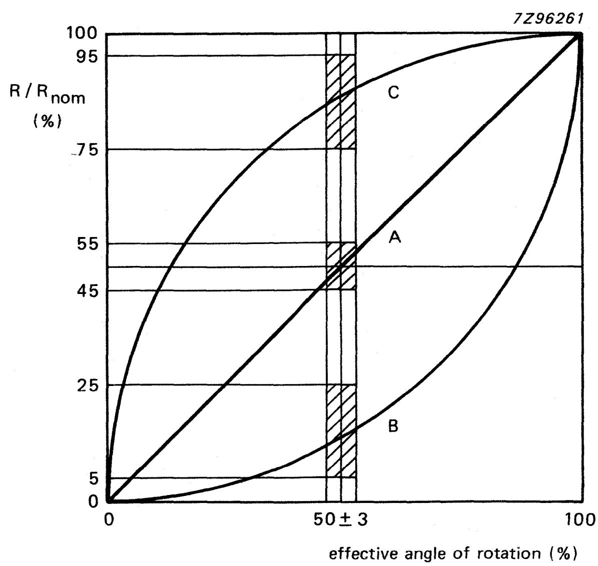


Fig. 8 Resistance laws: A = linear; B = logarithmic;
C = inverse logarithmic.

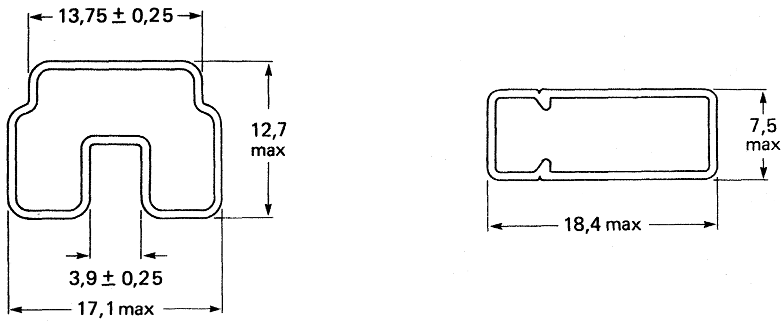
MARKING

The potentiometers are marked with the rated resistance, according to IEC 62, e.g. 10 kΩ = 10 k; 1 MΩ = 1 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.

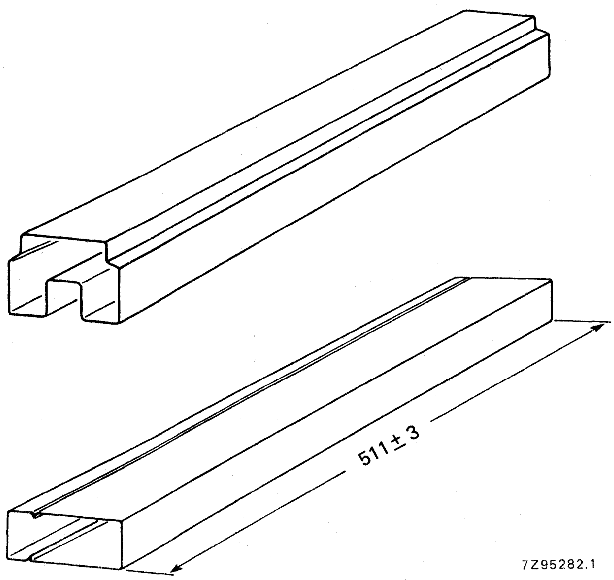


Fig. 9 Outlines of the rail packaging.

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

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 series includes two types:

- single potentiometers, for general purposes,
- tandem potentiometers, for stereophonic purposes.

The single potentiometers comprise 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 potentiometers can be supplied with a tap (d) at 46% (single) or 50% (tandem) of the total mechanical angle of rotation. The potentiometers are provided with plastic or metal spindles.

The tandem potentiometers are composed of two carbon tracks, on base plates of resin-bonded paper, in one housing. The base plates are placed in such a way that the tracks are opposite each other.

The single potentiometers can be delivered without switch or with a rotary switch; the tandem potentiometers are only supplied without switch. Both types are available with different connecting terminals, mounting facilities and spindles, see below.

Types

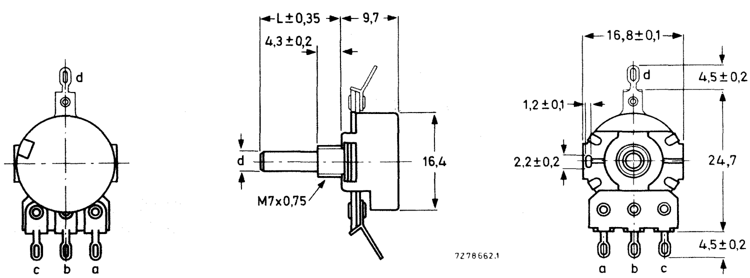


Fig. 1 Single potentiometer with mounting bushing. For dimensions d and L, see Spindles.

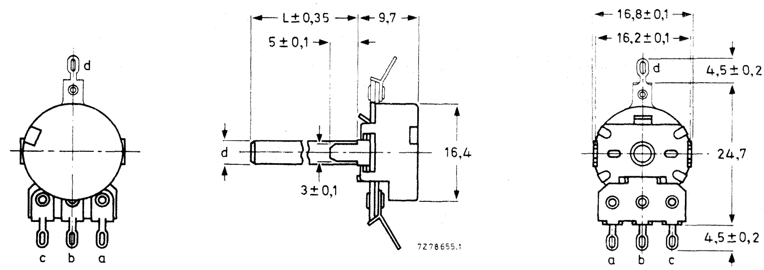


Fig. 2
Single potentiometer with twist tags. For dimensions d and L, see Spindles.

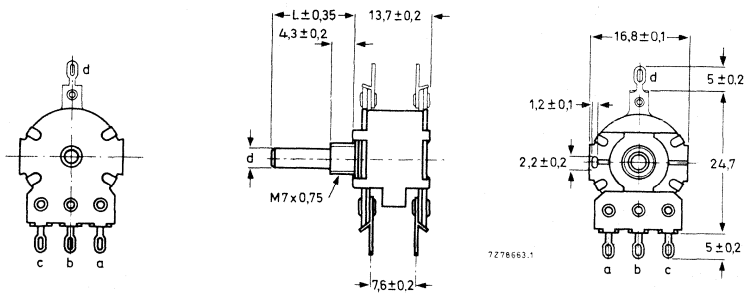


Fig. 3
Tandem potentiometer. For dimensions d and L, see Spindles.

Switches (maintenance types)

Single-pole, single-throw, rotary switch (s.p.s.t.).

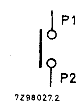


Fig. 4a Circuit in off-position of spindle (spindle turned fully counter-clockwise).

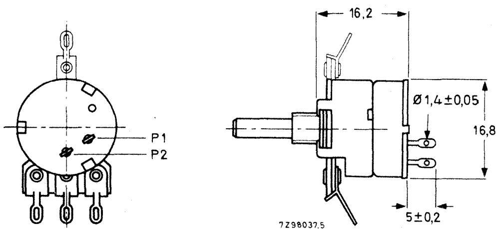


Fig. 4b Single potentiometer with s.p.s.t. rotary switch (spring actuated).

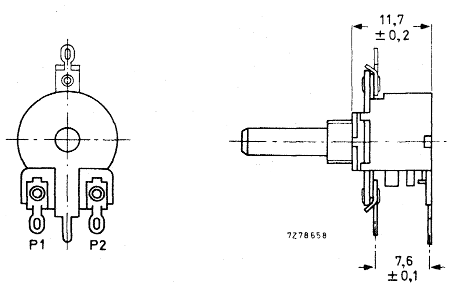


Fig. 4c Single potentiometer with s.p.s.t. rotary switch (direct operating).

Connecting terminals

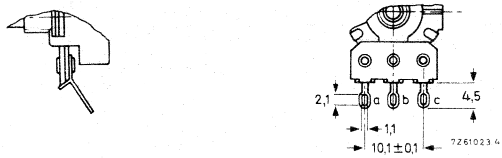


Fig. 5 Solder tags.

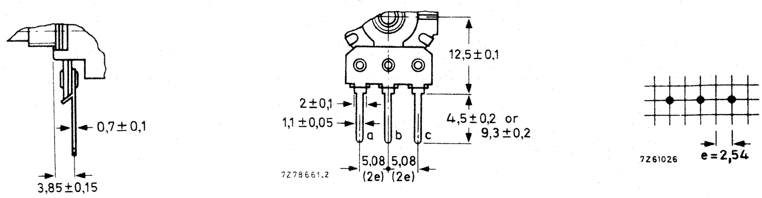


Fig. 6 Long or short printed-wiring pins (single potentiometer).

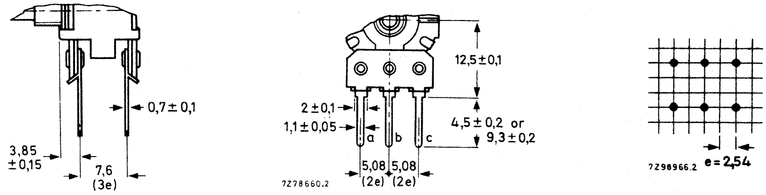


Fig. 7 Long or short printed-wiring pins (tandem potentiometer).

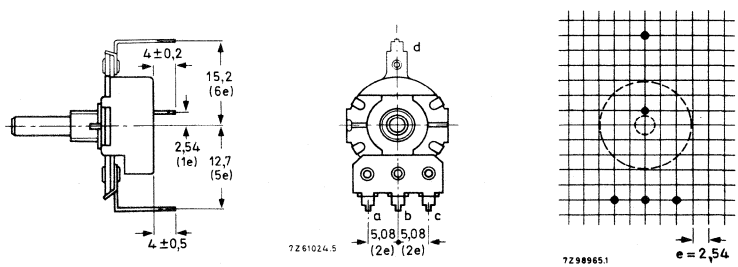
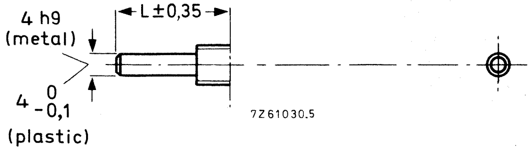
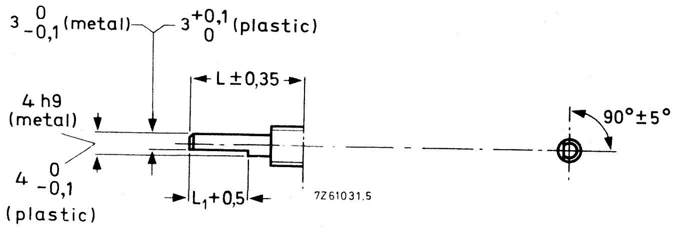
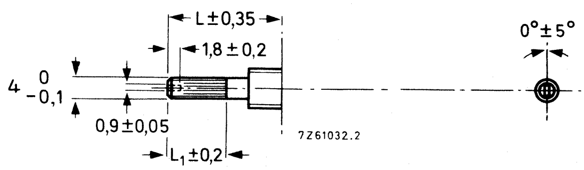
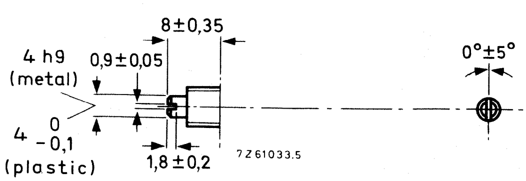
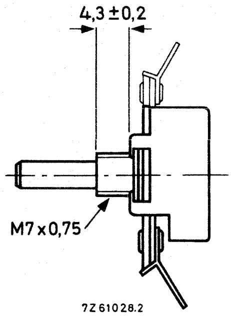
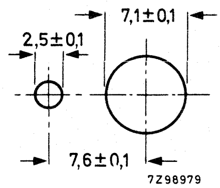


Fig. 8 Printed-wiring pins, bent backwards.

Spindles

type	off position	L mm	L_1 mm	material
		10 12 15 17 19 20 22 24 25 28 30		metal or plastic
		10 15 20 20	3.5 8.5 8.5 13.5	metal or plastic
		10 15 20	5 9 9	plastic
				metal or plastic

Mounting facilities

		required mounting holes in chassis	fixing of potentiometer
mounting bushing M7 x 0.75			with supplied mounting nut;* max. torque for tightening = 1 Nm; min. thickness of chassis = 1 mm

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 kΩ	a	10	25 Ω	–	4	10
2.2 kΩ	a	14	25 Ω	–	4	7
4.7 kΩ	a	22	25 Ω	–	4	5
10 kΩ	a	31	35 Ω	–	4	3.2
22 kΩ	a	45	35 Ω	–	4	2.2
47 kΩ	a	70	35 Ω	–	4	1.5
100 kΩ	a	100	100 Ω	–	4	1.0
220 kΩ	a	140	125 Ω	–	4	0.7
470 kΩ	a	220	250 Ω	–	4	0.5
1 MΩ	a	310	1 kΩ	–	4	0.32
2.2 MΩ	a	460	2 kΩ	–	4	0.22
4.7 MΩ	a	500	5 kΩ	–	4	0.14
1 kΩ	b	7	5 Ω **	50 **	6	7
2.2 kΩ	b	10	5 Ω **	50 **	6	5
4.7 kΩ	b	15	5 Ω **	60 **	6	3.2
10 kΩ	b	22	10 Ω **	60 **	6	2.2
22 kΩ	b	31	20 Ω **	60 **	6	1.5
47 kΩ	b	50	35 Ω **	60 **	6	1.0
100 kΩ	b	70	50 Ω **	70 **	6	0.7
220 kΩ	b	100	50 Ω **	80 **	6	0.5
470 kΩ	b	155	100 Ω **	80 **	6	0.32
1 MΩ	b	220	200 Ω **	80 **	6	0.22
2.2 MΩ	b	310	500 Ω **	80 **	6	0.15
5 + 42 kΩ	d	50	40 Ω **	60 **	6	1.0
20 + 200 kΩ	d	100	50 Ω **	80 **	6	0.5
50 + 420 kΩ	d	155	470 Ω **	80 **	6	0.32
100 + 900 kΩ	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.

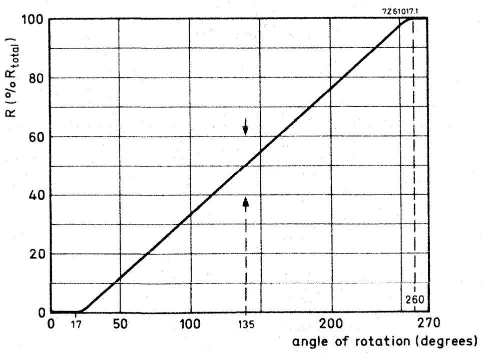


Fig. 9a Linear law, single potentiometers.

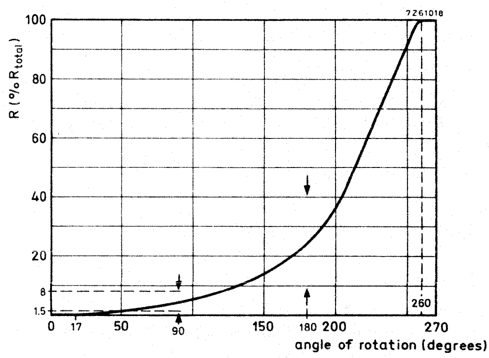


Fig. 9b Logarithmic law, single potentiometers.

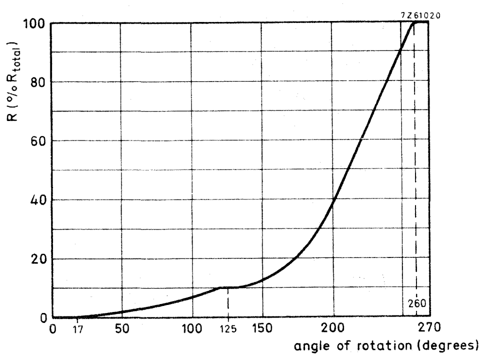


Fig. 9c Semi-logarithmic law, tap at 10%, single potentiometers.

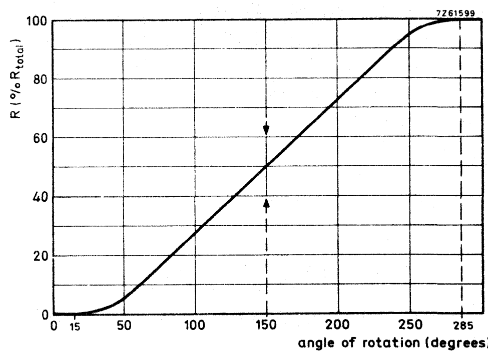


Fig. 10a Linear law, tandem potentiometers.

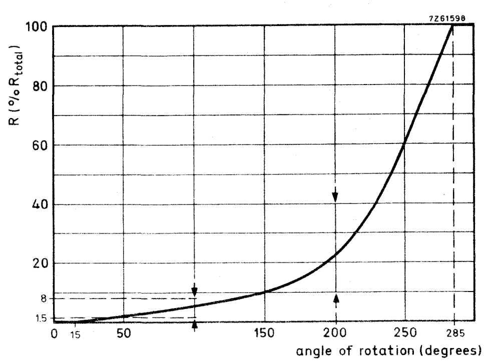


Fig. 10b Logarithmic law, tandem potentiometers.

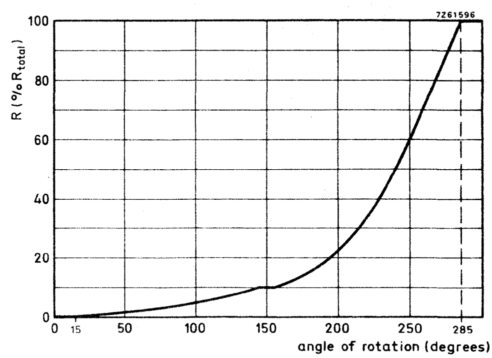


Fig. 10c Logarithmic law, tap at 10%, tandem potentiometers.

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	$\leqslant$ 1,5% of R_{nom}	
Insulation resistance,		
initially	$>$ 1000 MΩ	
after damp heat test (IEC 68, test C, 21 days)	$>$ 25 MΩ	
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	plastic	metal
plain spindles	$\leqslant$ 500 mNm	$\leqslant$ 600 mNm
spindles with flat face	$\leqslant$ 400 mNm	$\leqslant$ 600 mNm
spindles with screwdriver slot	$\leqslant$ 250 mNm	$\leqslant$ 600 mNm
Permissible axial spindle load	pull	push
single potentiometers	$\leqslant$ 100 N	$\leqslant$ 100 N
tandem potentiometers	$\leqslant$ 100 N	$\leqslant$ 60 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	$\leqslant$ 0.2 mm	
potentiometers with twist tags	$\leqslant$ 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} = ± 20%.
2. For tandem potentiometers only.

Mechanical angle of rotation single potentiometers	
without switch	270 ± 5°
with switch	292 ± 5°
tandem potentiometers	300 ± 5°
Life	after 10 000 cycles ΔR_{ac} < 25% of R_{ac}

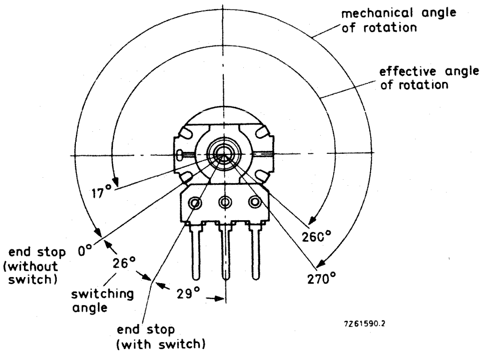


Fig. 11a Angles of rotation of single potentiometers with or without switch.

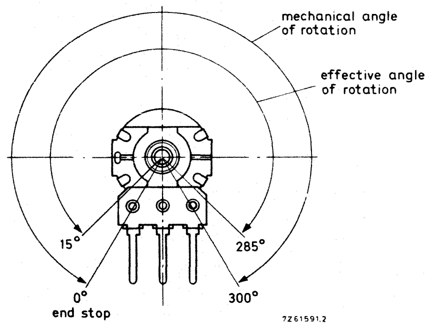


Fig. 11b Angles of rotation of tandem potentiometers.

	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 ± 2°	26 ± 2°
Total mechanical angle of rotation	295 ± 5°	295 ± 5°
Backlash	⩽ 10°	⩽ 10°
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	
without switch, single	= 380
without switch, tandem	= 390
single, with s.p.s.t. rotary switch (spring actuated)*	= 381
single, with s.p.s.t. rotary switch (direct operating)	= 387
single, without switch, with p.w. pins bent backwards**	= 389

code for terminals, mounting facility, spindle type and length

solder tags		p.w. pins, length 4.5 mm		p.w. pins, length 9.3 mm	
mounting bushing		mounting bushing		mounting bushing	
metal spindle	plastic spindle	metal spindle	plastic spindle	metal spindle	plastic spindle
0 . .	7 . .	0 . .	7 . .	1 . .	6 . .

spindle		solder tags	p.w. pins
plain	10 mm	= . 11	= . 61
	12 mm	= . 09	= . 59
	15 mm	= . 12	= . 62
	17 mm	= . 13	= . 63
	19 mm	= . 14	= . 64
	20 mm	= . 15	= . 65
	22 mm	= . 17	= . 67
	24 mm	= . 19	= . 69
	25 mm	= . 01	= . 51
	28 mm	= . 02	= . 52
	30 mm	= . 03	= . 53
with flat face	10 (L_1 = 3.5) mm	= . 42	= . 92
	15 (L_1 = 8.5) mm	= . 44	= . 94
	20 (L_1 = 8.5) mm	= . 45	= . 95
	20 (L_1 = 13.5) mm	= . 46	= . 96
knurled (only plastic)	10 mm	= . 26	= . 76
	15 mm	= . 27	= . 77
	20 mm	= . 28	= . 78
with screwdriver slot		= . 10	= . 60

code for resistance law and nominal resistance, see Table 2

* 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 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		
5 + 42 kΩ			72
20 + 200 kΩ			67
50 + 420 kΩ			73
100 + 900 kΩ			64

Notes

Detent potentiometers (11 click, 41 click and centre click versions), without switch, can be supplied on request.

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

The CRC23 carbon rotary control potentiometer series comprises single potentiometers with and without switches. The 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.

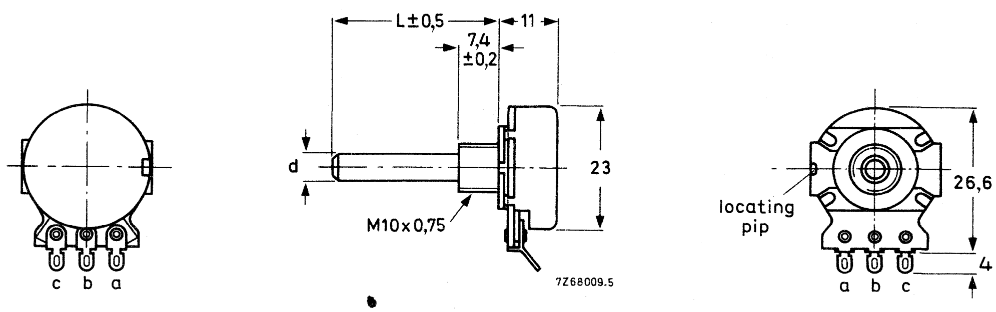


Fig. 1 Single potentiometer.

Mounting facilities

method	required mounting holes in chassis	fixing of potentiometer
mounting bushing M10 x 0,75	(Fig. 2)	with supplied mounting nut (catalogue number 4322 047 00350) max. torque for tightening = 3,5 Nm; min. thickness of chassis = 1,5 mm

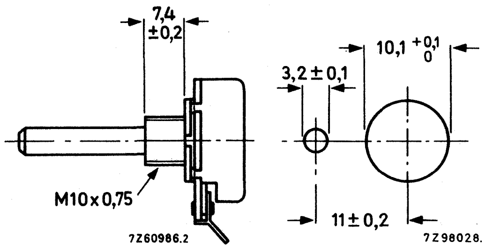


Fig. 2.

Connecting terminals

solder tags

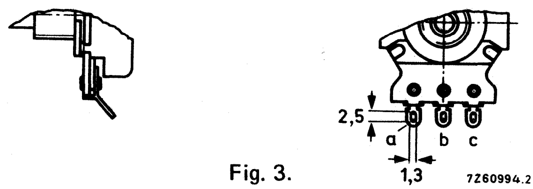


Fig. 3.

Spindles

type "off position"

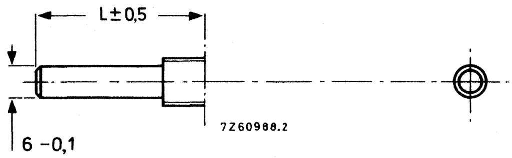


Fig. 4.

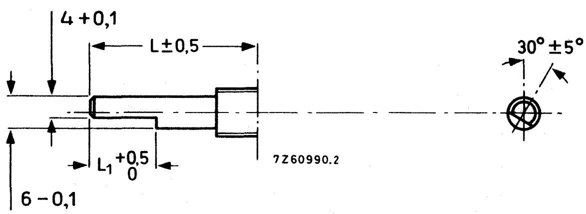


Fig. 5.

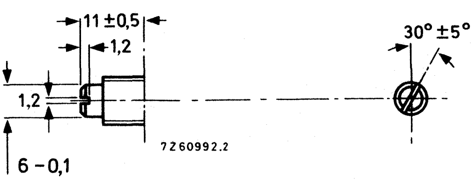
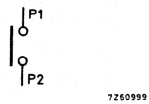
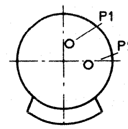
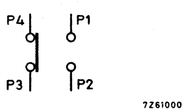
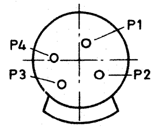
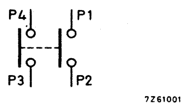
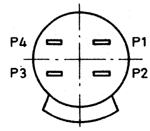
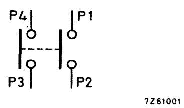
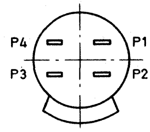


Fig. 6.

L mm	L_1 mm
17	–
18	8,5
19	–
20	–
22	–
25	13,5
30	–
35	–
40	13,5
60	13,5
70	–
90	–

Switches

type	circuit in "off"-position of spindle	position of terminals	Fig.
single-pole, single-throw rotary switch (s.p.s.t.)			7
single-pole, double-throw rotary switch (s.p.d.t.)			8
double-pole, single-throw rotary switch (d.p.s.t.)			9
double-pole, single-throw push-pull switch 2A (d.p.s.t.)			10

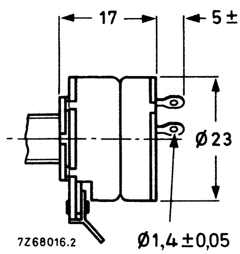


Fig. 7 S.P.S.T. rotary switch.

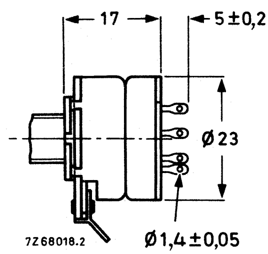


Fig. 8 S.P.D.T. rotary switch.

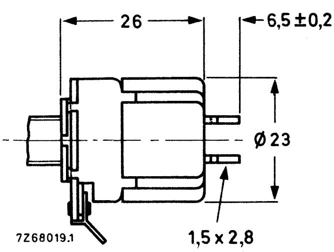


Fig. 9 D.P.S.T. rotary switch.

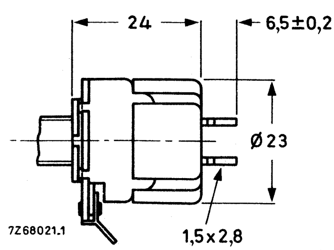


Fig. 10 D.P.S.T. push-pull switch.

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) at 40 °C	max. voltage (V) at 70 °C	max. terminal resistance	max. attenuation dB	max. contact resist. % R_{nom}	limiting wiper current at 40 °C mA
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 kΩ	a	16	12	25 Ω	–	3	16
2,2 kΩ	a	23	18	25 Ω	–	3	11
4,7 kΩ	a	34	26	25 Ω	–	3	7
10 kΩ	a	50	39	35 Ω	–	2,5	5
22 kΩ	a	74	57	35 Ω	–	2,5	3,5
47 kΩ	a	110	84	35 Ω	–	2,5	2,2
100 kΩ	a	160	120	100 Ω	–	2,5	1,4
220 kΩ	a	230	180	125 Ω	–	2,5	1,0
470 kΩ	a	340	265	250 Ω	–	2,5	0,65
1 MΩ	a	500	390	1 kΩ	–	2,5	0,45
2,2 MΩ	a	500	500	2,2 kΩ	–	2,5	0,32
4,7 MΩ	a	500	500	4,7 kΩ	–	2,5	0,22
470 Ω	b	8,4	6,9	5 Ω **	– **	6	14
1 kΩ	b	12	10	5 Ω **	50 **	4	10
2,2 kΩ	b	18	15	5 Ω **	60 **	4	7
4,7 kΩ	b	26	22	5 Ω **	60 **	4	4,5
10 kΩ	b	39	32	10 Ω **	60 **	4	3,2
22 kΩ	b	57	47	22 Ω **	60 **	4	2,2
47 kΩ	b	84	69	35 Ω **	70 **	4	1,4
100 kΩ	b	120	100	50 Ω **	70 **	4	1,0
220 kΩ	b	180	150	50 Ω **	80 **	4	0,7
470 kΩ	b	265	220	100 Ω **	80 **	4	0,45
1 MΩ	b	390	320	500 Ω **	80 **	4	0,32
2,2 MΩ	b	500	470	2,2 kΩ **	80 **	4	0,22

* Measured between terminals a and c.

**Measured between terminals a and b; spindle turned fully counter-clockwise.

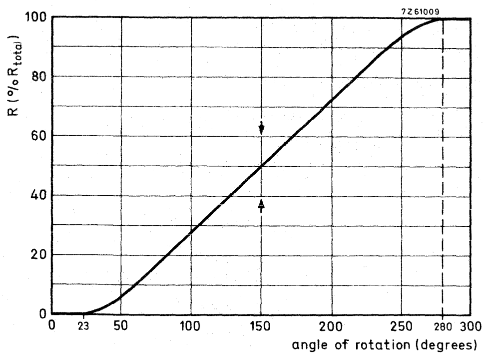


Fig. 11a Linear law.

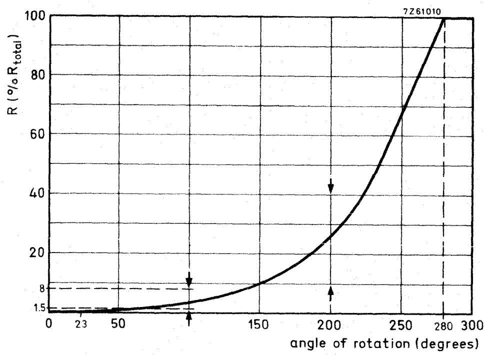


Fig. 11b Logarithmic law.

Tolerance on the nominal resistance	± 20%
Resistance law and tolerances	see Figs 11a and 11b
Minimum resistance at the tap	$\leqslant$ 1% of R_{nom}
Insulation resistance after damp heat test (IEC 68, test C, 21 days)	> 100 MΩ
Maximum dissipation	
linear law, acc. to Fig. 11a	
at 40 °C	0,25 W
at 70 °C	0,125 W
resistance law, acc. to Fig. 11b	
at 40 °C	0,125 W
at 70 °C	0,0625 W
Test voltage	1000 V, 50 Hz
Working temperature range	−10 to + 70 °C
Category (IEC 68)	10/070/21
Operating torque	3 to 20 mNm
Permissible torque with wiper at end stop	$\leqslant$ 0,8 Nm
Permissible axial spindle load	$\leqslant$ 100 N
Effective angle of rotation	250-265°
Mechanical angle of rotation	300 ± 5°
Life, $\Delta R_{ac}/R_{ac}$	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		flat faced	
	17 mm = 13		
	18 mm = 06		18 mm = .40
	19 mm = 14		
	20 mm = 15		
	22 mm = 17		
	25 mm = 01		25 mm = .41
	30 mm = 03		30 mm = .43
	35 mm = 04		
	40 mm = 05		40 mm = .45
	60 mm = 07		60 mm = .47
	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	

Table 1 Switch data

	switch type			
	rotary s.p.s.t.	rotary s.p.d.t.	rotary d.p.s.t.	push-pull d.p.s.t., 2A
Approved by			E.I., Demko, Semko, Nemko	Demko, Semko Nemko
Breaking capacity	250 V AC, 0,5 A, $\cos\varphi = 0{,}9$ 125 V AC, 1 A, $\cos\varphi = 0{,}9$	250 V AC, 0,5 A, $\cos\varphi = 0{,}9$ 125 V AC, 1 A, $\cos\varphi = 0{,}9$	250 V AC, 1,5 A/32 x (IEC 65)	250 V AC, 2 A/32 x (IEC 65)
Contact resistance, initially	< 25 mΩ	< 25 mΩ	< 20 mΩ (1)	< 20 mΩ (1)
after damp heat test (IEC 68, test C, 21 days)	< 40 mΩ	< 40 mΩ	< 40 mΩ	< 40 mΩ
after 10 000 on-off switching operations at breaking capacity	⩽ 200 mΩ (2)	⩽ 200 mΩ (2)	⩽ 200 mΩ (2)	⩽ 200 mΩ (2)
Insulation resistance, initially	> 100 MΩ	> 100 MΩ	> 5000 MΩ	> 5000 MΩ
after damp heat test (IEC 68, test C, 21 days)	> 2 MΩ	> 2 MΩ	> 25 MΩ	> 25 MΩ
Test voltage 3, initially	2000 V, 50 Hz	2000 V, 50 Hz	2000 V, 50 Hz	2200 V, 50 Hz
after damp heat test (IEC 68, test C, 21 days) (4)	500 V, 50 Hz	500 V, 50 Hz	2000 V, 50 Hz	2200 V, 50 Hz
Switching torque	4 - 8 Ncm	4 - 8 Ncm	4 - 8 Ncm	
Switching force				3,5 - 4,5 N
Switching angle	20 ± 2^{o}	20 ± 2^{o}	$25 - 35^{o}$	
Switching stroke				3,5 mm
Total mechanical angle of rotation	308 ± 5^{o}	308 ± 5^{o}	303 ± 5^{o}	300 ± 5^{o}
Backlash (rotary switch)	$\leqslant 6^{o}$	$\leqslant 6^{o}$	–	
Backlash (push-pull switch)				$\leqslant 9^{o}$
Permissible axial spindle load	⩽ 100 N	⩽ 100 N	⩽ 100 N	⩽ 100 N

Notes to Table 1

1. Measured per contact (e.g. between P_1 and P_2, see "Switches").
2. Averaged over 10 measurements: ⩽ 100 mΩ.
3. Measured at opened switch between the terminals, and between the case or spindle and interconnected terminals.
4. Measured after recovery period of 24 hours.

PP12 SERIES
MODULAR CARBON AND CERMET POTENTIOMETERS

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 comparitively 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.

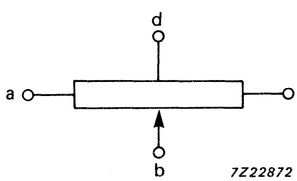
QUICK REFERENCE DATA

Resistance range (E3 series)	
carbon, linear law	470 Ω to 4,7 MΩ
carbon, logarithmic/reverse logarithmic law	2,2 kΩ to 470 kΩ
cermet, linear law	220 Ω to 4,7 MΩ
Maximum dissipation at T_{amb} = 40 °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

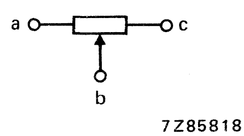
DESCRIPTION

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 one of many available spindle types (survey 2);

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



carbon types

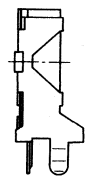
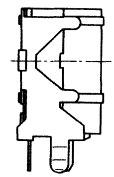
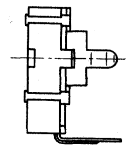


cermet types

Fig.1 Terminal designation.

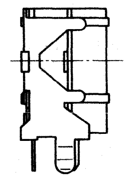
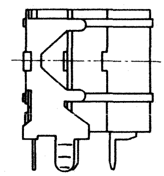
The resistance element is a carbon track on a phenolic paper base, or a metal-glass track on a cermamic Al_2O_3 base, fixed in a plastic housing. The metallic slider has a multi-finger wiper and is mounted in a plastic rotor. Terminals are designated as shown above in accordance with IEC 393-1, sub-clause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

SURVEY 1, VERSIONS WITHOUT SPINDLE

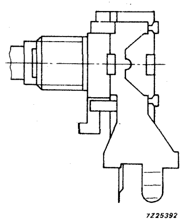
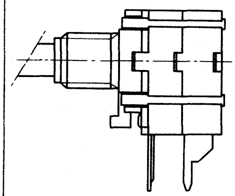
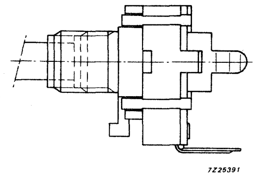
				single vertical		single horizontal
versions				 with bracket	 with bracket and battery switch	
	snap-in rotor			●	X	●
terminal configuration	in-line			●	X	●
type of terminal	vertical versions	spindle height	10 mm	X	X	
			12,5 mm	●	X	
		solder tag				
	horizontal versions					●
detent	none			●		●
	at 50%			X		X

Note dual versions available on request.

X = available.
● = recommended.

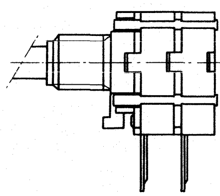
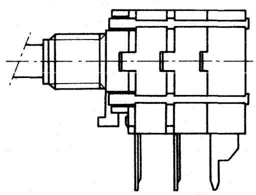
	tandem vertical	
	 with bracket	 with bracket and battery switch
	●	X
	●	X
	X	X
	●	X
	●	X
	X	X

SURVEY 2, VERSIONS WITH SPINDLE

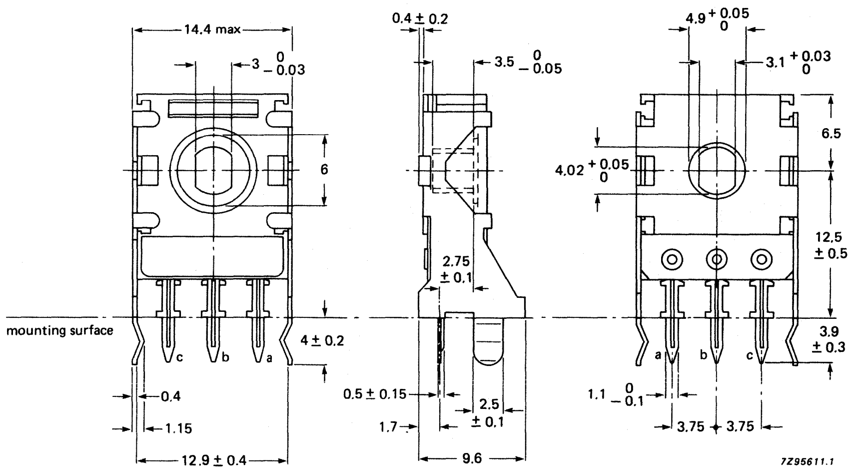
				single vertical		single horizontal
version				 standard * with bracket	 with battery switch	 * with bracket
bushing L = 8 mm	M7	spindle dia. 4 mm	plastic	●	●	●
			metal	●	●	●
		spindle dia. 6 mm	plastic	X	X	X
			metal	X	X	X
type of terminal	vertical versions	spindle height	12,5 mm	●	●	
			10 mm	X	X	
		solder tag		X		
	horizontal version					●
optional	bracket			X	X	
	centre detent (3)			X		X

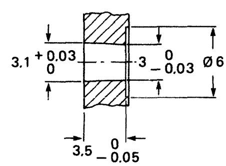
X = available
● = recommended

* These types are identified by non-standard code numbers which are available on request.

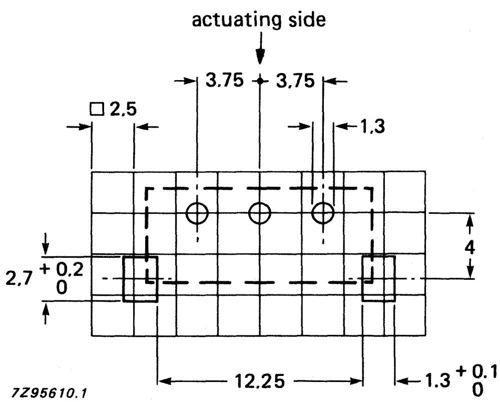
	tandem vertical	
		 with battery switch
	●	X
	●	X
	X	X
	X	X
	●	●
	X	X
	X	
	X	
	X	

VERSION WITHOUT SPINDLE, SINGLE VERTICAL WITH BRACKET

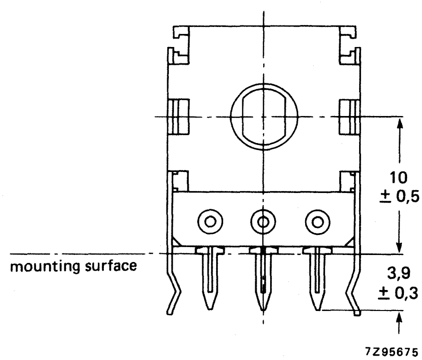




Rotor drawn at mid position long p.w. tags.



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



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

Fig.2 Version without spindle, single vertical with bracket.

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%
Resistance law (see Fig.18)	carbon A, B, C cermet A
Maximum dissipation at T_{amb} = 40 °C	
carbon, linear	0,2 W
carbon, non-linear	0,1 W
cermet, linear	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 5.5 00 . . .

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

Table for R_{nom}

R \ law	linear	20%**	logarithmic*	rev. logarithmic*
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	–	–

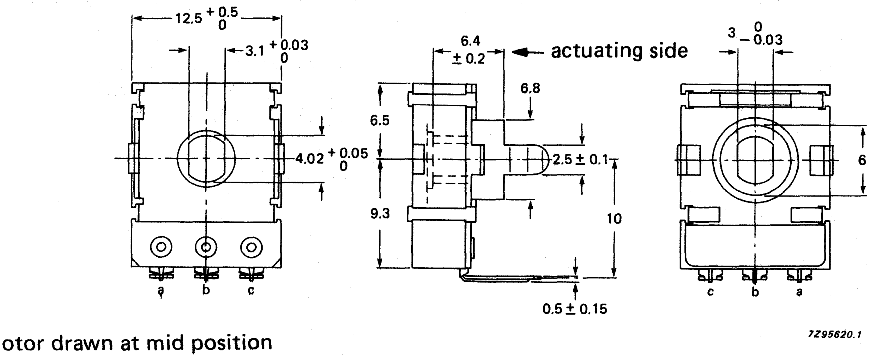
* carbon only.
** cermet only.

Note

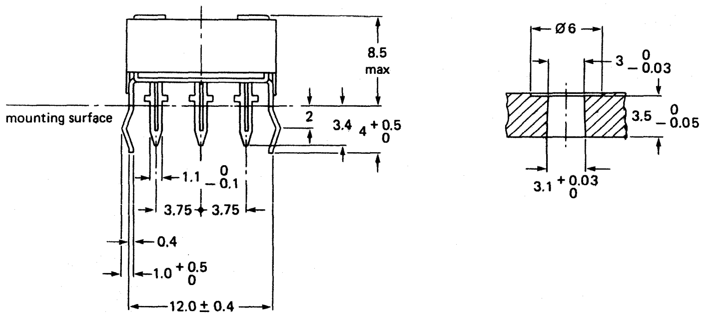
For log. and reverse log. resistance laws attention should be paid to the actuating side as indicated on the outline drawings.

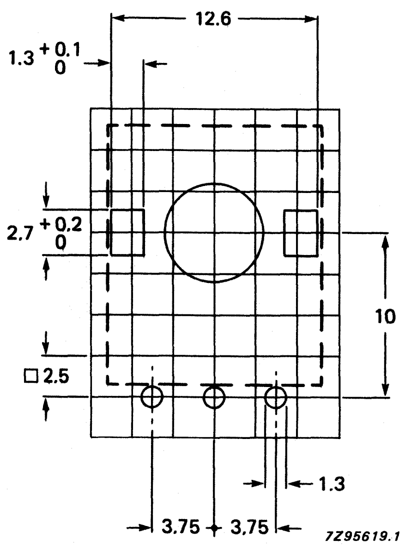
Catalogue numbers for other versions on request.

VERSION WITHOUT SPINDLE, SINGLE HORIZONTAL



Rotor drawn at mid position





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

Fig.3 Version without spindle, single horizontal.

Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/70/56
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%
Resistance law (see Fig.18)	carbon A, B, C cermet A
Maximum dissipation at T_{amb} = 40 °C	
carbon, linear	0,2 W
carbon, non-linear	0,1 W
cermet, linear	1,0 W
Test voltage for 1 minute	350 V, 50 Hz

For further information see Electrical Data, Mechanical Data and Battery Switch.

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

2322 5.5 00 . . .

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

Table for R_{nom}

R \ law	linear	20%**	logarithmic*	rev. logarithmic*
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	–	–

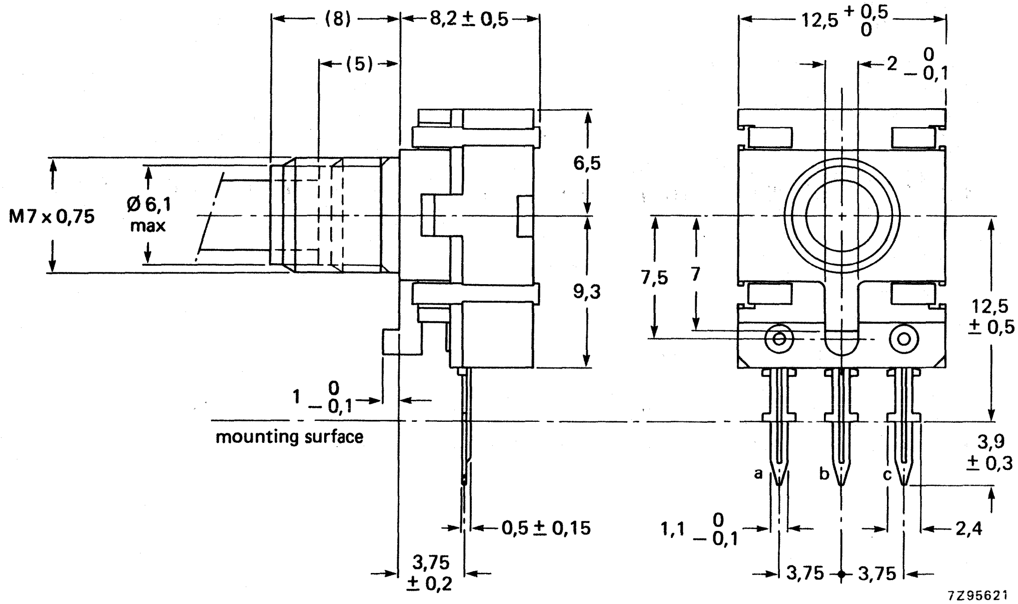
* carbon only.
** cermet only.

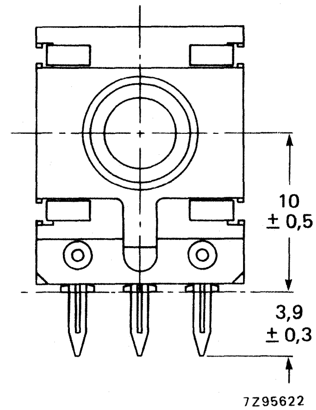
Note

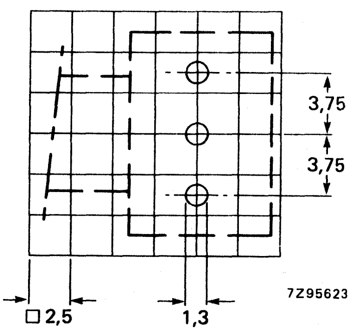
For log. and reverse log. resistance laws attention should be paid to the actuating side as indicated on the outline drawings.

Catalogue numbers for other versions on request.

VERSION WITH SPINDLE, SINGLE VERTICAL







Hole pattern in FC board,
viewed from component side.

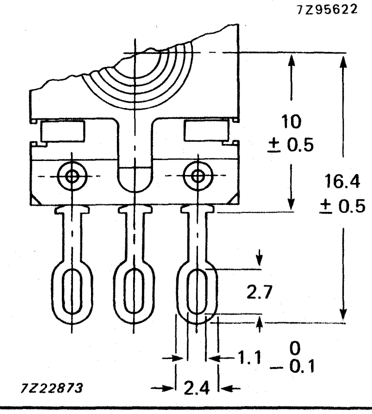


Fig.4 Version with spindle, single vertical.

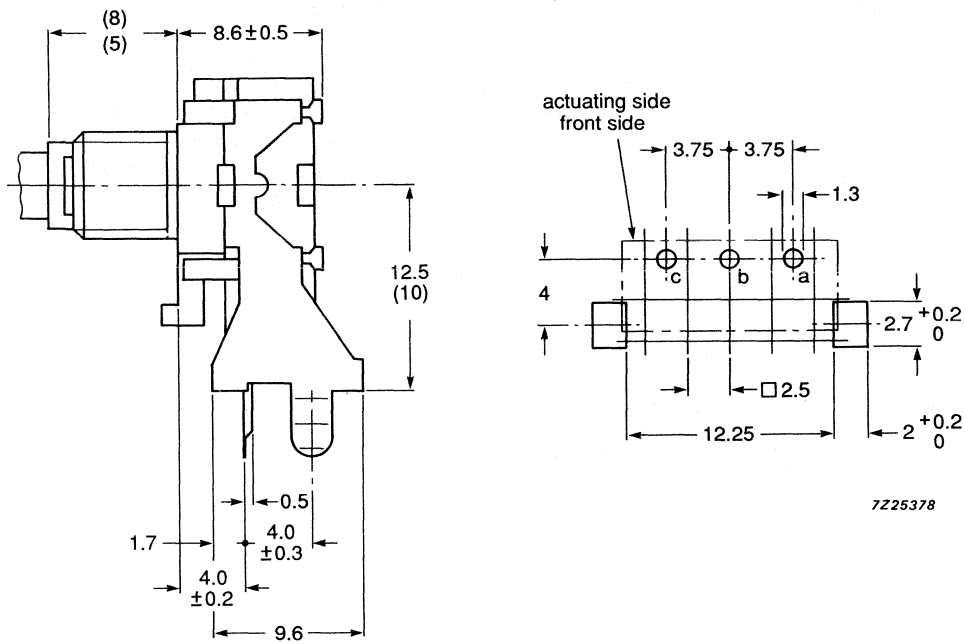


Fig.5 Outline and hole pattern for bracket version*.

