PASSIVE COMPONENTS

DATA HANDBOOK

Electrolytic Capacitors

BOOK PA01 1992

Philips Components

PHILIPS

QUALITY ASSURED

Our quality system focuses on the continuing high quality of our components and the best possible service for our customers. We have a three-sided quality strategy: we apply a system of total quality control and assurance; we operate customer-oriented dynamic improvement programmes; and we promote a partnering relationship with our customers and suppliers.

PRODUCT SAFETY

In striving for state-of-the-art perfection, we continuously improve components and processes with respect to environmental demands. Our components offer no hazard to the environment in normal use when operated or stored within the limits specified in the data sheet.

Some components unavoidably contain substances that, if exposed by accident or misuse, are potentially hazardous to health. Users of these components are informed of the danger by warning notices in the data sheets supporting the components. Where necessary the warning notices also indicate safety precautions to be taken and disposal instructions to be followed. Obviously users of these components, in general the set-making industry, assume responsibility towards the consumer with respect to safety matters and environmental demands.

All used or obsolete components should be disposed of according to the regulations applying at the disposal location. Depending on the location, electronic components are considered to be 'chemical', 'special' or sometimes 'industrial' waste. Disposal as domestic waste is usually not permitted.

Electrolytic Capacitors

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Sequence of series names

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ASD	2222 117	402
ASH	2222 041–043	490
ASM	2222 021	428
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CS	2222 085	92
CTS/49MC	2222 195	138
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PED–ST	2222 114/115	728
PLL–PW	2222 162/163	704
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RLP 7	2222 097	200
RML	2222 048	344
RMS	2222 047	288
RS	2222 035	230
RSH	2222 044	246
RSL	2222 046	358
RSM	2222 037	210
RSP	2222 036	272
RSS	2222 045	302
RSX	2222 164	372
SAL–A	2222 123	802
SAL–CPL	2222 127	120
SAL–RDC	2222 129	770
SAL–RP	2222 122	784
SAL–RPM	2222 128	750
TRM	2222 194	830
40AW (CLR79)	–	846
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49BC	–	174
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RADIAL	RLP 5	2222 134	190
	RLP 7	2222 097	200
	RSM	2222 037	210
	RS	2222 035	230
	RSH	2222 044	246
	RLC	2222 013	258
	RSP	2222 036	272
	RMS	2222 047	288
	RSS	2222 045	302
	RLL	2222 116	316
	RLI	2222 135	330
	RML	2222 048	344
	RSL	2222 046	358
	RSX	2222 164	372
	RHT	2222 165	386
AXIAL	ASD	2222 117	402
	ASC	2222 049	412
	ASM	2222 021	428
	ALC	2222 065	454
	AS	2222 030–033	466
	ASH	2222 041–043	490
	AML	2222 138	506
	ALL–DIN	2222 132/133	528
	ALL–IEC	2222 108	548
	AHT	2222 118	560
	AHT–DIN	2222 119	584
POWER	PSM–SI	2222 056/057	606
	PEC–SI	2222 054/055	626
	PLL–SI	2222 058/059	642
	PEC–PW	2222 051/053	662
	PED-PW	2222 050/052	682
	PLL–PW	2222 162/163	704
	PEC–ST	2222 154/155	718
	PED–ST	2222 114/115	728
SAL	SAL–RPM	2222 128	750
	SAL–RDC	2222 129	770
	SAL–RP	2222 122	784
	SAL–A	2222 123	802
TA	TRM	2222 194	830
	40SS (CSR13)	–	838
	40AW (CSR79)	–	846

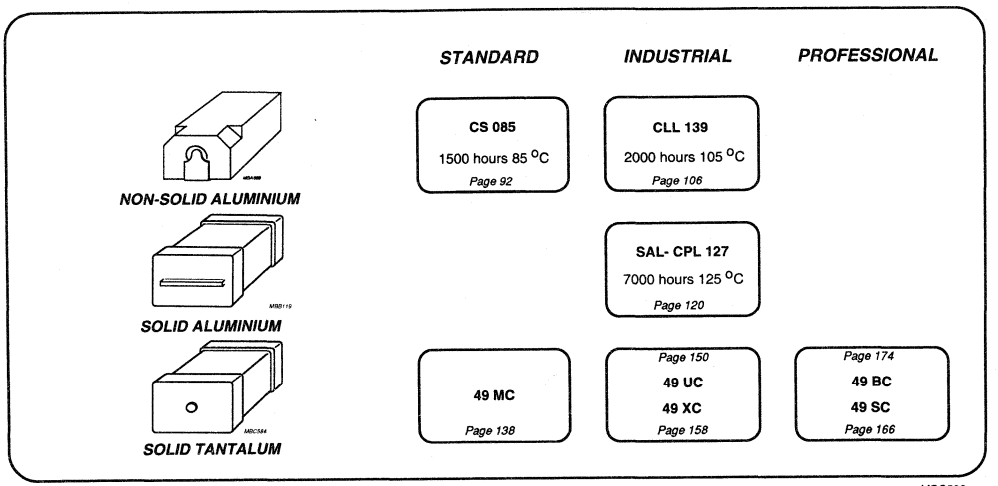
SELECTION MATRIX

Electrolytic Capacitors

Selection Matrix

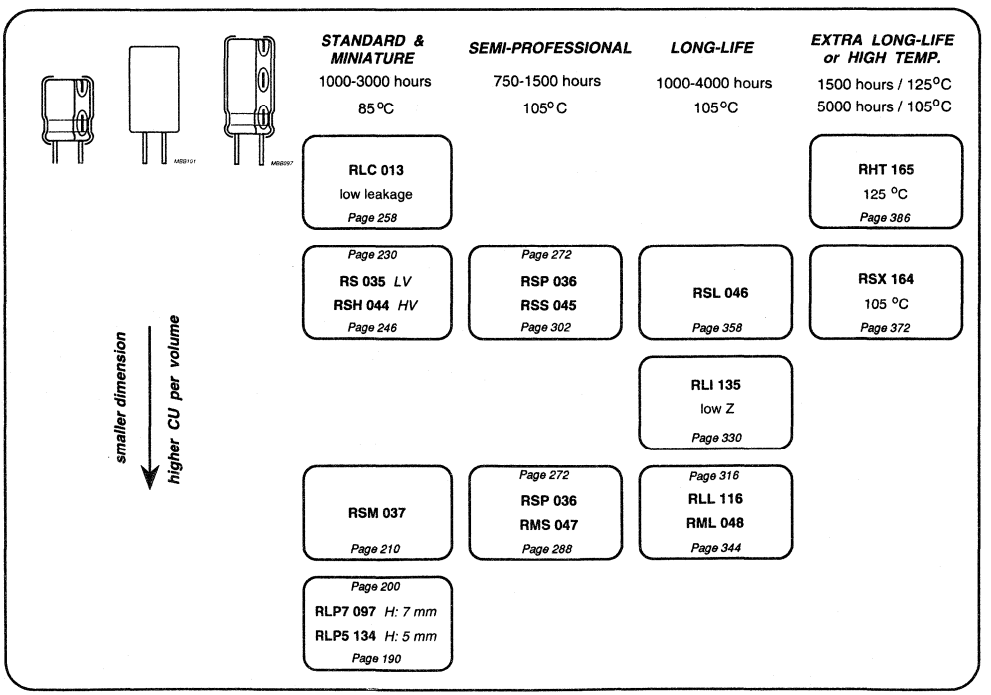
1

SMD ELECTROLYTIC CAPACITORS ('CHIPS')



MBC592

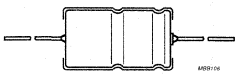
RADIAL NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS

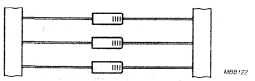


MRA515

Electrolytic Capacitors — Selection Matrix

AXIAL NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS





dimension (smaller)
CU per volume (higher)

MINIATURE	*STANDARD & SEMI-PROFESSIONAL*	*LONG-LIFE*	*EXTRA LONG-LIFE or HIGH TEMP.*
1500-2000 hours 85 °C	2500-8000 hours 85 °C	10-15 000 hours / 85 °C 2-3000 hours / 105 °C	4000 hours 125 °C
	ALC 065 *low leakage* *Page 454*	**ALL-IEC 108** *maintenance* *Page 548*	
	Page 466 **AS 030-033** *LV* **ASH 041-043** *HV* *Page 490*	**ALL-DIN 132** *LV* **ALL-DIN 133** *HV* *Page 528*	**AHT-DIN 119** *Page 584*
Page 466 **AS 030** Ø D = 3.3 mm **ASD 117** *Page 402*	**ASM 021** *Page 428*	**AML 138** *Page 506*	**AHT 118** *Page 560*
	ASC 049 *Page 412*		

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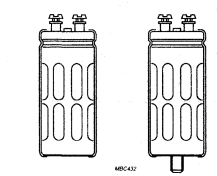
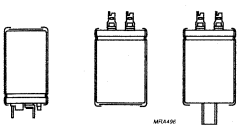
POWER ELECTROLYTIC CAPACITORS





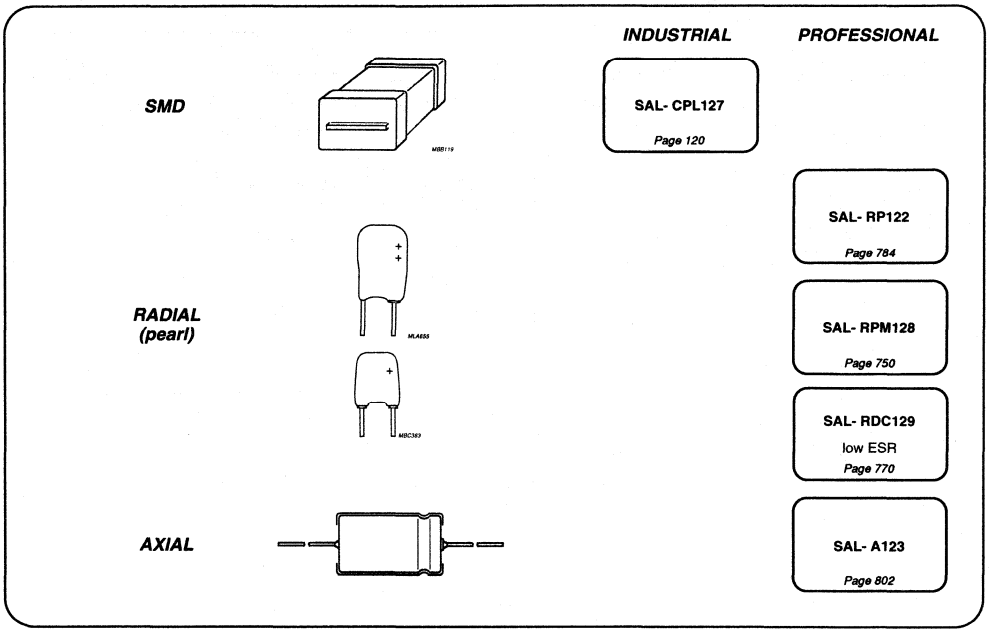
MINIATURE	*ECONOMY*	*EURO-DIN*	*LONG-LIFE*
10 000 hours 85 °C	12 000 hours 85 °C	15-20 000 hours 85 °C	5-10 000 hours 105 °C
	PEC-ST **PEC-STB** **154-155** *Page 718*	**PED-ST** **PED-STB** **114-115** *Page 728*	
PSM-PW on request *Page 606*	**PEC-PW** **PEC-SL** **PEC-SLB** **051-053** *Page 662*	**PED-PW** **PED-SL** **PED-SLB** **050-052** *Page 682*	**PLL-PW** **PLL-SL** **PLL-SLB** **162-163** *Page 704*
PSM-SI **056-057** *Page 606*	**PEC-SI** **054-055** Maintenance *Page 626*		**PLL-SI** **058-059** *Page 642*

MRA514

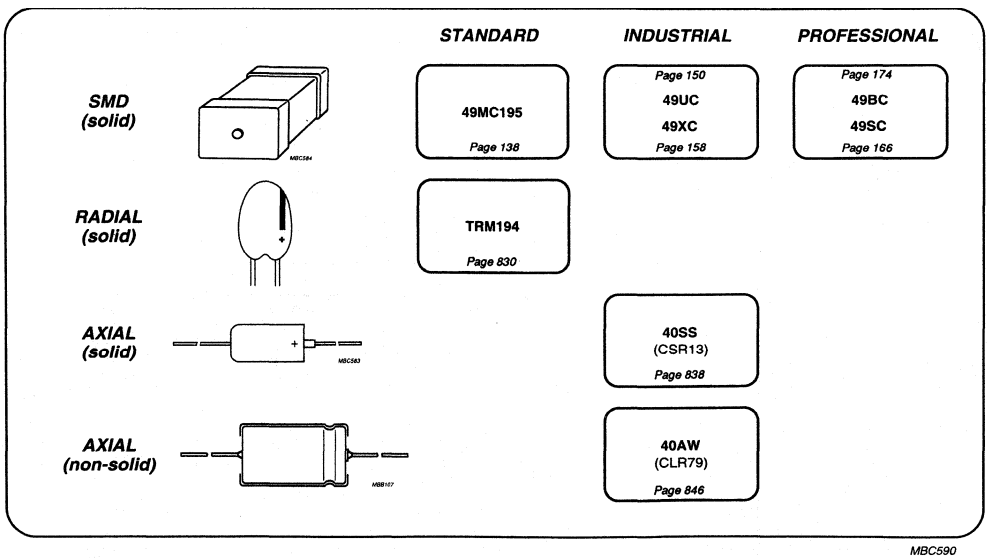
Electrolytic Capacitors

Selection Matrix

SOLID ALUMINIUM (SAL) ELECTROLYTIC CAPACITORS



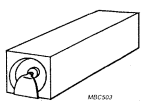
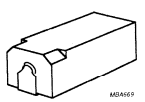
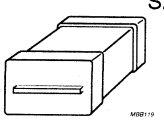
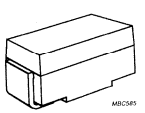
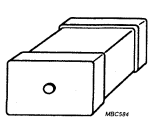
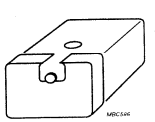
TANTALUM ELECTROLYTIC CAPACITORS



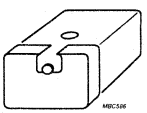
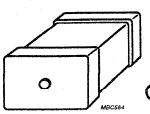
SELECTION GUIDE

Electrolytic Capacitors — Selection guide

SURFACE MOUNTING DEVICES (SMD)

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
SMD Non-solid Aluminium Electrolytic Capacitors						
 CS 085	low height general purpose	0.1 to 22	6.3 to 63	1500 h/85 °C 40 000 h/40 °C 40/085/56	consumer low profile equipment	92
 CLL 139	moulded extended CU range long life	0.22 to 220	6.3 to 100	2000 h/105 °C 200 000 h/40 °C 55/105/56	automotive telecom general industrial	106
SMD Solid Aluminium Electrolytic Capacitors						
 SAL-CPL 127	wide temp. range high reliability extra long life	0.15 to 68	4 to 25	7000 h/125 °C 100 000 h/40 °C 55/125/56	automotive telecom professional military	120
SMD Solid Tantalum Electrolytic Capacitors						
 CTS 195/ 49 MC	moulded, worldwide standardized dimensions IEC 384-3 DIN 44357	0.1 to 100	4 to 35	1-2000 h/85 °C 100 000 h/40 °C 55/085/21	general industrial telecom portable equipment	138
 49 UC ULTRA CHIP	sub-miniature, conformal coating low ESR high freq. pad-compatible with MIL-C-55365 (CWR-06)	0.1 to 6.8	4 to 50	55/125/21	general industrial telecom portable equipment	150
 49 XC XTRA CHIP	conformal coating high reliability, low Z very high CU/volume wide capacitance range	1.0 to 220	4 to 50	55/125/21	general industrial telecom portable equipment high mounting density	158

SURFACE MOUNTING DEVICES (SMD) *(Continued)*

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
SMD Solid Tantalum Electrolytic Capacitors						
 49 SC STAR CHIP	conformal coating high reliability, low Z pad-compatible with MIL-C-55365/4 (CWR-06)	0.47 to 100	4 to 50	55/125/21	general industrial telecom portable equipment	166
 49 BC BLUE CHIP CWR 06	conformal coating very high reliability high CU/volume, low Z MIL-C-55365/4B	0.1 to 100	4 to 50	failure rate level: B, C, D, M, P, R 55/125/21	human medical syst. high-professional military	174

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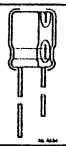
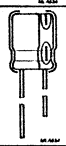
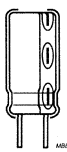
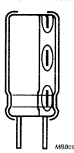
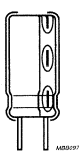
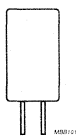
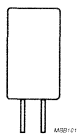
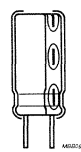
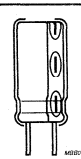
NON-SOLID, RADIAL

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Standard Types						
 RLP 5 134	miniature very low profile height 5 mm general purpose	0.1 to 100	6.3 to 50	1500 h/85 °C 40 000 h/40 °C 40/085/56	consumer low profile equipment high mounting density	190
 RLP 7 097	miniature low profile height 7 mm general purpose	0.1 to 220	6.3 to 63	1500 h/85 °C 40 000 h/40 °C 40/085/56	consumer automotive low profile equipment	200
 RSM 037	high CU/volume general purpose	0.10 to 10 000	6.3 to 100	2000 h/85 °C 60 000 h/40 °C 40/085/56	consumer automotive general industrial	210
 RS 035	standard dimensions general purpose DIN 41259	0.1 to 4700	6.3 to 100	2000 h/85 °C 60 000 h/40 °C 40/085/56	general industrial consumer	230
 RSH 044	high voltage long life DIN 41259	1 to 68	160 to 385	3000 h/85 °C 80 000 h/40 °C 25/085/56	consumer, lighting general industrial power supply smoothing	246

NON-SOLID, RADIAL *(Continued)*

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Semi-Professional Types						
 RLC 013	low leakage current e-pitch, all-insulated LNZ44-04	0.22 to 470	6.3 to 50	3000 h/85 °C 80 000 h/40 °C 55/085/56	audio-video telecom general industrial timing, coupling	258
 RSP 036	high CU/volume long life e-pitch, all insulated LNZ44-04 (COJ)	0.22 to 470	6.3 to 160	750 h/105 °C 3000 h/85 °C 80 000 h/40 °C 55/085/56	automotive telecom general industrial EDP	272
 RMS 047	high CU/volume high temp. 105 °C long life	68 to 10 000	16 to 63	1500 h/105 °C 150 000 h/40 °C 40/105/56	audio-video automotive telecom, EDP SMPS	288
 RSS 045	standard dimensions high temp. 105 °C long life DIN 41259	47 to 6800	16 to 63	1500 h/105 °C 150 000 h/40 °C 40/105/56	audio-video telecom, EDP general industrial SMPS	302

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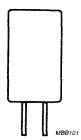
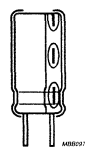
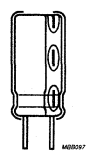
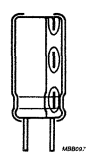
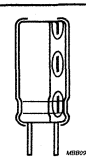
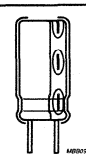
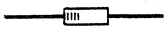
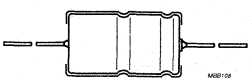
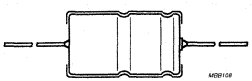
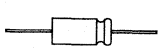
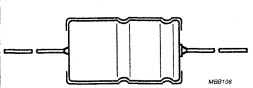
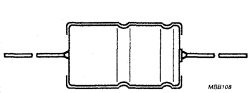
NON-SOLID, RADIAL (continued)

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Long-Life Types						
 RLL 116	high CU/volume e-pitch, all insulated long life	0.47 to 470	6.3 to 100	2000 h/105 °C 200 000 h/40 °C 55/105/56	automotive telecom, EDP general industrial DC-DC converters	316
 RLI 135	high CU/volume low impedance high ripple long life	22 to 10 000	6.3 to 100	1-2000 h/105 °C 100-200 000 h/40 °C 55/105/56	general industrial telecom, EDP SMPS DC-DC converters	330
 RML 048	miniature high CU/volume long life	68 to 15 000	6.3 to 63	3-4000 h/105 °C 200-260 000 h/40 °C 40/105/56	automotive telecom, EDP SMPS stand-by	344
 RSL 046	standard dimensions high ripple long life DIN 41259	47 to 10 000	6.3 to 63	3-4000 h/105 °C 200-260 000 h/40 °C 40/105/56	telecom, EDP general industrial SMPS stand-by	358
Extra-Long-Life Types						
 RSX 164	standard dimensions extra long life DIN 41259	47 to 10 000	10 to 63	5-6000 h/105 °C 240-280 000 h/40 °C 40/105/56	telecom, EDP outdoor electronics general industrial SMPS	372
 RHT 165	standard dimensions high temp. 125 °C extra long life	33 to 4 700	10 to 50	1500 h/125 °C 300 000 h/40 °C 40/125/56	automotive outdoor electronics professional telecom military	386

NON-SOLID, AXIAL

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Miniature Types						
ASD 117 	ultra miniature diameter 3.3 mm general purpose	0.1 to 22	6.3 to 63	2000 h/85 °C 60 000 h/40 °C 40/085/56	consumer low height low profile equipment	402
ASC 049 	super compact extremely high CU/volume long life	330 to 22 000	10 to 63	5000 h/85 °C 120 000 h/40 °C 40/085/56	consumer automotive compact design	412
ASM 021 	miniature high CU/volume general purpose/ long life	0.22 to 15 000	6.3 to 100	case length ≤25 mm 2500 h/85 °C 70 000 h/40 °C case length ≥30 mm 8000 h/85 °C 200 000 h/40 °C 40/085/56	consumer automotive general industrial audio-video telecom, EDP SMPS	428
Semi-Professional Types						
ALC 065 	low leakage current long life DIN 41316	0.33 to 68	6.3 to 25	3000 h/85 °C 80 000 h/40 °C 40/085/56	audio-video telecom general industrial timing, coupling	454
AS 030-033 	standard dimensions general purpose/ long life DIN 41316 LNZ 44-04	0.33 to 15 000	6.3 to 100	case length ≤25 mm 1500-3000 h/85 °C 40-80 000 h/40 °C case length ≥30 mm 8000 h/85 °C 200 000 h/40 °C 40/085/56	consumer telecom general industrial automotive SMPS	466
ASH 041-043 	high voltage long life DIN 41316	1.0 to 220	160 to 450	5-8000 h/85 °C 120-250 000 h/40 °C 40/085/56	consumer, lighting industrial power supply smoothing	490

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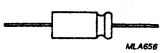
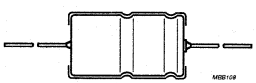
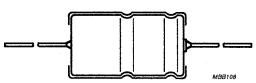
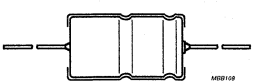
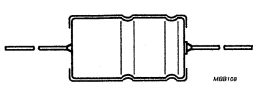
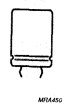
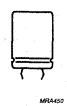
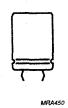
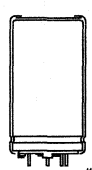
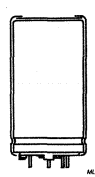
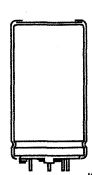
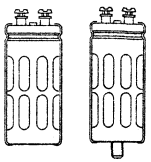
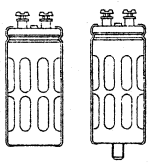
NON-SOLID, AXIAL (continued)

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Long-Life Types						
AML 138 	miniature high CU/volume high temp., 105 °C long life	0.22 to 15 000	6.3 to 100	2-5000 h/105 °C 200 000 h/40 °C 40/105/56	automotive general industrial telecom, EDP SMPS, stand-by	506
ALL-DIN 132/133 	long life, high reliability high ripple current CECC 30 301-801 CECC 30 301-056 UTE C031/C033 DIN 41257 DIN 45910 T.123	1.0 to 4700	10 to 400	10-15 000 h/85 °C 160-240 000 h/40 °C 40/085/56	telecom EDP general industrial power supply lighting	528
ALL-IEC 108 	MAINTENANCE TYPE long life CECC 30 301-027	2.2 to 2200	6.3 to 100	6-15 000 h/85 °C 160-300 000 h/40 °C 40/085/56	telecom industrial	548
High Temperature (Extra-Long-Life) Types						
AHT 118 	miniature high CU/volume high temp. 125 °C extra long life	1.0 to 15 000	6.3 to 200	4000 h/125 °C 500 000 h/40 °C (40)55/125/56	automotive general industrial telecom military	560
AHT-DIN 119 	high temp. 125 °C high ripple current CECC 30 301-802 CECC 30 301-055 (DIN 41257)	1.0 to 4700	10 to 200	4000 h/125 °C 500 000 h/40 °C 55/125/56	general industrial telecom, SMPS professional outdoor electronics military	584

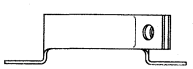
NON-SOLID, POWER

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Snap-in Types						
 PSM-SI 056/057	very high CU/volume snap-in	47 to 68 000	10 to 450	10 000 h/85 °C 175 000 h/40 °C 40/085/56	general industrial audio-video power supply smoothing	606
 PEC-SI 054/055	MAINTENANCE TYPES high CU/volume snap-in	47 to 33 000	10 to 385	12 000 h/85 °C 200 000 h/40 °C 40/085/56	general industrial audio-video power supply smoothing	626
 PLL-SI 058/059	high CU/volume very long life high temp. 105 °C CECC pending	33 to 47 000	10 to 400	10 000 h/105 °C 250 000 h/40 °C 40/105/56	general industrial telecom power supply smoothing	642
PW-Pin and Solder-Lug Types						
 PEC-PW 051/053	high CU/volume DIN 41240 LNZ44-04	68 to 150000	10 to 400	12 000 h/85 °C 200 000 h/40 °C 40/085/56	general industrial audio-video power supply smoothing	662
 PED-PW 050/052	high ripple, low ESR CECC 30 301-033 DIN 41238 LNZ44-04	47 to 68 000	10 to 400	15 000 h/85 °C 250 000 h/40 °C 40/085/56	general industrial telecom power supply smoothing	682
 PLL-PW 162/163	high CU/volume very long life high temp. 105 °C	68 to 150000	10 to 400	5000 h/105 °C 150 000 h/40 °C 40/105/56	general industrial telecom power supply smoothing	704

NON-SOLID, POWER *(Continued)*

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Screw Terminal (/Bolt) Types						
 PEC-ST 154/155	high CU/volume high ripple	220 to 470000	10 to 400	12 000 h/85 °C 200 000 h/40 °C 40/085/56	general industrial power supply smoothing	718
 PED-ST 114/115	very long life high ripple low ESR DIN 41248	150 to 220000	10 to 400	20 000 h/85 °C 350 000 h/40 °C 40/085/56	general industrial telecom power supply smoothing	728

MOUNTING ACCESSORIES

	clamps washers nuts				Power types	39

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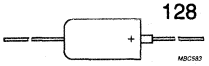
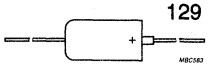
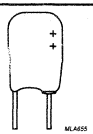
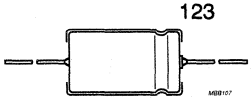
SAL, SOLID ALUMINIUM

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
SAL-RPM 128 	low profile height 9 mm CECC 30 302-005	0.1 to 68	6.3 to 40	20 000 h/125 °C 300 000 h/40° C 55/125/56	general industrial automotive telecom, EDP audio-video	750
SAL-RDC 129 	low profile height 9 mm high ripple, low ESR	0.22 to 68	6.3 to 40	20 000 h/125° C 300 000 h/40 °C 55/125/56	DC-DC converters general industrial SMPS high frequency	770
SAL-RP 122 	height 12 mm CECC 30 302-002 LNZ44-04	0.33 to 68	6.3 to 40	20 000 h/125 °C 300 000 h/40 °C 55/125/56	general industrial automotive telecom, EDP audio-video	784
SAL-A 123 	extremely long life very high reliability CECC 30 302-003 LNZ44-04	1 to 2200	4 to 40	20 000 h/125 °C 450 000 h/40 °C 55/125/56	general industrial telecom SMPS military	802
SAL-AG 123.8	shock- proof 10 000 g ESA	1 to 2200	4 to 40	20 000 h/125 °C 450 000 h/40 °C 55/125/56	aerospace military	802

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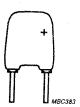
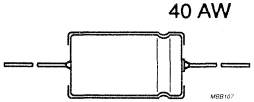
TANTALUM ELECTROLYTIC CAPACITORS

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (μF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
 TRM 194	solid radial lead resin-dipped DIN 44356	0.1 to 330	6.3 to 50	1000 h/85 °C 55/085/21	general industrial filtering timing	830
 40 SS 141	solid, axial lead hermetic seal industrial type of MIL-C-39003/01 style CSR13	0.0047 to 330	6 to 100	failure rate levels: M,P,R,S 55/125/56	general industrial military	838
 40 AW	wet-slug axial lead hermetic seal industrial type of MIL-C-39006/22 style CLR79	1.7 to 1200	6 to 125	failure rate levels: M,P,R,S 55/125/56	filtering buffering	846

SPECIAL DESIGNS

If you are unable to find the capacitor you require, please contact your local Philips Components sales organization; we are able to design and manufacture special capacitors to meet your specific requirements, for example:

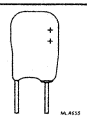
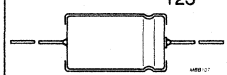
- Higher CV per unit volume
- Lower ESR
- Higher ripple current
- Lower leakage current
- Extended useful life
- Extended temperature range
- DC-capacitance selection
- Deviating capacitance tolerances
- Special marking
- Deviating packing.

Errata

Dear reader,

Unfortunately some errors occured on the pages 19 and 20.
The correct information is given below.

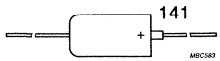
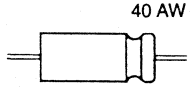
SAL, SOLID ALUMINIUM

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
 SAL-RPM 128	low profile height 9 mm CECC 30 302-005	0.1 to 68	6.3 to 40	20 000 h/125 °C 300 000 h/40° C 55/125/56	general industrial automotive telecom, EDP audio-video	750
 SAL-RDC 129	low profile height 9 mm high ripple, low ESR	0.22 to 68	6.3 to 40	20 000 h/125° C 300 000 h/40 °C 55/125/56	DC-DC converters general industrial SMPS high frequency	770
 SAL-RP 122	height 12 mm CECC 30 302-002 LNZ44-04	0.33 to 68	6.3 to 40	20 000 h/125 °C 300 000 h/40 °C 55/125/56	general industrial automotive telecom, EDP audio-video	784
 SAL-A 123	extremely long life very high reliability CECC 30 302-003 LNZ44-04	1 to 2200	4 to 40	20 000 h/125 °C 450 000 h/40 °C 55/125/56	general industrial telecom SMPS military	802
SAL-AG 123.8	shock- proof 10 000 g ESA	1 to 2200	4 to 40	20 000 h/125 °C 450 000 h/40 °C 55/125/56	aerospace military	802

page 19:

page 20:

TANTALUM ELECTROLYTIC CAPACITORS

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
 TRM 194	solid radial lead resin-dipped DIN 44356	0.1 to 330	6.3 to 50	1000 h/85 °C 55/085/21	general industrial filtering timing	830
 40 SS 141	solid, axial lead hermetic seal industrial type of MIL-C-39003/01 style CSR13	0.0047 to 330	6 to 100	failure rate levels: M,P,R,S 55/125/56	general industrial military	838
 40 AW	wet-slug axial lead hermetic seal industrial type of MIL-C-39006/22 style CLR79	1.7 to 1200	6 to 125	failure rate levels: M,P,R,S 55/125/56	filtering buffering	846

Please accept our apologies for this inconvienience.

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GENERAL INTRODUCTION

Electrolytic Capacitors — Translation of technical terms

Some important terms	des termes importantes	einige wichtige Begriffe
Ambient temperature (T_{amb})	température ambiante	Umgebungstemperatur
Assessment level	niveau d'assurance	Gütebestätigungsstufe
Axial terminations	sorties axiales	axiale Anschlußdrähte
Capacitance	capacité	Kapazität
Charge	charge	laden
Climatic category	catégorie climatique	Klimakategorie
Dimensions	dimensions	Maße
Discharge	décharge	entladen
Dissipation factor (tan δ)	tangente de l'angle de pertes	Verlustfaktor
Endurance	endurance	Dauerspannungsprüfung
Equivalent series resistance (ESR)	résistance série équivalente	äquivalenter Serienwiderstand
Equivalent series inductance (ESL)	inductance série équivalente	äquivalente Serieninduktivität
Failure rate	taux de fiabilité	Ausfallrate
Frequency (f)	fréquence	Frequenz
General purpose grade	usage général	allgemeine Anforderungen
Impedance (Z)	impédance	Scheinwiderstand, Impedanz
Leadless	sans fils	unbedrahtet
Leakage current (I_l)	courant de fuite	Reststrom
Long life grade	longue durée de vie	erhöhte Anforderungen
Method	méthode	Verfahren
Mounting	montage	Montage
No visible damage	aucun dommage	keine sichtbaren Schäden
Open circuit	circuit ouvert	Unterbrechung
Piercing diagram	dessin de montage	Bohrungsraster
Rated capacitance (C_R)	capacité nominale	Nennkapazitat
Rated voltage (U_R)	tension nominale	Nennspannung
Recovery	reprise	Nachbehandlung
Forming voltage (U_F)	tension de formation	Formierspannung
Requirements	exigences	Anforderungen
Reverse voltage (U_{rev})	tension inverse	Umpolspannung
Ripple current (I_R)	courant ondulé	überlagerter Wechselstrom
Short circuit	court-circuit	Kurzschluß
Surface mounting device (SMD)	composant pour montage en surface	oberflächenmontierbares Bauelement
Surge voltage (U_S)	surtension	Spitzenspannung
Terminations	sorties	Anschlüsse
Useful life	durée de vie	Brauchbarkeitsdauer
Visual examination	examen visuel	Sichtkontrolle

Electrolytic Capacitors — General Introduction

CAPACITOR PRINCIPLES

The essential property of a capacitor is to store electrical charge. The amount of electrical charge (Q) in the capacitor (C) is proportional to the applied voltage (U). The relationship of these parameters is:

$$Q = C \cdot U$$

where

Q = charge in coulombs (C)

C = capacitance in farads (F)

U = voltage in volts (V).

The value of capacitance is directly proportional to the (anode) surface area and inversely proportional to the thickness of the dieletric layer, thus:

$$C = \varepsilon_r \cdot \varepsilon_0 \cdot \frac{A}{d}$$

where

ε_0 = absolute permittivity (8.85×10^{-12} F/m)

ε_r = relative dielectric constant (dimensionless)

A = surface area (m^2)

d = thickness of the dielectric (oxide layer in electrolytic capacitors) in m

Energy content of a capacitor:

The energy content of a capacitor is given by:

$$P = \frac{1}{2} C \cdot U^2$$

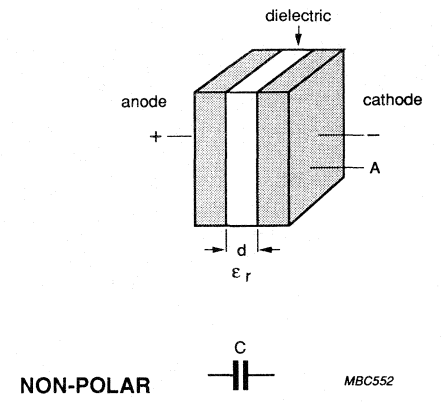
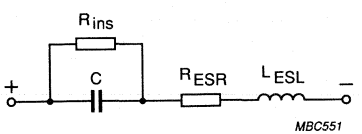
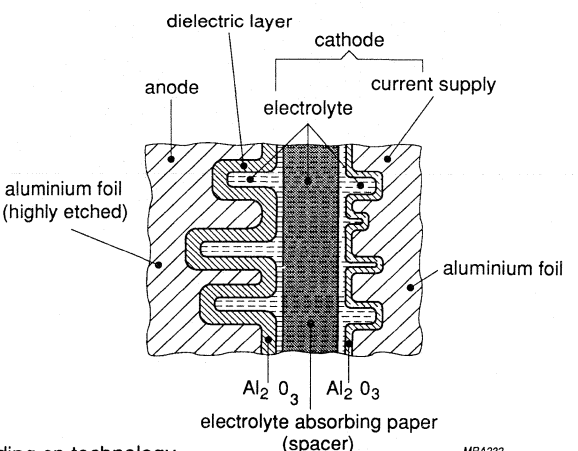


Fig.1 Equivalent circuit of an ideal capacitor.





POLAR

Anode electrode:

valve effect metal; aluminium or tantalum.

Dielectric:

Al_2O_3 or Ta_2O_5.

Cathode electrode, solid or non-solid electrolyte depending on technology

non-solid: wet electrolyte spacer and aluminium foil

solid: solid electrolyte (manganese dioxide), graphite and silver epoxy.

Fig.2 Equivalent circuit of an electrolytic capacitor.

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ELECTRICAL BEHAVIOUR

CHARACTERISTICS OF ELECTROLYTIC CAPACITORS VARY WITH TEMPERATURE, FREQUENCY, TIME AND APPLIED VOLTAGE.

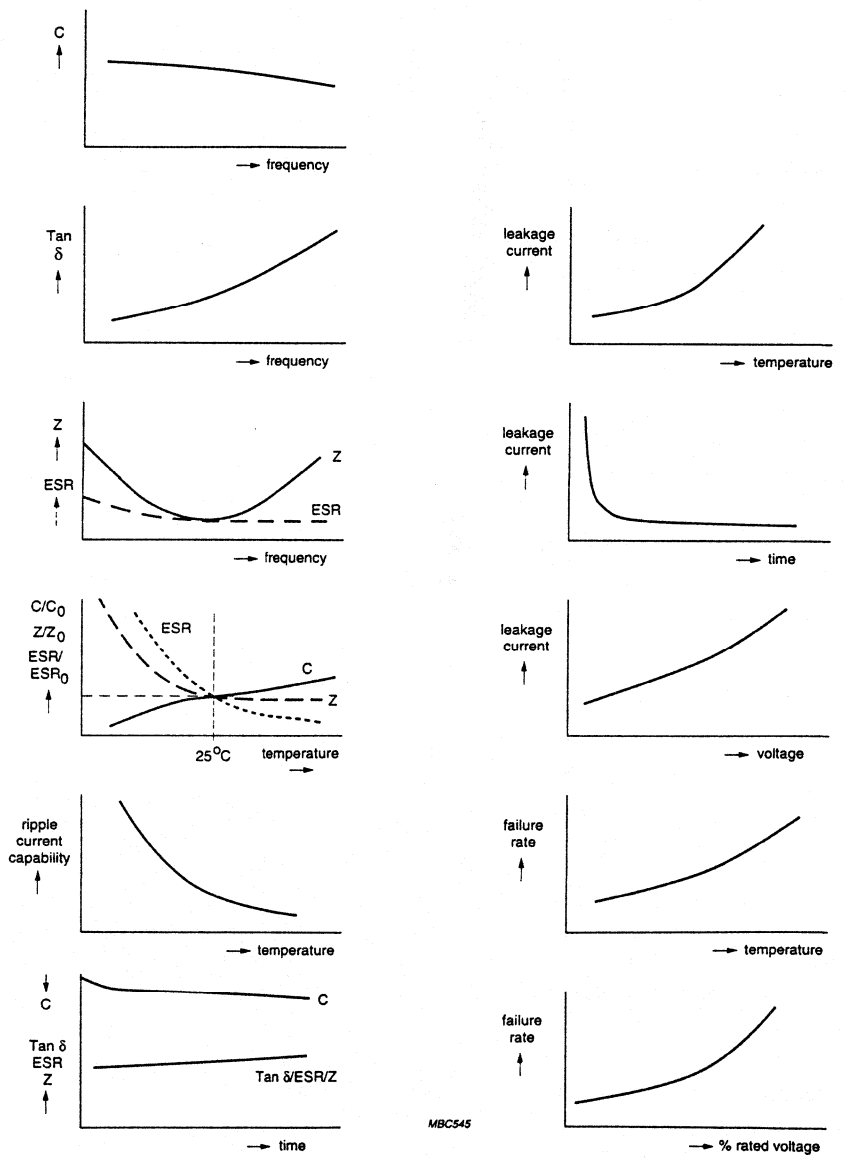


Fig.3 Typical variation of electrical parameters as a function of frequency, ambient temperature, voltage and time.

CONSTRUCTION

Examples

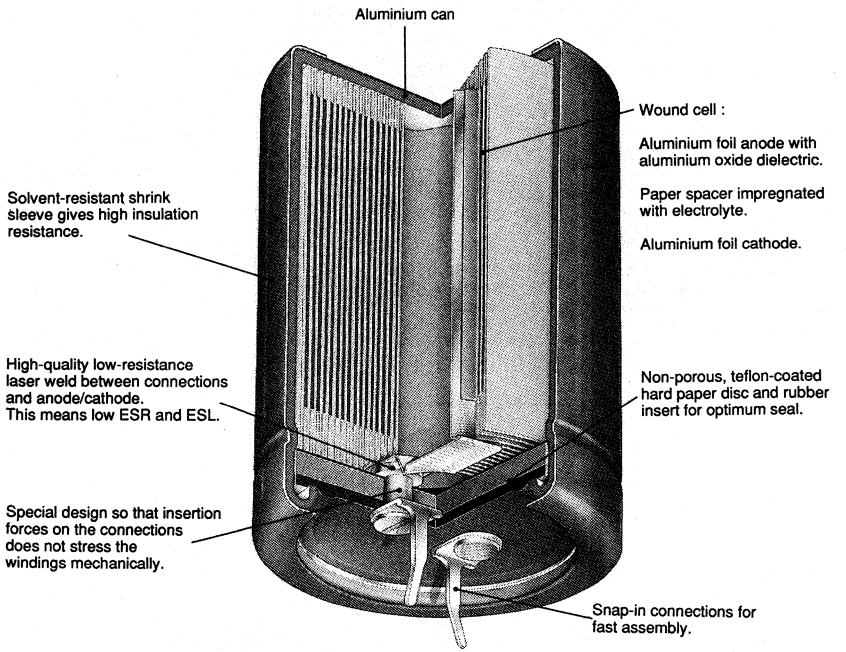


Fig.4 Power non-solid Aluminium, snap-in.

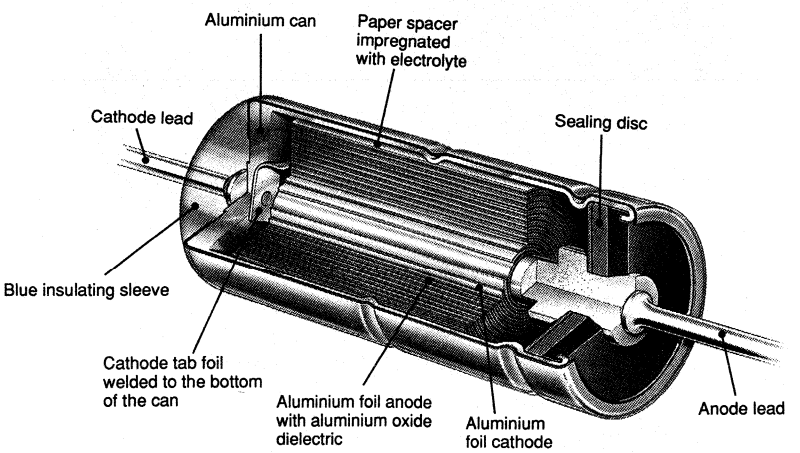


Fig.5 Non-solid Aluminium, axial.

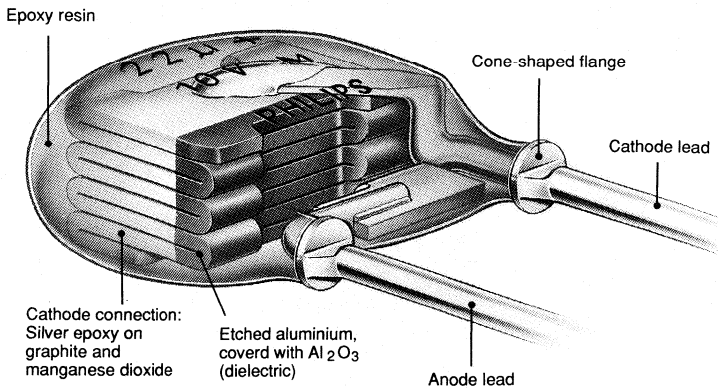


Fig.6 Solid Aluminium (SAL), radial.

