

DATA HANDBOOK

Variable Capacitors

B | 0 | 0 | K | P | A | 0 | 4 | 1 | 9 | 8 | 9

Philips Components






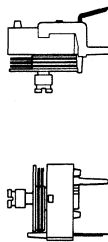
PHILIPS

VARIABLE CAPACITORS

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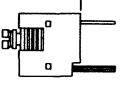

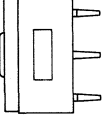
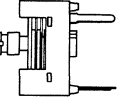
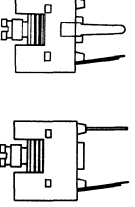
SELECTION GUIDE

SELECTION GUIDE

catalogue number	housing dimensions mm	capacitance range C _{min} /C _{max} pF	rated voltage V	temp. coeff. 10 ⁻⁶ /K	temperature range °C	page
FILM DIELECTRIC TRIMMERS; general purpose						
2222 808 2	φ 5 	1.2/5 to 3/27	150	-250 ± 200 to -50 ± 200	-40 to + 85	9
2222 810	φ 5 	1.5/10 to 5/40	150	-250 ± 300	-40 to + 85	19
2222 808	φ 7.5 	1.2/6 to 3/50	250	-500 ± 450 to -100 ± 300	-40 to + 70 -40 to + 85	25
2222 808 3 2222 808 6	φ 10 	1.8/15 to 5/105	250	-500 ± 150 to -100 ± 300	-40 to + 70 -40 to + 85	33

Notes

Some data on our trimmers, such as the temperature coefficient and the climatic category, are defined on the basis of type approval tests. All specified values are continuously checked by a random test system of which the results are gathered in periodical surveys from which typical values can be derived and made available on request.

catalogue number	housing dimensions mm	capacitance range C_{min}/C_{max} pF	rated voltage V	temp. coeff. $10^{-6}/K$	temperature range $^{\circ}C$	page
FILM DIELECTRIC TRIMMERS; professional purpose						
2222 809 050 ..	6 x 8 x 9 	0.5/2 to 2/18	300	-250 ± 150 and -350 ± 150	-40 to + 125	43
2222 811	φ 5 	1.5/5 to 4/20	300	-250 ± 200	-40 to + 125	51
2222 809 070 ..	11 x 14 x 9 	2/12 to 7/150	200	0 ± 200	-40 to + 125	57
2222 809 080 ..	10 x 11 x 11 	4/40 and 5/60	300	-250 ± 150	-40 to + 125	63
2222 809 090 ..	8 x 9 x 10 	1.4/5.5 to 2/18	300	-250 ± 150	-40 to + 125	71

DEVICE DATA

FILM DIELECTRIC TRIMMERS

- Housing diameter 5 mm
- For consumer and industrial equipment

QUICK REFERENCE DATA

C_{min}/C_{max}	1.25/5 to 3/27 pF
Rated voltage	150 V
Housing diameter	5 mm
Climatic category	40/85/21 for PC versions and 40/70/21 for PP versions
Related specification	IEC 418-1 and 4

Selection chart

Standard versions

Polypropylene, 5.6 mm and 5.08 mm pitch, round head

Value (pF) C_{min}/C_{max}	Top + bottom adjustment	Top adjustment only
	Catalogue number (5.6 mm pitch)	Catalogue number (5.08 mm pitch)
1.25/5	2222 808 23508	2222 808 20508
1.4/10	2222 808 23109	2222 808 20109
1.6/15	2222 808 23159	2222 808 20159
2.5/20	2222 808 23209	2222 808 20209
3/27	2222 808 23279	2222 808 20279

Economic versions

Polycarbonate, 5.6 mm pitch, round head, top adjustment only

Value (pF) C_{min}/C_{max}	Catalogue number
1.5/7	2222 808 20126
2/15	2222 808 20127
2.5/20	2222 808 20123
3.5/27	2222 808 20128

Hex. head versions

Polycarbonate, 5.6 mm pitch, hex. head, top adjustment only

Value (pF) C_{min}/C_{max}	Catalogue number
1.5/7	2222 808 21708
2/15	2222 808 21159
2.5/20	2222 808 21209
3.5/27	2222 808 21279

DESCRIPTION – Standard versions

The vanes of the trimmer are stacked on a sturdy plastic base, the colour of which indicates the maximum capacitance (Table 1). The dielectric is a film of polypropylene which supports the vanes in such a way that good stability is ensured and no microphony can occur. Flux absorption between the vanes is prevented. The trimmers are resistant to all standard cleaning solvents except trichloroethylene and trichloroethane, however, cleaning is not advised.

DESCRIPTION – Economic versions

The vanes of the trimmer are stacked on a sturdy plastic base, the colour of which indicates the maximum capacitance (Table 2). The dielectric is a film of polycarbonate which supports the vanes in such a way that good stability is ensured and no microphony can occur. Flux absorption between the vanes is prevented. The trimmers are resistant to all standard cleaning solvents except trichloroethylene and trichloroethane, however, cleaning is not advised.

MECHANICAL DATA

Outlines	see Fig.1
Effective angle of rotation	180 °C
Operating torque	1 to 15 mNm
Maximum axial thrust ($\Delta C \leq 0.3\%$ of C_{\max})	2 N
Mass	approx. 0.45 g

Mounting

The trimmer can be mounted on printed-circuit boards with hole diameter min. 1.25 mm. For hole pattern, see Fig.3. Soldering conditions: max. 260 °C, max. 10 s. (See also Tests and Requirements).

ELECTRICAL DATA

Rated voltage (DC)	150 V
Test voltage (DC) for 1 min.	300 V
Contact resistance	max. 10 mΩ
Insulation resistance	min. 10 000 MΩ
Tan δ at $C_{\max} \times 10^{-4}$, 1 MHz	≤ 55 for PC versions and ≤ 10 for PP versions
Category temperature range	-40 to + 70 °C
Climatic category (PP)	40/70/21
Climatic category (PC foil)	40/85/21
Minimum storage temperature	-55 °C

Table 1 – Standard versions

reference C _{min} /C _{max} (note 1)	catalogue number	guaranteed max. C _{min} min. C _{max} at 200 kHz pF	tan δ at C _{max} x 10 ⁻⁴ 1 100 MHz MHz	temp. coeff. (note 2) 10 ⁻⁶ /K	min. f _{res} at C _{max} MHz	colour of base	smallest packing quantity
1.25/5	2222 808 20508 2222 808 23508	1.5/5	≤ 10 ≤ 25	-200 ± 300	700	grey	1000
1.4/10	2222 808 20109 2222 808 23109	2/10	≤ 10 ≤ 25	-200 ± 300	500	yellow	1000
1.6/15	2222 808 20159 2222 808 23159	2.5/15	≤ 10 ≤ 25	-50 ± 200	400	blue	1000
2.5/20	2222 808 20209 2222 808 23209	4/20	≤ 10 ≤ 25	-50 ± 200	300	green	1000
3/27	2222 808 20279 2222 808 23279	4.5/27	≤ 10 ≤ 25	-250 ± 200	300	red	1000

Notes to Table 1

1. This column indicates the reference values of the capacitance ranges currently on the market which are equivalent to our range.
2. C at 60% to 80% of C_{max}; T from + 20 °C to + 70 °C.

Table 2 — Economic versions

reference C_{\min}/C_{\max} pF	catalogue number	shape of head	$\tan \delta$ at $C_{\max} \times 10^{-4}$ 1 MHz	temp. coeff. $10^{-6}/K$	colour of base	smallest packing quantity
1.5/7	2222 808 20126	round	≤ 55	-300 ± 200	grey	1000
2/15	2222 808 20127	round	≤ 55	-300 ± 300	blue	1000
2.5/20	2222 808 20123	round	≤ 55	-250 ± 300	green	1000
3/27	2222 808 20128	round	≤ 55	-250 ± 300	red	1000

Table 3 — Hex versions

reference C_{\min}/C_{\max} pF	catalogue number	shape of head	$\tan \delta$ at $C_{\max} \times 10^{-4}$ 1 MHz	temp. coeff. $10^{-6}/K$	colour of base	smallest packing quantity
1.5/7	2222 808 21708	hex	≤ 55	-300 ± 200	grey	1000
2/15	2222 808 21159	hex	≤ 55	-300 ± 300	blue	1000
2.5/20	2222 808 21209	hex	≤ 55	-250 ± 300	green	1000
3/27	2222 808 21279	hex	≤ 55	-250 ± 300	red	1000

2222 808
ø 5 mm

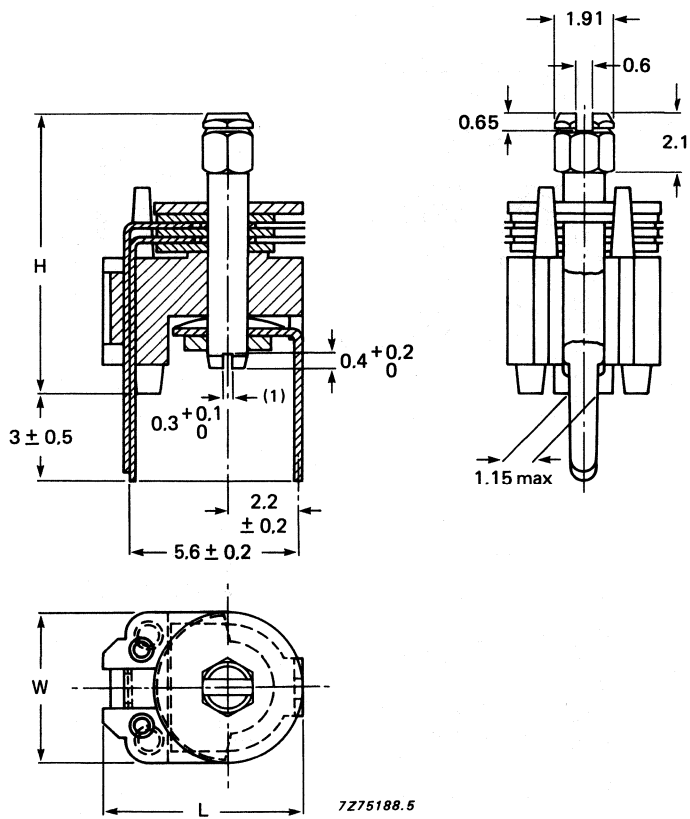


Fig.2 Trimmers 2222 808 series — hex head.
(see Tables 4 and 5 for dimensions H, W and L).

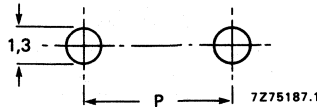


Fig.3 Trimmer pin holes, for P dimensions see selection chart.

Table 4 Standard versions

reference	H _{max}	W _{max}	L _{max}
C _{min} /C _{max} pF	mm	mm	mm
1.25/5	7	5.5	7.3
1.4/10	7	5.5	7.3
1.6/15	8.8	5.5	7.3
2.5/20	8.8	5.5	7.3
3/27	9.0	6.2	7.8

Table 5 Hex and economic versions

type of head	H _{max} mm	W _{max} mm	L _{max} mm
hex	9.7	5.5	7.3
round	7.7	5.5	7.3

PACKING

Bulk packing in cardboard boxes lined with expanded plastic, 1000 pieces per box.

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

AQL 0.4% major defects, 1.5% minor defects.

Each capacitor is tested for min. C_{max} and is also subjected to the full test voltage. See also note under survey of variable capacitors.

TESTS AND REQUIREMENTS

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		capacitance drift	after T.C. measurement	$\Delta C/C$	$\leq 1.75\%$
19		thrust	axial thrust of 2 N	$\Delta C/C$	$\leq 0.4\%$
21		robustness of terminations:			
21.1	Ua	tensile	1 N		
21.2	Ub	bending	1 cycle		no damage
22	Na	rapid change of temperature	1 cycle: ½ h ½ h at upper category temp.	$\Delta C/C$	$\leq 2.5\%$
23	T Ta	soldering solderability	solder bath immersion 3 mm, 235 °C, 2 s		good wetting no mechanical damage
	Tb	resistance to heat	solder bath 260 °C, 10 s		no mechanical damage
24	Eb	impact bump	4000 ± 10 bumps, 40 g, 6 ms	$\Delta C/C$	$\leq 1\%$ no mechanical damage
25	Fc	vibration	freq. 10 to 55 Hz, ampl. 0.75 mm 1.5 h	$\Delta C/C$	$\leq 1\%$ no mechanical damage

TESTS AND REQUIREMENTS (continued)

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements
26		climatic sequence		$\Delta C/C$ $\leq 4\%$ Tan δ – PP foil $\leq 15 \times 10^{-4}$ Tan δ – PC foil $\leq 60 \times 10^{-4}$
26.1	B	dry heat	16 h at upper category temp.	R_{ins} $\geq 10\,000\ M\Omega$ Rotor contact R $\leq 10\ m\Omega$
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	voltage proof 300 V for 1 min. visual examination no mechanical damage
26.3	Aa	cold	16 h, -40 °C	operating torque 1 to 20 mNm
26.5		damp heat accelerated, remaining cycles	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	
27	Ca	damp heat steady state	21 days, + 40 °C 90 to 95% R.H.	$\Delta C/C$ $\leq 3\%$ Tan δ – PP foil $\leq 15 \times 10^{-4}$ Tan δ – PC foil $\leq 60 \times 10^{-4}$ R_{ins} $\geq 10\,000\ M\Omega$ Rotor contact R $\leq 10\ M\Omega$ voltage proof 300 V for 1 min. visual examination no mechanical damage operating torque 1 to 20 mNm

TESTS AND REQUIREMENTS (continued)

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements
29		endurance	10 cycles	$\Delta C/C \leq 3\%$
29.1		mechanical		$\Delta C/C$ after axial thrust $\pm 0.3\%$ rotor contact R $\leq 10 \text{ m}\Omega$ voltage proof 300 V for 1 min. visual examination no mechanical damage operating torque 0.5 to 22.5 mNm

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

2222 810

FILM DIELECTRIC TRIMMERS

- For consumer and industrial equipment

QUICK REFERENCE DATA

C_{min}/C_{max}	10 to 40 pF
Rated voltage (DC)	100 V
Climatic category (IEC 68)	40/85/21
Related specification	IEC 418-1 and 4

Selection chart

Polycarbonate. 5 mm pitch, round head. Top adjustment with cross slot.