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	2200 Ω to 470 kΩ, tolerance 20%
cermet, linear	220 Ω to 4,7 MΩ tolerance 10%
Resistance law (see Fig.18)	carbon A, B, C, H, K cermet A
Maximum dissipation at T_{amb} = 40 °C	
carbon, linear	0,2 W
carbon, non-linear	0,1 W
cermet, linear	1,0 W
Test voltage for 1 minute	500 V, 50 Hz

For further information see Electrical Data and Mechanical Data.

* This product is not standard coded, codes available on request.

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

2322 5.6 . . . . .

code for element

0 = carbon
1 = cermet

code for bushing and material

	bushing length	spindle L = 20 type	material	dia
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

resistance code

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%

see next page

from previous page

Table for R_{nom}

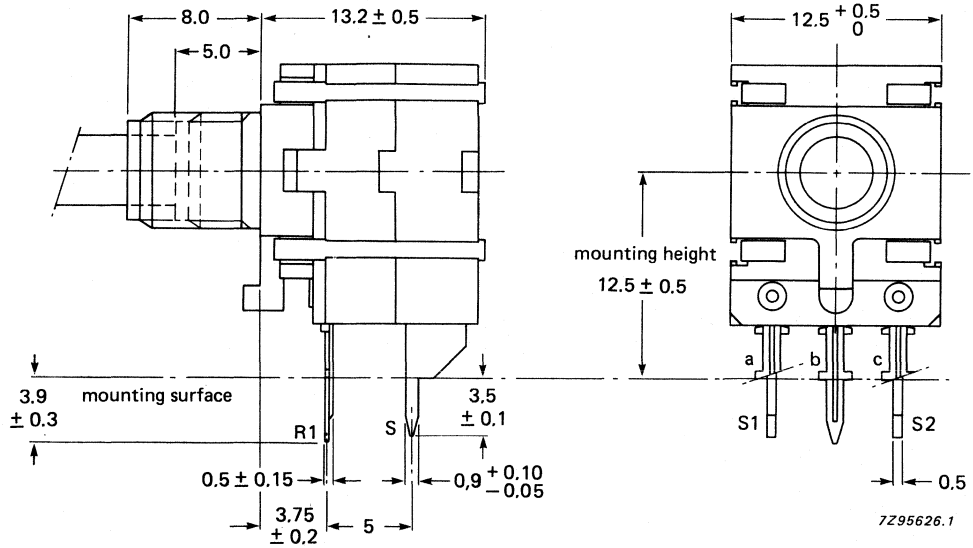
R \ law	linear	20%**	logarithmic*	rev. logarithmic*
220 Ω**	02	52	–	–
470 Ω	03	53	–	–
1 kΩ	04	54	–	–
2,2 kΩ	05	55	25	45
4,7 kΩ	06	56	26	46
10 kΩ	07	57	27	47
22 kΩ	08	58	28	48
47 kΩ	09	59	29	49
100 kΩ	11	61	31	51
220 kΩ	12	62	32	52
470 kΩ	13	63	33	53
1 MΩ	14	64	–	–
2,2 MΩ	15	65	–	–
4,7 MΩ	16	66	–	–

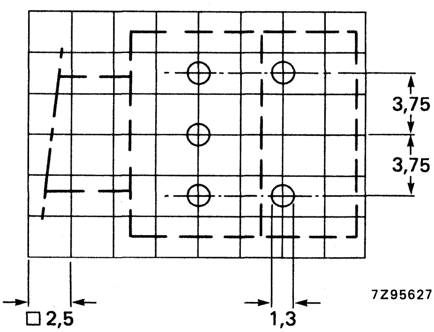
law	logarithmic* with tap*** at 10%	logarithmic* with tap*** at 20%
5 + 42 kΩ	72	–
20 + 200 kΩ	67	–
50 + 400 kΩ	73	–
100 + 900 kΩ	64	–
2 + 8 kΩ	–	76
5 + 17 kΩ	–	82
10 + 37 kΩ	–	86
20 + 80 kΩ	–	77
50 + 170 kΩ	–	83
100 + 370 kΩ	–	87

* carbon only.
** cermet only.
*** See Fig.9.

Catalogue numbers for other versions on request.

VERSION WITH SPINDLE, SINGLE VERTICAL WITH BATTERY SWITCH





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

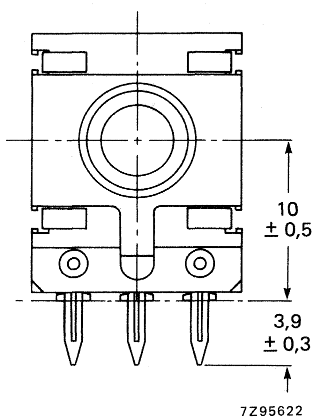


Fig.6 Version with spindle, single vertical with battery switch.

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	2200 Ω to 470 kΩ, tolerance 20%
cermet, linear	220 Ω to 4,7 MΩ tolerance 10%
Resistance law (see Fig.18)	carbon A, B, C, H, K cermet A
Maximum dissipation at T_{amb} = 40 °C	
carbon, linear	0,2 W
carbon, non-linear	0,1 W
cermet, linear	1,0 W
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, PP12 with spindle, single, vertical with battery switch

2322 5. 6 . . . . .

code for element
0 = carbon
1 = cermet

code for bushing and material

	bushing length	type	spindle material (L = 20)	dia
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

resistance code

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%

see next page

from previous page

Table for R_{nom}

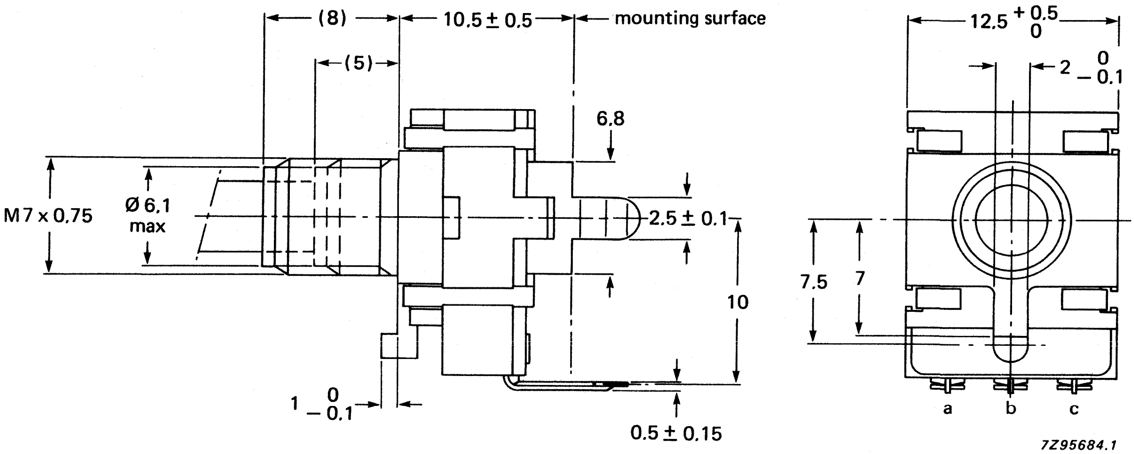
R \ law	linear	20%**	logarithmic*	rev. logarithmic*
220 Ω**	02	52	–	–
470 Ω	03	53	–	–
1 kΩ	04	54	–	–
2,2 kΩ	05	55	25	45
4,7 kΩ	06	56	26	46
10 kΩ	07	57	27	47
22 kΩ	08	58	28	48
47 kΩ	09	59	29	49
100 kΩ	11	61	31	51
220 kΩ	12	62	32	52
470 kΩ	13	63	33	53
1 MΩ	14	64	–	–
2,2 MΩ	15	65	–	–
4,7 MΩ	16	66	–	–

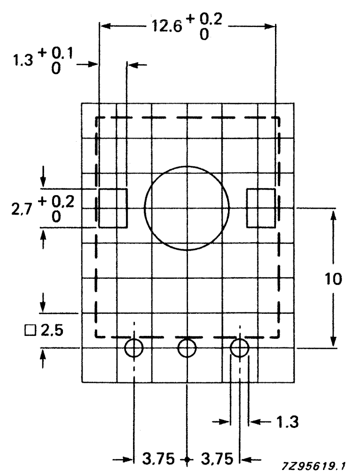
law	logarithmic* with tap***	
	at 10%	at 20%
5 + 42 kΩ	72	–
20 + 200 kΩ	67	–
50 + 400 kΩ	73	–
100 + 900 kΩ	64	–
2 + 8 kΩ	–	76
5 + 17 kΩ	–	82
10 + 37 kΩ	–	86
20 + 80 kΩ	–	77
50 + 170 kΩ	–	83
100 + 370 kΩ	–	87

* carbon only.
** cermet only.
*** see Fig.9.

Catalogue numbers for other versions on request.

VERSION WITH SPINDLE, SINGLE HORIZONTAL





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

Fig.7 Version with spindle, single horizontal.

Main properties

Climatic category	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	2200 Ω to 470 kΩ, tolerance 20%
cermet, linear	220 Ω to 4,7 MΩ, tolerance 10%
Resistance law (see Fig.18)	carbon A, B, C cermet A
Maximum dissipation at T_{amb} = 40 °C	
carbon, linear	0,2 W
carbon, non-linear	0,1 W
cermet, linear	1,0 W
Test voltage for 1 minute	500 V, 50 Hz

For further information see Electrical Data and Mechanical Data.

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

2322 5 . 6 . . . . .

code for element
0 = carbon
1 = cermet

code for bushing and material

resistance code

code for detent
3 = no detent
8 = detent at 50%

	bushing length	spindle L = 20 type	material	dia
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

see next page

from previous page

Table for R_{nom}

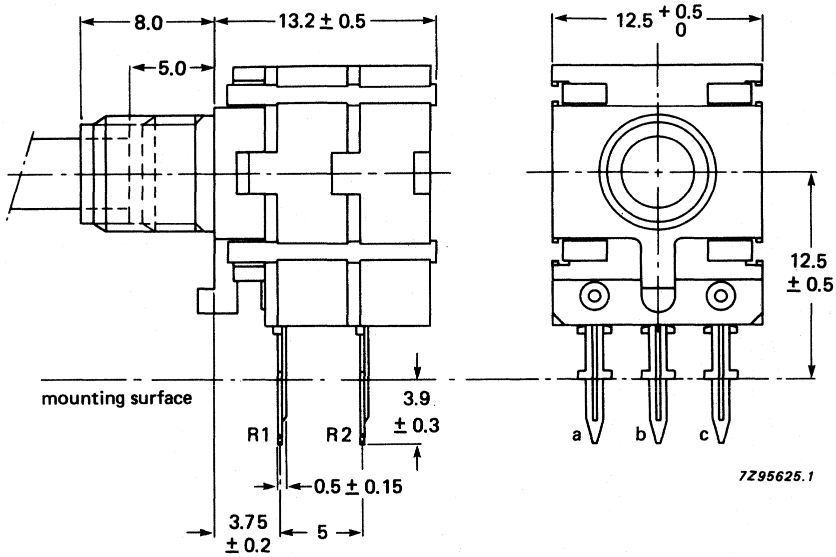
R \ law	linear	20%**	logarithmic*	rev. logarithmic*
220 Ω**	02	52	–	–
470 Ω	03	53	–	–
1 kΩ	04	54	–	–
2,2 kΩ	05	55	25	45
4,7 kΩ	06	56	26	46
10 kΩ	07	57	27	47
22 kΩ	08	58	28	48
47 kΩ	09	59	29	49
100 kΩ	11	61	31	51
220 kΩ	12	62	32	52
470 kΩ	13	63	33	53
1 MΩ	14	64	–	–
2,2 MΩ	15	65	–	–
4,7 MΩ	16	66	–	–

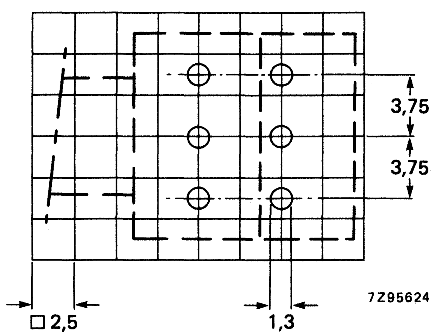
law	logarithmic* with tap***	
	at 10%	at 20%
5 + 42 kΩ	72	–
20 + 200 kΩ	67	–
50 + 400 kΩ	73	–
100 + 900 kΩ	64	–
2 + 8 kΩ	–	76
5 + 17 kΩ	–	82
10 + 37 kΩ	–	86
20 + 80 kΩ	–	77
50 + 170 kΩ	–	83
100 + 370 kΩ	–	87

* carbon only.
** cermet only.
*** see Fig.9.

Catalogue numbers for other versions on request.

VERSIONS WITH SPINDLE, TANDEM VERTICAL





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

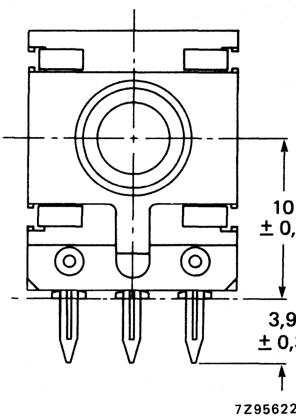


Fig.8 Version with spindle, tandem vertical.

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	2200 Ω to 470 kΩ, tolerance 20%
cermet, linear	220 Ω to 4,7 MΩ tolerance 10%
Resistance law (see Fig.18)	carbon A, B, C, H, K 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	1,0 + 1,0 W
Test voltage for 1 minute	500 V, 50 Hz

For further information see Electrical Data and Mechanical Data.

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

2322 5 . 7 . . . . .

code for element
0 = carbon
1 = cermet

code for bushing and material

code	bushing length	type	spindle material	L = 20 dia
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

resistance code

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%

see next page

from previous page

Table for R_{nom}

R \ law	linear	20%**	logarithmic*	rev. logarithmic*
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		

law	logarithmic* with tap*** at 10%	at 20%
5 + 42 kΩ	72	–
20 + 200 kΩ	67	–
50 + 400 kΩ	73	–
100 + 900 kΩ	64	–
2 + 8 kΩ	–	76
5 + 17 kΩ	–	82
10 + 37 kΩ	–	86
20 + 80 kΩ	–	77
50 + 170 kΩ	–	83
100 + 370 kΩ	–	87

* carbon only.
** cermet only.
*** see Fig.9.

Catalogue numbers for other versions on request.

VERSIONS WITH ONE TAP

(carbon versions only)

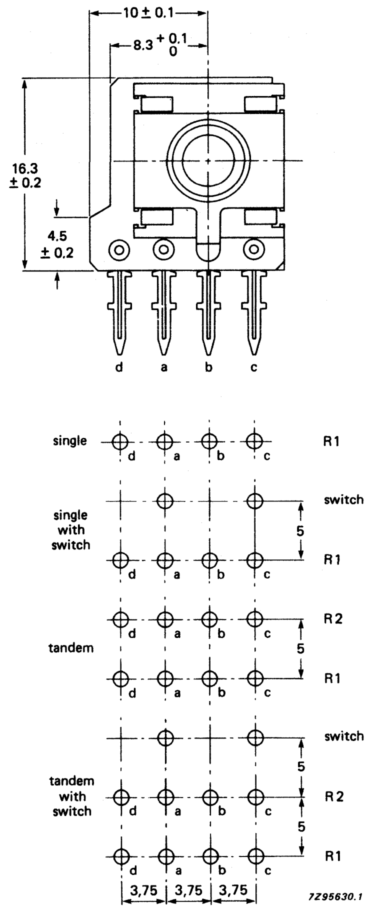


Fig.9 Versions with one tap.

Notes to Versions with One Tap

1. Versions with bracket cannot be supplied with a tap.
2. Tandem – or other multiple units in modular version – do not require a bracket for mechanical stability. Such types can be supplied, therefore, also with a tap.

Actuating device for potentiometers without spindle

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

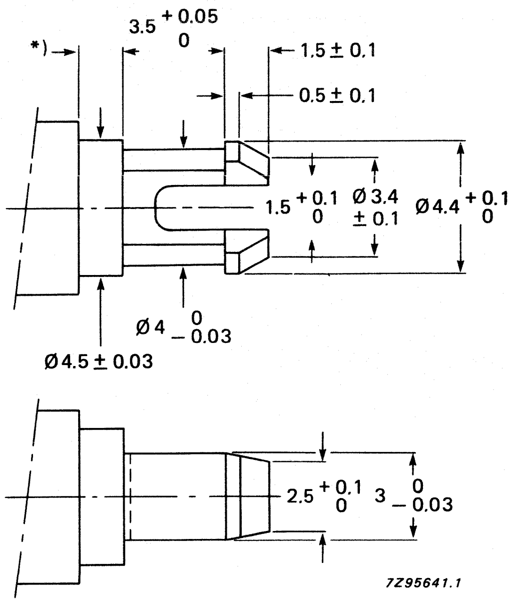
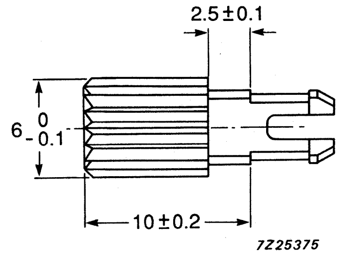


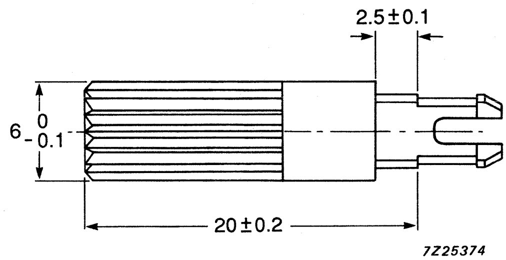
Fig.10 Dimensions for snap-in section of actuating device.

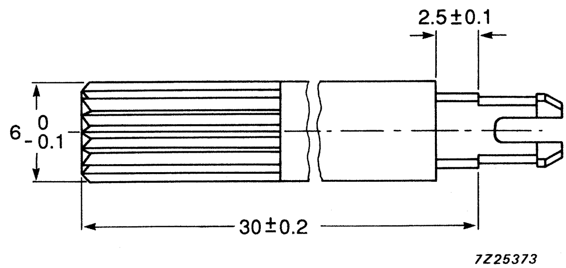
Table 1 snap-in device codes (see Figs 11 and 12)

length	code nr.	colour	type
10 mm	4322 046 20081	black	shaft ϕ 6 mm
20 mm	20091	"	"
30 mm	20101	"	"
60 mm	20111	"	"
25 mm	4322 046 20121	"	thumbwheel
30,7 mm	20131	"	"

* See Figs 11 and 12.







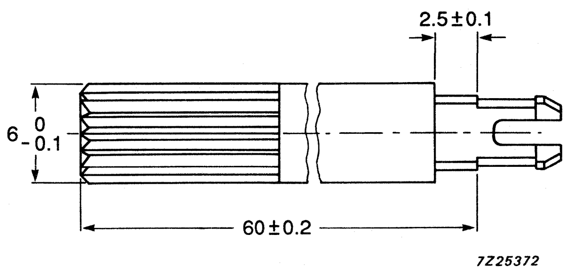


Fig.11 Small diameter plastic actuating devices*.

* Available in black only.

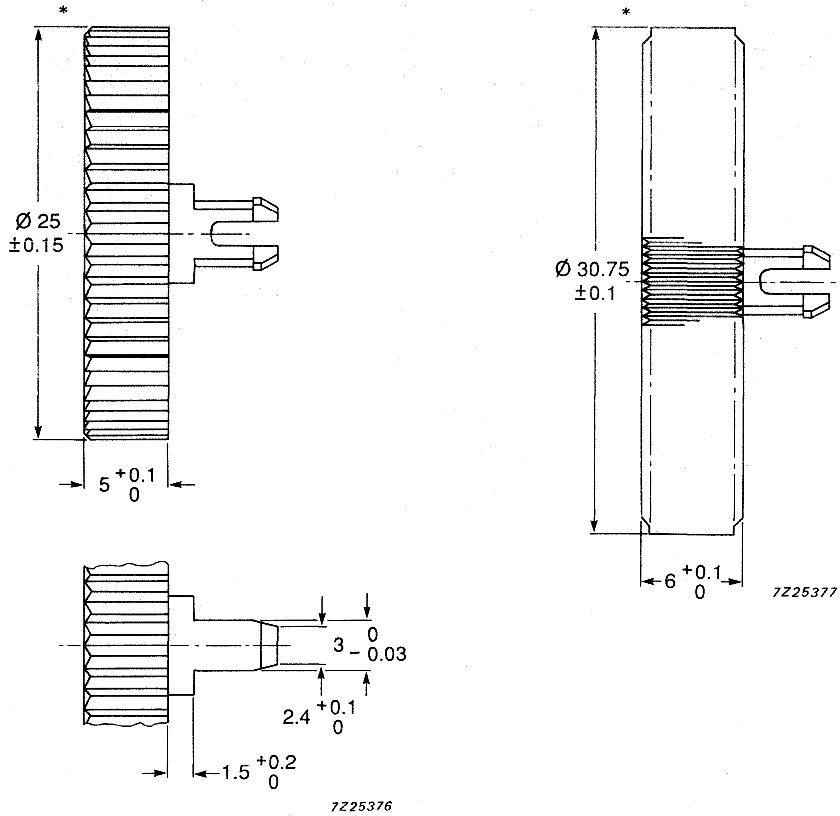


Fig.12 Thumbwheel actuating devices.

* Available in black, grey or beige.

Mounting holes for potentiometers with spindle

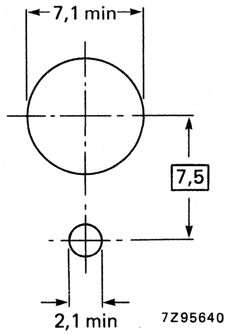
for single and tandem potentiometers	required mounting holes in chassis	fixing of potentiometer
with mounting bush M7 x 0,75 mm		with supplied mounting nut; max. torque for tightening = 1 Nm; minimum thickness of mounting plate = 1 mm

Fig.13 Potentiometers with spindle: mounting.

Spindles, metal or plastic, M7 bushing

CCW position

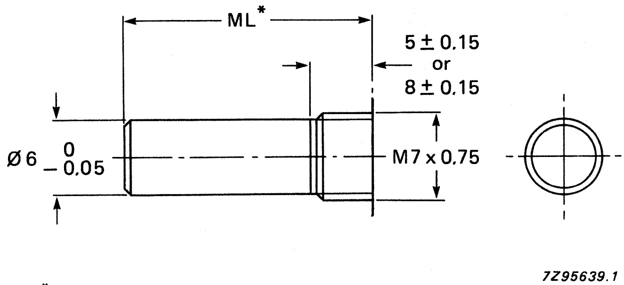


Fig.14.

ML* = 20 ± 0.3 and 30 ± 0.3 for metal spindle
30 ± 0.3 for plastic spindle

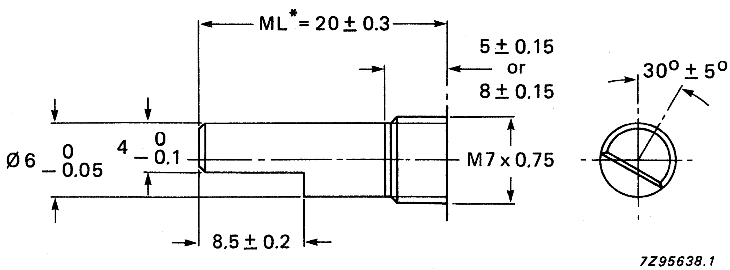


Fig.15.

*metal spindle only

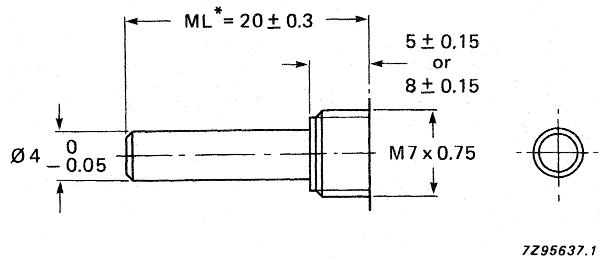


Fig.16.

*metal and plastic spindles

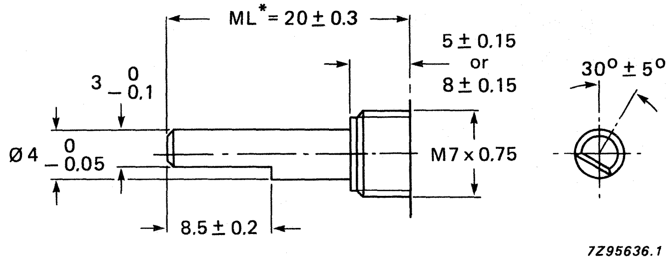


Fig.17.

*metal spindle only

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.

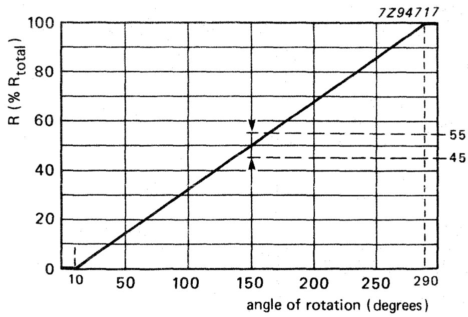
	carbon	cermet
Resistance range, E3 series		
potentiometers without spindle		
linear law	470 Ω to 4,7 MΩ	220 Ω to 4,7 MΩ
log/reverse log law	2,2 kΩ to 470 kΩ	
potentiometers with spindle		
linear law	470 Ω to 4,7 MΩ	220 Ω to 4,7 MΩ
log/reverse log law	2,2 kΩ to 470 kΩ	
Tolerance on resistance	± 20%	± 10% or ± 20%
Resistance law and tolerances (see Fig.18)	type A, B, C, H	type A

ELECTRICAL DATA (continued)

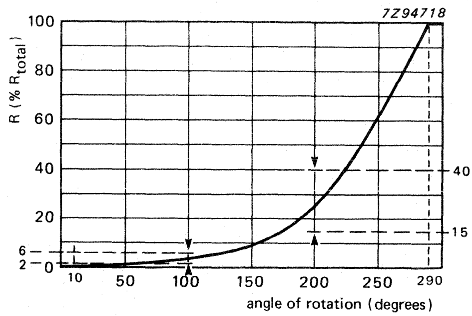
	carbon standard	carbon special	cermet
Ganging tolerance (tandem potentiometers)			
linear law			
at values between 10 and 90% of R_{total}	< 2 dB		
(reserved) logarithmic law			
at attenuations between 0 and 20 dB	< 2 dB		
at attenuations between 20 and 40 dB	< 3 dB		
at attenuations between 40 and 60 dB	< 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	< 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	
Terminal resistance, (residual)	⩽ 10 Ω		⩽ 1% or R_n or 1 Ω
Contact resistance moving (CRM)			
linear law	⩽ 2% of R_{ac}		⩽ 2,5% of R_{ac}
log/reverse log law	⩽ 4% of R_{ac}		–
Contact resistance variation (CRV), (acc. to IEC 393-1, sub. clause 4.17) initially,			
linear law	⩽ 1%		⩽ 1% of R_{ac}
log/reverse log law	⩽ 2%		–
Temperature coefficient of resistance	$\pm 500 \times 10^{-6}$/K		$\pm 100 \times 10^{-6}$/K
type A, B, C, H, K; 1 MΩ to 4,7 MΩ*	$\pm 1000 \times 10^{-6}$/K		
Insulation resistance after damp heat test (IEC 68, test C)	after 10 days ⩾ 100 MΩ		after 56 days ⩾ 100 MΩ
Maximum attenuation			
$R_{tot} \geqslant 22$ kΩ, type A, B, C, H, K	⩾ 90 dB		
$R_{tot} < 22$ kΩ, type A	⩾ 55 dB		
$R_{tot} < 22$ kΩ, type B, C, H, K	⩾ 75 dB		
Maximum dissipation at T_{amb} = 40 °C (P_{max})*			
linear law	0,2 W		1,0 W
log/reverse log law	0,1 W		
Rated element voltage, see Table 2 or 3 *500 V DC or 350 V AC never to be exceeded*	$\sqrt{P_{max} \times R_{nom}}$		$\sqrt{P_{max} \times R_{nom}}$
Limiting slider current, see Table 1	$\sqrt{P_{max}/R_{nom}}$		$\sqrt{P_{max}/R_{nom}}$
Test voltage for 1 minute	500 V, 50 Hz		500 V, 50 Hz
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

* For derating see Fig. 19.

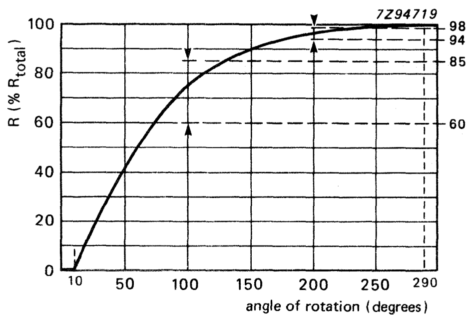
Characteristics of potentiometers without switch



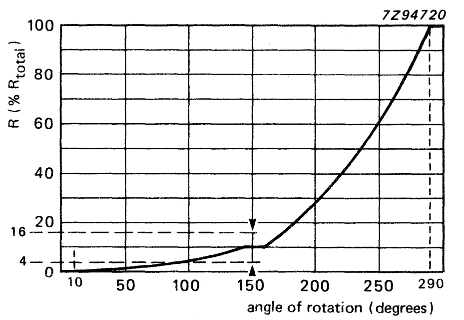
Type A
Fig. 18a Linear law.



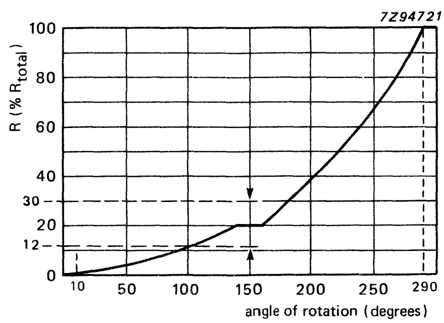
Type B
Fig. 18b Logarithmic law.



Type C
Fig. 18c Reversed logarithmic law.



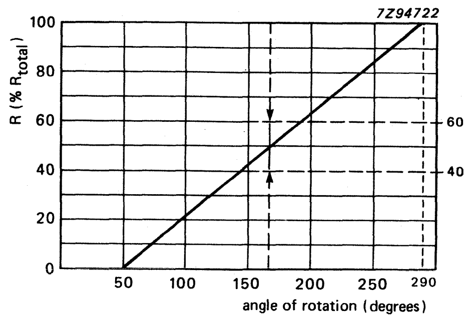
Type H
Fig. 18d Logarithmic law, tap at 10%.



Type K
Fig. 18e Logarithmic law, tap at 20%.

Characteristics of potentiometers with switch

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



Type A
Fig. 18f Linear law.

Table 2 Rated element voltage: carbon types A to H

nominal resistance	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 kΩ		14	10	14	10
2,2 kΩ		21	14	9,5	6,7
4,7 kΩ		30	21	6,5	4,6
10 kΩ		44	31	4,5	3,2
22 kΩ		66	47	3,0	2,1
47 kΩ		97	68	2,0	1,5
100 kΩ		141	100	1,4	1,0
220 kΩ		210	148	1,0	0,7
470 kΩ		306	216	0,7	0,5
1 MΩ		447	316	0,4	0,3
2,2 MΩ		500	470	0,3	0,2
4,7 MΩ		500	500	0,2	0,15
2,2 kΩ	log/rev. log.	14	21	6,5	4,6
4,7 kΩ		21	15	4,6	3,3
10 kΩ		31	22	3,2	2,2
22 kΩ		47	33	2,1	1,5
47 kΩ		68	48	1,5	1,0
100 kΩ		100	70	1,0	0,7
220 kΩ		148	104	0,7	0,5
470 kΩ		216	153	0,5	0,3

Table 3 Rated element voltage: cermet, type A only

nominal resistance	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		21,7	15,3	46,1	32,6
1 kΩ		31,6	22,4	31,6	22,4
2,2 kΩ		46,9	33,2	21,3	15,1
4,7 kΩ		50	48,5	10,6	10,3
10 kΩ		50	50	5	5
22 kΩ		50	50	2,3	2,3
47 kΩ		50	50	1,1	1,1
100 kΩ		50	50	0,5	0,5
220 kΩ		50	50	0,2	0,2
470 kΩ		50	50	0,1	0,1
1 MΩ		50	50	0,1	0,1
2,2 MΩ		50	50	—	—
4,7 MΩ		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
Non-linear law 100% = 0,1 W } carbon versions

100% = 1 W cermet versions

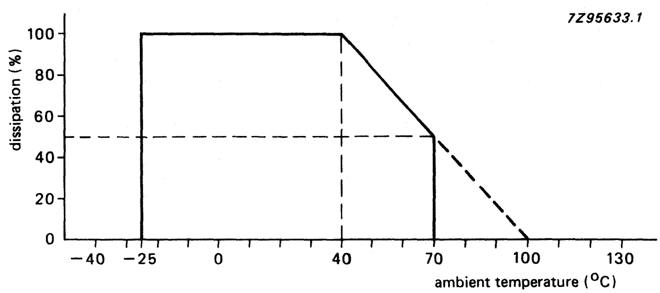


Fig.19 Maximum permissible dissipation as a function of ambient temperature.

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.

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 (carbon only).

MECHANICAL DATA

	versions without spindle		versions with spindle		
	single	tandem	single	tandem	unit
Max. axial force	60	60	80	80	N
Operating torque initial	3 to 10 3 to 14*	3 to 16 3 to 18*	3 to 12 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
Max. 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 with switch	280 ± 5 240 ± 8,5	280 ± 5 240 ± 8,5	280 ± 5 240 ± 8,5	280 ± 5 240 ± 8,5	deg 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

Angle of rotation

1. Types without switch
   total mechanical angle — 0° to 300° ± 2°
   effective R-angle — 10° to 290°
   For performance see Fig. 20a
2. Types with switch
   total mechanical angle — 0° to 300° ± 5°
   effective angle — 50° to 290° ± 5°

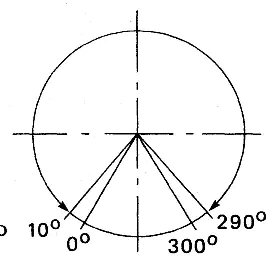


Fig.20a.

αA: Switch angle: 15° ± 10° (CCW)
Switch at "on" position and rotor at leftmost off position (CCW)

αB: Switch-off angle: 23° ± 10° (CW off to on position)

αC: Effective resistance starting angle: 50° ± 5°

αD: Switch-on angle: 277° ± 10° (CW in on position)

For performance see Fig. 20b

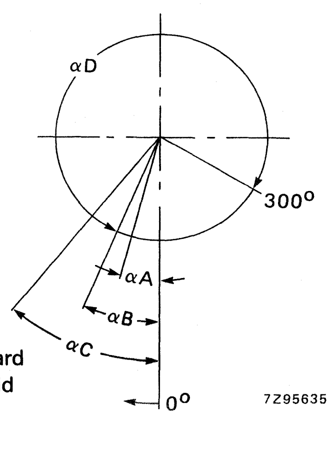


Fig.20b.

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.

* With switch.
** For metal spindles; 400 mNm for plastic spindles.

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.

Electrical ratings and characteristics

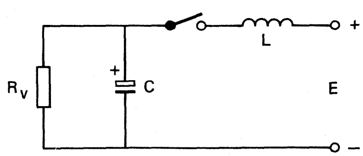
Unless otherwise specified, all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

D.C. voltage/current rating, see note 1	14,4 V/3,5 A
Isolation voltage, DC, for 1 minute	
initial	500 V
after 21 days humidity test to IEC 68	100 V
Contact resistance (C.R.) at max. 20 mV (DC or AC) and 100 mA	$\leqslant$ 20 mΩ
Insulation resistance, see note 2	
initial	$\geqslant$ 100 MΩ
after 21 days humidity test to IEC 68	$\geqslant$ 2 MΩ
Climatic sequence	ΔCR $\leqslant$ 30 mΩ
Damp heat, steady state	ΔCR $\leqslant$ 30 mΩ
Electrical endurance, 1000 h at 70 °C; 3,5 A, AC	ΔCR $\leqslant$ 30 mΩ
Bump and vibration	ΔCR $\leqslant$ 30 mΩ no interruption during test

Note 1

The specification holds for the switch being used as depicted in the circuit diagram below. Connection of the plus pole: under consideration.

During the switching action the current through the switch is determined by: E = 16 V (DC); L = 250 μH (R = 150 mΩ); C = 1000 μF; R_V = 32 Ω



7Z95632

Current through the switch in switched condition: max. 3,5 A (at 14,4 V).

Note 2

Measured between the switch terminals and measured between the interconnected terminals and other metal parts.

ENVIRONMENTAL TESTS

Note

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

tests	requirements		
		carbon	cermet
Climatic sequence	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 10%	$\leqslant$ 2%
Damp heat, steady state	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 15%	$\leqslant$ 2%
Mechanical endurance			
10 000 cycles	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 10%	
50 000 cycles	$\Delta R_{ac}/R_{ac}$		$\leqslant$ 2%
Electrical endurance			
1000 h at 70 °C, cyclic	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 10%	$\leqslant$ 2%
Resistance to soldering heat			
(IEC 68-2, test T_b)	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 2%	$\leqslant$ 0,5%
Change of temperature	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 3%	$\leqslant$ 1%
	$\Delta V_{ab}/V_{ac}$	$\leqslant$ 1%	$\leqslant$ 0,5%
Bump and vibration	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 2%	$\leqslant$ 2%
	$\Delta V_{ab}/V_{ac}$	$\leqslant$ 1%	$\leqslant$ 1%

PP17 SERIES
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 comparitively 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 MΩ
carbon, logarithmic law	2200 Ω to 2,2 MΩ
cermet, linear law	220 Ω to 4,7 MΩ
Maximum dissipation at T_{amb} = 40 °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).

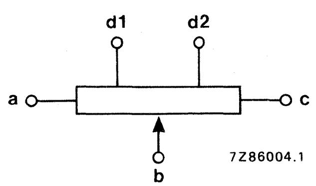
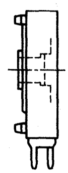
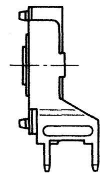
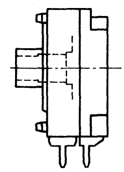
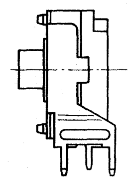


Fig. 1 Designation of terminals.

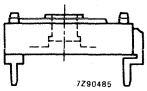
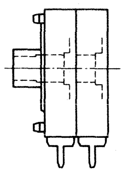
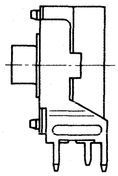
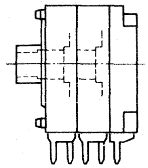
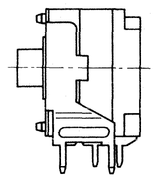
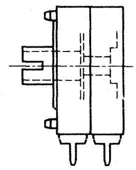
The carbon resistance element is a carbon track on a phenolic paper substrate; the cermet resistance element is Al_2O_3 substrate. The metallic multi-finger wiper is mounted in a plastic rotor.
Terminals are designated as shown in Fig. 1 in accordance with IEC 393-1, sub-clause 4.5.

SURVEY 1, VERSIONS WITHOUT SPINDLE

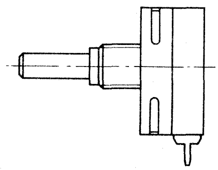
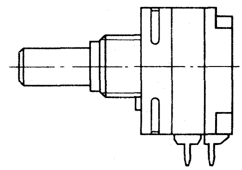
				single vertical			
version					 with bracket	 with battery switch	 with bracket and battery switch
page number				84	86	88	
rotor	flat, snap-in			●	●		
	protruding, snap-in			●	●	●	●
	flat, slotted			X (1)			
terminal configuration	in-line			●	●	●	●
	staggered			●	●	● tap version	X tap version
type of 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.

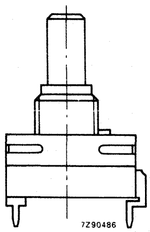
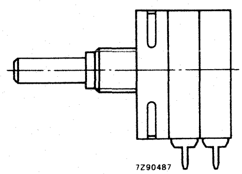
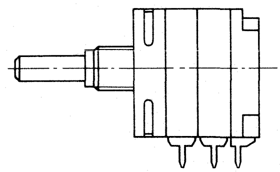
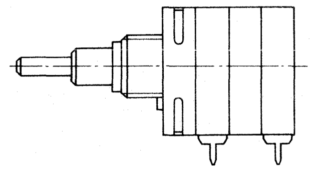
single horizontal	tandem vertical				dual vertical
 7Z90485		 with bracket	 with battery switch	 with bracket and battery switch	
90	92	94	96		98
●					
●	●	●	●	●	X
X (1)					
●	●	●	●	●	X
	●	●	● tap versions	X tap versions	X
	●	●	●	●	X
	X				X
	X				X
●					
	X	X			X
	X	X			X

SURVEY 2, VERSIONS WITH SPINDLE

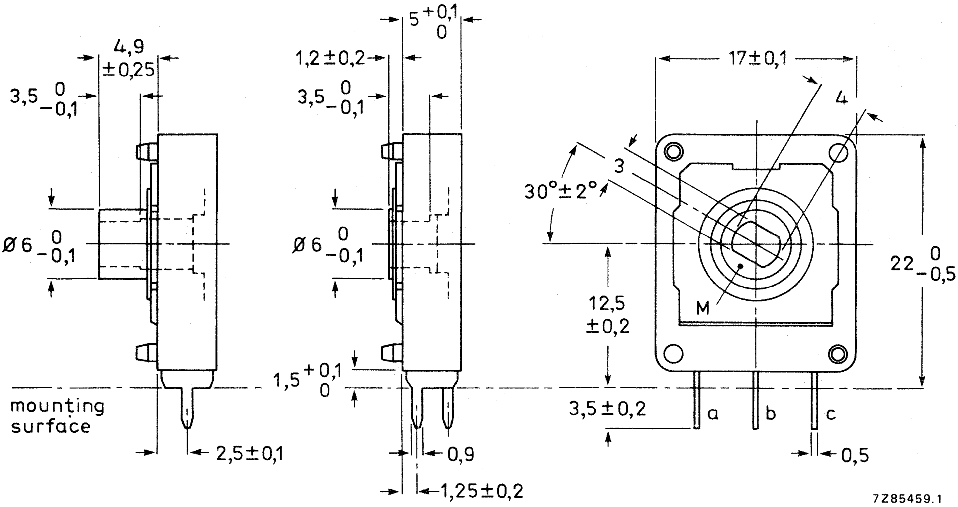
				single vertical	
version					 with battery switch
page number				100	103
bushing L = 8 mm (1)	M7	spindle dia. 4 mm	plastic	● (10)	● (10)
			metal	● (9)	● (9)
	M10	spindle dia. 6 mm	plastic	● (10)	● (10)
			metal	● (9)	● (9)
type of terminal (2)	vertical versions	spindle height	12,5 mm	●	●
			18,0 mm	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
		 with battery switch	
106	108	111	114
● (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



terminals in line, protruding rotor

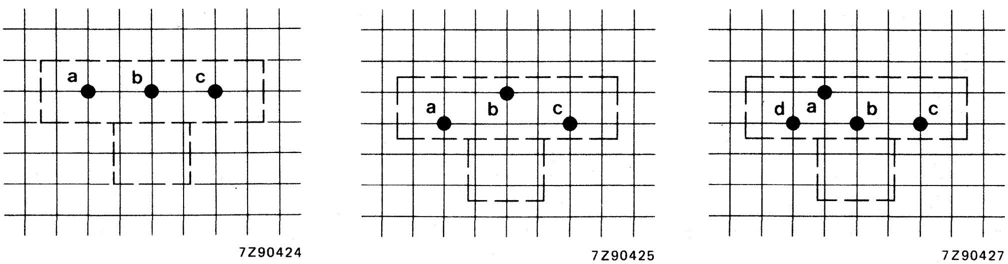
staggered terminals, flat rotor

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 ± 0,05 mm.



terminals in line

staggered terminals

with one tap

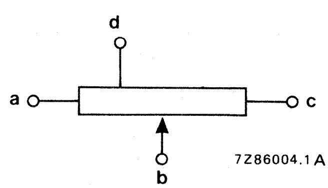


Fig.3 Version without spindle, single vertical: hole pattern and terminal designation.

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

2322 5.0 0. . . .

code for element
0 = carbon
1 = cermet

code for rotor
0 = protruding rotor
1 = flat rotor

resistance code

code for tags
0 = tags in-line
1 = tags staggered

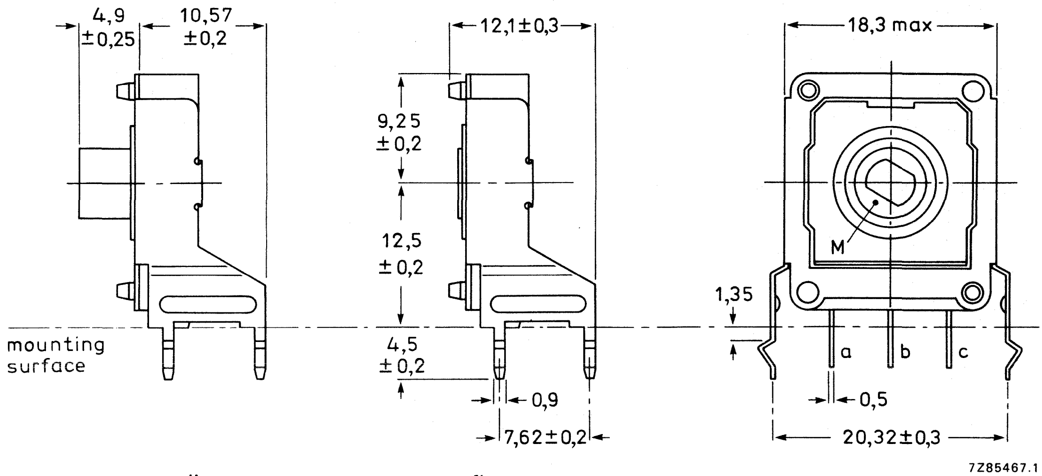
Table for R_{nom}

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



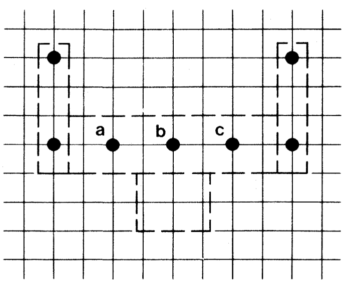
protruding rotor flat rotor

Rotor drawn at fully counter-clockwise position. M = mark for position of slider.

Fig.4 Version without spindle, single vertical with bracket.

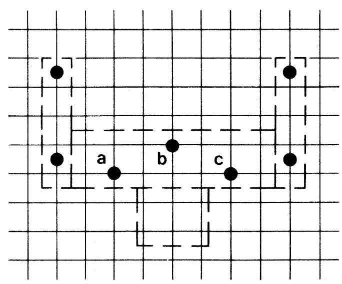
Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side. Hole diameter 1,3 ± 0,05 mm.



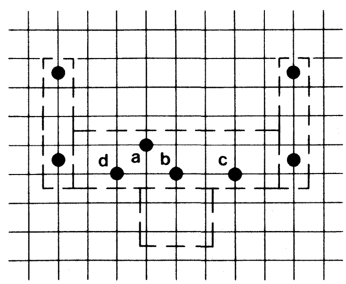
7Z90429

terminals in line



7Z90430

staggered terminals



7Z90432

with one tap

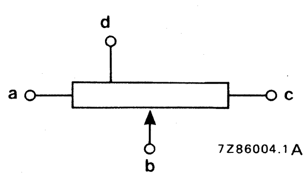


Fig.5 Version without spindle, single vertical with bracket: hole pattern and terminal designation.

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 °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

2322 5.0 0. . . .

code for element
0 = carbon
1 = cermet

code for rotor
2 = protruding rotor
3 = flat rotor

resistance code

code for tags
0 = tags in-line
1 = tags staggered

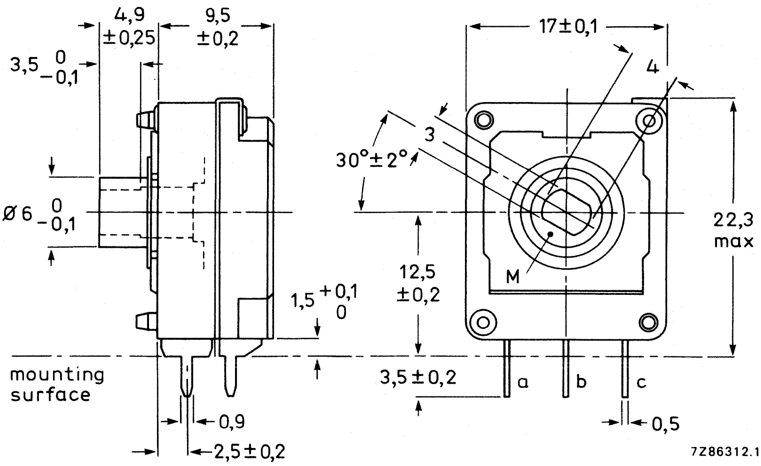
Table for R_{nom}

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

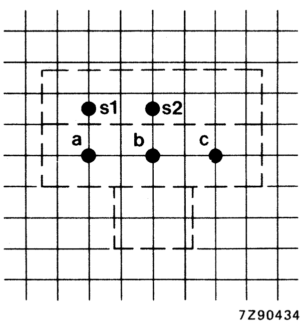


Rotor drawn at fully counter-clockwise position. M = mark for position of slider.