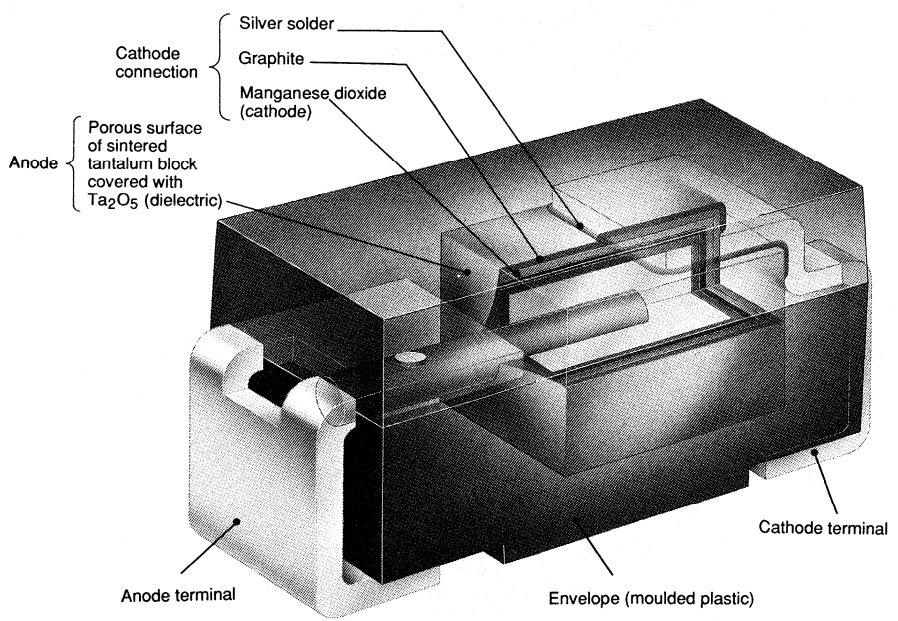


Fig.7 Solid Tantalum, SMD.

DEFINITIONS OF THE ELECTRICAL PARAMETERS

CAPACITANCE

AC Capacitance of an electrolytic capacitor

The capacitance of an equivalent circuit, having capacitance and resistance in series, measured with alternating current approximately sinusoidal waveform at a specified frequency, refer to Fig. 8.
Standard measuring frequencies for electrolytic capacitors are 100 or 120 Hz.

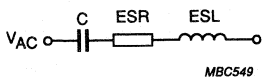


Fig.8 AC equivalent circuit of an electrolytic capacitor.

DC Capacitance of an electrolytic capacitor (for timing circuits)

DC capacitance is given by the amount of charge which is stored in the capacitor at the rated voltage (U_R). DC capacitance is measured by a single discharge of the capacitor under defined conditions. Measuring procedures are described in DIN 41328, sheet.4.
At any given time, the DC capacitance is higher than the AC capacitance.

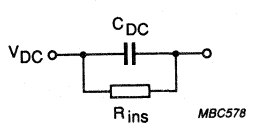


Fig.9 DC equivalent circuit of an electrolytic capacitor.

Rated capacitance (C_R)

The capacitance value for which the capacitor has been designed and which is usually indicated upon it.
Preferred values of rated capacitance and their decimal multiples are chosen from the E3 or E6 series of IEC Publication 63.

Tolerance on rated capacitance

Preferred values of tolerances on rated capacitance are:

−20/+20%, −10/+50%, −10/+30 and −10/+10%

VOLTAGE

Rated voltage (U_R)

The maximum direct voltage, or peak value of pulse voltage which may be applied continuously to a capacitor at any temperature between the lower category temperature and the rated temperature.

Category voltage (U_C)

The maximum voltage which may be applied continuously to a capacitor at its upper category temperature.

Temperature derated voltage

The temperature derated voltage is the maximum voltage that may be applied continuously to a capacitor, for any temperature between the rated temperature and the upper category temperature,

Ripple voltage (U_{Rpl})

An alternating voltage may be applied, provided that the peak voltage resulting from the alternating voltage, when superimposed on the direct voltage, does not exceed the value of rated direct voltage and that the ripple current and the permissible reverse voltage are not exceeded.

Reverse voltage (U_{rev})

The maximum voltage applied in the reverse polarity direction to the capacitor terminations.

Surge voltage (U_s)

The maximum instantaneous voltage which may be applied to the terminations of the capacitor for a specified time at any temperature within the category temperature range.

1

TEMPERATURE

Category temperature range

The range of ambient temperatures for which the capacitor has been designed to operate continuously: this is defined by the temperature limits of the appropriate category

Rated temperature

The maximum ambient temperature at which the rated voltage may be continuously applied.

Minimum storage temperature

The minimum permissible ambient temperature which the capacitor shall withstand in the non-operating condition, without damage.

RESISTANCE/REACTANCE

Equivalent series resistance (ESR)

The ESR of an equivalent circuit having capacitance and resistance in series measured with alternating current approximately sinusoidal waveform at a specified frequency, see Fig.8.

Equivalent series inductance (ESL)

The ESL of an equivalent circuit having capacitance, resistance and inductance in series measured with alternating current approximately sinusoidal waveform at a specified frequency, see Fig.8.

Dissipation factor, (tangent of loss angle; Tanδ)

The power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of specified frequency: $\tan\delta = ESR \cdot 2\pi fC$, see Fig.10.

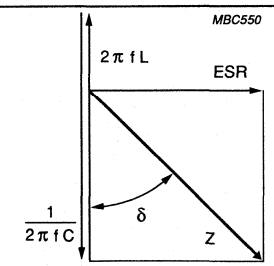


Fig.10 Vector diagram showing the AC parameters of a capacitor.

Impedance (Z)

The impedance (Z) of an electrolytic capacitor is given by capacitance, ESR and ESL according to the following equation:

$$Z = \sqrt{ESR^2 + (2\pi fESL - \frac{1}{2\pi fC})^2}$$

CURRENT

Leakage current (I_L)

Leakage current flows through a capacitor when a DC voltage is applied in correct polarity. It is dependent on voltage, temperature and time.

Leakage current for acceptance test (I_{L5})

In accordance with international standards (IEC 384-4, CECC 30 300) the leakage current **after 5 minutes** (I_{L5}) application of rated voltage, is considered as an acceptance requirement.
The leakage current requirements for the majority of Philips electrolytic capacitors, are lower than specified in IEC 384-4 or CECC 30 300.
If, for example, after prolonged storage and/or storage at excessive temperature (>40 °C), the leakage current at the first measurement does not meet requirements, pre-conditioning in accordance with CECC 30 300 sub clause 4.1 shall be carried out.

Leakage current at delivery (I_{L1} or I_{L2})

In addition to I_{L5}, the leakage current **after 1 minute** application of rated voltage (I_{L1}) is specified in most of the detail specifications.
For low leakage series this value is specified **after 2 minutes** (I_{L2}).

Operational leakage current (I_{OP})

After continuous operation (1 hour or longer) the leakage current will normally decrease to less than 20% of the 5 minute value (I_{L5}).

The operational leakage current depends on applied voltage and ambient temperature (see Tables 1 and 2).

Leakage current after storage with no voltage applied (shelf life)

If non-solid electrolytic capacitors are stored above room temperature for long periods of time, the oxide layer may react with the electrolyte, causing increased leakage current when switched on for the first time after storage.

Table 1 Typical multiplier of operational leakage current as a function of applied voltage.

U/U_R	<0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
I_L/I_{OP}	0.1	0.15	0.2	0.3	0.4	0.5	0.65	0.8	1

Table 2 Typical multiplier of operational leakage current as a function of ambient temperature (as far as allowed for the corresponding series).

T_{amb} (°C)	–55	–40	–25	0	20	45	65	85	105	125
I_L/I_{OP}	<0.5	0.5	0.6	0.8	1	1.5	2.5	4	7	10

No pre-condition will be necessary for Philips electrolytic capacitors, when stored at room temperature for the following periods of time:

2-3 years for non-solid 85 °C types

4 years for non-solid 105 °C types

10 years for non-solid 125 °C types

20 years for solid types.

After these periods, the leakage current for acceptance test shall not exceed twice the specified I_{L5} requirement.

Prior to insertion, the storage time shall not exceed 2-3 years for all types to ensure good solderability and quality of taping.

Ripple current (I_R)

Any pulsating voltage (or ripple voltage superimposed on DC bias) across a capacitor results in an alternating current through the capacitor.
Because of ohmic and dielectric losses in the capacitor, this alternating current produces an increase of temperature in the capacitor cell.
The heat generation depends on frequency and wave form of the alternating current.
The maximum RMS value of this alternating current, which is permitted to pass through the capacitor during its entire specified useful life (at defined frequency and defined ambient temperature), is called **rated ripple current** (I_R).

The rated ripple current is specified in the relevant detail specifications at 100 or 120 Hz (in special cases at 100 kHz) and at upper category temperature.
Usually the rated ripple current will cause a temperature increase of the capacitor's surface of approximately 3 or 5 K (dependent on series) compared with ambient temperature. A further temperature increase of 3 or 5 K, will be found in the core of the capacitor.

This temperature rise is the result of the balance between heat generated by electric losses:

$$P = I_R^2 \, ESR$$

and the carried off heat by radiation, convection and conduction:

$$P = \Delta T \, . \, A \, . \, \beta$$

where

ΔT = difference of temperature between ambient and case surface

A = geometric surface area of the capacitor

β = specific heat conductivity.

The heat, generated by ripple current, is an important factor of influence for non-solid electrolytic capacitors for calculating the useful life under certain circumstances. In the detail specifications this factor is considered in the so-called "life-time nomograms" ("Multiplier of useful life" graph in the detail specifications) as a ratio between actual ripple current (I_A) and rated ripple current (I_R), drawn on the vertical axis.

Care should be taken to ensure that the actual ripple current remains inside the graph at any time of the entire useful life. If this cannot be realized, it is more appropriate to choose a capacitor from a higher voltage or higher capacitance, than originally required by the application.

Both the internal losses and the ripple current of electrolytic capacitors are frequency dependent. Therefore, a relevant frequency conversion table is stated in the detail specifications.

1

CALCULATION OF THE APPLICABLE RMS RIPPLE CURRENT

Non-sinusoidal ripple currents (if not accessible by direct measurement) have to be analyzed into a number of sinusoidal ripple currents by means of Fourier-analysis; the sum of the currents thus found may not exceed the applicable ripple current.
For some frequently occurring waveforms, approximation formulae are stated in Fig.11 for calculating the corresponding RMS value.

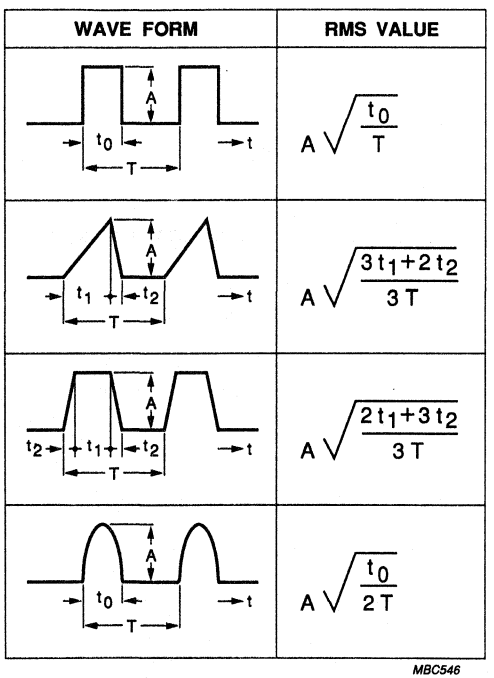


Fig.11 Approximation formulae for RMS values of non-sinusoidal ripple currents.

OPERATIONAL CONDITIONS

Charge-discharge proof

This term means the capability of capacitors to withstand frequent switching operations without significant change of capacitance.
Philips Al-electrolytic capacitors are charge-discharge proof in accordance with IEC 384-4/CECC 30 300: unless otherwise specified, 10^6 switching operations (R . C = 0.1 s) shall not cause a capacitance change of more than 10%.

If a capacitor is charged and discharged continuously several times per minute, the charge and discharge currents have to be considered as ripple currents flowing through the capacitor. The RMS value of these currents should be determined and the resultant value must not exceed the applicable limit.

Endurance test

In IEC 384-4 or CECC 30 300 the criteria for the acceptable drift of electrical parameters after the endurance test at U_R and upper category temperature are defined.
Test duration and conditions per series are stated in the relevant detail specification.

The endurance test does not provide information about the useful life of a capacitor, as no failure percentage is defined for this investigation.

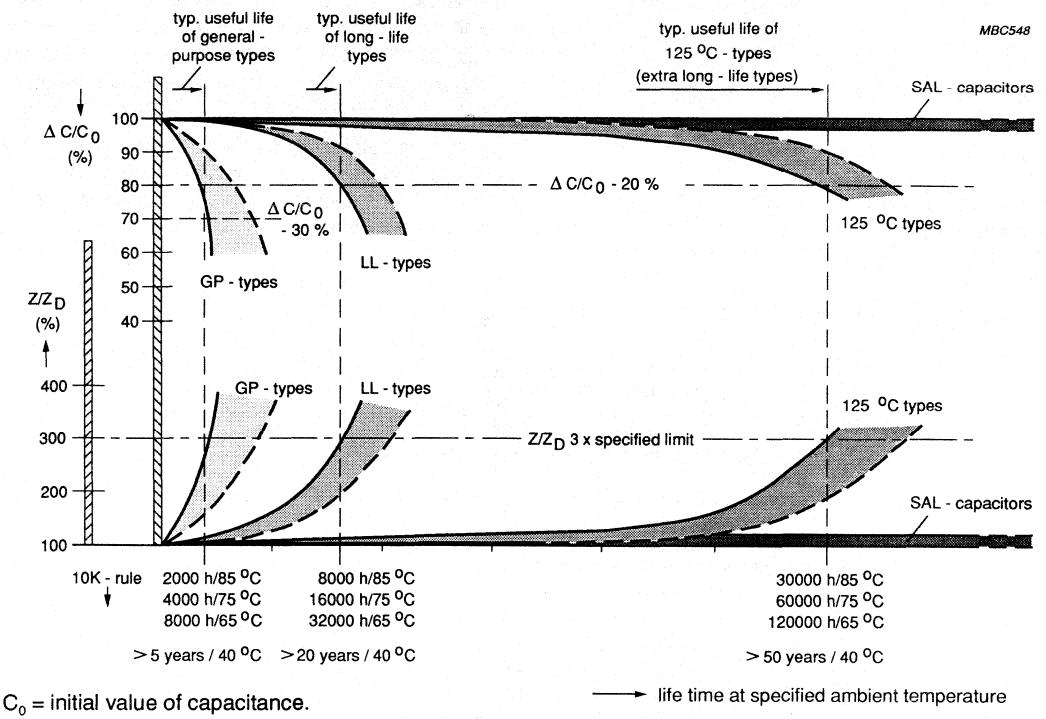
Useful life

Useful life (other names: load life, life time or typical life time) is that period of time, during which a given failure percentage may occur, under well defined conditions and requirements. Useful life data are usually calculated with a confidence level of 60%.

High quality of materials and controlled manufacturing processes provided, the useful life of non-solid electrolytic capacitors is solely determined by evaporation of electrolyte through the sealing.
Figure 12 shows the principal electrical consequences of this electrolyte loss: increasing impedance and decreasing capacitance at the end of useful life, for different non-solid (general purpose, long life and 125 °C types) and solid (SAL-) electrolytic capacitors. Tantalum (Ta) capacitors show similar behaviour to SAL-capacitors.

The influence of temperature on useful life is indicated by the so-called "10 K-rule" under the horizontal axis of the graph. The "10 K-rule" means approximately, that double the life time can be expected per 10 K temperature decrease; this principle is derived from the well known law of Arrhenius about acceleration of reaction processes.

The exact temperature dependence of useful life for a particular range is given in the corresponding detail specification in the "life-time nomogram" ("Multiplier of useful life" graph in the detail specifications). Detailed performance requirements, on which the definition



C_0 = initial value of capacitance.

Z_D = specified limit of impedance.

Fig.12 Principal trend of electrical parameters during useful life of different electrolytic capacitors.

"useful life" is based, are also stated in the relevant detail specifications.
Exceeding those requirements shall not necessarily induce a malfunction of the equipment involved. The performance requirements offer advice on the choice of components and design of the circuitry.

CALCULATION OF USEFUL LIFE BY MEANS OF "LIFE-TIME NOMOGRAMS"

Based on the Arrhenius law and on experience for some decades, a nomogram is specified in the detail specification for each range, where the influence of ambient temperature and ripple current on the expected useful life is shown.
The ratio of ripple current (I_A/I_R) is plotted on the vertical axis and the ambient temperature (T_{amb}) on the horizontal.

At the intersection of these two operational conditions the appropriate multiplier (correction factor) for useful life can be read. The useful life under certain conditions shall be calculated by multiplying (or dividing respectively) the specified useful life, with the resultant correction factor.

The useful life determined by this procedure is normally valid for applications without forced cooling. Under certain conditions and with additional cooling, the useful life may be considerably extended.

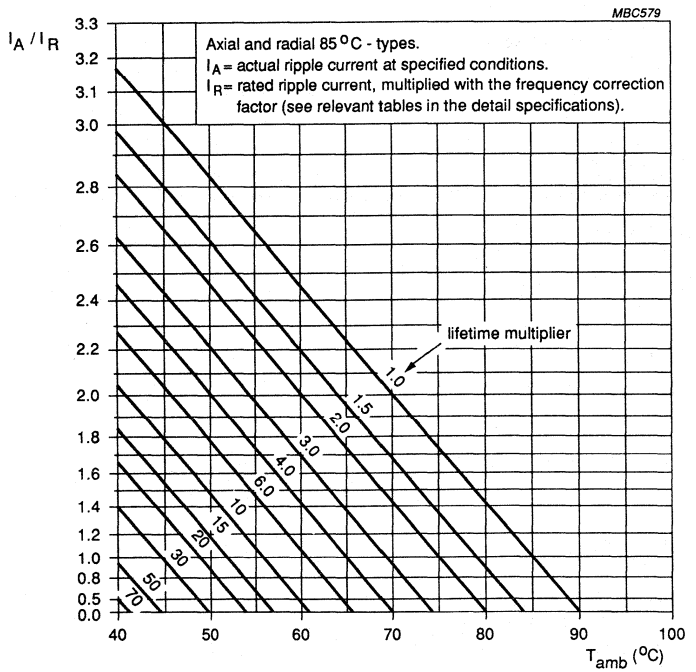


Fig.13 Typical example of a life-time nomogram: useful life as a function of ambient temperature and ripple current load (I_A/I_R); 85 °C types.

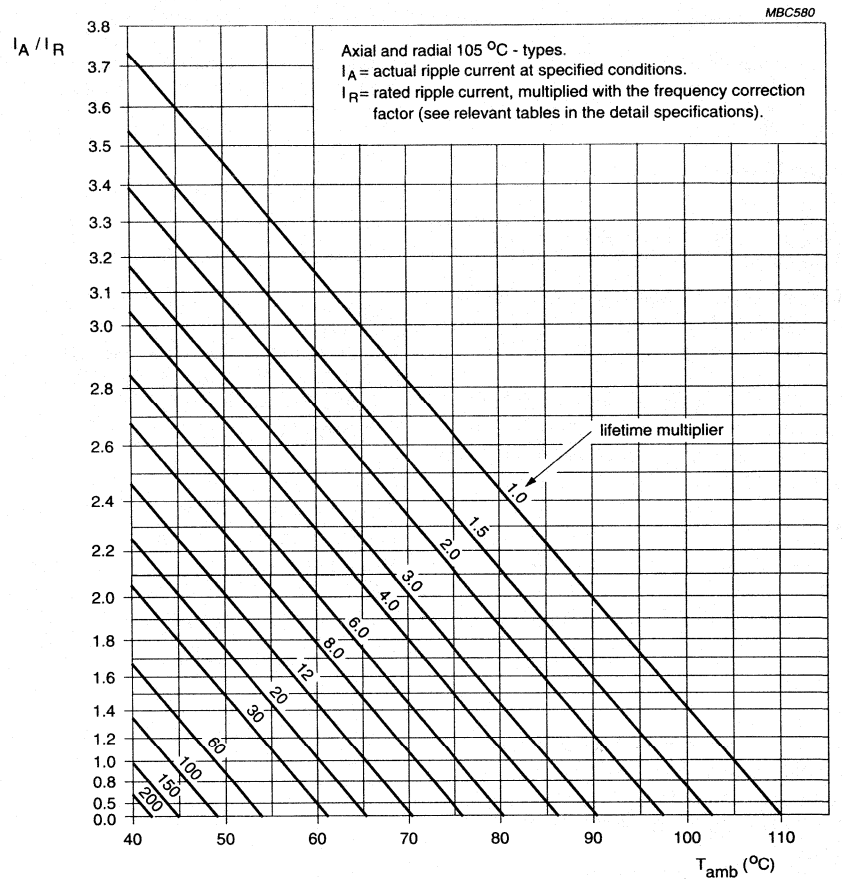


Fig.14 Typical example of a life-time nomogram: useful life as a function of ambient temperature and ripple current load (I_A/I_R); 105 °C types.

1

EXAMPLES FOR USE OF THE "LIFE-TIME NOMOGRAMS"

Example 1

Temperature in (operating) equipment is 45 °C

Ripple current load is exactly the rated value (thus: $I_A/I_R = 1$)

Which useful life can be expected (without pause and storage times):

a) for a capacitor with a specified useful life of 2000 hours/85 °C?

b) for a capacitor with a specified useful life of 2000 hours/105 °C?

Solution:

The corresponding life-time multiplier may be found at the intersection between the vertical "45 °C" - line and the horizontal "1" - line. For the 85 ° type this is "30" and for the 105 °C type it is "90".

Resulting useful life is thus:

a) for 85 °C type: 30 x 2000 hours = 60 000 hours or about 7 years

b) for 105 °C type: 90 x 2000 hours = 180 000 hours or about 2 years

Example 2

Which life time requirement has to be fulfilled by the capacitors, if the equipment life shall be 10 years (approx. 100 000 hours), consisting of 1000 hours/75 °C + 9000 hours/65 °C + 90 000 hours/40 °C? No ripple current applied (thus: $I_A/I_R = 0$).

Solution:

The mentioned life-times shall be converted to specified 85 °C or 105 °C life-times, i.e. they have to be divided through the correction factors found at the intersection of the respective operational conditions (see Table 3):

The required life-time can be fulfilled by types with a specified useful life of:

a) >2970 hours at 85 °C i.e. a 3000 hours/85 °C type, or

b) >935 hours at 105 °C i.e. a 1000 hours/105 °C type.

Example 3

Which internal temperature may occur in the equipment, if the actual ripple current is 2.5 times higher than the specified ripple current (thus: $I_A/I_R = 2.5$) and the load limit may not be exceeded?

Solution:

The load limit is defined by the diagonal line "multiplier 1" in the relevant nomogram.
This means here: the vertical line on the intersection of $I_A/I_R = 2.5$ and the multiplier 1 - line shows the maximum permitted internal temperature:

a) for 85 °C types this is max. 59 °C

b) for 105 °C types this is max. 79 °C

The corresponding life-time in this case is equal to the specified useful life.

Table 3

LIFE CONDITIONS	85 °C TYPES	105 °C TYPES
1000 hours at 75 °C	1000/2.9 = 345 hours	1000/8 = 125 hours
9000 hours at 65 °C	9000/6 = 1500 hours	9000/20 = 450 hours
90 000 hours at 40 °C	90 000/80 = 1125 hours	90 000/250 = 360 hours
	sum for 85 °C = **2970** hours	sum for 105 °C = **935** hours

Failure rate (λ)

The failure rate is defined by the number of components failing within a unit of time, related to the total quantity of components observed:

$$\lambda = \frac{number\ of\ failures\ (statistical\ upper\ limit\ 60\%)}{total\ number\ of\ components \times duration}$$

The failure rate (λ) is generally expressed in so-called "fit" (failure in time) = 10^{-9}/hours with an upper confidence level (UCL) of 60%. It is calculated from results of periodical tests in the quality laboratories or derived from field observations respectively.

Usually the failure rate during time shows the well known "bathtub" curve (see Fig.15):

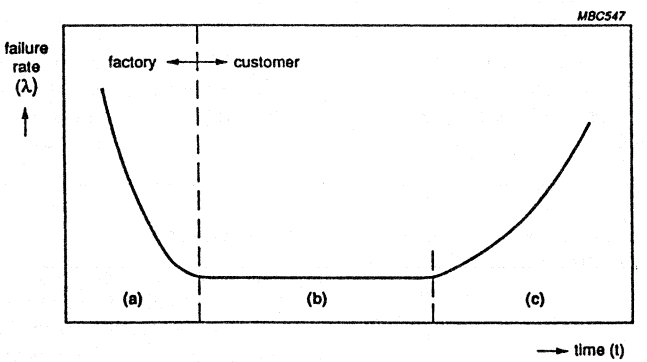
There are 3 periods in a typical capacitor life cycle:

a) Initial failure period, showing a rapidly decreasing failure rate. During production of Philips electrolytic capacitors, initial failures are removed after re-forming (which is a short burn-in); all capacitors shipped, have passed burn-in.

b) Random failure period, showing a low and constant failure rate. This period is identical with "useful life". The sum total of all (drift and accident) failures during this period, related to the total number of observed capacitors, is called "failure percentage". Both are specified in the detail specification of the relevant series.

c) Wear-out failure period, showing an increasing failure rate due to gradual deterioration.

Since the failure rate mainly depends on two stress factors (temperature and applied voltage), it is usually specified under reference conditions, which are: T_{amb} = 40 °C and U = 0.5 U_R.



a) initial failure period ("infant mortality")
b) random failure period (= useful life period)
c) wear-out failure period.

Fig.15 Failure rate (λ) as a function of time ("bathtub" curve).

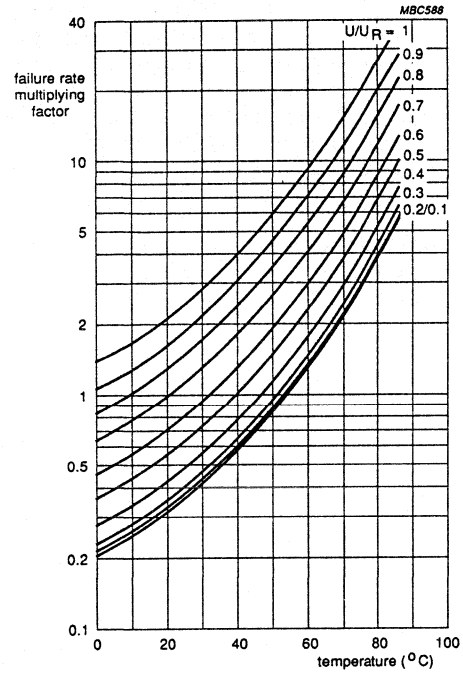


Fig.16 Conversion factors for failure rate (λ) as a function of ambient temperature (T_{amb}) and voltage ratio (U/U_R) for non-solid electrolytic capacitors.

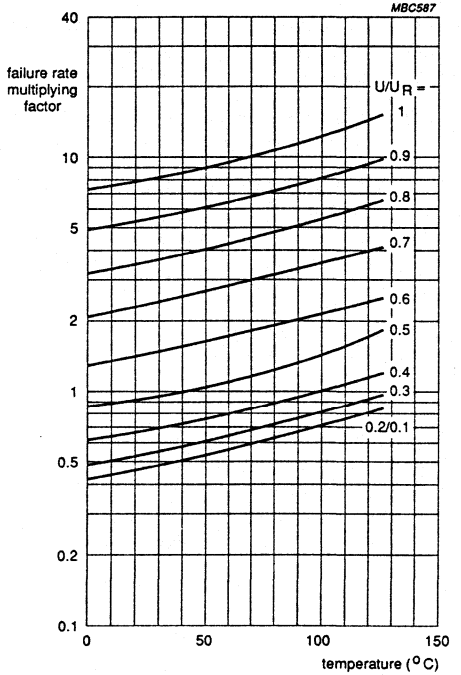


Fig.17 Conversion factors for failure rate (λ) as a function of ambient temperature (T_{amb}) and voltage ratio (U/U_R) for SAL electrolytic capacitors.

For other operational conditions, λ has to be converted correspondingly with the aid of Figs 16 and 17, failure rates as a function of stress factors (T_{amb} and U/U_R) for non-solid and SAL electrolytic capacitors.
Figure 16 is identical to Mil-Std 217, whereas Fig.17 has been derived from extended long term statistics compiled over 25 years by our test and quality laboratories.

Climatic category

For each capacitor range the climatic category in accordance with IEC 68-1 is stated in the relevant detail specification. The climatic category consists of three digit groups, having the following meaning:

Example:	40	085	56	
	40			lower category temperature (here: –40 °C)
		085		upper category temperature (here: +85 °C)
			56	duration of test "damp heat, steady state" (here: 56 days)

Application class

In DIN 40040 some application classes for climatic working conditions of components are defined, consisting of 3 code letters with the following meaning:

1st letter: lower category temperature
F: –55 °C; G: –40 °C; H: –25 °C

2nd letter: upper category temperature
P: +85 °C; M: +100 (+105) °C; K: +125 °C

3rd letter: maximum humidity conditions (see Table 4)

Table 4 Maximum humidity condition indication

CODE LETTER	RELATIVE AIR HUMIDITY			
	yearly average	30 days per year	occasionally	dewing
C	≤95%	100%	100%	permitted
D	≤80%	100%	90%	permitted
E	≤75%	95%	85%	slightly/rarely
F	≤75%	95%	85%	not permitted

MOUNTING

Mounting position of non-solid Al-electrolytic capacitors

Snap-in and printed wiring (PW) power electrolytic capacitors, in addition to the larger case sizes of axial and radial types, are normally equipped with a safety vent in the aluminium case. These and all smaller case size types, may be mounted in any position.

Screw-terminal and solder-lug power electrolytic capacitors have a safety vent in the sealing disc. These types shall be mounted so that if the vent is opened, no electrolyte or vapour may reach either the conductors under voltage or other parts of the printed circuit board. Vertical (vent up) or horizontal mounting position is recommended.

Design rules for "capacitor batteries"

MECHANICAL

Philips "large type" electrolytic capacitors are mainly used in power supply applications under high ripple current load. In these circumstances, the capacitors must be mounted with a distance of ≥15 mm from each other, in order to allow sufficient air circulation and to prevent mutual radiation.

Likewise, if axial or radial types are subject to high ripple load, they shall be mounted with sufficient distance (e.g. ≥10 mm) from each other for good convection.

ELECTRICAL

Parallel connection

Al-electrolytic capacitors may be connected in parallel, but for safety reasons, large sizes should be individually guarded against sudden energy discharge of the whole battery due to a defective specimen.
With smaller batteries, this safeguarding is sufficiently ensured by current limiting resistors.

Series connection

Al-electrolytic capacitors may be connected in series, but when doing so it should be noted that the voltage distribution will be according to their leakage currents. This phenomenon may induce irregularities in voltage load and cause maximum ratings to be exceeded; this could have drastic consequences, especially with high voltage capacitors.
Series-connected electrolytic capacitors should therefore be, either supplied by galvanically separated voltage sources or the voltages shall be proportionally distributed by balancing resistors.

The balancing resistors can be dimensioned in accordance with the following approximation formula:

$$R_{sym}\ (\text{in k}\Omega) = 10\ 000/C_R\ (\text{in } \mu\text{F})$$

Combined series/parallel connection

The above mentioned rules for both series and parallel connection are accordingly valid for any combination of these two cases.

1

MARKING

Philips electrolytic capacitors are identified in accordance with IEC rules. When sufficient space is available, capacitors are marked with the following details:

Table 5 Marking

Rated capacitance	in µF (the "µ" sign represents the position of the decimal point)
Rated voltage	in V
Tolerance on rated capacitance	if necessary, as a lettercode in accordance with IEC 62, e.g. T for −10/+50% M for ±20% K for ±10% Q for −10/+30% A for tolerance according to detail specification
Group number	3 digit part of the catalogue number, e.g. 036 for RSP series
Name of manufacturer	PHILIPS
Date code	abbreviation in 2 digits (IEC 62), e.g. 1st digit: U = 1987, V = 1988, W = 1989, A = 1990, B = 1991, C = 1992, D = 1993 2nd digit: 1 = January, 2 = February, ..., 9 = September, O = October, N = November, D = December example: A5 = produced in 1990, May production date may also be stated as year/week code: example: 9125 = produced in 1991, 25th week Date code for axial types 10 x 30 to 21 x 40 is stamped in the case next to cathode terminal
Factory code	indicating the factory of origin

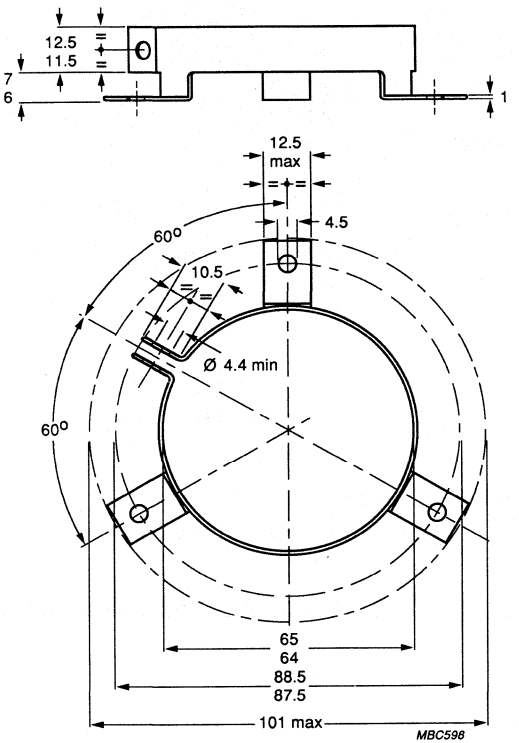
MOUNTING ACCESSORIES

Clamps for ST - versions, ∅35, 50, 65 and 75 mm

To facilitate vertical mounting, a series of rigid clamps made of zinc plated steel are available.
The clamps have either two or three mounting lugs, may be easily slipped over the capacitor and then clamped with a nut and bolt. Four types of clamps are available, one for each case diameter.
They are delivered without nuts or bolts.

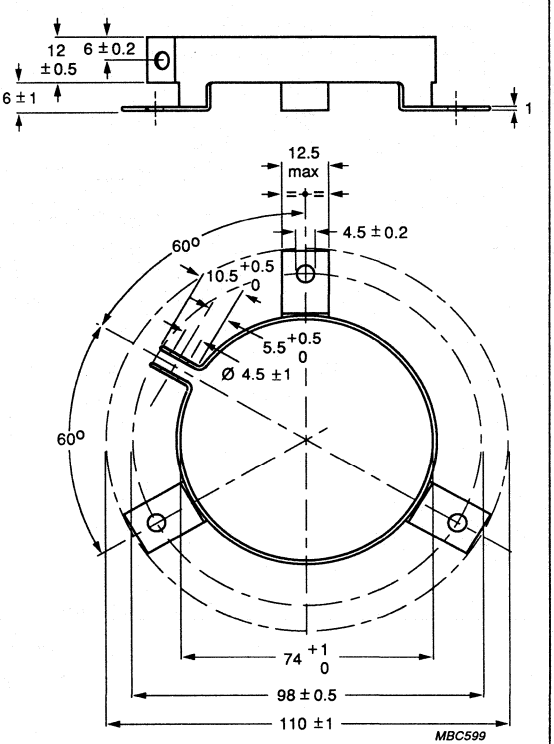
Note

To avoid damaging the insulation sleeve, do not overtighten the clamp.



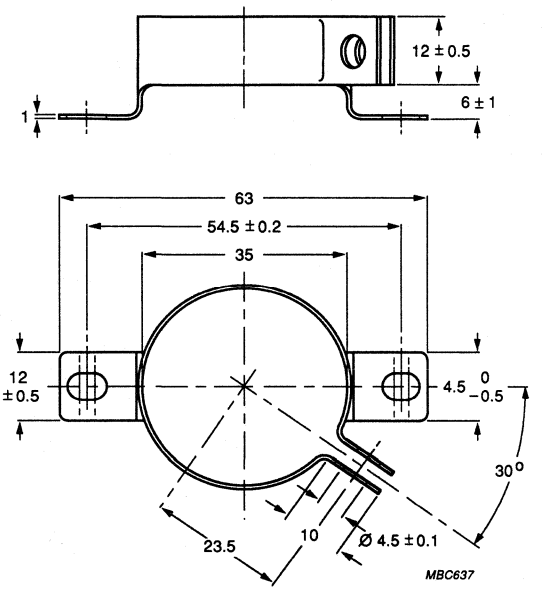
Dimensions in mm.
Catalogue number: 4322 043 04291.

Fig.18 Clamp for case diameter of 65 mm.



Dimensions in mm.
Catalogue number: 4322 043 12990.

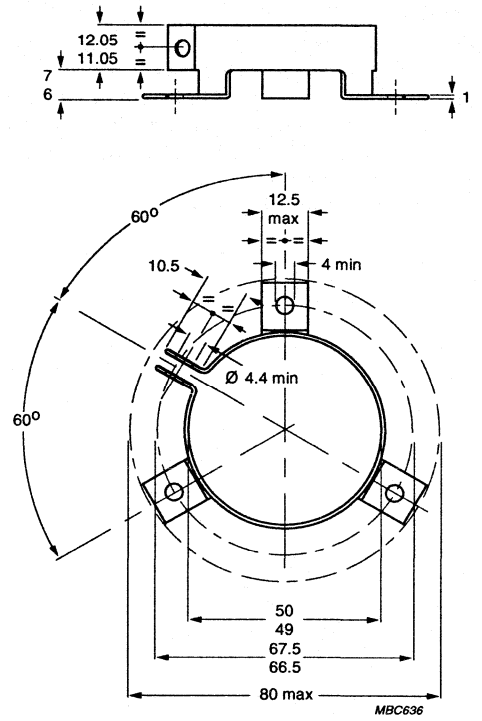
Fig.19 Clamp for case diameter of 75 mm.



Dimensions in mm.

Catalogue number: 4322 043 04272.

Fig.20 Clamp for case diameter of 35 mm.



Dimensions in mm.

Catalogue number: 4322 043 04281.

Fig.21 Clamp for case diameter of 50 mm.

Nuts and washers for STB - versions

When mounting with the bolt, which is an integral part of the case, standard metal M8 and M12 nuts and washers may be used; the maximum permissible torque is 7 Nm for M8 nuts and 19 Nm for M12 nuts.

If insulated mounting is required, synthetic nuts and rubber washers are available; for these nuts the maximum permissible torque is 4 Nm (M8) and 11 Nm (M12).

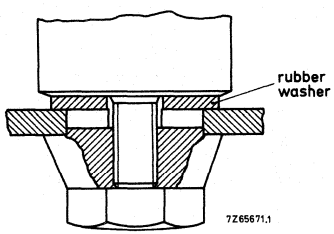
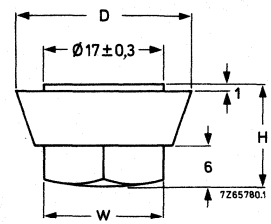


Fig.22 Insulated mounting.



Dimensions in mm.

Fig.23 Synthetic cap nut; see Table 6 for dimensions D, H and W.

Table 6 Dimensions of synthetic cap nut

CASE DIAMETER (mm)	THREAD	D (mm)	H (mm)	W (note 1) (mm)	MIN. THREADED DEPTH (mm)	CATALOGUE NUMBER
35	M8	25	15	17	11.5	4322 043 05561
≥50	M12	30	20	19	15.5	4322 043 05571

Note

1. Dimension W is measured across flats.

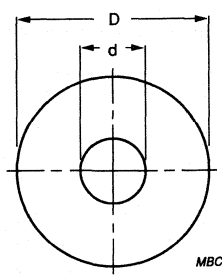


Fig.24 Rubber washer; thickness 2 mm.

Table 7 Rubber washer ordering codes

D (mm)	d (mm)	CATALOGUE NUMBER
34	8.4	4322 043 05591
49	13	4322 043 05531
64	13	4322 043 05521
74	13	4322 043 13000

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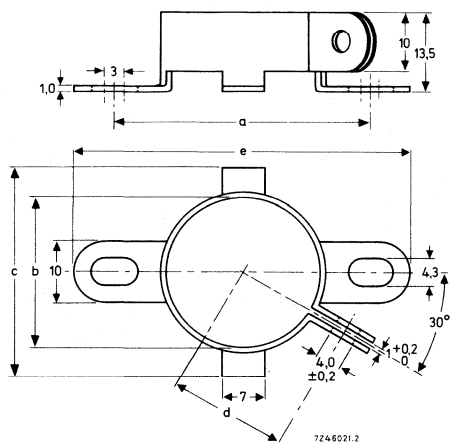
Clamps for SL - versions, ∅25, 30, 35 and 40 mm

To facilitate vertical mounting, a series of rigid clamps made of zinc plated steel are available.
The clamps have two mounting lugs, may be easily slipped over the capacitor and then clamped with a nut and bolt. Four types of clamps are available, one for each case diameter.
They are delivered without nuts or bolts.

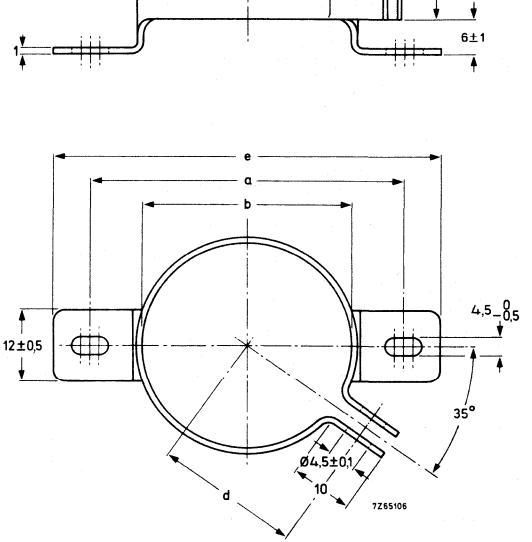
Note

To avoid damaging the insulation sleeve, do not overtighten the clamp screw.



Dimensions in mm.

Fig.25 Clamp for case diameters 25, 30 and 40 mm.



Dimensions in mm.

Fig.26 Clamp for case diameter 35 mm.

Table 8 Clamp dimensions

CASE DIAMETER (mm)	a (mm)	b (mm)	c (mm)	d (mm)	e (mm)	CATALOGUE NUMBER
25	41.5 ±0.2	25	35	18.5	56	4322 043 03301
30	46.5 ±0.2	30	40	21	61	4322 043 03311
35	51.5 ±0.2	35	–	23.5	63	4322 043 04272
40	56.5 ±0.2	40	50	26	71	4322 043 03331

Nuts and washers for SLB - versions

When mounting with the bolt, which is an integral part of the case, standard metal M8 nuts and washers may be used; the maximum permissible torque is 7 Nm.
If insulated mounting is required, synthetic nuts and rubber washers are available; for these nuts the maximum permissible torque is 4 Nm.

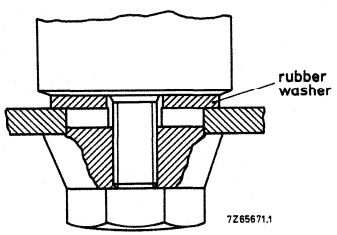
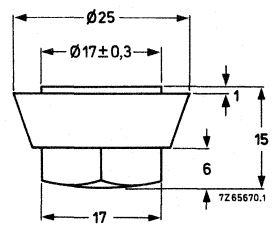


Fig.27 Cross section of bolt.



Dimensions in mm.
Threaded depth 11.5 mm minimum.
Catalogue number 4322 043 05561.

Fig.28 Synthetic cap nut M8.

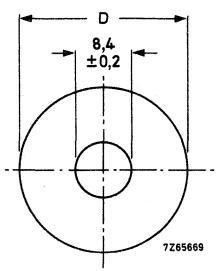


Fig.29 Rubber washer (thickness 2 mm).

Table 9 Rubber washer ordering codes

D (mm)	CATALOGUE NUMBER
24	4322 043 05611
29	4322 043 05601
34	4322 043 05591
39	4322 043 05581

Notes

1

APPLICATION GUIDELINES

Electrolytic Capacitors — Application guidelines

WARNING

Correct application and strict adherence to the important information listed below, will ensure optimum performance of the capacitors over their entire specified useful life.
Please note, that ignoring these rules may reduce the equipment life time or even destroy the capacitor, together with parts of the equipment or property involved. The consequences may be a short or open circuit of the component, or heat generation. Opening of the case or vent (danger of injury) may be regarded as hazardous and cause liquids, vapours or dust to be released. Similar precautions should be taken when testing electrolytic capacitors.
Please consult your local Philips Components sales organization, if one or more of these limits cannot be adhered to.