Value (pF)	Catalogue number
10	2222 810 00109
20	2222 810 00209
30	2222 810 00309
40	2222 810 00409

DESCRIPTION

The trimmer consists of an enclosed plastic housing of high temperature resistance material, a brass rotor and plated brass stator with a polycarbonate film as the dielectric. In addition there is a plastic actuating cross-slot and a position indicator for top adjustment only. The colour of the cover plate indicates the nominal C value. The stator vanes with their tag are heat sealed to the housing. The rotor contact surfaces are plated to ensure a long life and a stable contact even under severe climatic conditions. Flux absorption between the vanes is prevented.

MECHANICAL DATA

Effective angle of rotation	180 °C
Operating torque	1 to 20 mNm
Maximum axial thrust ($C \leq 0.3\%$ of C_{\max})	2 N
Mass	approx. 0.50 g

Mounting

The trimmer can be mounted on printed-circuit boards with hole diameter min. 1.25 mm.

Soldering condition: max. 260 °C, max. 10 s

ELECTRICAL DATA

Rated voltage (DC)	100 V
Test voltage (DC) for 1 min.	200 V
Insulation resistance	min. 10 000 M Ω
Tan δ at $C_{\max} \times 10^{-4}$, 1 MHz	≤ 55
Category temperature range	-40 to +85 °C
Minimum storage temperature	-55 °C

Table 1

reference C_{\max}	catalogue number	guaranteed max. C_{\min} min. C_{\max} at 200 kHz pF	temp. coeff.	colour of base	smallest packing quantity
10	2222 810 00109	1.5/10	-300 ± 350	yellow	1000
20	2222 810 00209	3/20	-200 ± 250	green	1000
30	2222 810 00309	4/30	-250 ± 250	red	1000
40	2222 810 00409	5/40	-250 ± 250	violet	1000

DEVELOPMENT DATA

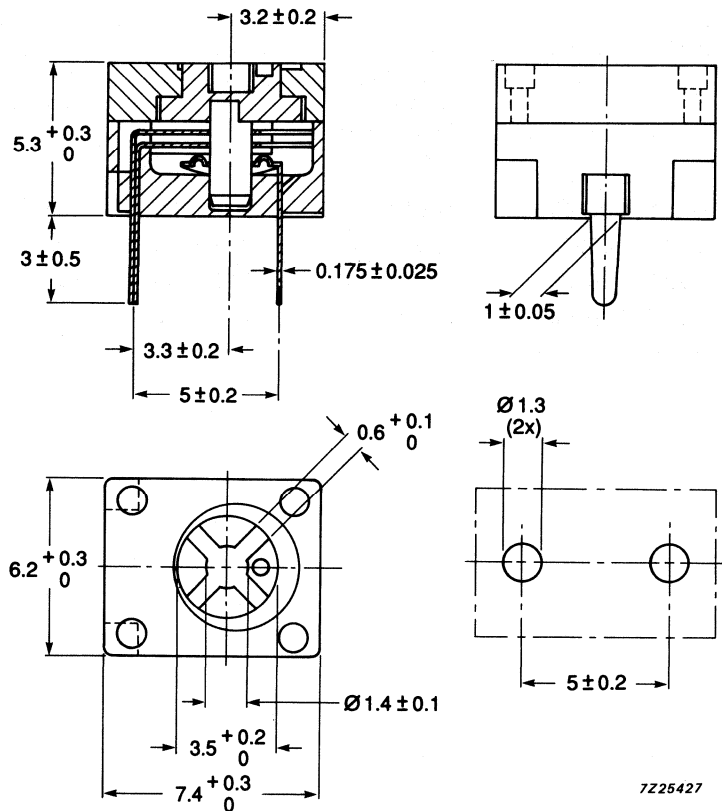


Fig.1 Trimmers 2222 810 series.

PACKING

Bulk packing in cardboard boxes lined with expanded plastic, 1000 pieces per box.

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

AQL 0.4% major defects, 1.5% minor defects

Each capacitor is tested for min. C_{max} and is also subjected to the full test voltage. See also note under survey of variable capacitors.

TESTS AND REQUIREMENTS

DEVELOPMENT DATA

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements
4.2		method of mounting	method A	
14		capacitance drift	after T.C. measurement	$\Delta C/C$ $\leq 1.75\%$
19		thrust	axial thrust of 2 N	$\Delta C/C$ $\leq 0.4\%$
21		robustness of terminations:		
21.1	Ub	tensile	1 N	
21.2	Ub	bending	1 cycle	no damage
22	Na	rapid change of temperature	1 cycle: ½ h at lower and ½ h at upper category temp.	$\Delta C/C$ $\leq 2.5\%$
23	T Ta	soldering solderability	solder bath immersion 3 mm, 235 °C, 2 s	good wetting, no mechanical damage
	Tb	resistance to heat	solder bath 260 °C, 10 s	no mechanical damage
24	Eb	impact bump	4000 ± 10 bumps, 40 g, 6 ms	$\Delta C/C$ $\leq 1\%$ no mechanical damage
25	Fc	vibration	freq. 10 to 55 Hz, ampl. 0.75 mm 1.5 h	$\Delta C/C$ $\leq 1\%$ no mechanical damage

TESTS AND REQUIREMENTS (continued)

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements
26		climatic sequence		$\Delta C/C$ $\leq 4\%$
26.1	B	dry heat	16 h at upper category temp.	Tan δ R_{ins} $\leq 60 \times 10^{-4}$ $\geq 10\,000\ M\Omega$
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	voltage proof 200 V for 1 min.
26.3	Aa	cold	16 h, -40 °C	visual examination no mechanical damage
26.5		damp heat accelerated, remaining cycles	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	operating torque 1 to 20 mNm
27	Ca	damp heat steady state	21 days, + 40 °C 90 to 95% R.H.	$\Delta C/C$ $\leq 3\%$ Tan δ R_{ins} $\leq 60 \times 10^{-4}$ $\geq 10\,000\ M\Omega$ voltage proof 200 V for 1 min. visual examination no mechanical damage operating torque 1 to 20 mNm
29		endurance mechanical	10 cycles	$\Delta C/C$ $\leq 3\%$ $\Delta C/C$ after axial thrust voltage proof $\leq 0.3\%$ visual examination 200 V for operating 1 min. torque no mechanical damage 0.5 to 22.5 mNm

FILM DIELECTRIC TRIMMERS

- Housing diameter 7,5 mm
- For basic grid of 2,54 mm (0,1 in) or 2,50 mm
- For consumer and industrial equipment

QUICK REFERENCE DATA

C_{min}/C_{max}	1,2/6 to 3/50 pF
Rated voltage (d.c.)	250 V
Housing diameter	7,5 mm
Climatic category (IEC 68)	40/070/21 or 40/085/21
Related specification	IEC 418-1 and 4

Selection chart

reference C_{min}/C_{max}	catalogue number 2222 808 followed by			
	vertical spindle		horizontal spindle	
pF	round head		hexagonal head	round head
	top + bottom adjustment	top adj.	top adjustment	top + bottom adjustment
1,2/6	11558	00004		
1,4/6	00018			
1,4/10	11109	00005	17109	51109
1,6/15	11159			
1,6/18	00016			
1,8/22	11229	00006	17229	51229
1,8/27	11279			51279
2/33	11339			
2/40	11409		17409	51409
3/50	11509		17509	51509

DESCRIPTION

The vanes of the trimmers are stacked on a sturdy plastic base, the colour of which indicates the maximum capacitance (Table 1). The dielectric is a film of polypropylene, polyethylene, polycarbonate or PTFE which supports the vanes in such a way that good stability is ensured and no microphony can occur. Flux absorption between the vanes is prevented.

The trimmers are resistant to all cleaning solvents except trichloroethane and trichloroethylene.

A version with vertical spindle (Fig.1) and a version with horizontal spindle (Fig.3) are available. Both versions have top adjustment by means of a screwdriver or trimming key, and bottom adjustment by means of a key according to Fig.5.

MECHANICAL DATA

Dimensions in mm

Outlines	See Figs 1 and 3
Effective angle of rotation	180°
Operating torque	1 to 15 mNm for 6 to 22 pF and 2 to 25 mNm for 27 to 50 pF
Maximum axial thrust ($\Delta C \leq 0.3\%$ of C_{max})	2 N
Mass	approx. 0.8 g

Mounting

The trimmers can be mounted on printed-wiring boards with a grid of 2,50 mm or 2,54 mm ; hole diameter min. 1,25 mm. See for hole patterns Figs 2 and 4.

Soldering conditions: max. 260 °C, max. 10 s. (See also 'Tests and Requirements'.)

ELECTRICAL DATA; see also Table 1

Rated voltage (d.c.)	250 V
Test voltage (d.c.) for 1 min.	500 V
Contact resistance	max. 10 mΩ
Insulation resistance	min. 10 000 MΩ
Category temperature range	
$C_{max} = 10, 15, 22, 33$ pF	- 40 to + 70 °C
$C_{max} = 5,5, 9, 18, 27, 40, 50$ pF	- 40 to + 85 °C
Climatic category (IEC 68)	
$C_{max} = 10, 15, 22, 33$ pF	40/070/21
$C_{max} = 5,5, 9, 18, 27, 40, 50$ pF	40/085/21
Minimum storage temperature	- 55 °C

Notes to Table 1 on the next page.

1. This column indicates the reference values of the capacitance ranges currently available on the market which are equivalent to our range.
2. PC = polycarbonate,
PE = polyethylene,
PP = polypropylene,
PTFE = polytetrafluorethylene.
3. C at 60 to 80% of C_{max} ; ΔT from + 20 to upper category temperature.

Table 1 (Notes are on preceding page)

reference C _{min} /C _{max} (note 1) pF	cat. number 2222 808 followed by	spindle shape of head	fig.	adjustment mode	diel- electric film (note 2)	guaranteed max. C _{min} min. C _{max} at 2000 kHz pF	tan δ at C _{max} × 10 ⁻⁴ MHz	temp. coeff. (note 3) 10 ⁻⁶ /K	min. f _{res} at C _{max} MHz	colour of base pack- ing quant.
1,2/6	11558 00004	vertical round	1	top + bottom top	PE	1,4/5,5	≤ 10	≤ 25	-400 ± 300	850 grey
1,4/6	00018	vertical round	1	top + bottom	PTFE	2/9	≤ 10	≤ 15	-500 ± 450	480 yellow
1,4/10	11109 00005 17109 51109	vertical round vertical hexagon. vertical horizont.	1 1 1 3	top + bottom top top top + bottom	PP	2/10	≤ 10	≤ 25	-450 ± 350	480 yellow
1,6/15	11159	vertical round	1	top + bottom	PP	2/15	≤ 10	≤ 25	-200 ± 350	450 blue
1,8/18	00016	vertical round	1	top + bottom	PTFE	2/18	≤ 10	≤ 15	-400 ± 200	350 green
1,8/22	11229 00006 17229 51229	vertical round vertical hexagon. vertical horizont.	1 1 1 3	top + bottom top top top + bottom	PP	2/22	≤ 10	≤ 25	-250 ± 350	350 green
1,8/27	11279 51279	vertical round vertical horizont.	1 3	top + bottom top + bottom	PC	2/27	≤ 50	≤ 50	-250 ± 300	350 red
2/33	11339	vertical round	1	top + bottom	PP	3/33	≤ 10	≤ 10	-250 ± 300	300 brown
2/40	11409 17409 51409	vertical round vertical hexagon. vertical horizont.	1 1 3	top + bottom top top + bottom	PC	3/40	≤ 50	≤ 50	-100 ± 300	300 violet
3/50	11509 17509 51509	vertical round vertical hexagon. vertical horizont.	1 1 3	top + bottom top top + bottom	PC	3/50	≤ 50	≤ 50	-100 ± 300	250 black