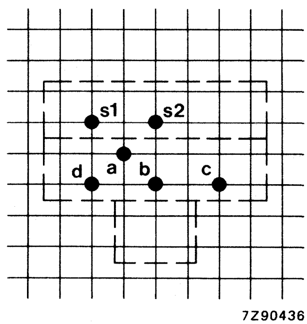
Fig.6 Version without spindle, single vertical with battery switch.

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

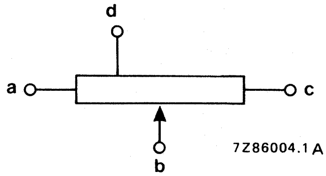


Fig.7 Version without spindle, single vertical with battery switch:
hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series	
carbon, linear (linarity 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, Mechanical Data and Battery Switch.

Composition of the catalogue number, PP17 without spindle, single, vertical with switch

2322 5.0 100 . .

code for element
0 = carbon
1 = cermet

resistance code

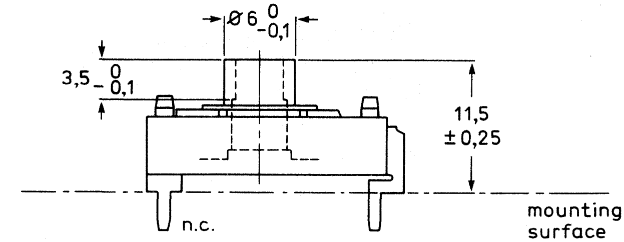
Table for R_{nom}

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	–	–	–

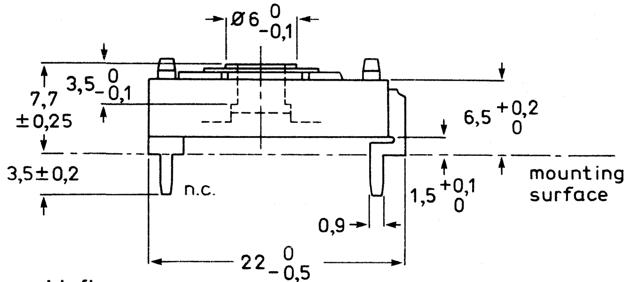
* carbon only.

Catalogue numbers for other versions on request.

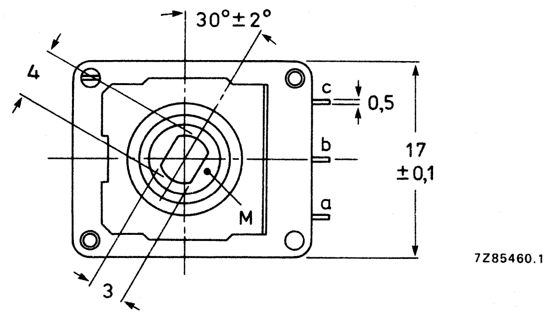
VERSION WITHOUT SPINDLE, SINGLE HORIZONTAL



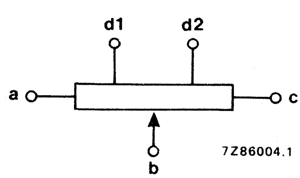
with protruding rotor



with flat rotor



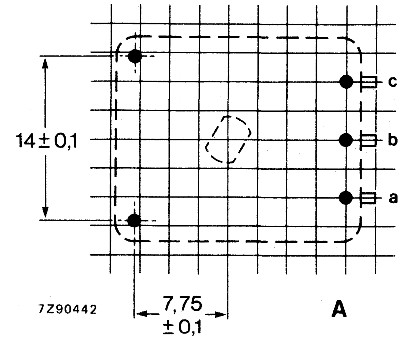
Rotor drawn at fully counter-clockwise position.
M = mark for position of slider.



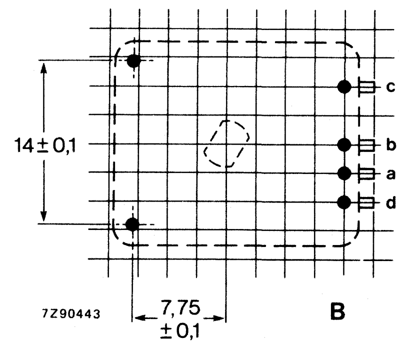
designation of terminals

Hole patterns

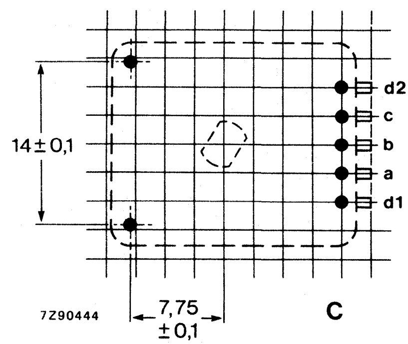
For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side. Hole dia. 1,3 ± 0,05 mm.



no tap



one tap



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

2322 5.0 0.5. .

code for element
0 = carbon
1 = cermet

code for rotor
0 = protruding rotor
1 = flat rotor

resistance code

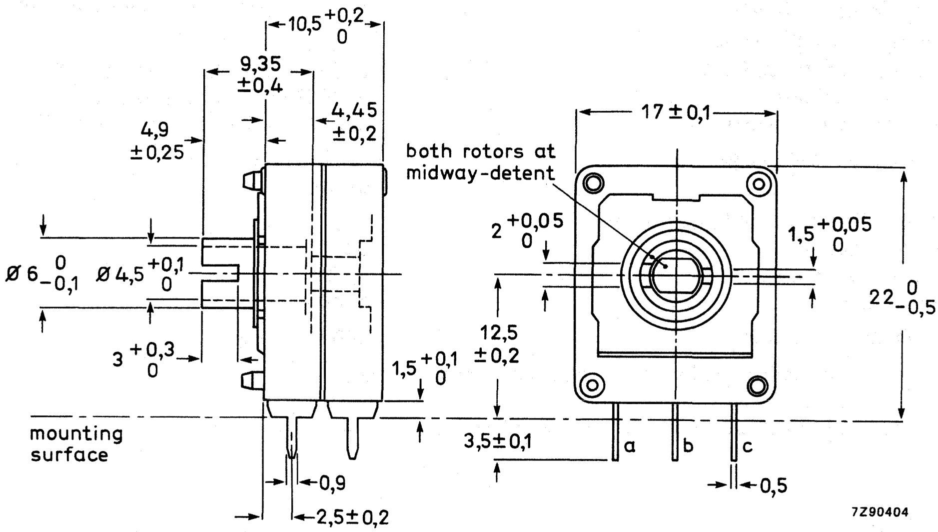
Table for R_{nom}

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



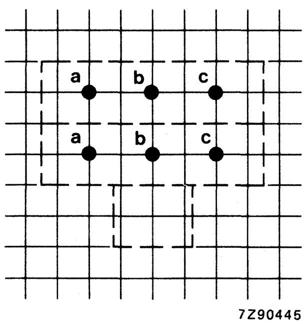
Both rotors at mid-position.

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 ± 0,05 mm.

Dual potentiometers with tap on request.



terminals in line

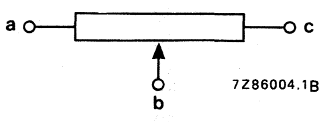


Fig.10 Version without spindle, dual vertical: hole pattern and terminal designation.

Main properties

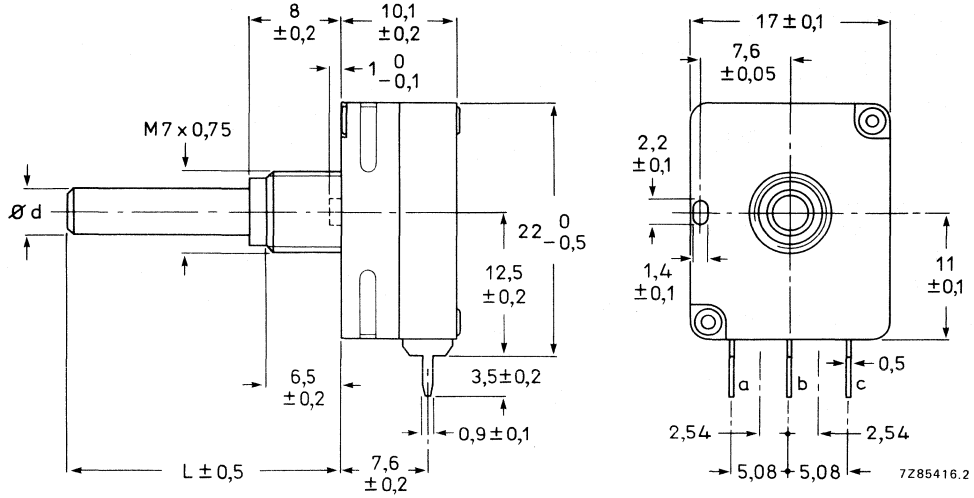
Climatic category (IEC 68)	carbon 25/070/10, cermet 25/070/56
Resistance range, E3 series	
carbon, linear (independent linearity 4%)	220 Ω to 2,2 MΩ, tolerance 20%
carbon, non-linear	2200 Ω to 2,2 MΩ, tolerance 20%
cermet, linear (independent linearity 4%)	220 Ω to 4,7 MΩ, tolerance 10%
Resistance law (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
Test voltage for 1 minute	500 V, 50 Hz

For further information see Electrical Data and Mechanical Data.

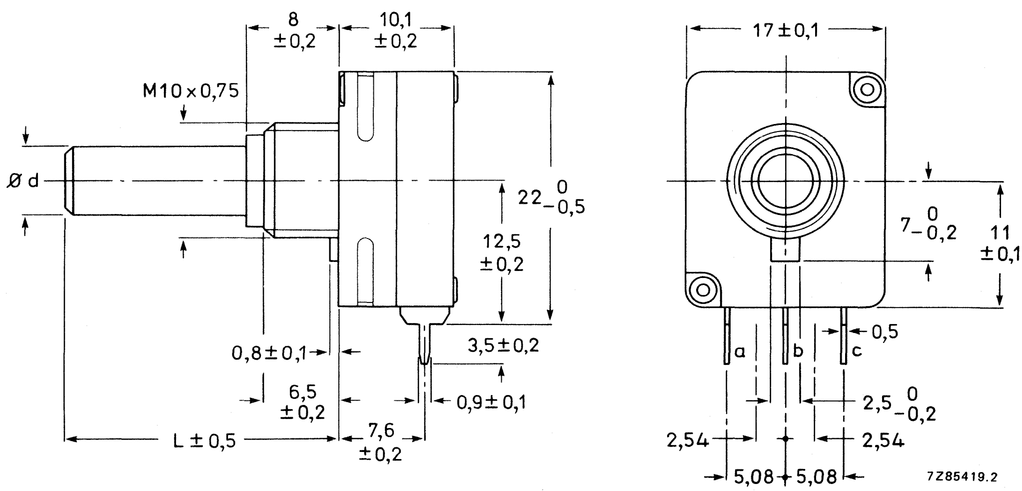
Catalogue number

On request.

VERSION WITH SPINDLE, SINGLE VERTICAL



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.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 ± 0,05 mm.

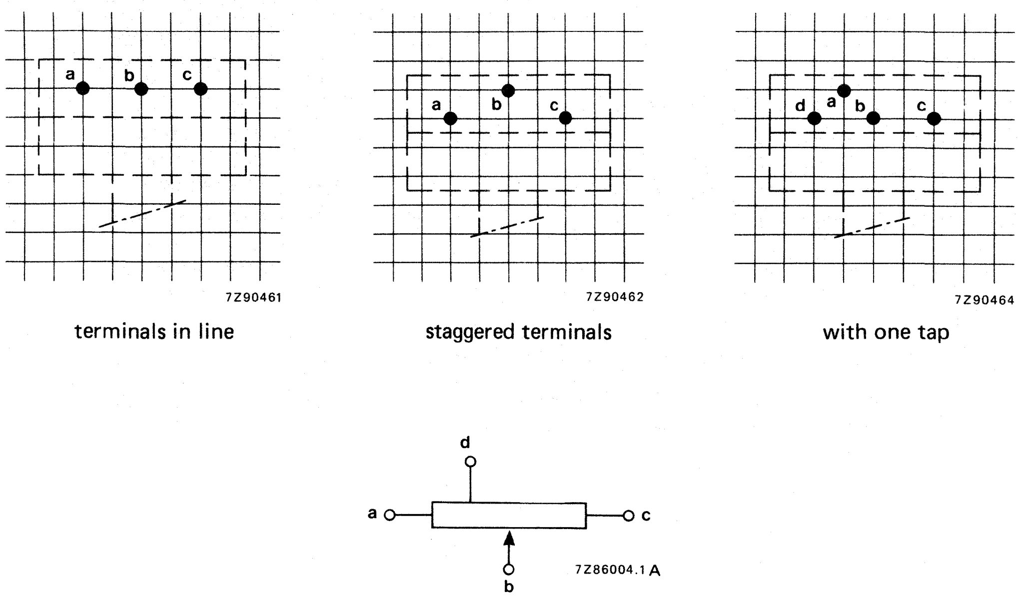


Fig. 12 Version with spindle, single vertical: hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)	metal spindle	carbon 25/070/10, cermet 40/125/56
	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 W
carbon, non-linear		0,1 W
cermet, linear		2 W metal spindle, 1 W plastic spindle
cermet, with heatsink		3 W metal spindle, 2 W plastic spindle
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 with spindle, single, vertical

2322 5.1 0. . . .

code for element
0 = carbon
1 = cermet

code for bushing; spindle dia. and material
0 = M10; dia. 6, plastic
→ 2 = M7; dia. 4, plastic
5 = M10; dia. 6, metal
7 = M7; dia. 4, metal

recommended spindles

resistance code

code for configuration of tags; spindle length and type
0 = in-line; 20, plain
1 = in-line; 30, plain
2 = in-line; 20, flat
3 = in-line; 30, flat
5 = staggered; 20, plain
6 = staggered; 30, plain
7 = staggered; 20, flat
8 = staggered; 30, flat

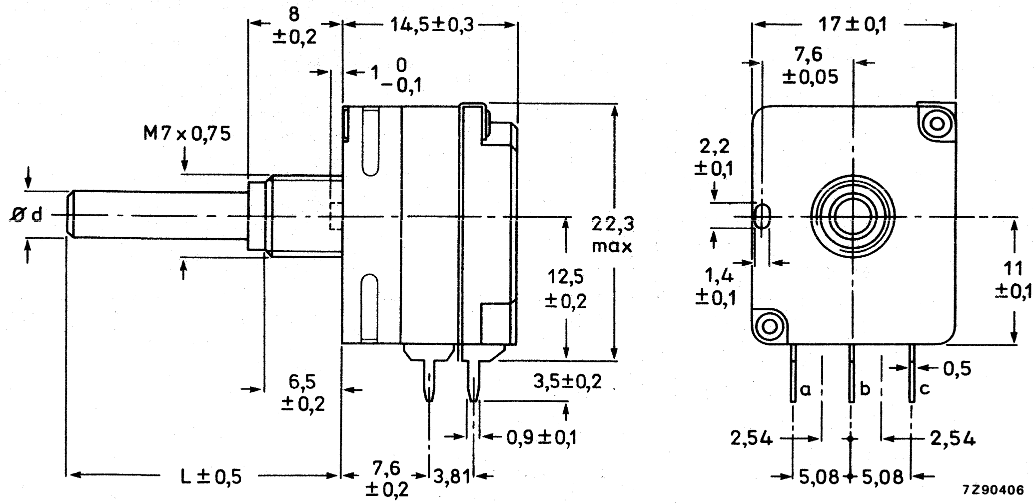
Table for R_{nom}

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	–	–	–

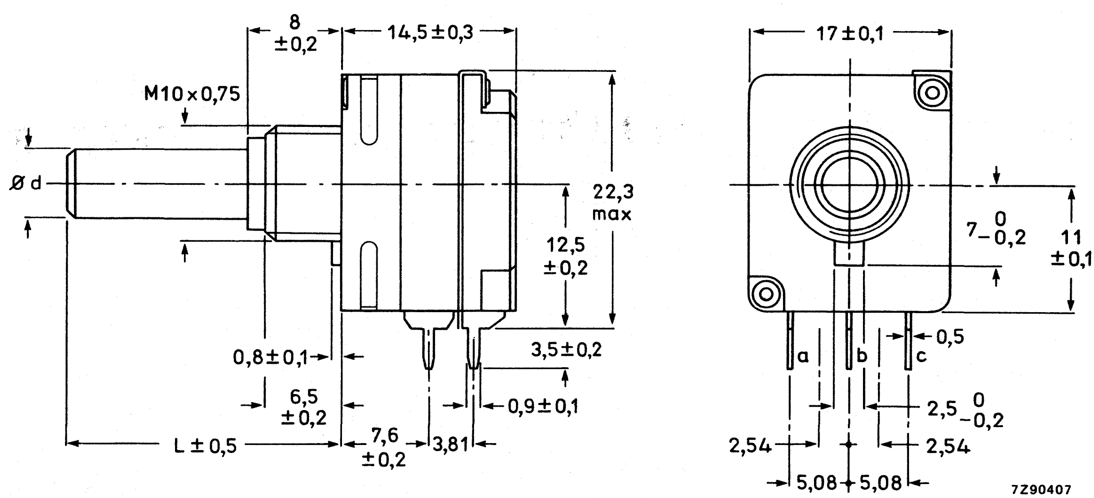
* carbon only.

Catalogue numbers for other versions on request.

VERSION WITH SPINDLE, SINGLE VERTICAL WITH BATTERY SWITCH



with mounting bush M7 x 0,75 mm.



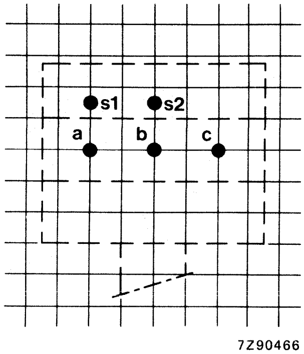
with mounting bush M10 x 0,75 mm.

For dimensions d and L see under Spindles. For other terminals see Fig.34.

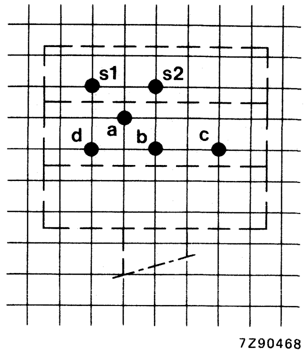
Fig.13 Version with spindle, single vertical with battery switch.

Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side.
Hole diameter 1,3 ± 0,05 mm.



without tap



with one tap

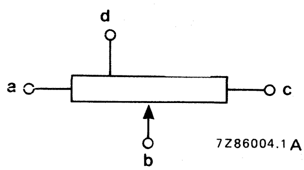


Fig.14 Version with spindle, single vertical with battery switch: hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)	metal spindle	carbon 25/070/10, cermet 40/125/56
	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 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

2322 5.1 1. . . .

code for element
0 = carbon
1 = cermet

code for bushing; spindle dia. and material
0 = M10; dia. 6, plastic
2 = M7; dia. 4, plastic
5 = M10; dia. 6, metal } recommended
7 = M7, dia. 4, metal } spindles

resistance code

code for configuration of tags; spindle length and type
0 = in-line; 20, plain
1 = in-line; 30, plain
2 = in-line; 20, flat
3 = in-line; 30, flat

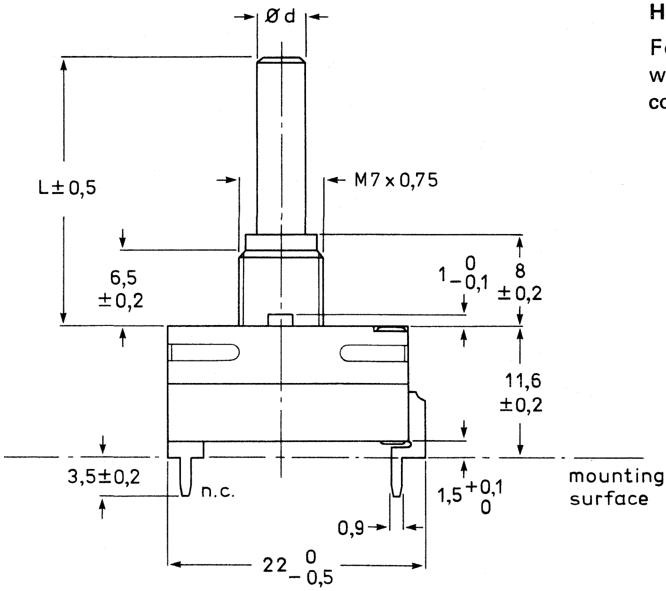
Table for R_{nom}

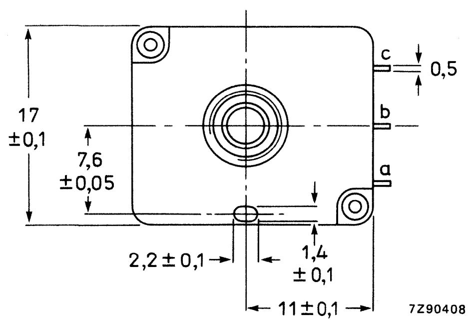
R \ law	linear	logarithmic*	rev. logarithmic*	log. with tap*
220 Ω	02	–	–	–
470 Ω	03	–	–	–
1 kΩ	04	–	–	–
2,2 kΩ	05	25	45	–
4,7 kΩ	06	26	46	–
10 kΩ	07	27	47	–
22 kΩ	08	28	48	–
47 kΩ	09	29	49	–
100 kΩ	11	31	51	–
220 kΩ	12	32	52	–
470 kΩ	13	33	53	–
1 MΩ	14	34	–	–
2,2 MΩ	15	35	–	–
4,7 MΩ	16	–	–	–

* carbon only.

Catalogue numbers for other versions on request.

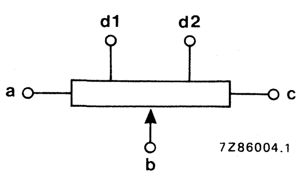
VERSION WITH SPINDLE, SINGLE HORIZONTAL





with mounting bush M7 x 0,75 mm.

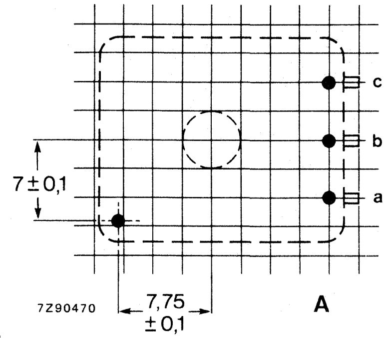
For dimensions d and L see under Spindles.



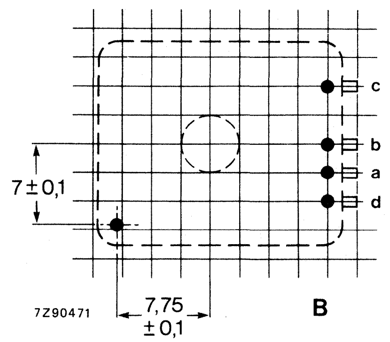
designation of terminals

Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side. Hole dia. 1,3 ± 0,05 mm.



no tap



one tap

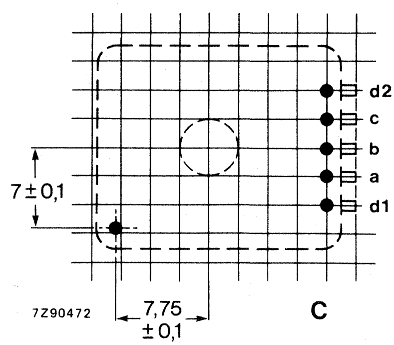
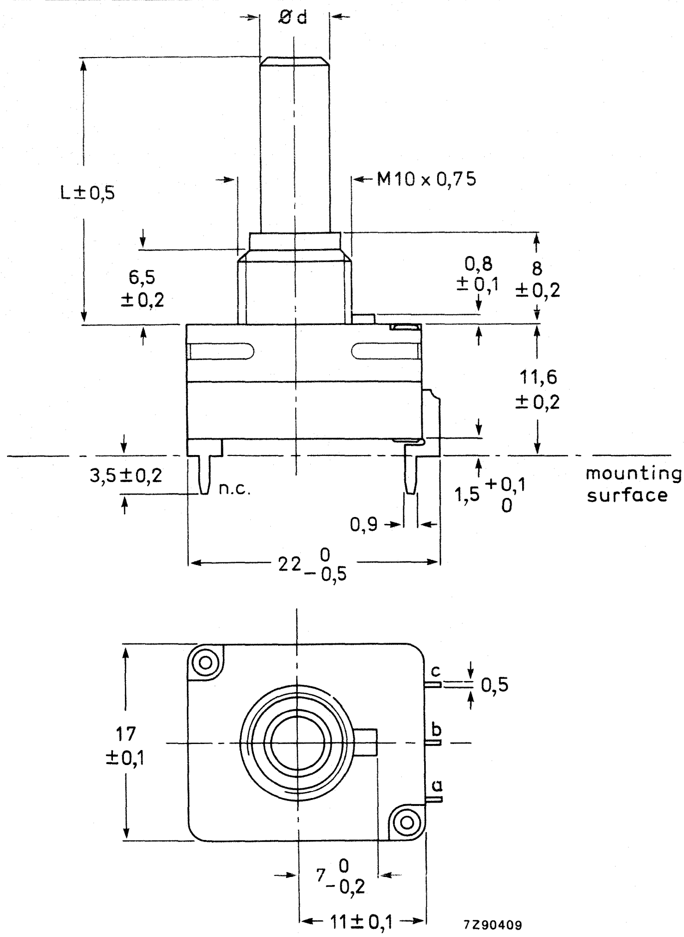


Fig. 15 Version with spindle, single horizontal.

two taps



with mounting bush M10 x 0,75 mm.

Fig.15 Version with spindle, single horizontal (continued).

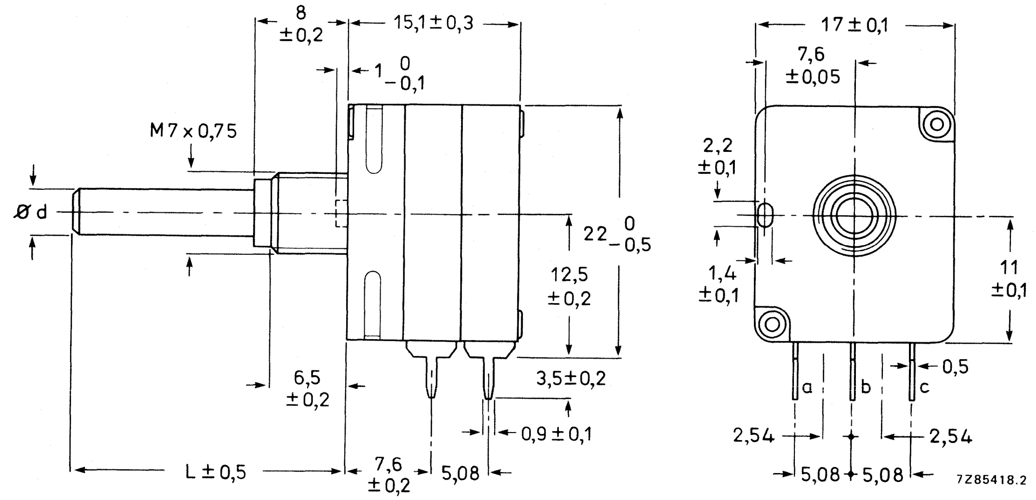
Main properties

Climatic category	metal spindle	carbon 25/070/10, cermet 40/125/56
	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 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

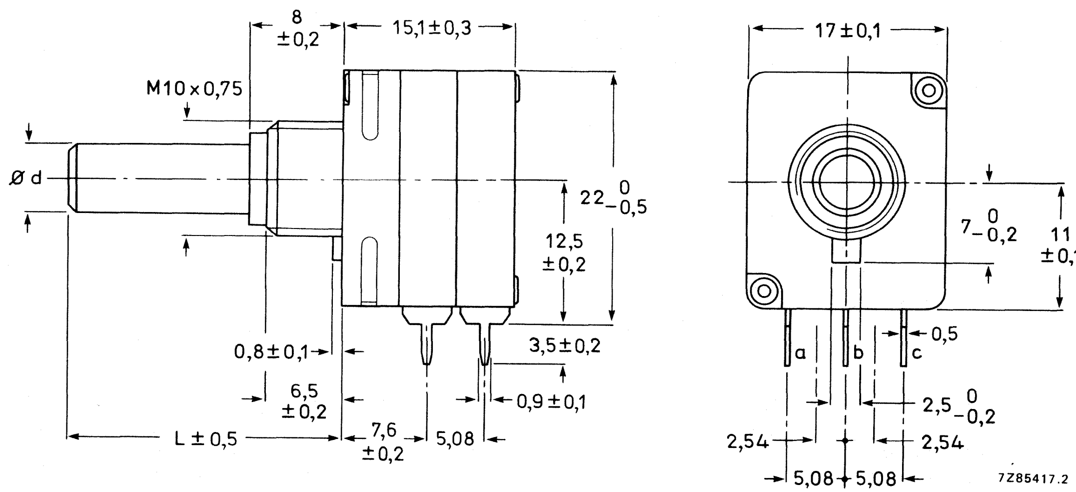
For further information see Electrical Data and Mechanical Data.

Catalogue numbers: On request.

VERSIONS WITH SPINDLE, TANDEM VERTICAL



with mounting bush M7 x 0,75 mm.



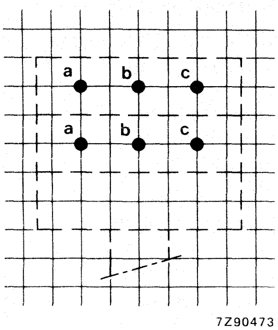
with mounting bush M10 x 0,75 mm.

For dimensions d and L see under Spindles.

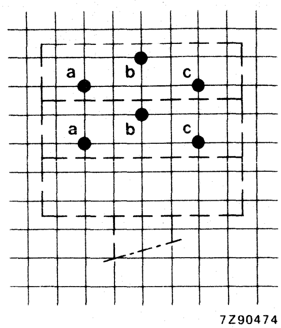
Fig.16 Version with spindle, tandem vertical.

Hole patterns

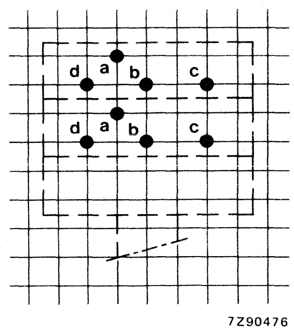
For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side.
Hole diameter 1,3 ± 0,05 mm.



terminals in line



staggered terminals



with one tap

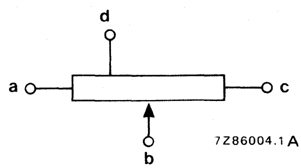


Fig.17 Version with spindle, tandem vertical: hole pattern and terminal designation.

Main properties

Climatic category (IEC 68)	metal spindle	carbon 25/070/10, cermet 40/125/56
	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 ^{o}C		
carbon, linear		0,2 + 0,2 W
carbon, non-linear		0,1 + 0,1 W
cermet, linear		1,25 + 1,25 W } metal 1 + 1 W } plastic
cermet, with heatsink		2 + 2 W } 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

2322 5.2 0. . . .

code for element
0 = carbon
1 = cermet

code for bushing; spindle dia. and material
0 = M10; dia. 6, plastic
2 = M7; dia. 4, plastic
5 = M10; dia. 6, metal } recommended spindles
7 = M7; dia. 4, metal }

resistance code

code for configuration of tags; spindle length and type
0 = in-line; 20, plain
1 = in-line; 30, plain
2 = in-line; 20, flat
3 = in-line; 30, flat
5 = staggered; 20, plain
6 = staggered; 30, plain
7 = staggered; 20, flat
8 = staggered; 30, flat

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

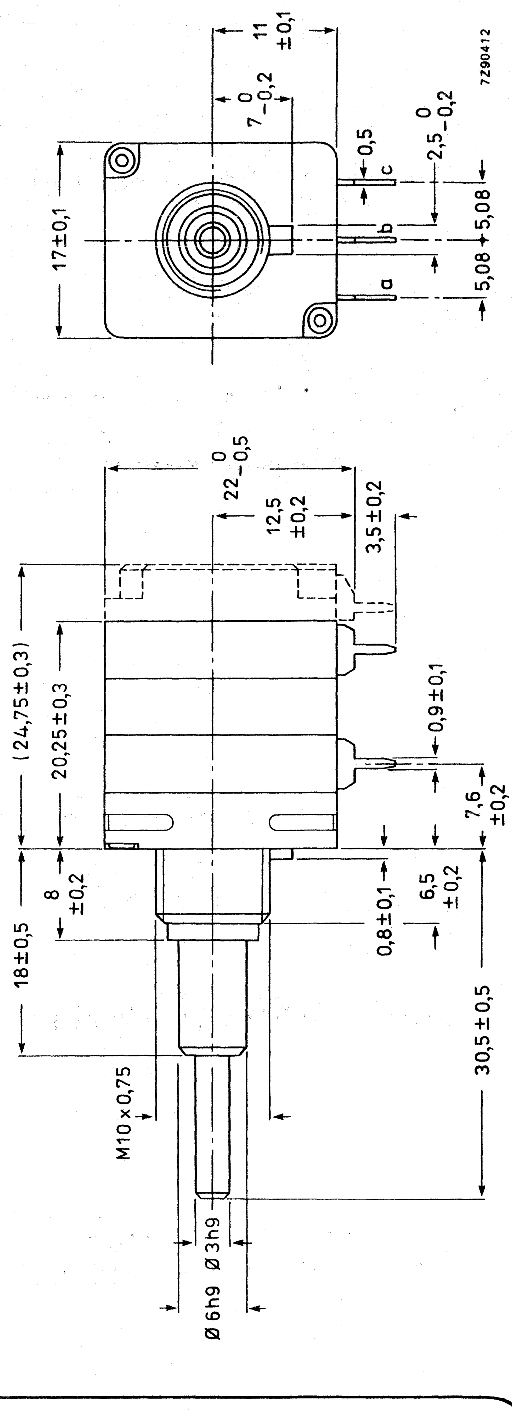
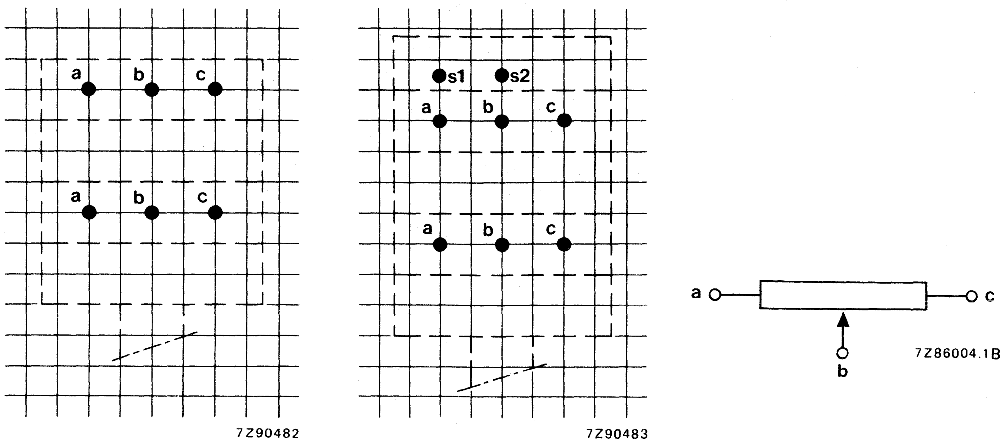


Fig.18 Version with spindle, dual vertical.

Hole patterns

For connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side.
Hole diameter 1,3 ± 0,05 mm.



without switch — 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 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 (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

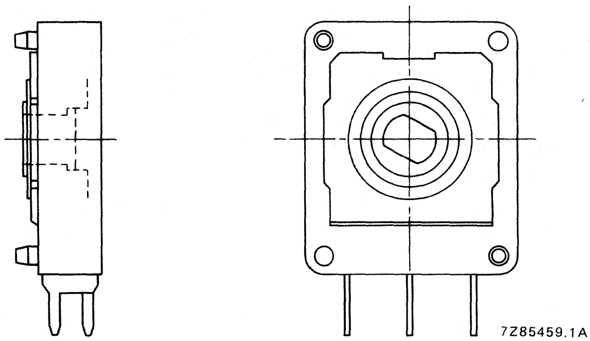


Fig.20 Flat rotor, snap-in type.

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

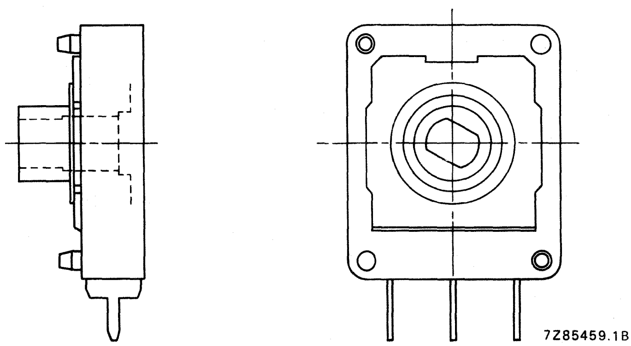


Fig.21 Protruding rotor, snap-in type.

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.

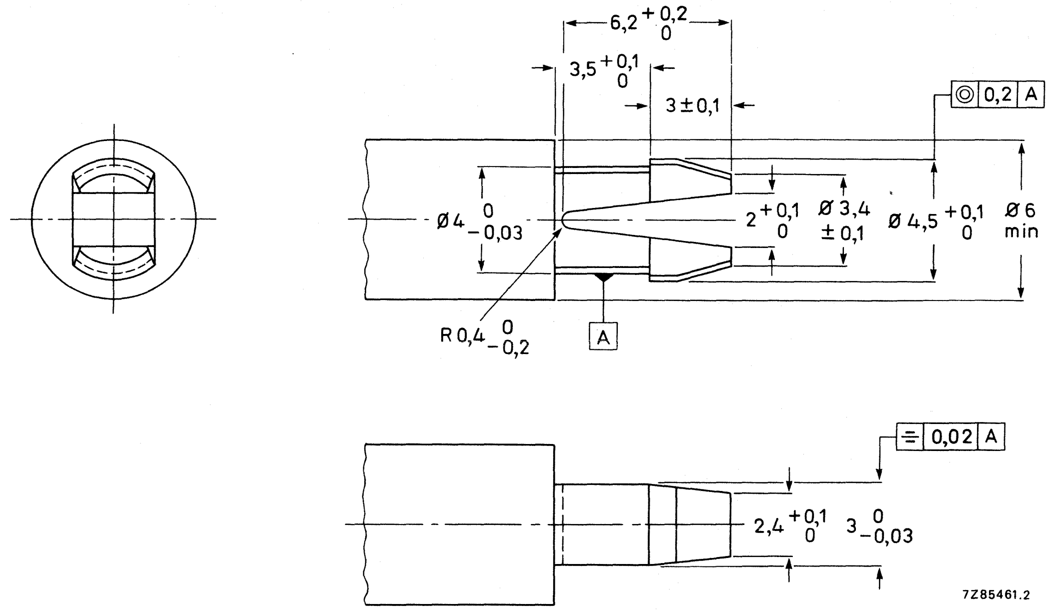


Fig.22 Actuating device.

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.

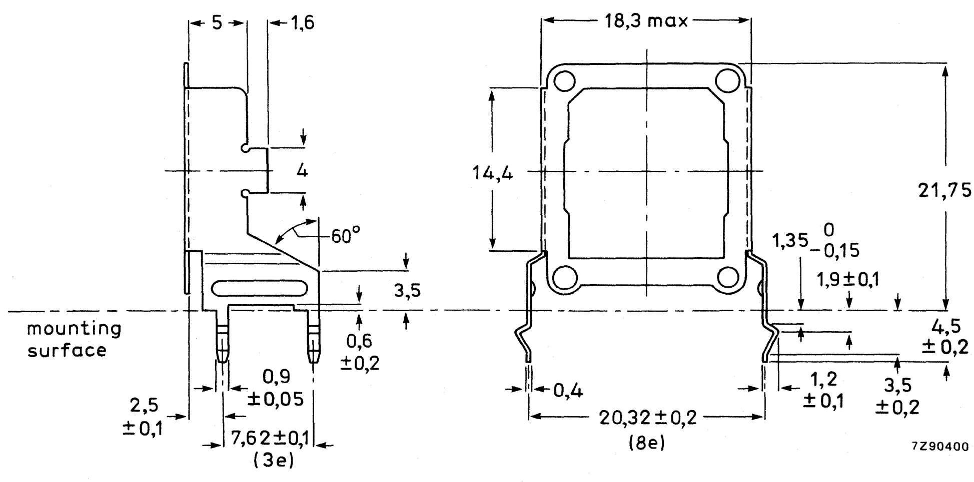


Fig.23 Mounting bracket.

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

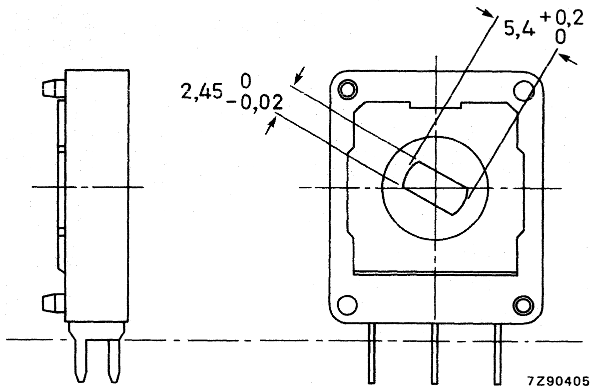


Fig.24 Flat rotor, slotted type.

Detents

A detent spring can be mounted in the bearing bush of the spindle to provide the potentiometer with a centre detent. More detents on request.

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.

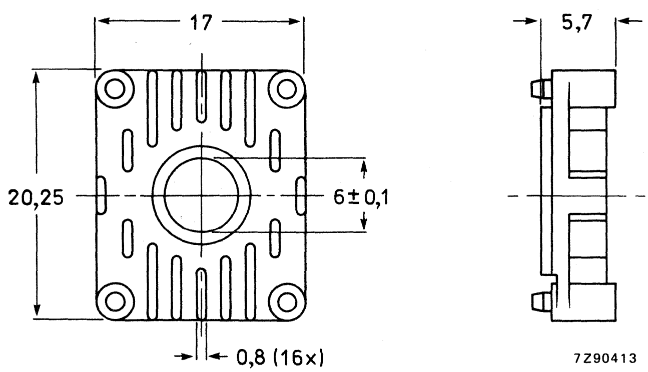
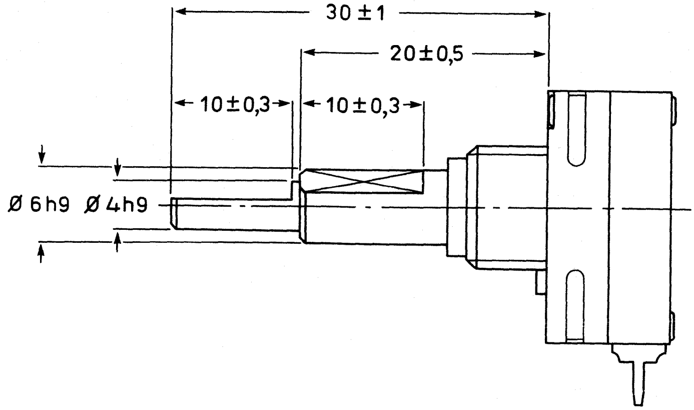


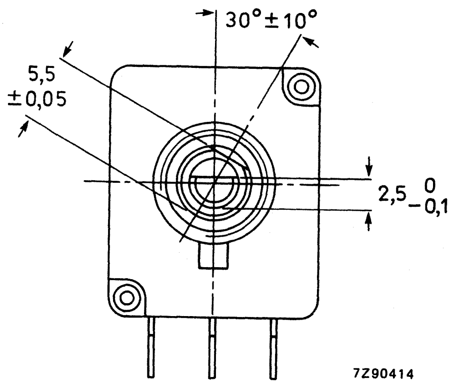
Fig.25 Heatsink.

Slow-motion drive

For fine adjustment. Gear ratio 4,6 : 1 and 7 : 1. (Other spindles on request.)



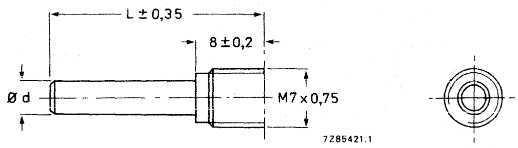
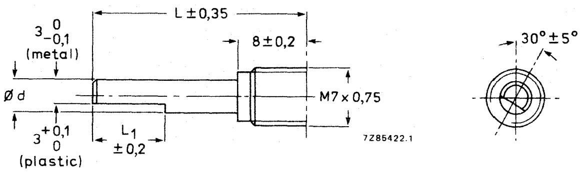
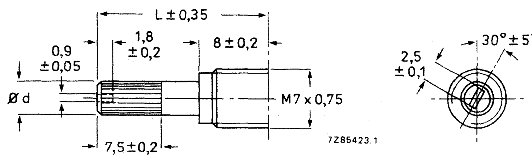
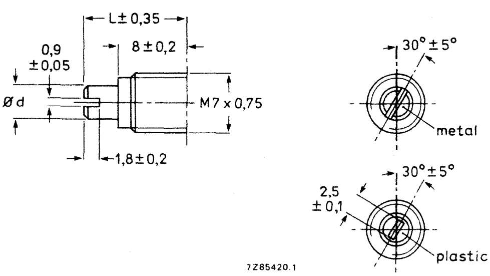
side view



front view

Fig.26 Slow-motion drive.

Spindles, metal or plastic, M7 bushing

	CCW position	L mm	L_1 mm	d metal	d plastic
 Fig.27a.		15		4h9	$4^{0}_{-0,1}$
		20		*4h9	*$4^{0}_{-0,1}$
		25		4h9	$4^{0}_{-0,1}$
		30		*4h9	*$4^{0}_{-0,1}$
 Fig.27b.		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	*$4^{0}_{-0,1}$
 Fig.27c.		20			$4^{0}_{-0,1}$
 Fig.27d.		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

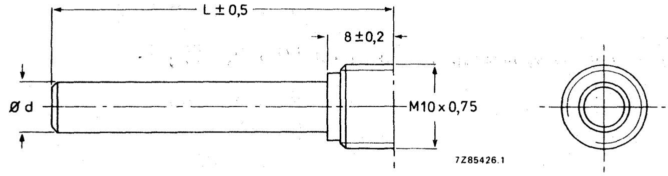


Fig.28a.

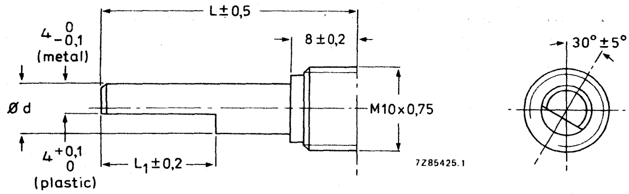


Fig.28b.

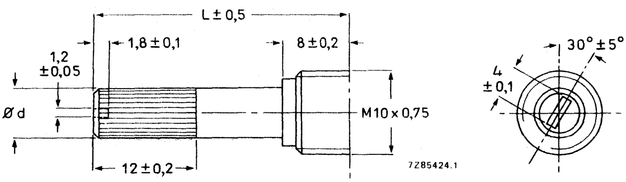


Fig.28c.

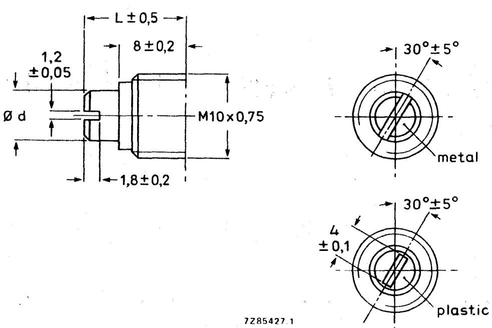
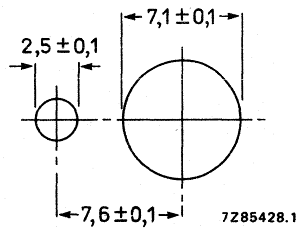
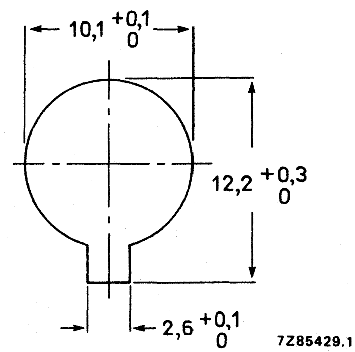


Fig.28d.

	L mm	L_1 mm	d metal	d plastic
Fig.28a.	20		*6h9	*$6^{\,0}_{-0,1}$
	30		*6h9	*$6^{\,0}_{-0,1}$
	40		6h9	$6^{\,0}_{-0,1}$
	60		6h9	$6^{\,0}_{-0,1}$
Fig.28b.	20	7,5	*6h9	*$6^{\,0}_{-0,1}$
	30	13,5	*6h9	*$6^{\,0}_{-0,1}$
	60	13,5	6h9	$6^{\,0}_{-0,1}$
Fig.28c.	30			$6^{\,0}_{-0,1}$
Fig.28d.	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

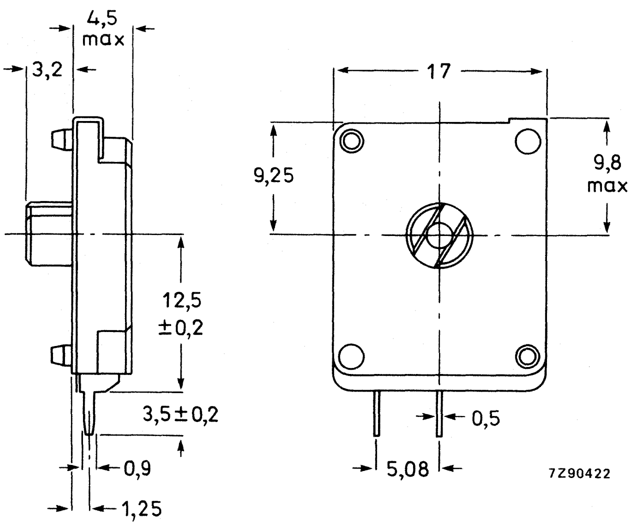


Fig.31 Battery switch (s.p.s.t.).