PARAMETER	IMPORTANT INFORMATION – PRODUCT SAFETY	MORE DETAILS
POLARITY, REVERSE VOLTAGE	**Electrolytic capacitors for DC applications require polarization.** Check the polarity of each capacitor: both in circuit design and in mounting (polarity is clearly indicated on the capacitor). For short periods a limited reverse voltage is allowed (see detail specification); for conditions and maximum parameter changes see Tests and Requirements. Exceeding reverse voltage may result in early failures.	detail specification, TESTS AND REQUIREMENTS
VOLTAGE	**Do not apply a voltage exceeding the capacitor's voltage rating.** Check the maximum voltage across the capacitor which can occur over the whole equipment life. In normal operation the rated voltage of the capacitor shall not be exceeded; if so, early failures may occur. However, for short periods the voltage may be raised up to surge voltage value (see detail specification); for conditions and maximum parameter changes see Tests and Requirements	detail specification, TESTS AND REQUIREMENTS
RIPPLE LOAD	**Do not allow excessive ripple current to pass.** The rated ripple current given for certain conditions (temperature, frequency and useful life) shall not be exceeded. If so, early failure may result. **Keep ripple voltage within ratings.** The sum of DC-bias and maximum amplitude of ripple voltage shall be within rated voltage and 0 V. Electrolytic capacitors are not normally designed for AC application	detail specification
TEMPERATURE RANGE	**Use capacitors within specified temperature range.** Applicable temperature range is given in the relevant detail specification. A general principle is that lower ambient temperature means longer life; therefore, electrolytic capacitors should be placed at the coolest positions on the board, wherever possible. Exceeding the permitted temperature range may cause early failures	detail specification
CHARGE-DISCHARGE	**Observe charge-discharge limitations.** Frequent charge-discharge load via low resistance may cause capacitance drop or destroy the capacitor. Under well defined conditions (see Tests and Requirements) frequent charge-discharge operation is allowed. The resulting current through the capacitor may not exceed the ripple current limit.	TESTS AND REQUIREMENTS

PARAMETER	IMPORTANT INFORMATION – PRODUCT SAFETY	MORE DETAILS
SERIES/ PARALLEL CONNECTIONS	**When connecting in series/parallel, apply corresponding design rules.** Connecting electrolytic capacitors in series/parallel is possible, provided that balancing resistors are applied to each capacitor, in order to stabilize the voltage over each individual capacitor. Rules for correct design are given in the introduction	INTRODUCTION
PROTECTIVE RESISTOR	**For tantalum electrolytic capacitors a protective resistor is required.** When using tantalum electrolytic capacitors, consider the appropriate series resistor for current limitation under certain circumstances.	detail specification
INSULATION	**The capacitor case is not insulated from the cathode terminal.** Axial capacitors have a direct contact between case and cathode terminal; radial and power capacitors exhibit an indeterminate resistance between the cathode terminal and the metal case. Metal parts other than terminals should never make contact to conducting tracks or metal parts of other components. Dummy pins are connected to the cathode.	
STORAGE	**Excessive storage time or conditions may have adverse effects on capacitors.** Capacitors should be stored at room temperature, low humidity and out of direct sunlight. Storage at elevated temperature and/or high relative humidity may have a negative influence to taping accuracy, solderability, leakage current and life expectancy.	INTRODUCTION TESTS AND REQUIREMENTS
HIGH AIR PRESSURE	**Do not expose capacitors to overpressure.** Maximum operating pressure is 150 kPa. Higher pressure may cause a short circuit.	
LOW AIR PRESSURE	**The capacitors may be used at an altitude ≤ 12 000 m.** Minimum air pressure: 8.6 kPa	TESTS AND REQUIREMENTS
MOUNTING	**Avoid excessive stress to the lead wires or terminals.** Excessive stress can be caused by component processing machines if lead wires are not sufficiently fixed during bending, cutting, cropping or inserting operations. Other possible reasons are incorrect hole distance at PC boards or bending of the component after soldering. For maximum allowed mechanical load see Tests and Requirements. Mechanically damaged capacitors may not be used. Safety vent should have enough space to function correctly.	TESTS AND REQUIREMENTS
SOLDERING	**Keep soldering temperature and time under control.** For maximum soldering conditions see Tests and Requirements. Additional temperature load e.g. for curing the glue of SMD's are allowed to a certain limit, which depends on series and exact details, please apply to your sales engineer for your specific conditions. Molten solder or the soldering iron should not make contact with the capacitor's insulation.	TESTS AND REQUIREMENTS

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PARAMETER	IMPORTANT INFORMATION – PRODUCT SAFETY	MORE DETAILS
BOARD CLEANING	**Halogenated cleaning agents may damage electrolytic capacitors.** Non-solid aluminium electrolytic capacitors may be affected adversely when in contact with halogenes, e.g. chlorine, fluorine, or chemicals containing halogene. Thereby, internal corrosion may be started with retarded effects as leakage current increase, open or short circuit, opening of case or vent. Therefore halogenated solvents are harmful for electrolytic capacitors; consequently, water-based or alcohol-based cleaning agents are preferable. If unavoidable, do not exceed recommended exposure times and make provision for thorough drying - especially if the board is laquered or embedded afterwards.	
ADHESIVES, COATING MATERIALS	**Some adhesives and coating materials affect capacitors adversely.** For varnishing, coating, laquering, embedding or glueing at the capacitor's sealing, ensure that the materials used are halogene-free in all their constituent parts (base material, thinners, binders, reacting agents, propellants, additives). For reasons see BOARD CLEANING above.	
DISPOSAL	**Electrolytic capacitors are subject to special waste regulations.** Aluminium and tantalum electrolytic capacitors are free from PCB- or PBDE-containing substances. Dioxines or furanes are not constituent parts of electrolytic capacitors. However, because of other polluting ingredients, larger quantities (in weight) of electrolytic capacitors are subject to special waste regulations in accordance with the relevant national laws. In general, electrolytic capacitors have to be disposed under controlled circumstances in a high temperature incinerator at minimum 900 °C.	
PERSONNEL SAFETY	**WARNING NOTE.** Non-solid electrolytic capacitors may contain chemicals which can be regarded as hazardous if handled incorrectly. Caution is necessary if the outer case is fractured; vapours or dust particles should not be inhaled (good ventilation is essential); skin, eye or clothing contact with liquids should be avoided. In case of such contact, flush thoroughly with running water as soon as possible, then wash skin or clothing with soap and water or a mild detergent. Any possible discolouration of the wetted skin will disappear after a few days. In the event of fire, the organic parts of electrolytic capacitors may release such constituents as carbon monoxide, nitric oxides or dust particles; take caution when breathing-in.	

TESTS AND REQUIREMENTS

1

This chapter contains an abridged version of tests and requirements given in IEC 384-4 or CECC 30 300 respectively. Series specific tests and requirements are given in the relevant detail specification.

Table 1 Non-solid Aluminium types

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Robustness of terminations	4.4			
Tensile strength		Ua	leaded types: loading force 10 N for 10 s power types: loading force 20 N for 10 s	no visible damage
Bending		Ub	leaded types: loading force 5 N, two consecutive bends	no visible damage
Torsion		Uc	leaded types, axial: two successive rotations of 180° in opposite direction, 5 s per rotation	no visible damage
Torque on nut (stud)		Ud	power types/screw terminal: torque of 1.76 Nm gradually applied	no visible damage
Resistance to soldering heat	4.5	Tb (method 1A)	solder bath: 260 °C, 10 s, for capacitors with printed-wiring pins	no visible damage, marking legible; $\Delta C/C \leq 5\%$
		Tb (method 1B)	solder bath: 350 °C, 3.5 s for capacitors with solder leads or tags	
Solderability	4.6	Ta	solder bath: 235 °C, 2 s; for capacitors with printed-wiring pins, 270 °C, 2 s; for capacitors with solder leads or tags, immersed up to 2 mm from the body; activated flux: 600/0.2% Cl	no visible damage, marking legible; ≥95% tinning
Rapid change of temperature	4.7	Na	5 cycles of 3 hours at lower and upper category temperature	no visible damage, no leakage of electrolyte
Vibration	4.8	Fc	long-life grade types: 10 to 500 Hz, 0.75 mm or 10 g (whichever is less), 3 directions, 2 hours per direction	no visible damage, no leakage of electrolyte, marking legible; $\Delta C/C \leq 5\%$ with respect to initial measurements
			general-purpose grade types: 10 to 55 Hz, 0.75 mm or 10 g (whichever is less), 3 directions, 2 hours per direction (Form MR types only)	

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Bump	4.9	Eb	long-life grade types: 40 g, 2 directions, 4000 bumps total	no visible damage, no leakage of electrolyte; ΔC/C ≤5% with respect to initial measurement
			general-purpose grade types: 40 g, 2 directions, 1000 bumps total	
Climatic sequence	4.11			
Dry heat	4.11.1	Ba	16 hours at upper category temperature, no voltage applied	no visible damage, no leakage of electrolyte
Damp heat, cyclic	4.11.2	Db	1 cycle of 24 hours at 55 ± 2 °C, RH 95 to 100%, no voltage applied	
Cold	4.11.3	Aa	2 hours at lower category temperature, no voltage applied	no visible damage, no leakage of electrolyte
Low air pressure	4.11.4	M	5 minutes at 15 to 35 °C, at atmospheric pressure of 85 mbar, U_R applied during last minute	no visible damage, no evidence of breakdown or flashover
Damp heat, cyclic	4.11.5	Db	5 cycles of 24 hours at 55 ± 2 °C, RH 95 to 100%, no voltage applied	
Sealing	4.11.6	Qc	1 minute in water at 90 °C	no continuous chain of bubbles
	4.11.7		final measurement after climatic sequence	no visible damage, no leakage of electrolyte, marking legible; leakage current ≤stated limit, tan δ ≤1.2 x stated limit; ΔC/C ≤10%
Damp heat, steady state	4.12	Ca	56 days at 40 °C, RH 90 to 95%, no voltage applied	no visible damage, no leakage of electrolyte, marking legible; leakage current ≤stated limit, tan δ ≤1.2 x stated limit, insulation resistance >100 MΩ, no breakdown or flashover below 1000 V
				long-life grade types: ΔC/C ≤10%
				general-purpose grade types: ΔC/C ≤20%

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Endurance	4.13		for test duration, refer to the relevant data sheet in this handbook; at upper category temperature, U_R applied	no visible damage, no leakage of electrolyte, marking legible; leakage current ≤stated limit, insulation resistance >100 MΩ, no breakdown or flashover below 1000 V
				long-life grade types: U_R ≤6.3 V: ΔC/C +15/–30% U_R 10 to 160 V: ΔC/C ±15% U_R ≥200 V: ΔC/C ±10% tan δ ≤1.3 x stated limit, impedance ≤2 x stated limit
				general-purpose grade types: U_R ≤6.3 V: ΔC/C +25/–40% U_R 10 to 160 V: ΔC/C ±30% U_R ≥200 V: ΔC/C ±15% tan δ ≤1.5 x stated limit or 0.40 (whichever is greater), impedance ≤3 x stated limit
Surge	4.14		from source of 1.15 x U_R for U_R ≤315 V or 1.1 x U_R for >315 V, RC = 0.1 ±0.05 s, 1000 cycles of 30 s on, 330 s off	no visible damage, no leakage of electrolyte; leakage current ≤stated limit, tan δ ≤stated limit, ΔC/C ≤15%
			long-life grade types: at upper category temperature	
			general-purpose grade types: at 25 °C	
Reverse voltage	4.15		1 V in reverse polarity followed by U_R in forward polarity, both for 125 hours at upper category temperature	leakage current ≤stated limit, tan δ ≤stated limit, ΔC/C ≤10%
Pressure relief (for types with vent only)	4.16		DC voltage applied in reverse direction producing a current of 1 to 10 A	pressure relief opens prior to danger of explosion or fire
Storage at upper category temperature	4.17	Ba	for test duration, refer to the relevant data sheet in this handbook; at upper category temperature	no visible damage, no leakage of electrolyte; leakage current ≤2 x stated limit, tan δ ≤1.2 x stated limit, ΔC/C ≤10%

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Storage at low temperature	4.18	Ab	72 hours at a temperature of 15 °C below the lower category temperature	no visible damage, no leakage of electrolyte; leakage current ≤stated limit, tan δ ≤stated limit, ΔC/C ≤10%
Characteristics at high and low temperature	4.19		step 1: reference measurement at 20 °C of capacitance, impedance and tan δ at 100 Hz	
		Aa	step 2: measurement at lower category temperature	Impedance at 100 Hz ≤7 x value of step 1 for U_R ≤6.3V or U_R >160 V, ≤5 x value of step 1 for 6.3 < U_R ≤16 V, ≤4 x value of step 1 for 16 < U_R ≤160 V
		Ba	step 3: measurement at upper category temperature	leakage current ≤10 x stated limit at 125 °C ≤8 x stated limit at 105 °C ≤5 x stated limit at 85 °C ≤3 x stated limit at 70 °C
Charge and discharge	4.20		for U_R ≤160 V: 10^6 cycles of 0.5 s charge to U_R (RC = 0.1 s) and 0.5 s discharge (RC = 0.1 s). for U_R > 160 V: under consideration	no visible damage, no leakage of electrolyte; ΔC/C ≤10%

Table 2 Solid Aluminium types

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Robustness of terminations	4.4			
Tensile strength		Ua	loading force: 10 N for 10 s	no visible damage
Bending		Ub	loading force: 5 N, two consecutive bends	no visible damage
Torsion (axial types)		Uc	two successive rotations of 180° in opposite direction, 5 s duration per rotation	no visible damage
Resistance to soldering heat	4.5	Tb (method 1A)	radial types: solder bath 260 °C for 10 s	no visible damage, markings legible; ΔC/C ≤5% with respect to initial measurement
		Tb (method 1B)	axial types: solder bath 350 °C for 3.5 s	
Solderability	4.6	Ta (method 1)	solder bath 235 °C for 2 s, immersed up to 2 mm from the body, activated flux 600 (0.2% Cl.)	no visible damage, marking legible; ≥95% tinning
Rapid change of temperature	4.7	Na	5 cycles of 30 minutes at lower and upper category temperature	no visible damage; leakage current (notes 1 and 4), tan δ and Z ≤stated limit
Vibration	4.8	Fc	10 to 500 Hz, 0.75 mm or 10 g (whichever is less severe), in 3 directions, 2 hours per direction	no visible damage, markings legible; ΔC/C ≤5% with respect to initial measurement
			SAL-AG 123: 10 to 2000 Hz, 1.5 mm or 20 g (whichever is less severe) in 3 directions, 2 hours per direction	no visible damage, markings legible; ΔC/C ≤5% with respect to initial measurement
Bump	4.9	Eb	40 g, 2 directions 4000 bumps total	no visible damage; ΔC/C ≤5% with respect to initial measurement
Shock	4.10	Ea	SAL-AG 123: acceleration: 29 400 m/sec² or 3000 g duration of pulse: 0.2 ms total number of shocks: 18	no visible damage; ΔC/C ≤5% with respect to initial measurement

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Climatic sequence	4.11			
Dry heat	4.11.1	Ba	16 hours at upper category temperature, no voltage applied	
Damp heat, cyclic	4.11.2	Db	1 cycle between 55 °C and 25 °C, 24 hours duration, 95 - 100% RH, no voltage applied	
Cold	4.11.3	Aa	2 hours at lower category temperature, no voltage applied	
Low air pressure	4.11.4	M	5 minutes at 25 + 10 °C atmospheric pressure: 8.5 kPa, U_R applied during last minute of test	no breakdown, flashover, or harmful deformation of case
Damp heat, cyclic	4.11.5	Db	5 cycles between 55 °C and 25 °C, 95 –100% RH, no voltage applied	
			final measurements after climatic sequence	no visible damage, markings legible; leakage current (notes 1 and 4) ≤stated limit, tan δ and Z ≤1.2 x stated limit
				axial types: $\Delta C/C \leq 5\%$ with respect to initial measurement radial types: $\Delta C/C \leq 10\%$ with respect to initial measurement

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Endurance	4.13		for test duration, refer to the relevant data sheet in this handbook; at upper category temperature U_R applied (note 2)	no visible damage, markings legible; leakage current ≤stated limit, $\Delta C/C \leq 10\%$ with respect to initial measurement, tan δ and Z ≤1.2 times the stated limit
				axial types: insulation resistance ≥100 MΩ no breakdown or flashover at 1000 V
Endurance (additional) SAL-A			2000 hours at 155 °C, maximum 0.63 U_R applied	leakage current ≤stated limit, $\Delta C/C \leq 20\%$ with respect to initial measurement, tan δ ≤1.5 x stated limit, Z ≤2.5 x stated limit
Surge	4.14		applied voltage source of 1.15 U_R (note 2) at 125 °C, 1000 cycles, 30 s on, 330 s off	no visible damage; leakage current ≤stated limit, tan δ ≤stated limit
				axial types: $\Delta C/C \leq 5\%$ with respect to initial measurement
				radial types: $\Delta C/C \leq 10\%$ with respect to initial measurement
Reverse voltage	4.15		0.15 U_R (note 2) in reverse polarity at 125 °C, for 125 hours, followed by U_R (note 2) in forward polarity at 125 °C for 125 hours	leakage current ≤stated limit, $\Delta C/C \leq 10\%$ with respect to initial measurement, tan δ and Z ≤stated limit
Reverse voltage (additional) Radial types			0.30 U_R (note 2) in reverse polarity at 125 °C for 125 hours, followed by U_R (note 2) in forward polarity at 125 °C for 125 hours	leakage current (note 1) ≤stated limit, $\Delta C/C \leq 10\%$ with respect to initial measurement, tan δ and Z ≤stated limit
Reverse voltage (additional) SAL-A			0.30 U_R in reverse polarity at 85 °C for 125 hours, followed by U_R in forward polarity at 85 °C for 125 hours	leakage current (note 4) ≤stated limit, $\Delta C/C \leq 10\%$ with respect to initial measurement, tan δ and Z ≤stated limit

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Storage at upper category temperature	4.17	Ba	96 ±4 hours at upper category temperature	no visible damage; leakage current ≤stated limit, ΔC/C ≤5% with respect to initial measurement SAL-RPM ΔC/C ≤10% with respect to initial measurement
Long storage ≥1 year (additional)			at ambient temperature	leakage current (note 1) ≤stated limit
Characteristics at high and low temperature	4.19		step 1: reference measurement at 20 °C, of capacitance, tan δ and impedance at 100 Hz	
			step 2: measurement at −55 °C, capacitance, tan δ and impedance at 100 Hz	ΔC/C ≤20% with respect to value in step 1 impedance ratio (100 Hz): ≤2 x the value of step 1 tan δ ≤2 x the stated limit
			step 3: measurement at 125 °C, capacitance, leakage current (note 2), tan δ and impedance at 100 Hz	leakage current (notes 1 and 3) ≤ 15 x the stated limit, ΔC/C ≤20% of the value measured in step 1, tan δ ≤stated limit
Charge and discharge	4.20		10^6 cycles charging to U_R for 0.5 s, and then discharging for 0.5 s	no visible damage; ΔC/C ≤5% with respect to inital measurement

Notes

1. For capacitors type SAL-RP 122, the 15 s value of leakage current measured after 5 minutes.
2. 25 V for 40 V versions (capacitor type SAL-RP 122) and 30 V for 35 V and 40 V versions (capacitor type SAL-RPM 128).
3. For capacitors type SAL-RP 122, 40 V version, <8 x the stated limit.
4. For capacitors type SAL-A 123, leakage current after 5 minutes.

Table 3 SMD Solid Aluminium type (SAL-CPL 127)

NAME OF TEST	IEC (sec)604/ CECC (sec)2454 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Mounting	4.3		preheating at 100 °C for 15 minutes, immersion in tin bath at 250 °C, soldering time 5 s	no visible damage; $\Delta C/C \leq 5\%$ leakage current tan δ and Z ≤stated limit
Resistance to soldering heat	4.6		total immersion for 10 s, bath temperature 260 °C	no visible damage, markings legible; $\Delta C/C \leq 5\%$ of initial measurement, tan δ and Z ≤stated limit
Solderability	4.7		immersion for 2 s, bath temperature 235 °C flux 600, including 0.2% chloride	visual examination in accordance with IEC 4.7.2
Adhesion	4.8		force 5 N for 10 ±1 s	no visible damage
Bond strength of end face plating	4.9		product mounted on 90 mm printboard, bending on radius 340 mm (mounting on convex side)	no intermittent contact during the bending operation; $\Delta C/C$ and Z drift ≤5% of initial measurement (board in bent position), no visible damage
Rapid change of temperature	4.10	Na	5 cycles, 30 minutes at −55 °C, followed by 30 minutes at +125 °C recovery period 16 hours	leakage current (note 1), capacitance tan δ and Z ≤stated limit
Vibration (additional)		Fc	10 to 500 Hz, 0.75 mm or 10 g, (whichever is less severe), 3 directions, 2 hours per direction	no visible damage, markings legible; $\Delta C/C \leq 5\%$ of initial measurement
Bump (additional)		Eb	40 g, 2 directions, 4000 bumps total	no visible damage, markings legible; $\Delta C/C \leq 5\%$ of initial measurement

NAME OF TEST	IEC (sec)604/ CECC (sec)2454 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Dry heat	4.11	Ba	16 hours at upper category temperature, no voltage applied	
Damp heat, cyclic		Db	1 cycle between 55 °C and 25 °C, 24 hours duration, 95-100% RH, no voltage applied	
Cold		Aa	2 hours at lower category temperature, no voltage applied	
Damp heat, cyclic		Db	5 cycles between 55 °C and 25 °C 24 hours duration, 95-100% RH, no voltage applied	
Final measurements				no visible damage, markings legible; leakage current (note 1) ≥stated limit, ΔC/C ≤5%, tan δ and Z ≤1.2 x stated limit
Damp heat, steady state	4.12	Ca	56 days at 40 °C, 90-95% RH, no voltage applied	no visible damage, markings legible; leakage current (note 1) ≤stated limit, tan δ and Z ≤1.2 x stated limit, ΔC/C ≤10% of initial measurement
Characteristics at high and low temperature	4.13		step 1: reference measurement of capacitance, tan δ and impedance at 20 °C, 100 Hz	reference values
			step 2: measurement at −55 °C of capacitance, tan δ and impedance at 100 Hz	ΔC/C ≤20% with respect to value measured in step 1, impedance ratio (100 Hz) ≤2 x value measured in step 1, tan δ ≤2 x stated limit
			step 3: measurement at 125 °C of leakage current, capacitance and tan δ	leakage current (note 2) ≤15 x stated limit, ΔC/C ≤20% of the value measured in step 1, tan δ ≤stated limit

NAME OF TEST	IEC (sec)604/ CECC (sec)2454 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Endurance	4.15		2000 hours at 125 °C, U_R applied	no visible damage, markings legible; leakage current ≤stated limit, $\Delta C/C \leq 15\%$, tan δ and Z ≤1.2 x the stated limit
Endurance (additional)			5000 hours at 85 °C, U_R applied	$\Delta C/C \leq 10\%$
Reverse voltage	4.16		0.15 U_R in reverse polarity at 125 °C for 125 hours, followed by U_R in forward polarity at 125 °C, 125 hours	leakage current ≤stated limit, $\Delta C/C \leq 10\%$, tan δ and Z ≤stated limit
Storage at high temperature	4.17	Ba	96 ±4 hours at 125 °C	no visible damage; leakage current (note 1) ≤stated limit, $\Delta C/C \leq 5\%$, tan δ and Z ≤stated limit
Long storage ≥1 year			at ambient temperature	leakage current (note 1) ≤stated limit

Notes

1. The 15 s value of leakage current measured after 5 minutes.
2. The 15 s value of leakage current measured after 1 minute.

PACKING - SURFACE MOUNTING DEVICES (SMD)

Electrolytic Capacitors

Packing - Surface Mounting Devices (SMD)

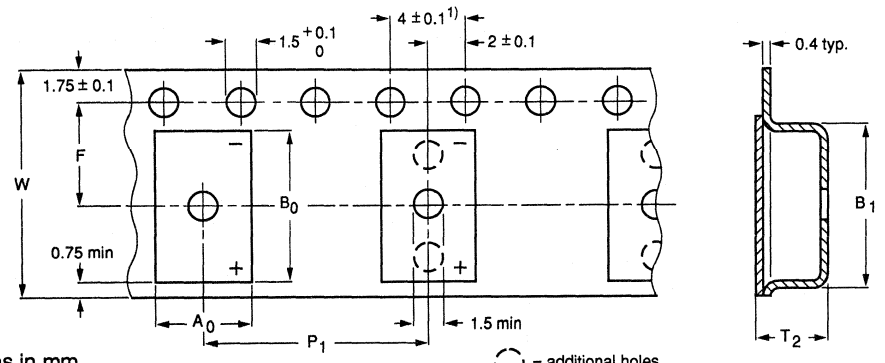
TAPING

The information contained within this part is valid for the following series:

- **CS 085**
- **CLL 139**
- **SAL-CPL 127**

For catalogue numbers, refer to the relevant detail specification.

Philips SMD solid and non-solid aluminium electrolytic capacitors are available in taped version corresponding to IEC 286-3. They are most suitable for use on automatic placement machines and are supplied in blister tape on reel (other versions are in magazine or bulk packing).



Dimensions in mm.

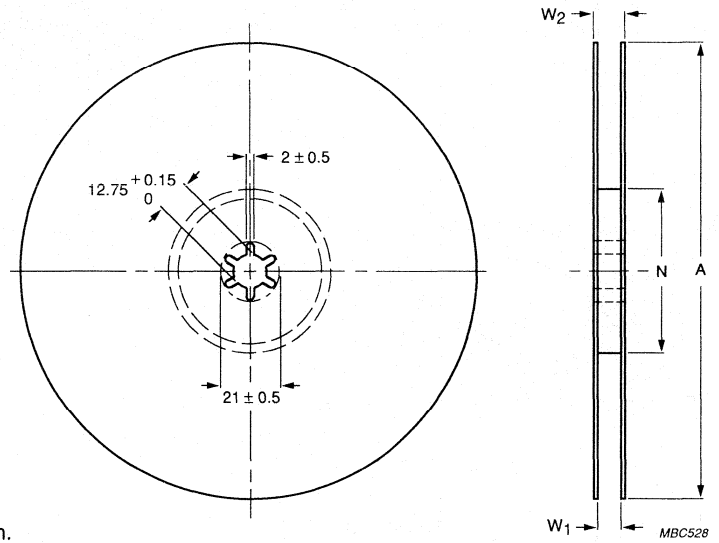
1) Tolerance over any 10 pitches: ±0.2 mm.

◯ = additional holes for CLL139 series only

Fig.1 Blister tape.

Table 1 Dimensions of blister tape (in mm)

PARAMETER	SERIES											TOLERANCE
	CS 085		CLL 139				SAL-CPL 127					
Case code	1a	1	1a	1	2	3	20	30	40	50	60	
Case size:												
L_{nom}	8.8	11.9	10.8	13.8	14.3	14.3	6.5	6.5	6.5	6.5	6.5	–
W_{nom}	3.7	3.7	4.1	4.1	6.2	7.6	4.4	5.5	5.5	7.5	7.5	–
H_{nom}	3.9	3.9	4.4	4.4	6.9	8.2	2.9	3.4	4.0	4.0	5.0	–
W	16	24	16	24	24	24	12	12	12	12	12	±0.3
T_2	4.9	4.9	5.6	5.6	7.7	9.1	3.8	4.2	4.5	4.5	5.8	max.
F	7.5	11.5	7.5	11.5	11.5	11.5	5.5	5.5	5.5	5.5	5.5	±0.1
P_1	8	8	8	8	12	12	8	8	8	12	12	±0.1
A_0	4.1	4.1	4.4	4.4	6.5	7.9	5.0	6.2	6.2	8.4	8.4	±0.2
B_0	9.3	12.5	11.3	14.3	14.8	14.8	8.0	8.0	8.0	8.0	8.0	±0.2
B_1	10	13.2	12	15	15.5	15.5	8.6	8.6	8.6	8.6	8.6	max.



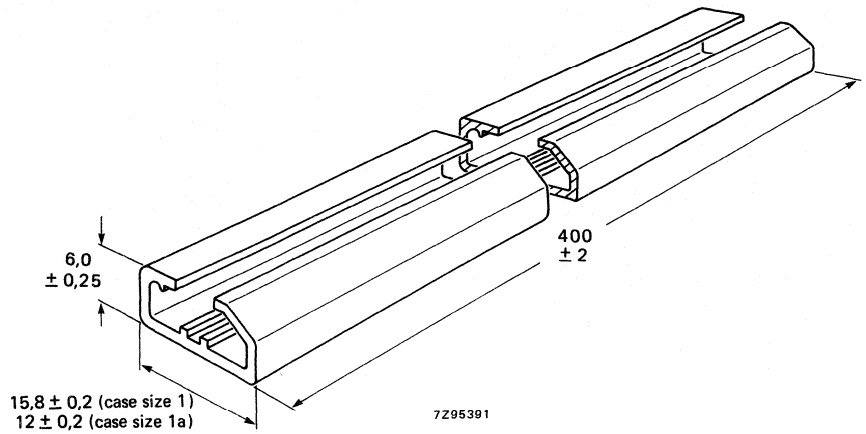
Dimensions in mm.

For other dimensions, see Table 2.

Fig.2 Reel for blister tape.

Table 2 Reel dimensions (in mm)

TAPE WIDTH	A	N	W_1	W_2
12	330	62 ±1.5	12.4 +2/–0	18.4 max.
16	330	62 ±1.5	16.4 +2/–0	22.4 max.
24	330	62 ±1.5	24.4 +2/–0	30.4 max.



Dimensions in mm.

Fig.3 Magazine (CS 085 only).

QUANTITIES per PACKING UNIT

Table 3 Number of capacitors per packing unit

CASE SIZE L_{nom} x W_{nom} x H_{nom}	CASE CODE	FORM SA bulk per box	FORM BR in blister tape per reel	FORM MA in magazine		
				per magazine	per inner box	per outer box
8.8 x 3.7 x 3.9	1a (CS 085)	–	2000	100	1000	5000
11.9 x 3.7 x 3.9	1 (CS 085)	–	2000	100	1000	5000
10.8 x 4.1 x 4.4	1a (CLL 139)	–	1500	–	–	–
13.8 x 4.1 x 4.4	1 (CLL 139)	–	1500	–	–	–
14.3 x 6.2 x 6.9	2 (CLL 139)	–	700	–	–	–
14.3 x 7.6 x 8.2	3 (CLL 139)	–	700	–	–	–
6.5 x 4.4 x 2.9	20	200	2500	–	–	–
6.5 x 5.5 x 3.4	30	200	2000	–	–	–
6.5 x 5.5 x 4	40	200	1500	–	–	–
6.5 x 7.5 x 4	50	200	1000	–	–	–
6.5 x 7.5 x 5	60	200	1000	–	–	–

PACKING - RADIAL LEADED DEVICES

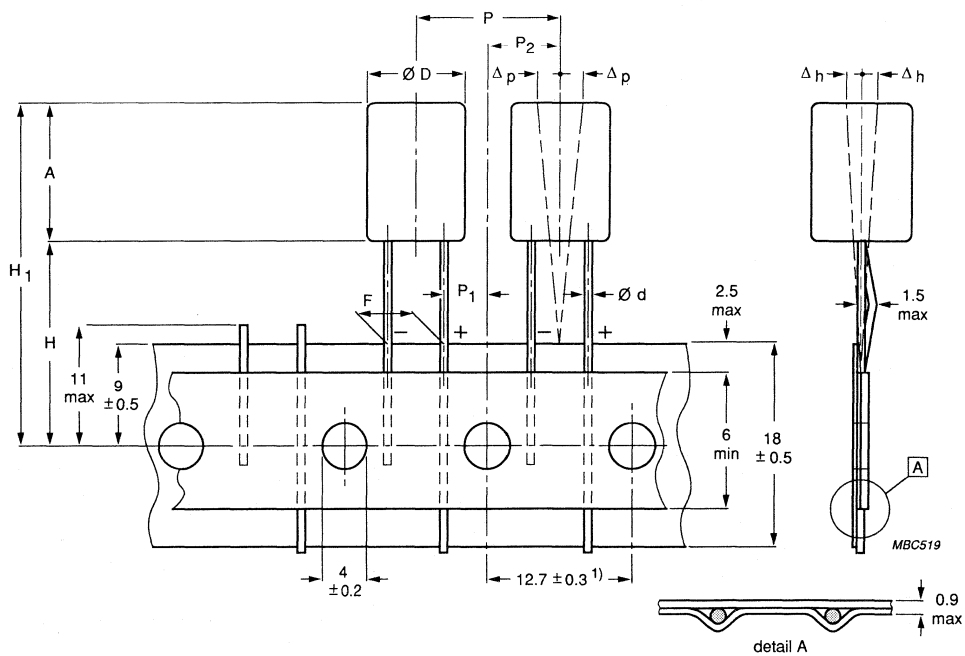
TAPING

Philips radial, solid and non-solid aluminium electrolytic capacitors in sizes up to ⌀ 16 mm, are available in taped version corresponding to IEC 286-2 or JIS C 0805. They are most suitable for use on automatic insertion machines, mounting robots or cutting and forming equipment and are supplied in box (ammopack preferred), or on reel.

For catalogue numbers, refer to the relevant detail specification.

The information contained within this part is valid for the following series:

- **RLC 013**
- **RSP 036**
- **RLL 116**



1) Tolerance over any 20 pitches: ±1.0 mm.

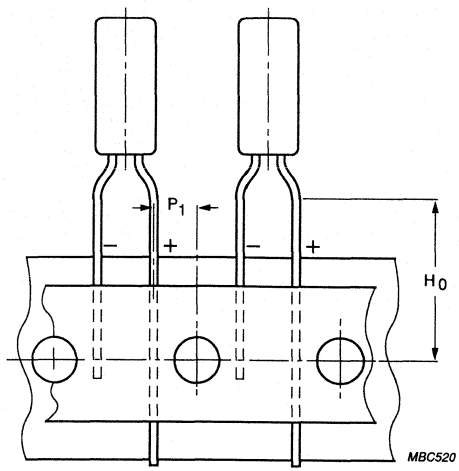
→ direction of tape transport for Form TR+ and TN+ (positive leading).

← direction of tape transport for Form TR- (negative leading).

Form TN+: 5 x 11: F = 2.5 mm.

Form TR+, TR– and **TFA:** 8.2 x 11: F = 5 mm.

Fig.1 Capacitors on tape, straight leads, case sizes 5 x 11 and 8.2 x 11.



→ direction of tape transport for Form TR+ (positive leading).
← direction of tape transport for Form TR- (negative leading).
Form TR+, TR– and **TFA:** 5 x 11: F = 5 mm.

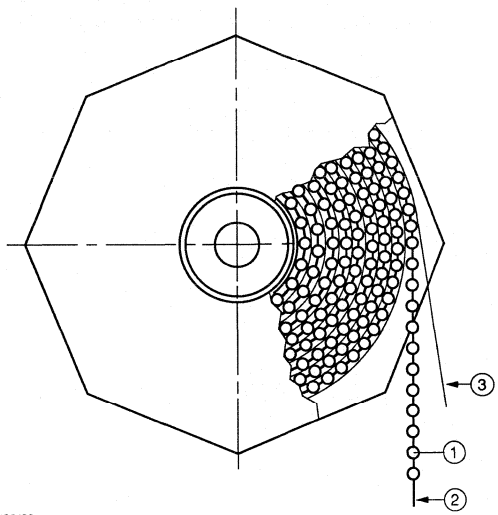
Fig.2 Capacitors on tape, formed leads, case size 5 x 11.

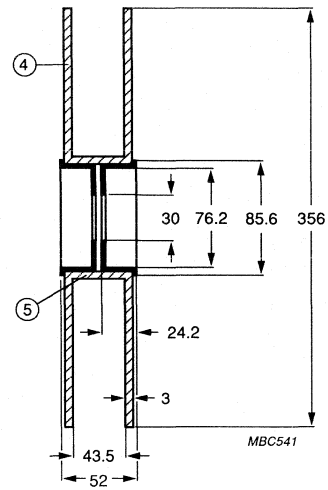
PARAMETER	Form TN+: F = 2.5 mm	Form TR+, TR– and TFA: F = 5 mm		TOLERANCE
Case size ($\varnothing D_{nom}$ x L_{nom})	5 x 11 (straight leads)	5 x 11 (formed leads)	8.2 x 11 (straight leads)	
∅ D	5.5	5.5	8.7	max.
A	12	12	12	max.
∅ d	0.5	0.5	0.6	±0.05
P	12.7	12.7	12.7	±1.0
P_1	5.1	3.85	3.85	±0.7
P_2	6.35	6.35	6.35	±0.7
F	2.5	5.0	5.0	+0.6/–0.1
Δh	0	0	0	±2.0
Δp	0	0	0	±1.3
H	18	18	18	+1.5/–0
H_0	–	16	–	±0.5
H_1	32	32	32	max.

QUANTITIES per PACKING UNIT

Table 1 Number of capacitors per packing unit

CASE SIZE ($\varnothing D_{nom} \times L_{nom}$)	CASE CODE	BULK per box			TAPED per reel			TAPED ammopack
		Form CA	Form CB	Form CC	Form TR+	Form TR-	Form TN+	Form TFA
5 x 11	11	1000	1000	1000	1000	1000	1000	2000
8.2 x 11	13	1000	1000	1000	500	500	500	1000

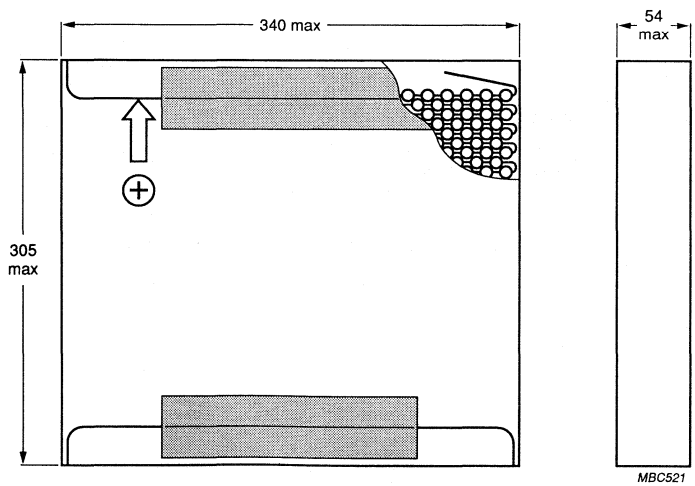




1 = capacitor
2 = tape
3 = paper
4 = flange
5 = cylinder.

Dimensions in mm.

Fig.3 Reel, Form TR+, TR– and TN+.



Dimensions in mm.
PREFERRED PACKING.

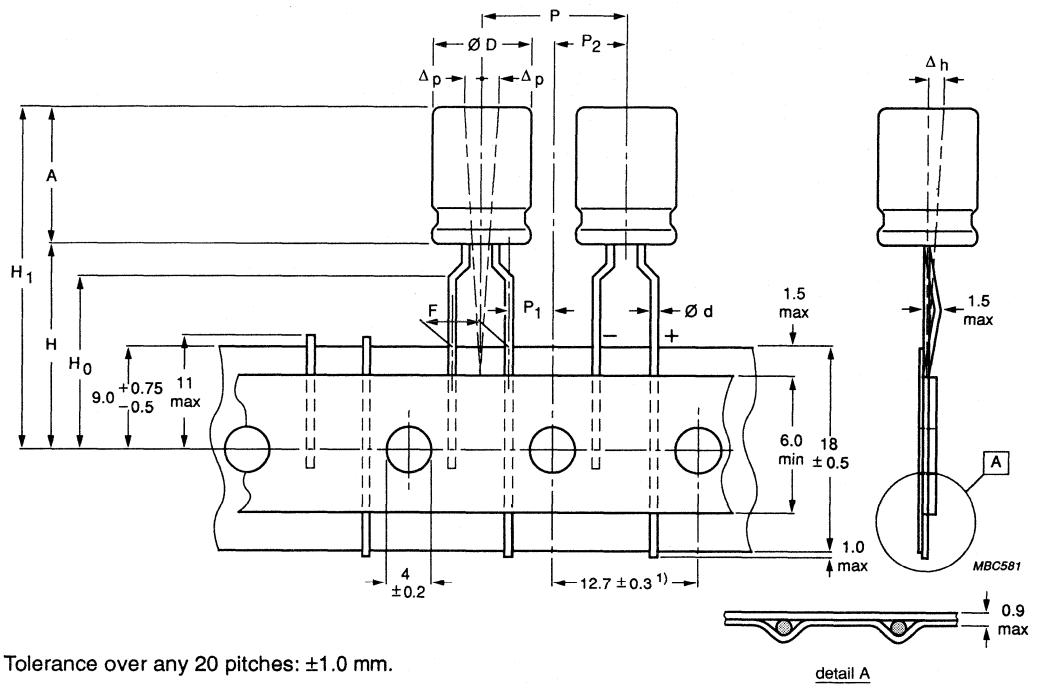
Fig.4 Ammopack, Form TFA.

The information contained within this part is valid for the following series:

- **RLP-5 134**
- **RLP-7 097**

For catalogue numbers, refer to the relevant detail specification.

2



1) Tolerance over any 20 pitches: ±1.0 mm.

→ direction of tape transport for Form TR+ (positive leading).

Fig.5 Capacitors on tape, capacitor height 5 or 7 mm.

Electrolytic Capacitors

Packing - Radial Electrolytic Capacitors

PARAMETER	Case size (∅ D_{nom} x L_{nom})									TOLERANCE
	3 x 5	3.5 x 5	4 x 5	5 x 5	6.3 x 5	4 x 7	5 x 7	6.3 x 7	7 x 7	
∅ D	3.5	4.0	4.5	5.5	6.8	4.5	5.5	6.8	7.5	max.
A	6.0	6.0	6.0	6.0	6.0	8.0	8.0	8.0	8.0	max.
∅ d	0.4	0.4	0.45	0.45	0.45	0.45	0.45	0.45	0.45	±0.05
P	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	±1.0
P_1	5.1	5.1	3.85	3.85	3.85	3.85	3.85	3.85	3.85	±0.7
P_2	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	±1.0
F	2.5	2.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0	+0.8/−0.2
Δh	0	0	0	0	0	0	0	0	0	±2.0
Δp	0	0	0	0	0	0	0	0	0	±1.3
H	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	±0.75
H_0	16	16	16	16	16	16	16	16	16	±0.5
H_1	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	max.

2

1 = capacitor
2 = tape
3 = paper
4 = reel box
5 = cylinder.

Dimensions in mm.

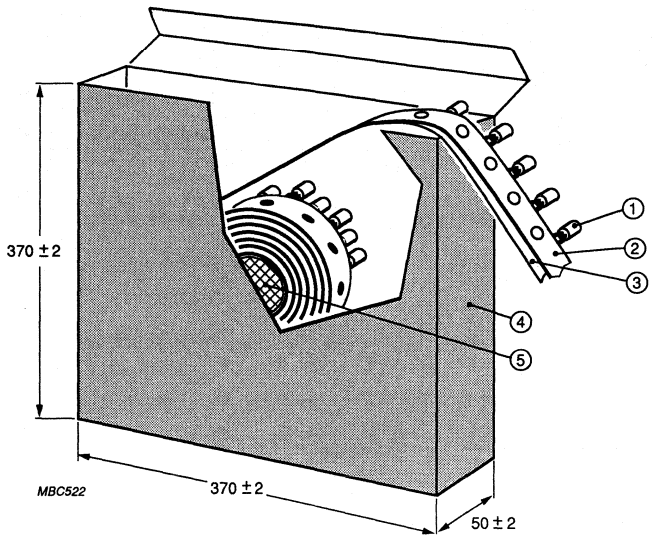
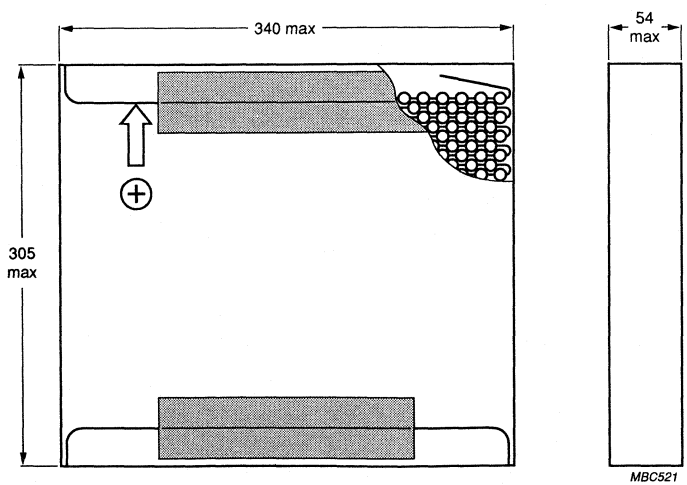


Fig.6 Reel packing box (RLP-7 097 only), Form TR+.



Dimensions in mm.

Fig.7 Ammopack (RLP-5 134 only), Form TFA.

QUANTITIES per PACKING UNIT

Table 2 Number of capacitors per packing unit

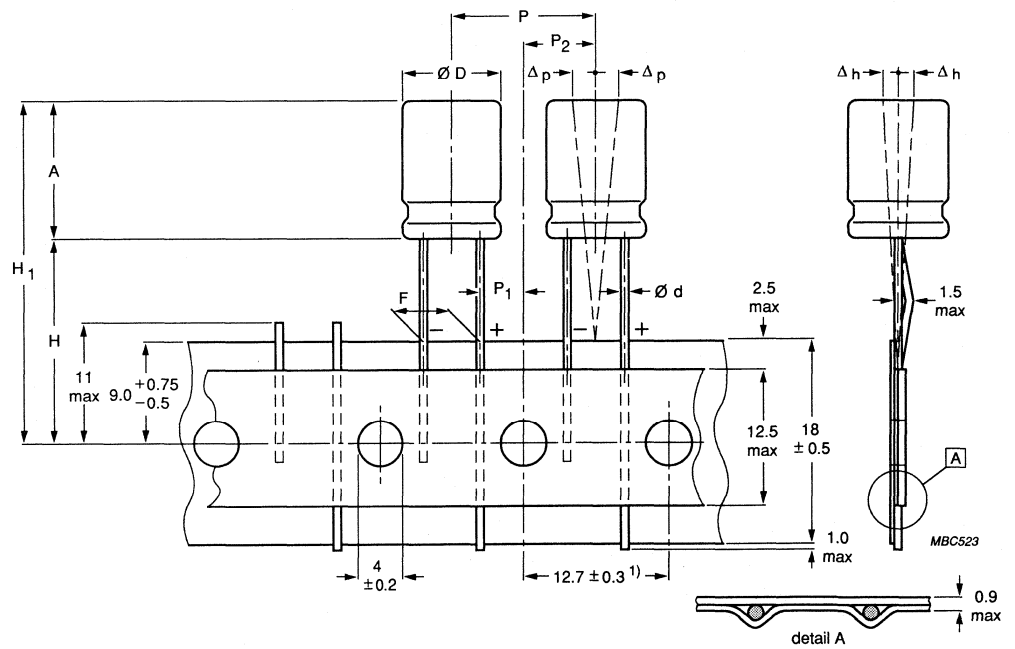
CASE SIZE ($\varnothing D_{nom} \times L_{nom}$)	CASE CODE	BULK per box		TAPED per reel	TAPED ammopack
		Form CA	Form CC	Form TR+	Form TFA
3 x 5	51	3000	4000	–	3000
3.5 x 5	52	3000	4000	–	3000
4 x 5	53	2000	3000	–	2000
5 x 5	54	2000	3000	–	2000
6.3 x 5	55	2000	2000	–	2000
4 x 7	71	2000	2000	1800	–
5 x 7	72	1000	1000	1500	–
6.3 x 7	73	1000	1000	1000	–
7 x 7	74	1000	1000	1000	–

The information contained in this part is valid for the following series:

- **RS 035**
- **RSM 037**
- **RSH 044**
- **RLI 135**

with a case diameter (∅D) of 5 to 8 mm.