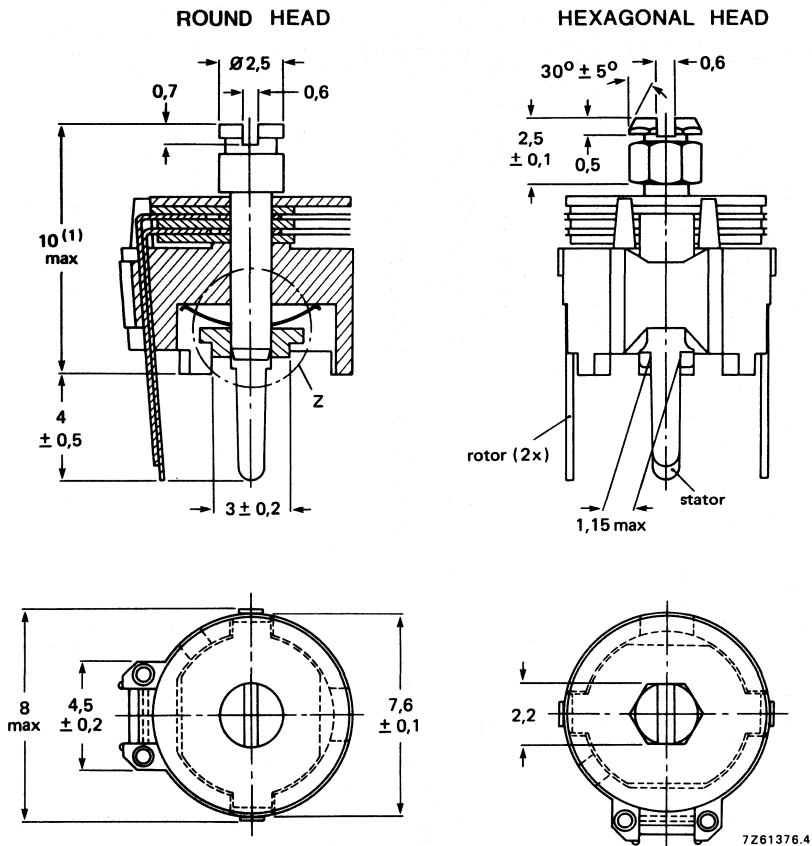


Fig.1 Version with vertical spindle.
 (1) 11 max. for $C_{\text{max}} = 40 \text{ pF}$ and 50 pF .

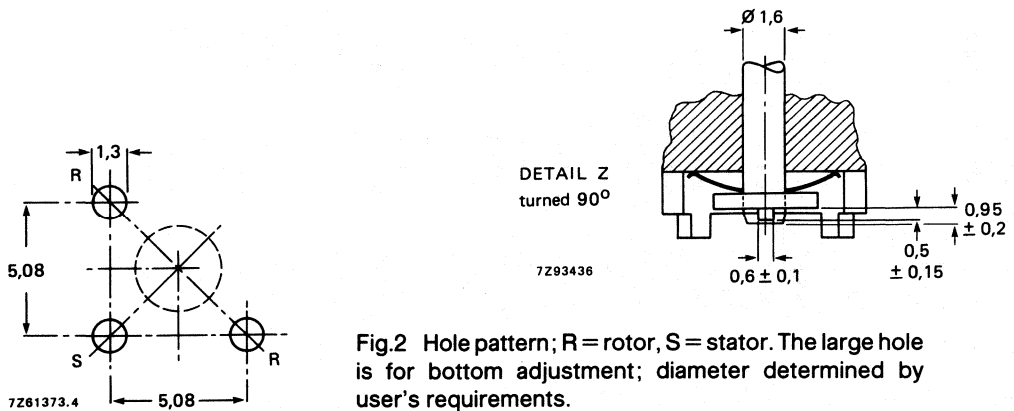


Fig.2 Hole pattern; R = rotor, S = stator. The large hole is for bottom adjustment; diameter determined by user's requirements.

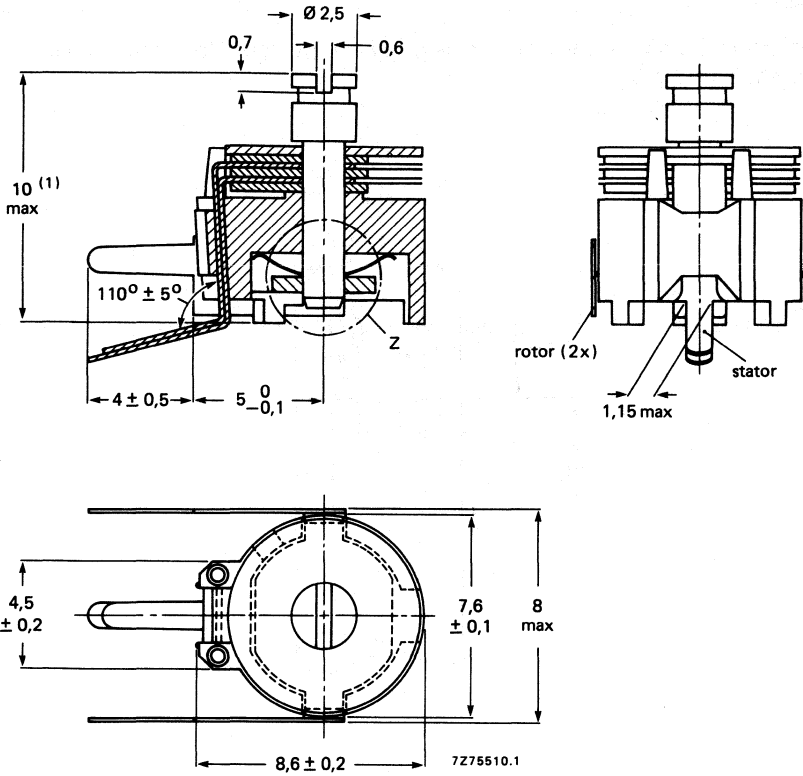


Fig.3 Version with horizontal spindle.
 (1) 11 max. for $C_{\text{max}} = 40 \text{ pF}$ and 50 pF .

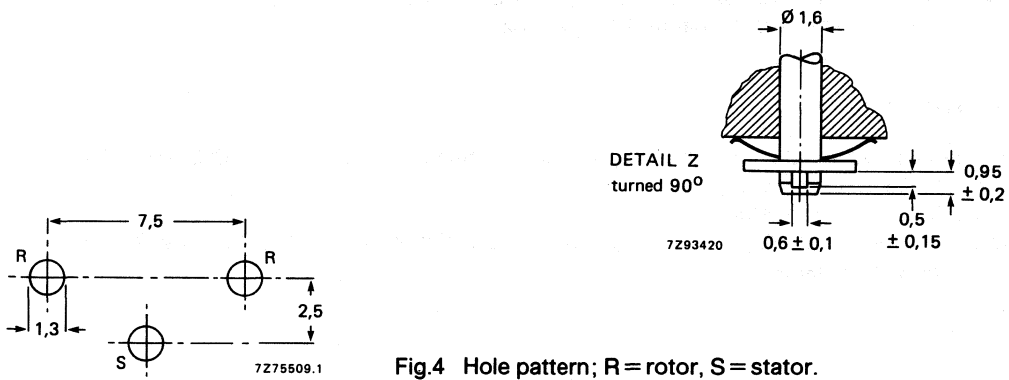


Fig.4 Hole pattern; R = rotor, S = stator.

ADJUSTMENT

For top adjustment a screwdriver or trimming key can be used; for bottom adjustment a key is required as shown in Fig.5.

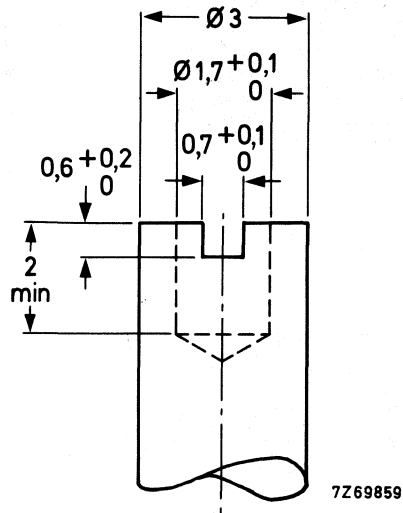


Fig.5.

PACKING

Bulk packing in cardboard boxes lined with expanded plastic; versions with vertical spindle 1400 per box, versions with horizontal spindle 1200 per box.

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max} and is also subjected to the full test voltage. See also Note under Survey of variable capacitors.

TESTS AND REQUIREMENTS

IEC418-1 clause	IEC68 test method	test	procedure	requirements
4.2		method of mounting	method A	
14		capacitance drift	after T.C. measurement	$\Delta C/C$ < 1%; < 2,5% for $C_{max} > 40$ pF
19		thrust	axial thrust of 2 N	$\Delta C/C$ < 0,3%
21		robustness of terminations:		
21.1	Ua	tensile	1 N	
21.2	Ub	bending	1 cycle	no damage
22	Na	rapid change of temperature	1 cycle: 1/2 h at lower and 1/2 h at upper category temp.	$\Delta C/C$ < 2%
23	T Ta	soldering solderability	solder bath, immersion 3 mm, 235 °C, 2 s	good wetting, no mechanical damage
	Tb	resistance to heat	solder bath 260 °C, 10 s	no mechanical damage
24	Eb	impact bump	4000 ± 10 bumps, 40g, 6 ms	$\Delta C/C$ < 0,6% no mechanical damage
25	Fc	vibration	freq. 10 to 55 Hz, ampl. 0,35 mm, 1,5 h	$\Delta C/C$ < 0,6% no mechanical damage

TESTS AND REQUIREMENTS (continued)

IEC418-1 clause	IEC68 test method	test	procedure	requirements
26		climatic sequence		$\Delta C/C$ < 4% $\tan \delta$ < 10×10^{-4} < 70×10^{-4} for $C_{max} > 27 \text{ pF}$
26.1	B	dry heat	16 h at upper category temp.	R_{ins} > 10 000 M Ω rotor contact R < 10 m Ω
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	voltage proof 500 V for 1 min visual examination no mechanical damage
26.3	Aa	cold	16 h, - 40 °C	operating torque 1 to 15 mNm
26.5		damp heat accelerated remaining cycles	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	
27	Ca	damp heat steady state	21 days, + 40 °C, 90 to 95% R.H.	$\Delta C/C$ < 5% $\tan \delta$ < 30×10^{-4} < 70×10^{-4} for $C_{max} > 27 \text{ pF}$ R_{ins} > 10 000 M Ω rotor contact R < 10 m Ω voltage proof 500 V for 1 min visual examination no mechanical damage operating torque 1 to 15 mNm
29 29.1		endurance mechanical	10 cycles	$\Delta C/C$ < 1,5% $\Delta C/C$ after axial thrust < 0,3% rotor contact R < 10 m Ω voltage proof 500 V for 1 min visual examination no mechanical damage operating torque 1 to 15 mNm

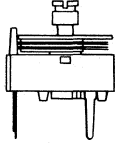
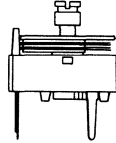
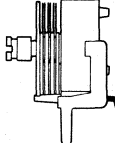
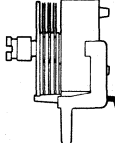
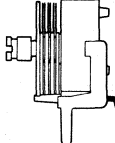
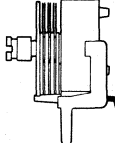
FILM DIELECTRIC TRIMMERS

- Housing diameter 10 mm
- For consumer and industrial equipment

QUICK REFERENCE DATA

C_{min}/C_{max}	1,8/15 to 5/105 pF
Rated voltage (d.c.)	250 V
Housing diameter	10 mm
Climatic category (IEC 68)	40/070/21 or 40/085/21
Related specification	IEC 418-1 and 4

Selection chart

reference C_{min}/C_{max}	catalogue number 2222 808 followed by					
	vertical spindle		vertical spindle		horizontal spindle	
						
	hole pattern 5 mm x 10 mm		hole pattern 7,5 mm x 5 mm		hole pattern 5 mm x 10 mm	
	round head	hexagonal head	round head	hexagonal head	round head	hexagonal head
pF	top + bottom adjustment		top + bottom adjustment		top + bottom adjustment	
1,8/15	31159*		32159*		61159*	
2,5/25	31229*		32229*		61229*	
4/40	31409		32409*		61409	
4/50	01029		01006*			
4,5/70	31659	34659	32659*		61659	64659
5/90	31809	34809	32809*	35809*	61809	64809
5/105	31101		32101*		61101 64101	

* Not for new design.

DESCRIPTION

The vanes of the trimmers are stacked on a sturdy plastic base, the colour of which indicates the maximum capacitance (Table 1). The dielectric is a film of polypropylene, polycarbonate or PTFE which supports the vanes in such a way that good stability is ensured and no microphony can occur. Flux absorption between the vanes is prevented. The trimmers are resistant to all standard cleaning solvents except trichloroethane and trichloroethylene.