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).

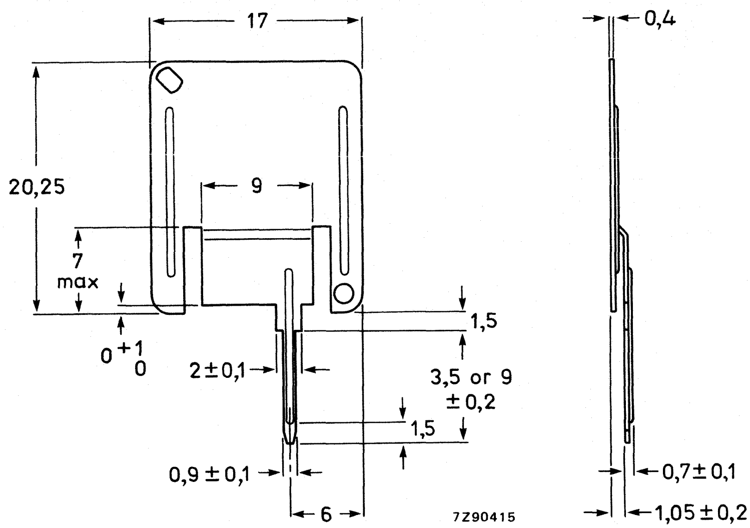


Fig.32 Metal shield.

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.

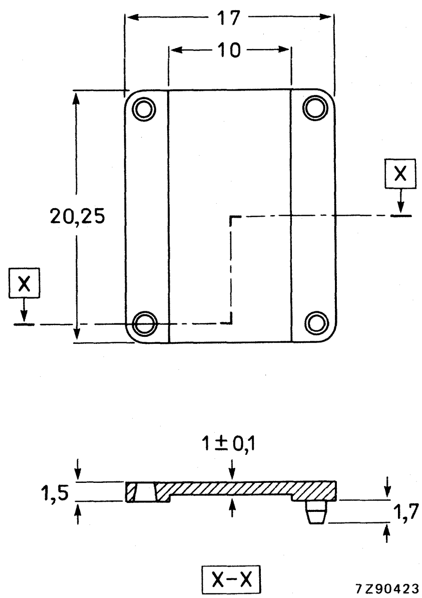


Fig.33 Plastic cover.

Terminals

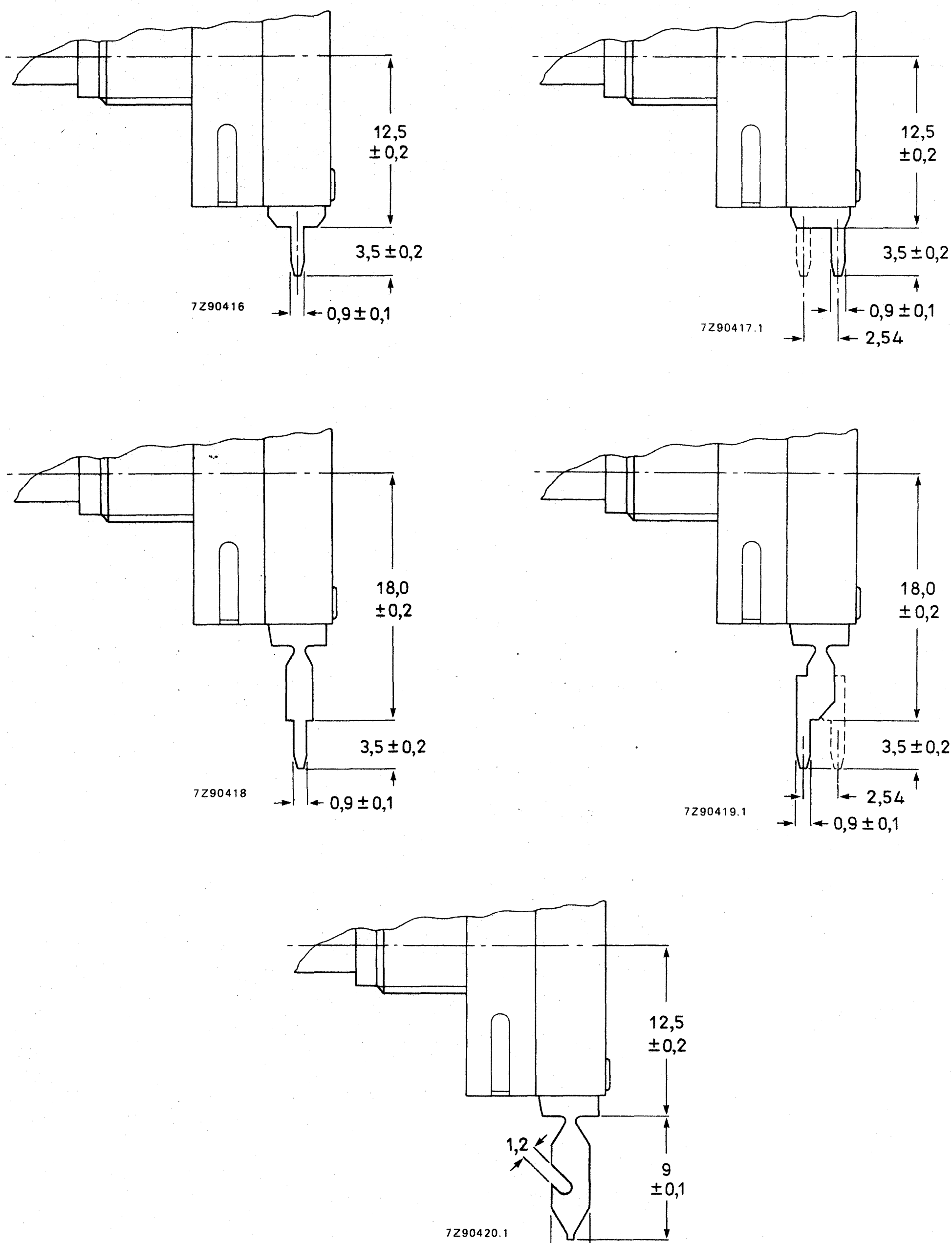


Fig.34 Terminals.

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)	standard	special	
linear law			
at values between 10 and 90% of R_{ac}	< 2 dB		
(reversed) logarithmic law			
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	$\pm 500 \times 10^{-6}$/K		$\pm 100 \times 10^{-6}$
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)

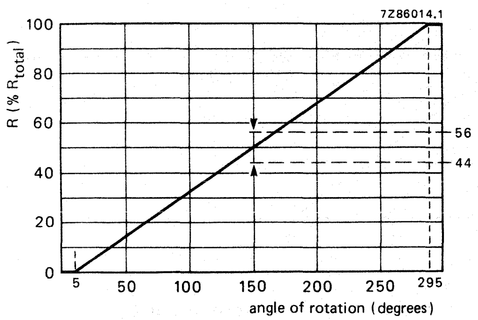
	carbon	cermet
Maximum attenuation		
R_{ac} ⩾ 22 kΩ, logarithmic law	⩾ 90 dB	
R_{ac} < 22 kΩ, logarithmic law	⩾ 75 dB	
R_{ac} < 22 kΩ, linear law	⩾ 55 dB	⩾ 60 dB
Maximum dissipation at T_{amb} = 40 °C (P_{max})*		
linear law	0,2 W	1,25 W **
logarithmic law	0,1 W	
linear law, using a heatsink		3 W **
Test voltage for 1 minute	500 V, 50 Hz	500 V, 50 Hz
with cover	1000 V, 50 Hz	1000 V, 50 Hz
Working temperature range		
versions without spindle	−25 to + 70 °C	−25 to + 70 °C
versions with spindle	−25 to + 70 °C	−40 to + 125 °C
Storage temperature range		
without switch, versions without spindle	−55 to + 100 °C	−55 to + 100 °C
without switch, versions with spindle		−55 to + 125 °C
with switch	−40 to + 85 °C	
Climatic category (IEC 68)		
versions without spindle	25/070/10	25/070/56
→ versions with metal spindle	25/070/10	40/100/56
versions with plastic spindle	25/070/10	26/070/56

ENVIRONMENTAL TESTS

tests	requirements		
		carbon	cermet
Climatic sequence	$\Delta R_{ac}/R_{ac}$	⩽ 10%	⩽ 2%
Damp heat, steady state			
R ⩽ 100 kΩ	$\Delta R_{ac}/R_{ac}$	⩽ 15%	⩽ 2%
R > 100 kΩ		⩽ 20%	⩽ 2%
Mechanical endurance 25 000 cycles	$\Delta R_{ac}/R_{ac}$	⩽ 10%	⩽ 2%
Electrical endurance 1000 h at 70 °C, cyclic	$\Delta R_{ac}/R_{ac}$	⩽ 10%	⩽ 2%
Resistance to soldering heat (IEC 68-2, test T)	$\Delta R_{ac}/R_{ac}$	⩽ 2%	⩽ 1%
Change of temperature	$\Delta R_{ac}/R_{ac}$	⩽ 3%	⩽ 1%
	$\Delta V_{ab}/V_{ac}$	⩽ 1%	⩽ 0,5%
Bump and vibration	$\Delta R_{ac}/R_{ac}$	⩽ 2%	⩽ 0,5%
	$\Delta V_{ab}/V_{ac}$	⩽ 1%	⩽ 0,5%

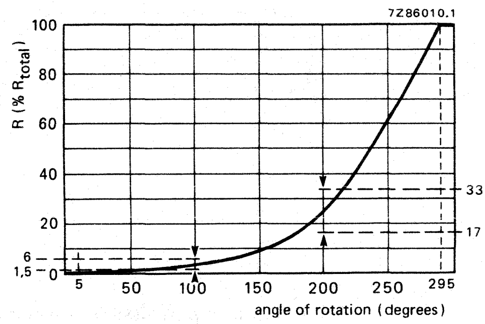
* For derating see Fig.36.
** For versions with metal spindle. The max. dissipation of cermet types with plastic spindle is 1 W (lin. law) and 2 W (lin. law with heatsink).

Characteristics of potentiometers without switch



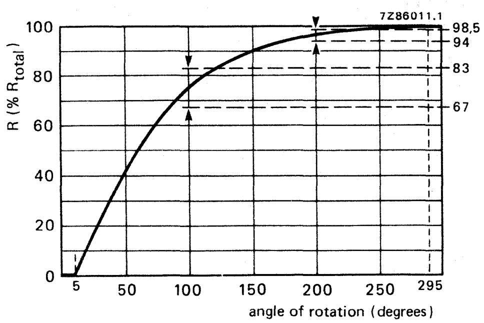
Type A

Fig.35a Linear law.



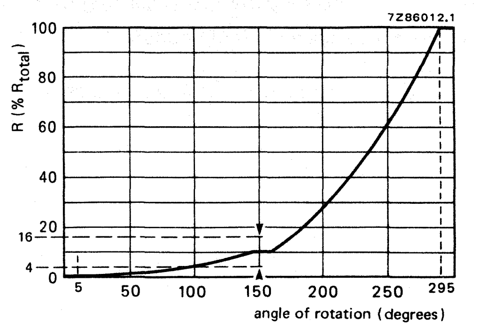
Type B

Fig.35b Logarithmic law.



Type C

Fig.35c Reversed logarithmic law.

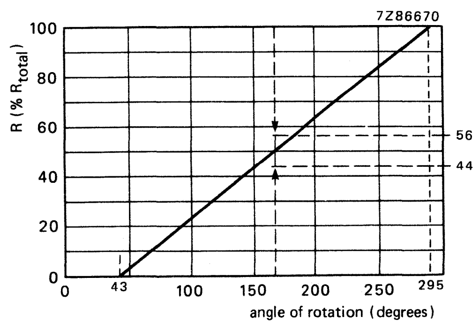


Type H

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.

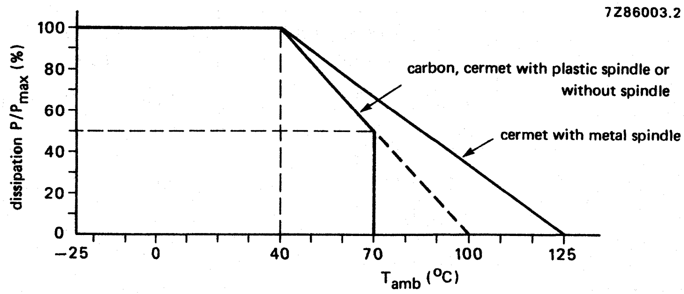


Fig.36 Maximum permissible dissipation as a function of ambient temperature.

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		
	single duo	tandem	single duo	tandem	unit
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	600	600	4ϕ: 600 6ϕ: 800	4ϕ: 600 6ϕ: 800	mNm 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

1. Types without switch
   total mechanical angle — 0° to 300°
   effective R-angle — 5° to 295°
   For performance see Fig.37a
2. Types with switch
   total mechanical angle — 0° to 300°
   O to A; radial spindle play in "off" position (c.c.w.) — 10° max.
   O to B; switch angle — 43° max.
   B to C; effective R-angle — 43° to 295°
   For performance see Fig.37b

a

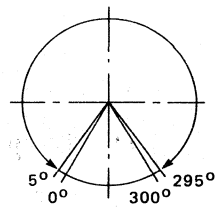


Fig.37a.

b

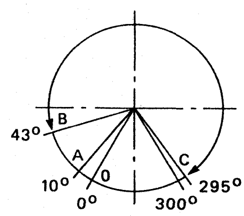


Fig.37b.

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 MΩ
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.

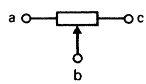


Fig. 1.

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.

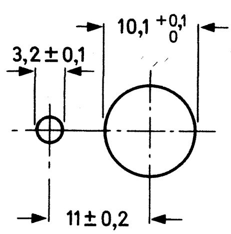


Fig. 2.

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.

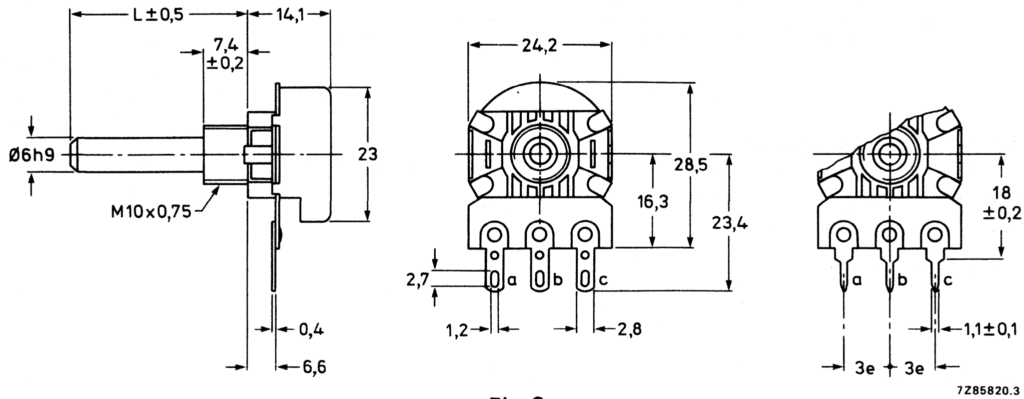


Fig. 3.

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	$\sqrt{P_{max} \cdot R_{nom}}$
Insulation resistance after damp heat test IEC 68, c 56 days	$\geq 10^5$ MΩ
Temperature coefficient	$\leq 100 \cdot 10^{-6}$/K
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. $\leq$ 2)	3 to 20 mNm
Permissible end-stop torque	$\leq$ 800 mNm
Permissible axial spindle load	$\leq$ 100 N
Effective angle of rotation	270° ± 2°
Mechanical angle of rotation	300° ± 5°
Rotation life	25 000 cycles

RESISTANCE

Potentiometers covered by this specification are linear, see Fig. 4.

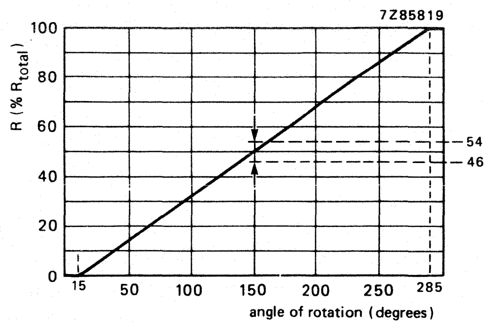


Fig. 4.

DERATING

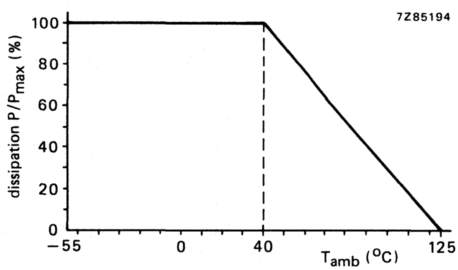


Fig. 5.

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 kΩ	04	54
2.2 kΩ	05	55
4.7 kΩ	06	56
10 kΩ	07	57
22 kΩ	08	58
47 kΩ	09	59
100 kΩ	11	61
220 kΩ	12	62
470 kΩ	13	63
1 MΩ	14	64
2.2 MΩ	15	65
47 MΩ	16	66
10 MΩ	17	67
22 MΩ	18	68

Note

E6 values available on request.

ENVIRONMENTAL TESTS

tests	requirements	
Climatic sequence	$\Delta R_{ac}/R_{ac}$	$\leqslant 2\%$
Damp heat, steady state	$\Delta R_{ac}/R_{ac}$	$\leqslant 2\%$
Mechanical endurance 25 000 cycles	$\Delta R_{ac}/R_{ac}$	$\leqslant 2\%$
CRV (contact resistance variation)		
initial	CRV	$\leqslant 1.5\%$
after 25 000 cycles	CRV	$\leqslant 1.5\%$
Electrical endurance 1000 h at 70 °C, cyclic	$\Delta R_{ac}/R_{ac}$	$\leqslant 2\%$
Resistance to soldering heat (IEC 68-2, test T)	$\Delta R_{ac}/R_{ac}$	$\leqslant 0.5\%$
Change of temperature	$\Delta R_{ac}/R_{ac}$	$\leqslant 1\%$
	$\Delta V_{ab}/V_{ac}$	$\leqslant 0.5\%$
Bump and vibration	$\Delta R_{ac}/R_{ac}$	$\leqslant 0.5\%$

PACKAGING

50 items per box.

25mm CARBON SLIDE CONTROL

QUICK REFERENCE DATA

Nominal resistance, E3 series	
linear law	470 Ω – 1 MΩ
logarithmic law	2,2 kΩ – 470 kΩ
Maximum dissipation at 40 °C	
linear law	0,2 W
logarithmic law	0,1 W
Climatic category, IEC 68	25/070/21

APPLICATION

These potentiometers are particularly suitable for audio, television, monitors and semi-industrial applications.

DESCRIPTION

A straight carbon track is fitted on to a base plate of resin bonded paper, which is mounted in a housing of black synthetic resin.
The slider contact is adjusted by means of a knob, which moves along a silvered spindle. Two types of slider knob are available. The potentiometers are available with linear or logarithmic resistance law.
The elements are provided with an external screening shield which is either black coated (shield without printed-wiring tags) or tin plated (shield with printed-wiring tags).

The terminals a and c (see Fig. 1) are the end terminals; b is the central terminal connected to the slider. All terminals are suited for mounting on printed-wiring boards.

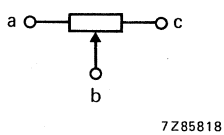


Fig. 1 Terminal allocations.

Outlines

Dimensions in mm

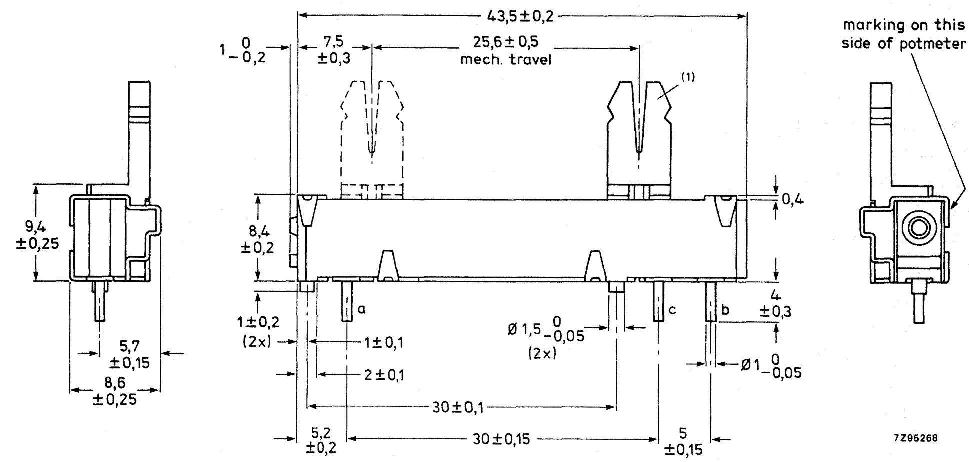


Fig.2 Version with black coated shield without p.w. tags.

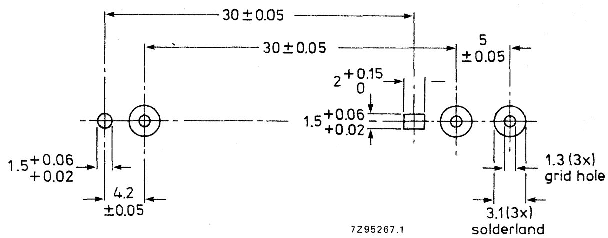


Fig.3 Hole pattern in the printed-wiring board, viewed from the component side.

Types of slider knobs

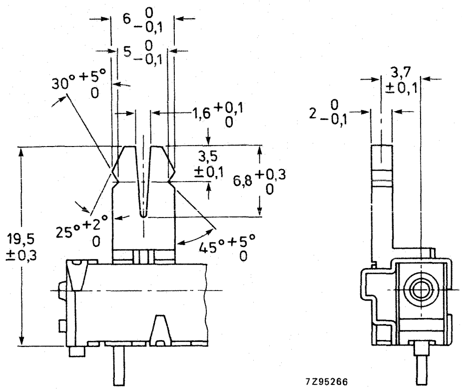


Fig.4 Dimensions of long slider knob.

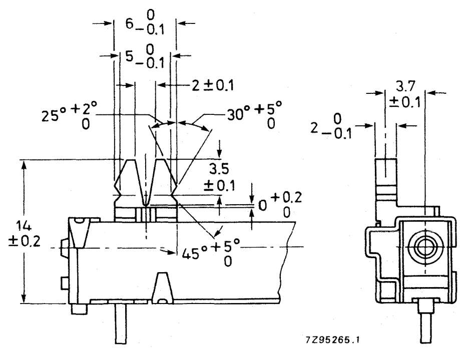


Fig.5 Dimensions of short slider knob.

TECHNICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 35 °C, an air pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Table 1 Linear resistance law

nominal resistance R_{nom}	maximum terminal resistance measured between terminals b and a or b and c	maximum attenuation dB
470 Ω	35 Ω	30
1 Ω	50 Ω	30
2,2 kΩ	100 Ω	40
4,7 kΩ	200 Ω	40
10 kΩ	300 Ω	40
22 kΩ	600 Ω	50
47 kΩ	1 kΩ	50
100 kΩ	2 kΩ	50
220 kΩ	3,5 kΩ	60
470 kΩ	6 kΩ	60
1 MΩ	10 kΩ	70

Table 2 Logarithmic resistance law

nominal resistance R_{nom}	maximum terminal resistance measured between terminals b and a	b and c	maximum attenuation dB
2,2 kΩ	20 Ω	250 Ω	50
4,7 kΩ	35 Ω	500 Ω	50
10 kΩ	50 Ω	1 kΩ	50
22 kΩ	100 Ω	1,5 kΩ	60
47 kΩ	200 Ω	2,5 kΩ	60
100 kΩ	250 Ω	5 kΩ	60
220 kΩ	500 Ω	7,5 kΩ	70
470 kΩ	1 kΩ	15 kΩ	70
1 MΩ	2 kΩ	30 kΩ	80
2,2 MΩ	5 kΩ	60 kΩ	80

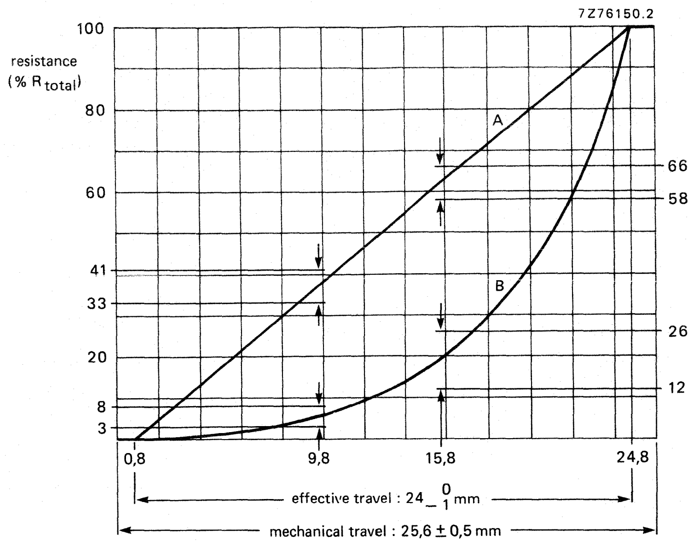


Fig.6 Resistance as a function of slider displacement.
curve A = linear law;
curve B = logarithmic law.

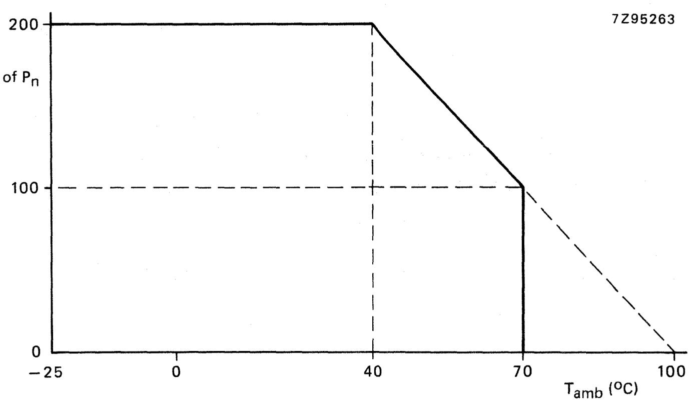


Fig.7 Derating curve.

	linear law	logarithmic law
T_{amb} = 40°	P_{max} = 0,2 W	P_{max} = 0,1 W
T_{amb} = 70°	P_{max} = 0,1 W	P_{max} = 0,05 W

Resistance range, E3 series, see Fig. 6	
linear law	470 Ω – 1 MΩ
logarithmic law	2,2 kΩ – 470 kΩ
Tolerance on nominal resistance, see Fig. 6	± 20%
Terminal resistance	see Tables 1 and 2
Temperature coefficient, –25 °C to + 70 °C	–500 to + 500·10^{-6}/K
Maximum dissipation (P_{max}), see Fig. 7	
linear law, at 40 °C	0,2 W
linear law, at 70 °C	0,1 W
logarithmic law at 40 °C	0,1 W
logarithmic law at 70 °C	0,05 W
Climatic category, (IEC 68)	25/070/21
Storage temperature range	–55 °C to + 70 °C
Operating force (F)	0,75 to 2,5 N ($\frac{F_{max}}{F_{min}} \leqslant 2$)
Permissible force with slider at end stop*	⩽ 30 N
Permissible load perpendicual to the direction of movement*	⩽ 10 N
Permissible axial force on slider (push and pull)*	⩽ 20 N
Effective travel of slider contact	24 – 1 mm
Mechanical travel of slider contact	25,6 ± 0,5 mm
Life	5000 x in both directions

MOUNTING

The terminals may be dip-soldered to a depth of 2 mm max. in a solder bath of 260 °C max. for 4 s max.

When a soldering bit is used, its temperature must not exceed 360 °C for 1,5 s and neither axial nor radial stress must be exerted on the terminals.

MARKING

The potentiometers are marked with nominal resistance, resistance law, period and year of manufacture.

PACKAGING

1000 items per box.

* Measured for 5 s, 5 mm above centre of potentiometer.

ENVIRONMENTAL TESTS

tests	requirements	
Climatic sequence	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 15%
Damp heat, steady state	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 15%
Mechanical endurance	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 10%
Electrical endurance 1000 h at 70 ^{o}C, cyclic	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 10%
Resistance to soldering heat (IEC 68-2, test T)	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 3%
Change of temperature	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 5%
Bump and vibration	$\Delta R_{ac}/R_{ac}$	$\leqslant$ 3%

COMPOSITION OF THE CATALOGUE NUMBER

2322 415 . . . . .

code for slider

6 = long (Fig.4)

7 = short (Fig.5)

code for shield

11 = black coated; without p.w. tags (Fig. 2)

code for nominal resistance

nominal resistance	linear law	logarithmic law
470 Ω	03	
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

40 mm CARBON SLIDE CONTROL

QUICK REFERENCE DATA

Nominal resistance	
linear law	220 Ω – 4,7 MΩ
logarithmic	1 kΩ–2,2 MΩ
Maximum dissipation at 40 °C	
linear law	0,25 W
logarithmic	0,125 W
Climatic category (IEC 68)	10/070/21

DESCRIPTION

These are general purpose slide potentiometers having a straight carbon track on a resin bonded paper base plate mounted in a black synthetic resin housing.

The potentiometers are available with a variety of connecting terminals and adjustment provisions.

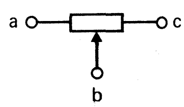


Fig.1 Terminal allocations.

MECHANICAL DATA

Dimensions in mm

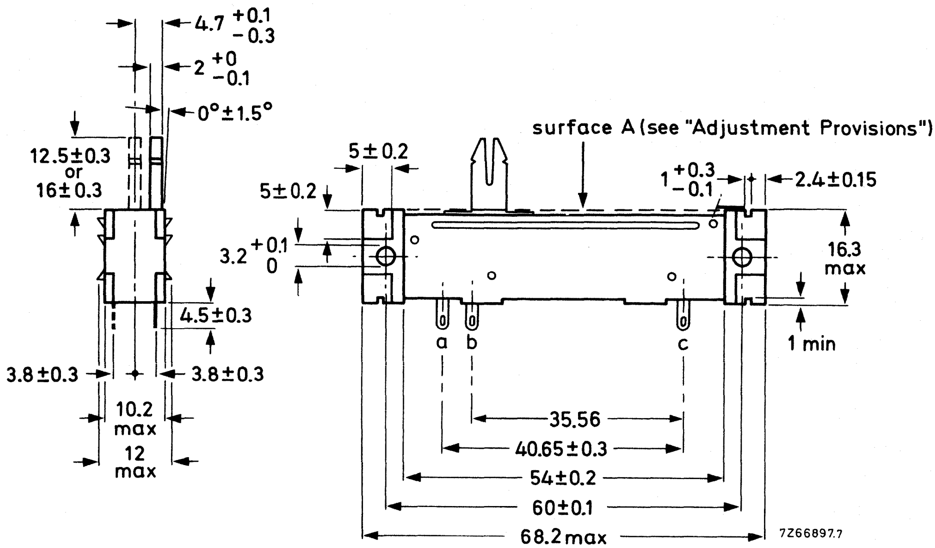


Fig.2 Slide potentiometer with solder tags.

Mounting

Use two type 4N Parker self-tapping screws (according to UN-B1005 or UN-B1023, minimum thread length 8 mm) in the two holes spaced 60 mm apart.

Maximum tightening torque: 500 mNm. Minimum stripping torque: 700 mNm.

Connecting terminals

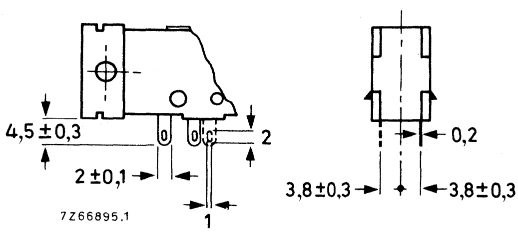


Fig.3 Solder tags.

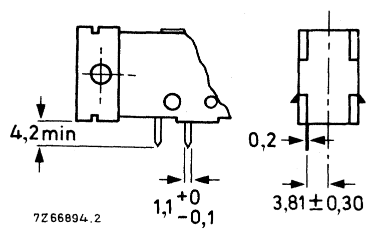


Fig.4 Printed-wiring pins.

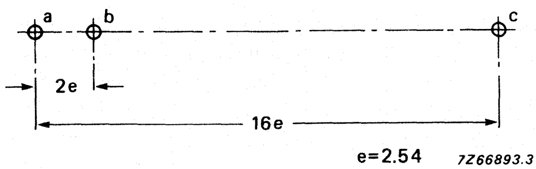


Fig.5 Hole pattern in printed-wiring board (viewed on component side).

Adjustment provisions

Four adjustment sliders are available:
— symmetrically placed, height 12,5 mm or 16 mm
— asymmetrically placed, height 12,5 mm or 16 mm

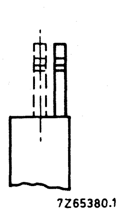


Fig.6 End view of potentiometer with symmetrically (dotted lines) and asymmetrically placed adjustment slider.

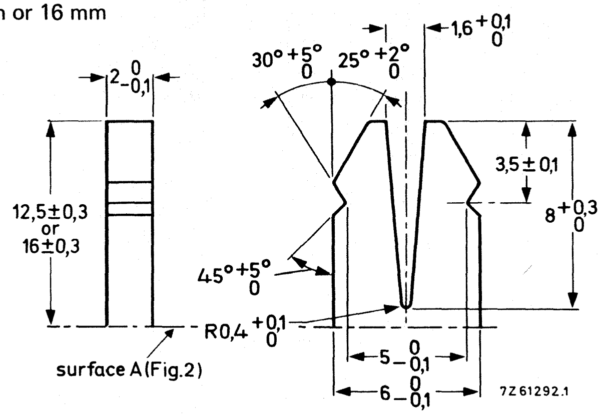


Fig.7 Adjustment slider.

TECHNICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 35 °C, an air pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Linear resistance law according to Fig.8

nom. resist. R_{nom}	max. voltage (V) at 40 °C	max. voltage (V) at 70 °C	max. terminal resistance	max. attenuation dB	max. contact resistance $\%R_{nom}$	limiting slider current at 40 °C mA
220 Ω	7,4	5,2	10 Ω	–	3	33
470 Ω	11	7,7	10 Ω	–	3	23
1 kΩ	16	11	25 Ω	–	3	16
2,2 kΩ	23	16	25 Ω	–	3	10
4,7 kΩ	34	24	25 Ω	–	2,5	7,2
10 kΩ	50	35	35 Ω	–	2,5	5
22 kΩ	74	52	35 Ω	–	2,5	3,3
47 kΩ	108	77	35 Ω	–	2,5	2,3
100 kΩ	158	112	100 Ω	–	2,5	1,6
220 kΩ	234	166	125 Ω	–	2,5	1,0
470 kΩ	342	242	250 Ω	–	2,5	0,72
1 MΩ	500	354	1 kΩ	–	2,5	0,50
2,2 MΩ	500	500	2,2 kΩ	–	2,5	0,33
4,7 MΩ	500	500	4,7 kΩ	–	2,5	0,23

Logarithmic resistance law according to Fig.9

nom. resist R_{nom}	max. voltage (V) at 40 °C	max. voltage (V) at 70 °C	max. terminal resistance	max. attenuation dB	max. contact resistance $\%R_{nom}$	limiting slider current at 40 °C mA
1 kΩ	11	7,9	25 Ω	50	4	11
2,2 kΩ	16	12	25 Ω	60	4	7,3
4,7 kΩ	24	17	25 Ω	60	4	5,1
10 kΩ	35	25	35 Ω	60	4	3,5
22 kΩ	52	37	35 Ω	70	4	2,4
47 kΩ	77	54	35 Ω	70	4	1,6
100 kΩ	112	79	50 Ω	80	4	1,1
220 kΩ	166	117	50 Ω	80	4	0,73
470 kΩ	242	170	100 Ω	80	4	0,51
1 MΩ	354	250	500 Ω	80	4	0,35
2,2 MΩ	500	370	500 Ω	80	4	0,24

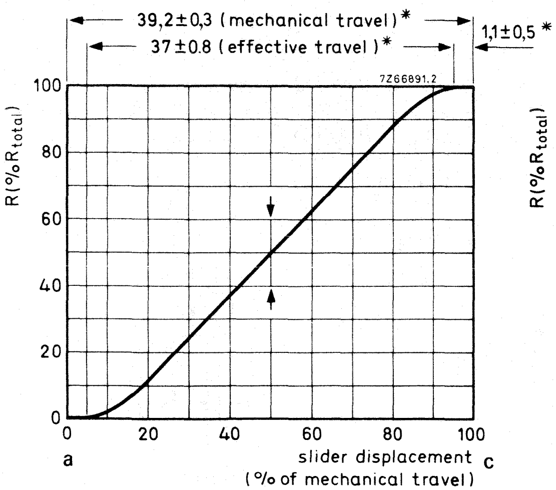


Fig.8 Linear law.

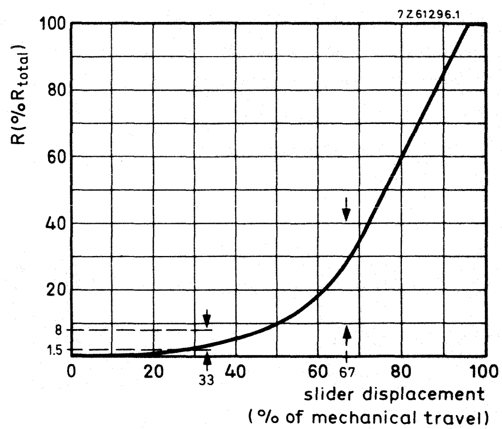


Fig.9 Logarithmic law.

Resistance law	linear, logarithmic; see Figs 8 and 9
Tolerance on nominal resistance	± 20%
Insulation resistance, initially	$> 10^4$ MΩ
Maximum dissipation (P_{max})	
linear law, at 40 °C	0,25 W
linear law, at 70 °C	0,125 W
logarithmic	
at 40 °C	0,125 W
at 70 °C	0,0625 W
Test voltage for 1 min	1000 V, 50 Hz
Working temperature range	−10 to + 70 °C
Storage temperature range	−25 to + 70 °C
Climatic category (IEC 68)	10/070/21

Operating force (F)*	0,75 – 2 N $\frac{F_{max}}{F_{min}} \leqslant 1{,}3$
Permissible force with slider at end stop *	$\leqslant$ 50 N (Fig.10)
Permissible load perpendicular to the direction of movement *	$\leqslant$ 20 N (Fig.11)
Permissible torque on slider *	$\leqslant$ 0,3 Nm (Fig.12)
Permissible axial force on slider (push and pull) *	$\leqslant$ 50 N

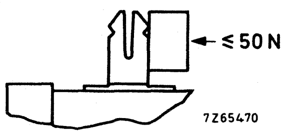


Fig.10.

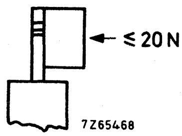


Fig.11.

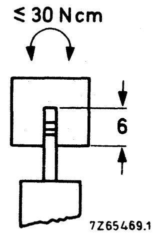


Fig.12.

Effective travel of slider contact	37 ± 0,8 mm	see also Fig.8
Mechanical travel of slider contact	39,2 ± 0,3	
Life	10 000 x in both directions	

MARKING

The potentiometers are marked at the side with nominal resistance, resistance law, period and year of manufacture.

PACKAGING

250 or 300 pieces per box.

* Measured for 5 s on a free slider without knob.

AVAILABLE VERSIONS AND COMPOSITION OF THE CATALOGUE NUMBER

2322 43 . . . . . .

code for type and screw-mounting facility
0 = single, without screw-mounting facility
1 = single, with screw-mounting facility

code for resistance law and nominal resistance, see table 3

code for tap
0 = without tap

code for terminals

solder tags	p.w. pins
0	5

code for adjustment provision
0 = asymmetrically placed
1 = symmetrically placed } length 12,5 mm
2 = asymmetrically placed
3 = symmetrically placed } length 16 mm

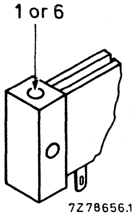


Fig.13.

Table 3 Resistance law and nominal resistance

nominal resistance	code in catalogue number	
	linear law	log. law
220 Ω	02	
470 Ω	03	
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	

60mm CARBON SLIDE CONTROL

QUICK REFERENCE DATA

Nominal resistance	
linear law	220 Ω − 4.7 MΩ
logarithmic law	1 kΩ − 1.0 MΩ
Maximum dissipation at 40 °C	
linear law	0.4 W
logarithmic law	0.2 W
Category (IEC 68)	10/070/21

DESCRIPTION

These are general purpose slide potentiometers having a straight carbon track on a resin bonded paper base plate mounted in a black synthetic resin housing.

The potentiometers are available with a variety of connecting terminals and adjustment provision.

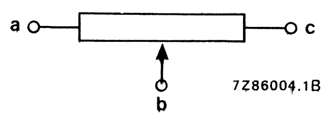


Fig.1 Terminal allocations.

MECHANICAL DATA

Dimensions in mm

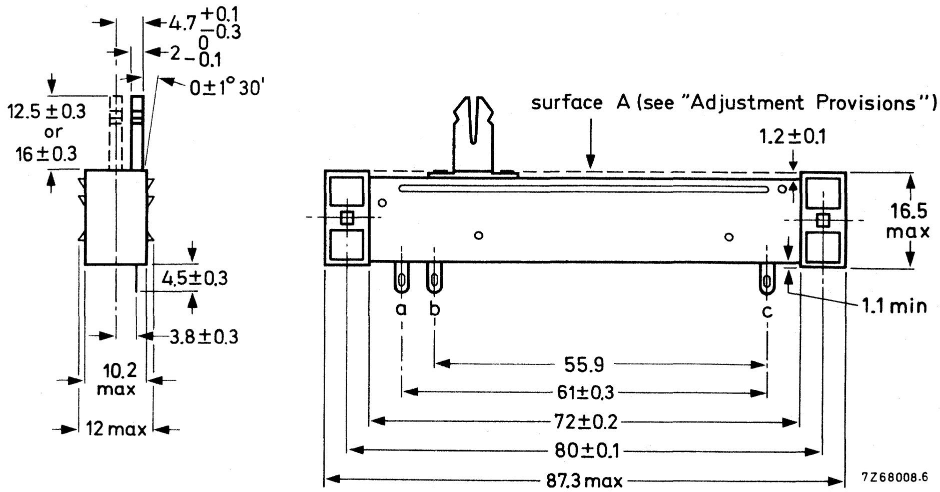


Fig.2 Slide potentiometer with solder tags.

Mounting

Use two type 4N Parker self-tapping screws (according to UN-B1005 or UN-B1023, minimum thread length 8 mm) in the two holes spaced 80 mm apart.

Maximum tightening torque: 500 mNm. Minimum stripping torque: 700 mNm.

Connecting terminals

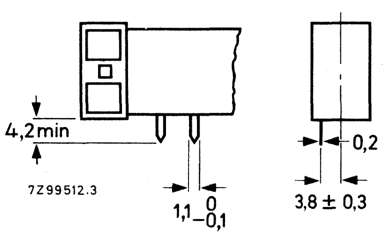


Fig.3 Solder tags.

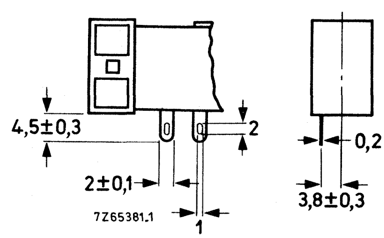


Fig.4 Printed-wiring tags.

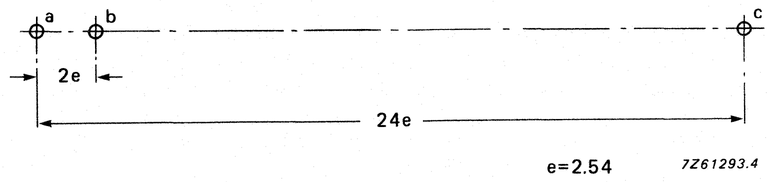


Fig.5 Hole pattern in printed-wiring board (viewed on component side).

Adjustment provisions

Four types of adjustment sliders are available:
– symmetrically positioned height 12.5 mm or 16 mm
– asymmetrically positioned height 12.5 mm or 16 mm

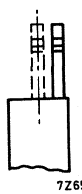


Fig.6 End view of potentiometer with symmetrically (dotted lines) and asymmetrically positioned adjustment slider.

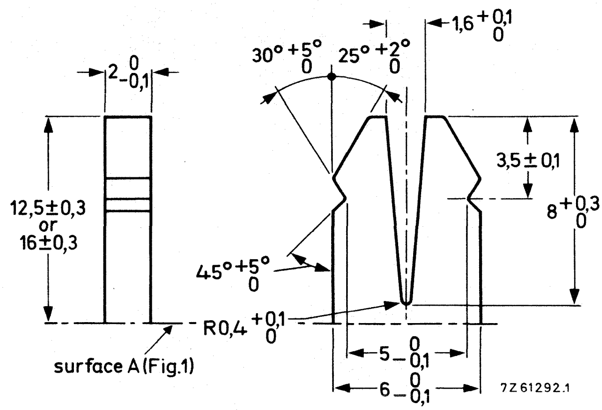


Fig.7 Adjustment slider.

TECHNICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 35 °C, an air pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Linear resistance law according to Fig.8

nom. resist. R_{nom}	max. voltage (V) at 40 °C	max. voltage (V) at 70 °C	max. terminal resistance	max. attenuation dB	max. contact resistance $\%R_{nom}$	limiting slider current at 40 °C mA
220 Ω	9.3	7.4	10 Ω	–	3	40
470 Ω	14	11	10 Ω	–	3	22
1 kΩ	20	16	25 Ω	–	3	16
2.2 kΩ	30	23	25 Ω	–	3	11
4.7 kΩ	41	34	25 Ω	–	2	7
10 kΩ	63	50	35 Ω	–	2	5
22 kΩ	93	74	35 Ω	–	2	3.5
47 kΩ	137	108	35 Ω	–	2	2.2
100 kΩ	200	158	100 Ω	–	2	1.4
220 kΩ	296	234	125 Ω	–	2	1.0
470 kΩ	410	342	250 Ω	–	2	0.65
1 MΩ	500	500	1 kΩ	–	2	0.45
2.2 MΩ	500	500	2.2 kΩ	–	2	0.32
4.7 MΩ	500	500	4.7 kΩ	–	2	0.22

Logarithmic resistance law according to Fig.9

nom. resist. R_{nom}	max. voltage (V) at 40 °C	max. voltage (V) at 70 °C	max. terminal resistance	max. attenuation dB	max. contact resistance $\%R_{nom}$	limiting slider current at 40 °C mA
1 kΩ	14	11	25 Ω	50	4	10
2.2 kΩ	21	16	25 Ω	60	4	7
4.7 kΩ	31	24	25 Ω	60	4	4.5
10 kΩ	45	35	35 Ω	60	4	3.2
22 kΩ	66	52	35 Ω	70	4	2.2
47 kΩ	97	77	35 Ω	70	4	1.4
100 kΩ	141	112	50 Ω	80	4	1.0
220 kΩ	210	166	50 Ω	80	4	0.7
470 kΩ	310	242	100 Ω	80	4	0.45
1 MΩ	447	354	500 Ω	80	4	0.32

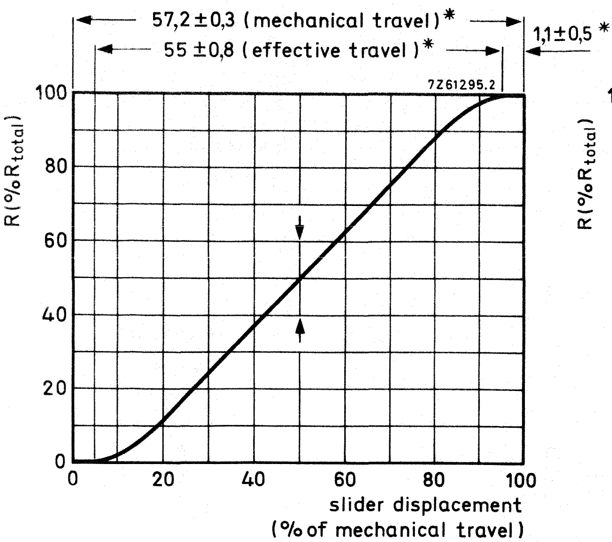


Fig.8 Linear law.

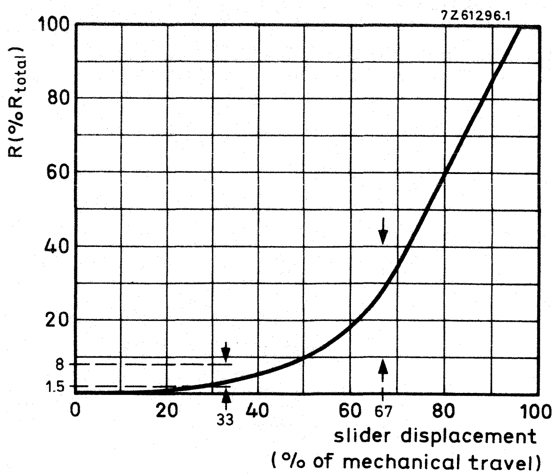


Fig.9 Logarithmic law.

Resistance law	linear, logarithmic, see Figs 8 and 9
Tolerance on nominal resistance	± 20%
Insulation resistance (versions with external screening), initially	$> 10^4$ MΩ
Maximum dissipation (P_{max})	
linear law, at 40 °C	0.4 W
linear law, at 70 °C	0.25 W
logarithmic law, at 40 °C	0.2 W
logarithmic law, at 70 °C	0.125 W
Test voltage for 1 min	1000 V, 50 Hz
Working temperature range	−10 to + 70 °C
Storage temperature range	−25 to + 70 °C
Category (IEC 68)	10/070/21

* Valid for all graphs.