For catalogue numbers, refer to the relevant detail specification.



1) Tolerance over any 20 pitches: ±1.0 mm.

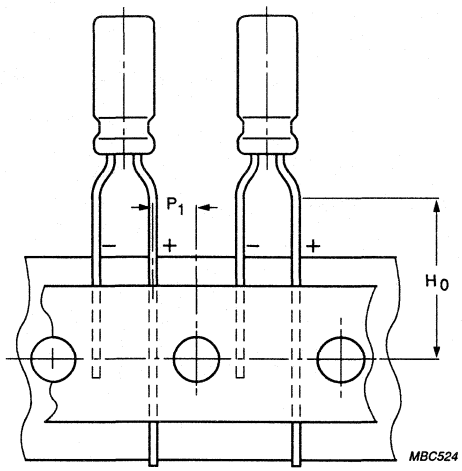
→ direction of tape transport for Form TN+ (positive leading).

Form TN+: 5 x 11: F = 2.5 mm (leads slightly bent)

6.3 x 11: F = 2.5 mm

8 x 12: F = 3.5 mm.

Fig.8 Capacitors on tape, straight leads, ∅ D = 5 to 8 mm.



→ direction of tape transport for Form TR+ (positive leading).

← direction of tape transport for Form TR- (negative leading).

Form TR+, TR– and **TFA:** F = 5 mm

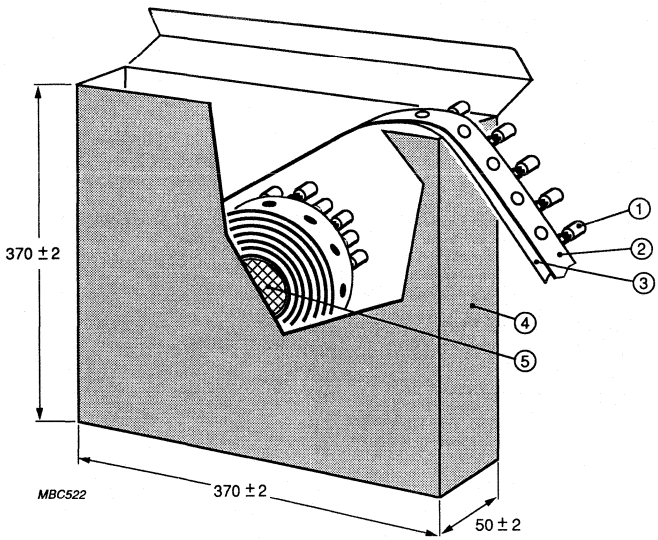
Fig.9 Capacitors on tape, formed leads, ∅ D = 5 to 8 mm.

PARAMETER	Case size (∅ D_{nom} x L_{nom})						TOLERANCE
	Form TN+			Form TR+, TR– and TFA			
	5 x 11	6.3 x 11	8 x 12	5 x 11	6.3 x 11	8 x 12	
∅ D	5.5	6.8	8.5	5.5	6.8	8.5	max.
A	12.5	12.5	13	12.5	12.5	13	max.
∅ d	0.5	0.6	0.6	0.5	0.6	0.6	±0.05
P	12.7	12.7	12.7	12.7	12.7	12.7	±1.0
P_1	5.1	5.1	4.6	3.85	3.85	3.85	±0.7
P_2	6.35	6.35	6.35	6.35	6.35	6.35	±1.0
F	2.5	2.5	3.5	5.0	5.0	5.0	+0.8/–0.2
Δh	0	0	0	0	0	0	±2.0
Δp	0	0	0	0	0	0	±1.3
H	18.5	18.5	20	18.5	18.5	20	±0.75
H_0	–	–	–	16	16	16	±0.5
H_1	32.2	32.2	32.2	32.2	32.2	32.2	max.

QUANTITIES per PACKING UNIT

Table 3 Number of capacitors per packing unit

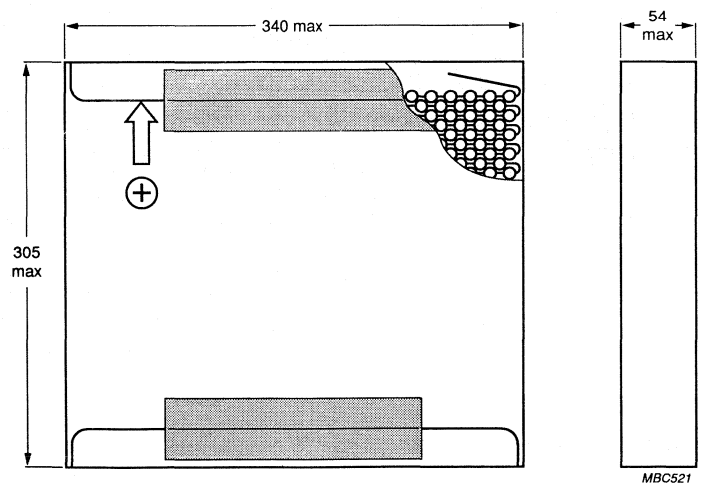
CASE SIZE ($\varnothing D_{nom} \times L_{nom}$)	CASE CODE	BULK per box			TAPED per reel			TAPED ammopack
		Form CA	Form CB	Form CC	Form TR+	Form TR–	Form TN+	Form TFA
5 x 11	11	1000	1000	1000	1000	1000	1000	2000
6.3 x 11	12	1000	1000	1000	1000	1000	1000	2000
8 x 11	13	1000	1000	1000	800	800	800	1000



1 = capacitor
2 = tape
3 = paper
4 = reel box
5 = cylinder.

Dimensions in mm.

Fig.10 Reel packing box, Form TR+, TR– and TN+.



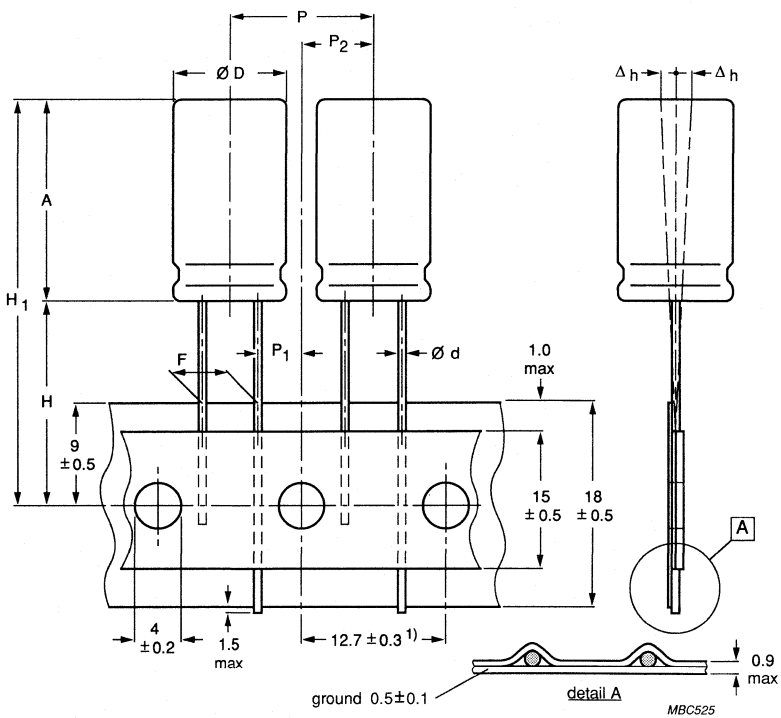
Dimensions in mm.
PREFERRED PACKING.

Fig.11 Ammopack, Form TFA.

The information contained within this part is valid for the following series:

- **RS 035**
- **RSM 037**
- **RSH 044**
- **RSS 045**
- **RSL 046**
- **RMS 047**
- **RML 048**
- **RSX 164**
- **RHT 165**

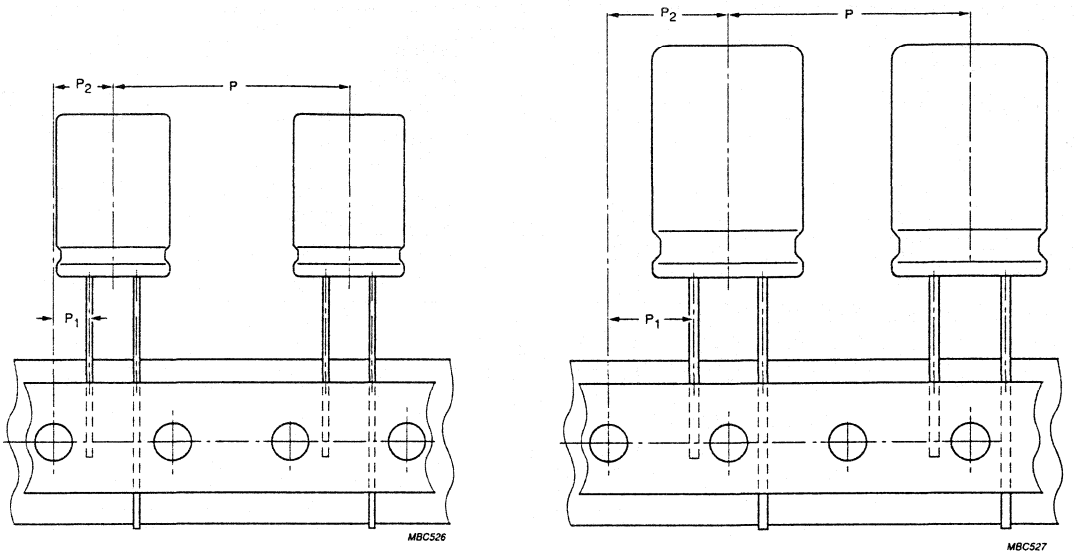
with a case diameter (∅D) of 10 to 16 mm.
For catalogue numbers, refer to the relevant detail specification.



1) Tolerance over any 20 pitches: ±1.0 mm.

→ direction of tape transport for Form TR+ (positive leading).

Fig.12 Capacitors on tape, ∅ D = 10 mm.



→ direction of tape transport for Form TR+ (positive leading).

Fig.13 Capacitors on tape, ∅ D = 12.5 and 16 mm.

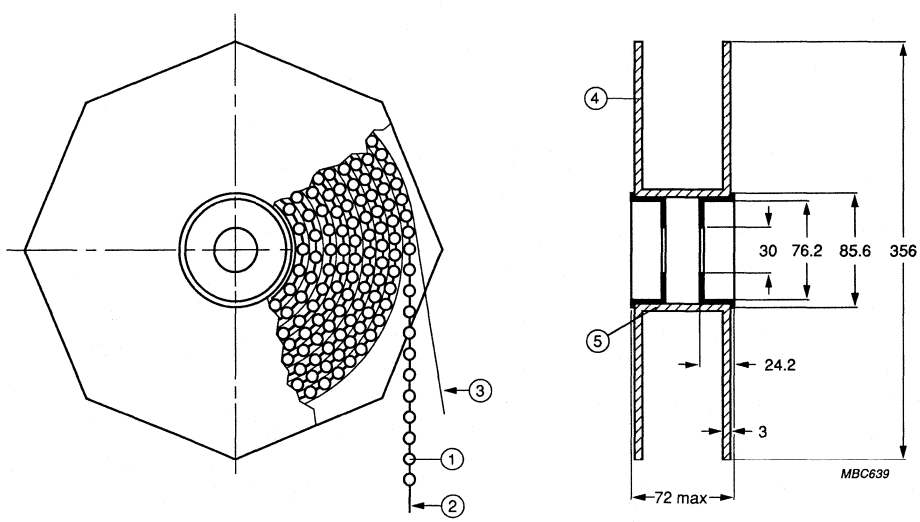
PARAMETER	Case size (∅ D_{nom} x L_{nom})							TOLERANCE
	10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31	
∅ D	10.5	10.5	10.5	13.0	13.0	16.5	16.5	max.
A	13.5	17.5	21.5	21.5	26.5	27	33.5	max.
∅ d	0.6	0.6	0.6	0.6	0.6	0.8	0.8	±0.05
P	12.7	12.7	12.7	25.4	25.4	25.4	25.4	±1.0
P_1	3.85	3.85	3.85	3.85	3.85	8.95	8.95	±0.7
P_2	6.35	6.35	6.35	6.35	6.35	12.7	12.7	±1.3
F	5.0	5.0	5.0	5.0	5.0	7.5	7.5	±0.8
Δh	0	0	0	0	0	0	0	±3.0
H	16.5	16.5	16.5	16.5	16.5	16.5	16.5	±0.5
H_1	30.5	34.5	38.5	38.5	43.5	44.0	50.5	max.

2

QUANTITIES per PACKING UNIT

Table 4 Number of capacitors per packing unit

CASE SIZE ($\varnothing D_{nom} \times L_{nom}$)	CASE CODE	BULK per box		TAPED per reel
		Form CA	Form CB	Form TR+
10 x 12	14	1000	1000	500
10 x 16	15	500	500	500
10 x 20	16	500	500	500
12.5 x 20	17	200	200	200
12.5 x 25	18	200	200	200
16 x 25	19	200	200	150
16 x 31	20	200	200	150
16 x 35	21	150	150	–
18 x 35	22	100	100	–
18 x 40	23	100	100	–



1 = capacitor
2 = tape
3 = paper
4 = flange
5 = cylinder.

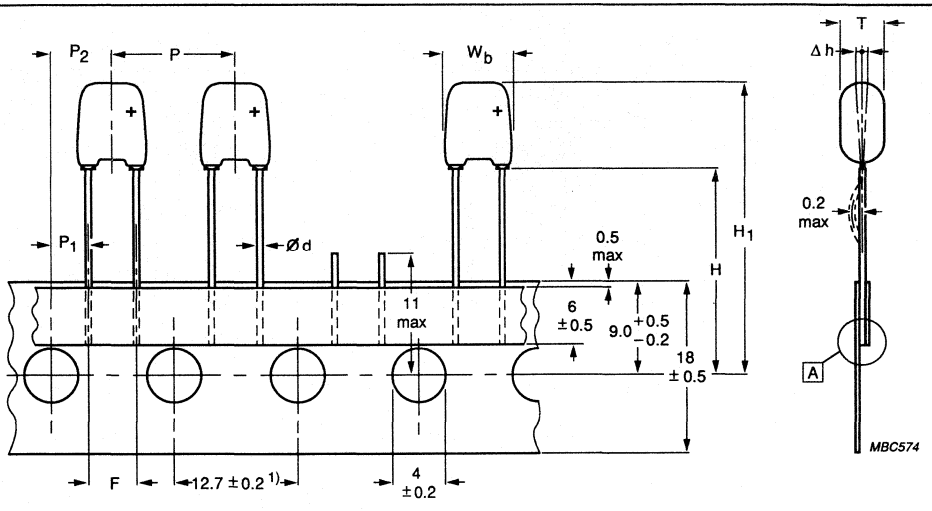
Dimensions in mm.

Fig.14 Reel, Form TR+.

The information contained within this part is valid for the following series:

- **SAL-RP 122**
- **SAL-RPM 128**
- **SAL-RDC 129**

For catalogue numbers, refer to the relevant detail specification.



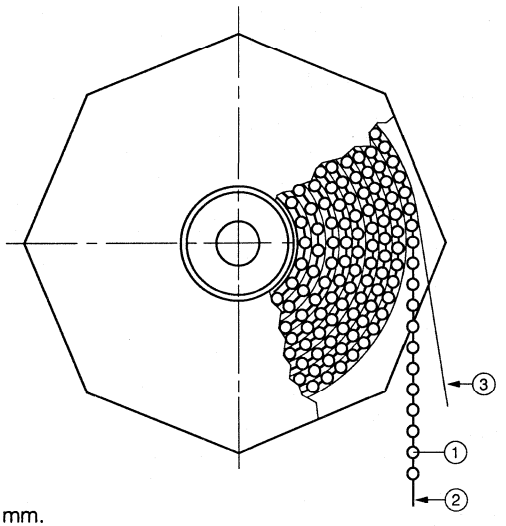
1) Tolerance over any 20 pitches: ±1.0 mm.

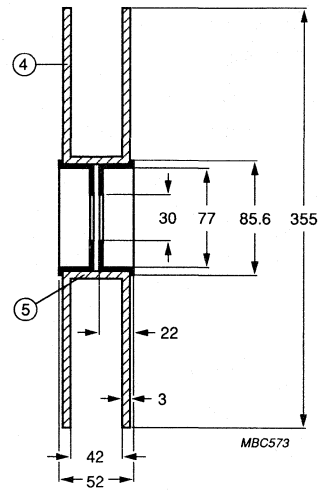
→ direction of tape transport for Form TR+ (positive leading).

Fig.15 Capacitors on tape, max. capacitor height 9.5 or 12.5 mm.

Table 5 Tape dimensions in mm

PARAMETER	SAL-RP 122 max. height 12.5 mm				SAL-RPM 128 and SAL-RDC 129 max. height 9.5 mm						TOLERANCE
CASE CODE	1	2	3	4	10	20	30	40	50	60	
T	3.5	4.5	5.0	6.0	3.0	3.5	4.0	5.0	5.0	6.0	max.
W_b	8.0	8.0	8.0	8.0	7.0	7.0	7.0	7.0	8.0	8.0	max.
Ø d	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	+0.02/−0
P	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	±1.0
P_1	3.85	3.85	3.85	3.85	3.85	3.85	3.85	3.85	3.85	3.85	±0.7
P_2	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	±1.0
F	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	±0.2
Δh	0	0	0	0	0	0	0	0	0	0	±1.0
H	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	±0.75
H_1	32	32	32	32	28	28	28	28	28	28	max.

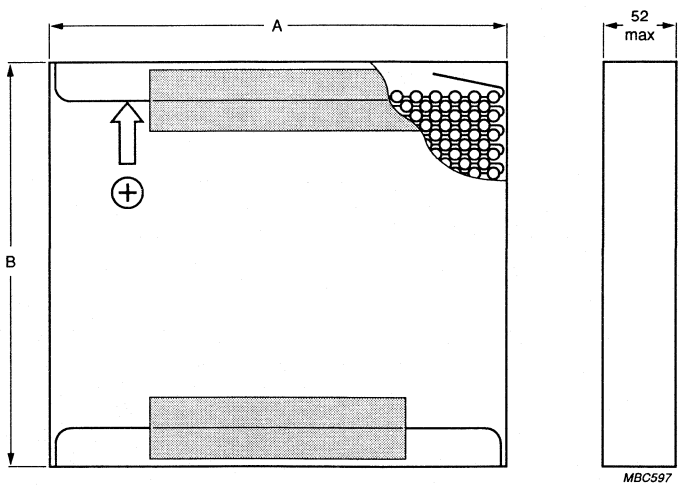




1 = capacitor
2 = tape
3 = paper
4 = flange
5 = cylinder.

Dimensions in mm.

Fig.16 Reel, Form TR+.



Dimensions in mm.

PREFERRED PACKING.

Fig.17 Ammopack, Form TFA.

Table 6 Ammopack dimensions in mm

PARAMETER	SAL-RP 122	SAL-RPM 128	A_{max}	B_{max}
Case code	1 and 2	10, 20 and 30	340	266
Case code	3 and 4	40, 50 and 60	340	176

QUANTITIES per PACKING UNIT

Table 7 Number of capacitors per packing unit

CASE SIZE H_{max} x W_{max} x T_{max}	CASE CODE	BULK per box		TAPED per reel	TAPED per box
		Form CA	Form CB	Form TR+	Form TFA
12.5 x 8.0 x 3.5	1	1000	1000	2000	2000
12.5 x 8.0 x 4.5	2	1000	1000	2000	2000
12.5 x 8.0 x 5.0	3	1000	1000	1000	1000
12.5 x 8.0 x 6.0	4	800	1000	1000	1000
9.5 x 7.0 x 3.0	10	1000	1000	2000	2000
9.5 x 7.0 x 3.5	20	1000	1000	2000	2000
9.5 x 7.0 x 4.0	30	1000	1000	2000	2000
9.5 x 7.0 x 5.0	40	1000	1000	1000	1000
9.5 x 8.0 x 5.0	50	1000	1000	1000	1000
9.5 x 8.0 x 6.0	60	1000	1000	1000	1000

Electrolytic Capacitors

Notes

PACKING - AXIAL LEADED DEVICES

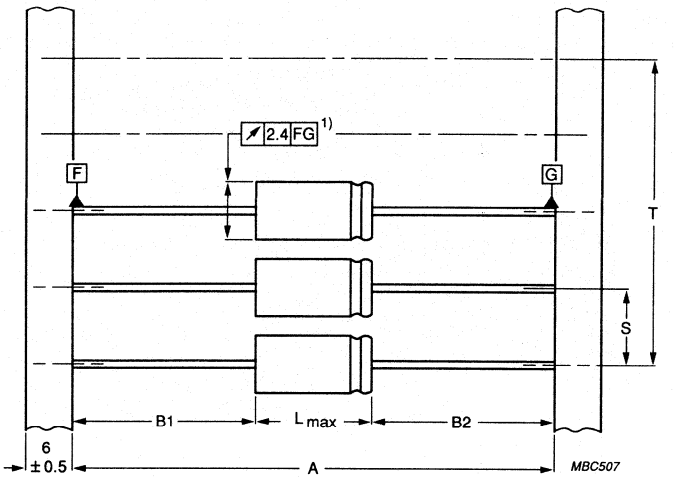
TAPING

Philips axial, solid and non-solid aluminium electrolytic capacitors in sizes up to ∅15 mm, are available in taped version corresponding to IEC 286-1.

They are most suitable for use on automatic insertion machines, cutting and forming equipment and are supplied in box (ammopack preferred), or on reel. For catalogue numbers, refer to the relevant detail specification.

Table 1 Taping dimensions

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	A (mm)	S (mm)	T for number (n)		L_{max} (mm)	C (mm)	D (mm)
				n<50	50<n<100			
Non-solid types								
3.3 x 8	1a	63.5 ±1.5	5 ±0.4	5(n-1) ±2	5(n-1) ±4	9	83.5	94.5
3.3 x 11	1	63.5 ±1.5	5 ±0.4	5(n-1) ±2	5(n-1) ±4	12	83.5	94.5
4.5 x 10	2	63.5 ±1.5	5 ±0.4	5(n-1) ±2	5(n-1) ±4	10.5	83.5	94.5
6 x 10	3	63.5 ±1.5	10 ±0.4	10(n-1) ±2	10(n-1) ±4	10.5	83.5	94.5
6.3 x 12.7	(2)	63.5 ±1.5	10 ±0.4	10(n-1) ±2	10(n-1) ±4	12.9	83.5	94.5
7.7 x 12.7	(3)	63.5 ±1.5	10 ±0.4	10(n-1) ±2	10(n-1) ±4	12.9	83.5	94.5
8 x 11	5a	63.5 ±1.5	10 ±0.4	10(n-1) ±2	10(n-1) ±4	11.5	83.5	94.5
6.5 x 18	4	73 ±1.6	10 ±0.4	10(n-1) ±2	10(n-1) ±4	18.5	88.5	99.5
6.5 x 25	4L	73 ±1.6	10 ±0.4	10(n-1) ±2	10(n-1) ±4	25	88.5	99.5
8 x 18	5	73 ±1.6	10 ±0.4	10(n-1) ±2	10(n-1) ±4	18.5	88.5	99.5
10 x 18	6	73 ±1.6	15 ±0.75	15(n-1) ±2	15(n-1) ±4	18.5	88.5	99.5
10 x 25	7	73 ±1.6	15 ±0.75	15(n-1) ±2	15(n-1) ±4	25.0	88.5	99.5
10 x 30	00	73 ±1.6	15 ±0.75	15(n-1) ±2	15(n-1) ±4	30.5	90	100
12.5 x 30	01	73 ±1.6	15 ±0.75	15(n-1) ±2	15(n-1) ±4	30.5	90	100
15 x 30	02	73 ±1.6	20 ±0.75	20(n-1) ±2	20(n-1) ±4	30.5	90	100
Solid types								
6.5 x 15	1	73 ±1.6	10 ±0.4	10(n-1) ±2	10(n-1) ±4	15.3	90	100
7.5 x 20	2A	73 ±1.6	10 ±0.4	10(n-1) ±2	10(n-1) ±4	20.4	90	100
9 x 22.5	4	73 ±1.6	10 ±0.4	10(n-1) ±2	10(n-1) ±4	23.3	90	100
10 x 31.5	5	73 ±1.6	15 ±0.75	15(n-1) ±2	15(n-1) ±4	32	90	100
12.5 x 31.5	6	73 ±1.6	15 ±0.75	15(n-1) ±2	15(n-1) ±4	32	90	100



Dimensions in mm.

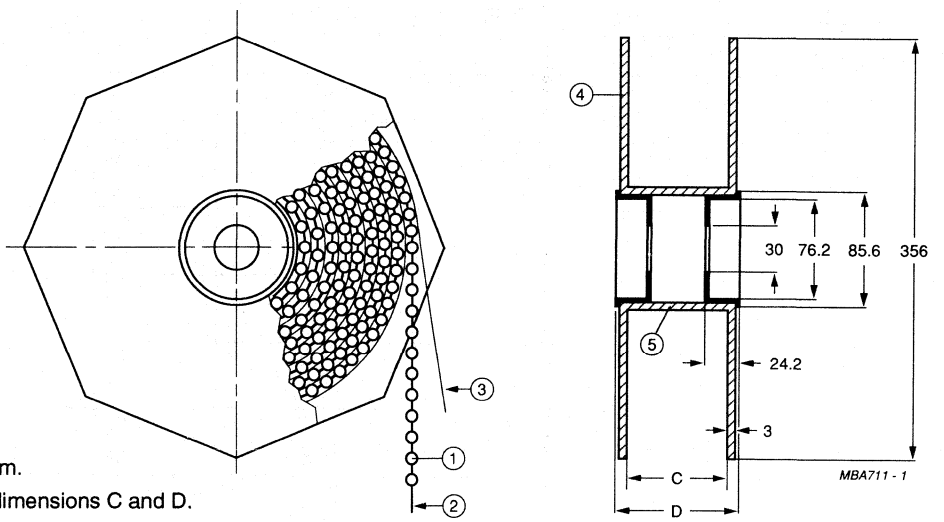
B1 – B2 = max. 1.4 mm.

The negative capacitor terminals are connected to the blue tape.

1) not for case size 15 x 30.

See Table 1 for dimensions A,S,T and L.

Fig.1 Axial capacitors on tape, case sizes 3.3 x 8 to 15 x 30 mm.

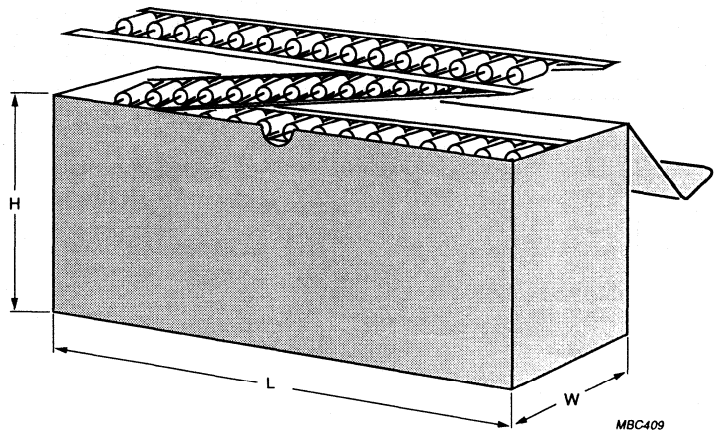


1 = capacitor
2 = tape
3 = paper
4 = flange
5 = cylinder.

Dimensions in mm.

See Table 1 for dimensions C and D.

Fig.2 Reel dimensions, case sizes 3.3 x 8 to 15 x 30 mm.



PREFERRED PACKING.

For dimensions L, W and H see Table 2.

Fig.3 Ammopack, case sizes 3.3 x 8 to 10 x 25 mm.

Table 2 Nominal outer dimensions of ammopack

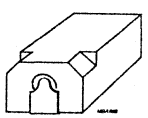
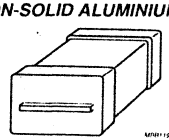
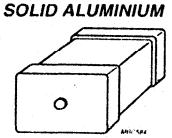
CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	L (mm)	W (mm)	H (mm)
Non-solid types				
3.3 x 8	1a	282	92	64
3.3 x 11	1	282	92	64
4.5 x 10	2	282	92	116
6 x 10	3	415	92	107
6.3 x 12.7	(2)	415	92	107
7.7 x 12.7	(3)	415	92	107
8 x 11	5a	415	92	107
6.5 x 18	4	415	98	127
6.5 x 25	4L	415	98	127
8 x 18	5	415	98	127
10 x 18	6	415	98	159
10 x 25	7	415	98	159

QUANTITIES per PACKING UNIT

Table 3 Number of capacitors per packing unit

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	AXIAL			SINGLE ENDED, Mounting Ring (bulk) Form MR
		TAPED IN AMMOPACK Form BA	TAPED ON REEL Form BR	BULK or PAPERSTRIP Form AA	
Non-solid types					
3.3 x 8	1a	1000	4000	–	–
3.3 x 11	1	1000	4000	–	–
4.5 x 10	2	1000	3000	–	–
6 x 10	3	1000	1000	–	–
6.3 x 12.7	(2)	1000	1000	–	–
7.7 x 12.7	(3)	500	500	–	–
8 x 11	5a	500	500	–	–
6.5 x 18	4	1000	1000	–	–
6.5 x 25	4L	1000	1000	–	–
8 x 18	5	500	500	–	–
10 x 18	6	500	500	–	–
10 x 25	7	500	500	–	–
10 x 30	00	–	500	200	–
12.5 x 30	01	–	400	200	–
15 x 30	02	–	250	200	200
18 x 30	03	–	–	200	200
18 x 40	04	–	–	100	100
21 x 40	05	–	–	100	100
Solid types					
6.5 x 15	1	–	800	100	–
7.5 x 20	2A	–	800	100	–
9 x 22.5	4	–	500	100	–
10 x 31.5	5	–	500	100	–
12.5 x 31.5	6	–	400	100	–

SMD ELECTROLYTIC CAPACITORS ('CHIPS')

	STANDARD	*INDUSTRIAL*	*PROFESSIONAL*
 ***NON-SOLID ALUMINIUM***	**CS 085** 1500 hours 85 °C *Page 92*	**CLL 139** 2000 hours 105 °C *Page 106*	
 ***SOLID ALUMINIUM***		**SAL- CPL 127** 7000 hours 125 °C *Page 120*	
 ***SOLID TANTALUM***	**49 MC** *Page 138*	*Page 150* **49 UC** **49 XC** *Page 158*	*Page 174* **49 BC** **49 SC** *Page 166*

Non-solid Al - electrolytic capacitors SMD (Chip) Standard

CS 085

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid, self healing
- SMD-version, rectangular case, insulated
- Miniaturized, high CV per unit volume, low height
- Flexible terminals, reflow and wave solderable
- Supplied in magazine or blister tape on reel
- Charge and discharge proof.

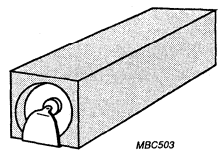


Fig.1 Component outline.

3

APPLICATIONS

- SMD technology, boards with restricted mounting height
- General applications, consumer electronics, low profile and lightweight equipment
- Decoupling, smoothing, filtering and buffering.

QUICK REFERENCE DATA

Nominal case sizes (L x W x H in mm)	8.8 x 3.7 x 3.9 and 11.9 x 3.7 x 3.9
Rated capacitance range, C_R	0.1 to 22 µF
Tolerance on C_R	–10 to +50% or ±20%
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	–40 to +85 °C
Endurance test at 85 °C	1000 hours
Useful life at 85 °C	1500 hours
Useful life at 40 °C, 1.4 I_R applied	40 000 hours
Shelf life at 0 V, 85 °C	500 hours
Resistance to soldering heat test	immersion in solder: 10 s at 260 °C or 20 s at 215 °C
Basic specification	IEC 384-4/CECC 30 300 GP grade
Detail specification	DIN 41332 type II
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (**L x W x H** in **mm**)

C_R (µF)	U_R (V)					
	6.3	**10**	**16**	**25**	**40**	**63**
0.1						8.8 x 3.7 x 3.9
0.22						8.8 x 3.7 x 3.9
0.47						8.8 x 3.7 x 3.9
1.0						8.8 x 3.7 x 3.9
1.5						8.8 x 3.7 x 3.9
2.2					8.8 x 3.7 x 3.9	11.9 x 3.7 x 3.9
3.3				8.8 x 3.7 x 3.9		11.9 x 3.7 x 3.9
4.7			8.8 x 3.7 x 3.9		11.9 x 3.7 x 3.9	
6.8		8.8 x 3.7 x 3.9		11.9 x 3.7 x 3.9		
10	8.8 x 3.7 x 3.9		11.9 x 3.7 x 3.9			
15		11.9 x 3.7 x 3.9				
22	11.9 x 3.7 x 3.9					

Non-solid Al - electrolytic capacitors SMD (Chip) Standard

CS 085

MECHANICAL DATA

Dimensions in mm

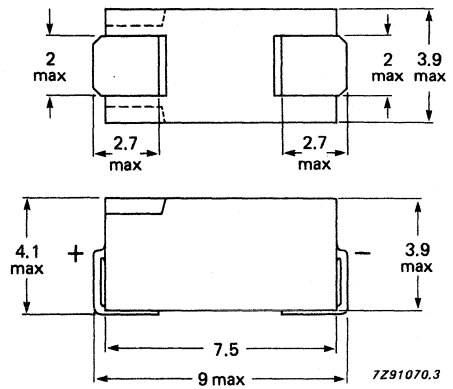


Fig.2 Case size 8.8 x 3.7 x 3.9.

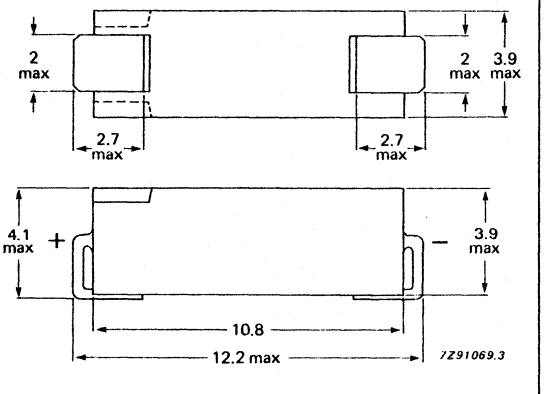


Fig.3 Case size 11.9 x 3.7 x 3.9.

PACKING QUANTITIES

- Magazine packing: 100 per magazine, 1000 per inner box, 5000 per outer box
- Tape on reel packing: 2000 per reel.

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Rated voltage code (see Table 2), the U_R code letter indicates the position of the decimal point in the capacitance value
- Name of manufacturer (PHILIPS)
- "–" sign indicating the cathode (bevelled edges identify the anode).

Examples for C_{nom} - U_R marking:

H22 represents 0.22 µF - 63 V
2G2 represents 2.2 µF - 40 V
22C represents 22 µF - 6.3 V

Table 2 Rated voltage marking code

U_R (V)	6.3	10	16	25	40	63
code letter	C	D	E	F	G	H

MOUNTING

The capacitors are designed for automatic placement on printed-circuit boards or hybrid circuits.

Optimum dimensions of soldering pads depend upon soldering method, mounting accuracy, print lay-out and/or adjacent components.

For recommended dimensions, refer to Fig. 4 and Table 3.

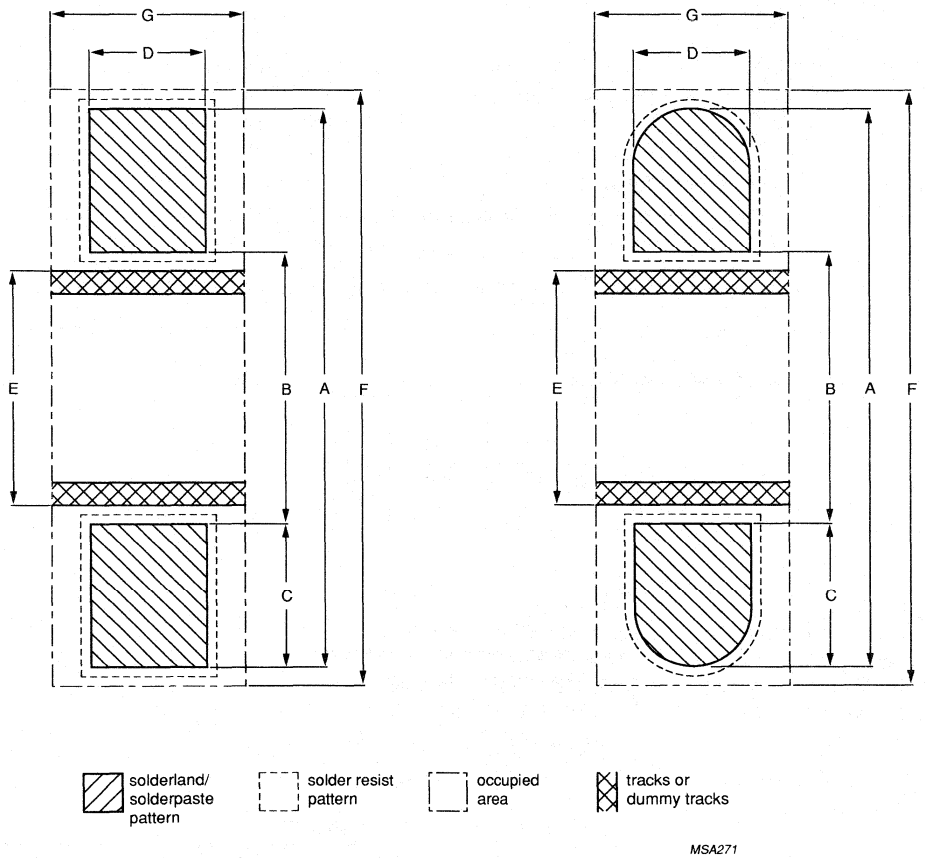
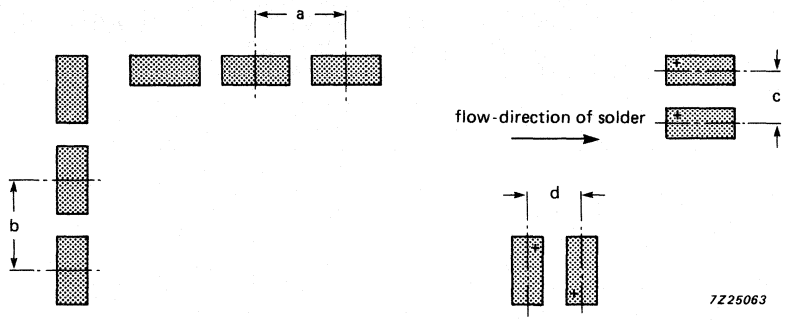


Fig.4 Recommended pad dimensions for reflow and wave soldering.

Table 3 Recommended soldering pad dimensions in mm. (placement accuracy ±0.25 mm)

CASE SIZE	FOR REFLOW SOLDERING							FOR WAVE SOLDERING						
	A	B	C	D	E	F	G	A	B	C	D	E	F	G
8.8 x 3.7 x 3.9	9.7	3.5	2.9	2.5	3.0	10.1	4.4	13.5	4.1	4.7	3.7	2.9	14.0	8.4
11.9 x 3.7 x 3.9	12.9	6.5	2.9	2.5	6.0	13.3	4.4	16.8	7.4	4.7	3.7	6.1	17.3	8.4



For dimensions a,b,c and d, refer to Table 4.

Flow direction of solder preferably onto side-walls or plus-side of the capacitors.

Fig.5 Minimum distances between CS 085 capacitors on a printed circuit board for wave soldering.

Table 4 Minimum distances between capacitors

Case size	a min.	b min.	c min.	d min.
8.8 x 3.7 x 3.9	12	12	6.8	6.8
11.9 x 3.7 x 3.9	15	15	6.8	6.8

Soldering

Soldering conditions are defined by the curve, temperature versus time. The temperature is that measured on the soldering pad during processing.

For maximum conditions of different soldering methods see Figs 6, 7 and 8.
Any temperature /time curve may be applied which does not exceed the specified maximum curves.

After soldering under maximum conditions, some drift of the electrical parameters may occur. Typical behaviour which can be expected under these circumstances is shown in Fig. 9.

Note:

AS A GENERAL PRINCIPLE, TEMPERATURE AND DURATION SHALL BE THE MINIMUM NECESSARY REQUIRED TO ENSURE GOOD SOLDERING CONNECTIONS.

Table 5 Curing conditions for SMD-glue

MAX. T_{amb} (°C)	MAX. EXPOSURE TIME (minutes)
125	10
140	3
150	1
160	0.5

Maximum temperature load

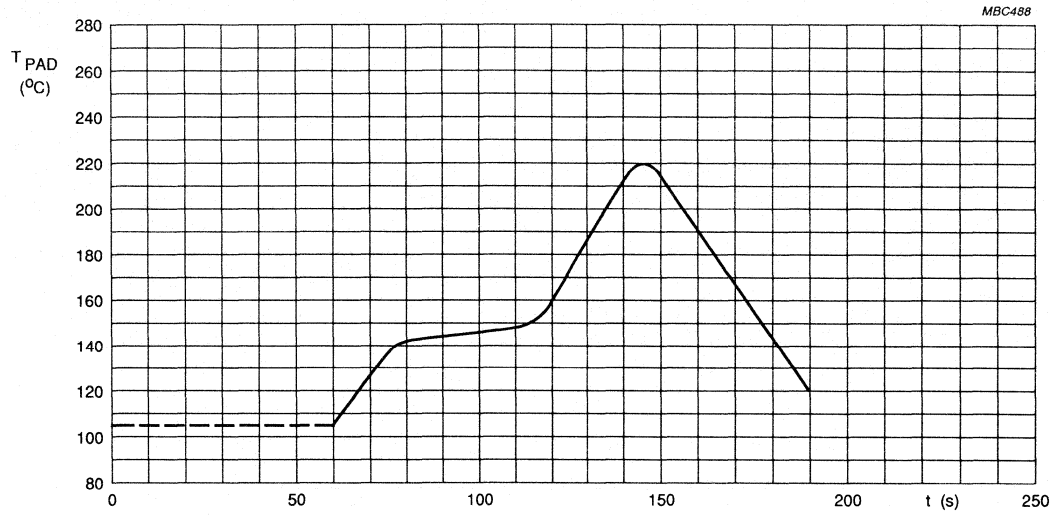


Fig.6 Maximum temperature load during infrared reflow soldering.

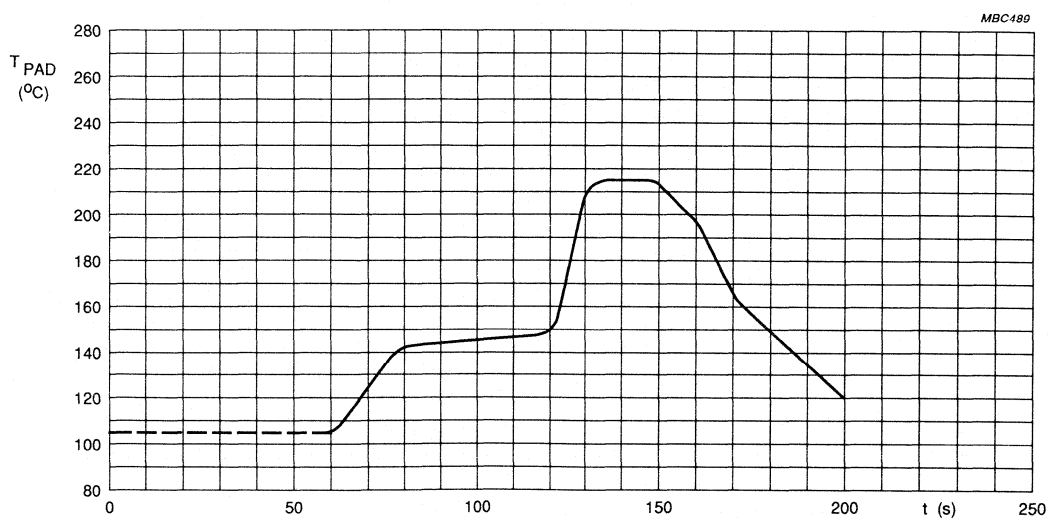


Fig.7 Maximum temperature load during vapour phase reflow soldering.