Two versions with vertical spindle (Figs 1 and 3) and a version with horizontal spindle (Fig.5) are available.

MECHANICAL DATA

Dimensions in mm

Outlines	See Figs 1, 3 and 5
Effective angle of rotation	180°
Operating torque	2 to 25 mNm
Maximum axial thrust ($\Delta C < 0,3\%$ of C_{max})	2 N
Mass	approx. 1,3 g

Mounting

The trimmers can be mounted on printed-wiring boards with a grid of 2,50 mm or 2,54 mm; hole diameter min. 1,25 mm. See for hole patterns Figs 2, 4 and 6.

Soldering conditions: max. 260 °C, max. 10 s. (See also 'Tests and Requirements'.)

ELECTRICAL DATA; see also Table 1

Rated voltage (d.c.)	250 V
Test voltage (d.c.) for 1 min.	500 V
Contact resistance	max. 10 mΩ
Insulation resistance	min. 10 000 MΩ
Category temperature range	
$C_{max} = 15, 25, 40, 70$ pF	- 40 to + 70 °C
$C_{max} = 50, 90, 105$ pF	- 40 to + 85 °C
Climatic category (IEC68)	
$C_{max} = 15, 25, 40, 70$ pF	40/070/21
$C_{max} = 50, 90, 105$ pF	40/085/21
Minimum storage temperature	- 55 °C

Notes to Table 1 on the next page

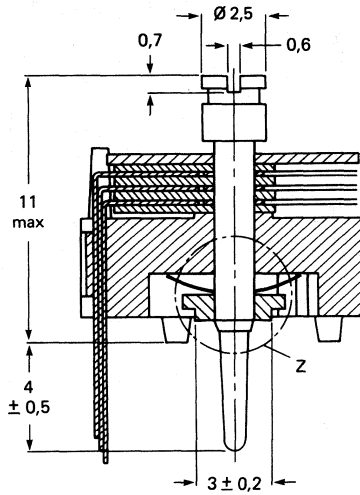
1. This column indicates the reference values of the capacitance ranges currently available on the market which are equivalent to our range.
2. PC = polycarbonate
PP = polypropylene
PTFE = polytetrafluorethylene
3. C at 60 to 80% of C_{max} ; ΔT from + 20 °C to upper category temperature.

Table 1 (Notes are on preceding page)

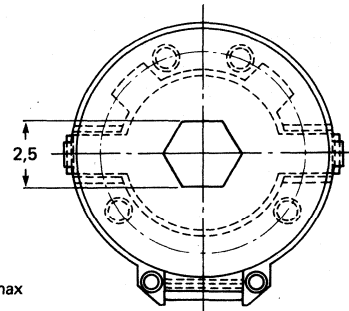
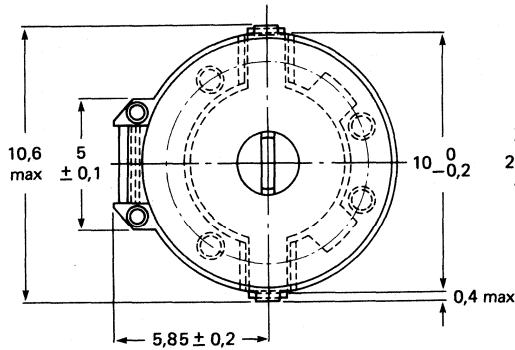
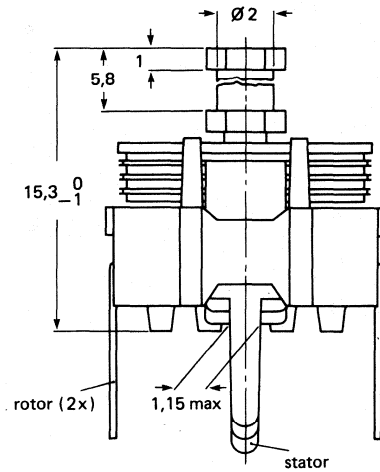
reference C_{min}/C_{max} (note 1) pF	cat. number 2222 808 followed by	spindle	shape of head	hole pattern Fig.	adjustment mode	dielectric film (note 2)	guaranteed max. C_{min} min. C_{max} at 200 kHz pF	$\tan \delta$ at $C_{max} \times 10^{-4}$ MHz	temp. coeff. (note 3) $10^{-5}/K$	min. f_{res} at C_{max} MHz	colour of base	small- est pack- ing quant.
1,8/15	31159*	vertical	round	2	top +	PP	2,5/15	<10	-150 ± 500	420	blue	800
	32159*	vertical	round	4	bottom							800
	61159*	horizont.	round	6								700
2,5/25	31229*	vertical	round	2	top +	PP	3/22,5	<10	-150 ± 400	200	green	800
	32229*	vertical	round	4	bottom							800
	61229*	horizont.	round	6								700
4/40	31409	vertical	round	2	top +	PP	5,5/40	<10	-150 ± 350	200	grey	800
	32409*	vertical	round	4	bottom							800
	61409	horizont.	round	6								700
4/50	01029	vertical	round	2	top +	PTFE	5,5/50	<10	-500 ± 150	170	yellow	800
	01006*	vertical	round	4	bottom							800
4,5/70	31659	vertical	round	2	top +	PP	5,5/65	<10	-200 ± 300	170	yellow	800
	32659*	vertical	round	4	bottom							800
	34659	vertical	hexagonal	2	top +							700
	61659	horizont.	round	6	bottom							700
	64659	horizont.	hexagonal	6								600
5/90	31809	vertical	round	2	top +	PC	6/80	<50	-100 ± 300	170	red	800
	34809	vertical	hexagonal	2	bottom							700
	32809*	vertical	round	4	top +							800
	35809*	vertical	hexagonal	4	bottom							700
	61809	horizont.	round	6								700
64809	horizont.	hexagonal	6								600	
5/105	31101	vertical	round	2	top +	PC	7/100	<50	-100 ± 300	170	violet	800
	32101*	vertical	round	4	bottom							800
	61101	horizont.	round	6								700
	64101	horizont.	hexagonal	6								600

* Not for new design.

ROUND HEAD



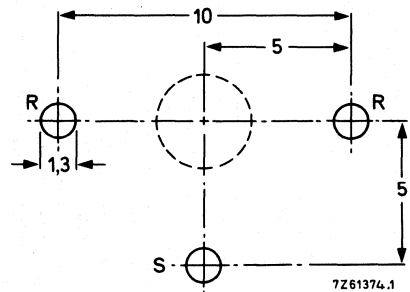
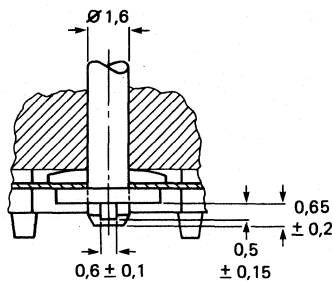
EXTENDED HEXAGONAL HEAD



7269862.1

DETAIL Z
 turned 90°

7293435



7261374.1

Fig.1 Version with vertical spindle;
 hole pattern 5 mm x 10 mm.

Fig.2 Hole pattern; R = rotor, S = stator.
 The large hole is for bottom adjustment;
 diameter determined by user's requirements.

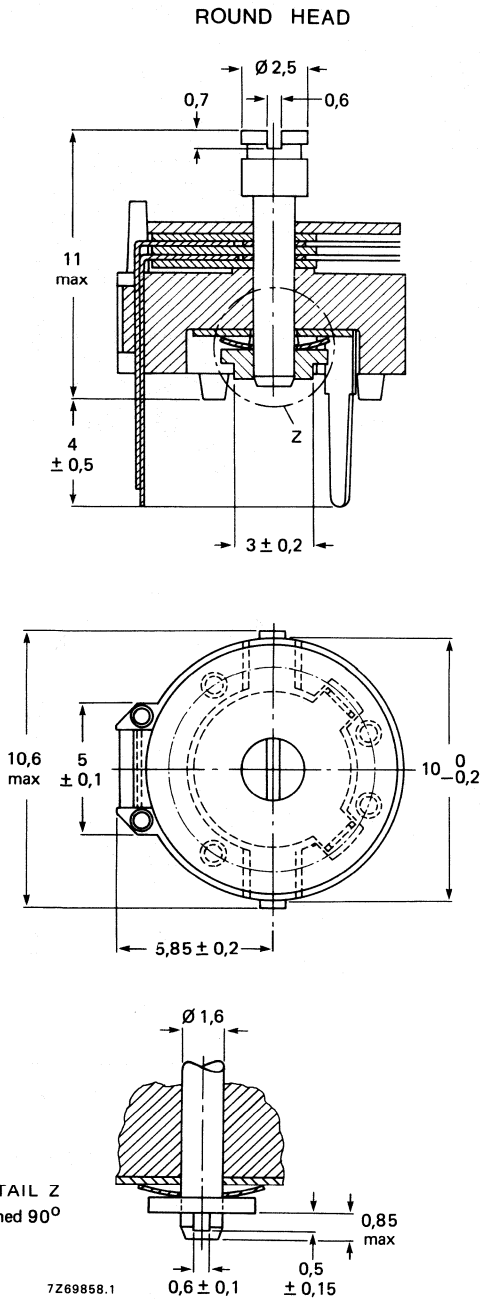


Fig.3 Version with vertical spindle;
 hole pattern 7,5 mm x 5 mm.

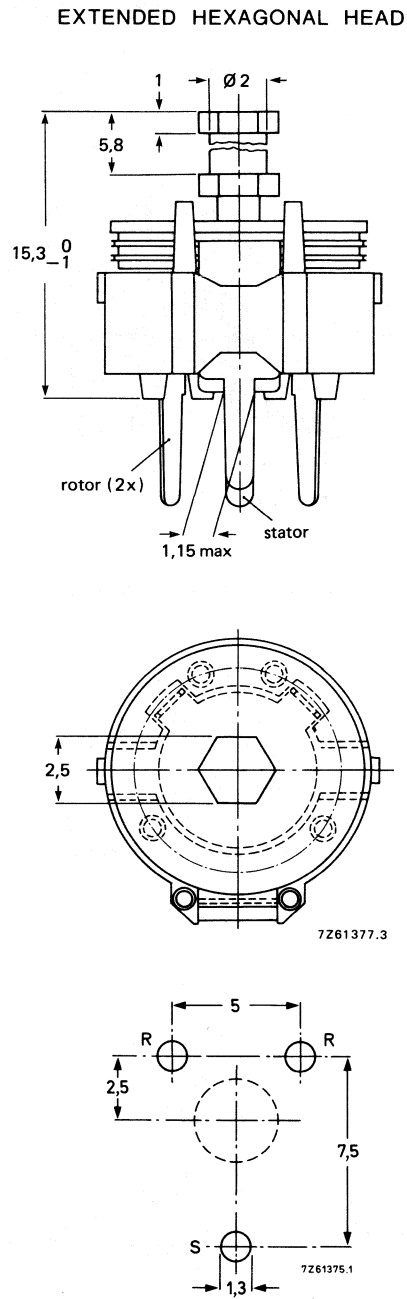


Fig.4 Hole pattern; R = rotor, S = stator.
 The large hole is for bottom adjustment;
 diameter determined by user's requirements.

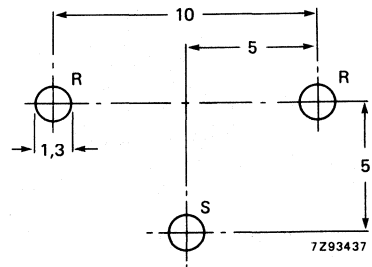
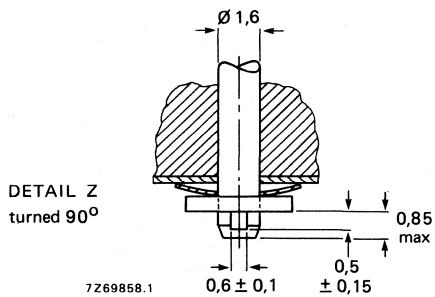
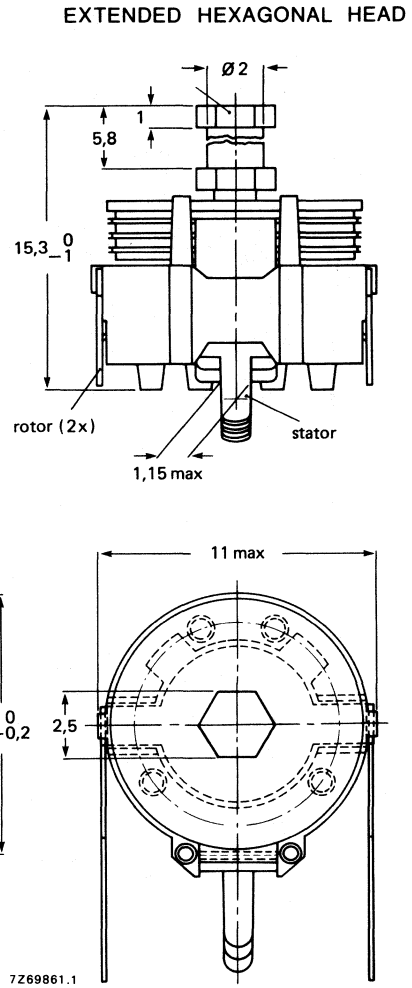
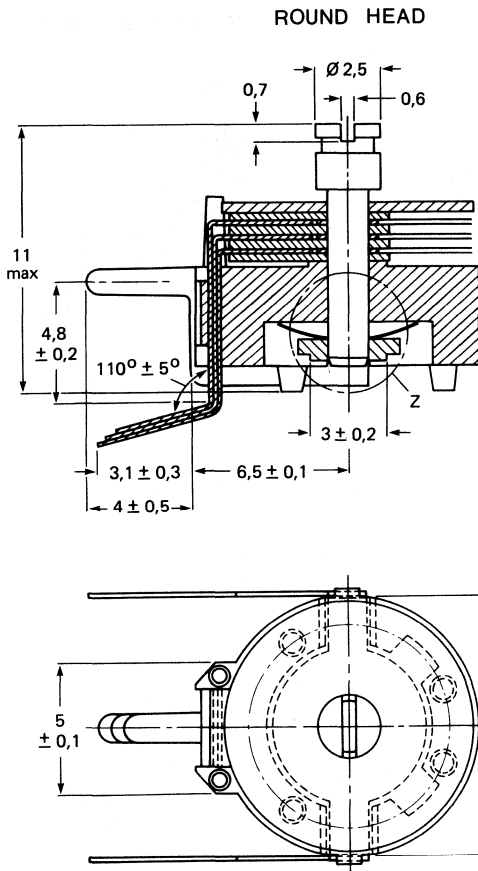


Fig.5 Version with horizontal spindle.