Operating force (F)	0.75 – 2 N $\frac{F_{max}}{F_{min}} \leqslant 1.5$
Permissible force with slider at end stop*	$\leqslant$ 50 N (Fig.10)
Permissible load perpendicular to the direction of movement*	$\leqslant$ 20 N (Fig.11)
Permissible torque on slider*	$\leqslant$ 0.3 Nm (Fig.12)
Permissible axial force on slider (push and pull)*	$\leqslant$ 50 N

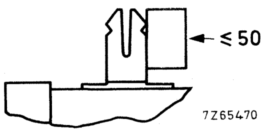


Fig.10.

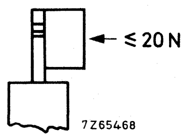


Fig.11.

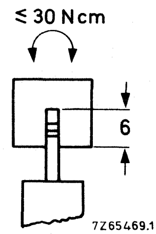


Fig.12.

Effective travel of slider contact	55 ± 0.8 mm } see also Fig.8
Mechanical travel of slider contact	57.2 ± 0.3 mm } see also Fig.8
Life	10 000 x in both directions

MARKING

The side of the potentiometer is marked with nominal resistance, resistance law, year and month of manufacture.

PACKAGING

250 or 300 pieces per box.

* Measured for 5 s on a free slider without knob.

AVAILABLE VERSIONS AND COMPOSITION OF THE CATALOGUE NUMBER

2322 42 . . . . . .

code for type

4 = single potentiometer

code for resistance law and nominal resistance, see Table 3

code for taps
0 = without taps

code for terminals

solder tags	p.w. pins
0	5

code for adjustment provision
0 = asymmetrically, 1 = symmetrically: length 12.5 mm
2 = asymmetrically, 3 = symmetrically: length 16 mm

Table 3 Resistance law and nominal resistance

nominal resistance	code in catalogue number	
	linear law	log. law
220 Ω	02	
470 Ω	03	
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	
4.7 MΩ	16	

PRESET POTENTIOMETERS

RELEASE OF NEW LOOSE LEAF DATA SHEET IMMINENT

10 mm CARBON PRESET POTENTIOMETERS

QUICK REFERENCE DATA

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

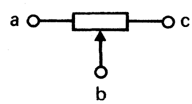
APPLICATION

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. Snap-in pins and cross slot are available on request.

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



7Z85818

COMPOSITION OF THE CATALOGUE NUMBER

2322 410 . . . . .

0 = without knob
4 = with knob (Fig. 2; only for 2322 410 .50..)
6 = with knob (Figs 4 and 6; only for 2322 410 .11.. and 2322 410 .33..)

code for resistance value, see Table 1

11 = vertical mounting (Fig. 3)
33 = horizontal mounting (Fig. 5)
50 = vertical mounting (Fig. 1)

Note: catalogue number of knob (Fig. 2): 4322 047 00190 (only for 2322 410 .50..);
catalogue number of knob (Figs 4 and 6): 4322 047 27740 (only for 2322 410 .11.. and 2322 410 .33..).

MARKING

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

OUTLINES

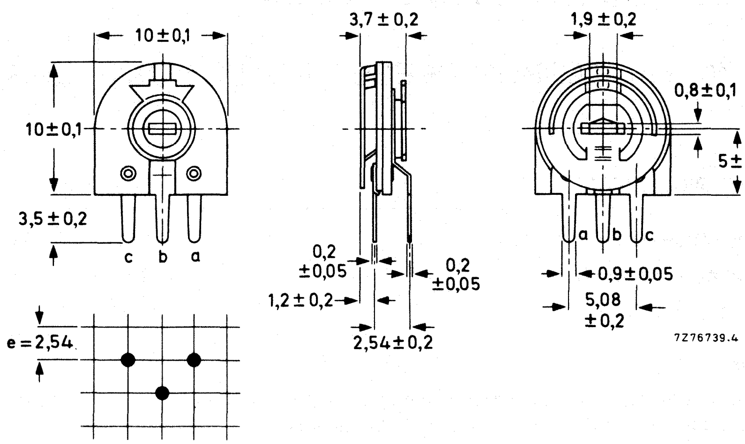


Fig.1 Potentiometer for vertical mounting 2322 410 050 . .

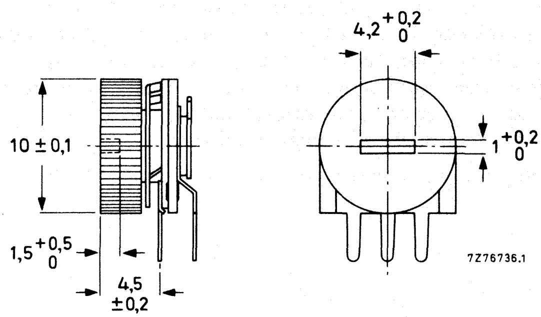


Fig.2 Potentiometer for vertical mounting with knob 2322 410 450 . .

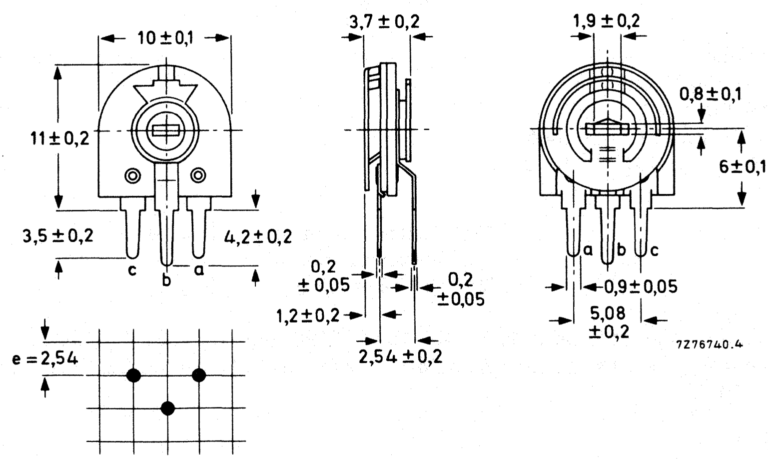


Fig.3 Potentiometer for vertical mounting 2322 410 011 . .

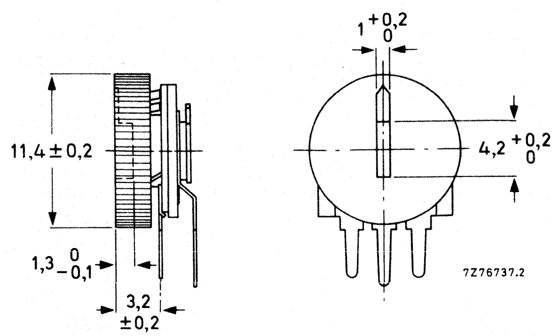


Fig. 4 Potentiometer for vertical mounting with knob 2322 410 611 . .

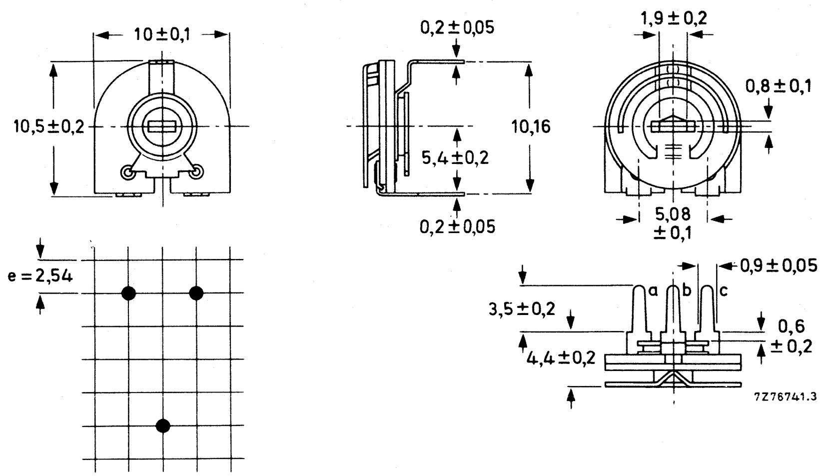


Fig. 5 Potentiometer for horizontal mounting 2322 410 033 . .

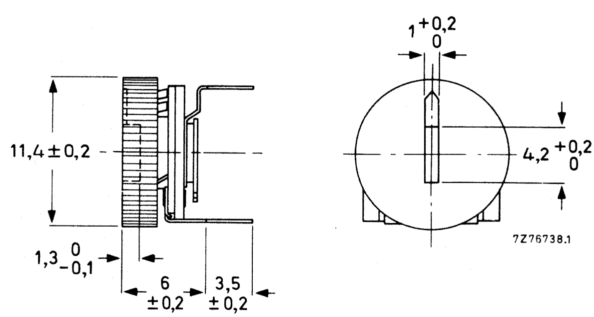


Fig. 6 Potentiometer for horizontal mounting with knob 2322 410 633 . .

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 kΩ	10	20	10	54
2,2 kΩ	14,8	40	6,7	55
4,7 kΩ	21,7	100	4,6	56
10 kΩ	32	200	3,2	57
22 kΩ	47	400	2,1	58
47 kΩ	69	1 000	1,5	59
100 kΩ	100	2 000	1,0	61
220 kΩ	148	4 000	0,7	62
470 kΩ	150	10 000	0,32	63
1 MΩ	150	20 000	0,15	64
2,2 MΩ	150	40 000	0,068	65
4,7 MΩ	150	100 000	0,032	66

Tolerance on the nominal resistance	± 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 150 V (see table above)
Ambient temperature range	−25 to + 70 °C
Climatic category, IEC 68	25/070/21
Temperature coefficient	−500 to + 300 . 10^{-6}/K
Operating torque	3,5 to 25 mNm
Maximum end stop torque	50 mNm
Effective angle of rotation	200 ± 10°
Mechanical angle of rotation	260 ± 5°
Mechanical endurance (200 cycles)	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$
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. ⩽ 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: 230° ± 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	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$
6.25	Eb	Bump	acceleration 40g number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 12\%$
6.24	Ec	Vibration	frequency: 10 to 500 Hz amplitude: 0,75 mm or 10g, 3 directions, 2 h per direction	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 2\%$ $\frac{\Delta V_{ab}}{V_{ab}} \leqslant 0{,}3\%$
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	–	Climatic sequence		
6.26.2	Ba	Dry heat	16 h at 70 ± 2 °C	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$
6.26.3	Db	Damp heat acc. 1st cycle	24 h at 55 ± 2 °C 95 – 100% R.H.	
6.26.4	Aa	Cold	2 h at –55 ± 3 °C	operating torque ⩽ 30 mNm
6.26.6	Db	Damp heat, remaining cycle	24 h at 55 ± 2 °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_{ac} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 10\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}5\%$
			Load: 0,033 W between a and b	$\frac{\Delta R_{ab}}{R_{ab}} \leqslant 10\%$

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.29	–	Mechanical endurance	200 cycles, 4 cycles/min, no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 3\%$ 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%	CRV $< 0,5\%$ of R_{ac} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0,2\%$

14 mm OPEN CARBON PRESET

QUICK REFERENCE DATA

Resistance range (E3-series), linear law	47 Ω – 4,7 MΩ
Maximum dissipation at 40 °C	0,3 W
Climatic category, IEC 68	55/100/10
Dimensions based upon spec.	DIN 44150

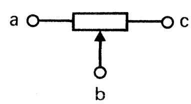
APPLICATION

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.



7Z85818

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

code for resistance value
91 = 47 Ω
51 = 100 Ω
52 = 220 Ω
69 = 330 Ω
53 = 470 Ω
54 = 1 kΩ
55 = 2,2 kΩ
56 = 4,7 kΩ
57 = 10 kΩ
58 = 22 kΩ
59 = 47 kΩ
61 = 100 kΩ
62 = 220 kΩ
63 = 470 kΩ
64 = 1 MΩ
65 = 2,2 MΩ
66 = 4,7 MΩ

MARKING

The potentiometers are marked with the rated resistance value, by letter punches on the wiper.

Outlines

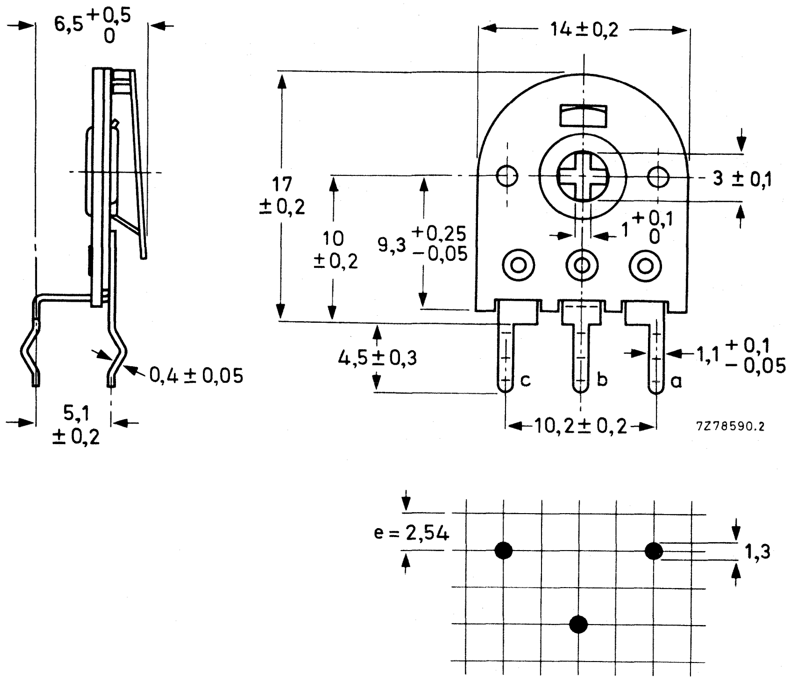


Fig.1 Potentiometer for vertical mounting, with snap-in printed-wiring pins, 2322 409 022.

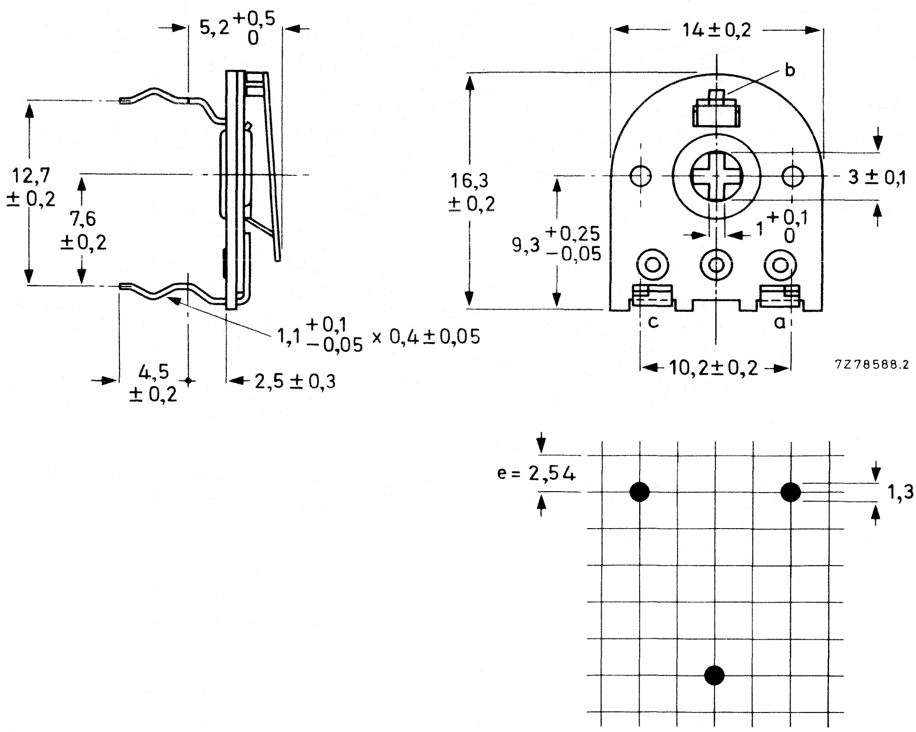
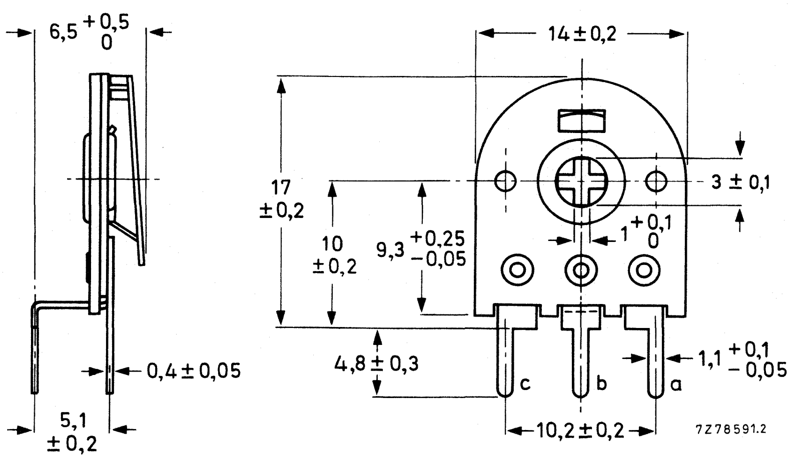


Fig.2 Potentiometer for horizontal mounting, with snap-in printed-wiring pins, 2322 409 033..



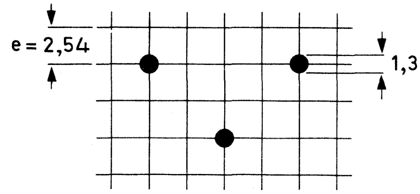
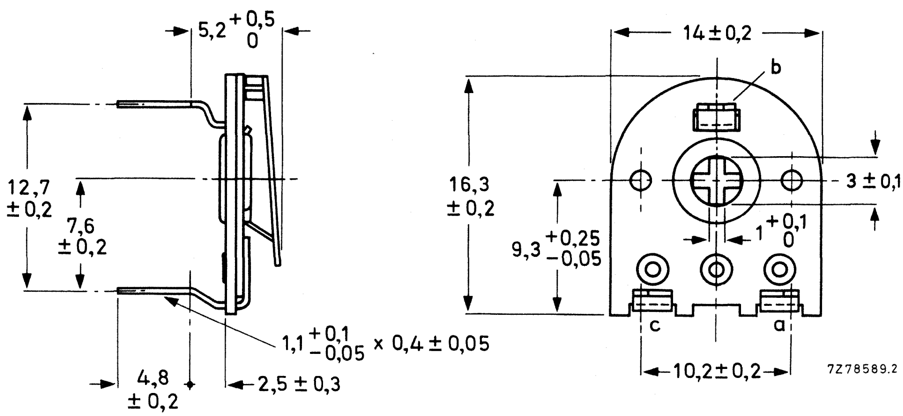


Fig.3 Potentiometer for vertical mounting, with straight printed-wiring pins, 2322 409 002..



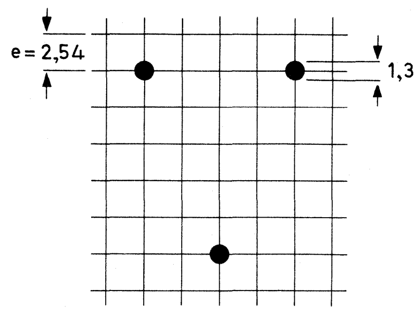


Fig.4 Potentiometer for horizontal mounting, with straight printed-wiring pins, 2322 409 013..

Note

For dimensions of knob or wheel versions see relevant drawing of snap-in-pin counterpart.

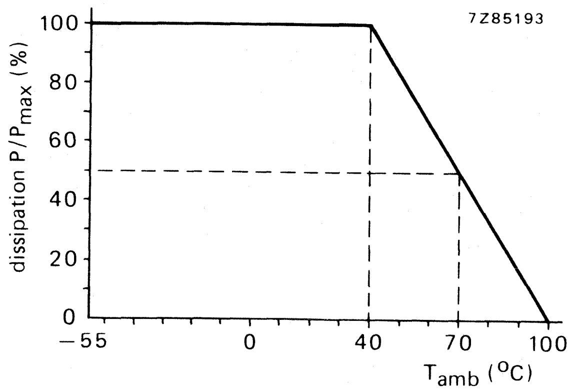
TECHNICAL DATA

Mass, per 100		72 g
Resistance range (E3-series)		47 Ω to 4,7 MΩ
Standard tolerance		± 20%
Resistance law		linear, see Fig. 6
Rated dissipation		
at 70 °C (P_{max})		0,15 W, see Fig. 5
at 40 °C		0,3 W
Limiting element voltage		500 V (DC)
Limiting wiper current		$\sqrt{\frac{P_{max}}{R_{nom}}}$
Terminal resistance		$\leqslant$ 2% of R_{nom}
Contact resistance variation (CRV)		$\leqslant$ 1% of R_{ac}
Temperature coefficient in the range −55 °C to + 100 °C		−500 to + 300 · 10^{-6}/K
Starting torque		$\leqslant$ 25 mNm
Operating torque		3,5 to 25 mNm
Permissible end-stop torque		max. 100 mNm
Total mechanical angle of rotation		230 ± 5°
Effective angle of rotation		210 ± 10°
Settability		0,1% within 10 s
Climatic category according to IEC 68-2		55/100/10
Climatic sequence		$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 10\%$
Damp heat, steady state, 10 days max.	$R_{nom} \leqslant 100$ K	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 15\%$
	$R_{nom} > 100$ K	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 20\%$
Mechanical endurance (200 cycles)		$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$
Electrical endurance (1000 h at 70 °C, cyclic)		$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 10\%$
Resistance to soldering heat		$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 2\%$
Bump		$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 2\%$
Vibration		$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 2\%$
		$\frac{\Delta V_{ab}}{V_{ab}} \leqslant 0{,}5\%$

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 $\Delta R_{ac} \leqslant 10\%$

Fig. 5 Dissipation as a function of ambient temperature.

RESISTANCE LAW

Potentiometers covered by this specification are linear.

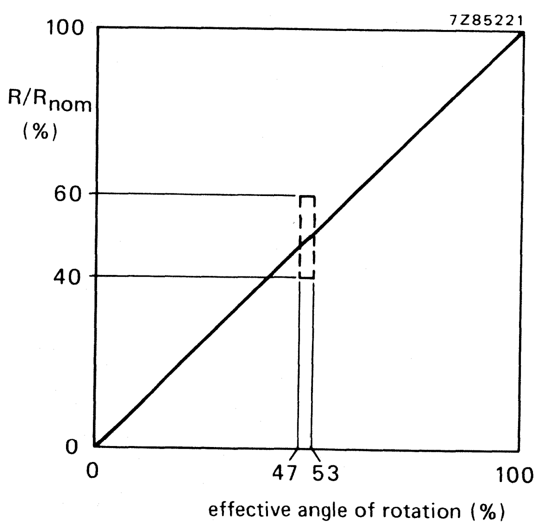


Fig. 6 Linear resistance law.

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 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.

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.22.3	T_a	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	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$
6.25	Eb	Bump	acceleration: 390 m/s² number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$
6.24	Ec	Vibration	frequency: 10 to 500 Hz amplitude: 0,75 mm or 98 m/s², 6 h	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 1\%$ $\frac{\Delta V_{ab}}{V_{ab}} \leqslant 0{,}1\%$
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.	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ 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} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 10\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 10\%$

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.29	–	Mechanical endurance	200 cycles, 4 cycles/min, no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 3\%$ 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} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0,2\%$

18 mm CARBON PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E3-series), linear law	100 Ω – 4.7 MΩ
Maximum dissipation at 25 °C	0.25 W

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 tin-plated printed-wiring pins. The pins a and c (see drawings) are connected to the ends of the carbon track; b is connected to the wiper. The wiper has a centre screwdriver slot.

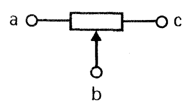


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Fig.1 Designation of terminals.

COMPOSITION OF THE CATALOGUE NUMBER

2322 411 0 . . . .

22 = with pins for vertical mounting (Fig.2)
33 = with pins for horizontal mounting (Fig.3)

code for resistance value, see table

MARKING

Nominal resistance and production code in ink on the base plate.

Outlines

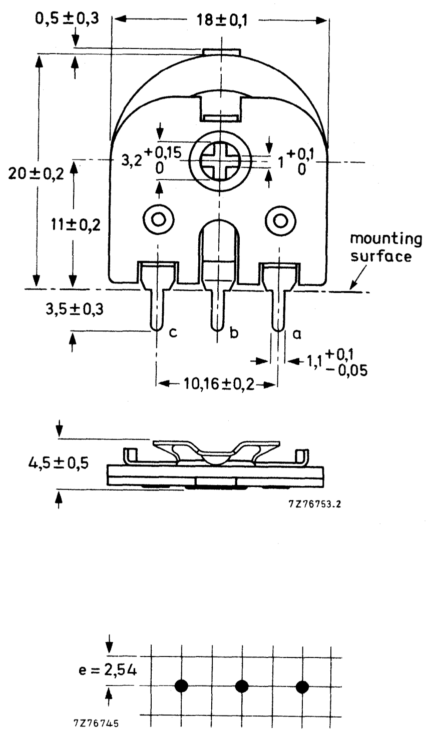


Fig.2 Potentiometer 2322 411 022 . .

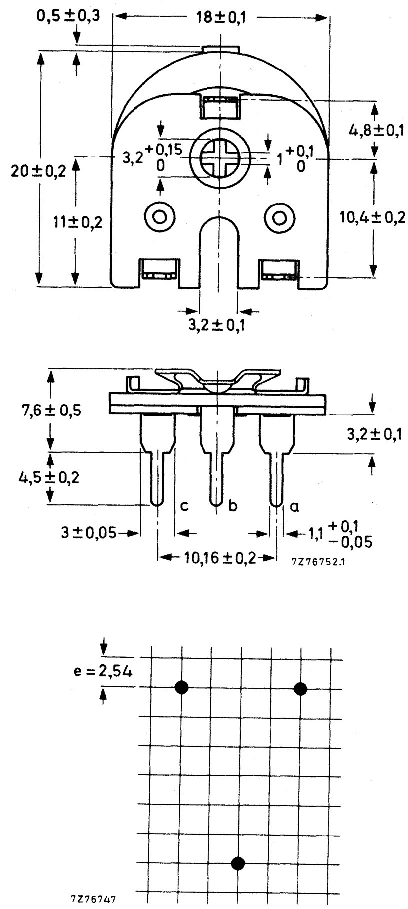


Fig.3 Potentiometer 2322 411 033 . .

TECHNICAL DATA

nom. resistance R_n	max. terminal resistance Ω	V_{max} (DC or RMS) at T_{amb} = 40 °C V	limiting wiper current mA	code in catalogue number
100 Ω	10	5	32	51
220 Ω	10	7	22	52
330 Ω	10	9	18	69
470 Ω	10	11	14	53
1 kΩ	25	16	10	54
2.2 kΩ	25	22	7	55
4.7 kΩ	100	35	4.5	56
10 kΩ	200	50	3.2	57
22 kΩ	400	70	2.2	58
47 kΩ	1 000	110	1.4	59
100 kΩ	2 000	160	1.0	61
220 kΩ	4 000	220	0.7	62
470 kΩ	10 000	370	0.45	63
1 MΩ	20 000	500	0.32	64
2.2 MΩ	40 000	500	0.22	65
4.7 MΩ	100 000	500	0.14	66

Tolerance on the nominal resistance	±20%
Resistance law	linear
Maximum dissipation	
at 25 °C	0.25 W
at 70 °C	0.15 W
Limiting voltage	500 V (DC) 500 V (RMS)
Ambient temperature range	−25 to + 70 °C
Resistance change after humidity test (21 days, T_{amb} = 40 °C, R.H. = 90 - 95%)	
after recovery of 1 h *	< 20%
after recovery of 24 h *	< 10%
Operating torque	5 to 35 mNm
Maximum end stop torque	100 mNm
Effective angle of rotation	200 ± 10°
Mechanical angle of rotation	215–225°
Temperature coefficient	−500 to + 300 . 10^{-6} /K

* Preconditioning (min 48 h) and recovery at 23 ± 1 °C, R.H. = 50 ± 2%.

RELEASE OF NEW LOOSE LEAF DATA SHEET IMMINENT

10 mm ENCLOSED CARBON PRESET

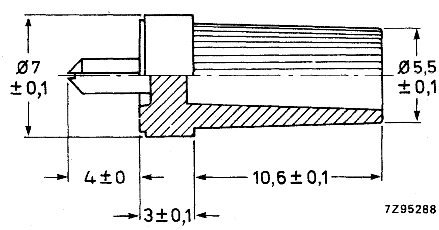
QUICK REFERENCE DATA

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

DESCRIPTION

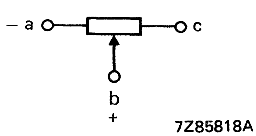
These preset potentiometers comprise a carbon resistive element on a phenolic paper base. The actuating device is a plastic rotor or a metal wiper. Adjustment is by means of cross or hexagonal slots. The overall width of 9,8 mm allows for high density use with air-gap isolation on a 2,5 mm grid; either 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 practiced. Versions with a hexagonal slot are available that can be provided with a knob to facilitate manual adjustment.



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

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.

* 33 Ω and 47 Ω on request.

MECHANICAL DATA

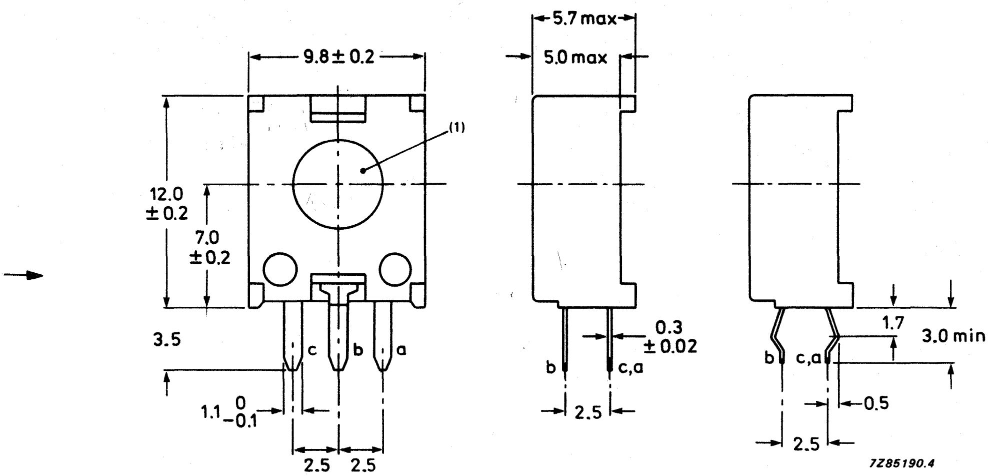


Fig. 1 Vertical mounting.

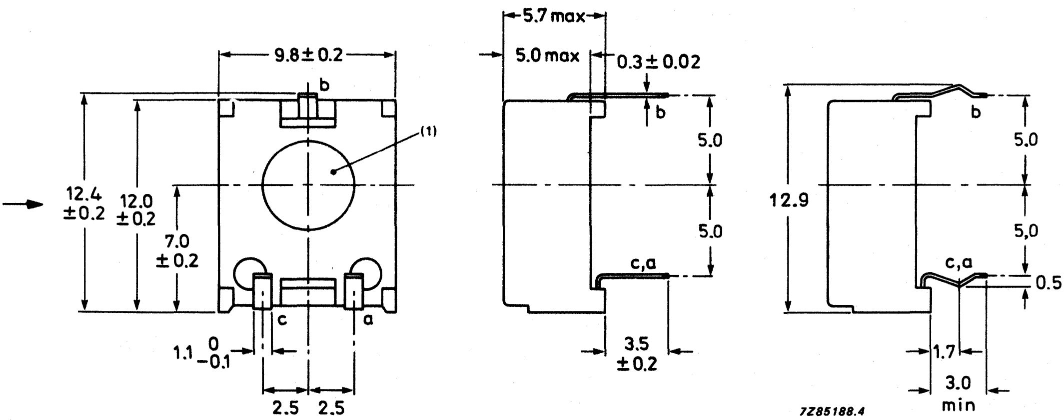


Fig. 2 Horizontal mounting.

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.

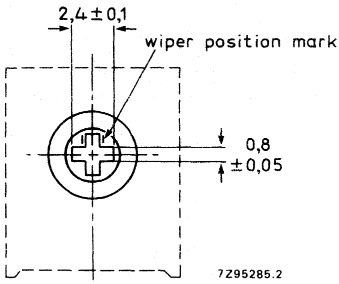


Fig. 3 Cross slot, non-insulated wiper for vertical and horizontal versions; straight pins only.

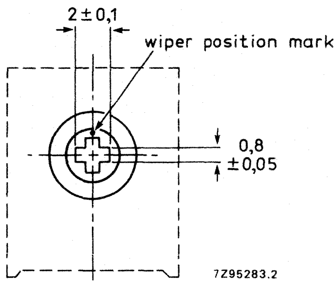


Fig. 4 Cross slot, insulated wiper for vertical and horizontal versions.

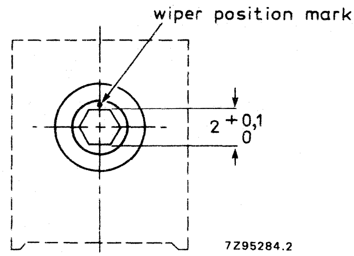


Fig. 5 Hexagonal slot, insulated wiper for vertical and horizontal versions.

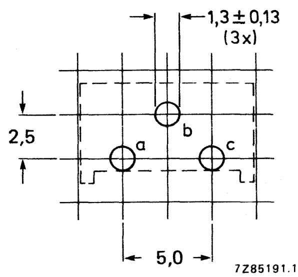


Fig. 6 Hole pattern for vertical versions, viewed from component side.

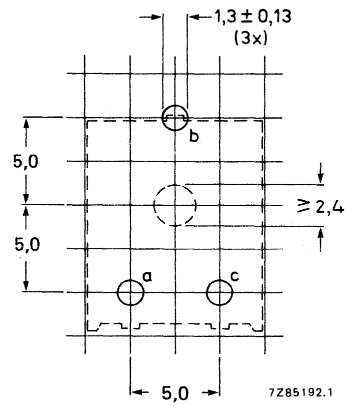


Fig . 7 Hole pattern for horizontal versions, viewed from component side.

TECHNICAL DATA

Mass		~0,6 g
Resistance range (E3-series)		100 Ω to 4,7 MΩ
Standard tolerance		± 20% and ± 10%
Resistance law		linear, see Fig. 9
Rated dissipation at 40 °C (P_{max})		0,1 W, see Fig. 8
Limiting element voltage		200 V (DC or AC)
Limiting wiper current		$\sqrt{\frac{P_{max}}{R_{nom}}}$
Minimum effective resistance		$\leqslant$ 2% of R_{ac} or 10 Ω, whichever is greater
Rotational noise limits (contact resistance variation)		$\leqslant$ 1,0% of R_{nom}
Temperature coefficient in the range −25 °C to + 85 °C		$\pm 300 \cdot 10^{-6}$/K
Operating torque		2 to 10 mNm
Permissible end-stop torque		max. 50 mNm
Permissible axial load on adjustment slot		20 N, max. 20 s
Total mechanical angle of rotation		300 ± 5°
Effective angle of rotation		285 ± 5°
Settability		0,2% within 10 s
Climatic category according to IEC 68–2		25/85/10
Climatic sequence	$\frac{\Delta R_{ac}}{R_{ac}}$	$\leqslant$ 5%
Damp heat, steady state, with or without load, between a and c, 10 days	$\frac{\Delta R_{ac}}{R_{ac}}$	$\leqslant$ 10%
Mechanical endurance (100 cycles)	$\frac{\Delta R_{ac}}{R_{ac}}$	$\leqslant$ 5%
Electrical endurance (1000 h at 70 °C, cyclic)	$\frac{\Delta R_{ac}}{R_{ac}}$	$\leqslant$ 5%
Resistance to soldering heat	$\frac{\Delta R_{ac}}{R_{ac}}$	$\leqslant$ 2%
Bump	$\frac{\Delta R_{ac}}{R_{ac}}$	$\leqslant$ 2%
Vibration	$\frac{\Delta R_{ac}}{R_{ac}}$	$\leqslant$ 2%
	$\frac{\Delta V_{ab}}{V_{ac}}$	$\leqslant$ 0,5%

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.

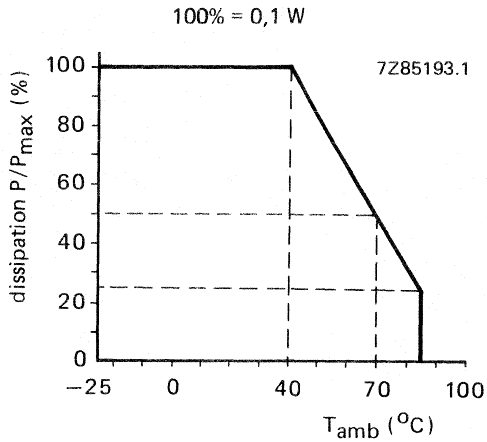


Fig. 8 Dissipation as a function of ambient temperature.

RESISTANCE

Potentiometers covered by this specification are linear.

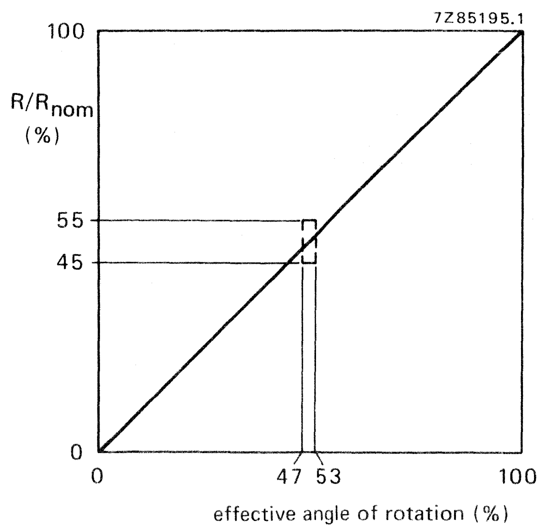


Fig. 9 Linear resistance law.

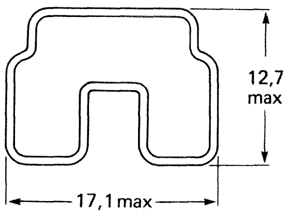
MARKING

The potentiometers are marked with the rated resistance, according to IEC 62, e.g. 220 Ω = 220 R; 10 kΩ = 10 k; 1 MΩ = 1 MO.

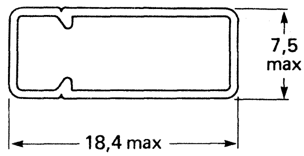
The package is marked with:
— catalogue number,
— date of production,
— quantity.

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.

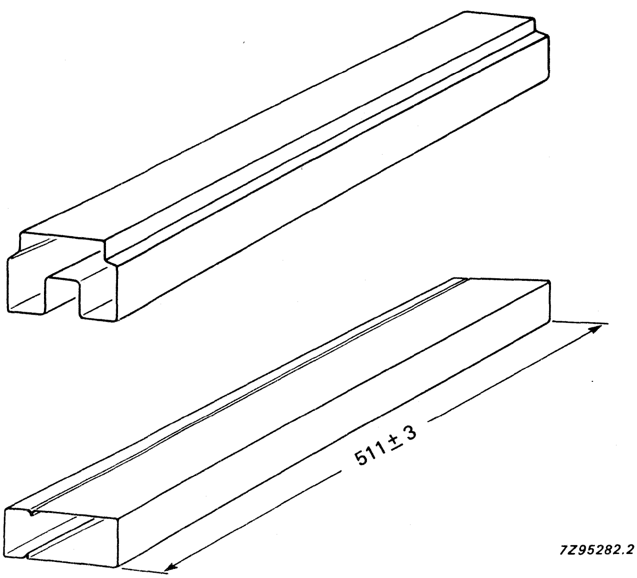


Fig. 10 Outlines of the rail packaging.

COMPOSITION OF THE CATALOGUE NUMBER

2322 483 . . . . .

code for version

0 = vertical, non-insulated cross slot *
1 = vertical, insulated hexagonal slot
2 = vertical, insulated cross slot
5 = horizontal, non-insulated cross slot *
6 = horizontal, insulated hexagonal slot
7 = horizontal, insulated cross slot

code for tolerance, tags, packaging

2 = ± 20%, snap-in pins, bulk packaging
3 = ± 10%, snap-in pins, bulk packaging
4 = ± 20%, straight pins, bulk packaging
5 = ± 10%, straight pins, bulk packaging
6 = ± 20%, snap-in pins, rail packaging
7 = ± 10%, snap-in pins, rail packaging
8 = ± 20%, straight pins, rail packaging
9 = ± 10%, straight pins, rail packaging

resistance code **

101 = 100 Ω
221 = 220 Ω
471 = 470 Ω
102 = 1 kΩ
222 = 2,2 kΩ
472 = 4,7 kΩ
103 = 10 kΩ
223 = 22 kΩ
473 = 47 kΩ
104 = 100 kΩ
224 = 220 kΩ
474 = 470 kΩ
105 = 1 MΩ
225 = 2,2 MΩ
475 = 4,7 MΩ

* 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: 230 ± 10 °C	good tinning
6.22.4	Tb	Resistance to heat	solder bath: 350 ± 10 °C 3,5 ± 0,5 s	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$
6.25	Eb	Bump	acceleration: 390 m/s^2 number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 2\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}5\%$

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/s², 6 h	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 2\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}3\%$
6.13		Temperature characteristic of resistance	temp. cycle: + 20 °C; –25 °C; + 20 °C; + 70 °C + 20 °C	$-300 < TC < +300 \cdot 10^{-6}/K$
6.26	–	Climatic sequence		
6.26.2	Ba	Dry heat	16 h at 85 °C	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$
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 Load: 0,033 W between a and b	CRV < 2% of R_{nom} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 5\%$
6.29	–	Mechanical endurance	100 cycles, 4 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ ($\leqslant$ 10% for R_{nom} = 4,7 MΩ) CRV < 1,0% of R_{nom}
(6.27)	C	Damp heat steady state	wiper at 0,67 a - c *no load;* 21 days; recovery 24 h, 22 ± 1 °C, 50% R.H. ± 5%	CRV < 1,0% of R_{nom} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}2\%$
(6.27)	C	Damp heat steady state	*with load* between a and c, 10 days; recovery 24 h, 22 °C ± 1 °C, 50% R.H. ± 5%	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 10\%$ ($\leqslant$ 15% for R_{nom} = 4,7 MΩ)

10 mm OPEN METAL-GLAZE PRESET

QUICK REFERENCE DATA

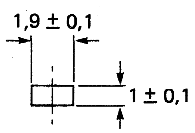
Resistance range (E6-series), linear law	100 Ω to 10 MΩ
Maximum dissipation at 70 °C	0.5 W
Climatic category, IEC 68	55/125/56

APPLICATION

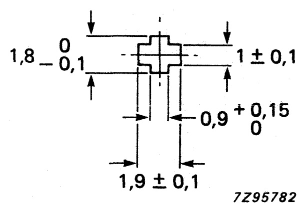
These potentiometers are for preset resistance control with provision for re-adjustments. They are particularly suitable for use in professional apparatus and/or in those applications where stability is of extreme importance.

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 longitudal or cross shaped:



longitudinal



cross

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

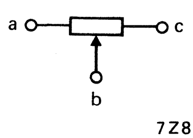


Fig. 1 Terminal allocations.

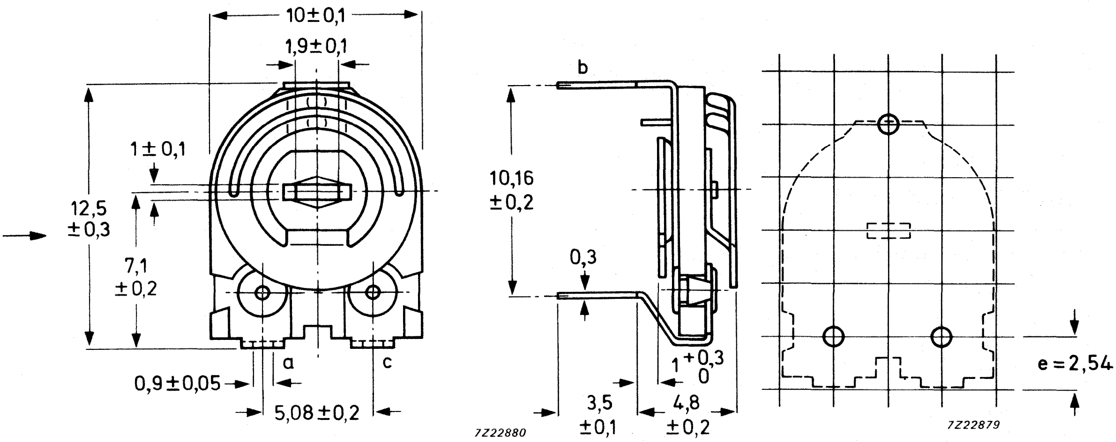


Fig. 2 Potentiometer for horizontal mounting, 2322 482 4 . . . .

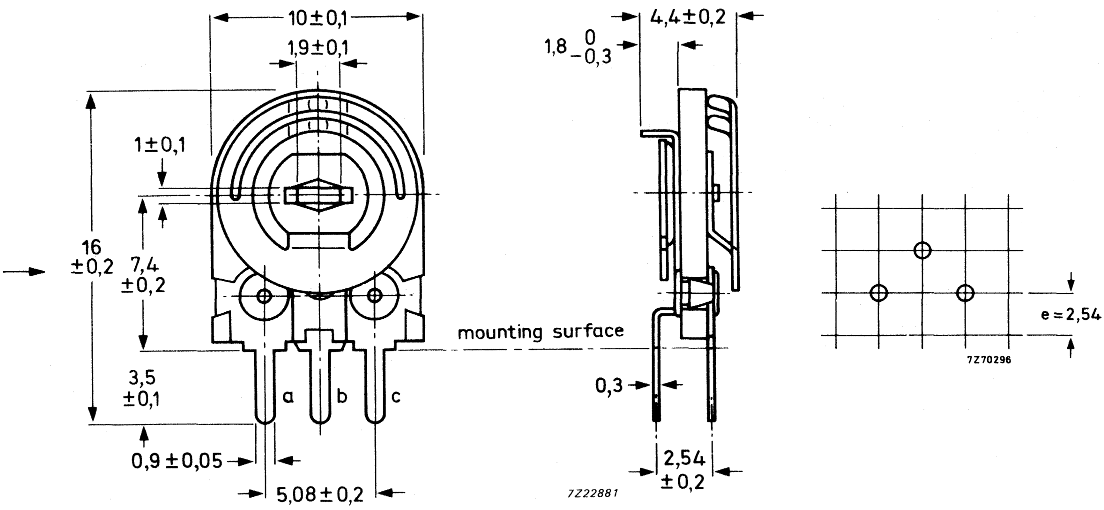


Fig. 3 Potentiometer for vertical mounting, 2322 482 3 . . . .

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 MΩ, see Table 1
Tolerance on the nominal resistance	± 20% and ± 10%
Resistance law and tolerances	linear, see Fig. 4
Terminal resistance	⩽ 0.5% of R_{ac} or 2 Ω, whichever is the greater
Contact resistance variation (CRV)	⩽ 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	
$R_{nom} \leqslant 1\ M\Omega$	$\pm\ 50 \cdot 10^{-6}$/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 ± 5°
Mechanical angle of rotation	235 ± 5°
Rotational life	200 cycles
Settability	0.1% of R_{ac} within 10 s
Mass	approx. 0.8 g

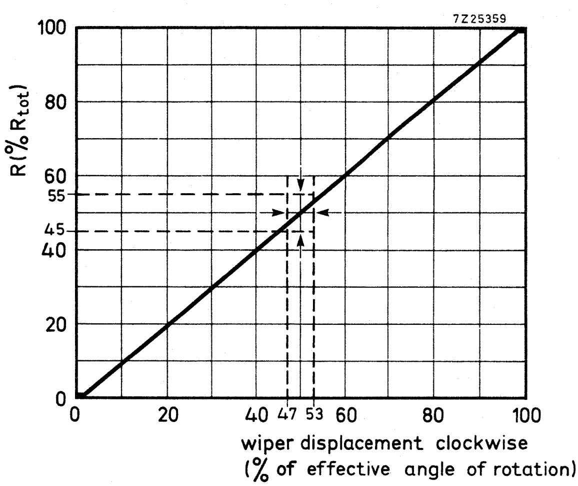


Fig. 4 Linear law.

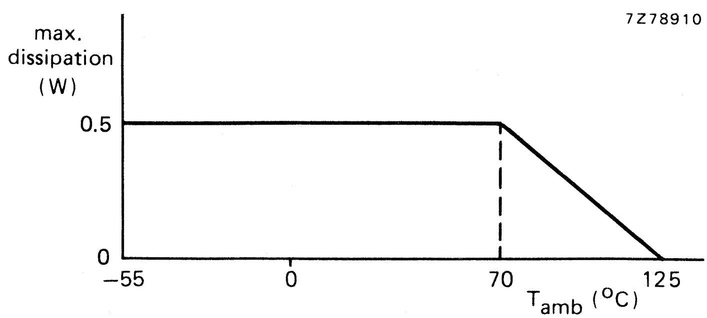


Fig. 5 Maximum dissipation as a function of ambient temperature.