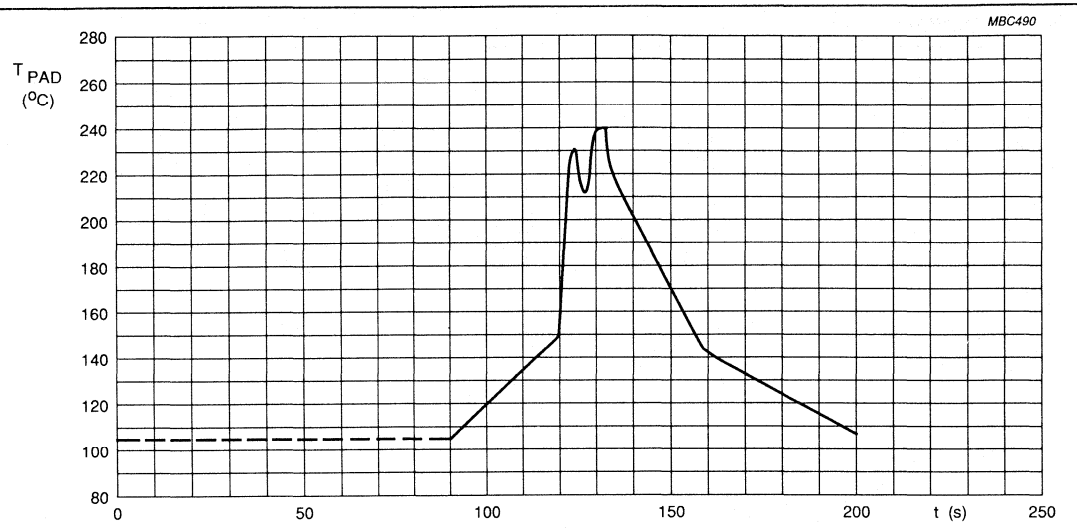


Fig.8 Maximum temperature load during (double-) wave soldering.

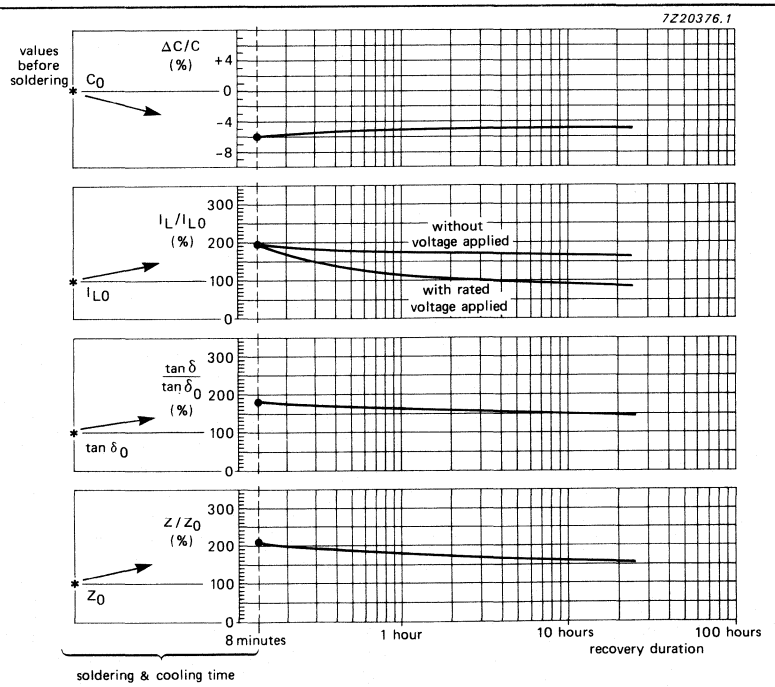
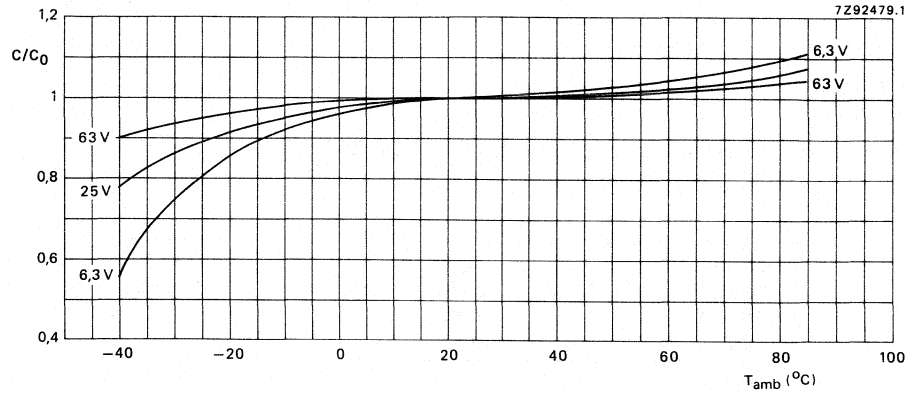


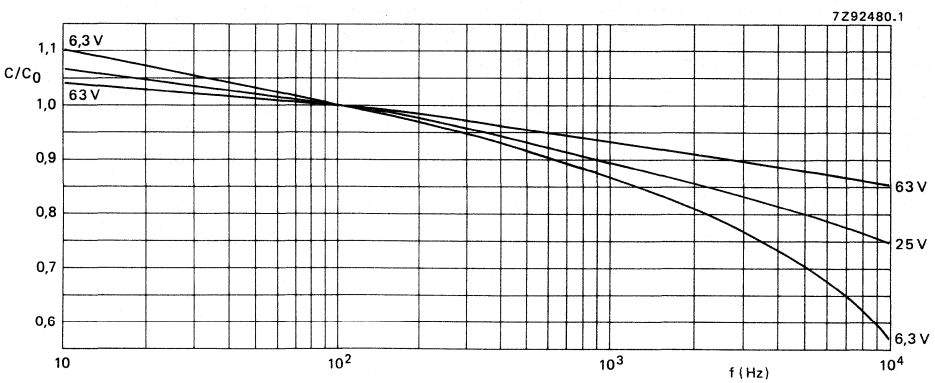
Fig.9 Typical drift of electrical parameters after soldering under maximum conditions, and subsequent recovery.

Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

Fig.10 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz.

Fig.11 Multiplier of capacitance (C/C_0) as a function of frequency.

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 6 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance −10 to +50% or ±20%

I_R = rated RMS ripple current at 100 Hz, 85 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz.

3

Table 6 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE L x W x H (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
6.3	10	8.8 x 3.7 x 3.9	1a	11	4	3.1	0.30	48	20
	22	11.9 x 3.7 x 3.9	1	20	6	3.3	0.30	22	9
10	6.8	8.8 x 3.7 x 3.9	1a	10	4	3.1	0.25	59	24
	15	11.9 x 3.7 x 3.9	1	18	6	3.3	0.25	27	11
16	4.7	8.8 x 3.7 x 3.9	1a	9	5	3.2	0.20	68	26
	10	11.9 x 3.7 x 3.9	1	16	6	3.3	0.20	32	12
25	3.3	8.8 x 3.7 x 3.9	1a	8	5	3.2	0.18	87	27
	6.8	11.9 x 3.7 x 3.9	1	14	6	3.3	0.18	42	13
40	2.2	8.8 x 3.7 x 3.9	1a	7	5	3.2	0.16	120	32
	4.7	11.9 x 3.7 x 3.9	1	13	7	3.4	0.16	54	15
63	0.1	8.8 x 3.7 x 3.9	1a	2	4	3.0	0.10	1600	550
	0.22	8.8 x 3.7 x 3.9	1a	3	4	3.0	0.10	720	250
	0.47	8.8 x 3.7 x 3.9	1a	4	4	3.1	0.10	340	120
	1.0	8.8 x 3.7 x 3.9	1a	6	4	3.1	0.12	190	55
	1.5	8.8 x 3.7 x 3.9	1a	7	5	3.2	0.14	150	37
	2.2	11.9 x 3.7 x 3.9	1	11	6	3.3	0.14	87	25
	3.3	11.9 x 3.7 x 3.9	1	13	7	3.4	0.14	68	17

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor CS 085
10 µF/16 V, –10/+50%
Case size 11.9 x 3.7 x 3.9; Form BR
Catalogue number: 2222 085 25109.

Table 7 Ordering information

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE L x W x H (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				–10/+50%		±20%	
				BLISTER TAPE ON REEL Form BR	MAGAZINE IN BOX Form MA	BLISTER TAPE ON REEL Form BR	MAGAZINE IN BOX Form MA
6.3	10	8.8 x 3.7 x 3.9	1a	085 23109	085 33109	085 63109	085 73109
	22	11.9 x 3.7 x 3.9	1	085 23229	085 33229	085 63229	085 73229
10	6.8	8.8 x 3.7 x 3.9	1a	085 24688	085 34688	085 64688	085 74688
	15	11.9 x 3.7 x 3.9	1	085 24159	085 34159	085 64159	085 74159
16	4.7	8.8 x 3.7 x 3.9	1a	085 25478	085 35478	085 65478	085 75478
	10	11.9 x 3.7 x 3.9	1	085 25109	085 35109	085 65109	085 75109
25	3.3	8.8 x 3.7 x 3.9	1a	085 26338	085 36338	085 66338	085 76338
	6.8	11.9 x 3.7 x 3.9	1	085 26688	085 36688	085 66688	085 76688
40	2.2	8.8 x 3.7 x 3.9	1a	085 27228	085 37228	085 67228	085 77228
	4.7	11.9 x 3.7 x 3.9	1	085 27478	085 37478	085 67478	085 77478
63	0.1	8.8 x 3.7 x 3.9	1a	085 28107	085 38107	085 68107	085 78107
	0.22	8.8 x 3.7 x 3.9	1a	085 28227	085 38227	085 68227	085 78227
	0.47	8.8 x 3.7 x 3.9	1a	085 28477	085 38477	085 68477	085 78477
	1.0	8.8 x 3.7 x 3.9	1a	085 28108	085 38108	085 68108	085 78108
	1.5	8.8 x 3.7 x 3.9	1a	085 28158	085 38158	085 68158	085 78158
	2.2	11.9 x 3.7 x 3.9	1	085 28228	085 38228	085 68228	085 78228
	3.3	11.9 x 3.7 x 3.9	1	085 28338	085 38338	085 68338	085 78338

Voltage

Surge voltage for short periods $U_s \leq 1.15 \times U_R$

Reverse voltage for short periods $U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R $I_{L1} \leq 0.02\ C_{nom} \times U_R + 3$ µA

After 5 minutes at U_R $I_{L5} \leq 0.002\ C_{nom} \times U_R + 3$ µA

Dissipation factor (tan δ)

Curve 1: 6.3 V
Curve 2: 10 V
Curve 3: 16 V
Curve 4: 25 V
Curve 5: 40 V
Curve 6: 63 V, 1.5 to 3.3 µF
Curve 7: 63 V, 1 µF
Curve 8: 63 V, 0.22 to 0.47 µF
Curve 9: 0.1 µF.

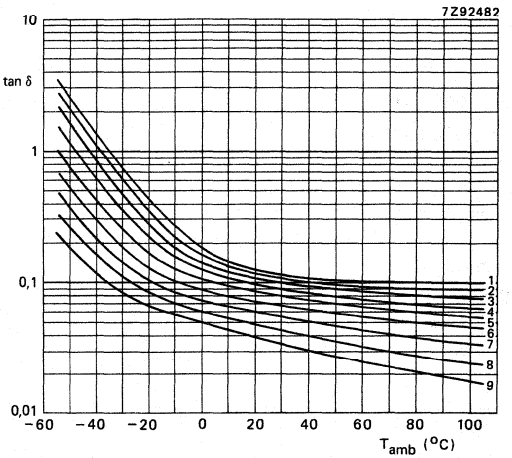


Fig.12 Typical tan δ as a function of ambient temperature at 100 Hz.

Curve 1: 6.3 V
Curve 2: 10 V
Curve 3: 16 V
Curve 4: 25 V
Curve 5: 40 V
Curve 6: 63 V, 1.5 to 3.3 µF
Curve 7: 63 V, 1 µF
Curve 8: 63 V, 0.22 to 0.47 µF
Curve 9: 0.1 µF.

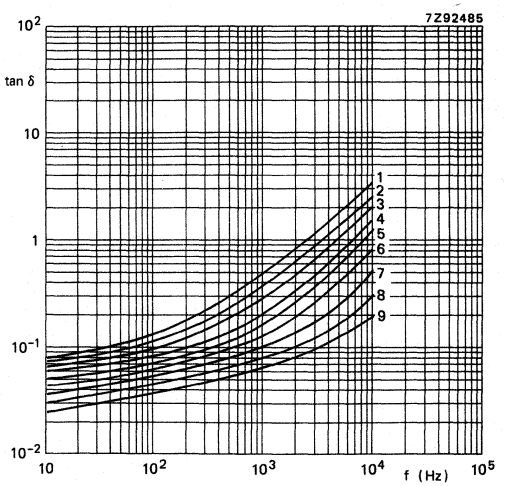


Fig.13 Typical tan δ as a function of frequency at 20 °C.

Equivalent series inductance (ESL)

case size 8.8 x 3.7 x 3.9	typ. 11 nH
case size 11.9 x 3.7 x 3.9	typ. 13 nH

Impedance (Z)

Curve 1: 0.1 µF
Curve 2: 0.22 µF
Curve 3: 0.47 µF
Curve 4: 1 µF
Curve 5: 2.2 µF
Curve 6: 4.7 µF
Curve 7: 10 µF.

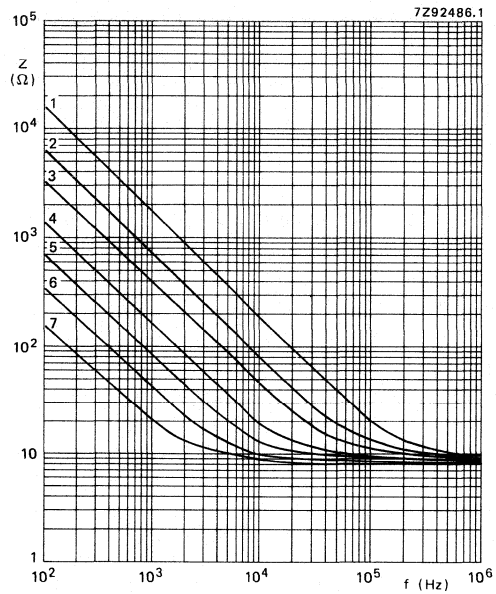


Fig.14 Typical impedance as a function of frequency at 20 °C; case size 8.8 x 3.7 x 3.9.

Curve 1: 2.2 µF
Curve 2: 3.3 µF
Curve 3: 4.7 µF
Curve 4: 6.8 µF
Curve 5: 10 µF
Curve 6: 15 µF
Curve 7: 22 µF.

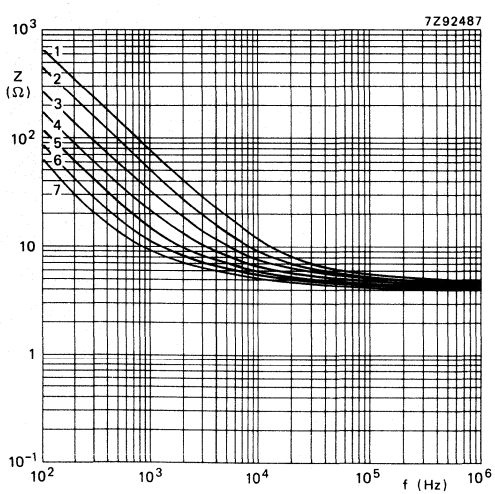
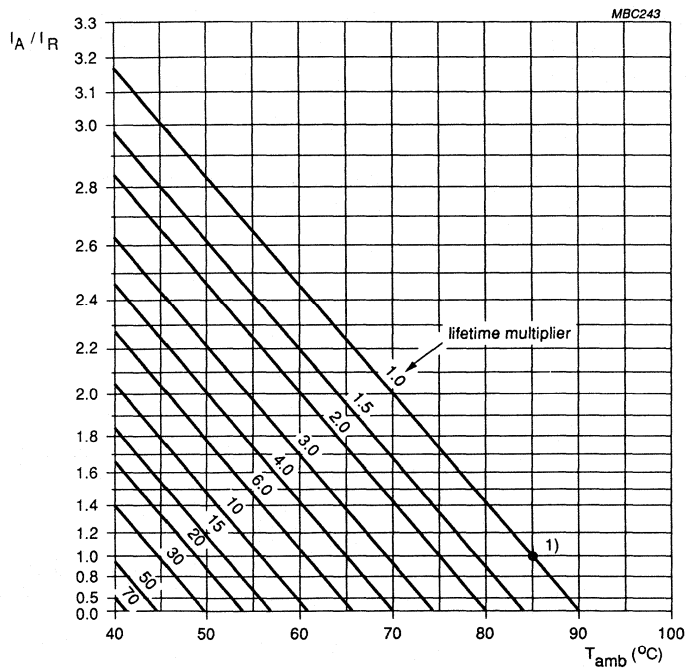


Fig.15 Typical impedance as a function of frequency at 20 °C; case size 11.9 x 3.7 x 3.9.

RIPPLE CURRENT and USEFUL LIFE

Table 8 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 85 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 16 V	U_R = 25 to 40 V	U_R = 63 V
50	0.8	0.75	0.7
100	1.0	1.0	1.0
300	1.2	1.3	1.55
1000	1.35	1.55	1.9
3000	1.45	1.7	2.3
≥10 000	1.5	1.8	2.5



I_A = actual ripple current at 100 Hz

I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied: 1500 hours.

Fig.16 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 9

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Mounting	IEC 384-1, sub clause 4.33	shall be performed prior to tests mentioned below. method: reflow or (double-) wave soldering for maximum temperature load see chapter MOUNTING.	 $\Delta C/C$ ±10% tan $\delta \leq$spec. limit I_{L5} ≤2 x spec. limit.
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied 1000 hours	$\Delta C/C$ ±20% tan $\delta \leq 2$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 1500 hours	$\Delta C/C$ ±50% tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

Non-solid Al - electrolytic capacitor SMD (Chip) Long Life

CLL 139

FEATURES

- Polarized Aluminium electrolytic capacitors, non-solid electrolyte, self healing
- Extended voltage and capacitance range
- SMD-version, fully moulded, insulated
- Flexible terminals, reflow and wave solderable
- Compact, rectangular shape
- Charge and discharge proof, no peak current limitation.

APPLICATIONS

- SMD technology
- Industrial and professional applications
- Telecommunications, automotive, EDP general industrial
- Coupling, decoupling, smoothing, filtering, buffering, timing.

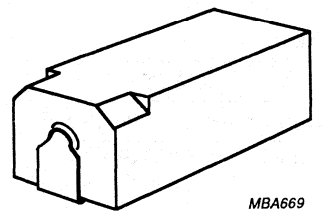


Fig.1 Component outline.

QUICK REFERENCE DATA

Nominal case sizes (L x W x H in mm)	10.8 x 4.1 x 4.4 and 13.8 x 4.1 x 4.4	14.3 x 6.2 x 6.9 and 14.3 x 7.6 x 8.2
Rated capacitance range, C_R	0.22 to 220 uF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	6.3 to 100 V	
Category temperature range	–40 to +105 °C	–55 to +105 °C
Endurance test at 105 °C	1000 hours	
Useful life at 105 °C	2000 hours	
Useful life at 40 °C; 1.3 x I_R applied	200 000 hours	
Shelf life at 0 V, 105 °C	500 hours	
Resistance to soldering heat test	immersion in solder: 10 s at 260 °C or 40 s at 215 °C	
Basic specifications	IEC 384-4/CECC 30 300	
Detail specification	similar to DIN 41316	
Climatic category IEC 68 DIN 40040	40/105/56 GMF	55/105/56 FMF

Non-solid Al - electrolytic capacitor SMD (Chip) Long Life

CLL 139

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (**L x W x H** in **mm**).

C_R (µF)	U_R (V)								
	6.3	**10**	**16**	**25**	**40**	**50**	**63**		**100**
0.22							10.8 x 4.1 x 4.4	14.3 x 6.2 x 6.9	14.3 x 6.2 x 6.9
0.47							10.8 x 4.1 x 4.4	14.3 x 6.2 x 6.9	14.3 x 6.2 x 6.9
1							10.8 x 4.1 x 4.4	14.3 x 6.2 x 6.9	14.3 x 6.2 x 6.9
1.5						10.8 x 4.1 x 4.4	13.8 x 4.1 x 4.4	14.3 x 6.2 x 6.9	
2.2					10.8 x 4.1 x 4.4		13.8 x 4.1 x 4.4	14.3 x 6.2 x 6.9	14.3 x 6.2 x 6.9
3.3				10.8 x 4.1 x 4.4		13.8 x 4.1 x 4.4	14.3 x 6.2 x 6.9		14.3 x 7.6 x 8.2
4.7			10.8 x 4.1 x 4.4		13.8 x 4.1 x 4.4		14.3 x 6.2 x 6.9		14.3 x 7.6 x 8.2
6.8		10.8 x 4.1 x 4.4		13.8 x 4.1 x 4.4		14.3 x 6.2 x 6.9	14.3 x 7.6 x 8.2		
10	10.8 x 4.1 x 4.4		13.8 x 4.1 x 4.4	14.3 x 6.2 x 6.9		14.3 x 6.2 x 6.9	14.3 x 7.6 x 8.2		
15		13.8 x 4.1 x 4.4			14.3 x 6.2 x 6.9	14.3 x 7.6 x 8.2			
22	13.8 x 4.1 x 4.4		14.3 x 6.2 x 6.9	14.3 x 6.2 x 6.9		14.3 x 7.6 x 8.2			
33		14.3 x 6.2 x 6.9		14.3 x 6.2 x 6.9	14.3 x 7.6 x 8.2				
47	14.3 x 6.2 x 6.9		14.3 x 6.2 x 6.9	14.3 x 7.6 x 8.2					
68		14.3 x 6.2 x 6.9							
100	14.3 x 6.2 x 6.9		14.3 x 7.6 x 8.2						
150		14.3 x 7.6 x 8.2							
220	14.3 x 7.6 x 8.2								

Non-solid Al - electrolytic capacitor SMD (Chip) Long Life

CLL 139

MECHANICAL DATA

Dimensions in mm.

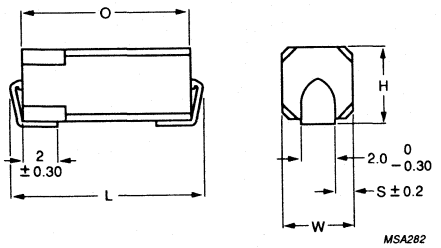


Fig.2 Case sizes 10.8 x 4.1 x 4.4 and 13.8 x 4.1 x 4.4.

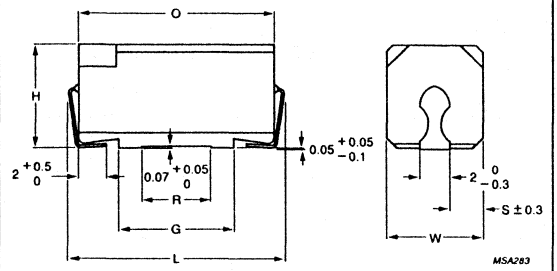


Fig.3 Case sizes 14.3 x 6.2 x 6.9 and 14.3 x 7.6 x 8.2.

Table 2 Dimensions in mm; mass in g

CASE SIZE	CASE CODE	$L_{max.}$	$W_{max.}$	$H_{max.}$	$O_{max.}$	S	$G_{max.}$	$R_{min.}$	MASS	PACKING QUANTITIES per reel
10.8 x 4.1 x 4.4	1a	11.0	4.2	4.5	9.6	1.10	–	–	0.3	1500
13.8 x 4.1 x 4.4	1	14.0	4.2	4.5	12.6	1.10	–	–	0.65	1500
14.3 x 6.2 x 6.9	2	14.5	6.3	7.05	13.0	2.15	7.5	4.7	0.95	700
14.3 x 7.6 x 8.2	3	14.5	7.7	8.35	13.0	2.85	7.5	4.7	1.3	700

MARKING

Case sizes 14.3 x 6.2 x 6.9 and 14.3 x 7.6 x 8.2 mm

- Rated capacitance (in µF)
- Rated voltage (in V)
- Series number (139)
- Name of manufacturer (PHILIPS)
- Date code (year and month) in accordance with IEC 62
- "-" sign indicating the cathode

(bevelled edges identify the anode).

Case sizes 10.8 x 4.1 x 4.4 and 13.8 x 4.1 x 4.4 mm

- Rated capacitance (in µF)
- Rated voltage code (see Table 3), the U_R code letter indicates the position of the decimal point in the capacitance value
- Name of manufacturer (PHILIPS)
- Date code (year and month) in accordance with IEC 62
- "-" sign indicating the cathode

(bevelled edges identify the anode).

EXAMPLES FOR C_R - U_R MARKING:

H22 represents 0.22 µF - 63 V
2G2 represents 2.2 µF - 40 V
22C represents 22 µF - 6.3 V

Table 3 Rated voltage marking code

U_R (V)	6.3	10	16	25	40	50	63	100
code letter	C	D	E	F	G	A	H	I

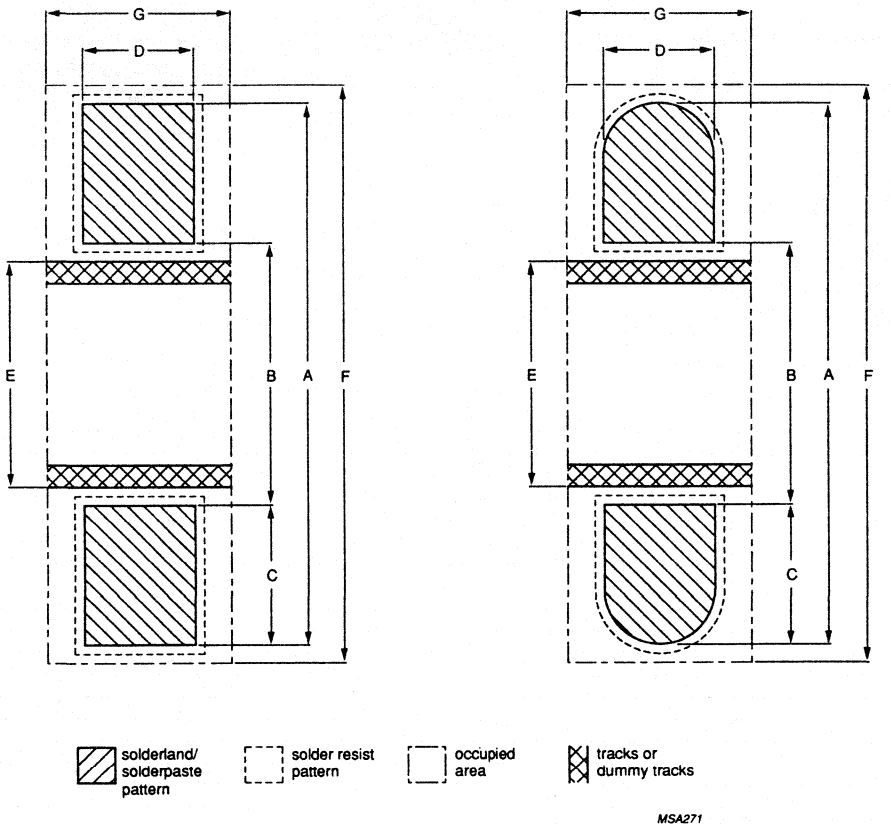


Fig.4 Recommended pad dimensions for reflow and wave soldering.

Table 4 Recommended soldering pad dimensions in mm. (placement accuracy ±0.25 mm)

CASE SIZE	FOR REFLOW SOLDERING							FOR WAVE SOLDERING						
	A	B	C	D	E	F	G	A	B	C	D	E	F	G
10.8 x 4.1 x 4.4	11.8	4.8	3.5	2.5	4.0	12.2	5.3	14.5	6.5	4.0	3.5	5.3	15.0	8.5
13.8 x 4.1 x 4.4	14.8	7.8	3.5	2.5	7.0	15.2	5.3	17.5	9.5	4.0	3.5	8.3	18.0	8.5
14.3 x 6.2 x 6.9	15.8	8.8	3.5	2.8	8.0	16.2	7.7	18.6	10.0	4.3	5.0	8.8	20.5	11.5
14.3 x 7.6 x 8.2	15.8	8.8	3.5	2.8	8.0	16.2	9.1	18.6	10.0	4.3	6.0	8.8	21.5	13.0

MOUNTING

The capacitors are designed for automatic placement on to printed-circuit boards or hybrid circuits.

Optimum dimensions of soldering pads depend amongst others on soldering method, mounting accuracy, print lay-out and/or adjacent components.

For recommended dimensions, refer to Fig. 4 and Table 4.

Soldering

Soldering conditions are defined by the curve temperature versus time, at which the temperature is that measured on the soldering pad during processing.

For maximum conditions of different soldering methods see Figs 5, 6 and 7.
Any temperature vs. time curve may be applied which does not exceed the specified maximum curves.

Maximum temperature load

Table 5 Curing conditions for SMD-glue

MAX. T_{amb} (°C)	MAX. EXPOSURE TIME (minutes)
125	30
140	10
150	5
160	2

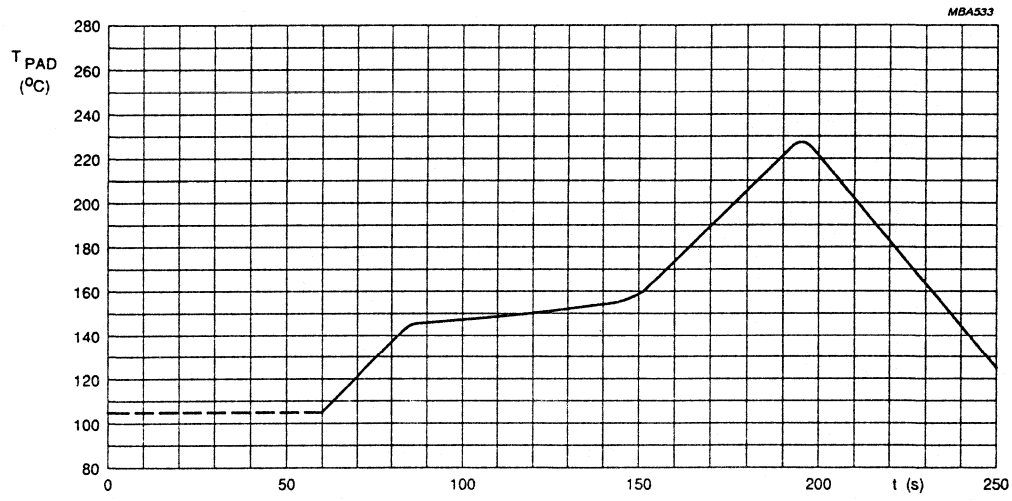


Fig.5 Max. temperature load during infrared reflow soldering.

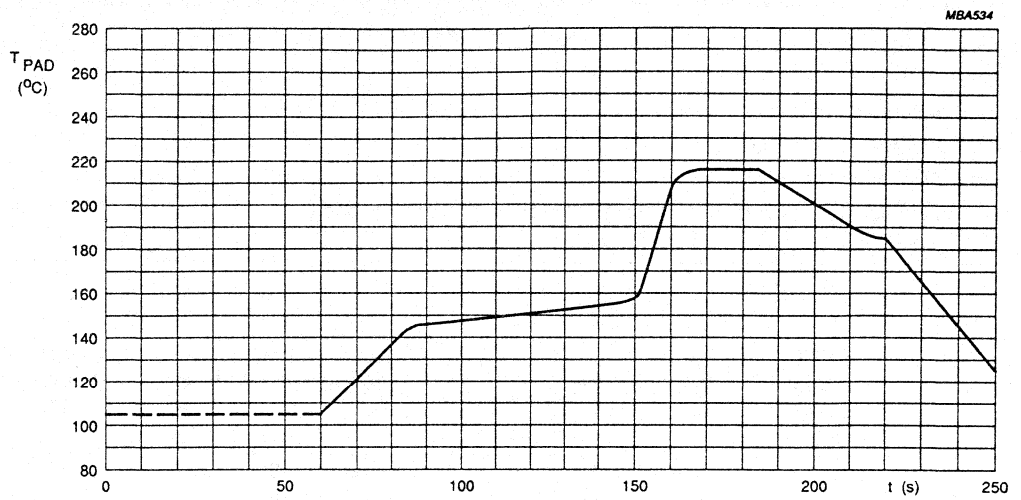


Fig.6 Max. temperature load during vapour phase reflow soldering.

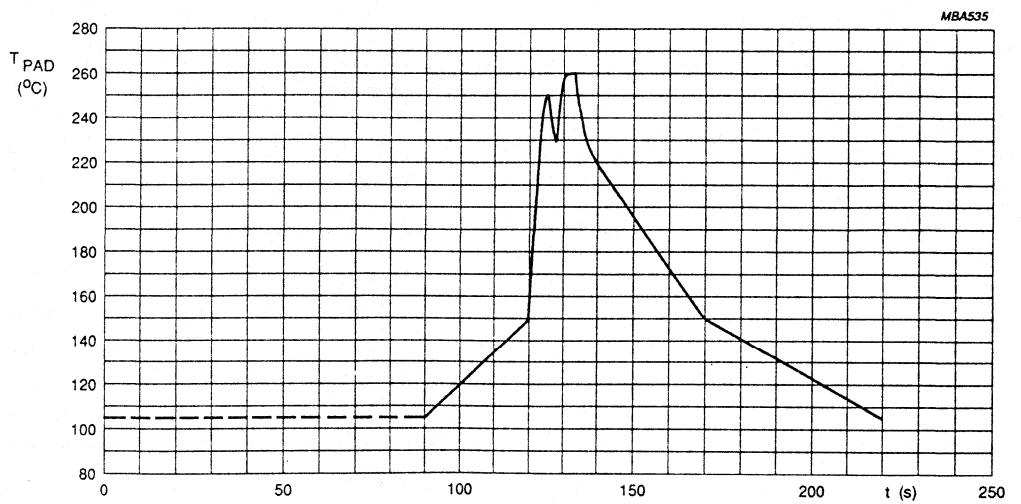


Fig.7 Max. temperature load during (double-) wave soldering.

Non-solid Al - electrolytic capacitor SMD (Chip) Long Life

CLL 139

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 6 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R	= nominal capacitance at 100 Hz, tolerance ±20%
I_R	= rated RMS ripple current at 100 Hz, 105 °C
I_{L1}	= max. leakage current after 1 minute at U_R
I_{L5}	= max. leakage current after 5 minutes at U_R
tan δ	= max. dissipation factor at 100 Hz
ESR	= equivalent series resistance at 100 Hz (calculated from tan δ max. and C_R).
Z	= max. impedance at 10 kHz

3

Table 6 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE L x W x H (mm)	CASE CODE	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222 ... .
6.3	10	10.8 x 4.1 x 4.4	1a	13	4	3.1	0.30	48	20.0	139 63109
	22	13.8 x 4.1 x 4.4	1	25	6	3.3	0.30	22	9.0	139 63229
	47	14.3 x 6.2 x 6.9	2	62	9	3.6	0.16	5.4	6.4	139 63479
	100	14.3 x 6.2 x 6.9	2	79	16	4.3	0.24	3.8	3.0	139 63101
	220	14.3 x 7.6 x 8.2	3	120	32	5.8	0.24	1.7	1.4	139 63221
10	6.8	10.8 x 4.1 x 4.4	1a	13	5	3.1	0.25	59	24.0	139 64688
	15	13.8 x 4.1 x 4.4	1	23	6	3.3	0.25	27	11.0	139 64159
	33	14.3 x 6.2 x 6.9	2	59	10	3.7	0.14	6.8	6.1	139 64339
	68	14.3 x 6.2 x 6.9	2	71	17	4.4	0.20	4.7	2.9	139 64689
	150	14.3 x 7.6 x 8.2	3	110	33	6.0	0.20	2.1	1.3	139 64151
16	4.7	10.8 x 4.1 x 4.4	1a	12	5	3.2	0.20	68	26.0	139 65478
	10	13.8 x 4.1 x 4.4	1	21	6	3.3	0.20	32	12.0	139 65109
	22	14.3 x 6.2 x 6.9	2	52	10	3.7	0.12	8.7	7.3	139 65229
	47	14.3 x 6.2 x 6.9	2	66	18	4.5	0.16	5.4	3.4	139 65479
	100	14.3 x 7.6 x 8.2	3	100	35	6.2	0.16	2.5	1.6	139 65101
25	3.3	10.8 x 4.1 x 4.4	1a	11	5	3.2	0.18	87	27.0	139 66338
	6.8	13.8 x 4.1 x 4.4	1	18	6	3.3	0.18	42	13.0	139 66688
	10	14.3 x 6.2 x 6.9	2	40	8	3.5	0.09	14	12	139 66109
	22	14.3 x 6.2 x 6.9	2	48	14	4.1	0.14	10	5.5	139 66229
	33	14.3 x 6.2 x 6.9	2	59	19	4.7	0.14	6.8	3.7	139 66339
	47	14.3 x 7.6 x 8.2	3	79	27	5.4	0.14	4.7	2.6	139 66479
40	2.2	10.8 x 4.1 x 4.4	1a	9	5	3.2	0.16	120	32.0	139 67228
	4.7	13.8 x 4.1 x 4.4	1	16	7	3.4	0.16	54	15.0	139 67478
	15	14.3 x 6.2 x 6.9	2	45	15	4.2	0.11	12	6	139 67159
	33	14.3 x 7.6 x 8.2	3	75	29	5.6	0.11	5.3	2.7	139 67339

Non-solid Al - electrolytic capacitor SMD (Chip) Long Life

CLL 139

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE L x W x H (mm)	CASE CODE	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222 ... .
50	1.5	10.8 x 4.1 x 4.4	1a	8	5	3.2	0.15	160	40.0	139 61158
	3.3	13.8 x 4.1 x 4.4	1	14	7	3.3	0.15	72	14.0	139 61338
	6.8	14.3 x 6.2 x 6.9	2	33	10	3.7	0.09	21	10	139 61688
	10	14.3 x 6.2 x 6.9	2	40	13	4.0	0.09	14	7	139 61109
	15	14.3 x 7.6 x 8.2	3	56	18	4.5	0.09	9.5	4.7	139 61159
	22	14.3 x 7.6 x 8.2	3	67	25	5.2	0.09	6.5	3.2	139 61229
63	0.22	10.8 x 4.1 x 4.4	1a	2.5	4	3.0	0.10	720	250	139 90012
	0.22	14.3 x 6.2 x 6.9	2	2.5	4	3.0	0.09	650	160	139 68227
	0.47	10.8 x 4.1 x 4.4	1a	5	4	3.1	0.10	340	117	139 90013
	0.47	14.3 x 6.2 x 6.9	2	5	4	3.1	0.09	300	95	139 68477
	1	10.8 x 4.1 x 4.4	1a	8	4	3.1	0.12	190	55	139 90014
	1	14.3 x 6.2 x 6.9	2	11	4	3.1	0.09	140	55	139 68108
	1.5	13.8 x 4.1 x 4.4	1	10	5	3.2	0.14	150	37	139 90015
	1.5	14.3 x 6.2 x 6.9	2	15	5	3.2	0.09	95	37	139 68158
	2.2	13.8 x 4.1 x 4.4	1	12	6	3.3	0.14	100	25	139 90016
	2.2	14.3 x 6.2 x 6.9	2	19	6	3.3	0.09	65	25	139 68228
	3.3	14.3 x 6.2 x 6.9	2	23	7	3.4	0.09	43	21	139 68338
	4.7	14.3 x 6.2 x 6.9	2	28	9	3.6	0.09	30	17	139 68478
	6.8	14.3 x 7.6 x 8.2	3	40	12	3.9	0.08	19	11	139 68688
	10	14.3 x 7.6 x 8.2	3	48	16	4.3	0.08	13	8	139 68109
100	0.22	14.3 x 6.2 x 6.9	2	4	4	3.0	0.09	650	160	139 69227
	0.47	14.3 x 6.2 x 6.9	2	8	4	3.1	0.09	300	95	139 69477
	1.0	14.3 x 6.2 x 6.9	2	12	5	3.2	0.09	140	55	139 69108
	2.2	14.3 x 6.2 x 6.9	2	19	7	3.4	0.09	65	29	139 69228
	3.3	14.3 x 7.6 x 8.2	3	27	10	3.7	0.08	39	17	139 69338
	4.7	14.3 x 7.6 x 8.2	3	33	12	3.9	0.08	27	11	139 69478

Voltage

Surge voltage for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

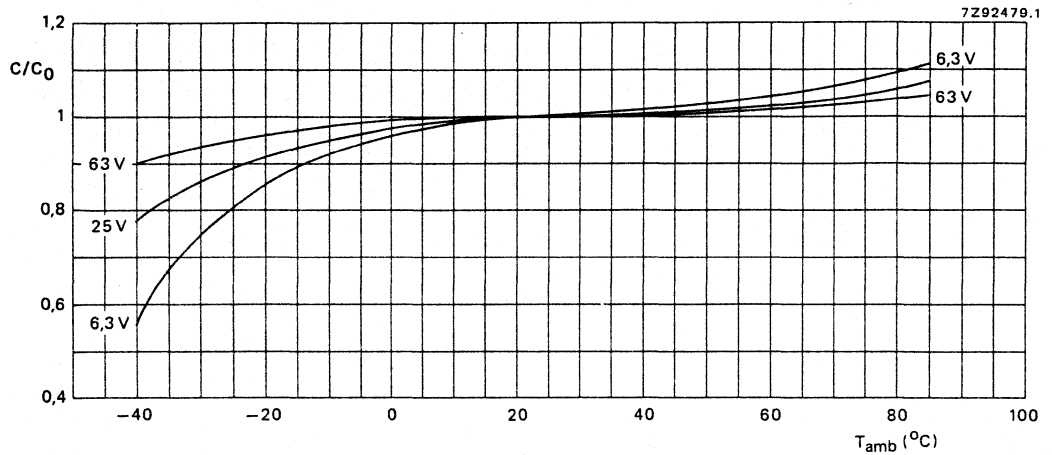
Leakage current

After 1 min at U_R	$I_{L1} \leq 0.02\ C_R \times U_R + 3$ µA
After 5 min at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3$ µA

Ordering Example

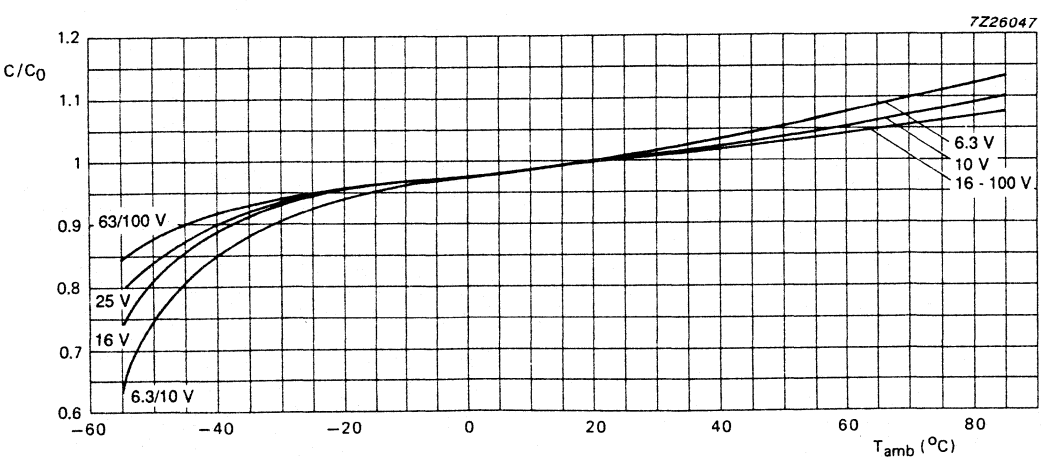
Electrolytic Capacitor CLL 139
100 µF/16 V, ±20%
Case size 14.3 x 7.6 x 8.2; taped on reel
Catalogue number: 2222 139 65101.

Capacitance (C)



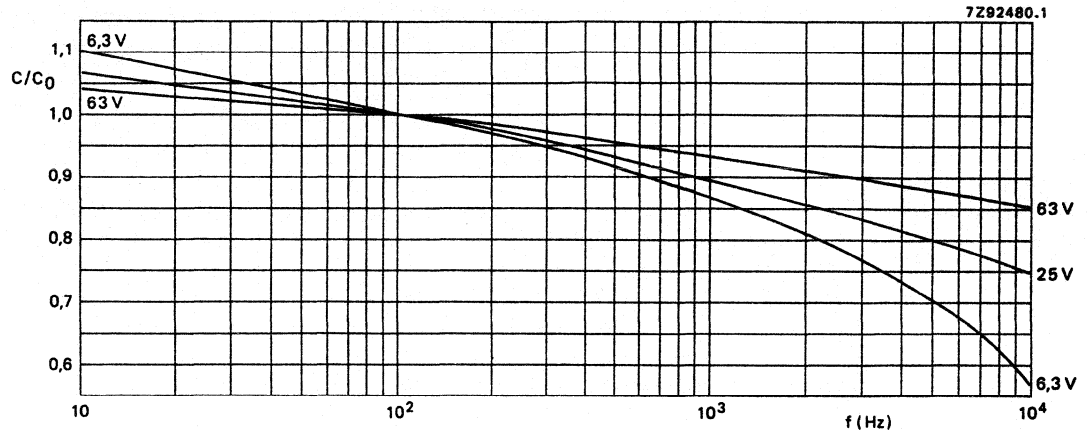
C_0 = capacitance at 20 °C, 100 Hz.