Fig.6 Hole pattern; R = rotor, S = stator

ADJUSTMENT

For top adjustment a screwdriver or spanner can be used, for bottom adjustment a key is required as shown in Fig.7.

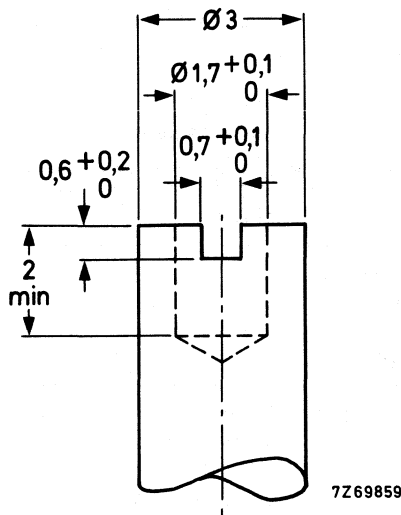


Fig.7.

The hexagonal spindle head is specially designed for the trimming of car radios with a spanner. It enables adjustment of the trimmer from the front by means of a long flexible rod provided with a hexagonal hole. The special shape of the trimmer head prevents a bending load on the trimmer spindle when the adjustment rod and spindle are not in line. It also allows a large axial tolerance.

PACKING

Bulk packing in cardboard boxes lined with expanded plastic.

Version with vertical spindle and round head:	800.
Version with vertical spindle and hexagonal head:	700
Version with horizontal spindle and round head:	700
Version with horizontal spindle and hexagonal head:	600.

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max} and is also subjected to the full test voltage. See also Note under Survey of variable capacitors.

TESTS AND REQUIREMENTS

IEC418-1 clause	IEC68 test method	test	procedure	requirements
4.2		method of mounting	method A	
14		capacitance drift	after T.C. measurement	$\Delta C/C$ $< 1,5\%$; $< 1\%$ for $C_{max} > 50$ pF
19		thrust	axial thrust of 2 N	$\Delta C/C$ $< 0,3\%$
21		robustness of terminations:		
21.1	Ua	tensile	1 N	
21.2	Ub	bending	1 cycle	no damage
22	Na	rapid change of temperature	1 cycle: 1/2 h at lower and 1/2 h at upper category temp.	$\Delta C/C$ $< 1,5\%$
23	T	soldering		
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s	good wetting, no mechanical damage
	Tb	resistance to heat	solder bath 260 °C, 10 s	no mechanical damage
24	Eb	impact bump	4000 ± 10 bumps, 40g, 6 ms	$\Delta C/C$ $< 0,4\%$ no mechanical damage
25	Fc	vibration	freq. 10 to 55 Hz, ampl. 0,35 mm, 1,5 h	$\Delta C/C$ $< 0,8\%$ no mechanical damage

TESTS AND REQUIREMENTS(continued)

IEC418-1 clause	IEC68 test method	test	procedure	requirements
26		climatic sequence		$\Delta C/C$ < 3%; < 6% for $C_{max} > 80$ pF $\tan \delta$ < 15×10^{-4} ; < 85×10^{-4} for $C_{max} > 80$ pF
26.1	B	dry heat	16 h at upper category temp.	R_{ins} > 10 000 M Ω rotor contact R < 10 m Ω
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	voltage proof 500 V for 1 min visual examination no mechanical damage
26.3	Aa	cold	16 h, - 40 °C	operating torque 2 to 35 mNm
26.5		damp heat accelerated remaining cycles	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	
27	Ca	damp heat steady state	21 days, + 40 °C, 90 to 95% R.H.	$\Delta C/C$ < 3%; < 3,5% for $C_{max} > 100$ pF $\tan \delta$ < 20×10^{-4} ; < 70×10^{-4} for $C_{max} > 80$ pF R_{ins} > 10 000 M Ω rotor contact R < 10 m Ω voltage proof 500 V for 1 min visual examination no mechanical damage operating torque 2 to 35 mNm
29 29.1		endurance mechanical	10 cycles	$\Delta C/C$ < 1% $\Delta C/C$ after axial thrust < 0,4% rotor contact R < 10 m Ω voltage proof 500 V for 1 min visual examination no mechanical damage operating torque 1,5 to 37 mNm

FILM DIELECTRIC TRIMMERS

- High temperature type
- Housing dimensions 6 mm x 8 mm x 9 mm
- For basic grid of 2.54 mm
- For professional applications, e.g. fine adjustment of h.f. tuned circuits

QUICK REFERENCE DATA

C_{\min}/C_{\max}	0.5/2 to 2/18 pF
Rated voltage (DC)	300 V
Housing diameter	6 mm x 8 mm x 9 mm
Climatic category (IEC 68)	40/125/21
Related specification	IEC 418-1 and 4

Selection chart

Vertical spindle, top and bottom adjustment.

value (pF)	round head	hex. head
C_{\min}/C_{\max}	catalogue number	catalogue number
0.5/2	2222 809 05011	2222 809 05021
1.2/3.5	2222 809 05215	2222 809 05225
1.8/10	2222 809 05216	2222 809 05226
2/18	2222 809 05217	2222 809 05227

DESCRIPTION

The trimmers consist of a polysulphone housing, brass rotor and plated brass stator with a PTFE film as the dielectric. The stator plates with their tag are heat sealed to the housing. The rotor contact surfaces are plated to ensure a long life and a stable contact even under severe climatic conditions. Flux absorption between the vanes is prevented. A colour dot indicates the maximum capacitance. The trimmers have top and bottom adjustment. Top adjustment should be done by means of a screw-driver and bottom adjustment by means of the key as shown in Fig.4.

MECHANICAL DATA

Outlines	see Fig.1
Effective angle of rotation	180°
Operating torque	
$C_{max} = 3.5 \text{ pF}$	1 to 15 mNm
$C_{max} = 10 \text{ and } 18 \text{ pF}$	2.5 to 20 mNm
Maximum axial thrust ($\Delta C \leq 0.3\%$ of C_{max})	2 N
Mass	approx. 0.45 g

Mounting

The trimmers can be mounted on printed-circuit boards with hole diameter min. 2.54 mm. For hole pattern, see Fig.3.

Soldering conditions: max. 260 °C, max. 10 s. (See Tests and Requirements).

ELECTRICAL DATA

Rated voltage (DC)	300 V
Test voltage (DC) for 1 min.	600 V
Contact resistance	max. 5 m Ω
Insulation resistance between stator and rotor	min. 10 000 M Ω
Category temperature range	-40 to + 125 °C
Climatic category (IEC 68)	40/125/21
Minimum storage temperature	-55 °C

Table 1

guaranteed max. C_{min} min. C_{max} at 200 kHz pF	catalogue number	shape of head	$\tan \delta$ at $C_{max} \times 10^{-4}$ 1 100 MHz MHz	temp. coeff. (note 1) $10^{-6}/K$	min. f_{res} at C_{max} MHz	colour of base	smallest packing quantity
0.6/2	2222 809 05011 2222 809 05021	round hex	≤ 10 ≤ 20	-250 ± 200	1200	no	140
1.2/3.5	2222 809 05215 2222 809 05225	round hex	≤ 10 ≤ 20	-250 ± 150	850	orange	140
1.8/10	2222 809 05216 2222 809 05226	round hex	≤ 10 ≤ 20	-350 ± 150	580	white	140
2/18	2222 809 05217 2222 809 05227	round hex	≤ 10 ≤ 25	-350 ± 150	360	red	140

Note

1. C at 60% to 80% of C_{max} ; T from +20 °C to +125 °C.

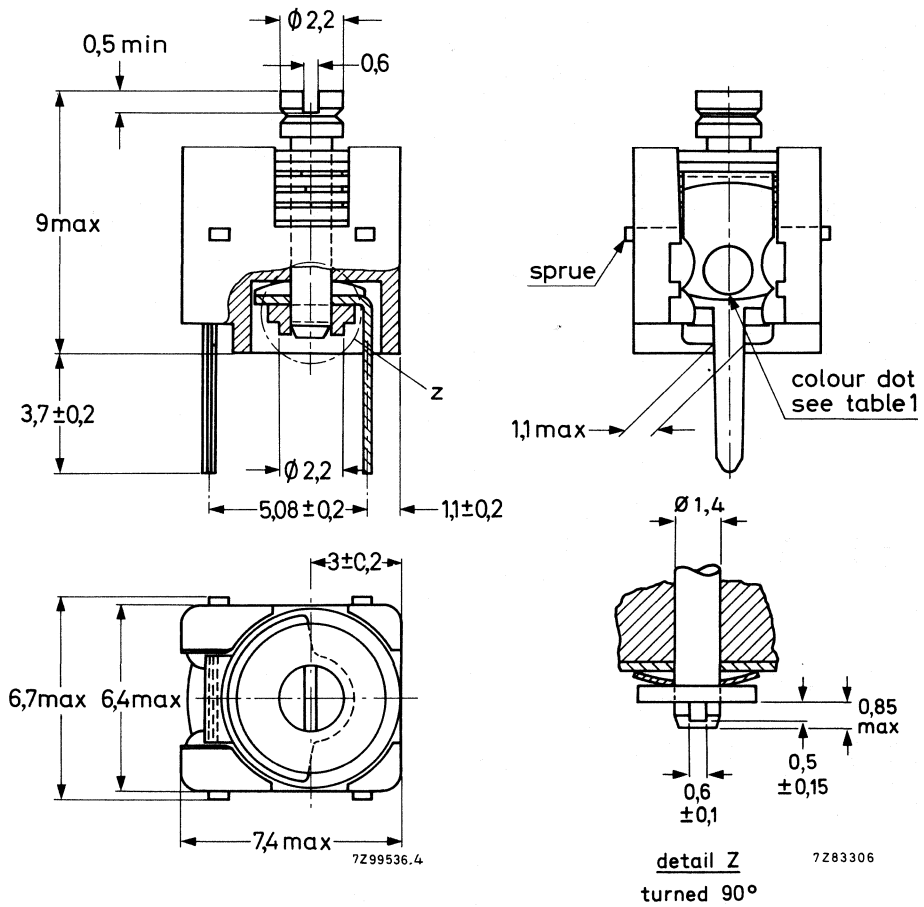
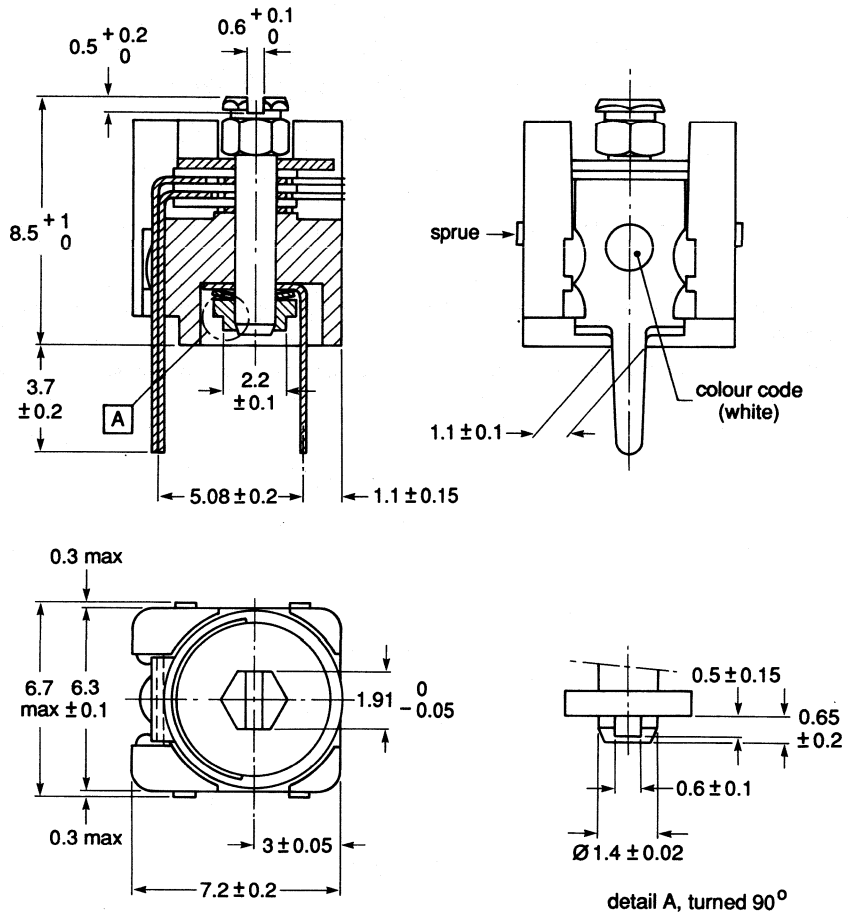
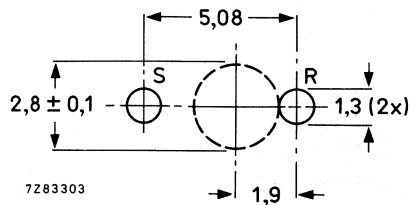


Fig.1 Trimmers 2222 809 05 . . . series, round head.