COMPOSITION OF THE CATALOGUE NUMBER

2322 482 . . . . .

code for version — code for tolerance — code for nominal resistance, see Table 1

code for tolerance
0 = ± 20%
2 = ± 10%

code for version:

2 = horizontal mounting (assymetric), longitudinal slot
3 = vertical mounting, longitudinal slot
4 = horizontal mounting (symmetric), longitudinal slot
6 = horizontal mounting (assymmetric), cross slow
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	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0.1\%$
6.25	Eb	Bump	acceleration: 40g number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0.1\%$
6.24	Fc	Vibration	frequency: 10 - 500 Hz amplitude: 0.75 mm or 10g, 3 directions, 2h per direction	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0.1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0.2\%$
6.13		Temperature characteristic of resistance	temp. cycle: + 20 °C; −25 °C; + 20 °C; + 70 °C + 20 °C	$-50 < TC < +50.10^{-6}/K$
6.23	Na	Change of temperature	−55 °C and + 125 °C; 5 cycles, ½ h	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0.5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0.2\%$
6.26	—	Climatic sequence		
6.26.2	Ba	Dry heat	16 h at 70 °C	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0.5\%$ operating torque $\leqslant$ 36 mNm
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	CRV < 1% of R_{nom} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0.2\%$
			Load: 0.33 W between a and b	$\frac{\Delta R_{ab}}{R_{ab}} \leqslant 3\%$

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

→ **PACKAGING**

50 items per blister
1000 per box.

6 mm SEALED CERMET PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range, linear law	10 Ω to 2 MΩ
Maximum dissipation at 70 °C	0.5 W
Climatic category, IEC 68	55/125/56
Immersion sealed	

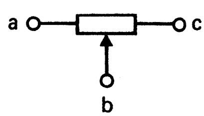
APPLICATION

These potentiometers are for preset resistance control with provision for re-adjustments. They are particularly suitable for use in professional and industrial applications where:

- Immersion cleaning of printed circuit boards is employed
- High stability and/or protection against industrial environment is necessary.

DESCRIPTION

The potentiometers comprise a thick film resistance element on a ceramic base. Terminals a and c (Figs 1 to 7) are connected to the ends of the resistance element; terminal b is connected to the wiper. The potentiometers are available in versions for either horizontal or for vertical mounting on printed wiring boards.



7Z85818

Fig.1 Terminal designation.

MECHANICAL DATA

Dimensions in mm

All unspecified tolerances: ± 0.3

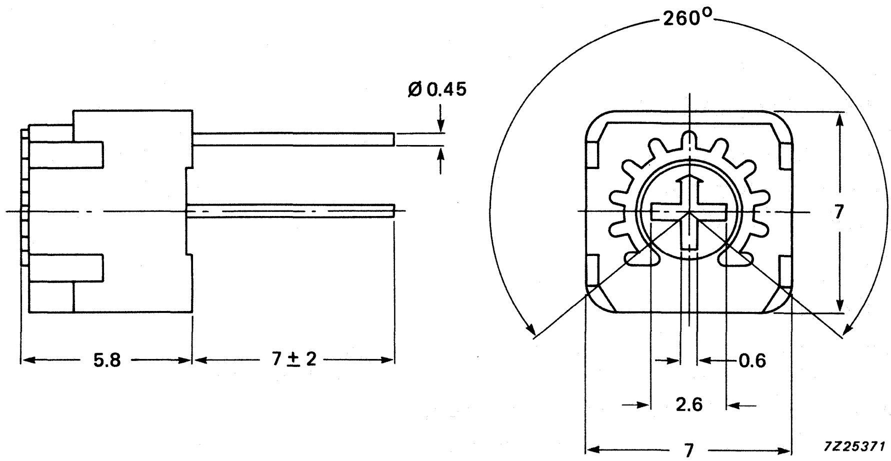


Fig.2 Horizontal mounting version.

Hole patterns for horizontal mounting version

Viewed from component side

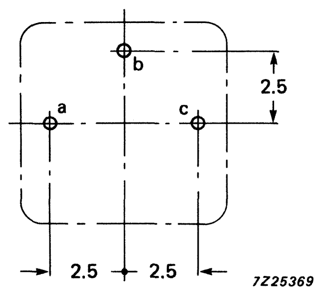


Fig.3 Potentiometer 2322 491 00 . . .
(P type)

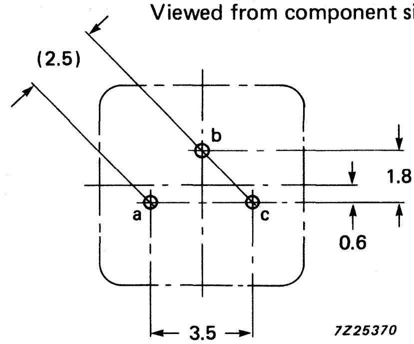


Fig.4 Potentiometer 2322 491 01 . . .
(W type)

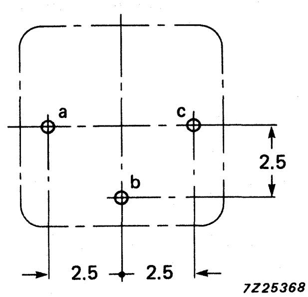


Fig.5 Potentiometer 2322 491 02 . . .
(R type)

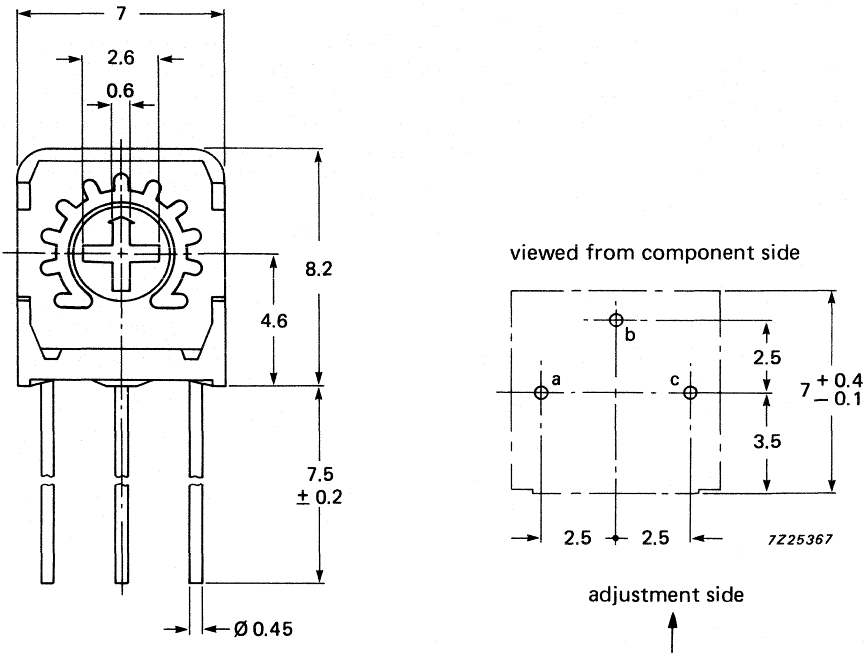


Fig.6 Outline and hole pattern for vertical mounting version 2322 491 04 . . . (S type).

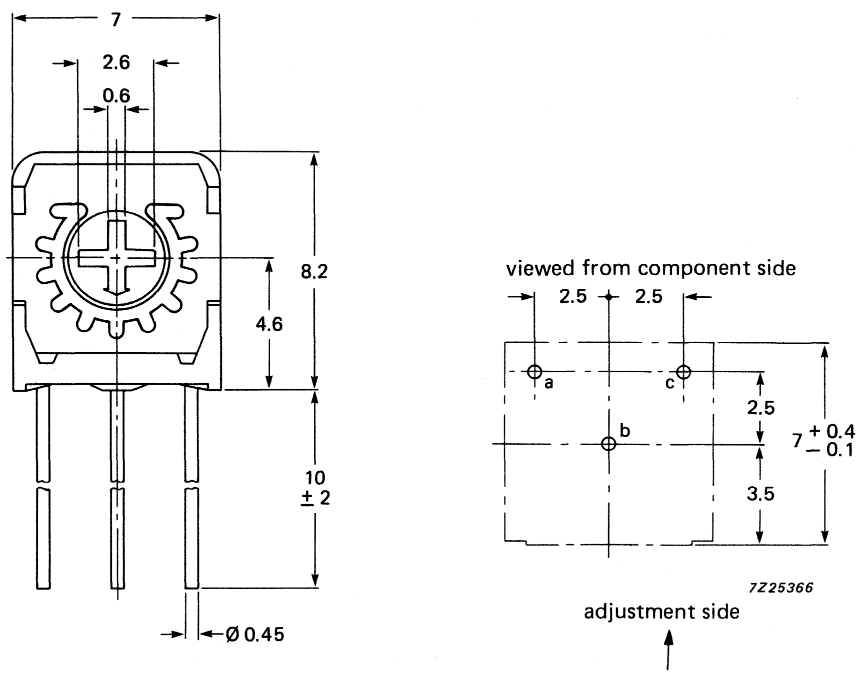


Fig.7 Outline and hole pattern for vertical mounting version 2322 491 05 . . . (X type).

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})	10 Ω to 2 MΩ
Tolerance on the nominal resistance	± 10%
Resistance law and tolerances	linear (see Fig.8)
Terminal resistance	≤ 1% of R_{ac} or 2 Ω whichever is the greater
Contact resistance variation (CRV)	≤ 1% of R_{ac} or 2 Ω whichever is the greater
Maximum dissipation (P_{max}) at 70 °C	0.5 W (see Fig.9)
Limiting voltage (DC)	250 V
Limiting wiper current	100 mA or $\sqrt{\frac{P_{max}}{R_{nom}}}$ whichever is the smaller
Operating temperature range	−55 to + 125 °C
Temperature coefficient	
$R_{nom} \leq 50\ \Omega$	$\pm 250.10^{-6}$ /K
$R_{nom} \geq 100\ \Omega$	$\pm 100.10^{-6}$ /K
Operating torque	≤ 20 mNm
Maximum permissible end stop torque	± 50 mNm
Effective angle of rotation	220°
Mechanical angle of rotation	260°
Rotational life	200 cycles
Settability	0.1% of R_{ac} within 10 s
Mass	approx. 0.5 g
DC insulation resistance	≥ 1000 MΩ (500 V)
Minimum AC dielectric strength (1 minute)	900 V

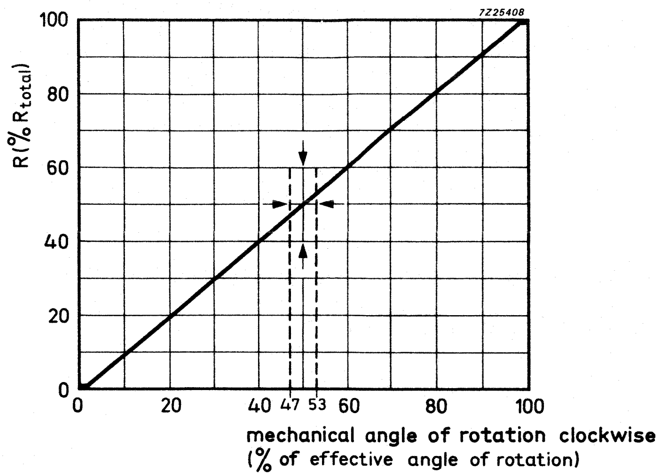


Fig.8 Linear law.

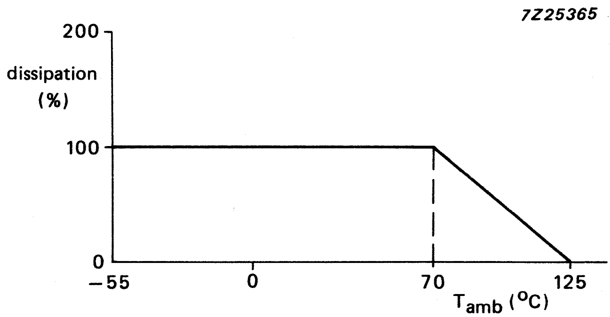


Fig.9 Maximum dissipation as a function of ambient temperature.

MARKING

The potentiometers are marked with the coded resistance value, the design code and a production code.

Example of resistance code: 200 Ω = 201
10 KΩ = 103
1 MΩ = 105

The package is marked with: code number
date of production
quantity.

PACKAGING

The potentiometers are supplied in bulk; i.e. 2000 per package (2322 491 0 . . . .) .

COMPOSITION OF THE CATALOGUE NUMBER

2322 491 . . . . .

code for type and packaging

0 = bulk packaging
1 = reserved
2 = reserved
9 = reserved for specials

code for version PW tags

0 = P type
1 = W type
2 = R type
4 = S type
5 = X type

code for nominal resistance

109	= 10 Ω	103	= 10 kΩ
209	= 20 Ω	203	= 20 kΩ
509	= 50 Ω	503	= 50 kΩ
101	= 100 Ω	104	= 100 kΩ
201	= 200 Ω	204	= 200 kΩ
501	= 500 Ω	504	= 500 kΩ
102	= 1 kΩ	105	= 1 MΩ
202	= 2 kΩ	205	= 2 MΩ
502	= 5 kΩ		

TESTS AND REQUIREMENTS

clause number and test	D or ND	conditions of test	performance requirements
Sub-group B2 4.23.1 Soldering: Solderability	D	Solder bath method: Temperature: 230 °C ± 10 °C Duration: 2 ± 0.5 s	The terminations shall be examined for good tinning as evidenced by free flowing of the solder with wetting of the terminations
Sub-group C1 4.14 Temperature characteristic of resistance 4.18 End-stop torque	ND	 50 mNm	See ratings and characteristics As specified in 4.18.1
Sub-group C2A 4.23.2 Soldering: Resistance to heat	D	350 °C 3 s Element resistance	ΔR: ≤ ± 1% R
Sub-group C2B 4.24 Change of temperature	D	T_A: Lower category temperature T_B: Upper category temperature Visual examination Output ratio Element resistance	 As specified in 4.24.5 $\frac{\Delta V_{ab}}{V_{ac}}$: ≤ ± 1% ΔR : ≤ ± 1% R
Shock	D	100 g: 6 directions; 3 times Element resistance Output ratio	 ΔR : ≤ ± 1% R $\frac{\Delta V_{ab}}{V_{ac}}$: ≤ ± 1%
Vibration	D	20 g: 10/2000 Hz; 12 hours Element resistance Output ratio	 ΔR: ≤ ± 1% R $\frac{\Delta V_{ab}}{V_{ac}}$: ≤ ± 1%

Tests and requirements (continued)

clause number and test	D or ND	conditions of test	performance requirements
Sub-group C2C	D		
4.28 Climatic test:		Visual examination	As specified in 4.28.2.2
Damp heat, cyclic, 10 cycles		Element resistance	ΔR: $\leqslant \pm$ 2% R
Cold		−55 °C Duration 2 hours	
		Visual examination	As specified in 4.28.10.1
		Element resistance	ΔR: $\leqslant \pm$ 2% R
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm$ 2%
Sub-group C3	D		
4.32.2 Electrical endurance at 70 °C		See D1.3 Duration: 1000 hours Loaded between a and c	
		Visual examination	As in 4.32.2.6(1)
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm$ 1%
		Element resistance	Δ_R : $\leqslant \pm$ 2% R
All specimens		Rotational noise	(0 to top) $\leqslant$ 1% R or 3 Ω
Sub-group C4	D		
4.30 Mechanical endurance		Number of cycles: 200 Rate: 4 ± 1 cycles per minute See C1.4	
		Visual examination	As in 4.30.6
		Element resistance	ΔR : $\leqslant \pm$ (3% R + 2 Ω)
		Starting torque	As in detail specification
		Rotational noise	(0 to top) $\leqslant$ 1% or 3 Ω

clause number and test	D or ND	conditions of test	performance requirements
Sub-group D1	D		
4.29 Damp heat, steady state		4.29.2.2 shall apply. Each group shall contain four specimens	
		DC load (see note 3)	
		Final measurements: Visual examination	As specified in 4.29.6.1
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}: \leqslant \pm 2\%$
		Element resistance	$\Delta R: \leqslant \pm 2\%$ R
		Starting torque	As in detail specification
		Rotation noise Method B	$\leqslant 2\%$ R
Sub-group D2	D		
4.32.3 Electrical endurance at upper category temperature		See D1.2 Duration: 250 hours	
		Visual examination	As specified in 4.32.3.7. (1)
		Element resistance	$\Delta R: \leqslant \pm 3\%$ R
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}: \leqslant \pm 2\%$

Notes to Tests and Requirements

1. Paragraph numbers refer to CECC 41 000.
2. Abbreviations in column 2 are as follows: D = Destructive
ND = Non-destructive.
3. The DC load test or the isolation voltage test are alternatives. The detail specification shall indicate which test has been selected.

RELATED DOCUMENTS

IEC 62 : Marking codes for resistors and capacitors.

IEC 63 : Preferred number series for resistors and capacitors.

IEC68 : Basic environmental testing procedures for electronic components and electronic equipment.

IEC 393-1 : Potentiometers — Part 1 : terms and methods of test.

CECC 41 000 (1976) — Generic specification for potentiometers and amendments 1 to 3.

CECC 41 100 (1978) — Sectional specification for lead-screw actuated and rotary preset potentiometers and amendment 1.

CECC 41 101 (1978) — Blank detail specification for preset potentiometers.

MIL-Std-202 : Test methods for electronic and electrical component parts.

10 mm ENCLOSED CERMET PRESET POTENTIOMETERS

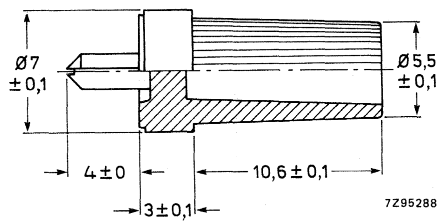
QUICK REFERENCE DATA

Resistance range (E6-series), linear law	47 Ω to 10 MΩ
Maximum dissipation at 40 °C	0,5 W
Climatic category, IEC 68-2	55/125/56

DESCRIPTION

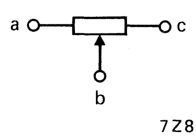
These preset potentiometers comprise a metal-glaze resistive element on a ceramic base. The actuating device is a plastic rotor. Adjustment is by means of insulated hexagonal or cross slots. The overall width of 9,8 mm alows for high density use with air-gap isolation on a 2,5 mm grid; either horizontal 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.



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

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.

MECHANICAL DATA

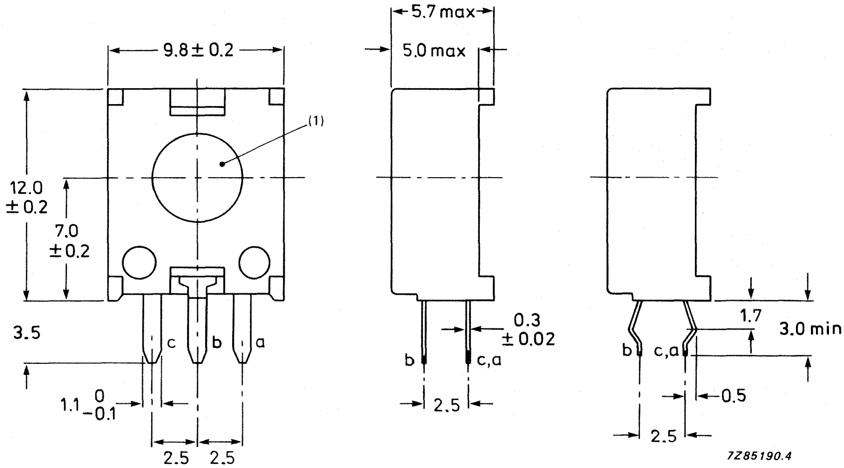


Fig. 1 Vertical mounting version.

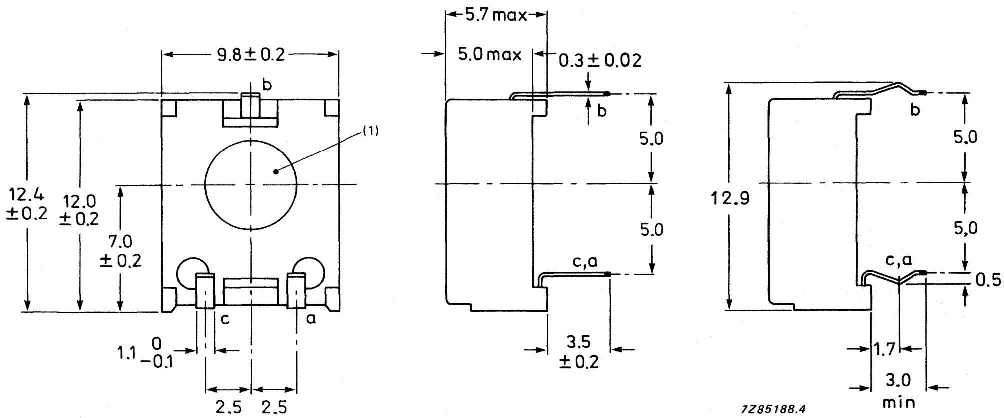


Fig. 2 Horizontal mounting.

Note to mechanical data

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

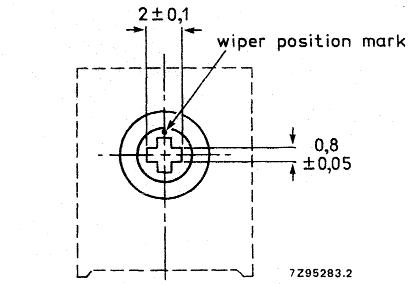


Fig. 3 Cross slot.

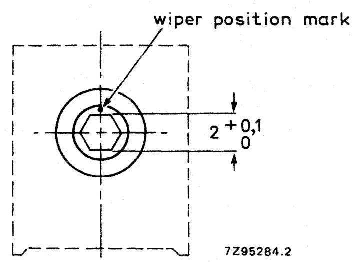


Fig. 4 Hexagonal slot.

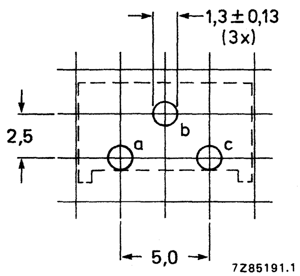


Fig. 5 Hole pattern for vertical versions, viewed from component side.

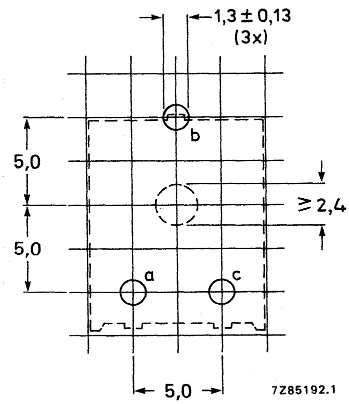


Fig. 6 Hole pattern for horizontal versions, viewed from component side.

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. 8
Rated dissipation at 40 °C (P_{max})		0,5 W, see Fig. 7
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		
$R_{nom} \leqslant 100\ \Omega$		$\pm 200 \cdot 10^{-6}$/K
$100 < R_{nom} < 1\ M\Omega$		$\pm 50 \cdot 10^{-6}$/K
$R_{nom} \leqslant 1\ M\Omega$		$\pm 100 \cdot 10^{-6}$/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		295 ± 5°
Settability		0,1% within 10 s
Climatic category according to IEC 68-2		55/125/56
Climatic sequence	$\frac{\Delta R_{ac}}{R_{ac}}$	≤ 2%
Damp heat, steady state	$\frac{\Delta R_{ac}}{R_{ac}}$	≤ 2%
Mechanical endurance (200 cycles)	$\frac{\Delta R_{ac}}{R_{ac}}$	≤ 2%
Electrical endurance (1000 h at 70 °C, cyclic)	$\frac{\Delta R_{ac}}{R_{ac}}$	≤ 2%
Change of temperature (between −55 °C and + 125 °C)	$\frac{\Delta R_{ac}}{R_{ac}}$	≤ 2%
	$\frac{\Delta V_{ab}}{V_{ac}}$	≤ 1%
Resistance to soldering heat	$\frac{\Delta R_{ac}}{R_{ac}}$	≤ 0,5%
Bump	$\frac{\Delta R_{ac}}{R_{ac}}$	≤ 1%
Vibration	$\frac{\Delta R_{ac}}{R_{ac}}$	≤ 1%
	$\frac{\Delta V_{ab}}{V_{ac}}$	≤ 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.

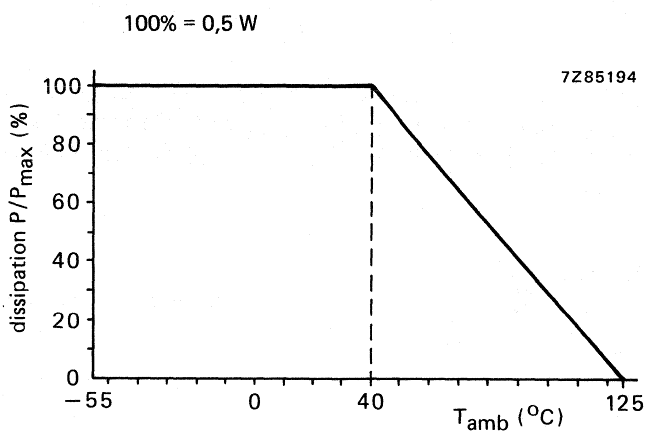


Fig. 7 Dissipation as a function of ambient temperature.

RESISTANCE LAW

Potentiometers covered by this specification are linear.

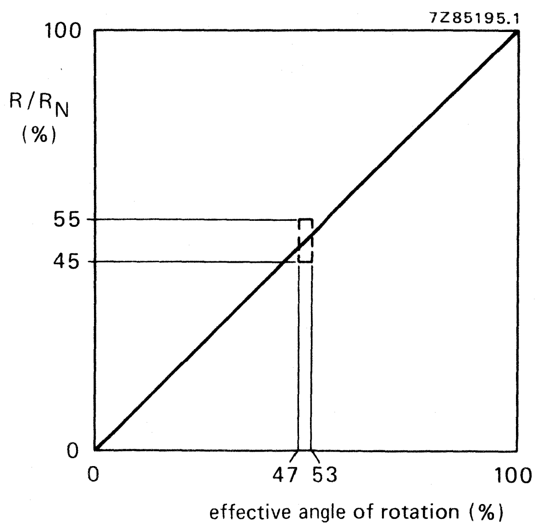


Fig. 8 Linear resistance law.

MARKING

The potentiometers are marked with the rated resistance, according to IEC 62, e.g. 220 Ω = 220 R; 10 kΩ = 10 k; 1 MΩ = 1 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.9.

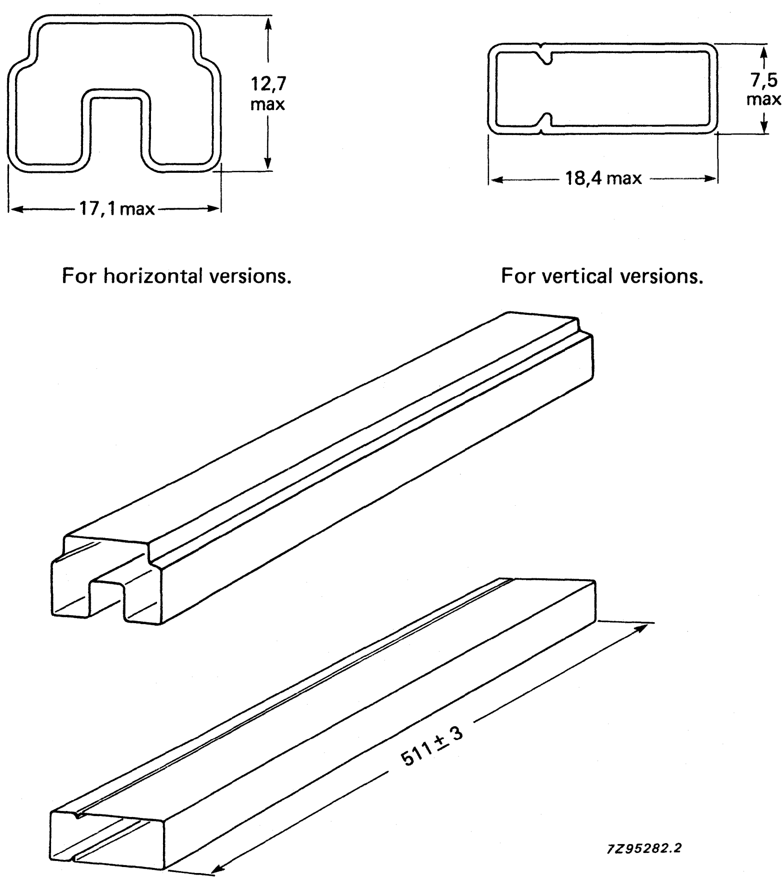


Fig.9 Outlines of the rail packaging.

COMPOSITION OF THE CATALOGUE NUMBER

2322 484 . . . . .

code for version
1 = vertical, hexagonal slot
2 = vertical, cross slot
6 = horizontal, hexagonal slot
7 = horizontal, cross slot

code for tolerance, tags, packaging
2 = ± 20%, snap-in pins, bulk packaging
3 = ± 10%, snap-in pins, bulk packaging
4 = ± 20%, straight pins, bulk packaging
5 = ± 10%, straight pins, bulk packaging
6 = ± 20%, snap-in pins, rail packaging
7 = ± 10%, snap-in pins, rail packaging
8 = ± 20%, straight pins, rail packaging
9 = ± 10%, straight pins, rail packaging

resistance code

479 = 47 Ω	333 = 33 kΩ
689 = 68 Ω	473 = 47 kΩ
101 = 100 Ω	683 = 68 kΩ
151 = 150 Ω	104 = 100 kΩ
221 = 220 Ω	154 = 150 kΩ
331 = 330 Ω	224 = 220 kΩ
471 = 470 Ω	334 = 330 kΩ
681 = 680 Ω	474 = 470 kΩ
102 = 1 kΩ	684 = 680 kΩ
152 = 1,5 kΩ	105 = 1 MΩ
222 = 2,2 kΩ	155 = 1,5 MΩ
332 = 3,3 kΩ	225 = 2,2 MΩ
472 = 4,7 kΩ	335 = 3,3 MΩ
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	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}1\%$
6.25	Eb	Bump	acceleration: 390 m/s^2 number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}1\%$
6.24	Fc	Vibration	frequency: 10 - 500 Hz amplitude: 0,75 mm or 98 m/s^2, 6 h	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}3\%$

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	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}2\%$
6.26	–	Climatic sequence		
6.26.2	Ba	Dry heat	16 h at 125 °C	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$
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} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 5\%$
6.29	–	Mechanical endurance	200 cycles, 4 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 1\%$ 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} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 1\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 2\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}2\%$

MULTITURN POTENTIOMETERS

CARBON MULTITURN PRESET

QUICK REFERENCE DATA

Nominal resistance	
linear law	100 Ω – 4,7 MΩ
logarithmic law	1 kΩ – 2,2 MΩ
special law	100 kΩ
Number of turns of spindle	
potentiometers CMP10	10
potentiometers CMP20	20
potentiometers CMP40	40
Climatic category (IEC 68)	25/070/21

APPLICATION

The potentiometers are for preset tuning adjustment in variable capacitance diode television tuners, but can also be used for variable capacitance diode tuning radio receivers, or for any other fine resistance adjustment.

DESCRIPTION

A straight carbon track is fitted on to a base plate of resin-bonded paper, which is mounted in a housing of black synthetic resin. The terminals are suited for mounting on printed-wiring boards. The slider is activated by a silvered threaded spindle. The potentiometer will not be damaged if the spindle is turned beyond its extreme position. The potentiometers can be supplied with various adjustments and with or without a scale indicator.

All versions are available with linear or logarithmic resistance law; the 100 kΩ versions are also available with special resistance law.

COMPOSITION OF THE CATALOGUE NUMBER

2322 41 . . . . .

code for number of turns of spindle
2 = 20 turns, type CMP20
3 = 10 turns, type CMP10
4 = 40 turns, type CMP40

code for indicator, see Indicators

code for adjustment provision, see Adjustment provisions.

code for nominal resistance value, see Table 1

MECHANICAL DATA

Dimensions of the housing (mm)

The housing has been drawn without scale indicator and adjustment provision; these parts are described in the relevant paragraph.

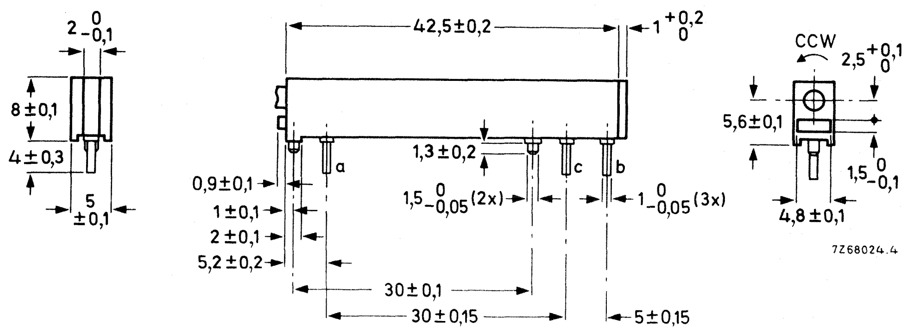


Fig. 1 Terminals a and c are connected to the ends of the carbon track; terminal b is connected to the slider contact.

Operating temperature range	−25 to + 70 °C
Climatic category (IEC 68)	25/070/21
Operating torque	1,5 to 10 mNm
Number of turns of spindle	
potentiometers CMP10	9½ ± ½
potentiometers CMP20	19 ± ½
potentiometers CMP40	38 ± 1
Maximum permissible axial spindle load (push and pull)	≤ 2,5 N
Mechanical travel of slider contact	25,6 ± 0,3 mm
Effective travel of slider contact	24 − 1 mm
Solderability (to IEC 68-2, test T)	230 ± 10 °C, for 2 ± 0,5 s
Thermal shock test (to IEC 68-2, test T)	350 ± 10 °C, for 2 ± 0,5 s
Life (at a rate of 20 rev/min)	50 x in both directions + 3 rotations at both ends

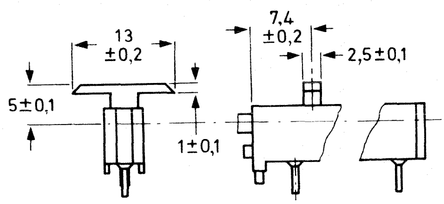
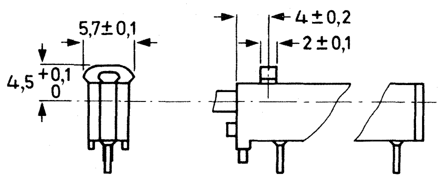
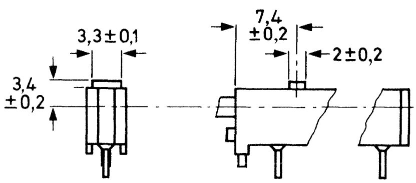
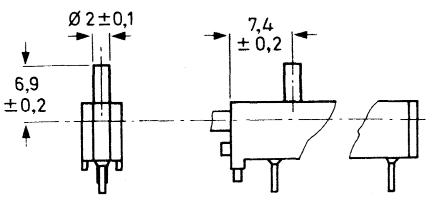
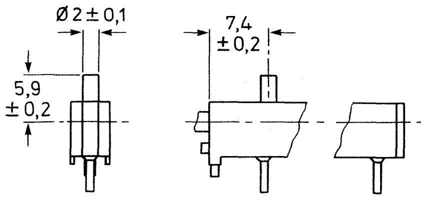
MOUNTING

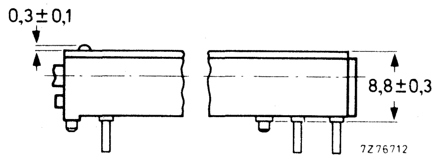
The terminals may be dip-soldered to a depth of 2 mm max in a solder bath of 260 °C max for 4 s max. When a soldering bit is used, its temperature must not exceed 360 °C for 1,5 s and neither axial nor radial stress must be exerted on the terminals.

MARKING

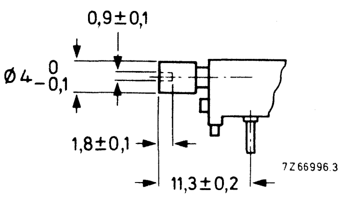
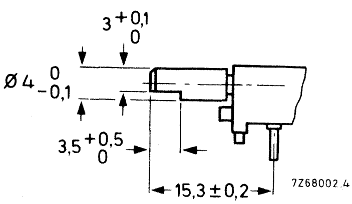
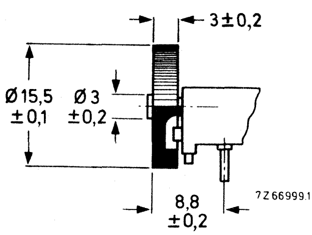
The potentiometers are marked with nominal resistance, resistance law, month and year of manufacture.

Indicators

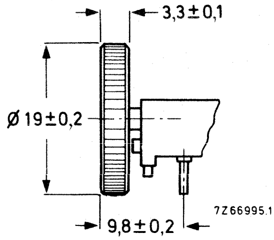
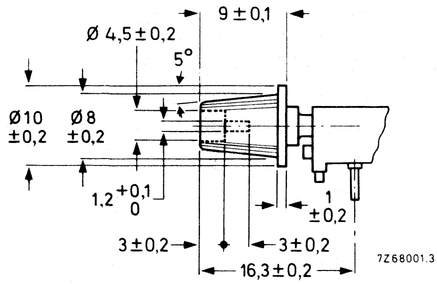
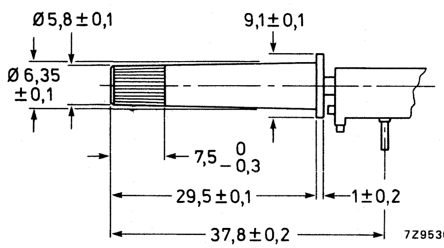
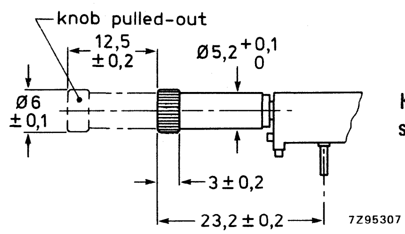
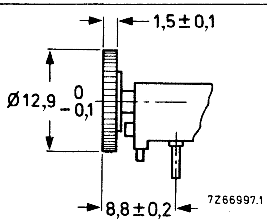
type	colour	code in catalogue number 2322 41 . . . . . .
 7Z68006.3	red	1
 7Z68004.1	red	3
 7Z68005.1	yellow	4
 7Z68007.1	red	5
 7Z95306	red	7

type	colour	code in catalogue number 2322 41 . ...
without indicator		0
without indicator, with black dust cover on the housing 		8

Adjustment provisions

type	colour	code in catalogue number 2322 41 . .....
	grey	51
	grey	52
 Knob: approx. 60 notches	red	61

→ **Note:** Other indicators and knobs are available on request.

type	colour	code in catalogue number 2322 41 . .....
 Knob: approx. 48 notches	black	62
	black	63
 Knob with cross shaped trimming slot 4,4 x 1,6	black	69
 Knob with trimming slot 4,4 x 0,8	black	71
 number of teeth = 24 tooth height = 1,2	white	82

ELECTRICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 35 °C, an air pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Table 1

nominal resistance R_{nom}	resist. law	max. voltage (V DC or V AC) T_{amb} = 40 °C $\Delta R < 20\%$ (note 1)	max. voltage T_{amb} = 40 °C $\Delta R < 10\%$ (note 1)	max. voltage T_{amb} = 70 °C $\Delta R < 20\%$ (note 1)	maximum terminal resistance	max. attenuation dB	limiting slider current mA	code in cat. no.
100 Ω	linear	5,5	5,0	3,9	10 Ω	20	55	01
220 Ω	linear	8,1	7,4	5,7	20 Ω	20	37	02
470 Ω	linear	11,8	10,8	8,4	35 Ω	30	25	03
1 kΩ	linear	17	15,8	12,2	50 Ω	30	17	04
2,2 kΩ	linear	26	23	18	100 Ω	40	11	05
4,7 kΩ	linear	37	34	24	200 Ω	40	8	06
10 kΩ	linear	53	47	37	300 Ω	40	5,3	07
22 kΩ	linear	76	66	54	600 Ω	50	3,5	08
47 kΩ	linear	108	91	76	1 kΩ	50	2,3	09
100 kΩ	linear	152	122	107	2 kΩ	50	1,5	11
220 kΩ	linear	217	166	153	3,5 kΩ	60	0,99	12
470 kΩ	linear	306	216	216	6 kΩ	60	0,85	13
1 MΩ	linear	425	274	300	10 kΩ	70	0,43	14
2,2 MΩ	linear	600	330	420	20 kΩ	70	0,27	15
4,7 MΩ	linear	840 (2)	340	590	50 kΩ	70	0,18	16
1 kΩ	logarithmic	10	8,9	7,1	10 Ω (5)	40	10 (3)	24
2,2 kΩ	logarithmic	14	12,8	10,2	20 Ω (5)	50	6,8 (3)	25
4,7 kΩ	logarithmic	20	17,5	14,5	35 Ω (5)	50	4,4 (3)	26
10 kΩ	logarithmic	29	24	20	50 Ω (5)	50	2,9 (3)	27
22 kΩ	logarithmic	42	34	29	100 Ω (5)	60	1,9 (3)	28
47 kΩ	logarithmic	59	47	41	200 Ω (5)	60	1,3 (3)	29
100 kΩ	logarithmic	85	63	60	250 Ω (5)	60	0,85 (3)	31
220 kΩ	logarithmic	122	87	86	500 Ω (5)	70	0,55 (3)	32
470 kΩ	logarithmic	172	112	120	1 kΩ (5)	70	0,37 (3)	33
1 MΩ	logarithmic	240	141	170	2 kΩ (5)	80	0,24 (3)	34
2,2 MΩ	logarithmic	350	182	244	5 kΩ (5)	80	0,16 (3)	35
100 kΩ	special	85	63	60	500 Ω	60	0,85 (4)	38

Notes

1. Measured after 1000 h.
2. Max. 600 V (AC).
3. Slider contact between 20 and 100% of R_{ac}. For slider contact positions between 0 and 20% of R_{ac} the values have to be multiplied by 6.
4. Slider contact between 20 and 100% of R_{ac}. For slider contact positions between 0 and 20% of R_{ac} the value has to be multiplied by 2,4.
5. Measured between terminals a and b.

Tolerance on nominal resistance	± 20%
Resistance law and tolerance	see Fig. 2
Maximum permissible dissipation (P_{max})	see Fig. 3
Contact resistance between carbon track and slider contact, the slider being moved 1 mm/s (see also Measurement of the contact resistance)	
linear law	$\leqslant$ 3% of R_{ac}
logarithmic law,	
for 0 – 40% of effective travel	$\leqslant$ 0,75% of R_{ac}
for 40 – 70% of effective travel	$\leqslant$ 2% of R_{ac}
for 70 – 100% of effective travel	$\leqslant$ 8% of R_{ac}
special law,	
for 0 – 40% of effective travel	$\leqslant$ 1,2% of R_{ac}
for 40 – 60% of effective travel	$\leqslant$ 3% of R_{ac}
for 60 – 100% of effective travel	$\leqslant$ 6% of R_{ac}
Crackle voltage at maximum slider current of 1 mA, the slider being moved maximum 0,025 mm/s.	
R_{nom} = 100 kΩ, linear law	$\leqslant$ 100 mV
R_{nom} = 100 kΩ, special law,	
for 0 – 60% of effective travel	$\leqslant$ 100 mV
for 60 – 100% of effective travel	$\leqslant$ 150 mV
Change of preset voltage after vibration test (IEC 68, test Fc) and shock test (IEC 68, test Ea)	$\leqslant$ 0,1% of total voltage typ. 0,05% of total voltage

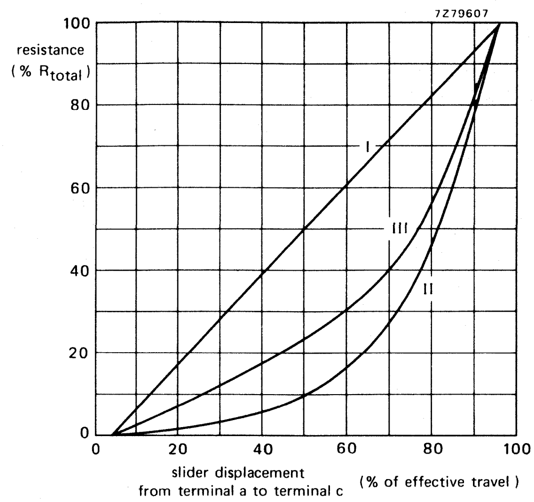


Fig. 2 Resistance as a function of slider displacement. Counter-clockwise knob rotation results in an increase of resistance between a and b (Fig. 1).

curve	resistance law	tolerance on resistance law	
		displacement	resistance
		% of effective travel	% of R_{total}
I	linear	between 36,5 and 38,5 between 61,5 and 63,5	33,5 - 41,5 58,5 - 66,5
II	logarithmic	between 36,5 and 38,5 between 61,5 and 63,5	3,5 - 8,5 12 - 26
III	special	between 36,5 and 38,5 between 61,5 and 63,5 between 86,5 and 88,5	14 - 22 28 - 38 60 - 75

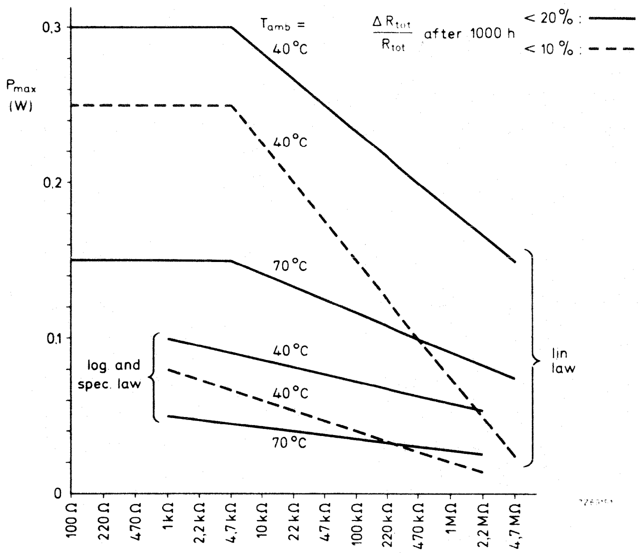


Fig. 3 Maximum permissible power dissipation.

Resistance change as a function of temperature; relative humidity 40 to 80% at 25 °C.

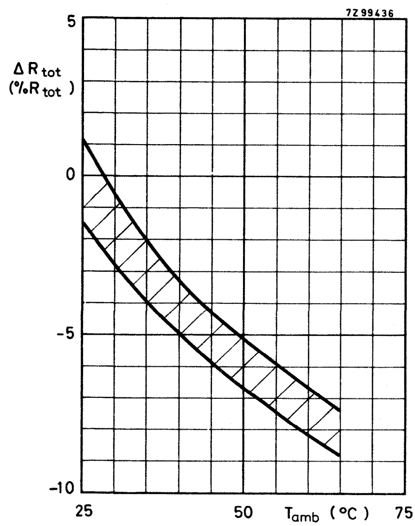


Fig. 4 R_{nom} = 100 kΩ, linear law.

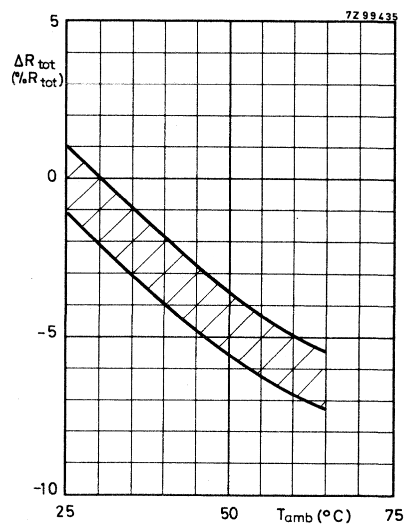


Fig. 5 R_{nom} = 100 kΩ, special law.

Change of preset voltage as a function of temperature, V_{a-b} being 30% of V_{a-c}; relative humidity 40 to 80% at 25 °C.

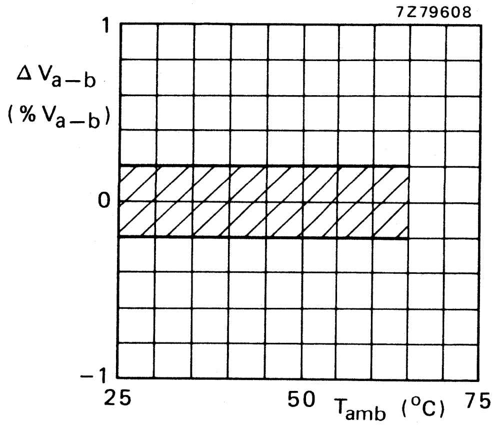


Fig. 6 R_{nom} = 100 kΩ, linear law.

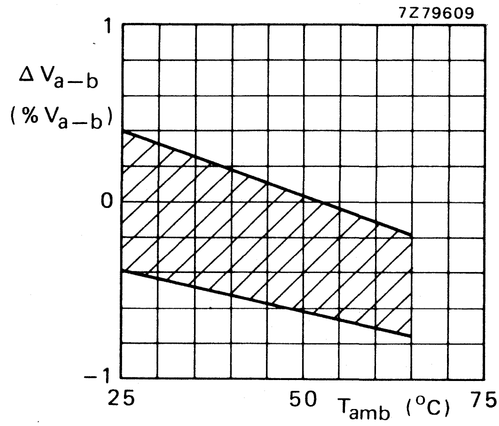


Fig. 7 R_{nom} = 100 kΩ, special law.

→ **PACKAGING**

1000 items per box

9 mm SEALED MULTITURN CERMET PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range, linear law	10 Ω to 5 MΩ
Maximum dissipation at 70 °C	0.5 W
Climatic category, IEC 68	55/125/56
Multiturn - 18 turns	

APPLICATION

These potentiometers are for precision preset resistance control with provision for re-adjustments. They are particularly suitable for use in professional and industrial applications where:

- Immersion cleaning of printed circuit boards is employed
- High stability and/or protection against industrial environment is necessary

DESCRIPTION

The potentiometers comprise a thick film resistance element on a ceramic base. The rotor with multifinger wiper is leadscrew activated.
Terminals a and c (Figs 1 to 4) are connected to the ends of the resistance element; terminal b is connected to the wiper.
The potentiometers are available in versions for either horizontal or for vertical mounting on printed wiring boards.