Fig.8 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 10.8 x 4.1 x 4.4 and 13.8 x 4.1 x 4.4.



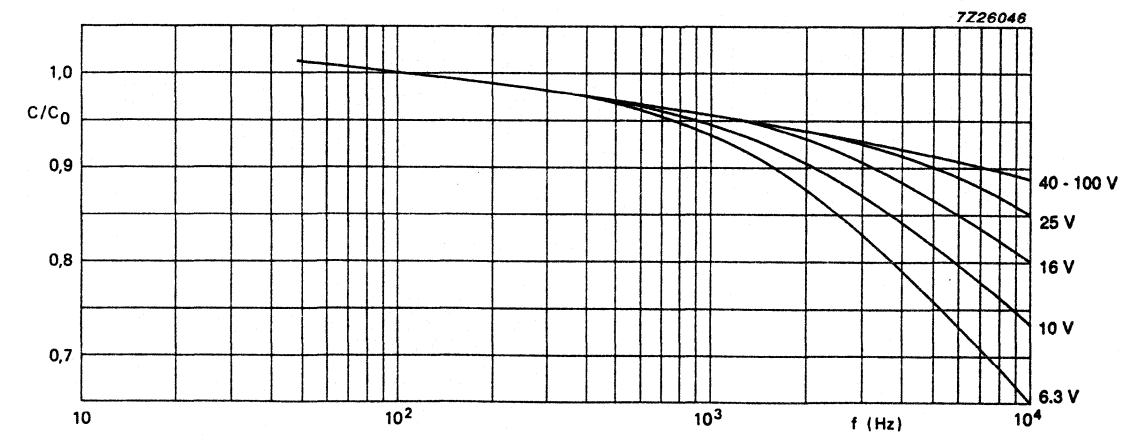
C_0 = capacitance at 20 °C, 100 Hz.

Fig.9 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes14.3 x 6.2 x 6.9 and 14.3 x 7.6 x 8.2.



C_0 = capacitance at 20 °C, 100 Hz.

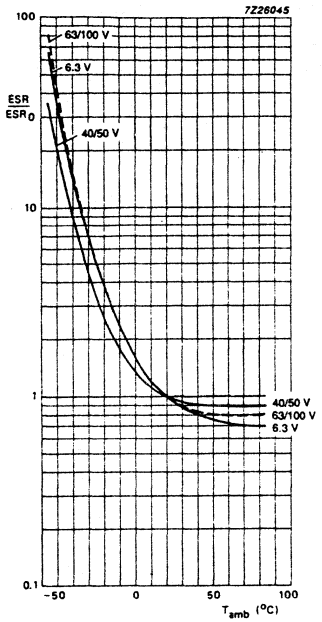
Fig.10 Multiplier of capacitance (C/C_0) as a function of frequency; case sizes 10.8 x 4.1 x 4.4 and 13.8 x 4.1 x 4.4.



C_0 = capacitance at 20 °C, 100 Hz.

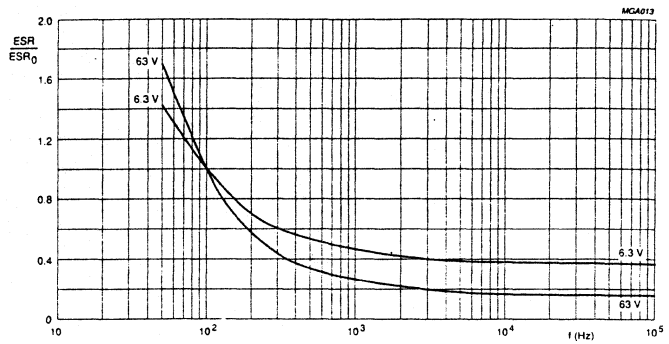
Fig.11 Multiplier of capacitance (C/C_0) as a function of frequency; case sizes 14.3 x 6.2 x 6.9 and 14.3 x 7.6 x 8.2.

Equivalent series resistance (ESR)



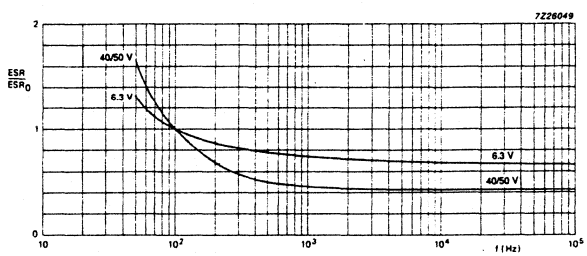
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.12 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.13 Multiplier of ESR (ESR/ESR_0) as a function of frequency; case sizes 10.8 x 4.1 x 4.4 and 13.8 x 4.1 x 4.4.



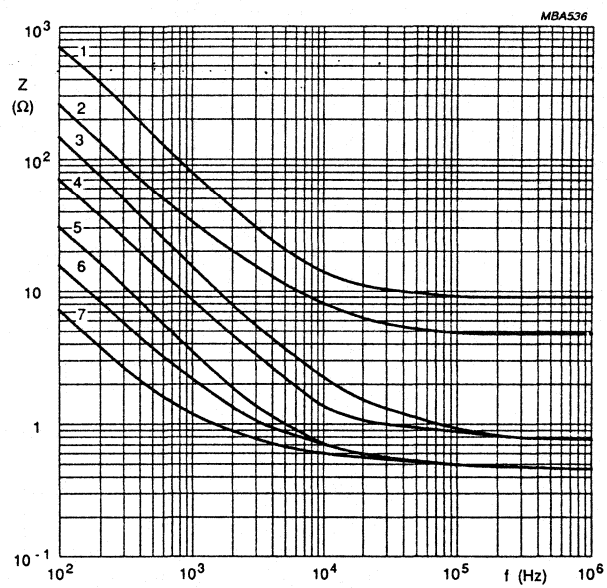
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.14 Multiplier of ESR (ESR/ESR_0) as a function of frequency; case sizes 14.3 x 6.2 x 6.9 and 14.3 x 7.6 x 8.2.

Equivalent series inductance (ESL)

case size 10.8 x 4.1 x 4.4	typ. 11 nH
case size 13.8 x 4.1 x 4.4	typ. 13 nH
case size 14.3 x 6.2 x 6.9	typ. 18 nH
case size 14.3 x 7.6 x 8.2	typ. 28 nH

Impedance (Z)



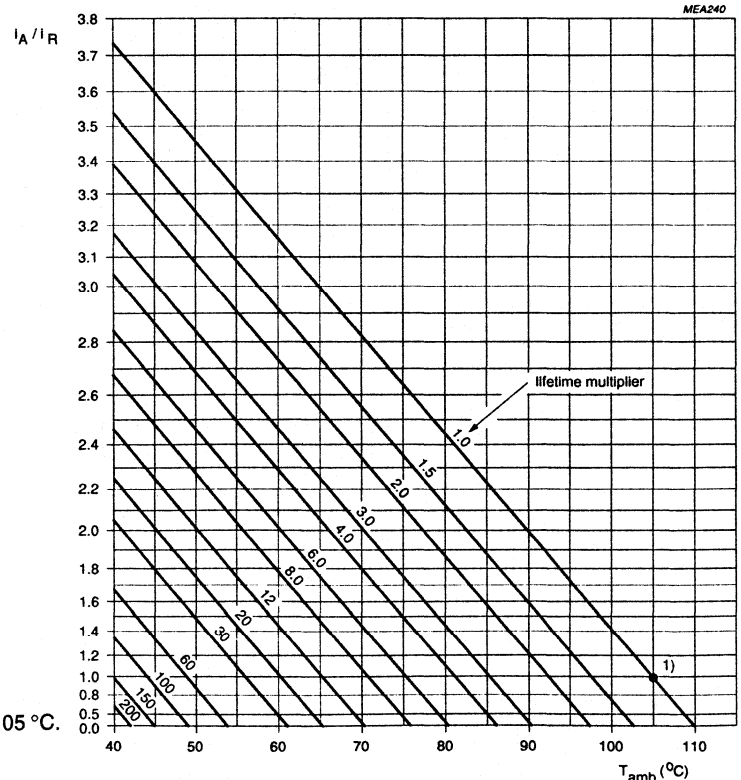
Curve 1 : 2.2 µF - 40 V
Curve 2 : 4.7 µF - 40 V
Curve 3 : 10 µF - 50 V
Curve 4 : 22 µF - 25 V
Curve 5 : 47 µF - 25 V
Curve 6 : 100 µF - 16 V
Curve 7 : 220 µF - 6.3 V.

Fig.15 Typical impedance as a function of frequency at T_{amb} = 20 °C.

RIPPLE CURRENT and USEFUL LIFE

Table 7 Multiplier of ripple current as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER					
	CASE SIZES 10.8 x 4.1 x 4.4 and 13.8 x 4.1 x 4.4			CASE SIZES 14.3 x 6.2 x 6.9 and 14.3 x 7.6 x 8.2		
	U_R = 6.3-16 V	U_R = 25-50 V	U_R = 63-100 V	U_R = 6.3-16 V	U_R = 25-50 V	U_R = 63-100 V
50	0.85	0.8	0.75	0.95	0.9	0.85
100	1	1	1	1	1	1
300	1.2	1.35	1.5	1.07	1.12	1.2
1000	1.3	1.6	2	1.12	1.2	1.3
3000	1.35	1.8	2.3	1.15	1.25	1.35
≥10 000	1.4	2	2.4	1.2	1.3	1.4



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 105 °C.

1) Useful life at 105 °C, U_R and I_R applied: 2000 hours.

Fig.16 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 8

TEST		PROCEDURE (quick reference)	SPECIFIC REQUIREMENTS
Name of test	**Reference**		
Mounting	IEC-384-1 sub clause 4.33	to be performed prior to tests and method mentioned below: reflow or (double-) wave soldering for max. temperature load, see chapter "Mounting"	$\Delta C/C \leq \pm 5\%$ tan $\delta \leq$ spec. limit $I_{L5} \leq$ spec limit
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_A = 105 °C, U_R applied 1000 hours	$U_R \leq 6.3$ V: $\Delta C/C$ +15/–30% U_R = 10 to 100 V : $\Delta C/C$ +15/–15% tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 ammendment 2640 sub clause 1.8.1	T_A = 105 °C, U_R and I_R applied 2000 hours	$U_R \leq 6.3$ V: $\Delta C/C$ +45/–50% U_R = 10 to 100 V : $\Delta C/C$ +45/–45% tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 group 5a, 4.17	T_A = 105 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	see Endurance (above)

Solid Al - electrolytic SMD capacitors Chip Professional extended Life

SAL-CPL 127

FEATURES

- Polarized aluminium electrolytic capacitors, solid electrolyte MnO_2
- SMD version, plastic housing, rectangular shaped with metal end caps
- Extremely long useful life 20 000 hours/125 °C
- Extended temperature range up to 125 °C
- Excellent low temperature impedance and ESR behaviour
- Charge and discharge proof, application with 0 Ω resistance allowed
- Reverse DC voltage up to 0.3 x U_R allowed
- AC voltage up to 0.8 x U_R allowed.

APPLICATIONS

- EDP, telecommunications, general industrial, automotive
- Smoothing, filtering, buffering
- For small power supplies, DC/DC converters.

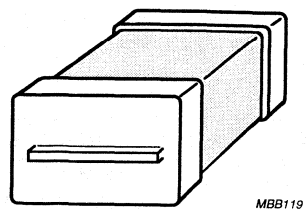


Fig.1 Component outline.

3

QUICK REFERENCE DATA

Case size (L_{nom} x W_{nom} x H_{nom} in mm)	6.5 x 4.4 x 2.9 to 6.5 x 7.5 x 5
Rated capacitance range, C_R	0.15 to 68 µF
Tolerance on C_R	±20%
Rated voltage range, U_R	4 to 25 V
Category temperature range	−55 to +125 °C
Endurance test at 125 °C	2000 hours
Useful life at 125 °C	7000 hours
Useful life at 40 °C	100 000 hours
Shelf life at 0 V, 125 °C	500 hours
Basic specifications	IEC 384-4/CECC 30 300
Climatic category IEC 68 DIN 40040	 55/125/56 FKD
Maximum soldering conditions, wave soldering	260 °C, 10 s

Solid Al - electrolytic SMD capacitors
Chip Professional extended Life

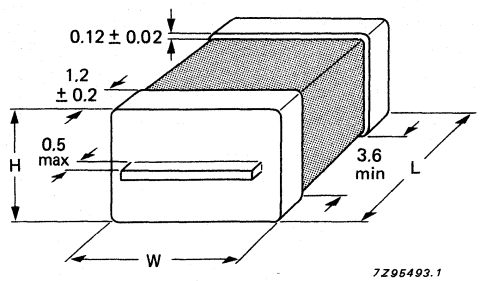
SAL-CPL 127

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (L_{nom} x W_{nom} x H_{nom} in mm)

C_R (µF)	U_R (V)					
	4	6.3	10	16	20	25
0.15						6.5 x 4.4 x 2.9
0.22						6.5 x 4.4 x 2.9
0.33					6.5 x 4.4 x 2.9	6.5 x 5.5 x 3.4
0.47					6.5 x 5.5 x 3.4	6.5 x 5.5 x 4.0
0.68					6.5 x 5.5 x 3.4	6.5 x 5.5 x 4.0
1					6.5 x 5.5 x 4.0	6.5 x 7.5 x 4.0
1.5				6.5 x 4.4 x 2.9	6.5 x 7.5 x 4.0	6.5 x 7.5 x 5.0
2.2				6.5 x 5.5 x 4.0	6.5 x 7.5 x 5.0	
3.3			6.5 x 4.4 x 2.9	6.5 x 5.5 x 4.0		
4.7			6.5 x 5.5 x 3.4	6.5 x 7.5 x 4.0		
6.8		6.5 x 4.4 x 2.9	6.5 x 5.5 x 3.4	6.5 x 7.5 x 5.0		
10	6.5 x 4.4 x 2.9	6.5 x 5.5 x 3.4	6.5 x 5.5 x 4.0			
15	6.5 x 5.5 x 3.4	6.5 x 5.5 x 3.4	6.5 x 7.5 x 4.0			
22	6.5 x 5.5 x 3.4	6.5 x 5.5 x 4.0	6.5 x 7.5 x 5.0			
33	6.5 x 5.5 x 4.0	6.5 x 7.5 x 4.0				
47	6.5 x 7.5 x 4.0	6.5 x 7.5 x 5.0				
68	6.5 x 7.5 x 5.0	6.5 x 7.5 x 5.0				

MECHANICAL DATA and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING".



For dimensions L,W and H, refer to Table 2.

Fig.2 Capacitor dimensions.

Table 2 Dimensions in mm; mass in g

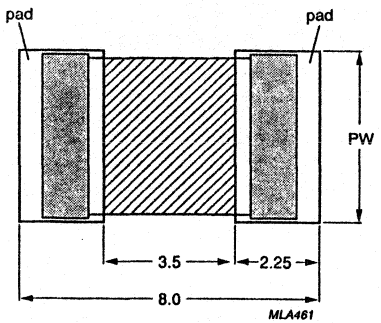
CASE		L_{max}	W_{max}	H_{max}	APPROX. MASS	PACKING QUANTITIES per reel
SIZE L_{nom} x W_{nom} x H_{nom}	CODE					
6.5 x 4.4 x 2.9	20	6.7	4.5	3.0	0.25	2500
6.5 x 5.5 x 3.4	30	6.7	5.8	3.5	0.30	2000
6.5 x 5.5 x 4.0	40	6.7	5.8	4.1	0.35	1500
6.5 x 7.5 x 4.0	50	6.7	7.9	4.1	0.50	1000
6.5 x 7.5 x 5.0	60	6.7	7.9	5.2	0.60	1000

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance value
- Tolerance code on rated capacitance (M for ±20%)
- Rated voltage
- Negative and positive terminal identification
- Name of manufacturer "PH"
- Date code, in accordance with IEC 62.

Mounting



Dimensions in mm.

Fig.3 Recommended pad dimensions for reflow and wave soldering.

Soldering conditions (infrared)

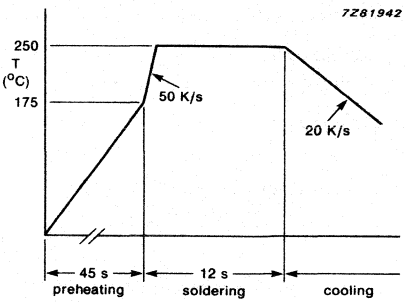


Fig.4 Typical temperature / time curve for infrared reflow soldering.

Table 3 Pad design (dimensions in mm)

CASE CODE	PW SIZE
20	4.6
30 and 40	5.9
50 and 60	8.0

Soldering conditions (wave)

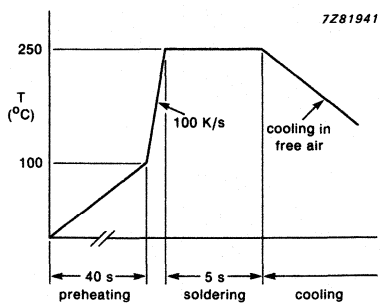


Fig.5 Typical temperature / time curve for wave soldering.

Soldering conditions (dual-vapour)

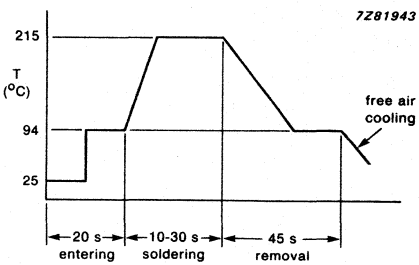


Fig.6 Typical temperature / time curve for dual-vapour reflow soldering.

Solid Al - electrolytic SMD capacitors Chip Professional extended Life

SAL-CPL 127

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified all electrical values in Table 4 apply at T_{amb} = 20 to 25 °C, P = 86 to 106 kP and RH = 45 to 75%

C_R = rated capacitance at 100 Hz (tolerance ±20%)

I_R = max. RMS ripple current, no necessary DC voltage applied

I_{L5} = max. leakage current after 5 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = max. equivalent series resistance at 100 Hz or 100 kHz

Z = max. impedance at 100 kHz.

Ordering Example

Electrolytic capacitors
SAL-CPL 127
10 µF/4 V, ±20%
Case size 6.5 x 4.4 x 2.9 mm
Catalogue number:
2222 127 22109

3

Table 4 Electrical data and ordering information for 127 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE L x W x H (mm)	I_R 100 Hz 125 °C (mA)	I_R 100 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER [1] 2222 . . . . .
4	10	6.5 x 4.4 x 2.9	4	140	210	2	0.15	30	3	127 22109
	15	6.5 x 5.5 x 3.4	6	210	310	2	0.15	20	2	127 22159
	22	6.5 x 5.5 x 3.4	9	250	370	2	0.15	14	1	127 22229
	33	6.5 x 5.5 x 4.0	13	350	520	3	0.15	9	0.9	127 22339
	47	6.5 x 7.5 x 4.0	19	450	680	5	0.15	6.4	0.7	127 22479
	68	6.5 x 7.5 x 5.0	27	590	890	7	0.15	4.4	0.5	127 22689
6.3	6.8	6.5 x 4.4 x 2.9	4	140	210	2	0.10	30	5	127 23688
	10	6.5 x 5.5 x 3.4	6	210	310	2	0.10	20	1.5	127 23109
	15	6.5 x 5.5 x 3.4	9	250	370	3	0.10	14	1	127 23159
	22	6.5 x 5.5 x 4.0	14	350	520	4	0.10	9	0.7	127 23229
	33	6.5 x 7.5 x 4.0	21	460	690	5	0.10	6.1	0.5	127 23339
	47	6.5 x 7.5 x 5.0	29	600	900	7	0.10	4.3	0.5	127 23479
	68	6.5 x 7.5 x 5.0	42	600	900	11	0.15	4.4	0.5	127 23689
10	3.3	6.5 x 4.4 x 2.9	3	100	150	2	0.10	61	7	127 24338
	4.7	6.5 x 5.5 x 3.4	5	140	210	2	0.10	43	2	127 24478
	6.8	6.5 x 5.5 x 3.4	7	170	250	2	0.10	30	1.5	127 24688
	10	6.5 x 5.5 x 4.0	10	230	350	3	0.10	20	1	127 24109
	15	6.5 x 7.5 x 4.0	15	310	460	4	0.10	14	0.7	127 24159
	22	6.5 x 7.5 x 5.0	22	420	620	6	0.10	9	0.7	127 24229
16	1.5	6.5 x 4.4 x 2.9	2	68	100	2	0.10	135	15	127 25158
	2.2	6.5 x 5.5 x 4.0	3	110	160	2	0.10	91	10	127 25228
	3.3	6.5 x 5.5 x 4.0	5	130	200	2	0.10	61	7	127 25338
	4.7	6.5 x 7.5 x 4.0	7	180	260	2	0.10	43	5	127 25478
	6.8	6.5 x 7.5 x 5.0	11	230	340	3	0.10	30	3	127 25688

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SAL-CPL 127

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE L x W x H (mm)	I_R 100 Hz 125 °C (mA)	I_R 100 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER [1] 2222 . . . . .
20	0.33	6.5 x 4.4 x 2.9	1	32	48	2	0.10	610	30	127 28337
	0.47	6.5 x 5.5 x 3.4	1	45	67	2	0.10	430	30	127 28477
	0.68	6.5 x 5.5 x 3.4	1	54	80	2	0.10	295	20	127 28687
	1.0	6.5 x 5.5 x 4.0	2	74	110	2	0.10	200	15	127 28108
	1.5	6.5 x 7.5 x 4.0	3	100	150	2	0.10	135	10	127 28158
	2.2	6.5 x 7.5 x 5.0	4	130	200	2	0.10	91	5	127 28228
25	0.1	6.5 x 4.4 x 2.9	0	12	19	2	0.10	1990	70	127 26107
	0.15	6.5 x 4.4 x 2.9	0	15	23	2	0.10	1330	50	127 26157
	0.22	6.5 x 5.8 x 3.0	1	18	28	2	0.10	910	30	127 26227
	0.33	6.5 x 5.5 x 3.4	1	21	40	2	0.10	610	30	127 26337
	0.47	6.5 x 5.5 x 4.0	1	28	53	2	0.10	430	20	127 26477
	0.68	6.5 x 5.5 x 4.0	2	43	64	2	0.10	295	15	127 26687
	1.0	6.5 x 7.5 x 4.0	2	57	86	2	0.10	200	10	127 26108
	1.5	6.5 x 7.5 x 5.0	4	76	110	2	0.10	135	7	127 26158

Note

[1] Catalogue number applies to the taped version; for bulk version (200 units/bag), replace 8th digit by "1" (2222 127 1....).

Voltages

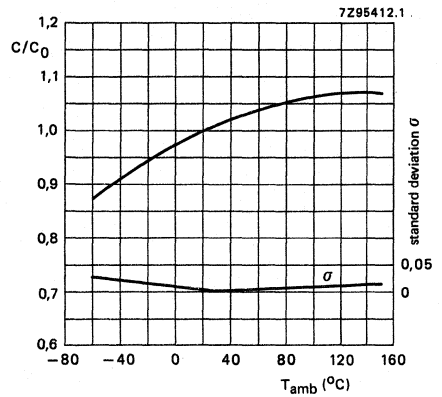
Surge voltage for short periods	$U_s \leq 1.15 \cdot U_R$	
Reverse voltage	$U_{rev} < 0.3 \cdot U_R$	
Max. peak AC voltage, reverse voltage applied	≤2 V	
Max. peak AC voltage, without reverse voltage applied		
	$T_{amb} \leq 85$ °C	85 °C $< T_{amb} \leq 125$ °C
at f ≤ 0.1 Hz	0.30 x U_R	0.15 x U_R
at 0.1 Hz < f ≤ 1 Hz	0.45 x U_R	0.22 x U_R
at 1 Hz < f ≤ 10 Hz	0.60 x U_R	0.30 x U_R
at 10 Hz < f ≤ 50 Hz	0.65 x U_R	0.32 x U_R
at f > 50 Hz	0.80 x U_R	0.40 x U_R

Ripple current (I_R)

Applying the max. RMS ripple current given in Table 4 will cause a device temperature of 138 °C. The 100 kHz values in Table 4 for other temperatures are to be calculated with the following I_R multipliers:

T_{amb}	25 °C	40 °C	65 °C	85 °C	105 °C	125 °C
I_R multiplier	1.1	1.0	0.88	0.75	0.59	0.37

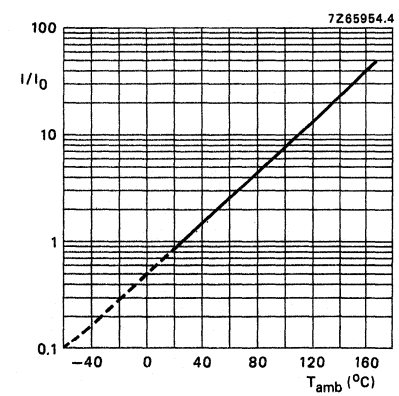
Capacitance (C)



C_0 = capacitance at 25 °C, 100 Hz.

Fig.7 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.

Leakage current



I_0 = leakage current during continuous operation at U_R and T_{amb} = 25 °C.

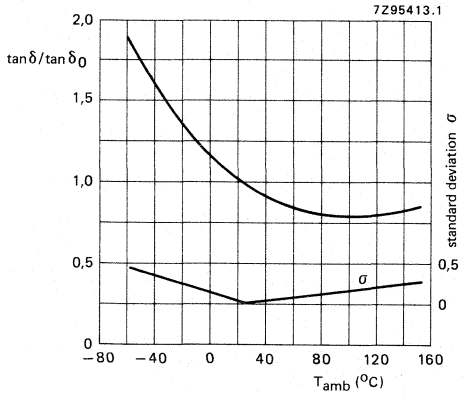
Fig.8 Typical multiplier of leakage current (I/I_0) as a function of ambient temperature.

Maximum leakage current after 5 minutes at U_R and T_{amb} = 25 °C	I_{L5} ≤0.02 C_R x U_R or 2 µA whichever is greater , (see Table 4)

Typical leakage current 15 s at U_R and T_{amb} = 25 °C

6.3 to 16 V versions	approx. 0.2 x value stated in Table 4
25 V versions	approx. 0.1 x value stated in Table 4

Dissipation factor (tan δ)



Tan δ_0 = dissipation factor at T_{amb} = 25 °C and 100 Hz.

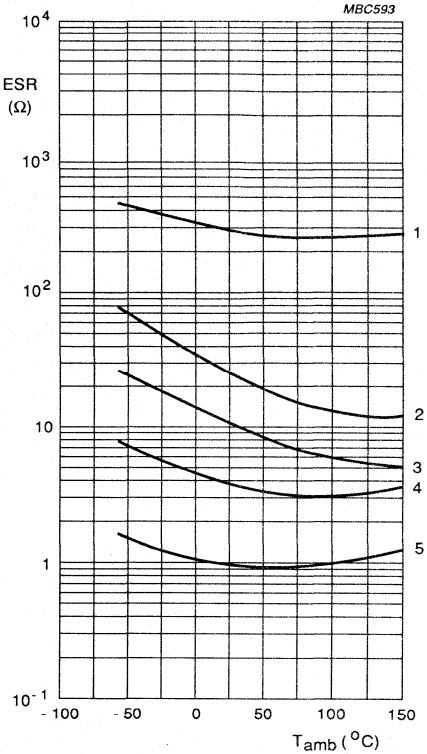
Fig.9 Typical multiplier of dissipation factor (tan δ/tan δ_0) as a function of ambient temperature.

Max. power dissipation

case sizes 6.5 x 4.4 x 2.9 to 6.5 x 5.5 x 4.0:
P_{125} = 45 mW

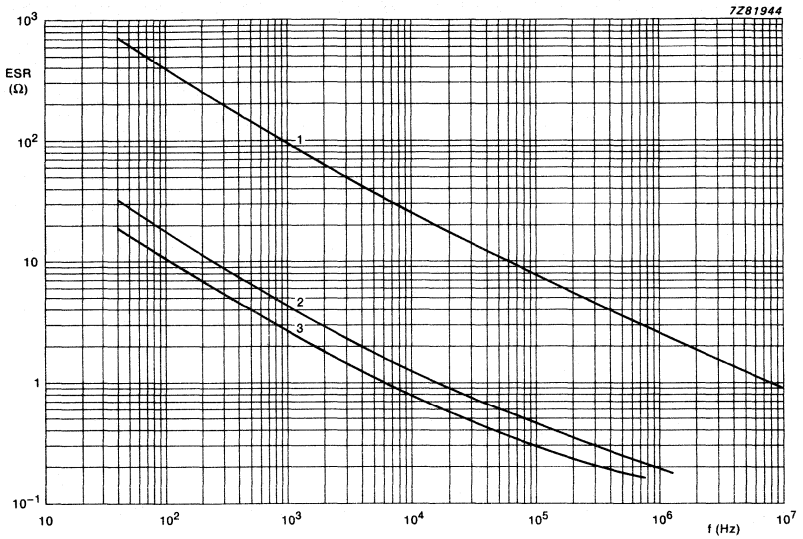
case sizes 6.5 x 7.5 x 4.0 to 6.5 x 7.5 x 5.0:
P_{125} = 65 mW.

Equivalent series resistance (ESR)



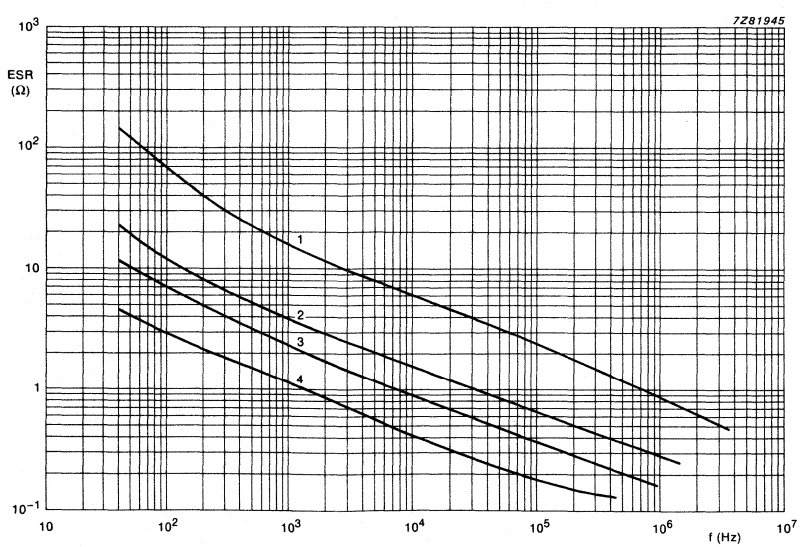
Curve 1 : 1.5 µF, 25 V
Curve 2 : 3.3 µF, 16 V
Curve 3 : 10 µF, 4 V
Curve 4 : 22 µF, 6.3 V
Curve 5 : 68 µF, 6.3 V.

Fig.10 Typical ESR as a function of ambient temperature at 100 Hz.



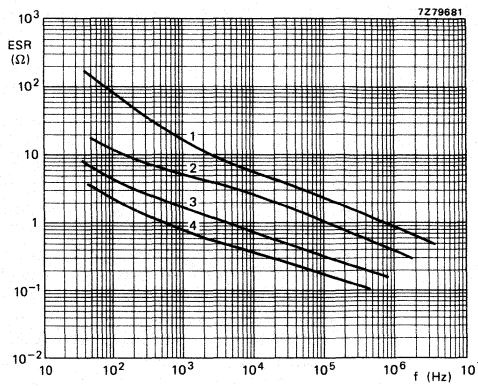
Curve 1 : 0.33 µF, 20 V
Curve 2 : 3.3 µF, 10 V
Curve 3 : 10 µF, 4 V.

Fig.11 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size 6.5 x 4.4 x 2.9 mm.



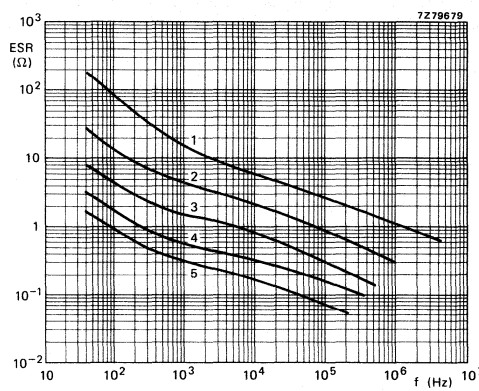
Curve 1 : 0.47 µF, 20 V
Curve 2 : 4.7 µF, 10 V
Curve 3 : 10 µF, 6.3 V
Curve 4 : 22 µF, 4 V.

Fig.12 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size 6.5 x 5.5 x 3.4 mm.



Curve 1 : 1 µF, 25 V; size 6.5 x 7.5 x 4.0
Curve 2 : 4.7 µF, 16 V; size 6.5 x 7.5 x 4.0
Curve 3 : 10 µF, 10 V; size 6.5 x 5.5 x 4.0
Curve 4 : 33 µF, 4 V; size 6.5 x 5.5 x 4.0.

Fig.13 Typical ESR as a function of frequency at T_{amb} = 25 °C; case sizes 6.5 x 5.5 x 4.0 and 6.5 x 7.5 x 4.0 mm.

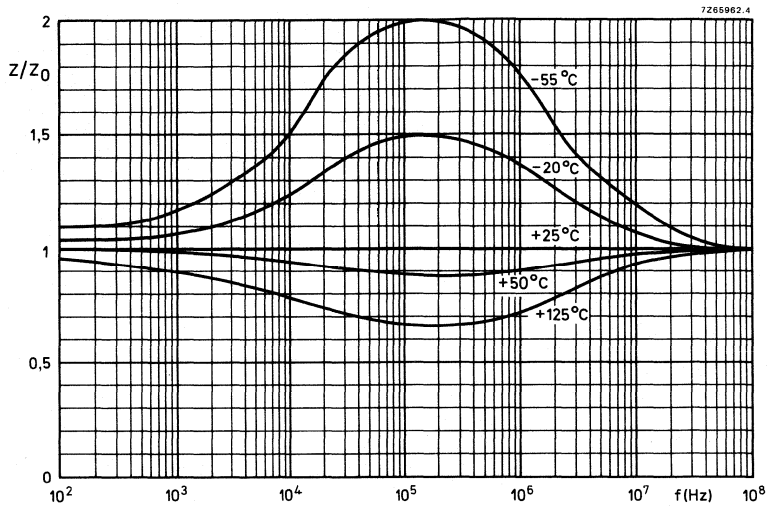


Curve 1 : 1.5 µF, 25 V; size 6.5 x 7.5 x 5.0
Curve 2 : 6.8 µF, 16 V; size 6.5 x 7.5 x 5.0
Curve 3 : 15 µF, 10 V; size 6.5 x 7.5 x 4.0
Curve 4 : 33 µF, 6.3 V; size 6.5 x 7.5 x 4.0
Curve 5 : 68 µF, 6.3 V; size 6.5 x 7.5 x 5.0.

Fig.14 Typical ESR as a function of frequency at T_{amb} = 25 °C; case sizes 6.5 x 7.5 x 4.0 and 6.5 x 7.5 x 5.0 mm.

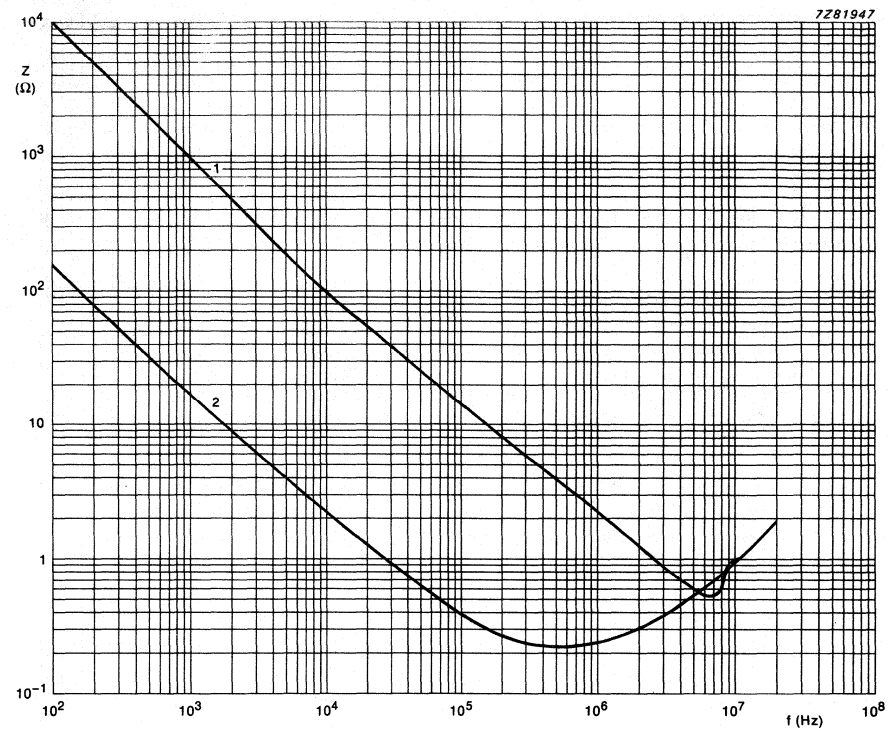
Impedance (Z)

Maximum impedance at 100 kHz and T_{amb} = 25 °C, measured by means of a four terminal (Thomson) circuit, see Table 4.



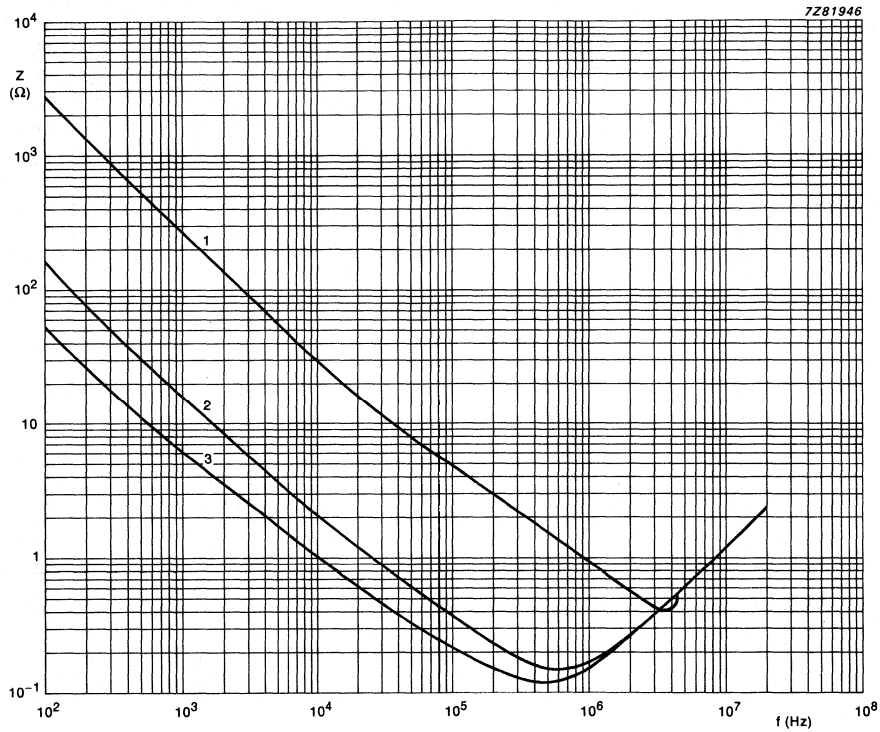
Z_0 = initial impedance value at any frequency and T_{amb} = 25 °C.

Fig.15 Typical multiplier of impedance (Z/Z_0) as a function of frequency at different ambient temperatures.



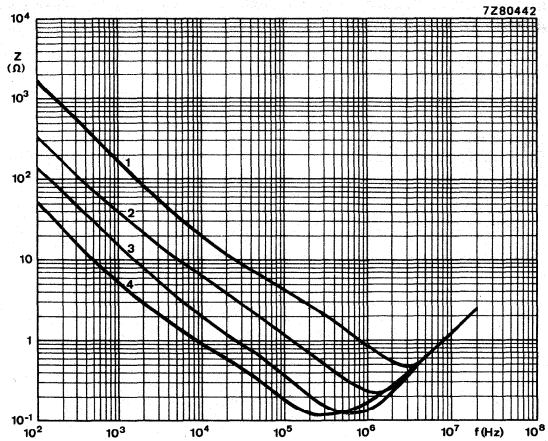
Curve 1 : 0.15 µF, 25 V
Curve 2 : 10 µF, 4 V.

Fig.16 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 6.5 x 4.4 x 2.9 mm.



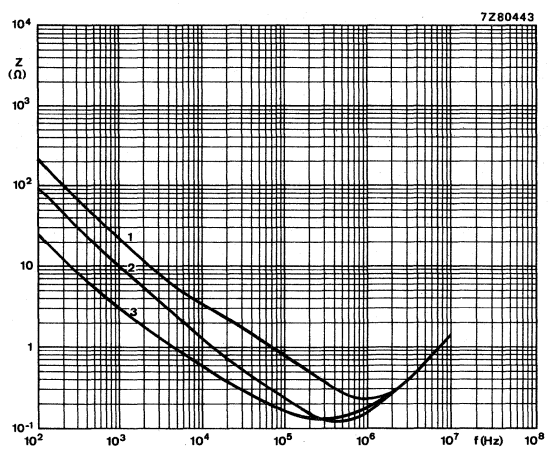
Curve 1 : 0.47 µF, 20 V
Curve 2 : 10 µF, 6.3 V
Curve 3 : 22 µF, 4 V.

Fig.17 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 6.5 x 5.5 x 3.4 mm.



Curve 1 : 1 µF, 25 V; size 6.5 x 7.5 x 4.0
Curve 2 : 4.7 µF, 16 V; size 6.5 x 7.5 x 4.0
Curve 3 : 10 µF, 10 V; size 6.5 x 5.5 x 4.0
Curve 4 : 33 µF, 4 V; size 6.5 x 5.5 x 4.0.

Fig.18 Typical impedance as a function of frequency at T_{amb} = 25 °C; case sizes 6.5 x 5.5 x 4.0 and 6.5 x 7.5 x 4.0 mm.



Curve 1 : 6.8 µF, 16 V; size 6.5 x 7.5 x 5.0
Curve 2 : 15 µF, 10 V; size 6.5 x 7.5 x 4.0
Curve 3 : 68 µF, 6.3 V; size 6.5 x 7.5 x 5.0.

Fig.19 Typical impedance as a function of frequency at T_{amb} = 25 °C; case sizes 6.5 x 7.5 x 4.0 and 6.5 x 7.5 x 5.0 mm.