7225428

Fig.2 Trimmers 2222 809 05 . . . series, hex. head.



Note: The large hole is required only where bottom adjustment is used. R = rotor, S = stator.

Fig.3 Trimmer pin holes.

ADJUSTMENT

For top adjustment a screwdriver or trimming key can be used; for bottom adjustment a key is required as shown in Fig.4.

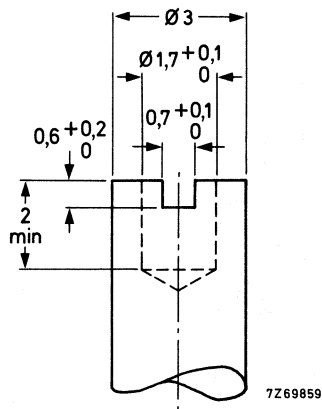


Fig.4 Bottom adjustment key.

PACKING

Blister packs of 140 pieces each.

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

AQL 0.4% major defects, 1.5% minor defects.

Each capacitor is tested for min. C_{max} and is also subjected to the full test voltage. See also note under survey of variable capacitors.

TESTS AND REQUIREMENTS

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements
4.2		method of mounting	method A	
14		capacitance drift	after T.C. measurement	$\Delta C/C$ $\leq 1\%$
19		thrust	axial thrust of 2 N	$\Delta C/C$ $\leq 0.3\%$
21		robustness of terminations:		
21.1	Ua	tensile	1 N	
21.2	Ub	bending	1 cycle	no damage
22	Na	rapid change of temperature	1 cycle: ½ h at lower and ½ h at upper category temp.	$\Delta C/C$ $\leq 2\%$
23	T Ta	soldering solderability	solder bath, immersion 3 mm, 235 °C, 2 s	good wetting, no mechanical damage
	Tb	resistance to heat	solder bath 260 °C, 10 s	no mechanical damage
24	Eb	impact bump	4000 ± 10 bumps, 40g, 6 ms	$\Delta C/C$ $\leq 0.6\%$ no mechanical damage
25	Fc	vibration	freq. 10 to 55 Hz, ampl. 0.35 mm 1.5 h	$\Delta C/C$ $\leq 0.2\%$ no mechanical damage

TESTS AND REQUIREMENTS (continued)

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements
26		climatic sequence		$\Delta C/C$ $\leq 2.5\%$
				$\tan \delta (< 18 \text{ pF})$ $\leq 10 \times 10^{-4}$ $(\geq 18 \text{ pF})$ $\leq 40 \times 10^{-4}$
26.1	B	dry heat	16 h at upper category temp.	R_{ins} $\geq 10\,000 \text{ M}\Omega$ rotor contact R $\leq 5 \text{ m}\Omega$
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	voltage proof 600 V for 1 min visual examination no mechanical damage
26.3	Aa	cold	16 h, -40 °C	operating torque 1 to 20 mNm
26.5		damp heat accelerated remaining cycles	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	
27	Ca	damp heat steady state	21 days, + 40 °C 90 to 95% R.H.	$\Delta C/C$ $\leq 2.5\%$
				$\tan \delta (< 18 \text{ pF})$ $\leq 10 \times 10^{-4}$ $(\geq 18 \text{ pF})$ $\leq 25 \times 10^{-4}$
				R_{ins} $\geq 10\,000 \text{ M}\Omega$ rotor contact R $\leq 5 \text{ m}\Omega$
				voltage proof 600 V for 1 min visual examination no mechanical damage
				operating torque 1 to 20 mNm
29 29.1		endurance mechanical	25 cycles	$\Delta C/C$ $\leq 0.3\%$
				$\Delta C/C$ after axial thrust $\leq 0.3\%$
				rotor contact R $\leq 5 \text{ m}\Omega$
				voltage proof 600 V for 1 min
				visual examination no mechanical damage
				operating torque 1 to 20 mNm

FILM DIELECTRIC TRIMMERS

- High temperature resistance type
- For professional application

QUICK REFERENCE DATA

C_{max}	5 to 20 pF
Rated voltage (DC)	300 V
Climatic category (IEC 68)	40/125/21
Related specification	IEC 418-1 and 4

Selection chart

PTFE, 5 mm pitch, round head. Top adjustment with cross slot.

Value (pF)	Catalogue number
5	2222 811 00508
10	2222 811 00109
15	2222 811 00159
20	2222 811 00209

DESCRIPTION

The trimmer consists of an enclosed plastic housing of high temperature resistance material, a brass rotor and plated brass stator with a PTFE film as the dielectric. In addition there is a plastic actuating cross-slot and a position indicator for top adjustment only. The colour of the cover plate indicates the nominal C value.

The stator vanes with their tag are heat sealed to the housing.

The rotor contact surfaces are plated to ensure a long life and a stable contact even under severe climatic conditions.

Flux absorption between the vanes is prevented.

MECHANICAL DATA

Effective angle of rotation	180 °C
Operating torque	1 to 20 mNm
Maximum angle thrust ($C \leq 0.3\%$ of C_{\max})	2 N
Mass	approx. 0.5 g

Mounting

The trimmer can be mounted on printed-circuit boards with hole diameter min. 1.25 mm.

Soldering condition: max. 260 °C, max. 10 s.

ELECTRICAL DATA

Rated voltage (DC)	300 V
Test voltage (DC) for 1 min.	600 V
Insulation resistance	min. 10 000 M Ω
$\tan \delta$ at $C_{\max} \times 10^{-4}$, 1 MHz	≤ 10
Temperature coefficient	$-250 \pm 200 \times 10^{-6}$
Category temperature range	-40 to + 125 °C
Minimum storage temperature	-55 °C

DEVELOPMENT DATA

Table 1

reference C _{max} pF	catalogue number	guaranteed max. C _{min} min. C _{max} at 200 kHz pF	tan δ at C _{max} x 10 ⁻⁴ 1 100 MHz MHz	temp. coeff.	min. f _{res} at C _{max} MHz	colour of base	smallest packing quantity
5	2222 811 00508	1.5/5	≤ 10 ≤ 20	-250 ± 200	1000	grey	140
10	2222 811 00109	2/10	≤ 10 ≤ 20	-250 ± 200	650	yellow	140
15	2222 811 00159	2.5/15	≤ 10 ≤ 20	-250 ± 200	500	blue	140
20	2222 811 00209	4/20	≤ 10 ≤ 20	-250 ± 200	400	green	140

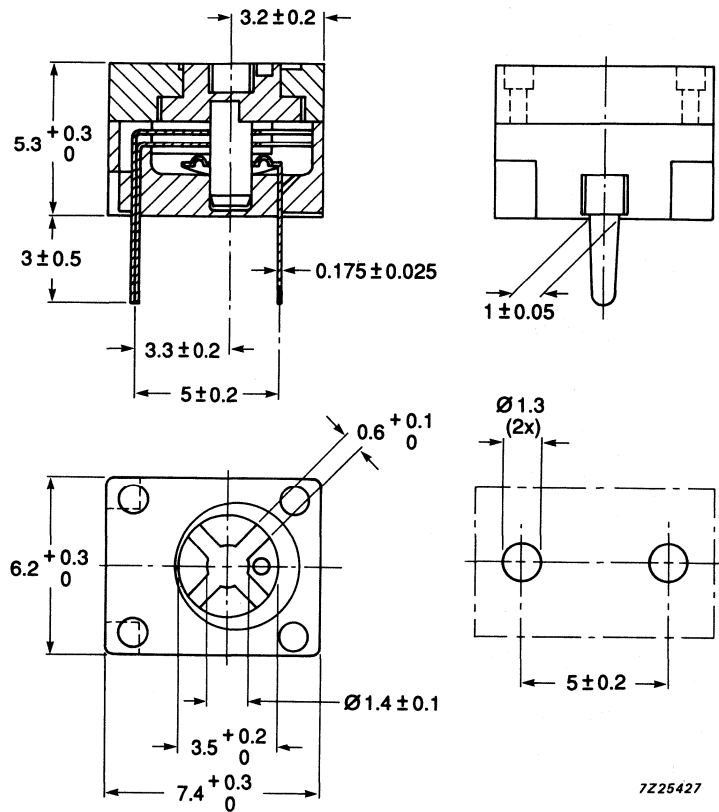


Fig.1 Trimmers 2222 811 series.

PACKING

Blister packs of 140 pieces each.

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

AQL 0.4% major defects, 1.5% minor defects.

Each capacitor is tested for min. C_{max} and is also subjected to the full test voltage.

TESTS AND REQUIREMENTS

DEVELOPMENT DATA

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		capacitance drift	after T.C. measurement	$\Delta C/C$	$\leq 1\%$
19		thrust	axial thrust of 2 N	$\Delta C/C$	$\leq 0.3\%$
21		robustness of terminations:			
21.1	Ua	tensile	1 N		
21.2	Ub	bending	1 cycle		no damage
22	Na	rapid change of temperature	1 cycle: ½ h at lower end and ½ h at upper category temp.	$\Delta C/C$	$\leq 2\%$
23	T Ta	soldering solderability	solder bath immersion 3 mm, 235 °C, 2 s		good wetting no mechanical damage
	Tb	resistance to heat	solder bath 260 °C, 10 s		no mechanical damage
24	Eb	impact bump	4000 ± 10 bumps, 40 g, 6 ms	$\Delta C/C$	$\leq 0.6\%$ no mechanical damage
25	Fc	vibration	freq. 10 to 55 Hz, ampl. 0.75 mm 1.5 h	$\Delta C/C$	$\leq 0.2\%$ no mechanical damage

TESTS AND REQUIREMENTS (continued)

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements
26		climatic sequence		$\Delta C/C$ $\leq 2.5\%$
26.1	B	dry heat	16 h at upper category temp.	$\text{Tan } \delta$ $\leq 60 \times 10^{-4}$ R_{ins} $\geq 10\,000 \text{ M}\Omega$
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	voltage proof 600 V for 1 min.
26.3	Aa	cold	16 h, -40 °C	visual examination no mechanical damage
26.5		damp heat accelerated, remaining cycles	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	operating torque 1 to 20 mNm
27	Ca	damp heat steady state	21 days, + 40 °C 90 to 95% R.H.	$\Delta C/C$ $\leq 2.5\%$ $\text{Tan } \delta$ $\leq 10 \times 10^{-4}$ R_{ins} $\geq 10\,000 \text{ M}\Omega$ voltage proof 600 V for 1 min. visual examination no mechanical damage operating torque 1 to 20 mNm
29		endurance	10 cycles	$\Delta C/C$ $\leq 3\%$
29.1		mechanical		$\Delta C/C$ after axial thrust $\pm 0.3\%$ voltage proof 600 V for 1 min. visual examination no mechanical damage operating torque 1 to 20 mNm

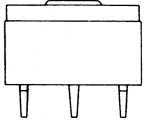
FILM DIELECTRIC TRIMMERS

- High temperature type
- Housing dimensions 11 mm x 14 mm x 9 mm
- For basic grid of 2,54 mm
- For professional applications, e.g. fine adjustment of h.f. tuned circuits, capacitive volume or voltage control

QUICK REFERENCE DATA

C_{\min}/C_{\max}	
single stator type	2,5/20 to 7/100
differential type	2/12 to 7/150
Rated voltage (d.c.)	200 V
Housing dimensions	11 mm x 14 mm x 9 mm
Climatic category (IEC 68)	40/125/21
Related specification	IEC 418-1 and 4

Selection chart

C_{\min}/C_{\max}	catalogue number	
	vertical spindle	
pF	single stator type	differential type
2/12		2222 809 07018
2,5/20	2222 809 07004	2222 809 07006
4/40	2222 809 07008	2222 809 07009
5/60	2222 809 07011	2222 809 07012
6/80	2222 809 07013	2222 809 07014
7/100	2222 809 07015	2222 809 07016
7/150		2222 809 07107

DESCRIPTION

The trimmers consist of a glass reinforced polysulphone frame with a polysulphone dust cover, brass rotor and stator with PTFE or polycarbonate film as the dielectric. The stator plates are stacked on pins and separated by rings, so that it is possible to produce a single-stator or a differential type. The rotor contact surfaces are plated to ensure a long life and a stable contact even under severe climatic conditions.