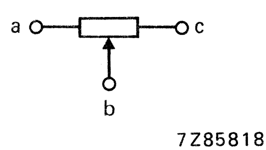
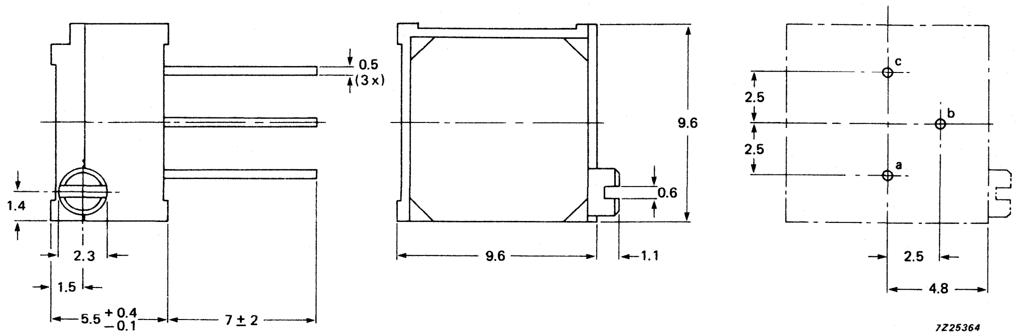


Fig.1 Terminal designation.

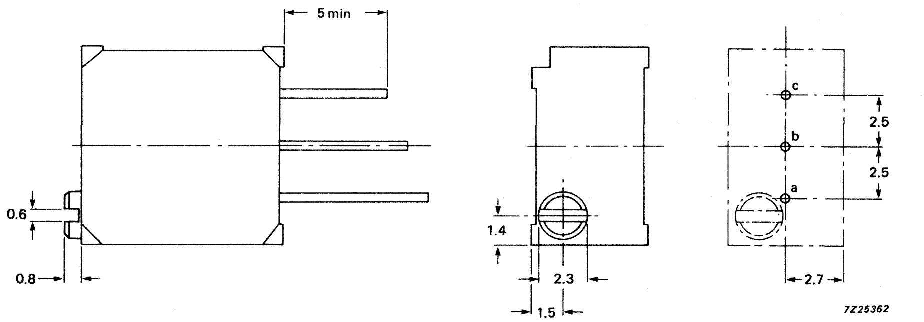
MECHANICAL DATA

Dimensions in mm
All unspecified tolerances: ± 0.3



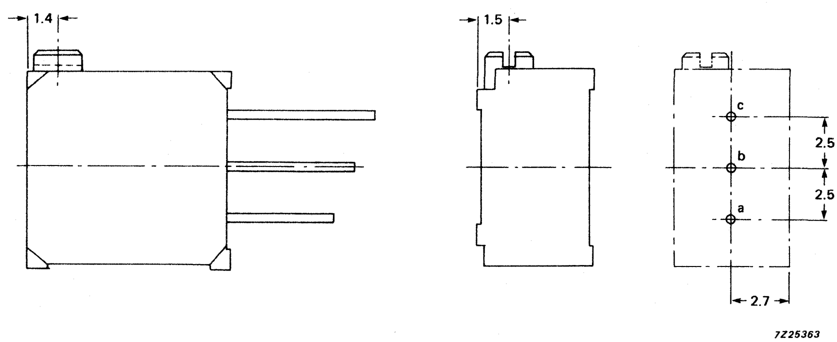
viewed from component side

Fig.2 Outline and hole pattern for horizontal version 2322 491 40 . . . (P type) with side adjustment.



viewed from component side

Fig.3 Outline and hole pattern for vertical version 2322 491 41 . . . (W type) with top adjustment.



viewed from component side

Fig.4 Outline and hole pattern for vertical version 2322 491 45 . . . (X type) with side adjustment.

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})	10 Ω to 5 MΩ
Tolerance on the nominal resistance	± 10%
Resistance law and tolerances	linear see (see Fig.4)
Terminal resistance	$\leqslant$ 1% of R_{ac} or 2 Ω whichever is the greater
Contact resistance variation (CRV)	$\leqslant$ 1% of R_{ac} or 2 Ω whichever is the greater
Maximum dissipation (P_{max}) at 70 °C	0.5 W (see Fig.5)
Limiting voltage (DC)	300 V
Limiting rotor current	100 mA or $\sqrt{\frac{P_{max}}{R_{nom}}}$ whichever is the smaller
Operating temperature range	−55 to + 125 °C
Temperature coefficient	
$R_{nom} \leqslant 50\ \Omega$	$\pm 250.10^{-6}$/K
$R_{nom} \geqslant 100\ \Omega, \leqslant 2\ M\Omega$	$\pm 100.10^{-6}$/K
$R_{nom} > 2\ M\Omega$	$\pm 250.10^{-6}$/K
Operating torque	$\leqslant$ 36 mNm
Maximum permissible end stop torque	wiper idles
Mechanical rotations	18 turns
Settability	0.01% of R_{ac} within 1 s
Mass	approx. 0.97 g
DC insulation resistance	$\geqslant$ 1000 MΩ (500 V)
Minimum AC dielectric strength (1 minute)	900 V

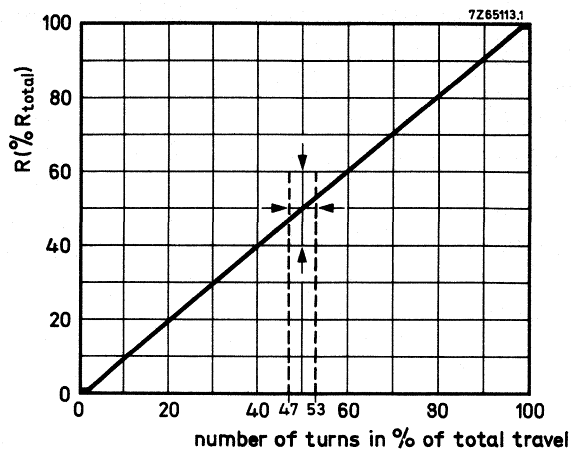


Fig.5 Linear law.

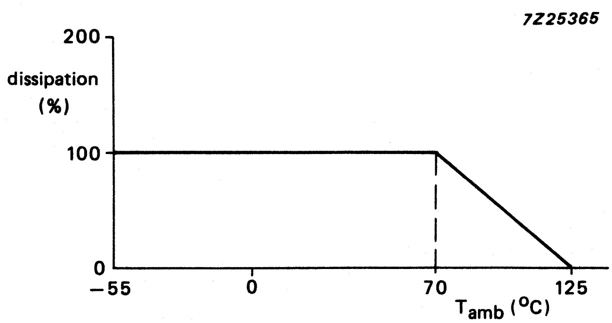


Fig.6 Maximum dissipation as a function of ambient temperature.

MARKING

The potentiometers are marked with the coded resistance value, the design code and a production code.

Example of resistance code: 200 Ω = 201
10 KΩ = 103
1 MΩ = 105

The package is marked with: code number
date of production
quantity.

PACKAGING

The potentiometers are supplied in bulk; i.e. 1000 per package (2322 491 9 . . . .) .

COMPOSITION OF THE CATALOGUE NUMBER

2322 491 . . . . .

code for type and packaging

4 = bulk packaging
9 = reserved for specials

code for version PW tags

0 = P type
1 = W type
5 = X type

code for nominal resistance

109	= 10 Ω	103	= 10 kΩ
209	= 20 Ω	203	= 20 kΩ
509	= 50 Ω	253	= 25 kΩ
101	= 100 Ω	503	= 50 kΩ
201	= 200 Ω	104	= 100 kΩ
501	= 500 Ω	204	= 200 kΩ
102	= 1 kΩ	254	= 250 kΩ
202	= 2 kΩ	504	= 500 kΩ
502	= 5 kΩ	105	= 1 MΩ
		205	= 2 MΩ
		505	= 5 MΩ

TESTS AND REQUIREMENTS

clause number and test	D or ND	conditions of test	performance requirements
Sub-group B2	D		
4.23.1 Soldering Solderability		Solder bath method: Temperature: 230 °C ± 10 °C Duration: 2 ± 0.5 s	The terminations shall be examined for good tinning as evidenced by free flowing of the solder with wetting of the terminations
Sub-group C1	ND		
4.14 Temperature characteristic of resistance			See ratings and characte
4.18 End-stop torque		Wiper idles	
Sub-group C2A	D		
4.23.2 Soldering: Resistance to heat		350 °C 3 s	
		Element resistance	ΔR: ⩽ ± 1% R
Sub-group C2B	D		
4.24 Change of temperature		T_A: Lower category temperature T_B: Upper category temperature	
		Visual examination	As specified in 4.24.5
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: ⩽ ± 1%
		Element resistance	ΔR: ⩽ ± 1% R
Shock	D	100 g: 6 directions; 3 times	
		Element resistance	ΔR: ⩽ ± 1% R
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: ⩽ ± 1%
Vibration	D	20 g: 10/2000 Hz; 12 hours	
		Element resistance	ΔR: ⩽ ± 1% R
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: ⩽ ± 1%

clause number and test	D or ND	conditions of test	performance requirements
Sub-group C2C	D		
4.28 Climatic test:		Visual examination	As specified in 4.28.2.2
Damp heat, cyclic, 10 cycles		Element resistance	ΔR: $\leqslant \pm$ 1% R
Cold		-55 °C Duration 2 hours	
		Visual examination	As specified in 4.28.10.1
		Element resistance	ΔR: $\leqslant \pm$ 1% R
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm$ 2%
Sub-group C3	D D		
4.32.2 Electrical endurance at 70 °C		See D1.3 Duration: 1000 hours Loaded between a and c	
		Visual examination	As in 4.32.2.6(1)
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm$ 1%
		Element resistance	ΔR: $\leqslant \pm$ 2% R
All specimens		Rotational noise	(0 to top) $\leqslant$ 1% R or 2 Ω
Sub-group C4	D		
4.30 Mechanical endurance		Number of cycles: 200 Rate: 4 ± 1 cycles per minute See C1.4	
		Visual examination	As in 4.30.6
		Element resistance	ΔR: $\leqslant \pm$ (3% R + 2 Ω)
		Starting torque	As in detail specification
		Rotational noise	(0 to top) $\leqslant$ 1% or 2 Ω

Tests and Requirements (continued)

clause number and test	D or ND	conditions of test	performance requirements
Sub-group D1	D		
4.29 Damp heat, steady state		4.29.2.2 shall apply. Each group shall contain four specimens	
		DC load (See note 3)	
		Final measurements: Visual examination	As specified in 4.29.6.1
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm 2\%$
		Element resistance	ΔR: $\leqslant \pm 2\%$ R
		Starting torque	As in detail specification
		Rotation noise Method B	$\leqslant 2\%$ R
Sub-group D2	D		
4.32.3 Electrical endurance at upper category temperature		See D1.2 Duration: 250 hours	
		Visual examination	As specified in 4.32.3.7. (1)
		Element resistance	ΔR: $\leqslant \pm 2\%$ R
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm 2\%$

Notes to Tests and Requirements

1. Paragraph numbers refer to CECC 41 000.
2. Abbreviations in column 2 are as follows: D = Destructive
ND = Non-destructive
3. The DC load test or the isolation voltage test are alternatives. The detail specification shall indicate which test has been selected.

RELATED DOCUMENTS

IEC 62 : Marking codes for resistors and capacitors.

IEC 63 : Preferred number series for resistors and capacitors.

IEC 68 : Basic environmental testing procedures for electronic components and electronic equipment.

IEC 393-1 : Potentiometers - Part 1 : terms and methods of test.

CECC 41 000 (1976) - Generic specification for potentiometers and amendments 1 to 3.

CECC 41 100 (1978) - Sectional specification for lead-screw actuated and rotary preset potentiometers and amendment 1.

CECC 41 101 (1978) - Blank detail specification for preset potentiometers.

MIL-Std-202 : Test methods for electronic and electrical component parts.

20 mm SEALED MULTITURN CERMET PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range, linear law	10 Ω to 5 MΩ
Maximum dissipation at 70 °C	0.5 W
Climatic category, IEC 68	55/125/56
Multiturn - 15 turns	

APPLICATION

These potentiometers are for precision preset resistance control with provision for re-adjustments. They are particularly suitable for use in professional and industrial applications where:

- Immersion cleaning of printed circuit boards is employed
- High stability and/or protection against industrial environment is necessary

DESCRIPTION

The potentiometers comprise a thick film resistance element on a ceramic base. The slider with multifinger wiper is leadscrew activated.
Terminals a and c (Figs 1 to 3) are connected to the ends of the resistance element; terminal b is connected to the wiper.
The potentiometers are available in versions for horizontal mounting on printed-wiring boards.

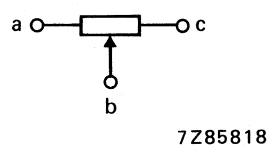


Fig.1 Terminal designation.

MECHANICAL DATA

Dimensions in mm

All unspecified tolerances: ± 0.3

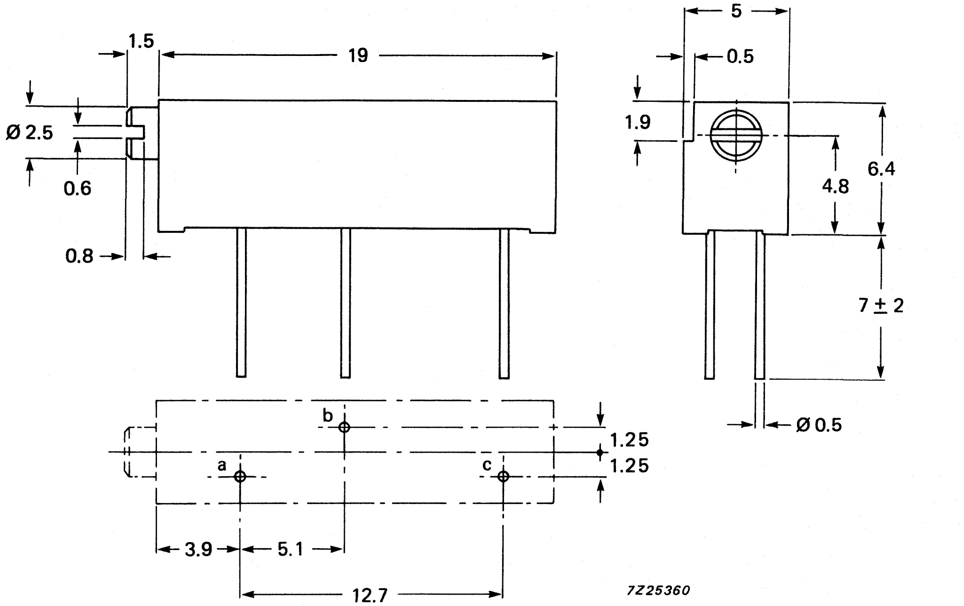


Fig.2 Outline and hole pattern for version 2322 491 60 . . . (P type).

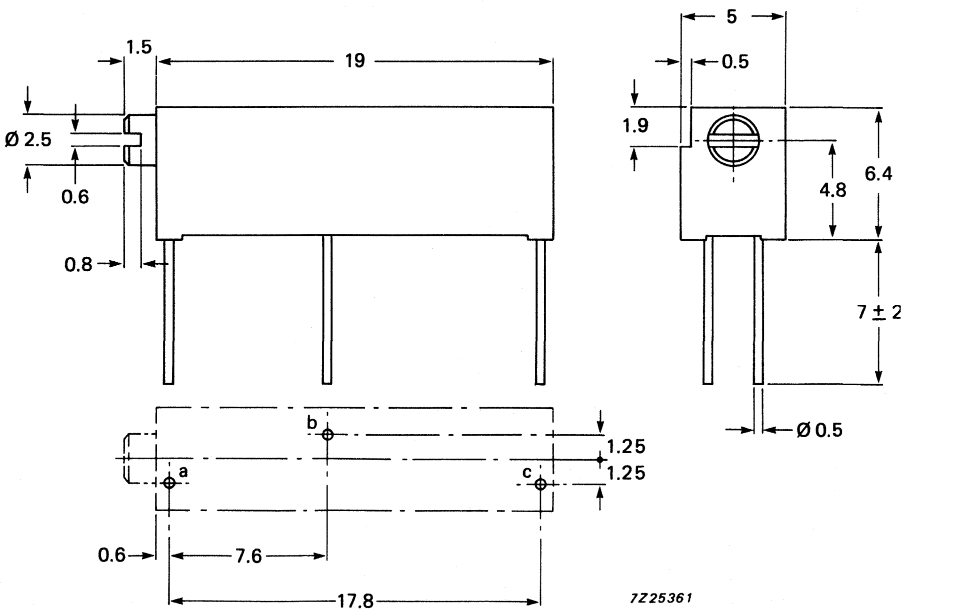


Fig.3 Outline and hole pattern for version 2322 491 65 . . . (X type).

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})	10 Ω to 5 MΩ
Tolerance on the nominal resistance	± 10%
Resistance law and tolerances	linear (see Fig.4)
Terminal resistance	$\leqslant$ 1% of R_{ac} or 2 Ω whichever is the greater
Contact resistance variation (CRV)	$\leqslant$ 1% of R_{ac} or 2 Ω whichever is the greater
Maximum dissipation (P_{max}) at 70 °C	0.5 W (see Fig.5)
Limiting voltage (DC)	300 V
Limiting slider current	100 mA or $\sqrt{\frac{P_{max}}{R_{nom}}}$ whichever is the smaller
Operating temperature range	–55 to + 125 °C
Temperature coefficient	
$R_{nom} \leqslant 50\ \Omega$	$\pm 250.10^{-6}$/K
$R_{nom} \geqslant 100\ \Omega, \leqslant 2$ MΩ	$\pm 100.10^{-6}$/K
$R_{nom} > 2$ MΩ	$\pm 250.10^{-6}$/K
Operating torque	$\leqslant$ 36 mNm
Maximum permissible end stop torque	wiper idles
Mechanical rotations	15 turns
Settability	0.01% of R_{ac} within 1 s
Mass	approx. 1.05 g
DC insulation resistance	$\geqslant$ 1000 MΩ (500 V)
Minimum AC dielectric strength (1 minute)	600 V

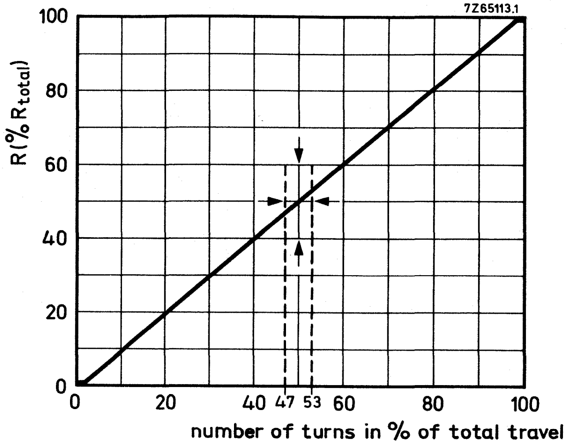


Fig.4 Linear law.

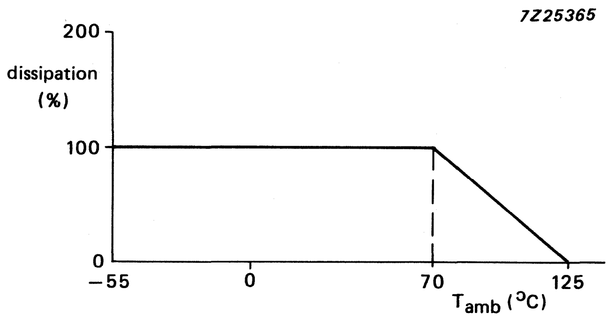


Fig.5 Maximum dissipation as a function of ambient temperature.

MARKING

The potentiometers are marked with the coded resistance value, the design code and a production code.

Example of resistance code: 200 Ω = 201
10 kΩ = 103
1 MΩ = 105

The package is marked with: code number
date of production
quantity.

PACKAGING

The potentiometers are supplied in bulk; i.e. 1000 per package (2322 491 6 . . . .) .

COMPOSITION OF THE CATALOGUE NUMBER

2322 491 . . . . .

code for type and packaging

6 = bulk packaging
9 = reserved for specials

code for version PW tags

0 = P type
5 = X type

code for nominal resistance

109	=	10 Ω	103	=	10 kΩ
209	=	20 Ω	203	=	20 kΩ
509	=	50 Ω	253	=	25 kΩ
101	=	100 Ω	503	=	50 kΩ
201	=	200 Ω	104	=	100 kΩ
501	=	500 Ω	204	=	200 kΩ
102	=	1 kΩ	254	=	250 kΩ
202	=	2 kΩ	504	=	500 kΩ
502	=	5 kΩ	105	=	1 MΩ
			205	=	2 MΩ
			505	=	5 MΩ

TESTS AND REQUIREMENTS

clause number and test	D or ND	conditions of test	performance requirements
Sub-group B2 4.23.1 Soldering: Solderability	D	Solder bath method: Temperature: 230 °C ± 10 °C Duration: 2 ± 0.5 s	The terminations shall be examined for good tinning as evidenced by free flowing of the solder with wetting of the terminations
Sub-group C1 4.14 Temperature characteristic of resistance 4.18 End-stop torque	ND	 Wiper idles	See ratings and characteristics
Sub-group C2A 4.23.2 Soldering: Resistance to heat	D	350 °C 3 s Element resistance	 ΔR: $\leqslant \pm 1\%$ R
Sub-group C2B 4.24 Change of temperature	D	T_A: Lower category temperature T_B: Upper category temperature Visual examination Output ratio Element resistance	 As specified in 4.24.5 $\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm 1\%$ ΔR: $\leqslant \pm 1\%$ R
Shock	D	100 g: 6 directions; 3 times Element resistance Output ratio	 ΔR: $\leqslant \pm 1\%$ R $\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm 1\%$
Vibration	D	20 g: 10/2000 Hz; 12 hours Element resistance Output ratio	 ΔR: $\leqslant \pm 1\%$ R $\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm 1\%$

clause number and test	D or ND	conditions of test	performance requirements
Sub-group C2C	D		
4.28 Climatic test:		Visual examination	As specified in 4.28.2.2
Damp heat, cyclic, 10 cycles		Element resistance	ΔR: $\leqslant \pm$ 1% R
Cold		–55 °C Duration 2 hours	
		Visual examination	As specified in 4.28.10.1
		Element resistance	ΔR: $\leqslant \pm$ 1% R
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm$ 2%
Sub-group C3	D		
4.32.2 Electrical endurance at 70 °C		See D1.3 Duration: 1000 hours Loaded between a and c	
		Visual examination	As in 4.32.2.6(1)
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm$ 1%
		Element resistance	ΔR: $\leqslant \pm$ 2% R
All specimens		Rotational noise	(0 to top) $\leqslant$ 1% R or 2 Ω
Sub-group C4	D		
4.30 Mechanical endurance		Number of cycles: 200 Rate: 4 ± 1 cycles per minute See C1.4	
		Visual examination	As in 4.30.6
		Element resistance	ΔR: $\leqslant \pm$ (3% R + 2 Ω)
		Starting torque	As in detail specification
		Rotational noise	(0 to top) $\leqslant$ 1% or 2 Ω

Tests and Requirements (continued)

clause number and test	D or ND	conditions of test	performance requirements
Sub-group D1	D		
4.29 Damp heat, steady state		4.29.2.2 shall apply. Each group shall contain four specimens	
		DC load (See note 3)	
		Final measurements: Visual examination	As specified in 4.29.6.1
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm 2\%$
		Element resistance	ΔR: $\leqslant \pm 2\%$ R
		Starting torque	As in detail specification
		Rotation noise Method B	$\leqslant 2\%$ R
Sub-group D2	D		
4.32.3 Electrical endurance at upper category temperature		See D1.2 Duration: 250 hours	
		Visual examination	As specified in 4.32.3.7. (1)
		Element resistance	ΔR: $\leqslant \pm 2\%$ R
		Output ratio	$\frac{\Delta V_{ab}}{V_{ac}}$: $\leqslant \pm 2\%$

Notes to Tests and Requirements

1. Paragraph numbers refer to CECC 41 000.
2. Abbreviations in column 2 are as follows: D = Destructive
   ND = Non-destructive
3. The DC load test or the isolation voltage test are alternatives. The detail specification shall indicate which test has been selected.

RELATED DOCUMENTS

IEC 62: Marking codes for resistors and capacitors.

IEC 63: Preferred number series for resistors and capacitors.

IEC 68: Basic environmental testing procedures for electronic components and electronic equipment.

IEC 393-1: Potentiometers - Part 1: terms and methods of test.

CECC 41 000 (1976) — Generic specification for potentiometers and amendments 1 to 3.

CECC 41 100 (1978) — Sectional specification for lead-screw actuated and rotary preset potentiometers and amendment 1.

CECC 41 101 (1978) — Blank detail specification for preset potentiometers.

MIL-Std-202: Test methods for electronic and electrical component parts.

FOCUS CERMET POTENTIOMETERS

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 MΩ ± 20% and 83 MΩ ± 15%*
Maximum dissipation at 70 °C	3,8 W
Climatic category, IEC 68	20/070/21

APPLICATION

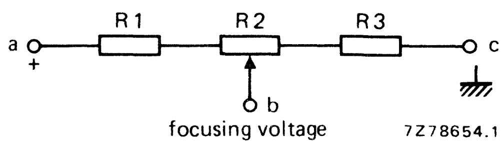
These focus potentiometer units are for adjustment of the focusing voltage for colour picture tubes.

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 Al_2O_3 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

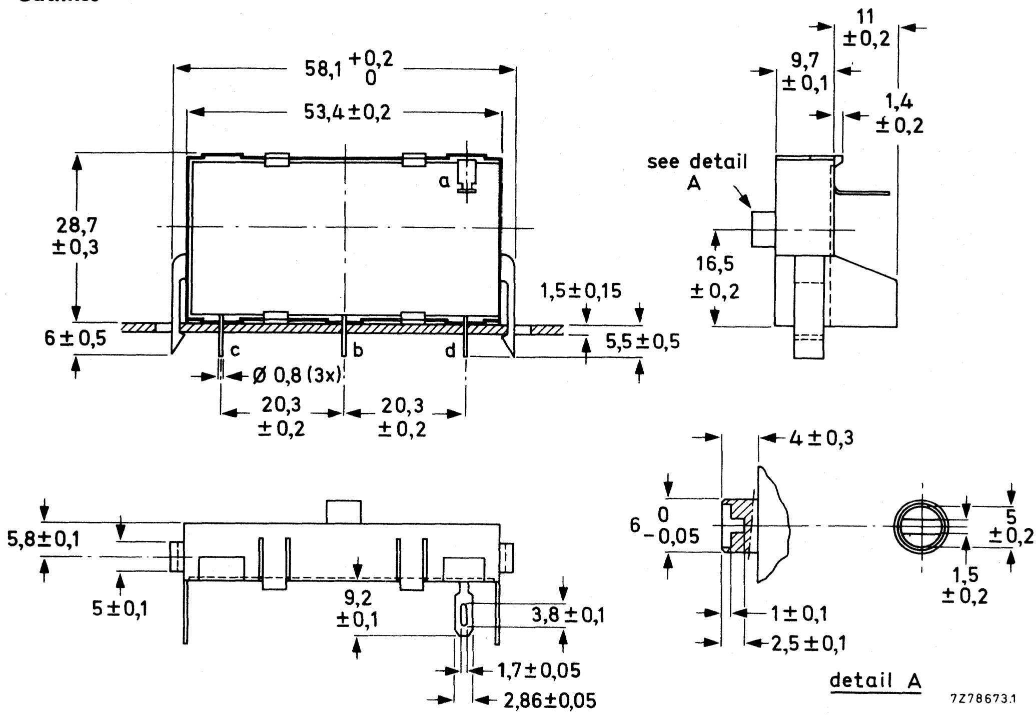


Fig. 2 Potentiometer unit **2322 460 90016**. The indication of the terminals corresponds to those shown in Fig. 1; terminal d serves for mechanical fitting of the unit. Solder tag a fits Faston receptacles (2,8 x 0,5).

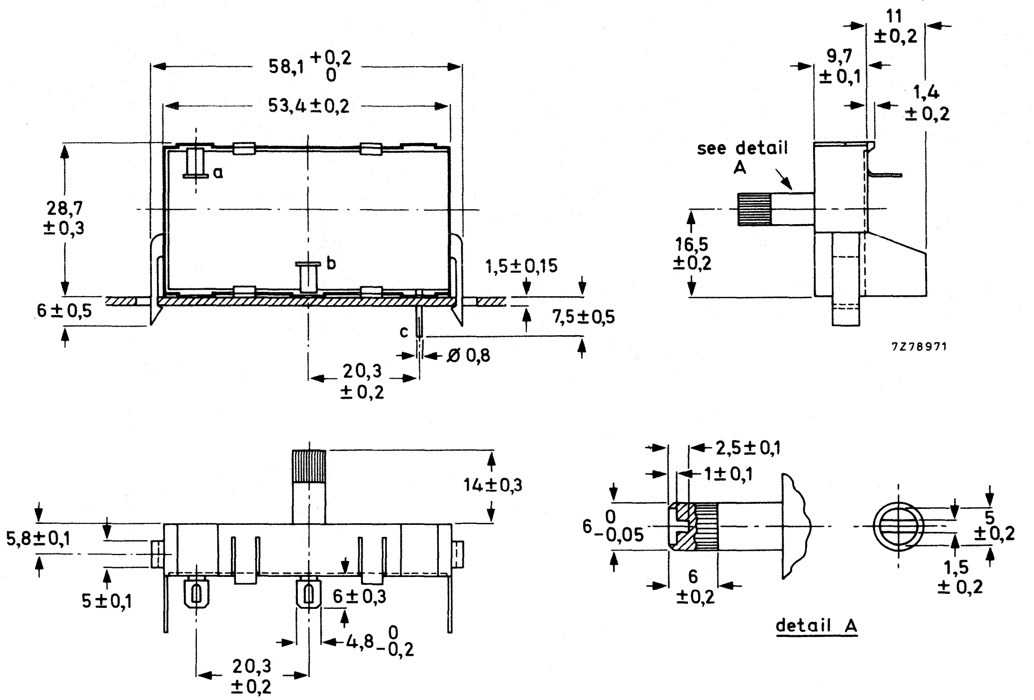


Fig. 3 Potentiometer unit **2322 460 90022**. The indication of the terminals corresponds to those shown in Fig. 1. The solder tags fit on Faston receptacles (4,8 x 0,5).

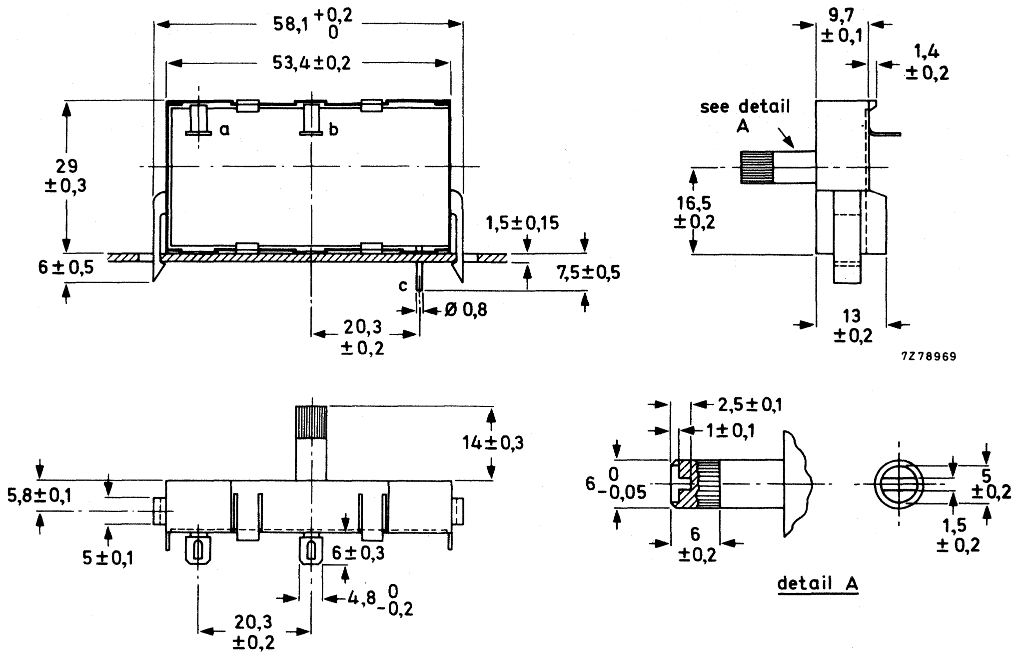


Fig. 4 Potentiometer unit **2322 460 90027**. The indication of the terminals corresponds to those shown in Fig. 1. The solder tags fit on Faston receptacles (4,8 x 0,5).

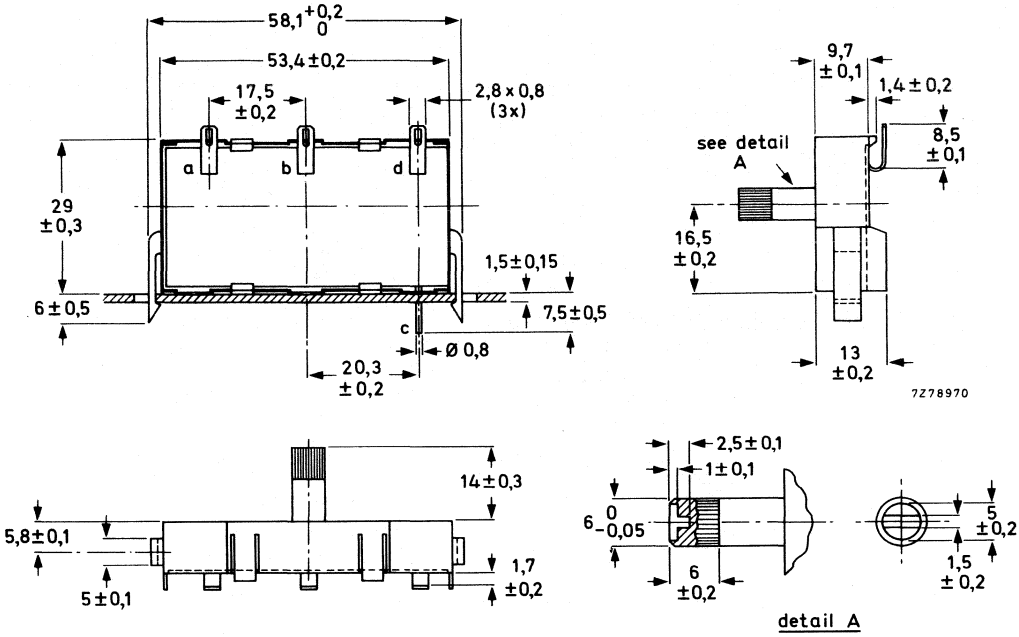


Fig. 5 Potentiometer unit **2322 460 90028**. The indication of the terminals corresponds to those shown in Fig. 6. The solder tags fit on Faston receptacles (2,8 x 0,8).

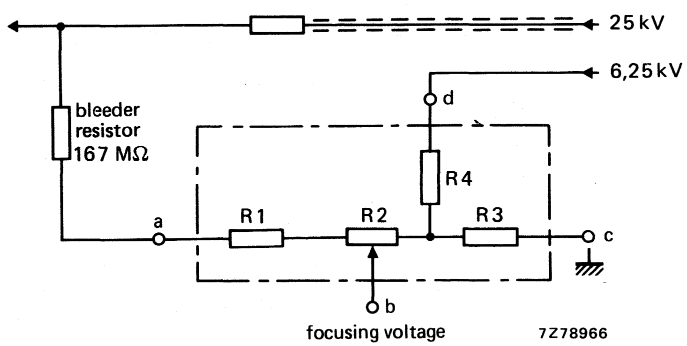


Fig. 6 Diagram of potentiometer unit **2322 460 90028**.

a = EHT voltage via bleeder resistor;

b = focusing voltage;

c = earth;

d = 6,25 kV connection.

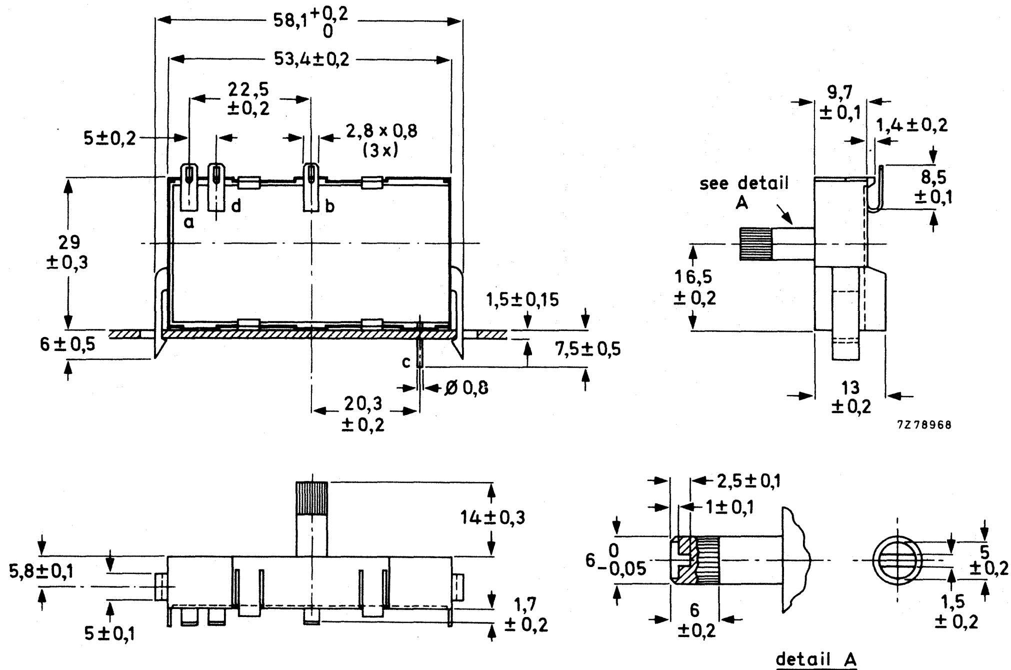


Fig. 7 Potentiometer unit **2322 460 90029**. The indication of the terminals corresponds to those shown in Fig. 8. The solder tags fit on Faston receptacles (2,8 x 0,8).

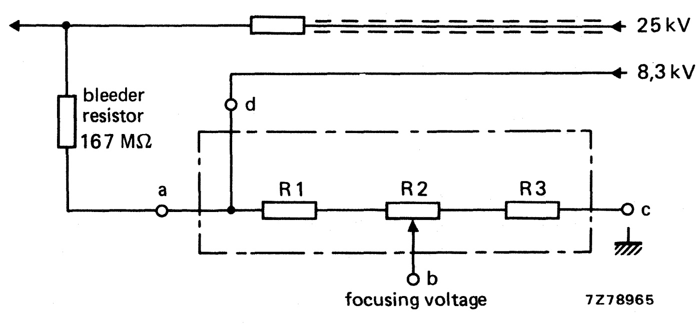


Fig. 8 Diagram of potentiometer unit **2322 460 90029.**

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

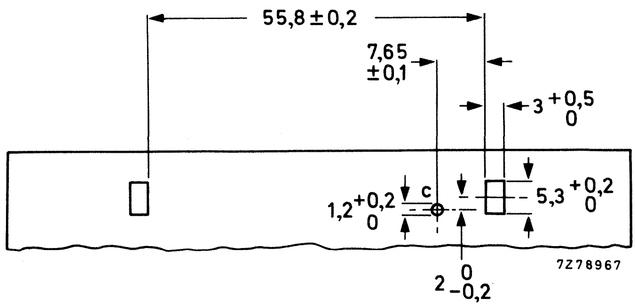


Fig. 9.
Piercing diagram for board mounting (component side).

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 °C; 1000 h load: 9,5 kV (DC) at 80 ± 5% of V_{ac}	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 3\%$ $\frac{\Delta V_{bc}}{V_{bc}} \leqslant 0,3\%$
6.27	Ca	Damp heat steady state	b at 0,80 V_{ac} no load, 21 days, T_{amb} = 40 °C, 93% R.H.	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0,5\%$
6.24	Fc	Vibration	frequency 50 Hz, amplitude 1 mm, 3 directions, 2 h per direction	$\frac{\Delta V_{bc}}{V_{bc}} \leqslant 0,1\%$
6.29	–	Mechanical endurance	50 cycles, 10 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 3\%$
9	–	Insulation resistance	500 V (DC)	min. 10^3 MΩ
–	Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °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 Al_2O_3 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.

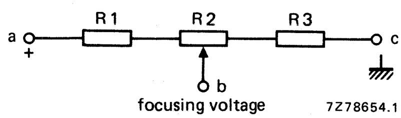


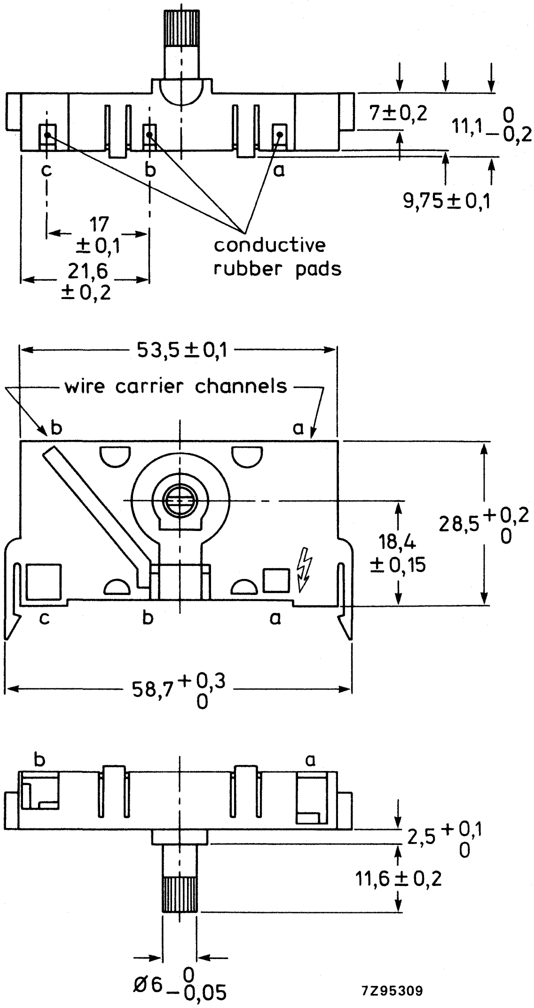
Fig.1 Diagram of potentiometer unit.

a = focus input voltage of EHT device
b = focusing voltage;
c = earth.

MECHANICAL DATA

Outlines (see Fig.2)		
Mechanical angle of rotation		252 ± 5^o
Operating torque		3.5 to 30 mNm
Torque against end stop	$\leqslant$	800 mNm
Permissible axial spindle load	$\leqslant$	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



7Z95309

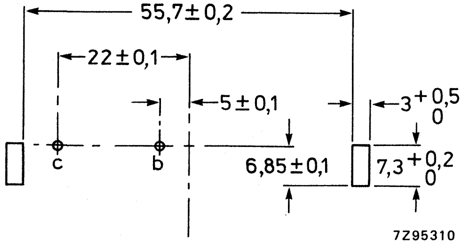
Holes b and c are designed for pre-mounted contact pins, dia. 1 mm x 6 mm, cat. number 3122 121 63560.

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.



7Z95310

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}		±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	⩽	1 %
Resistance law of R2		linear
Contact resistance	⩽	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)	⩾	10^3 MΩ
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} MΩ	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 °C; 1000 h load: 9.5 kV (DC) at 80 ± 5% of V_{ac}	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 3\%$ $\frac{\Delta V_{bc}}{V_{bc}} \leqslant 0.3\%$
6.27	Ca	Damp heat steady state	b at 0.80 V_{ac} no load, 21 days, T_{amb} = 40 °C, 93% R.H.	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0.5\%$
6.24	Fc	Vibration	frequency 50 Hz, amplitude 1 mm, 3 directions, 2h per direction	$\frac{\Delta V_{bc}}{V_{bc}} \leqslant 0.1\%$
6.29	–	Mechanical endurance	50 cycles, 10 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 3\%$
9	–	Insulation resistance	500 V (DC)	min. 10^3 MΩ

PACKAGING

100 items per box.

DSB SLOT FOCUS UNITS

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.

These units are designed to be integrated into a high-voltage unit (e.g. line output transformer, diode split transformer etc.).

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 (b1) and screen (b2) outputs (Figs 1 and 4) is achieved by simply pressing single-core stripped wires into the respective holes. Wire used should have an insulation diameter of 3 mm max., a stripped lead diameter of 0.8 mm and should be stripped over 4 + 1 mm for the focus input (b1) and 3.5 + 1 mm for the screen (b2) input (Fig.3). Earth connection is effected through the printed-wiring board.

SPECIFIC CUSTOMER REQUIREMENTS

The DSB-slot focus units are custom designed. Adaptations (special designs) are made on request. Variations are possible on:

- total resistance and tolerance
- focus and screen voltage range
- 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.

Further information is available on request from:

Marketing department
Potentiometers
N.V. Philips industries
Wynendale Str. 160
8800 Roeselare
Belgium
Tel. (0) 51233404
Fax (0) 51233431

MECHANICAL DATA

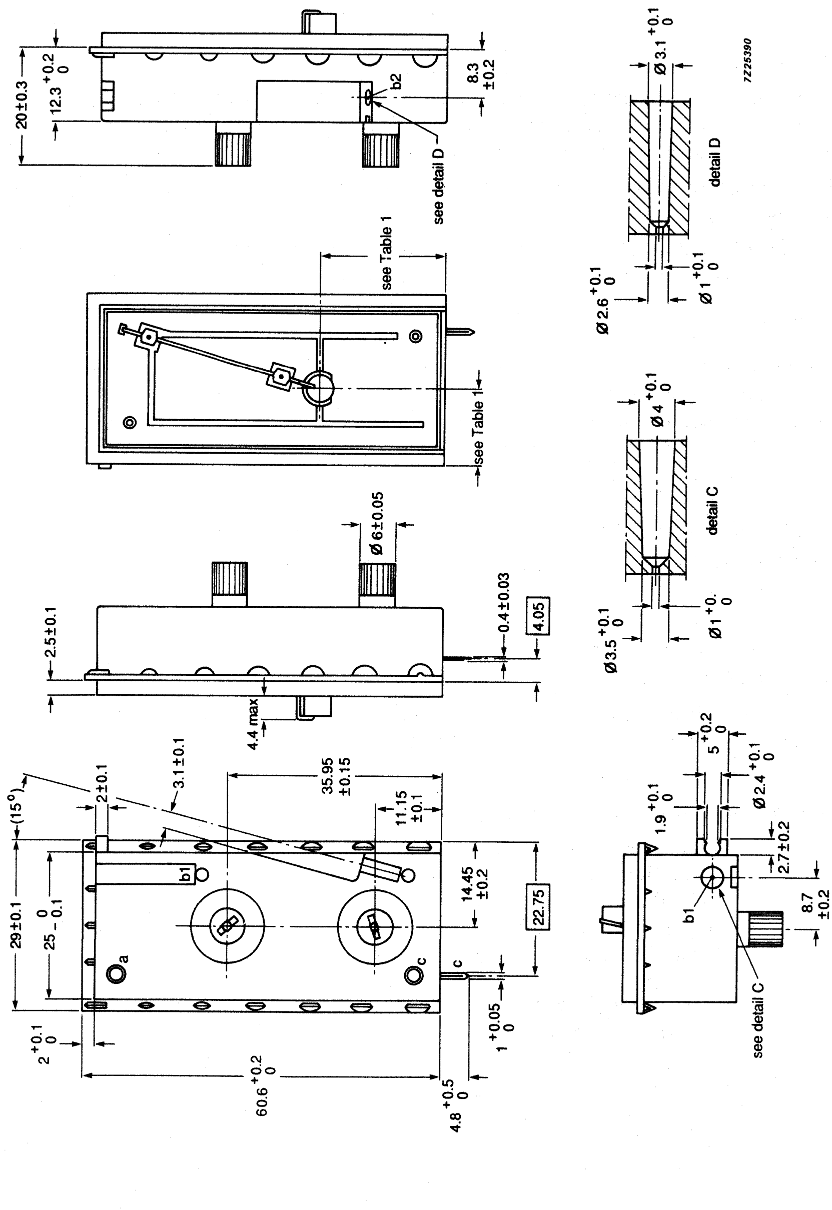


Fig.1 Outline details.

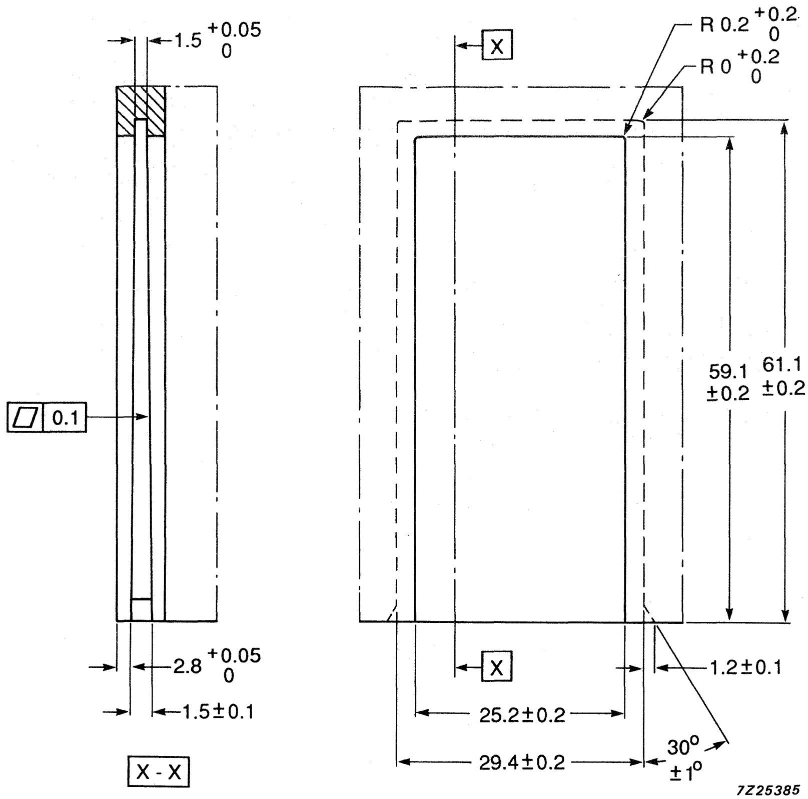


Fig.2 Slot dimensions.