Equivalent series inductance (ESL), f = 10 MHz

Typical ESL for case sizes:	
6.5 x 4.4 x 2.9 to 6.5 x 5.5 x 4.0	9 to 14 nH
6.5 x 7.5 x 4.0 and 6.5 x 7.5 x 5.0	11 to 16 nH
Maximum ESL for all case sizes	20 nH

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 5

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-2/ CECC 30 302 group C3, 4.13	T_{amb} = 125 °C U_R = 6.3 to 25 V with U_R applied U_R = 35 and 40 V with U_C applied 10 000 hours	$\Delta C/C$ ≤±10% tan δ ≤1.2 x spec. limit Z ≤1.2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 302 amendment 2642 sub clause 1.8.1	T_{amb} = 125 °C, I_R applied and U_R = 6.3 to 25 V with U_R applied U_R = 35 and 40 V with U_C applied 20 000 hours	$\Delta C/C$ ≤15% tan δ ≤1.5 x spec. limit Z ≤1.5 x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage <3%
Shelf life (storage at high temp.)	IEC 384-4-2/ CECC 30 302 group C 5a, 4.17	T_{amb} = 125 °C, no voltage applied 500 hours	$\Delta C/C$ ≤±10% tan δ ≤1.2 x spec. limit I_{L5} ≤1 x spec. limit
Charge and discharge	IEC 384-4-2 sub clause 9.21	10^6 cycles without series resistance 0.5 s to U_R 0.5 s to ground	$\Delta C/C$ ≤5% no short or open circuit no visible damage [
Solvent resistance test	IEC 68-2-45, IEC 653 test XA	sequence: - 30 s vapour phase - 5 minutes ultrasonic immersion at ambient temperature - 30 s vapour phase Solvents: - deionized water (50 ±5 °C); - calgonite solution (20 g/l, 70 ±5 °C); - 1.1.1.-trichloro-ethane; - mixtures of 1.1.2.-trichloro-1.2.2.-trifluoro-ethane (fluorocarbon 113) and the following solvents in the respective mass percentage ratios of these solvents to fluorocarbon; * ARKLONE K; 75% w/w F113 and 25% w/w isopropanol * FREON TE; 95.5% w/w F113 and 4.5% w/w ethanol * FREON TMS; 94% w/w F113, 5.7% w/w methanol and 0.3% w/w nitro-methane *ARKLONE F; 95.6% w/w F113, 4.0% w/w ethylalcohol, 0.07% w/w stabilizer and 0.3% w/w special additives * ARKLONE A-M; 94.15% w/w F113, 3.7% w/w ethylalcohol, 2.1% w/w methylacetate and 0.05% w/w stabilizer	visual appearance not affected

Solid Al - electrolytic SMD capacitors
Chip Professional extended Life

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TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Extended vibration test	IEC 68-2-6 test Fc	10 to 2 000 Hz 1.5 mm or 20 g 1 octave/minute 3 directions 1 sweep per direction no voltage applied	no intermittent contacts; no breakdown; no open circuiting; no mechanical damage; $\Delta C/C \leq 5\%$ tan $\delta \leq 1.2$ x spec. limit $Z \leq 1.2$ x spec. limit $I_{L5} \leq 1.5$ x spec. limit
Shock test	IEC 68-2-27 test Ea	half-sine or saw tooth pulse shape 50 g, 11 ms, 3 successive shocks in each direction of 3 mutually perpendicular axes, no voltage applied	no intermittent contacts; no breakdown; no open circuiting; no mechanical damage; $\Delta C/C \leq 5\%$ tan $\delta \leq 1.2$ x spec. limit $Z \leq 1.2$ x spec. limit $I_{L5} \leq 1.5$ x spec. limit

Notes

1. ARKLONE is a trade mark of I.C.I.
2. FREON is a trade mark of Dupont de Nemours.

Electrolytic Capacitors

Notes

Chip Tantalum Standard CTS 195/49 MC

FEATURES

- Polarized tantalum electrolytic capacitors, solid electrolyte MnO_2
- SMD type, moulded, dimensions A, B, C and D
- Long life, high reliability
- High CU product per unit volume
- Worldwide standardized dimensions, IEC, CECC, DIN
- Automatic placement, taped, reel 8 and 12 mm
- Allowed soldering methods: reflow, double wave and vapour phase

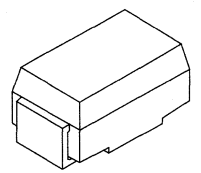


Fig.1 Component outline

APPLICATIONS

- SMD technology, for very small applications
- EDP, telecommunication, general industrial, automotive and audio-video
- Filtering, buffering, storage and timing
- Portable and mobile equipment (small size)

QUICK REFERENCE DATA

Case size, L_{nom} x W_{nom} x H_{nom} in mm	A=3.2x1.6x1.6, B=3.4x2.8x1.9, C=5.8x3.2x2.5, D=7.3x4.3x2.8
Rated capacitance range, C_R	0.1 to 100 µF
Tolerance on C_R	±10 %, ±20 %
Rated voltage range, U_R	4 to 35 V
Rated temperature range, T_R	–55 to +85 °C
Category temperature range T_C	–55 to +125 °C
Endurance test at 85 °C, case A and B case C and D	2000 hours 1000 hours
Useful life at 40 °C	100000 hours
Resistance to soldering heat, dip soldering reflow soldering vapour phase soldering	260 °C, 5 s 230 °C, 20 s 215 °C, 30 s
Basic specification	IEC 384-3, CECC 30800
Climatic category IEC 68	55/085/21
Climatic category DIN 40 040	FPE

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (length x width x height in mm)

C_R	U_R (V)						
µF	4	6.3	10	16	20	25	35
0.10							A 3.2x1.6x1.6
0.15							A 3.2x1.6x1.6
0.22							A 3.2x1.6x1.6
0.33							A 3.2x1.6x1.6
0.47						A 3.2x1.6x1.6	A 3.2x1.6x1.6 B 3.4x2.8x1.9
0.68					A 3.2x1.6x1.6	A 3.2x1.6x1.6	A 3.2x1.6x1.6 B 3.4x2.8x1.9
1.0				A 3.2x1.6x1.6	A 3.2x1.6x1.6	A 3.2x1.6x1.6	B 3.4x2.8x1.9
1.5			A 3.2x1.6x1.6	A 3.2x1.6x1.6	A 3.2x1.6x1.6	B 3.4x2.8x1.9	B 3.4x2.8x1.9 C 5.8x3.2x2.5
2.2		A 3.2x1.6x1.6	A 3.2x1.6x1.6	A 3.2x1.6x1.6	B 3.4x2.8x1.9	B 3.4x2.8x1.9	C 5.8x3.2x2.5
3.3		A 3.2x1.6x1.6	A 3.2x1.6x1.6	B 3.4x2.8x1.9	B 3.4x2.8x1.9		C 5.8x3.2x2.5
4.7		A 3.2x1.6x1.6	B 3.4x2.8x1.9	B 3.4x2.8x1.9		C 5.8x3.2x2.5	D 7.3x4.3x2.8
6.8	A 3.2x1.6x1.6	B 3.4x2.8x1.9	B 3.4x2.8x1.9		C 5.8x3.2x2.5	D 7.3x4.3x2.8	D 7.3x4.3x2.8
10	B 3.4x2.8x1.9	B 3.4x2.8x1.9		C 5.8x3.2x2.5	C 5.8x3.2x2.5	D 7.3x4.3x2.8	
15	B 3.4x2.8x1.9		C 5.8x3.2x2.5	C 5.8x3.2x2.5	D 7.3x4.3x2.8		
22		C 5.8x3.2x2.5	C 5.8x3.2x2.5	D 7.3x4.3x2.8	D 7.3x4.3x2.8		
33		C 5.8x3.2x2.5	D 7.3x4.3x2.8	D 7.3x4.3x2.8			
47	C 5.8x3.2x2.5	D 7.3x4.3x2.8	D 7.3x4.3x2.8				
68		D 7.3x4.3x2.8					
100	D 7.3x4.3x2.8						

MECHANICAL DATA Dimensions (in mm)

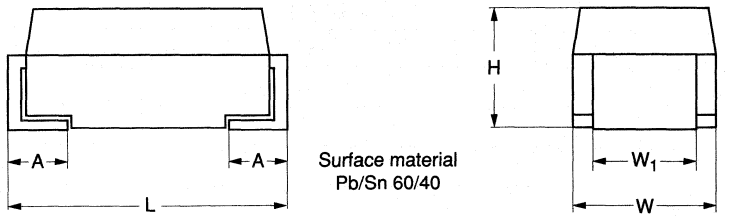


Fig. 2 Case sizes;
see Table 2 for dimensions.

3

Table 2 Dimensions (in mm) and packing quantities

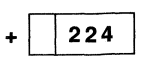
CASE SIZE L_{nom} x W_{nom} x H_{nom}	CASE CODE	MOULDED CHIP					TAPE WIDTH	NUMBER per Reel
		L	W	H	W1	A		
3.2 x 1.6 x 1.6	A	3.2 ± 0.2	1.6 ± 0.2	1.6 ± 0.2	1.0 ± 0.1	0.8 ± 0.3	8	2000
3.4 x 2.8 x 1.9	B	3.4 ± 0.2	2.8 ± 0.2	1.9 ± 0.2	2.0 ± 0.1	0.8 ± 0.3	8	2000
5.8 x 3.2 x 2.5	C	5.8 ± 0.2	3.2 ± 0.2	2.5 ± 0.2	2.2 ± 0.1	1.3 ± 0.3	12	500
7.3 x 4.3 x 2.8	D	7.3 ± 0.2	4.3 ± 0.2	2.8 ± 0.2	2.5 ± 0.1	1.3 ± 0.3	12	500

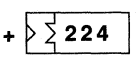
MARKING

The capacitors are marked on the top surface with the following information:

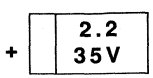
- Polarity (anode) indicated by either a white stripe or a white "M"
- Capacitance in µF and rated voltage on B, C and D case sizes
  Capacitance in picofarad code only on A case size

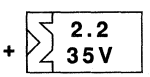
Marking Examples





0.22 µF A case size





2.2 µF B case size
35 V C case size
D case size

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 apply at an ambient temperature of 20 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75 %.

C_R = rated capacitance at 120 Hz, tolerance ±20 % or ±10 %

I_{L5} = max. leakage current after 5 min. at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = max. equivalent series resistance at 100 Hz

Z = max. impedance at 100 kHz

ORDERING EXAMPLE

Tantalum Chip CTS 195/49 MC

22 µF/6.3 V, ±20 %, Case C

Catalogue number 2222 195 23229

Table 3 Electrical data and ordering information

U_R	C_R	CASE CODE	I_{L5}	tan δ	ESR	Z	CATALOGUE NUMBER 2222	
			5 min.	100 Hz	100 Hz	100 kHz		
(V)	(µF)		(µA)		(Ω)	(Ω)	Tolerance ±20 %	Tolerance ±10 %
4	6.8	A	0.5	0.08			195 22688	195 62688
	10	B	0.5	0.06	8	4.5	22109	62109
	15	B	0.6	0.08			22159	62159
	47	C	1.9	0.08			22479	62479
	100	D	4.0	0.08			22101	62101
6.3	2.2	A	0.5	0.06	43	15	195 23228	195 63228
	3.3	A	0.5	0.06	39	7	23338	63338
	4,7	A	0.5	0.08	27	5.5	23478	63478
	6.8	B	0.5	0.06	14	4.5	23688	63688
	10	B	0.5	0.08	13	3.5	23109	63109
	22	C	1.4	0.06	4	2.5	23229	63229
	33	C	2.1	0.08	3	2.0	23339	63339
	47	D	3.0	0.06	2	1.8	23479	63479
	68	D	4.3	0.08	1.5	1.5	23689	63689
10	1.5	A	0.5	0.06	64	15	195 24158	195 64158
	2.2	A	0.5	0.06	58	7	24228	64228
	3.3	A	0.5	0.08	39	5.5	24338	64338
	4.7	B	0.5	0.06	20	4.5	24478	64478
	6.8	B	0.5	0.08	19	3.5	24688	64688
	15	C	1.5	0.06	6	2.5	24159	64159
	22	C	2.2	0.08	4	2.0	24229	64229
	33	D	3.3	0.06	3	1.8	24339	64339
	47	D	4.7	0.08	2	1.5	24479	64479
16	1.0	A	0.5	0.04	64	15	195 25108	195 65108
	1,5	A	0.5	0.06	62	8.0	25158	65158
	2.2	A	0.5	0.08	58	6.5	25228	65228
	3.3	B	0.5	0.06	29	5.0	25338	65338
	4.7	B	0.5	0.08	27	3.5	25478	65478
	10	C	1.6	0.08	10	2.5	25109	65109
	15	C	2.4	0.08	8	2.0	25159	65159
	22	D	3.5	0.08	4	1.8	25229	65229
	33	D	5.2	0.08	3	1.5	25339	65339

Table 3 Electrical data and ordering information (continued)

U_R	C_R	CASE CODE	I_{L5}	tan δ	ESR	Z	CATALOGUE NUMBER	
			5 min.	100 Hz	100 Hz	100 kHz	2222	
(V)	(μF)		(μA)		(Ω)	(Ω)	Tolerance ±20 %	Tolerance ±10 %
20	0.68	A	0.5	0.04	94	15	195 28687	195 68687
	1.0	A	0.5	0.08	95	9	28108	68108
	1.5	A	0.5	0.08	85	7	28158	68158
	2.2	B	0.5	0.06	43	6	28228	68228
	3.3	B	0.6	0.08	39	4.5	28338	68338
	6.8	C	1.4	0.06	14	2.5	28688	68688
	10	C	2.0	0.08	10	2.0	28109	68109
	15	D	3.0	0.06	6	1.8	28159	68159
	22	D	4.4	0.08	4	1.5	28229	68229
25	0.47	A	0.5	0.04	138	18	195 26477	195 66477
	0.68	A	0.5	0.06	140	10	26687	66687
	1.0	A	0.5	0.06	95	8	26108	66108
	1.5	B	0.5	0.06	64	7	26158	66158
	2.2	B	0.5	0.06	58	5	26228	66228
	3.3	C	0.6	0.06	30	4	26338	66338
	4.7	C	1.2	0.06	20	3	26478	66478
	6.8	D	1.7	0.06	14	2.5	26688	66688
	10	D	2.5	0.06	10	2.0	26109	66109
35	0.10	A	0.5	0.04	640	24	195 27107	195 67107
	0.15	A	0.5	0.04	430	21	27157	67157
	0.22	A	0.5	0.04	290	19	27227	27227
	0.33	A	0.5	0.04	193	18	27337	67337
	0.47	A	0.5	0.06	136	11	90001	90004
	0.47	B	0.5	0.06	136	11	27477	67477
	0.68	A	0.5	0.04	94	8	90002	90005
	0.68	B	0.5	0.04	94	8	27687	67687
	1.0	B	0.5	0.06	64	7	27108	67108
	1.5	B	0.6	0.06	64	6	90003	90006
	1.5	C	0.6	0.06	64	6	27158	67158
	2.2	C	0.8	0.06	43	4	27228	67228
	3.3	C	1.2	0.06	29	3	27338	67338
	4.7	D	1.7	0.06	20	2.5	27478	67478
	6.8	D	2.4	0.06	14	2.0	27688	67688

ADDITIONAL ELECTRICAL DATA

Table 4 Voltage ratings (in V)

RATED VOLTAGE U_R	DERATED VOLTAGE U_C	SURGE VOLTAGE U_S	
-55 to +85 °C	125 °C	85 °C	125 °C
4	2.5	5.0	3.2
6.3	4.0	8.0	5.0
10	6.3	13.0	8.0
16	10.0	20.0	13.0
20	13.0	25.0	16.0
25	16.0	32.0	20.0
35	22.0	45.0	28.0

Max. reverse voltage $U_{rev} \leq 0.01\ U_C$

Recommended series resistance
at U_R, U_C $R_s \geq 3\ \Omega/V$
at 0.5 (U_R, U_C), 40 °C $R_s \geq 0.1\ \Omega/V$

Max. power dissipation

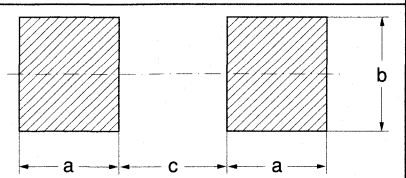
		25 °C	85 °C	125 °C
Case A	P ≤	0.075 W	0.067 W	0.030 W
Case B	P ≤	0.085 W	0.077 W	0.035 W
Case C	P ≤	0.110 W	0.100 W	0.045 W
Case D	P ≤	0.150 W	0.135 W	0.060 W

Max. permissible ripple current, rms $I_{r\,max} = \sqrt{P/ESR}$

Max. permissible ripple voltage, rms (within specified DC voltage limits) $U_{r\,max} = Z\sqrt{P/ESR}$

APPLICATION NOTE

Table 5 Recommended pad dimensions for soldering

CASE	PAD DIMENSIONS	WAVE SOLDERING a	REFLOW SOLDERING a	b	c
A		2.9 mm	1.6 mm	1.7 mm	1.2 mm
B		3.0 mm	1.6 mm	1.8 mm	1.6 mm
C		4.1 mm	2.4 mm	2.3 mm	2.4 mm
D		5.2 mm	2.4 mm	2.9 mm	3.7 mm

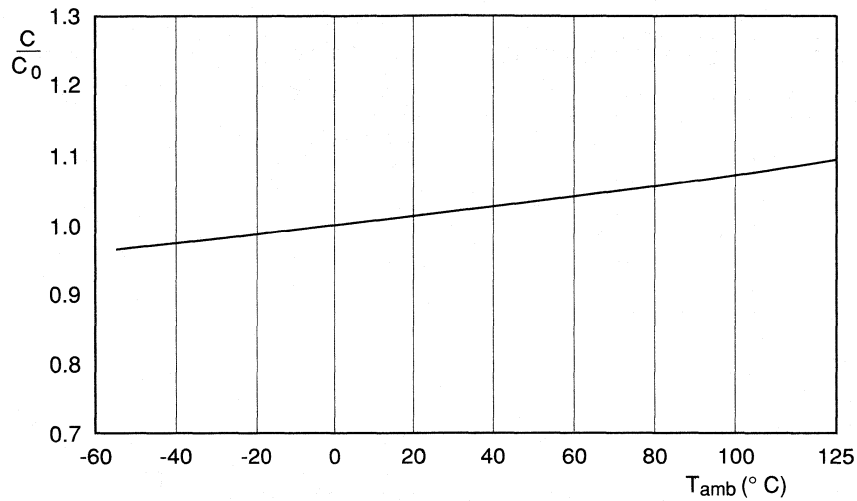


Fig. 3 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature; C_0 = Capacitance at 20 °C, 120 Hz.

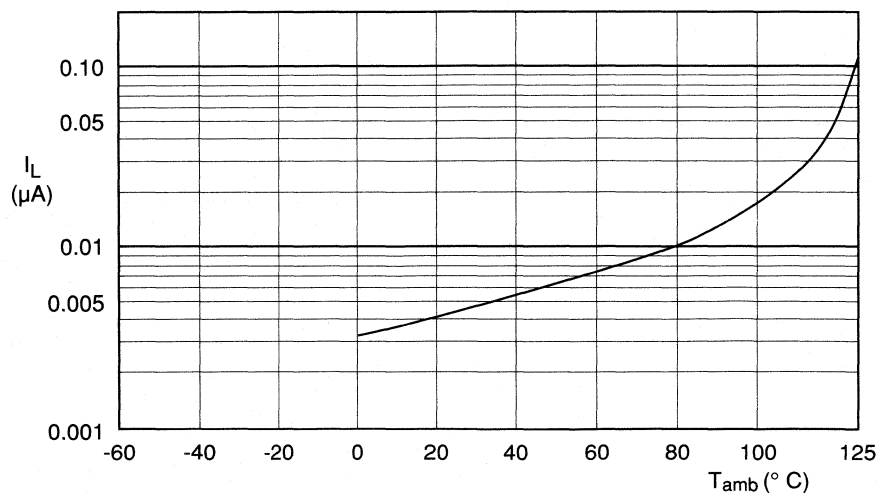


Fig. 4 Typical leakage current as a function of ambient temperature.

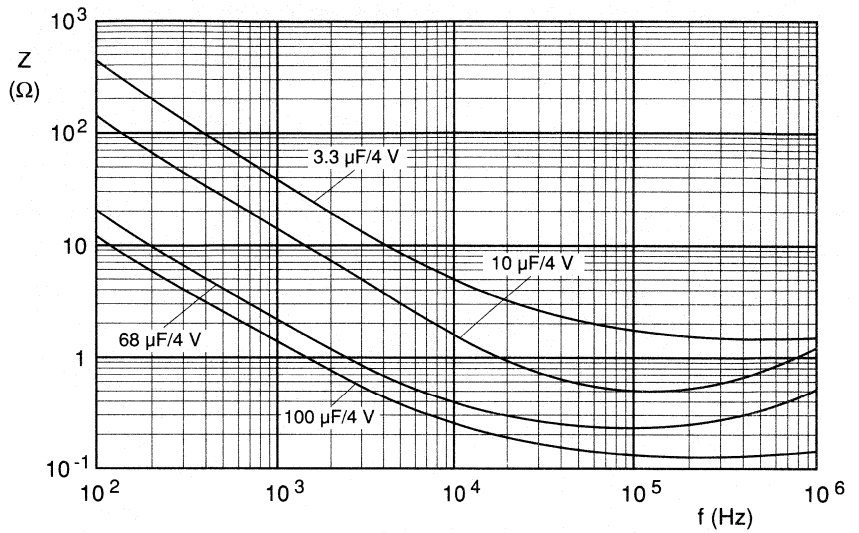


Fig. 5 Typical impedance as a function of frequency.

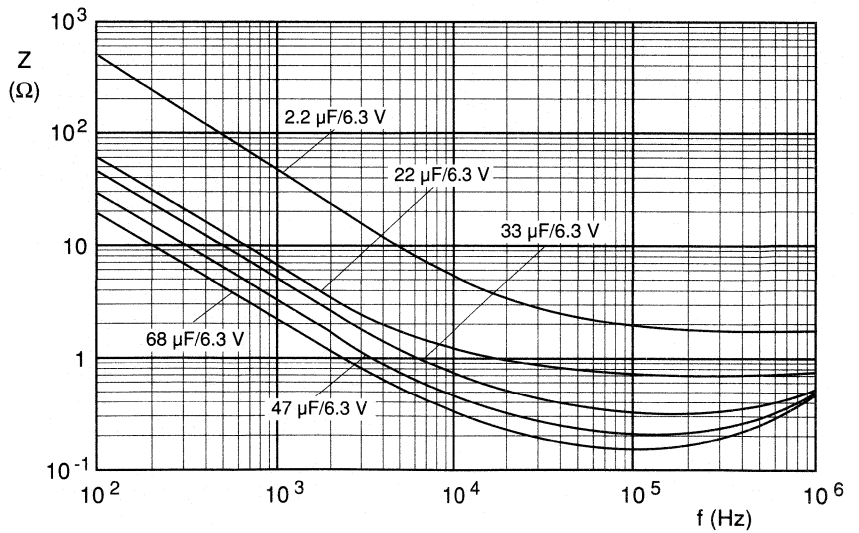


Fig. 6 Typical impedance as a function of frequency.

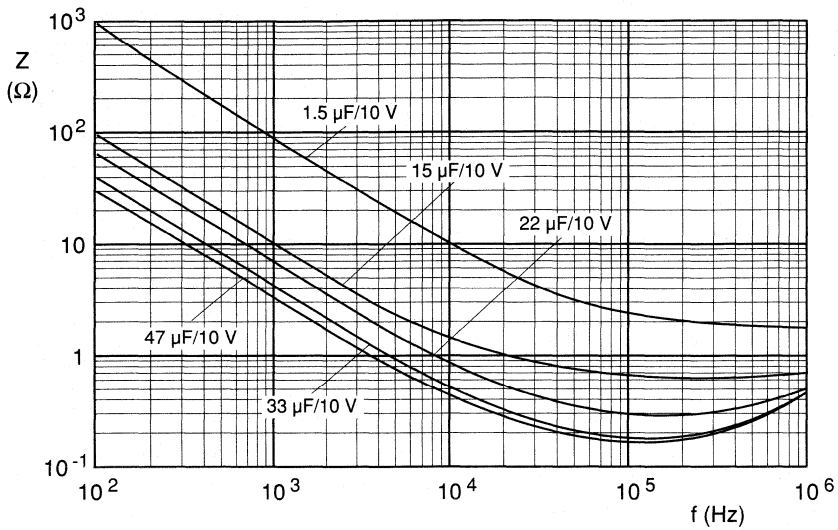


Fig. 7 Typical impedance as a function of frequency.

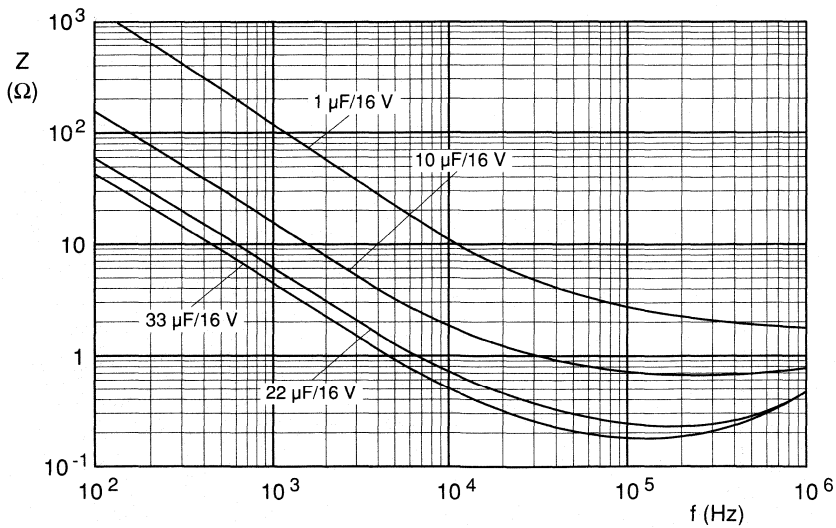


Fig. 8 Typical impedance as a function of frequency.

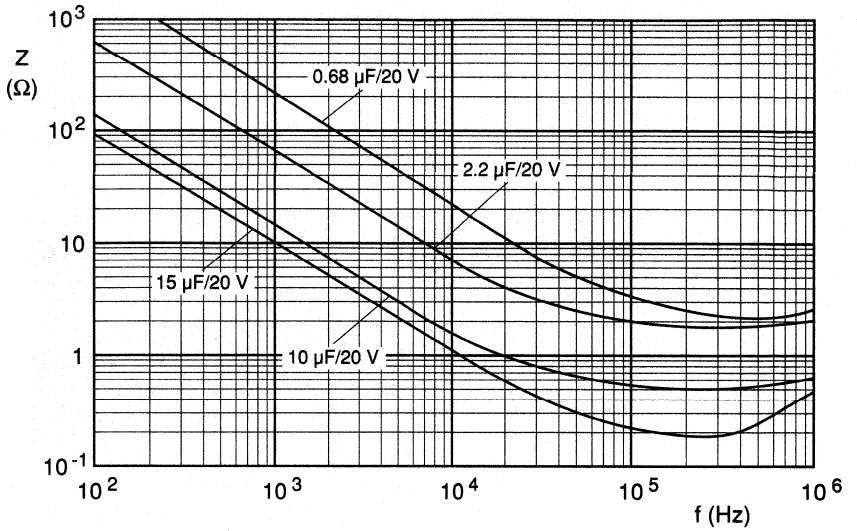


Fig. 9 Typical impedance as a function of frequency.

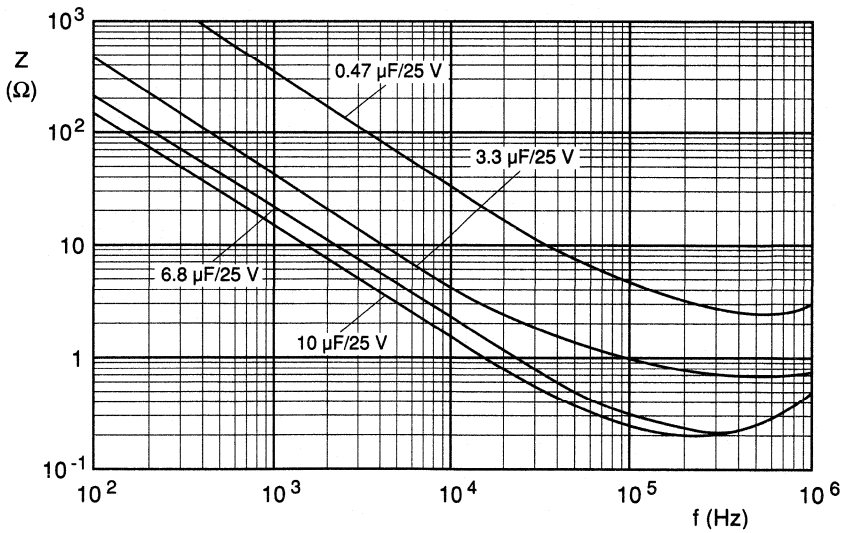


Fig. 10 Typical impedance as a function of frequency.

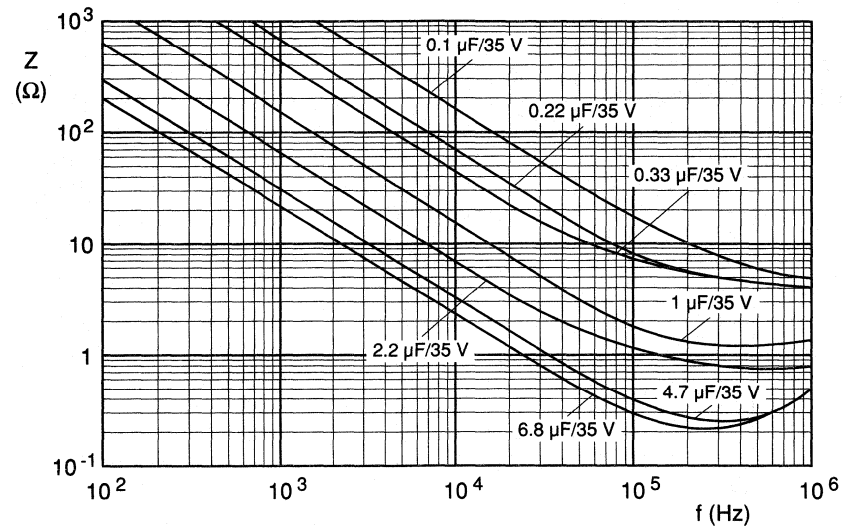


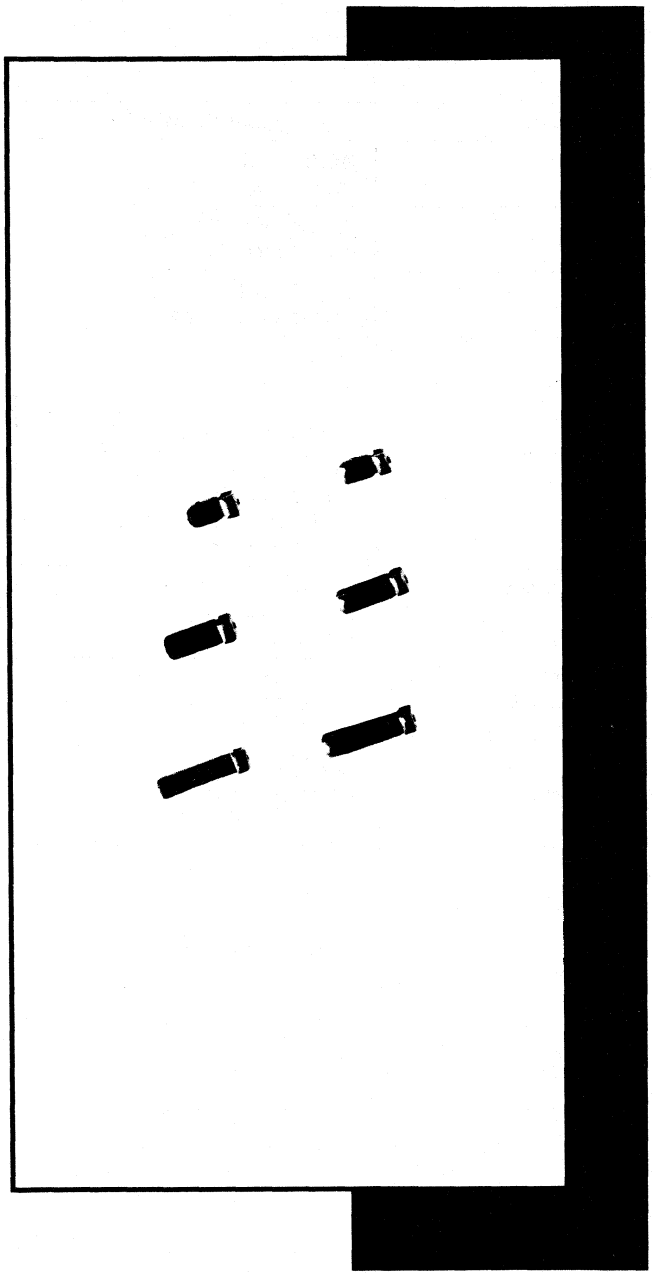
Fig. 11 Typical impedance as a function of frequency.

SPECIFIC TESTS AND REQUIREMENTS

Table 6

TEST	PROCEDURE	REQUIREMENTS
Soldering heat	(260 ± 5) °C, 5 s	$\|\Delta C/C\| \leq \pm 5$ % tan $\delta \leq$ spec. limit
Stability at low and high temperature	T_{amb} = –55 °C	$\|\Delta C/C\| \leq \pm 12$ % tan $\delta \leq$ spec. limit
	T_{amb} = +20 °C	$I_L \leq 0.01$ CU or 0.5 µA whichever is greater
	T_{amb} = +85 °C	$\|\Delta C/C\| \leq \pm 12$ % tan $\delta \leq$ spec. limit $I_L \leq 0.1$ CU or 5 µA whichever is greater
	T_{amb} = +125 °C	$\|\Delta C/C\| \leq \pm 15$ % tan $\delta \leq$ spec. limit $I_L \leq 0.125$ CU or 6.25 µA whichever is greater
Humidity	T_{amb} = 40 °C, RH = 90 to 95 % t = 500 hours	$\|\Delta C/C\| \leq \pm 5$ % tan $\delta \leq$ spec. limit $I_L \leq$ spec. limit
Surge voltage	T_{amb} = 85 °C, charge 0.5 min. discharge 5.5 min., total 6 min. 1000 cycles	$\|\Delta C/C\| \leq \pm 5$ % tan $\delta \leq$ spec. limit $I_L \leq$ spec. limit
Endurance	T_{amb} = 85 °C Case A and B 2000 hours Case C and D 1000 hours	$\|\Delta C/C\| \leq \pm 10$ % tan $\delta \leq$ spec. limit $I_L \leq 1.25$ x spec. limit

Tantalum SMD ULTRA CHIP 49 UC



DESCRIPTION

■ The 49UC ULTRA CHIP Series is a companion to the patented Philips Components Blue Chip, which has gai world-wide acceptance as the ultra high reliability capacitive component for military electronics and othe sophisticated micro-electronic systems. It is a cost-effec alternative to the Blue Chip in high volume industrial applications.

■ The 49UC Series provides maximum volumetric efficie in a conformally coated device. The capacitive elemen protected from external contaminates by a proprietary conformal coating.

■ The ULTRA CHIP is available in three standard size which are physically similar to the Blue Chip and dire pad-compatible with MIL-C-55365/4 (CWR-06) style capacitors.

■ Philips Components 49UC series is especially suited use on SMD circuit boards, as well as in thick or thin film hybrid circuits, where cap values between 0.1 μF 6.8 μF are required.

■ ULTRA CHIP Surface Mount Devices are supplied in 8 and 12 mm embossed tape for efficiency in handling and storage as well as being compatible with all tape-f high speed placement equipment.

■ Electrical characteristics such as low leakage curren and low equivalent series resistance and minimum capacitance shift at high frequencies make the ULTRA CHIP an excellent choice for circuits where actual performance must be weighed against low initial cost.

■ Philips Components manufactures the ULTRA CHIP products utilizing advanced Statistical Process Contro methods (SPC). The use of Statistical Process Control techniques provides a very consistent and reliable prod

FEATURES

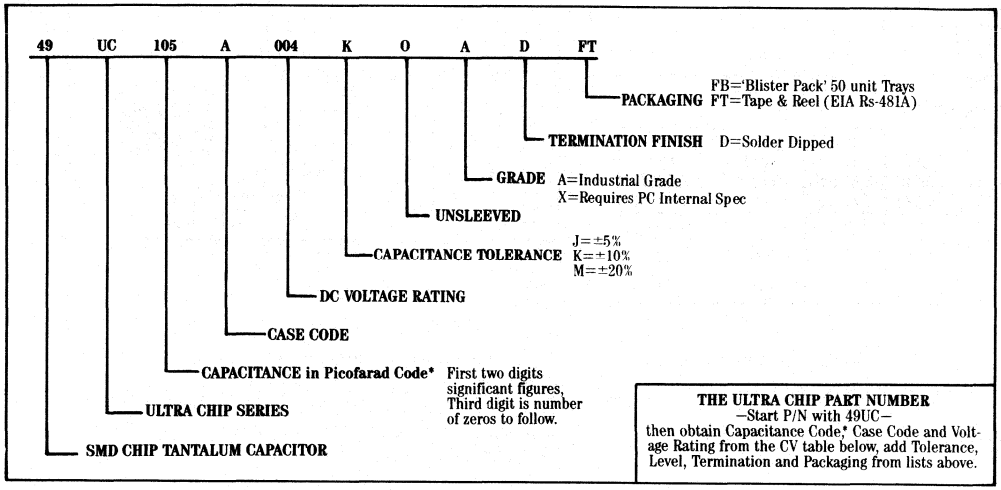
- −55°C through +85°C Operation (125°C with Volta Derating)
- Capacitance Range: 0.1 μF to 6.8 μF
- Rated Voltages: 4 VDC to 50 VDC
- Three Standard Case Sizes A, B, C (Pad-Compatible with CWR-06)
- Low Electrical losses and minimum capacitance shi in High-Frequency Applications
- Solder-Dipped Terminations Ideally Suited for Solde Reflow Techniques
- Conformally Coated Construction Provides Minimur Height as well as the Ultimate in Real Estate Efficie
- Standard Tape & Reel Packaging

49UC is pad-compatible with CWR06 (Mil-C-55365/4) A, B, and C case sizes.

*SMD is a Service Mark of North American Philips Corporation

PART NUMBER DESIGNATION

Philips Components Series 49UC ULTRA CHIP Capacitors can be completely specified using the following designation:



49UC CAPACITANCE–VOLTAGE–CASE CODE TABLE

Select standard Capacitance/Voltage ratings and corresponding standard ULTRA CHIP case codes from this table.

CAP μF	PICOFARAD CODE*	004 V	006 V	010 V	015 V	020 V	025 V	035 V	050 V
0.10	104	A	A	A	A	A	A	A	A
0.15	154	A	A	A	A	A	A	A	A
0.22	224	A	A	A	A	A	A	A	B
0.33	334	A	A	A	A	A	A	B	B
0.47	474	A	A	A	A	A	B	B	C
0.68	684	A	A	A	A	B	B	C	
1.0	105	A	A	A	B	B	C		
1.5	155	A	A	B	B	C			
2.2	225	A	B	B	C				
3.3	335	B	B	C					
4.7	475	B	C						
6.8	685	C							

PHYSICAL SPECIFICATIONS

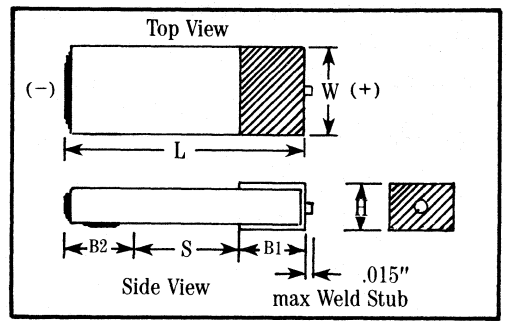
DIMENSIONS—Inches

CASE CODE	(W) WIDTH ±0.015	(L) LENGTH ±0.015	(H) HEIGHT ±0.015	(S) SPACING Typical	(B1) + PAD WIDTH ±0.010	(B2) − PAD WIDTH −.010/+.025
A	.050	.100	.050	.040	.030	.030
B	.050	.150	.050	.090	.030	.030
C	.050	.200	.050	.140	.030	.030

DIMENSIONS—mm

CASE CODE	(W) WIDTH ±0.381	(L) LENGTH ±0.381	(H) HEIGHT ±0.381	(S) SPACING Typical	(B1) + PAD WIDTH ±0.254	(B2) − PAD WIDTH −.254/+.635
A	1.27	2.54	1.27	1.02	0.76	0.76
B	1.27	3.81	1.27	2.29	0.76	0.76
C	1.27	5.08	1.27	3.55	0.76	0.76

CASE OUTLINE DRAWING



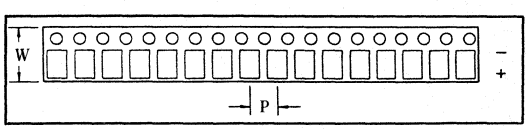
NOTES:

1. For polarity identification, when chip is in mounting position, bare metal clip and weld stub are positive. The top negative surface is conformally coated.
2. Metric Equivalents are for general information purposes only and are based on 1"=25.4 mm.
3. Anode Riser (Weld Stub) may extend case size Length dimension by 0.015" (.38 mm) max.
4. Spacing Dimension is typical distance between chip mounting terminations and therefore average distance between mounting pads on substrate.

PACKAGING

TAPE & REEL

■ 49UC Series capacitors are shipped in Tape & Reel packaging to facilitate the use of automatic placement equipment. Tape & Reel is per EIA (Electronic Industries Association) specification RS-481A. Capacitor orientation within tape pockets is negative terminal toward sprocket holes and mounting side down. 8 and 12 mm tape widths are used according to case size. Quantities less than minimum reel will be shipped in Blister Pack trays.

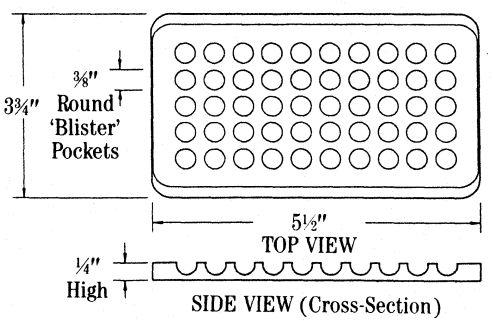


TAPE & REEL SPECIFICATIONS

49UC Case Code	(W) Tape Width	(P) Unit Pitch Ctr/Ctr	Quantity per full 7" Reel	Minimum Quantity per Reel
A	8 mm	4 mm	3,000	1,500
B	12 mm	4 mm	3,000	1,500
C	12 mm	4 mm	3,000	1,500

BLISTER-PACK TRAYS

■ 49UC Series capacitors are available in 'Blister Pack' trays containing 50 pieces each in a 5 x 10 matrix configuration. The Blister Pack provides a separate pocket for each unit to prevent damage to the capacitors during shipping, handling and storage.



■ Blister Pack trays are stamped polystyrene with a clear plastic cover. Orientation of the capacitors within the pockets is random with respect to polarity and mounting surface. This packaging is ideal for hand placement of the capacitors as it takes up very little room at a work station. It is recommended that operators remove and work with the ULTRA CHIPs using a blunt, coated tweezer to prevent damage to the conformal coating.

APPLICATION NOTES

CAPACITANCE

■ Capacitance shall be measured at or referred to 120 Hz at 25°C. The AC signal shall not exceed 1.0 VRMS.

■ TOLERANCE—Type 49UC are available in ±20%, ±10% and ±5% capacitance tolerances.

■ CAPACITANCE CHANGE WITH TEMPERATURE—from 25°C reading (maximum):
at −55°C −10% Δ
at +85°C +10% Δ
at +125°C +15% Δ

DISSIPATION FACTOR (DF)

■ DF is determined by the same method as capacitance.

DC LEAKAGE CURRENT (DCL)

■ DCL shall be measured at WVDC after a 5 minute electrification period with a 1000 ohm current-limiting resistor in series.

VOLTAGE RATING

■ ULTRA CHIPS can be used at elevated temperatures when voltage is derated in accordance with the following:

Rated WVDC −55°C to 85°C	Derated (DC) 125°C	Surge Voltage (DC) 85°C	Surge Voltage (DC) 125°C
4	2.7	5.0	3.4
6	4.0	8.0	5.0
10	7.0	13.0	9.0
15	10.0	20.0	12.0
20	13.0	26.0	16.0
25	17.0	32.0	20.0
35	23.0	46.0	26.0
50	33.0	65.0	38.0

SURGE VOLTAGE

■ The surge voltage is the maximum DC voltage, including AC or other pulses applied for short duration.

REVERSE VOLTAGE

■ Series 49UC capacitors will withstand momentary voltage reversals up to 15% at 25°C, 10% at 55°C and 1% at 125°C of their rated voltage.

ULTRA CHIP ELECTRICAL LIMITS & CASE CODES

Cap. (nom) µF	Rated VDC 85°C	DC Leakage (max) 25°C µA	DC Leakage (max) 85°C µA	DC Leakage (max) 125°C µA	DF 120Hz %	ESR (max)* 120Hz Ω	ESR (max)* 100KHz Ω	Case Code
2.2	4	0.5	5	7	6	36	9.0	A
4.7	4	0.5	5	7	6	17	5.5	B
6.8	4	0.5	5	7	6	12	3.5	C
1.5	6	0.5	5	7	6	53	9.0	A
3.3	6	0.5	5	7	6	24	5.5	B
4.7	6	0.5	5	7	6	17	3.5	C
1.0	10	0.5	5	7	6	80	9.0	A
2.2	10	0.5	5	7	6	36	5.5	B
3.3	10	0.5	5	7	6	24	3.5	C
.68	15	0.5	5	7	6	120	10.0	A
1.5	15	0.5	5	7	6	53	6.0	B
2.2	15	0.5	5	7	6	36	4.0	C
.47	20	0.5	5	7	6	170	12.0	A
.68	20	0.5	5	7	6	120	8.0	B
1.0	20	0.5	5	7	6	80	8.0	B
1.5	20	0.5	5	7	6	53	6.0	C
.33	25	0.5	5	7	6	240	15.0	A
.68	25	0.5	5	7	6	120	10.0	B
1.0	25	0.5	5	7	6	80	8.0	C
.22	35	0.5	5	7	6	360	18.0	A
.47	35	0.5	5	7	6	170	12.0	B
.68	35	0.5	5	7	6	120	9.0	C
.10	50	0.5	5	7	6	800	20.0	A
.15	50	0.5	5	7	6	530	20.0	A
.22	50	0.5	5	7	6	360	15.0	B
.33	50	0.5	5	7	6	240	15.0	B
.47	50	0.5	5	7	6	170	10.0	C

*120 Hz ESR is maximum at nominal capacitance.

MARKING

■ The small physical size of the ULTRA CHIP does not permit alpha-numeric marking on the body of the capacitor. Color dots on the body of the capacitor are available on special order, if required. Series 49UC capacitors are identified in their package container.

POLARITY

■ Series 49UC capacitors are polar devices. Proper polarity must be observed or damage to the capacitor and/or the circuit will result.