The trimmers have top adjustment by means of a screwdriver; capacitance increase is obtained with clockwise rotation. (Trimmers with counter-clockwise rotation and trimmers with insulated rotor are available on request.)

MECHANICAL DATA

Dimensions in mm

Outlines	See Fig.1
Effective angle of rotation	180°
Operating torque	1,5 to 25 mNm
Maximum axial thrust ($\Delta C < 0,3\%$ of C_{max})	2 N
Mass	
single-stator type	approx. 2,3 g
differential type	approx. 2,9 g

Mounting

The trimmers can be mounted on printed-wiring boards with a grid of 2,54 mm; hole diameter min. 1,25 mm. See for hole pattern Fig.2.

Soldering conditions: max. 260 °C, max. 10 s. (See also 'Tests and Requirements'.)

ELECTRICAL DATA; see also Table 1

Rated voltage (d.c.)	200 V
Test voltage (d.c.) for 1 min.	400 V
Contact resistance	max. 5 m Ω
Insulation resistance between stator and rotor	min. 10 000 M Ω
Category temperature range	- 40 to + 125 °C
Climatic category (IEC 68)	40/125/21
Minimum storage temperature	- 55 °C

Table 1

guaranteed max. C_{\min} min. C_{\max} at 200 kHz pF	type	cat. number 2222 809 followed by	spindle	adjustment mode	dielectric film (note 1)	$\tan \delta$ at C_{\max} $\times 10^{-4}$ 1 MHz 100 MHz (note 2) $10^{-6}/K$	temp. coeff. 0 ± 200	smallest packing quantity
2/12	differential	07018	vertical	top	PTFE	< 10	0 ± 200	70
2,5/20	single-stator differential	07004 07006	vertical	top	PTFE	< 10	0 ± 200	70
4/40	single-stator differential	07008 07009	vertical	top	PTFE	< 10	0 ± 200	70
5/60	single-stator differential	07011 07012	vertical	top	PTFE	< 10	0 ± 200	70
6/80	single-stator differential	07013 07014	vertical	top	PTFE	< 10	0 ± 200	70
7/100	single-stator differential	07015 07016	vertical	top	PTFE	< 10	0 ± 200	70
7/150	differential	07107	vertical	top	PC	< 50	0 ± 200	70

Notes to Table 1

1. PTFE = polytetrafluorethylene;
PC = polycarbonate.
2. C at 60 to 80% of C_{\max} ; ΔT from $+20$ to $+125$ °C.

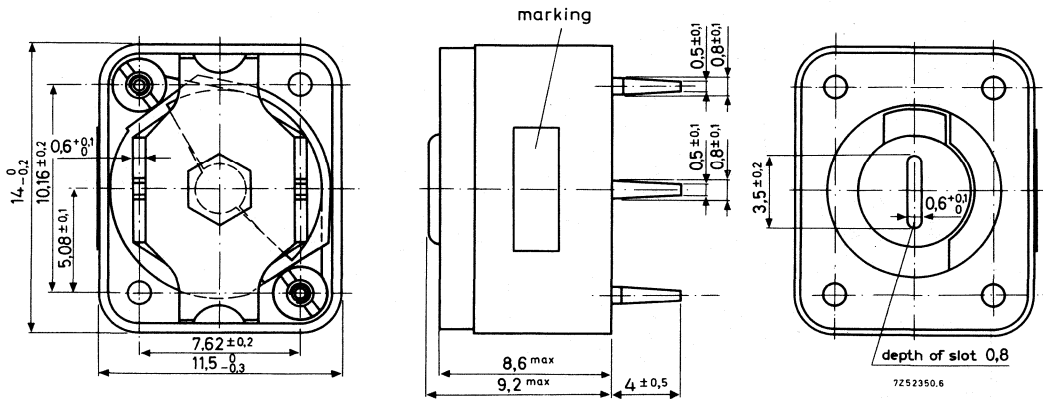


Fig.1.

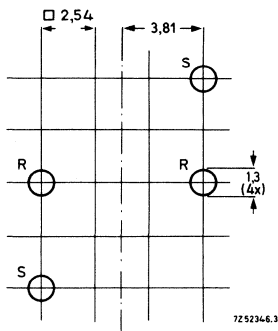


Fig.2 Hole pattern; R = rotor, S = stator.

MARKING

The trimmers are marked with the capacitance value in pF, followed by the letter E (single-stator type) or the letter D (differential type).

ADJUSTMENT

The trimmers can be adjusted with a screwdriver or trimming key (top adjustment).

PACKING

Blister packs of 70 pieces each.

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max} and is also subjected to the full test voltage. See also Note under Survey of variable capacitors.

TESTS AND REQUIREMENTS

IEC418-1 clause	IEC68 test method	test	procedure	requirements
4.2		method of mounting	method A	
14		capacitance drift	after T.C. measurement	$\Delta C/C$ < 1%
19		thrust	axial thrust of 2 N	$\Delta C/C$ < 0,3%
21		robustness of terminations:		
21.1	Ua	tensile	1 N	no damage
21.2	Ub	bending		bending not allowed
22	Na	rapid change of temperature	1 cycle: 1/2 h at lower and 1/2 h at upper category temp.	$\Delta C/C$ < 1%
23	T	soldering		
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s	good wetting, no mechanical damage
	Tb	resistance to heat	solder bath 260 °C, 10 s	no mechanical damage
24	Eb	impact bump	4000 ± 10 bumps, 40g, 6 ms	$\Delta C/C$ < 0,2% no mechanical damage
25	Fc	vibration	freq. 10 to 55 Hz, ampl. 0,35 mm, 1,5 h	$\Delta C/C$ < 0,25% no mechanical damage

TESTS AND REQUIREMENTS (continued)

IEC418-1 clause	IEC68 test method	test	procedure	requirements
26		climatic sequence		$\Delta C/C$ < 3% $\tan \delta$ < 10×10^{-4}
26.1	B	dry heat	16 h at upper category temp.	R_{ins} > 10 000 M Ω rotor contact R < 10 m Ω
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	voltage proof 400 V for 1 min visual examination no mechanical damage
26.3	Aa	cold	16 h, -40 °C	operating torque 1,5 to 35 mNm
26.5		damp heat accelerated remaining cycles	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	
27	Ca	damp heat steady state	21 days, + 40 °C, 90 to 95% R.H.	$\Delta C/C$ < 3% $\tan \delta$ < 10×10^{-4} R_{ins} > 10 000 M Ω rotor contact R < 10 m Ω voltage proof 400 V for 1 min visual examination no mechanical damage operating torque 1,5 to 35 mNm
29 29.1		endurance mechanical	25 cycles	$\Delta C/C$ < 0,3% $\Delta C/C$ after axial thrust < 0,3% rotor contact R < 10 m Ω voltage proof 400 V for 1 min visual examination no mechanical damage operating torque 1 to 50 mNm

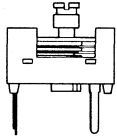
FILM DIELECTRIC TRIMMERS

- High temperature type
- Housing dimensions 10 mm x 11 mm x 11 mm
- For basic grid of 2,54 mm
- For professional applications, e.g. fine adjustment of h.f. tuned circuits

QUICK REFERENCE DATA

C_{min}/C_{max}	4/40 pF and 5/60 pF
Rated voltage (d.c.)	300 V
Housing dimensions	10 mm x 11 mm x 11 mm
Climatic category (IEC 68)	40/125/21
Related specification	IEC 418-1 and 4

Selection chart

catalogue number	
C_{min}/C_{max}	vertical spindle 
pF	round head; top + bottom adjustment
4/40	2222 809 08002
5/60	2222 809 08003

DESCRIPTION

The trimmers consist of a polysulphone housing, brass rotor and plated brass stator with a PTFE film as the dielectric. The stator plates with their tag are heat-sealed to the housing. The rotor contact surface is plated to ensure a long life and a stable contact even under severe climatic conditions. Flux absorption between the vanes is prevented. A colour dot indicates the maximum capacitance.

The trimmers have top and bottom adjustment; top adjustment should be done by means of a screwdriver, bottom adjustment by means of the key according to Fig.3.

MECHANICAL DATA

Dimensions in mm

Outlines	See Fig.1
Effective angle of rotation	180°
Operating torque	2 to 25 mNm
Maximum axial thrust ($\Delta C \leq 0,3\%$ of C_{max})	2 N
Mass	approx. 1,6 g

Mounting

The trimmers can be mounted on printed-wiring boards with a grid of 2,54 mm; hole diameter min. 1,25 mm. See for hole pattern Fig.2.

Soldering conditions: max. 260 °C, max. 10 s. (See also 'Tests and Requirements'.)

ELECTRICAL DATA; see also Table 1

Rated voltage (d.c.)	300 V
Test voltage (d.c.) for 1 min.	600 V
Contact resistance	max. 5 m Ω
Insulation resistance	min. 10 000 M Ω
Category temperature range	- 40 to + 125 °C
Climatic category (IEC 68)	40/125/21
Minimum storage temperature	- 55 °C

Table 1

guaranteed max. C_{\min} min. C_{\max} at 200 KHz pF	cat. number 2222 809 followed by	spindle	shape of head	adjustment mode	dielectric film (note 1)	$\tan \delta$ at $C_{\max} \times 10^{-4}$ MHz	temp. coeff. (note 2) $10^{-6}/K$	min. f_{res} at C_{\max} MHz	colour of dot	smallest packing quantity
4/37	08002	vertical	round	top + bottom	PTFE	< 10	-250 ± 150	170	yellow	70
5/57	08003	vertical	round	top + bottom	PTFE	< 10	-250 ± 150	150	blue	70

Notes to Table 1

1. PTFE = polytetrafluorethylene.
2. C at 60 to 80% of C_{mac} ; ΔT from +20 to +125 °C.

ADJUSTMENT

For top adjustment a screwdriver or trimming key can be used; for bottom adjustment a key is required as shown in Fig.3.

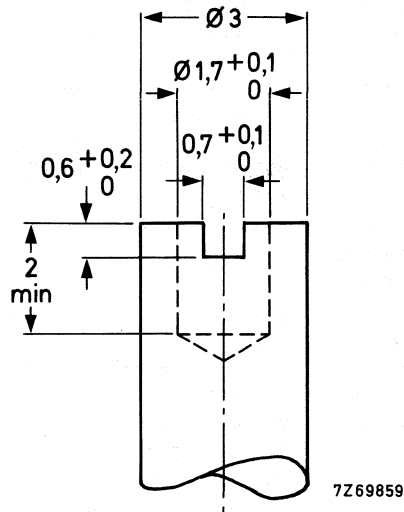


Fig.3.

PACKING

Blister packs of 70 pieces each.

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max} and is also subjected to the full test voltage. See also Note under Survey of variable capacitors.