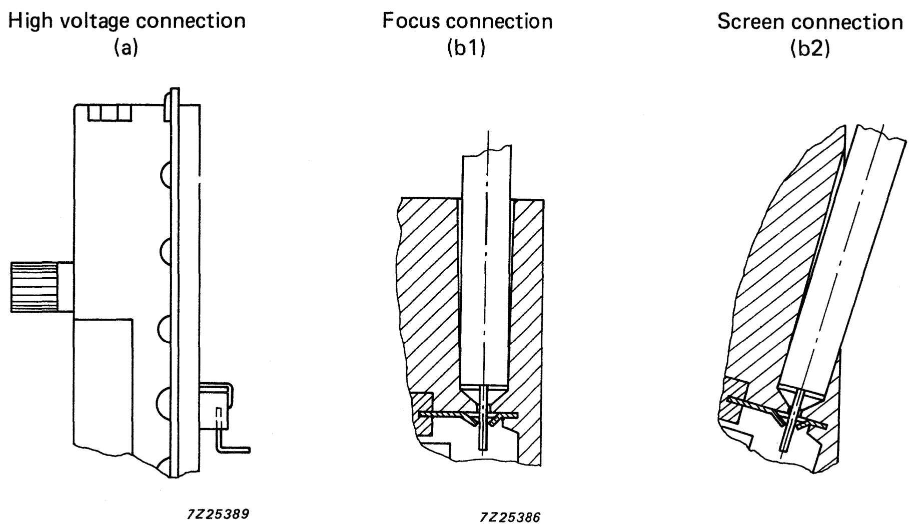


Fig.3 Connection details.

TECHNICAL DATA

Mechanical angle of rotation	
focus	175 ± 5^{o}
screen	200 ± 5^{o}
Mechanical life focus/screen	50 operational cycles
Operating torque	3 to 30 mNm
Initial torque	$\leqslant$ 30 mNm
Maximum permissible end stop torque	$\leqslant$ 150 mNm
Maximum permissible push/pull force on spindle	50 N
Insertion force of wire, connections b1, b2	$\leqslant$ 25 N
Extraction force of wire, connections b1, b2	$\geqslant$ 50 N
Inflammability	
self-extinguishing in accordance with UL94-VO	

ELECTRICAL DATA

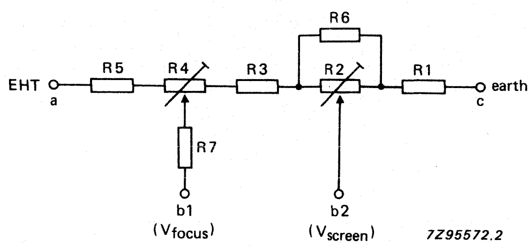


Fig.4 Circuit diagram.

Total resistance and tolerance	see Table 1
Nominal resistance of R1 to R7	see Table 1
Screen voltage range (b2)	see Table 1
Focus voltage range (b1)	see Table 1
Maximum operating voltage	16 kV
Maximum dissipation at 70 °C	2 W
Setting ability, in accordance with IEC 393/6.34	
focus	± 25 V
screen	± 5 V
Contact resistance focus/screen	⩽ 2% of R_{tot}
Temperature characteristic (20 to 100 °C)	⩽ 100×10^{-6}/°C
Voltage coefficient	⩽ 2×10^{-6}/V

Table 1 Focus unit types

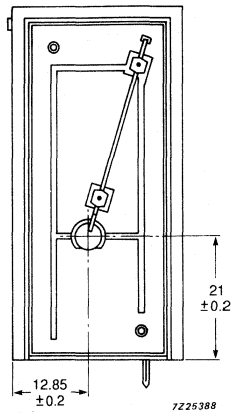
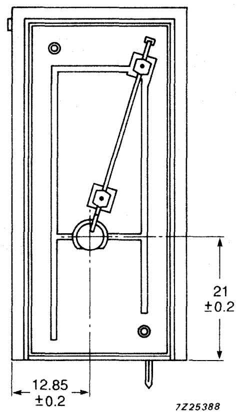
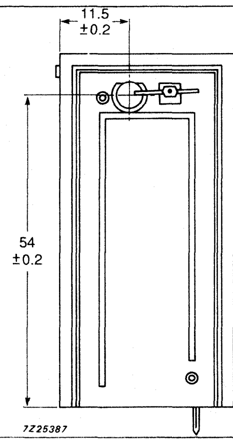
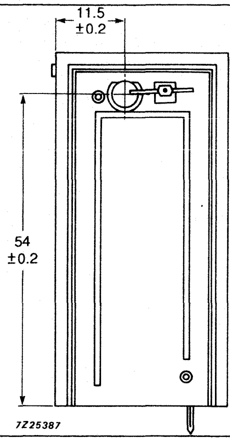
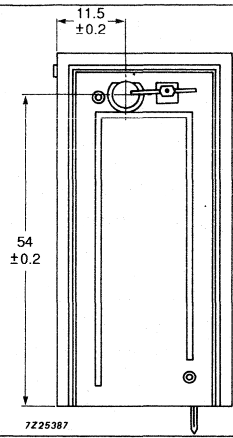
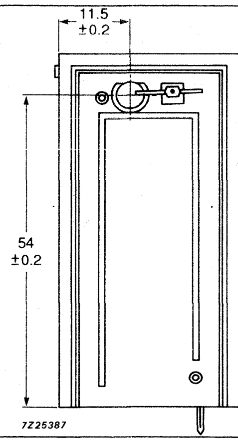
Catalogue number 2322 460	90316	90317	90318
Rear view of unit showing EHT connection point (a)			
Total resistance	200 MΩ	69 MΩ	120 MΩ
Tolerance	± 10%	± 10%	± 20%
Nominal resistance value R1 R2/R6 R3 R4 R5 R7	 2.7 MΩ 15.7 MΩ 61.6 MΩ 50 MΩ 70 MΩ —	 1.48 MΩ 6.8 MΩ 33.12 MΩ 26.91 MΩ 0.69 MΩ 7.5 MΩ	 1.38 MΩ 11.58 MΩ 45.6 MΩ 32.28 MΩ 29.16 MΩ 15 MΩ
Screen voltage (b2) range in % of V_{tot}	1.35 ± 0.65% to 9.2 ± 2%	2.15 ± 1.15% to 12 ± 2%	1.15 ± 1.1% to 10.8 ± 2.2%
Focus voltage (b1) range in % of V_{tot}	40 ± 4% to 65 ± 5%	60 ± 5% to 99 ± 0.4%	4.88 ± 4.8% to 75.7 ± 3%

Table 1 Focus unit types (continued)

Catalogue number 2322 460	90319	90322	90326
Rear view of unit showing EHT connection point (a)			
Total resistance	164 MΩ	90 MΩ	90 MΩ
Tolerance	± 10%	± 20%	± 20%
Nominal resistance value			
R1	1.48 MΩ	1.35 MΩ	1.35 MΩ
R2/R6	14.18 MΩ	10.71 MΩ	14.85 MΩ
R3	36.57 MΩ	46.35 MΩ	42.21 MΩ
R4	38.79 MΩ	27.9 MΩ	27.9 MΩ
R5	72.98 MΩ	3.69 MΩ	3.69 MΩ
R7	15 MΩ	15 MΩ	15 MΩ
Screen voltage (b2) range in % of V_{tot}	0.9 ± 0.5% to 9.55 ± 2.45%	1.5 ± 0.17% to 13.4 ± 2.3%	1.5 ± 0.7% to 18 ± 2.5%
Focus voltage (b1) range in % of V_{tot}	31.85 ± 3.85% to 55.15 ± 5.5%	64.9 ± 4.5% to 95.9 ± 1.5%	64.9 ± 4.5% to 95.9 ± 1.5%

MARKING

The units are marked 460 . . . . . followed by the last five digits of the catalogue number, source code and data code (year and month of manufacture).

PACKAGING

The units are blister packed suitable for automatic handling; 30 items per blister, 5 blisters per box.

TESTS AND REQUIREMENTS

name of test	details of test	requirements
Electrical endurance	After integration Test data after 167 cycles 1 cycle: 6 hours loaded 16 kV at 65 °C 2 hours non-loaded at 20 °C	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔV R_{tot} $\leqslant$ 3% of R_{tot}
Cold test	IEC 63-2-1 test Ab (−25 °C/96 hours)	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}
Dry heat	IEC 68-2-2 test Bb (100 °C/96 hours)	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}
Change of temperature (2 chamber test)	T_a = −30 °C, T_b = 100 °C within 30 sec 1 hour at each temperature 5 cycles	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}
Humidity test	After integration IEC 68-2-30 test Db 40 °C, 95% RH, 21 days 1 hour/24 hours loaded at 16 kV	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.5% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}
Vibration	IEC 68-2-6 test F 10 - 55 Hz in 3 directions 30 minutes in each direction	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}
Shock test	IEC 68-2-27 test Ea peak acceleration 490 m/s^2 3 shocks per direction 6 directions	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}

name of test	details of test	requirements
Breakdown voltage at underpressure conditions	IEC 68-2-13 test M 18 kV – 30 minutes b1 and b2 at maximum setting 55 °C and 655 hPa	No flashovers No breakdown
Corona test	PRV-53-8-52/43 20 kV during 5 s b1 and b2 at maximum setting (1013 hPa) standard atmospheric conditions	No flashovers No breakdown
Flash test (fault condition picture tube)	PRV-53-8-52/42 477 hPa 50 flashes	No permanent damage
Safety test	PRV-53-8-52/45 16 kV	No flashovers No breakdown

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
Bottom	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
Contacting plug	Silicone rubber	K 1764	Philips	UL-94-VO	E45111
Contacting plug	Silicone rubber	P 9274	Philips	UL-94-HB	E45111
Vacuum grease	Silicone grease	TKHV-1	Kluber		

RELIABILITY

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

F(300)	$\leqslant$ 0.01%
F(10.000)	$\leqslant$ 0.25%
F(30.000)	$\leqslant$ 5%

MICRO-SLOT FOCUS UNITS

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.

These units are designed to be integrated into a high-voltage unit (e.g. line output transformer, diode split transformer etc.).

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 (b1) and screen (b2) outputs (Figs 1 and 4) is achieved by simply pressing single-core stripped wires into the respective holes. Wire used should have an insulation diameter of 3 mm max., a stripped lead diameter of 0.8 mm and should be stripped over 4 + 1 mm for the focus input (b1) and 3.5 + 1 mm for the screen (b2) input (Fig.3). Earth connection is effected through the printed-wiring board.

SPECIFIC CUSTOMER REQUIREMENTS

The micro-slot focus units are custom designed. Adaptations (special designs) are made on request. Variations are possible on:

- total resistance and tolerance
- focus and screen voltage range
- 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.

Further information is available on request from:

Marketing department
Potentiometers
N.V. Philips industries
Wynendale Str. 160
8800 Roeselare
Belgium
Tel. (0) 51233404
Fax (0) 51233431

MECHANICAL DATA

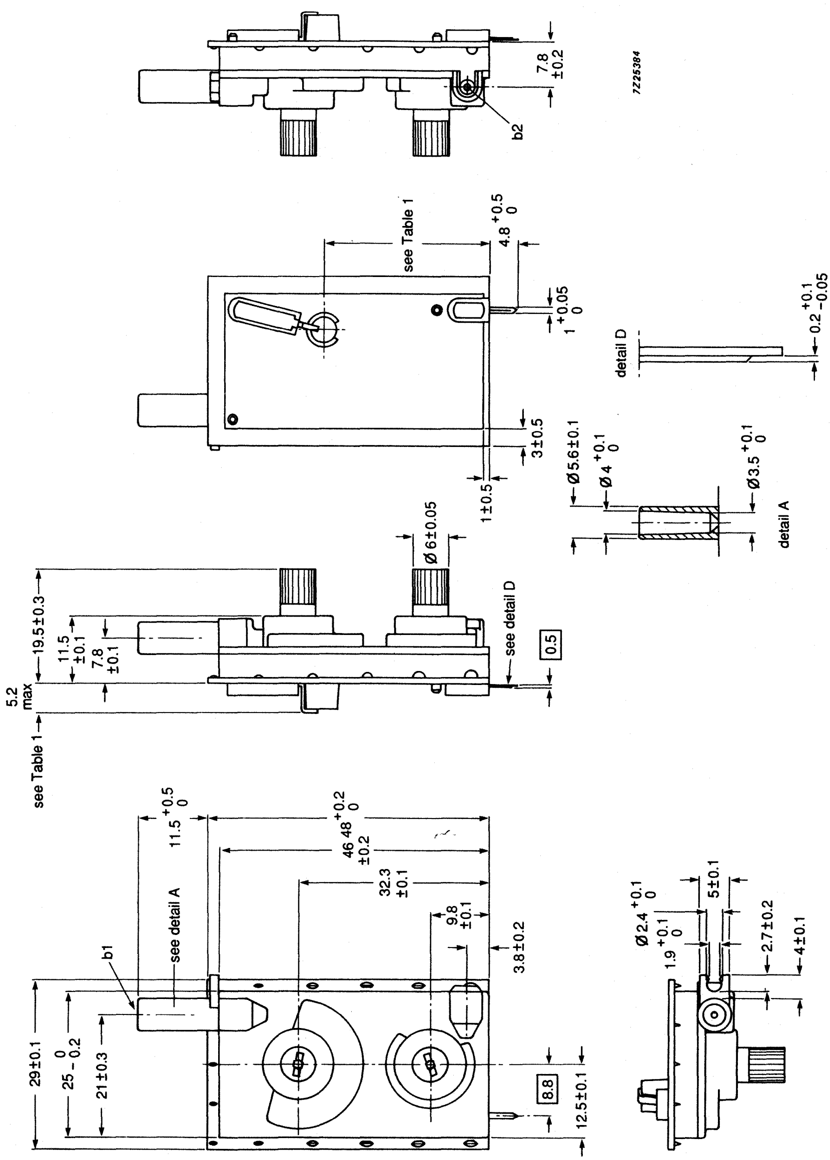


Fig.1 Outline details.

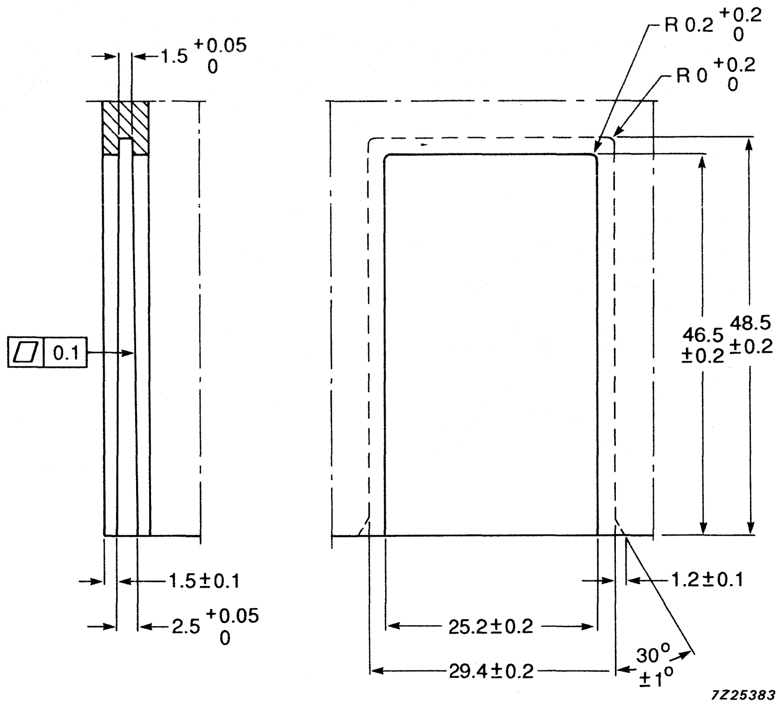


Fig.2 Slot dimensions.

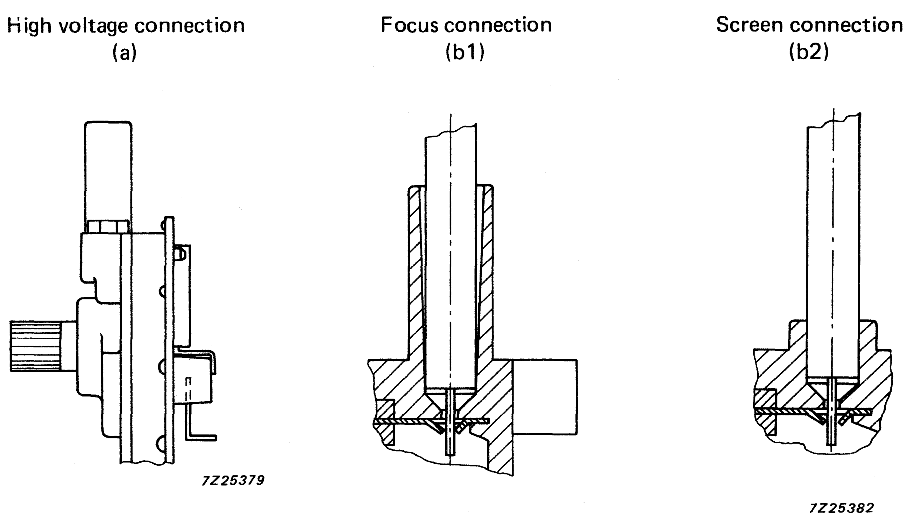


Fig.3 Connection details.

TECHNICAL DATA

Mechanical angle of rotation	
focus	175 ± 5^o
screen	200 ± 5^o
Mechanical life focus/screen	50 operational cycles
Operating torque	3 to 30 mNm
Initial torque	$\leqslant$ 30 mNm
Maximum permissible end stop torque	$\leqslant$ 150 mNm
Maximum permissible push/pull force on spindle	50 N
Insertion force of wire, connections b1, b2	$\leqslant$ 25 N
Extraction force of wire, connections b1, b2	$\geqslant$ 50 N
Inflammability	
self-extinguishing in accordance with UL94-VO	

ELECTRICAL DATA

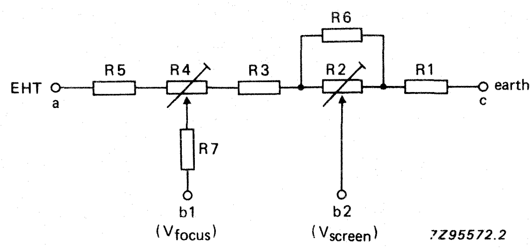
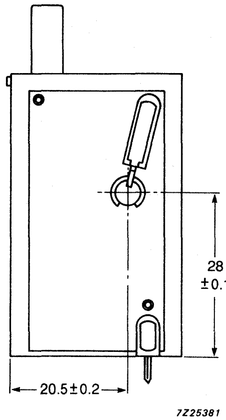
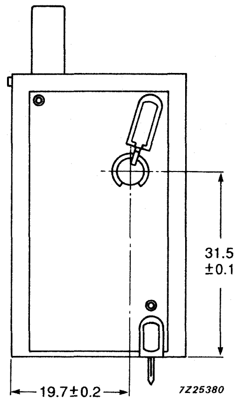
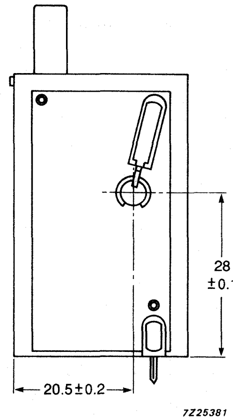


Fig.4 Circuit diagram.

Total resistance and tolerance	see Table 1
Nominal resistance of R1 to R7	see Table 1
Screen voltage range (b2)	see Table 1
Focus voltage range (b1)	see Table 1
Maximum operating voltage	10 kV
Maximum dissipation at 70 °C	1.5 W
Setting ability, in accordance with IEC 393/6.34	
focus	± 25 V
screen	± 5 V
Contact resistance focus/screen	$\leqslant$ 2% of R_{tot}
Temperature characteristic (20 to 100 °C)	$\leqslant 100 \times 10^{-6}$/°C
Voltage coefficient	$\leqslant 2 \times 10^{-6}$/V

Table 1 Focus unit types

Catalogue number 2322 460	90311	90315	90323 90324
Rear view of unit showing EHT connection point (a)			
Total resistance	70 MΩ	70 MΩ	105 MΩ
Tolerance	± 10%	± 10%	± 15%
Nominal resistance value			
R1	1.0 MΩ	1.0 MΩ	2.25 MΩ
R2/R6	6.9 MΩ	6.9 MΩ	10.35 MΩ
R3	34.1 MΩ	34.1 MΩ	50.4 MΩ
R4	25.4 MΩ	25.4 MΩ	40.95 MΩ
R5	2.6 MΩ	2.6 MΩ	1.05 MΩ
R7	15 MΩ	15 MΩ	11.4 MΩ
Screen voltage (b2) range in % of V_{tot}	1.45 ± 0.75% to 11.3 ± 2.5%	1.45 ± 0.75% to 11.3 ± 2.5%	2.15 ± 1.15% to 12.0 ± 2%
Focus voltage (b1) range in % of V_{tot}	60 ± 5% to 96.3 ± 1.3%	60 ± 5% to 96.3 ± 1.3%	60 ± 5% to 99 ± 0.4%

MARKING

The units are marked 460 . . . . . followed by the last five digits of the catalogue number, source code and data code (year and month of manufacture).

PACKAGING

The units are blister packed suitable for automatic handling; 30 items per blister, 5 blisters per box.

TESTS AND REQUIREMENTS

name of test	details of test	requirements
Electrical endurance	After integration Test data after 167 cycles 1 cycle: 6 hours loaded 10 kV* at 65 °C 2 hours non-loaded at 20 °C	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔV R_{tot} $\leqslant$ 3% of R_{tot}
Cold test	IEC 63-2-1 test Ab (−25 °C/96 hours)	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}
Dry heat	IEC 68-2-2 test Bb (100 °C/96 hours)	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}
Change of temperature (2 chamber test)	T_a = −30 °C, T_b = 100 °C within 30 sec 1 hour at each temperature 300 cycles	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}
Humidity test	After integration IEC 68-2-30 test Db 40 °C, 95% RH, 21 days 1 hour/24 hours loaded at 10 kV*	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.5% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}
Vibration	IEC 68-2-6 test F 10 - 55 Hz in 3 directions 30 minutes in each direction	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}
Shock test	IEC 68-2-27 test Ea peak acceleration 490 m/s^2 3 shocks per direction 6 directions	ΔV focus $\leqslant$ 0.2% of V_{tot} ΔV screen $\leqslant$ 0.05% of V_{tot} ΔR_{tot} $\leqslant$ 1% of R_{tot}

* Voltage to be limited at maximum dissipation.

name of test	details of test	requirements
Breakdown voltage at underpressure conditions	IEC 68-2-13 test M 10 kV – 30 minutes b1 and b2 at maximum setting 55 ^{o}C and 655 hPa	No flashovers No breakdown
Corona test	PRV-53-8-52/43 13 kV during 5 s b1 and b2 at maximum setting (1013 hPa) standard atmospheric conditions	No flashovers No breakdown
Flash test (fault condition picture tube)	PRV-53-8-52/42 477 hPa 50 flashes	No permanent damage
Safety test	PRV-53-8-52/45 14 kV	No flashovers No breakdown

LIST OF MATERIALS

name of part	material	type	manufacturer	flame class	UL file number
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Contacting plug	Silicone rubber	K 1764	Philips	UL-94-VO	E45111
Contacting plug	Silicone rubber	P 9274	Philips	UL-94-HB	E45111
Vacuum grease	Silicone grease	TKHV-1	Kluber		

RELIABILITY

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

F(300)	$\leqslant$ 0.01%
F(10.000)	$\leqslant$ 0.25%
F(30.000)	$\leqslant$ 5%

SWITCHES

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.

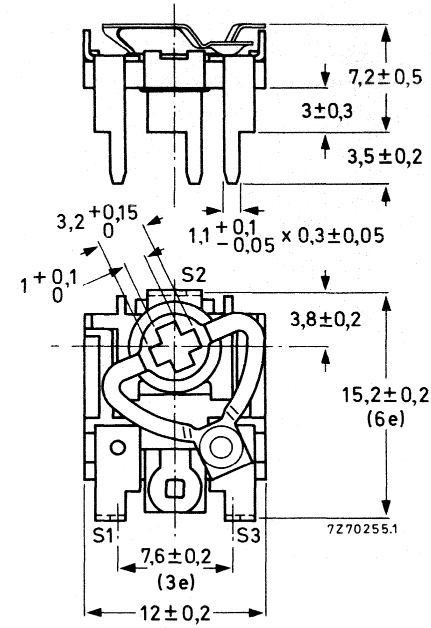
One switch type is provided with two active switch connections and a "centre-off" position. The second type has three active switch connections; the third type has two active switch connections (without "centre-off" position).

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.

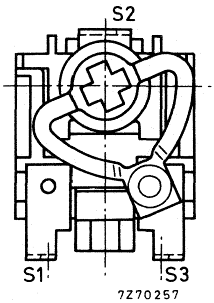
OUTLINES

Dimensions in mm

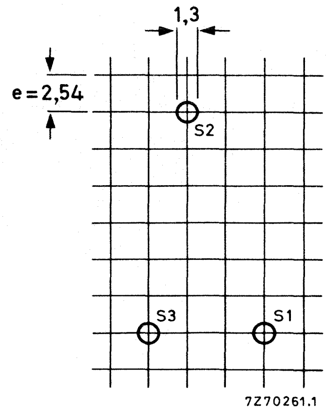
Fig. 1 Test switch for horizontal mounting, with two active switch connections:
a. with "centre-off" position,
b. without "centre-off" position,
c. hole pattern for mounting on a printed-wiring board (solder side).



a.



b.



c.

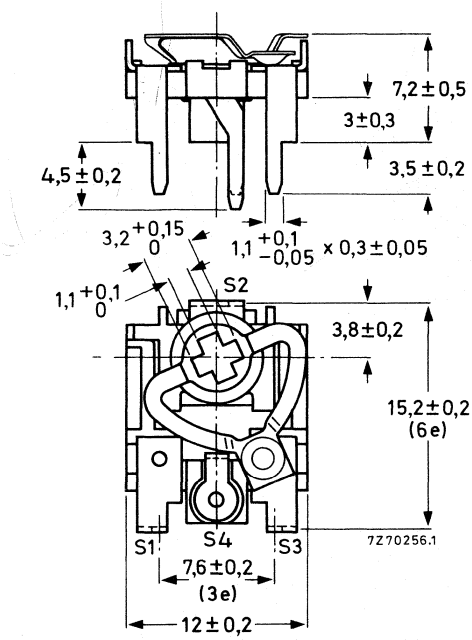


Fig. 2a Test switch for horizontal mounting, with three active switch connections.

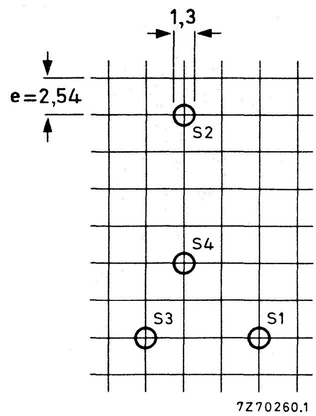


Fig. 2b Hole pattern for mounting on a printed-wiring board (solder side).

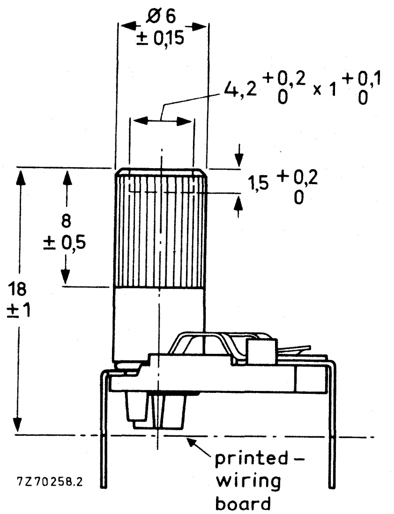


Fig. 3 Test switch for horizontal mounting with adjustment knob at the side of the selector contact.

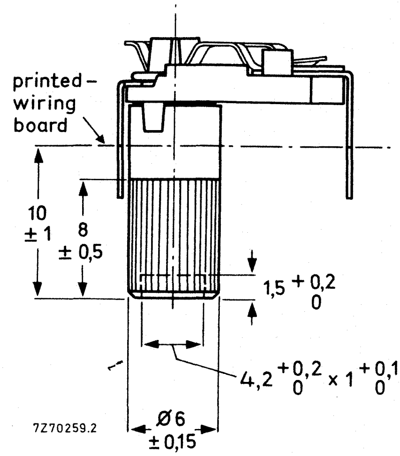
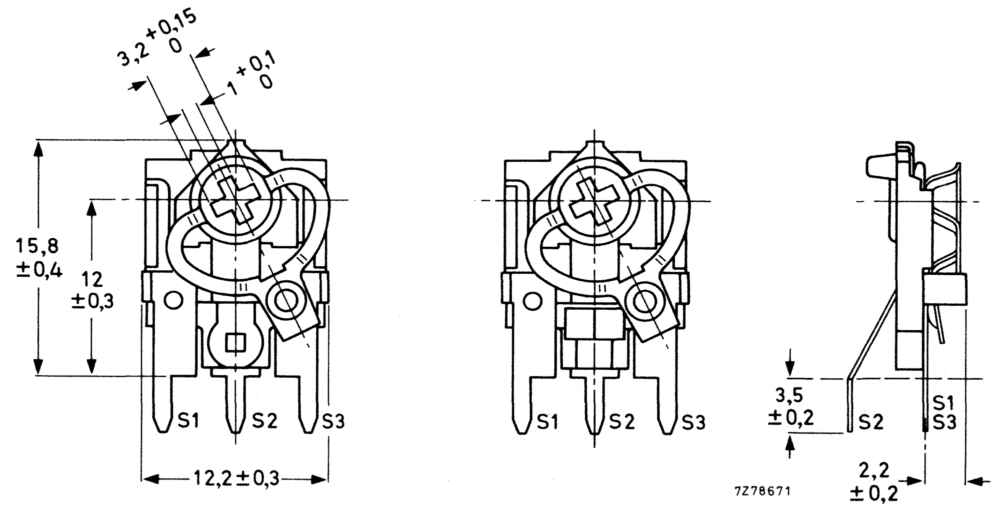
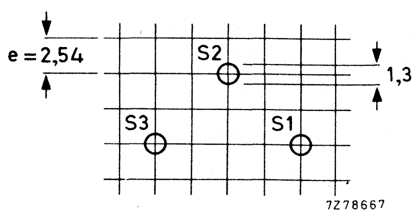


Fig. 4 Test switch for horizontal mounting with adjustment knob at the side of the base plate.



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).

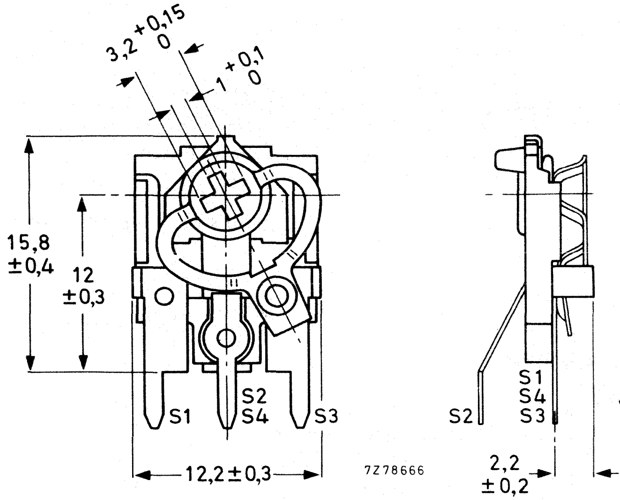


Fig. 6a Test switch for vertical mounting, with three active switch conditions.

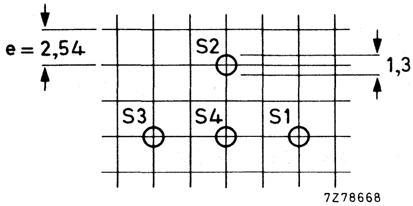
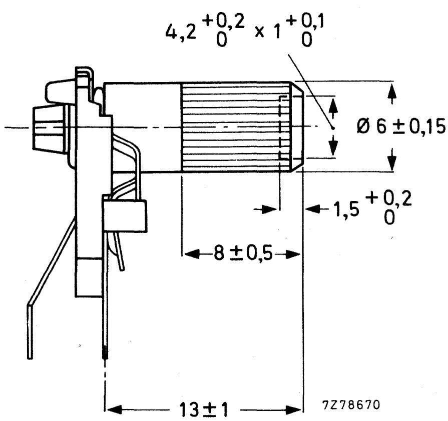


Fig. 6b Hole pattern for mounting on a printed-wiring board (solder side).



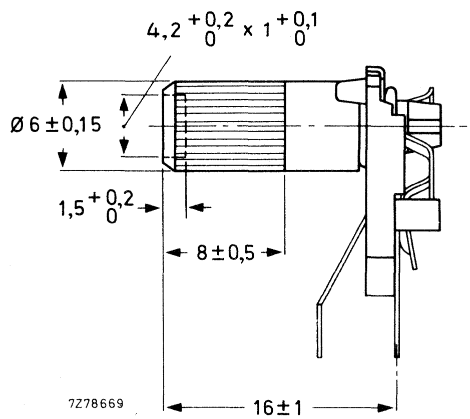


Fig. 7 Test switch for vertical mounting with adjustment knob at the side of the selector contact.

Fig. 8 Test switch for vertical mounting, with adjustment knob at the side of the base plate.

TECHNICAL DATA

Contact resistance	
initially	⩽ 20 mΩ
after 50 switching operations at ⩽ 10 mA, ⩽ 500 V	⩽ 200 mΩ
Operating torque	5 to 50 mNm
End stop torque	⩽ 100 mNm
Life	⩾ 50 switching operations
Mass	
switch without knob	approx. 1 g
switch with knob	approx. 1,5 g

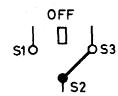
COMPOSITION OF THE CATALOGUE NUMBER

2422 136 7 ....

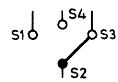
0 = without knob
1 = with knob at the side of the base plate
2 = with knob at the side of the selector contact

33 = horizontal mounting
72 = vertical mounting

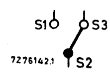
2 = with 2 active switch connections; with off position



3 = with 3 active switch connections



4 = with 2 active switch connections; without off position



The catalogue number of a loose knob, such as used with CTP14, is 4322 047 08280.

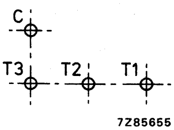
BAND SWITCH

The switch is designed for band switching in television or radio tuners. It has three positions of the "break before make" type, and is operated by a lever. It is meant to be used with multiturn carbon preset potentiometers CMP10, CMP20, CMP40.

MECHANICAL DATA

Outline drawing

- Type 2422 136 80213



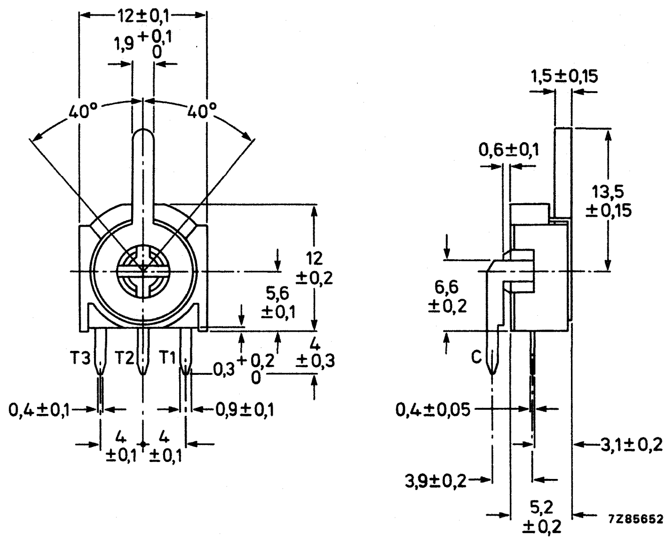
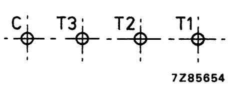


Fig. 1.

- Type 2422 136 80223



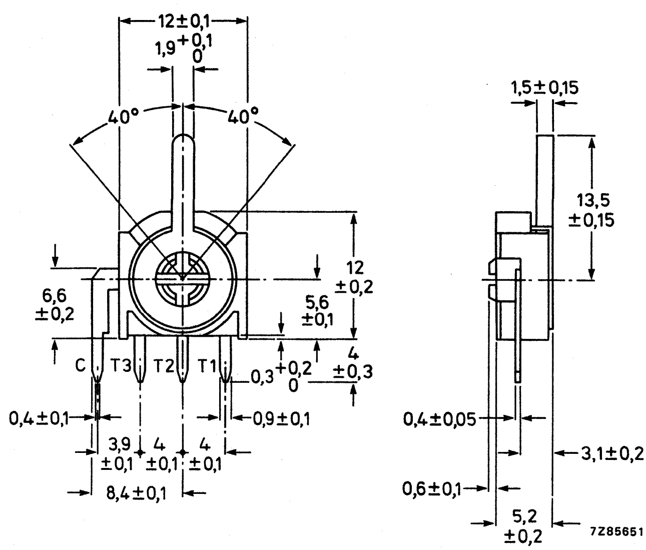


Fig. 2.

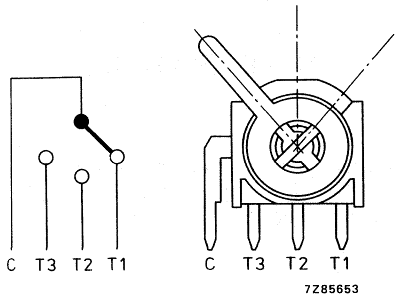


Fig. 3.

Operating torque	10 to 40 mNm
End stop torque	$>$ 200 mNm
Switching angle	2 x 40 degrees
Climatic category	25/070/21
Life	$>$ 250 cycles
No marking on the switch	

ELECTRICAL DATA

Rating (load applied)	12 V/40 mA
Function	1 section, 3 contacts
Contact resistance, max.	50 mΩ at 5 mA

COMPOSITION OF THE CATALOGUE NUMBER

2422 136 802 . .

13 = vertical, p.w. tags displaced, see Fig. 1.

23 = vertical, p.w. tags in line, see Fig. 2.

CIRCUIT BREAKER SWITCH

This circuit breaker switch is for switching off the a.f.c. system in colour television receivers for optimum channel selection.

ELECTRICAL DATA

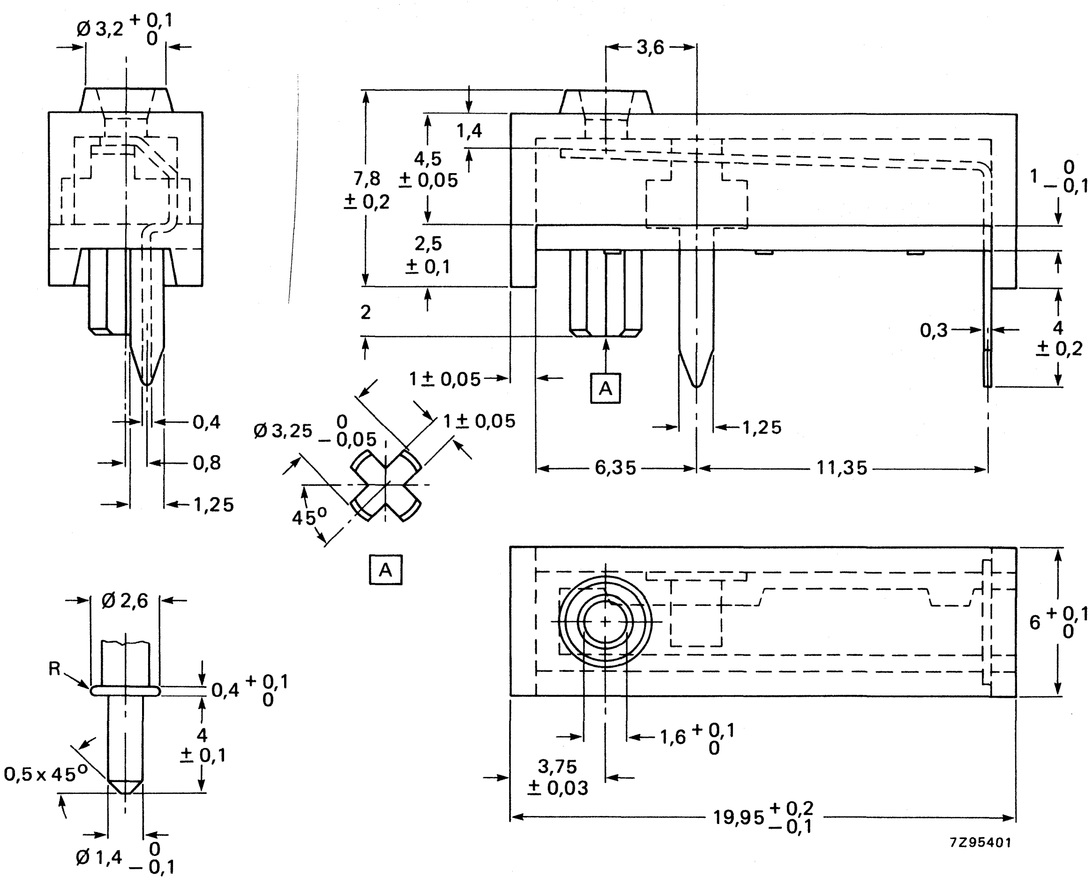
Contact resistance	$< 60\ m\Omega$
Insulation resistance	$> 10\ M\Omega$
Maximum load	25 mA/30 V (d.c.)
Maximum voltage (r.m.s.)	100 V (a.c.)
Maximum leakage current	$10\ \mu A$

CATALOGUE NUMBER 8222 412 73731

MECHANICAL DATA

Dimensions in mm

Outlines



Dimensions of key.

The switch is a single pole type, ususally closed. It is operated by a key which brakes the contact.

Key action	min. 1 mm, max. 2,5 mm
Operating force at 2 mm compression	0,7 N ± 0,3 N
Contact force (when closed)	min. 0,3 N
Operating life	16 000 cycles, loaded 25 mA/30 V (d.c.)
Contacts	phosphor bronze
Operating temperature	−10 to 70 °C
Storage temperature	−25 to 70 °C
Solderability	230 ± 10 °C during 2 ± 0,5 s

TESTS AND REQUIREMENTS

Unless otherwise specified, the electrical and mechanical values apply at an ambient free air temperature of 15 to 35 °C, an atmospheric pressure of 860 to 1060 hPa and a relative humidity of 45 to 75%.

Table

IEC 393-1 clause	IEC 68-2 test method	test	procedure	requirement
2.14	Na	Rapid change of temperature	5 cycles 34 - 25 °C/34 + 70 °C	The values quoted at Electrical Data are not surpassed
2.3	Ca	Damp heat steady state	21 days at 40 °C R.H. 90 to 95%	
2.30	Db	Damp heat acc. 1st cycle		
2.2	Bb	Dry heat	96 h at 70 °C	
2.1	Ab	Cold	96 h at –25 °C	
–	–	Corrosion	48 h $H_2S + SO_2$	
2.6	Fc	Vibration	frequency 10-55-10 Hz in one octave/min amplitude 0,35 mm 30 min in 3 directions	no damage
	T	Solderability	230 ± 10 °C, 2 ± 0,5 s	good tinning no damage

INDEX

INDEX OF CATALOGUE NUMBERS

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DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of six series of handbooks:

INTEGRATED CIRCUITS

DISCRETE SEMICONDUCTORS

DISPLAY COMPONENTS

PASSIVE COMPONENTS*

PROFESSIONAL COMPONENTS**

MATERIALS*

The contents of each series are listed on pages iii to viii.

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Components is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.
Product specialists are at your service and enquiries will be answered promptly.

* Will replace the Components and materials (green) series of handbooks.
** Will replace the Electron tubes (blue) series of handbooks.

INTEGRATED CIRCUITS

This series of handbooks comprises:

code	handbook title
IC01	**Radio, audio and associated systems** Bipolar, MOS
IC02a/b	**Video and associated systems** Bipolar, MOS
IC03	**ICs for Telecom** Bipolar, MOS Subscriber sets, Cordless Telephones
IC04	**HE4000B logic family** CMOS
IC05	**Advanced Low-power Schottky (ALS) Logic Series**
IC06	**High-speed CMOS; PC74HC/HCT/HCU** Logic family
IC07	**Advanced CMOS logic (ACL)**
IC08	**ECL 10K and 100K logic families**
IC09N	**TTL logic series**
IC10	**Memories** MOS, TTL, ECL
IC11	**Linear Products**
IC12	**I^2C-bus compatible ICs**
IC13	**Semi-custom** Programmable Logic Devices (PLD)
IC14	**Microcontrollers** NMOS, CMOS
IC15	**FAST TTL logic series**
Supplement to IC15	**FAST TTL logic series**
IC16	**CMOS integrated circuits for clocks and watches**
IC17	**ICs for Telecom** Bipolar, MOS Radio pagers Mobile telephones ISDN
IC18	**Microprocessors and peripherals**
IC19	**Data communication products**

DISCRETE SEMICONDUCTORS

This series of data handbooks comprises:

current code	new code	handbook title
S1	**SC01**	**Diodes** High-voltage tripler units
S2a	**SC02***	**Power diodes**
S2b	**SC03***	**Thyristors and triacs**
S3	**SC04**	**Small-signal transistors**
S4a	**SC05**	**Low-frequency power transistors and hybrid IC power modules**
S4b	**SC06**	**High-voltage and switching power transistors**
S5	**SC07**	**Small-signal field-effect transistors**
S6	**SC08** **SC09**	**RF power transistors** **RF power modules**
S7	**SC10**	**Surface mounted semiconductors**
S8a	**SC11***	**Light emitting diodes**
S8b	**SC12**	**Optocouplers**
S9	**SC13***	**PowerMOS transistors**
S10	**SC14**	**Wideband transistors and wideband hybrid IC modules**
S11	**SC15**	**Microwave transistors**
S15**	**SC16**	**Laser diodes**
S13	**SC17**	**Semiconductor sensors**
S14	**SC18***	**Liquid crystal displays and driver ICs for LCDs**

* Not yet issued with the new code in this series of handbooks.
** New handbook in this series; will be issued shortly.

DISPLAY COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
T8	**DC01**	**Colour display components**
T16	**DC02**	**Monochrome monitor tubes and deflection units**
C2	**DC03***	**Television tuners, coaxial aerial input assemblies**
C3	**DC04***	**Loudspeakers**
C20	**DC05***	**Wire-wound components for TVs and monitors**

* These handbooks are currently issued in another series; they are not yet issued in the Display Components series of handbooks.

PASSIVE COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
C14	**PA01**	**Electrolytic capacitors; solid and non-solid**
C11	**PA02***	**Varistors, thermistors and sensors**
C12	**PA03**	**Potentiometers and switches**
C7	**PA04***	**Variable capacitors**
C22	**PA05***	**Film capacitors**
C15	**PA06***	**Ceramic capacitors**
C9	**PA07***	**Piezoelectric quartz devices**
C13	**PA08***	**Fixed resistors**

* Not yet issued with the new code in this series of handbooks.

PROFESSIONAL COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
T1	*	**Power tubes for RF heating and communications**
T2a	*	**Transmitting tubes for communications, glass types**
T2b	*	**Transmitting tubes for communications, ceramic types**
T3	PC01**	**High-power klystrons**
T4	*	**Magnetrons for microwave heating**
T5	PC02**	**Cathode-ray tubes**
T6	PC03**	**Geiger-Müller tubes**
T9	PC04**	**Photo and electron multipliers**
T10	PC05	**Plumbicon camera tubes and accessories**
T11	PC06	**Circulators and Isolators**
T12	PC07	**Vidicon and Newvicon camera tubes and deflection units**
T13	PC08	**Image intensifiers**
T15	PC09**	**Dry reed switches**
C8	PC10	**Variable mains transformers; annular fixed transformers**
	PC11	**Solid state image sensors and peripheral integrated circuits**

* These handbooks will not be reissued.
** Not yet issued with the new code in this series of handbooks.

MATERIALS

This series of data handbooks comprises:

current code	new code	handbook title
C4 C5	MA01*	**Soft Ferrites**
C16	MA02**	**Permanent magnet materials**
C19	MA03**	**Piezoelectric ceramics**

* Handbooks C4 and C5 will be reissued as one handbook having the new code MA01.

** Not yet issued with the new code in this series of handbooks.

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					
127	127	127	215	215	215	365	365	365	619	619	619			
129			218			370			626					
130	130		221	221		374	374		634	634				
132			223			379			642					
133	133	133	226	226	226	383	383	383	649	649	649			
135			229			388			657					
137	137		232	232		392	392		665	665				
138			234			397			673					
140	140	140	237	237	237	402	402	402	681	681	681			
142			240			407			690					
143	143		243	243		412	412		698	698				
145			246			417			706					
147	147	147	249	249	249	422	422	422	715	715	715			
149			252			427			723					
150	150		255	255		432	432		732	732				
152			258			437			741					
154	154	154	261	261	261	442	442	442	750	750	750			
156			264			448			759					
158	158		267	267		453	453		768	768				
160			271			459			777					
162	162	162	274	274	274	464	464	464	787	787	787			
164			277			470			796					
165	165		280	280		475	475		806	806				
167			284			481			816					

E24	E12	E6	E3
10	10	10	10
11			
12	12		
13			
15	15	15	
16			
18	18		
20			
22	22	22	22
24			
27	27		
30			
33	33	33	
36			
39	39		
43			
47	47	47	47
51			
56	56		
62			
68	68	68	
75			
82	82		
91			

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For all other countries apply to: Philips Components Division, International Business Relations, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Telex 35000 phtcnl

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