TESTS AND REQUIREMENTS

IEC418-1 clause	IEC68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		capacitance drift	after T.C. measurement	$\Delta C/C$	< 1,5%
19		thrust	axial thrust of 2 N	$\Delta C/C$	< 0,2%
21		robustness of terminations:			
21.1	Ua	tensile	1 N		
21.2	Ub	bending	1 cycle		no damage
22	Na	rapid change of temperature	1 cycle: 1/2 h at lower and 1/2 h at upper category temp.	$\Delta C/C$	< 2,5%
23	T	soldering			
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s		good wetting, no mechanical damage
	Tb	resistance to heat	solder bath 260 °C, 10 s		no mechanical damage
24	Eb	impact bump	4000 \pm 10 bumps, 40g, 6 ms	$\Delta C/C$	< 0,5% no mechanical damage
25	Fc	vibration	freq. 10 to 55 Hz, ampl. 0,35 mm, 1,5 h	$\Delta C/C$	< 0,2% no mechanical damage

TESTS AND REQUIREMENTS (continued)

IEC418-1 clause	IEC68 test method	test	procedure	requirements	
26		climatic sequence		$\Delta C/C$	$\leq 2,5\%$
				$\tan \delta$	$\leq 10 \times 10^{-4}$
26.1	B	dry heat	16 h at upper category temp.	R_{ins} rotor contact R	$\geq 10\,000\,M\Omega$ $\leq 5\,m\Omega$
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	voltage proof	600 V for 1 min
				visual examination	no mechanical damage
26.3	Aa	cold	16 h, - 40 °C	operating torque	1 to 20 mNm
26.5		damp heat accelerated remaining cycles	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.		
27	Ca	damp heat steady state	21 days, + 40 °C, 90 to 95% R.H.	$\Delta C/C$	$\leq 2,5\%$
				$\tan \delta$	$\leq 10 \times 10^{-4}$
				R_{ins} rotor contact R	$\geq 10\,000\,M\Omega$ $\leq 5\,m\Omega$
				voltage proof	600 V for 1 min
				visual examination	no mechanical damage
				operating torque	1 to 20 mNm
29		endurance mechanical	25 cycles	$\Delta C/C$	$\leq 0,3\%$
29.1				$\Delta C/C$ after axial thrust	$\leq 0,3\%$
				rotor contact R	$\leq 5\,m\Omega$
				voltage proof	600 V for 1 min
				visual examination	no mechanical damage
				operating torque	1 to 20 mNm

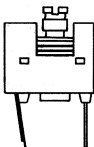
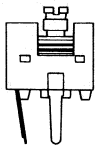
FILM DIELECTRIC TRIMMERS

- High temperature type
- Housing dimensions 8 mm x 9 mm x 10 mm
- For basic grid of 2,54 mm
- For professional applications, e.g. fine adjustment of h.f. tuned circuits

QUICK REFERENCE DATA

C_{min}/C_{max}	1,4/5,5 to 2/18 pF
Rated voltage (d.c.)	300 V
Housing dimensions	8 mm x 9 mm x 10 mm
Climatic category (IEC 68)	40/125/21
Related specification	IEC 418-1 and 4

Selection chart

	catalogue number	
C_{min}/C_{max}	vertical spindle 	vertical spindle 
	round head; top + bottom adjustment	round head; top + bottom adjustment
pF	version with 1 rotor tag	version with 2 rotor tags
1,4/5,5	2222 809 09004	2222 809 09001
2/9	2222 809 09005	2222 809 09002
2/18	2222 809 09006	2222 809 09003

DESCRIPTION

The trimmers consist of a polysulphone housing, brass rotor and plated brass stator with a PTFE film as the dielectric. The stator plates with their tag are heat-sealed to the housing. The rotor contact surface is plated to ensure a long life and a stable contact even under severe climatic conditions. Flux absorption between the vanes is prevented. A colour dot indicates the maximum capacitance.

Versions with one rotor tag and with two rotor tags are available. The trimmers have top and bottom adjustment; top adjustment should be done by means of a screwdriver, bottom adjustment by means of the key according to Fig.5.

MECHANICAL DATA

Dimensions in mm

Outlines	See Figs 1 and 3
Effective angle of rotation	180°
Operating torque	
$C_{\max} = 5,5 \text{ pF}$	1 to 15 mNm
$C_{\max} = 9 \text{ and } 18 \text{ pF}$	2,5 to 20 mNm
Maximum axial thrust ($\Delta C < 0,3\%$ of C_{\max})	2 N
Mass	approx. 0,8 g

Mounting

The trimmers can be mounted on printed-wiring boards; hole diameter min. 1,25 mm. See for hole patterns Figs 2 and 4.

Soldering conditions: max. 260 °C, max. 10 s. (See also 'Tests and Requirements'.)

ELECTRICAL DATA; see also Table 1

Rated voltage (d.c.)	300 V
Test voltage (d.c.) for 1 min.	500 V
Contact resistance	max. 5 mΩ
Insulation resistance between stator and rotor	min. 10 000 MΩ
Category temperature range	-40 to +125 °C
Climatic category (IEC 68)	40/125/21
Minimum storage temperature	-55 °C

Table 1

guaranteed max. C_{\min} min. C_{\max} at 200 kHz pF	cat. number 2222 809 followed by	spindle	shape of head	adjustment mode	dielectric film (note 1)	$\tan \delta$ at $C_{\max} \times 10^{-4}$ MHz	temp. coeff. (note 2) $10^{-5}/K$	min. f_{res} at C_{\max} MHz	colour of dot	smallest packing quantity
1,4/5,5	09004* 09001**	vertical	round	top + bottom	PTFE	< 10	- 250 ± 150	850	green	105
2/9	09005* 09002**	vertical	round	top + bottom	PTFE	< 10	- 250 ± 150	580	white	105
2/18	09006* 09003**	vertical	round	top + bottom	PTFE	< 10	- 250 ± 150	360	red	105

* With one rotor contact

** With two rotor contacts

Notes to Table 1

1. PTFE = polytetrafluoroethylene.
2. C at 60 to 80% of C_{\max} ; ΔT from + 20 to + 125 °C.

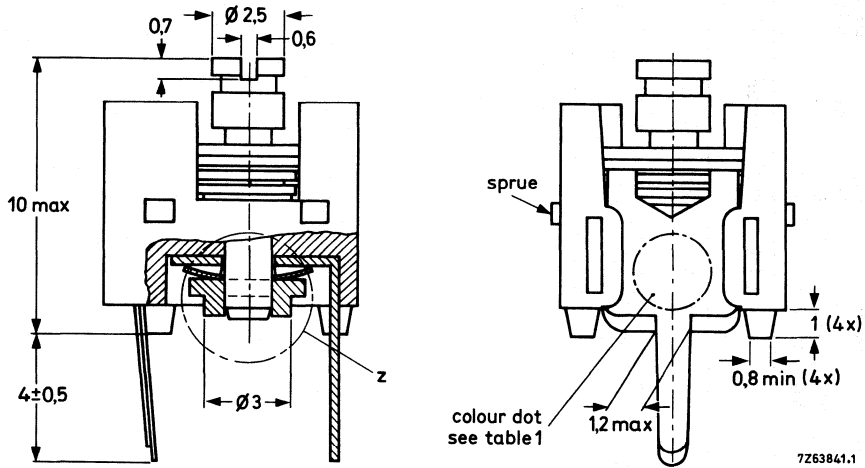


Fig.1 Version with one rotor contact.

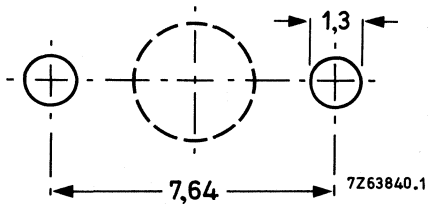
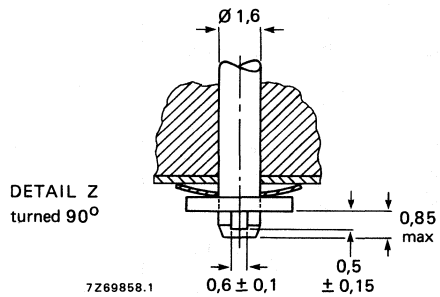


Fig.2 Hole pattern. The large hole is for bottom adjustment; the diameter is determined by user's requirements.

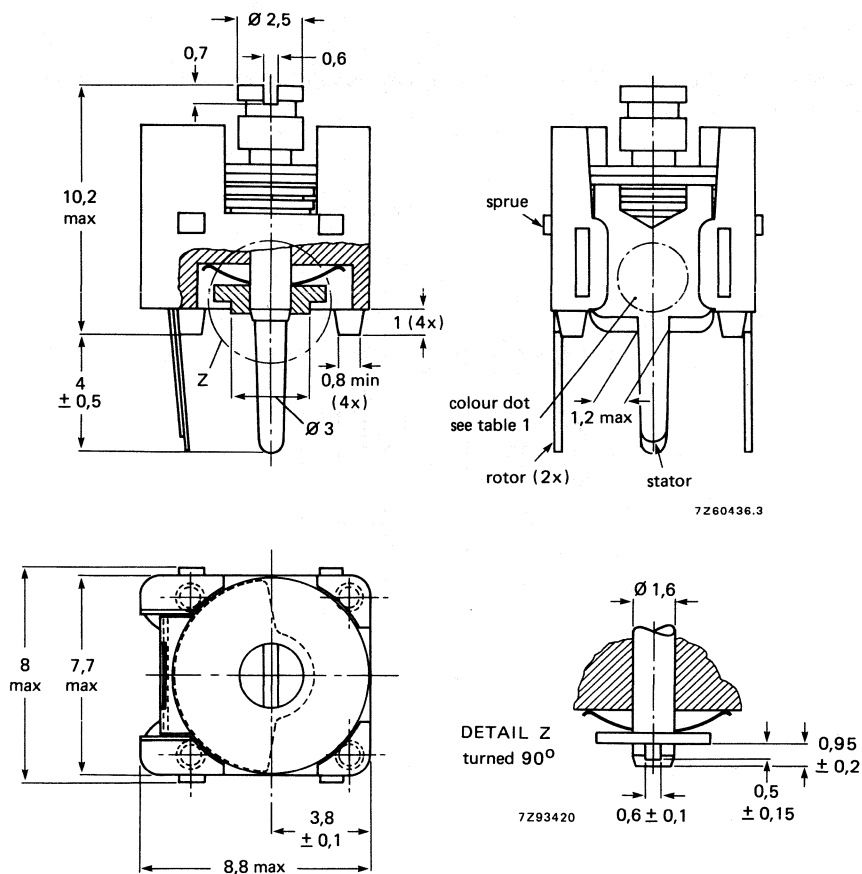


Fig.3 Version with two rotor contacts.

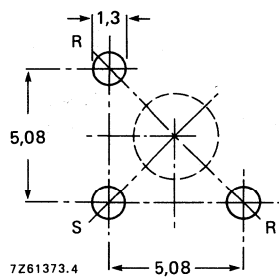


Fig.4 Hole pattern; R=rotor, S=stator. The large hole is for bottom adjustment; the diameter is determined by user's requirements.

ADJUSTMENT

For top adjustment a screwdriver or trimming key can be used; for bottom adjustment a key is required as shown in Fig.5.

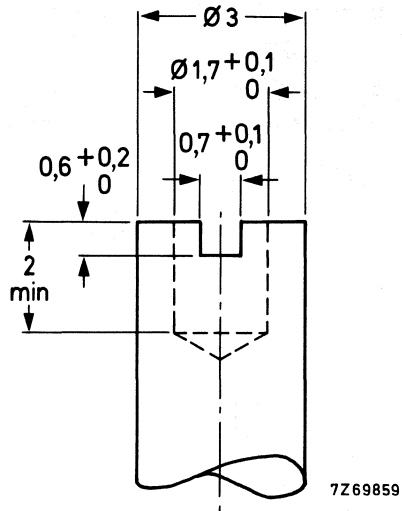


Fig.5.

PACKING

Blister packs of 105 pieces each.

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{\max} and is also subjected to the full test voltage. See also Note under Survey of variable capacitors.

TESTS AND REQUIREMENTS

IEC418-1 clause	IEC68 test method	test	procedure	requirements
4.2		method of mounting	method A	
14		capacitance drift	after T.C. measurement	$\Delta C/C$ $< 1,5\%$
19		thrust	axial thrust of 2 N	$\Delta C/C$ $< 0,3\%$
21		robustness of terminations:		
21.1	Ua	tensile	1 N	
21.2	Ub	bending	1 cycle	no damage
22	Na	rapid change of temperature	1 cycle: 1/2 h at lower and 1/2 h at upper category temp.	$\Delta C/C$ $< 1\%$
23	T Ta	soldering solderability	solder bath, immersion 3 mm, 235 °C, 2 s	good wetting, no mechanical damage
	Tb	resistance to heat	solder bath 260 °C, 10 s	no mechanical damage
24	Eb	impact bump	4000 \pm 10 bumps, 40g, 6 ms	$\Delta C/C$ $< 0,5\%$ no mechanical damage
25	Fc	vibration	freq. 10 to 55 Hz, ampl. 0,35 mm, 1,5 h	$\Delta C/C$ $< 0,3\%$ no mechanical damage

TESTS AND REQUIREMENTS (continued)

IEC418-1 clause	IEC68 test method	test	procedure	requirements
26		climatic sequence		$\Delta C/C$ < 2,5% $\tan \delta$ < 10×10^{-4}
26.1	B	dry heat	16 h at upper category temp.	R_{ins} > 10 000 M Ω rotor contact R < 5 m Ω
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	voltage proof 500 V for 1 min visual examination no mechanical damage
26.3	Aa	cold	16 h, - 40 °C	operating torque 1 to 20 mNm
26.5		damp heat accelerated remaining cycles	1 cycle, 24 h, + 40 °C, 95 to 100% R.H.	
27	Ca	damp heat steady state	21 days, + 40 °C, 90 to 95% R.H.	$\Delta C/C$ < 3% $\tan \delta$ < 10×10^{-4} R_{ins} > 10 000 M Ω rotor contact R < 5 m Ω voltage proof 500 V for 1 min visual examination no mechanical damage operating torque 1 to 20 mNm
29 29.1		endurance mechanical	25 cycles	$\Delta C/C$ < 3% $\Delta C/C$ after axial thrust < 0,3% rotor contact R < 5 m Ω voltage proof 500 V for 1 min visual examination no mechanical damage operating torque 1 to 20 mNm

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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	I²C-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	RF power transistors
	SC09	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

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.

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