AC POWER DISSIPATION

CASE CODE	MAXIMUM POWER DISSIPATION IN WATTS AMBIENT TEMPERATURE		
	25°C	85°C	125°C
A	.063	.056	.025
B	.075	.067	.030
C	.081	.073	.032

■ Major physical factors which limit the ability of the capacitor to dissipate internally generated heat produced during AC circuit operation, include unit construction features as related to a particular capacitor design, and heat transfer characteristics of the materials used in the construction of the capacitor. Larger volumetric packages exhibiting electrical characteristics similar to those of smaller physical packages will, under similar conditions, be capable of dissipating more power. Conformally coated capacitors, such as the ULTRA CHIP series, exhibit more efficient heat dissipation capabilities, due to the absence of relatively thick thermally insulative coatings, as incorporated in "molded" tantalum chip capacitor styles.

■ Maximum power dissipation levels shown represent an empirically determined wattage level required to cause a 10 degree centigrade temperature increase above the stated temperature in "still air" as measured on the external capacitor body, utilizing a thermo-couple or other appropriate measuring device.

AC RIPPLE CURRENT

■ Circuit design and physical layout should provide "cool" circuit board locations for capacitors operating at high AC current levels. Capacitor temperature may increase due to heat transfer/absorption from the ambient environment or a "hot" component mounted in close proximity to the capacitor. The result of increased AC current is increased internal heat generation within the capacitor body. Waveform envelope is also a factor in the amount of internal heat generated within the capacitor since non-sinusoidal waveshapes produce heating effects different than those of sinusoidal waveforms.

■ The ripple current and voltage level impressed across the capacitor should not exceed the maximum power dissipation of the capacitor unless special provisions are made to increase the rate of heat dissipation from the body of the capacitor, such as by the use of a heat sink or providing air flow. Excessive power dissipation in tantalum chip capacitors may cause catastrophic failure. The I_{max} value of current must be used to determine the operating conditions.

■ The maximum permissible AC (rms) current applied across the capacitor is related to the equivalent series resistance (ESR) and the physical power dissipation capability of the capacitor. The maximum (rms) ripple current at a given frequency may be determined by:

$$I_{max}\,(rms) = \sqrt{Pdm/ESR}$$

where... Pdm = Maximum Power Dissipation in watts, at the maximum circuit operating temperature

$$ESR = \frac{1}{2\pi * \text{AC Frequency} * \text{Capacitance}} * \text{D.F.}$$

AC Frequency in Hertz
Capacitance is in Farads
Dissipation Factor is in decimal form

AC RIPPLE VOLTAGE

■ The maximum AC ripple voltage at the applied frequency must be limited to an rms value which permits only the recommended maximum power dissipation specified for a given case code.

■ The maximum AC ripple voltage may be determined by:

$$E_r\,(rms) = Z\sqrt{Pdm/ESR}$$

where... E_r = AC Ripple Voltage
Z is the Impedance in ohms
Pdm is the Maximum Power Dissipation in watts, at the maximum circuit operating temperature
ESR is the Equivalent Series Resistance in ohms

■ Both voltage and current levels at a given frequency must be maintained so as not to exceed the recommended maximum power dissipation levels at the maximum circuit operating temperature. The DC bias voltage applied in series with the AC source applied across polar style capacitors, on which the AC voltage is "riding," may be ignored when considering the heating effects of AC current on the capacitor. The positive peak AC voltage plus the DC voltage must not exceed the rated DC voltage of the capacitor. The negative peak AC voltage in combination with the DC voltage may not obtain a level which will damage the dielectric due to reverse voltage being applied across a polar solid electrolyte tantalum chip capacitor.

NON-POLAR OPERATION

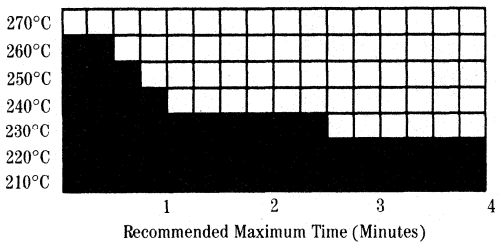
■ When two polar capacitors of the same DC voltage rating are connected back-to-back in non-polar configuration, i.e. positive-to-positive terminals or negative-to negative terminals; the "non-polar" pair may be operated without DC bias voltage. If DC voltage is applied, the positive peak AC voltage plus the DC voltage must not exceed the rated voltage of the capacitor in either direction.

SURFACE-MOUNT APPLICATION

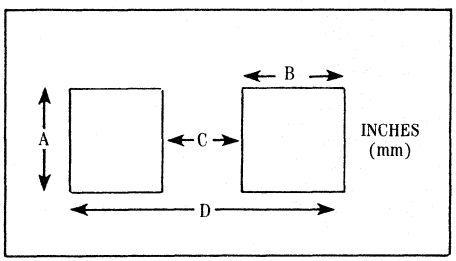
■ ULTRA CHIP capacitors are ideally suited for use on SMD circuit boards where circuit density requires the use of components with the highest cap/unit volume efficiency. Current solder reflow techniques such as IR (Infra-Red), Wave Soldering and Vapor Phase may be utilized with these capacitors.

REFLOW TIMES and TEMPERATURES

The optimum reflow profile will include a preheat cycle to provide proper fluxing prior to reflow.



RECOMMENDED PAD DIMENSIONS FOR REFLOW SOLDERING

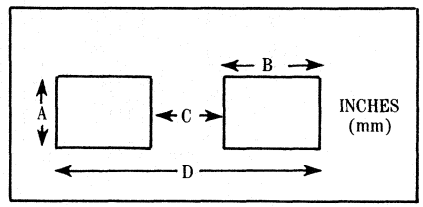


CASE SIZE	A MIN.	B MIN.	C NOM.	D NOM.
A	.085 (2.15)	.062 (1.58)	.030 (0.77)	.204 (5.17)
B	.085 (2.15)	.062 (1.58)	.080 (2.04)	.254 (6.44)
C	.085 (2.15)	.062 (1.58)	.130 (3.31)	.304 (7.71)

ADDITIONAL PHYSICAL STATISTICS

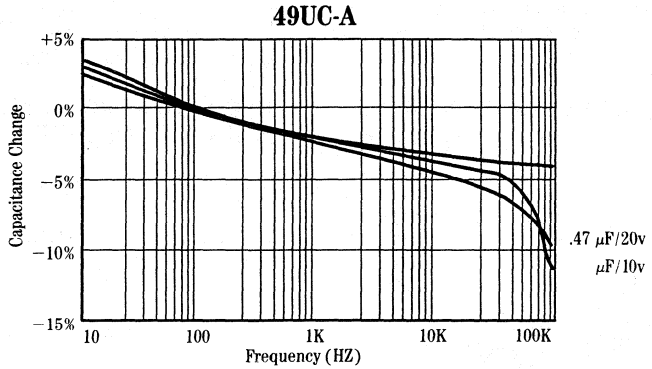
49UC Case Codes	PHYSICAL STATISTICS				Typical Weight (grams)
	Substrate Area		Typical Volume		
	sq. in.	sq. cm	cu. in.	cu. cm	
A	0.00500	0.0323	0.000250	0.0041	0.02
B	0.00750	0.0484	0.000375	0.0062	0.03
C	0.01000	0.0645	0.000500	0.0082	0.04

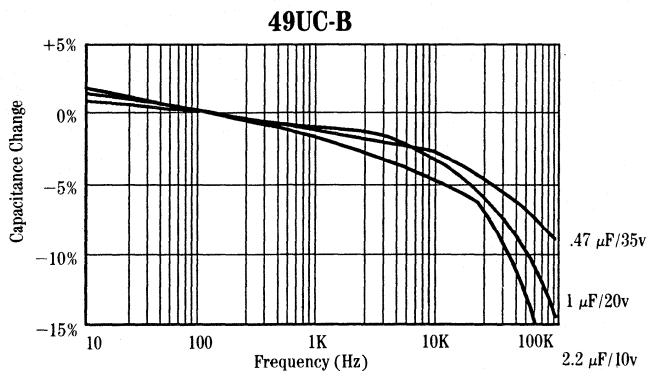
RECOMMENDED PAD DIMENSIONS FOR WAVE SOLDERING

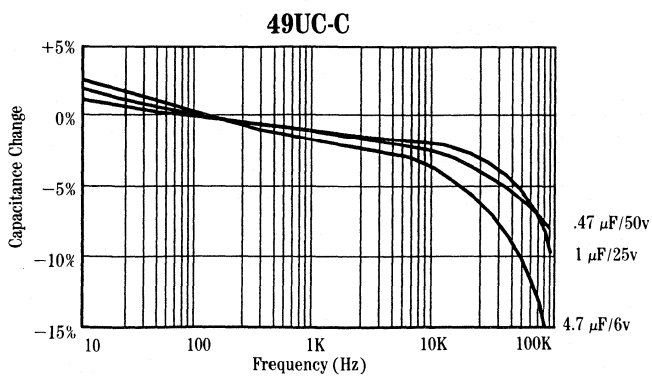


CASE SIZE	A MIN.	B MIN.	C NOM.	D NOM.
A	.044 (1.11)	.067 (1.70)	.030 (0.77)	.204 (5.17)
B	.044 (1.11)	.067 (1.70)	.080 (2.04)	.254 (6.44)
C	.044 (1.11)	.067 (1.70)	.130 (3.31)	.304 (7.71)

TYPICAL CHARACTERISTICS

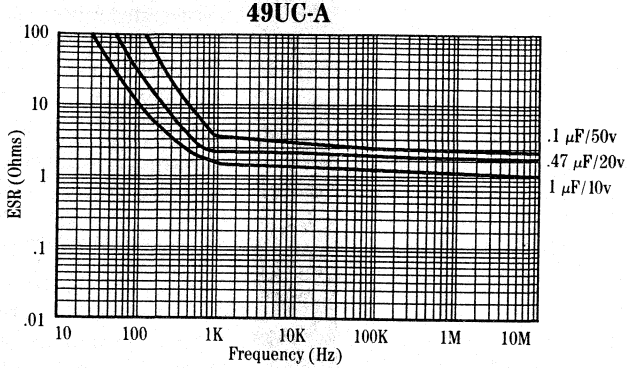




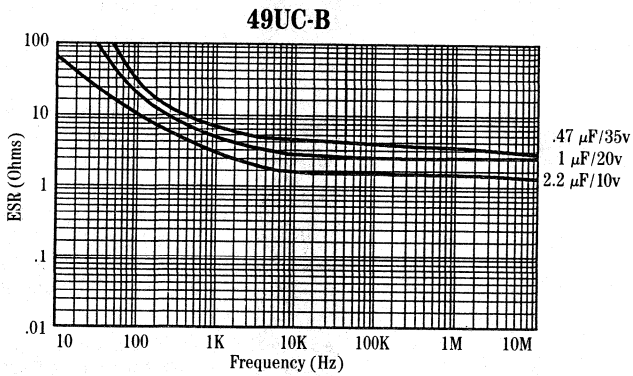


TYPICAL CHARACTERISTICS

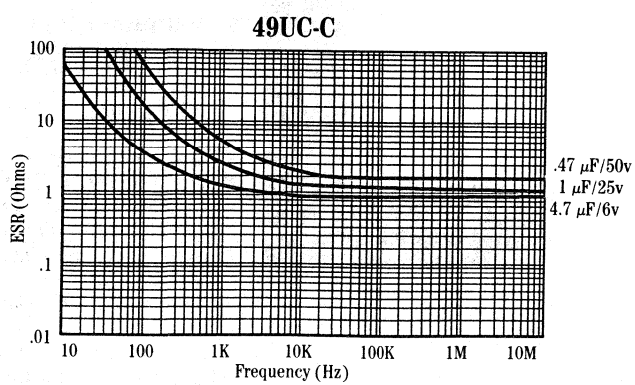
49UC-A



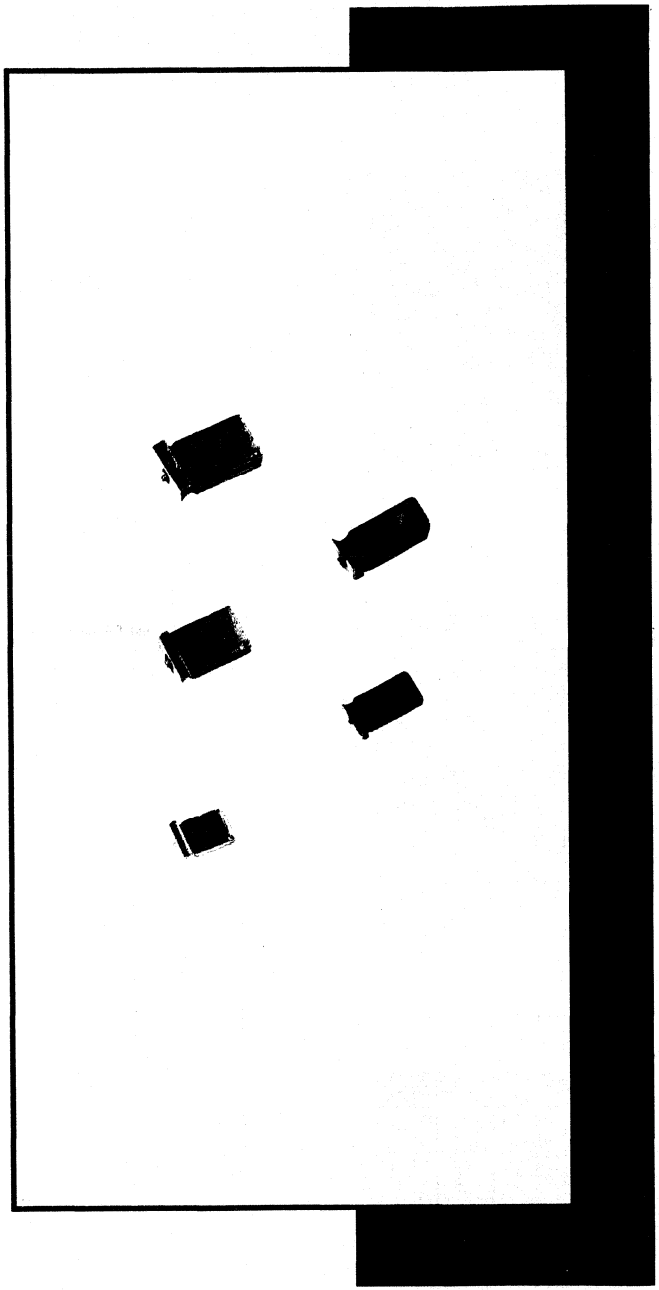
49UC-B



49UC-C



Tantalum SMD XTRA CHIP 49 XC



3

DESCRIPTION

■ The 49XC XTRA CHIP Series surface mounted tantal chip capacitor offers the highest capacitance rating at a given rated voltage of any tantalum chip capacitor series currently available in the industry...a true state-of-the-art" product.

■ The 49XC Series tantalum chip capacitor is the most volumetric efficient tantalum chip capacitor available printed wiring board or thick/thin film hybrid circuit applications. The 49XC tantalum chip capacitor requi as little as 1/7 (one-seventh) the volume required by commercially available molded tantalum chip capacito series, for comparable capacitance-voltage (CV) rating This advanced series offers up to 4 times the capacita currently available in other conformally coated tantal chip capacitors of the same voltage rating and size.

■ The XTRA CHIP tantalum chip capacitor is available five standard case sizes which are identical to the STA CHIP tantalum chip capacitor and cover the capacitan range of 1.0 μF through 220 μF in the voltage range of 4 through 50 VDC.

■ The capacitive element of each XTRA CHIP tantalu chip capacitor is protected by a "near-hermetic" paten construction feature which provides total compatibilit with all standard soldering fluxes, soldering methods cleaning solvents. This construction also provides effic ripple current heat dissipation in each of the five case sizes.

■ XTRA CHIP Surface Mount Devices are supplied in 12 embossed tape for efficiency in handling and storage. packaging conforms to EIA standard RS-481 and is compa with all tape-fed high speed placement equipment. cost.

■ Philips Components utilizes modern automated manufacturing processes incorporating Statistical Pro Control (SPC) methods interacting with an integrated Manufacturing Resources Planning (MRP II) system t manufacture a very consistent and reliable product.

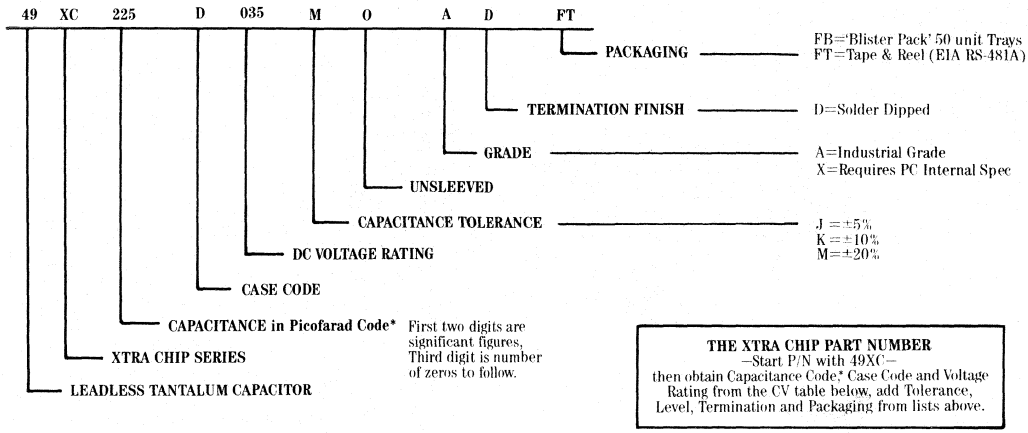
FEATURES

- −55°C through +85°C Operation (125°C with Volt Derating)
- Capacitance Range: 1.0 μF to 220 μF
- Rated Voltages: 4 VDC to 50 VDC
- Five Standard Case Sizes: D, E, F, G, H
- Low ESR in High-Frequency Applications
- Solder-Dipped Terminations Ideally Suited for Solde Reflow Techniques
- Conformally Coated Construction Provides Minimu Height
- 12 mm Tape & Reel (Standard Packaging) Conforms EIA RS-481 Specifications

*SMD is a Service Mark of North American Philips Corporation
The Xtra Chip is covered by US Patent No. 4,571,664

PART NUMBER DESIGNATION

Philips Components Series 49XC XTRA CHIP Capacitors can be completely specified using the following designation:



3

49XC CAPACITANCE—VOLTAGE—CASE CODE TABLE

Select standard Capacitance-Voltage ratings and corresponding standard XTRA CHIP case codes from this table.

CAP μF	PICOFARAD CODE*	004 V	006 V	010 V	015 V	020 V	025 V	035 V	050 V
1.0	105	→	→	→	→	→	→	D	D
1.5	155	→	→	→	→	→	→	D	D
2.2	225	→	→	→	→	→	→	D	E
3.3	335	→	→	→	→	→	D	E	F
4.7	475	→	→	→	→	→	D	F	G
6.8	685	→	→	→	→	D	E	F	G
10	106	→	→	→	D	E	F	G	H
15	156	→	→	→	D	→	F	H	
22	226	→	→	D	→	F	G		
33	336	→	D	→	F	G	H		
47	476	→	E	F	G	H			
68	686	→	F	G	H				
100	107	F	G	H					
120	127	→	G	H					
150	157	→	G						
180	187	G	H						
220	227	H							

Arrow indicates that next higher voltage is the standard rating available.

Tantalum SMD XTRA CHIP | 49 XC

PHYSICAL SPECIFICATIONS

DIMENSIONS—Inches

CASE CODE	(W) WIDTH ±0.015	(L) LENGTH ±0.015	(H) HEIGHT ±0.015	(S) SPACING Typical	(B1) +PAD WIDTH ±0.010	(B2) −PAD WIDTH −.010/+.025
D	.100	.150	.050	.090	.030	.030
E	.100	.200	.050	.140	.030	.030
F	.135	.220	.070	.160	.030	.030
G	.110	.265	.110	.165	.050	.050
H	.160	.275	.110	.175	.050	.050

DIMENSIONS—mm

CASE CODE	(W) WIDTH ±0.381	(L) LENGTH ±0.381	(H) HEIGHT ±0.381	(S) SPACING Typical	(B1) +PAD WIDTH ±0.254	(B2) −PAD WIDTH −.254/+.635
D	2.54	3.81	1.27	2.29	0.76	0.76
E	2.54	5.08	1.27	3.56	0.76	0.76
F	3.43	5.59	1.78	4.06	0.76	0.76
G	2.79	6.73	2.79	4.19	1.27	1.27
H	4.06	6.99	2.79	4.45	1.27	1.27

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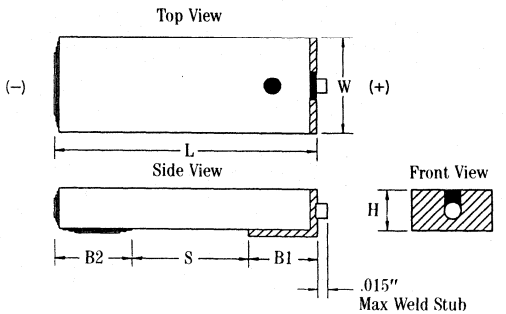
CASE OUTLINE DRAWING



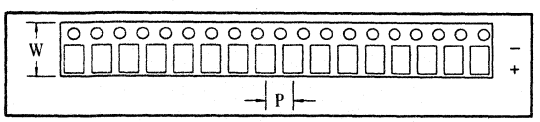
NOTES:

1. For polarity identification, when chip is in mounting position, metal "L" clip and weld stub are positive. The top negative surface is conformally coated.
2. Metric equivalents are for general information purposes only and are based on 1"=25.4 mm.
3. Anode riser (Weld Stub) may extend case size Length dimension by 0.015" (.38 mm) max.
4. Spacing dimension is typical distance between chip mounting terminations and therefore average distance between mounting pads on substrate.

PACKAGING

TAPE & REEL

■ XTRA CHIP Series capacitors are shipped in Tape & Reel packaging to facilitate the use of automatic placement equipment. Tape & Reel is per EIA (Electronic Industries Association) specification RS 481. Orientation of the chip within the tape pockets is negative terminal toward sprocket holes and mounting side down. Quantities less than minimum reel will be shipped in Blister-Pack trays.

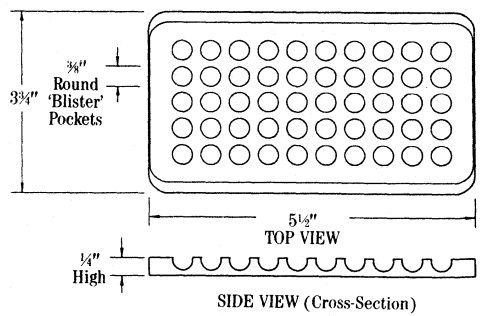


TAPE & REEL SPECIFICATIONS

CASE CODE	(W) Tape Width	(P) Unit Pitch Ctr/Ctr	Quantity per full 7" Reel	Minimum Quantity per Reel
D	12mm	4mm	2,700	1,350
E	12mm	4mm	2,700	1,350
F	12mm	8mm	1,000	500
G	12mm	8mm	700	350
H	12mm	8mm	700	350

BLISTER-PACK TRAYS

■ 49XC Series capacitors are available in Blister-Pack tray containing 50 pieces each in a 5 x 10 matrix configuration. Blister Pack trays are stamped polystyrene with a clear plastic cover.



■ Orientation of the capacitors within the tray pockets is random with respect to polarity and mounting surface. This packaging is ideal for hand placement of the capacitors as it takes up very little room at the workstation.

APPLICATION NOTES

CAPACITANCE

■ Capacitance shall be measured at or referred to 120 Hz at 25°C. The AC signal shall not exceed 1.0 VRMS.

TOLERANCE: ±20%, ±10% and ±5% cap tolerances are available.

MAX CAPACITANCE CHANGE WITH TEMPERATURE from 25°C

Temperature	−55°C	+85°C	+125°C
Max. Cap Change	−10%△	+10%△	+15%△

DC LEAKAGE CURRENT (DCL)

■ DCL shall be measured at WVDC after a 5 minute electrification period with a 1000 ohm current-limiting resistor in series.

VOLTAGE RATING

■ All XTRA CHIP tantalum chip capacitors can be used at elevated temperatures when the working voltage is derated in accordance with the following table.

Rated WVDC −55°C to +85°C	Derated (DC) +125°C	Surge Voltage (DC) +85°C	Surge Voltage (DC) +125°C
4	2.7	5.0	3.4
6	4.0	8.0	5.0
10	7.0	13.0	9.0
15	10.0	20.0	12.0
20	13.0	26.0	16.0
25	17.0	32.0	20.0
35	23.0	46.0	26.0
50	33.0	65.0	38.0

3

XTRA CHIP ELECTRICAL LIMITS & CASE CODES

Cap. (nom) µF	Rated VDC 85°C	DC Leakage (max) 25°C µA	85°C µA	125°C µA	Dissipation Factor 25°C %	85°C 125°C	-55°C %	ESR(max) 100KHz Ω	Case Code
100	4	4.0	40	48	10	12	12	0.5	F
180	4	8.0	80	96	10	12	12	0.5	G
220	4	9.0	90	108	10	12	12	0.5	H
33	6	2.0	20	24	10	12	12	1.0	D
47	6	3.0	30	36	10	12	12	0.8	E
68	6	4.0	40	48	10	12	12	0.7	F
100	6	6.0	60	72	10	12	12	0.5	G
120	6	8.0	80	96	10	12	12	0.5	G
150	6	9.0	90	108	10	12	12	0.5	G
180	6	11.0	110	132	10	12	12	0.5	H
22	10	3.0	30	36	10	12	12	1.0	D
47	10	5.0	50	60	10	12	12	0.7	F
68	10	7.0	70	84	10	12	12	0.7	G
100	10	10.0	100	120	10	12	12	0.5	H
120	10	12.0	120	144	10	12	12	0.5	H
10	15	2.0	20	24	6	8	8	1.5	D
15	15	3.0	30	36	6	8	8	1.5	D
33	15	5.0	50	60	6	8	8	0.8	F
47	15	8.0	80	96	6	8	8	0.8	G
68	15	11.0	110	132	6	8	8	0.8	H
6.8	20	2.0	20	24	6	8	8	2.5	D
10	20	2.0	20	24	6	8	8	2.5	E
22	20	5.0	50	60	6	8	8	1.0	F

Cap. (nom) µF	Rated VDC 85°C	DC Leakage (max) 25°C µA	85°C µA	125°C µA	Dissipation Factor 25°C %	85°C 125°C	-55°C %	ESR(max) 100KHz Ω	Case Code
33	20	7.0	70	84	6	8	8	1.0	G
47	20	10.0	100	120	6	8	8	1.0	H
3.3	25	1.0	10	12	6	8	8	3.5	D
4.7	25	2.0	20	24	6	8	8	2.5	D
6.8	25	2.0	20	24	6	8	8	2.0	E
10	25	3.0	30	36	6	8	8	2.0	F
15	25	4.0	40	48	6	8	8	1.0	F
22	25	6.0	60	72	6	8	8	1.0	G
33	25	9.0	90	108	6	8	8	1.0	H
1.0	35	1.0	10	12	6	8	8	6.0	D
1.5	35	1.0	10	12	6	8	8	5.0	D
2.2	35	1.0	10	12	6	8	8	5.0	D
3.3	35	2.0	20	24	6	8	8	2.5	E
4.7	35	2.0	20	24	6	8	8	2.5	F
6.8	35	3.0	30	36	6	8	8	2.0	F
10	35	4.0	40	48	6	8	8	2.0	G
15	35	6.0	60	72	6	8	8	2.0	H
1.0	50	1.0	10	12	6	8	8	6.0	D
1.5	50	1.0	10	12	6	8	8	5.0	D
2.2	50	2.0	20	24	6	8	8	3.5	E
3.3	50	2.0	20	24	6	8	8	2.5	F
4.7	50	3.0	30	36	6	8	8	2.5	G
6.8	50	4.0	40	48	6	8	8	2.5	G
10	50	5.0	50	60	6	8	8	2.5	H

APPLICATION NOTES

AC POWER DISSIPATION

CASE CODE	MAXIMUM POWER DISSIPATION IN WATTS AMBIENT TEMPERATURE		
	+25°C	+85°C	+125°C
D	.095	.085	.038
E	.100	.090	.040
F	.125	.112	.050
G	.150	.135	.060
H	.200	.180	.080

■ Major physical factors which limit the ability of the capacitor to dissipate internally generated heat produced during AC circuit operation, include unit construction features as related to a particular capacitor design, and heat transfer characteristics of the materials used in the construction of the capacitor. Larger volumetric packages exhibiting electrical characteristics similar to those of smaller physical packages will, under similar conditions, be capable of dissipating more power. Conformally coated capacitors, such as the XTRA CHIP series tantalum chip capacitor, exhibit more efficient heat dissipation capabilities, due to the absence of relatively thick thermally insulative coatings, as incorporated in "molded" tantalum chip capacitor styles.

■ Maximum power dissipation levels shown represent an empirically determined wattage level required to cause a 10 degree centigrade temperature increase above the stated temperature in "still air" as measured on the external capacitor body, utilizing a thermo-couple or other appropriate measuring device.

AC RIPPLE CURRENT

■ Circuit design and physical layout should provide "cool" circuit board locations for capacitors operating at high AC current levels. Capacitor temperature may increase due to heat transfer or absorption from the ambient environment or a "hot" component mounted in close proximity to the capacitor. The result of increased AC current is increased internal heat generation within the capacitor body. Waveform envelope is also a factor in the amount of internal heat generated within the capacitor since non-sinusoidal waveshapes produce heating effects different than those of sinusoidal waveforms.

■ The ripple current and voltage level impressed across the capacitor should not exceed the maximum power dissipation of the capacitor unless special provisions are made to increase the rate of heat dissipation from the body of the capacitor, such as by the use of a heat sink or providing air flow. Excessive power dissipation in tantalum chip capacitors may cause catastrophic failure. The I_{max} value of current must be used to determine the operating conditions.

■ The maximum permissible AC (rms) current applied across the capacitor is related to the equivalent series resistance (ESR) and the physical power dissipation capability of the capacitor. The maximum (rms) ripple current at a given frequency may be determined by:

$$I_{max}\,(rms) = \sqrt{Pdm/ESR}$$

where... Pdm=Maximum Power Dissipation in watts, at the maximum circuit operating temperature

$$ESR = \frac{D.F.}{2\pi * AC\ Frequency * Capacitance}$$

AC Frequency is in Hertz
Capacitance is in Farads
Dissipation Factor is in decimal form

AC RIPPLE VOLTAGE

■ The maximum AC ripple voltage at the applied frequency must be limited to an rms value which permits only the recommended maximum power dissipation specified for a given case code. The maximum AC ripple voltage may be determined by:

$$E_r\,(rms) = Z\sqrt{Pdm/ESR}$$

where... E_r=AC Ripple Voltage
Z is the Impedance in ohms
Pdm is the Maximum Power Dissipation in watts, at the maximum circuit operating temperature
ESR is the Equivalent Series Resistance in ohms

■ Both voltage and current levels at a given frequency must be maintained so as not to exceed the recommended maximum power dissipation levels at the maximum circuit operating temperature. The DC bias voltage applied in series with the AC source applied across polar style capacitors, on which the AC voltage is "riding," may be ignored when considering the heating effects of AC current on the capacitor. The positive peak AC voltage plus the DC voltage must not exceed the rated DC voltage of the capacitor. The negative peak AC voltage in combination with the DC voltage may not obtain a level which will damage the dielectric due to reverse voltage being applied across a polar solid electrolyte tantalum chip capacitor.

SURGE VOLTAGE

■ The surge voltage is the maximum DC voltage, including AC or other pulses applied for short duration.

REVERSE VOLTAGE

■ Series 49XC hybrid capacitor will withstand momentary voltage reversals up to 15% at 25°C, 10% at 55°C and 1% at 125°C of the capacitor's rated voltage.

POLARITY

■ Series 49XC capacitors are polar devices. Proper polarity must be observed or damage to the capacitor and/or the circuit will result. The positive end is marked with a dot or stripe.

APPLICATION NOTES

MARKING

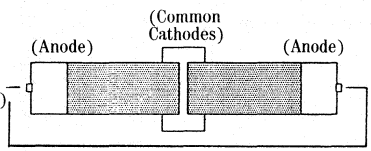
■ The small physical size of the XTRA CHIP capacitor does not permit alpha-numeric marking on the body of the capacitor. Color dots on the body of the capacitor are available on special order, if required. Series 49XC capacitors are identified on their package container.

NON-POLAR OPERATION

■ When two polar capacitors of the same DC voltage rating are connected back-to-back in non-polar configuration, i.e. positive-to-positive terminals or negative-to-negative terminals; the "non-polar" pair may be operated without DC bias voltage. If DC voltage is applied, the positive peak AC voltage plus the DC voltage must not exceed the rated voltage of the capacitor in either direction. In circuits where voltage reversals exceeding 15% at 25°C occur, or where AC ripple voltages are high, XTRA CHIP capacitors should be mounted in a non-polar configuration.

■ In these cases, if two identical XTRA CHIP capacitors are mounted in this fashion, the resulting capacitance will be ½ the value of the original devices and the voltage will be the same as the rating of the original devices.

Non-Polar Operation
Voltage dropped across anodes of capacitors in non-polar configuration (cathodes tied together)

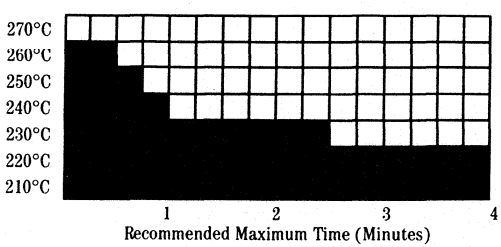


SURFACE-MOUNT APPLICATION

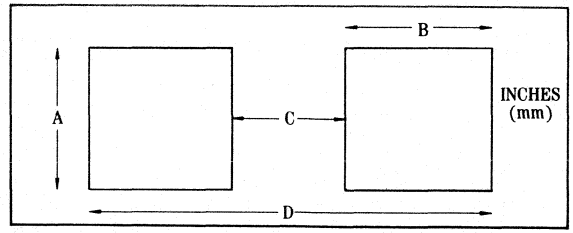
■ XTRA CHIP capacitors are ideally suited for use on SMD circuit boards where circuit density requires the use of components with the highest cap/unit volume efficiency. Current solder reflow techniques such as IR (Infra-Red), Wave Soldering and Vapor Phase may be utilized with these capacitors.

REFLOW TIMES AND TEMPERATURES

■ The optimum reflow profile will include a preheat cycle to provide proper fluxing prior to reflow.

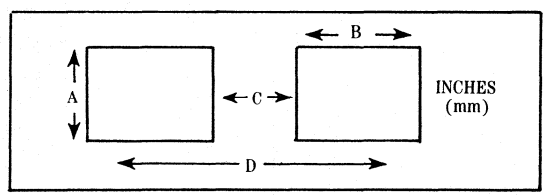


RECOMMENDED PAD DIMENSIONS FOR REFLOW SOLDERING



CASE SIZE	A MIN.	B MIN.	C NOM.	D NOM.
D	.135 (3.42)	.062 (1.58)	.080 (2.04)	.254 (6.44)
E	.135 (3.42)	.062 (1.58)	.130 (3.31)	.304 (7.71)
F	.170 (4.31)	.062 (1.58)	.150 (3.82)	.324 (8.22)
G	.145 (3.67)	.082 (2.08)	.155 (3.94)	.369 (9.36)
H	.195 (4.94)	.082 (2.08)	.165 (4.20)	.379 (9.62)

RECOMMENDED PAD DIMENSIONS FOR WAVE SOLDERING



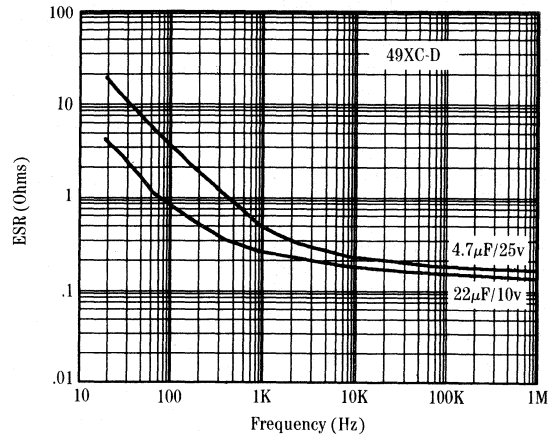
CASE SIZE	A MIN.	B MIN.	C NOM.	D NOM.
D	.077 (1.96)	.067 (1.70)	.080 (2.04)	.254 (6.44)
E	.077 (1.96)	.067 (1.70)	.130 (3.31)	.304 (7.71)
F	.101 (2.55)	.067 (1.70)	.150 (3.81)	.324 (8.22)
G	.084 (2.13)	.087 (2.21)	.155 (3.94)	.369 (9.36)
H	.117 (2.98)	.087 (2.21)	.165 (4.20)	.379 (9.62)

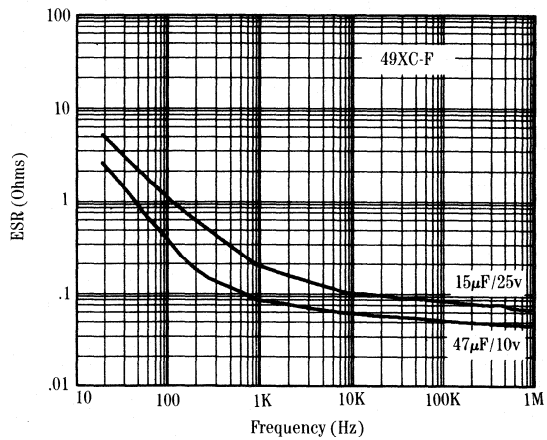
ADDITIONAL PHYSICAL STATISTICS

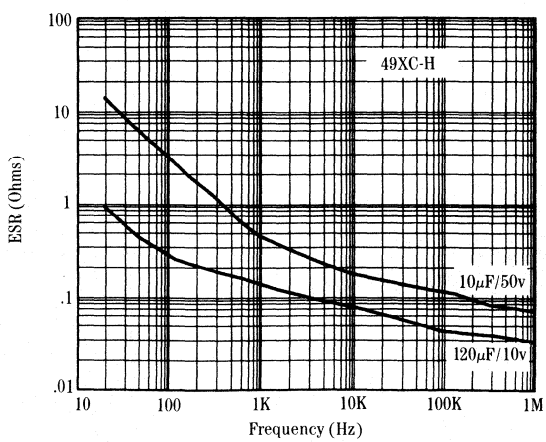
PHYSICAL STATISTICS					Typical Weight (grams)
CASE CODE	Substrate Area sq. in.	Substrate Area sq. cm	Typical Volume cu. in.	Typical Volume cu. cm	
D	0.01500	0.0967	0.000750	0.0123	0.07
E	0.02000	0.1290	0.001000	0.0164	0.09
F	0.02970	0.1917	0.002079	0.0341	0.18
G	0.02915	0.1878	0.003200	0.0524	0.27
H	0.04560	0.2944	0.005060	0.0821	0.44

APPLICATIONS GUIDELINES

EQUIVALENT SERIES RESISTANCE vs FREQUENCY

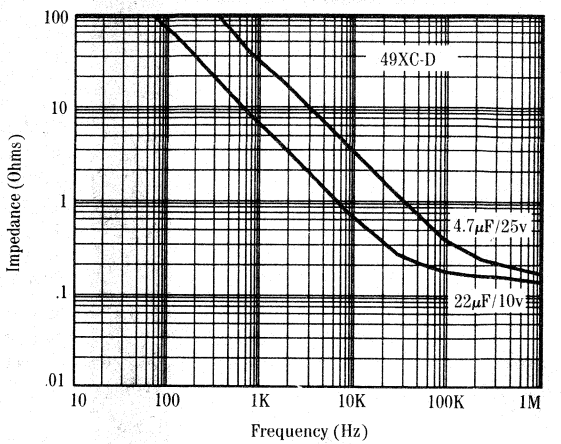


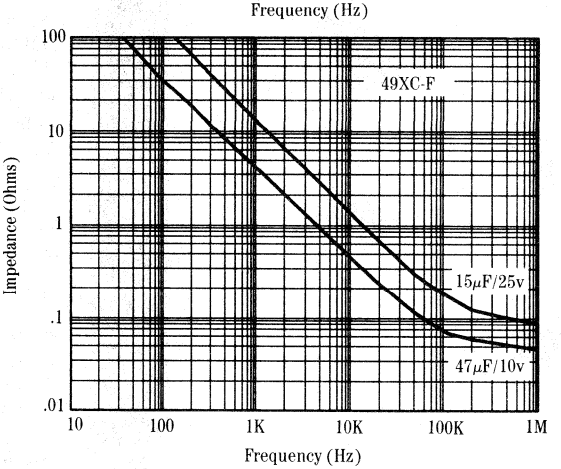


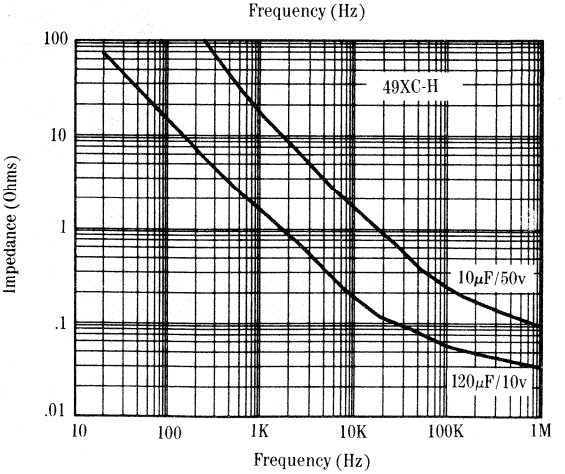


APPLICATIONS GUIDELINES

IMPEDANCE vs FREQUENCY

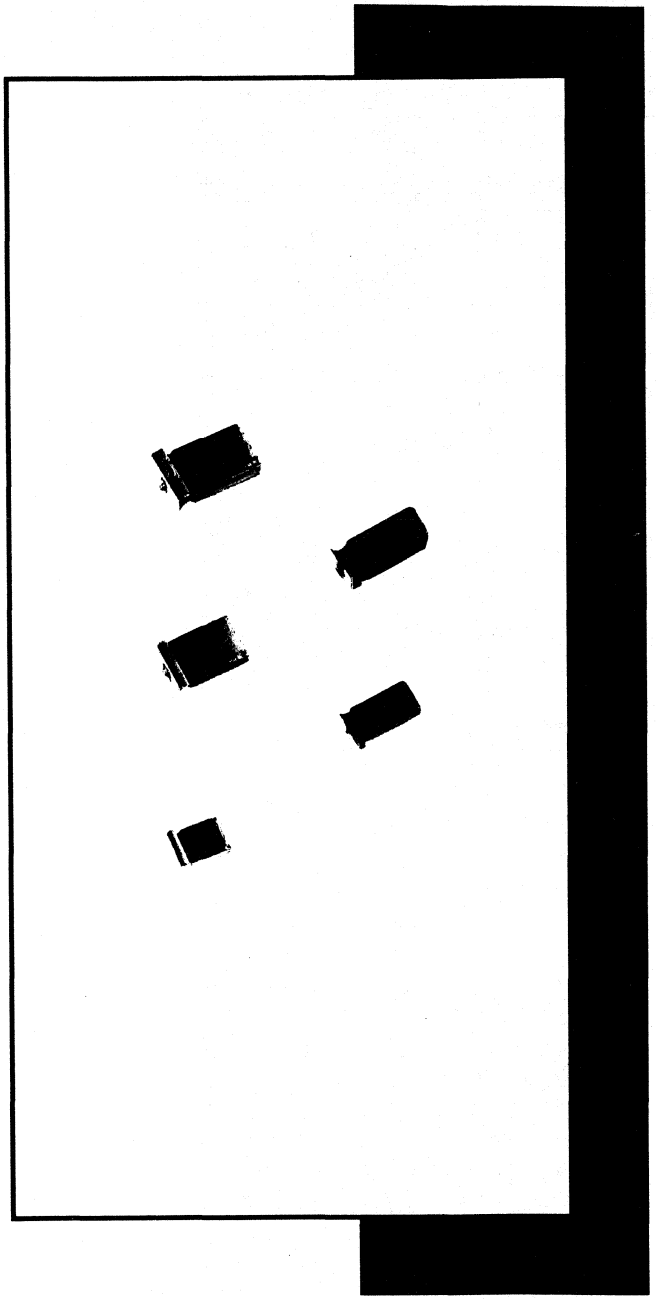






Tantalum SMD STAR CHIP

49 SC



3

DESCRIPTION

■ The 49SC/STAR CHIP Series is a companion to the patented Philips Components Blue Chip, which has gair world-wide acceptance as the ultra high reliability capacitive component for military electronics and othe sophisticated micro-electronic systems. It is a cost-effect alternative to the Blue Chip in high volume industrial applications.

■ The 49SC Series provides maximum volumetric efficien in a conformally coated device. The capacitive element protected from external contaminates by a proprietary conformal coating.

■ The STAR CHIP is available in five standard case size which are physically similar to the Blue Chip and direc pad-compatible with MIL-C-55365/4 (CWR-06 style) capacitors.

■ Philips Components 49SC series is especially suited f use on SMD circuit boards, as well as in thick or thin film hybrid circuits, where cap values between .47 μF a 100 μF are required.

■ STAR CHIP Surface Mount Devices are supplied in 12 r embossed tape for efficiency in handling and storage a well as being compatible with all tape-fed high speed placement equipment.

■ Electrical characteristics such as low leakage curren and low equivalent series resistance at high frequencie make the Star Chip an excellent choice for circuits where actual performance must be weighed against lov initial cost.

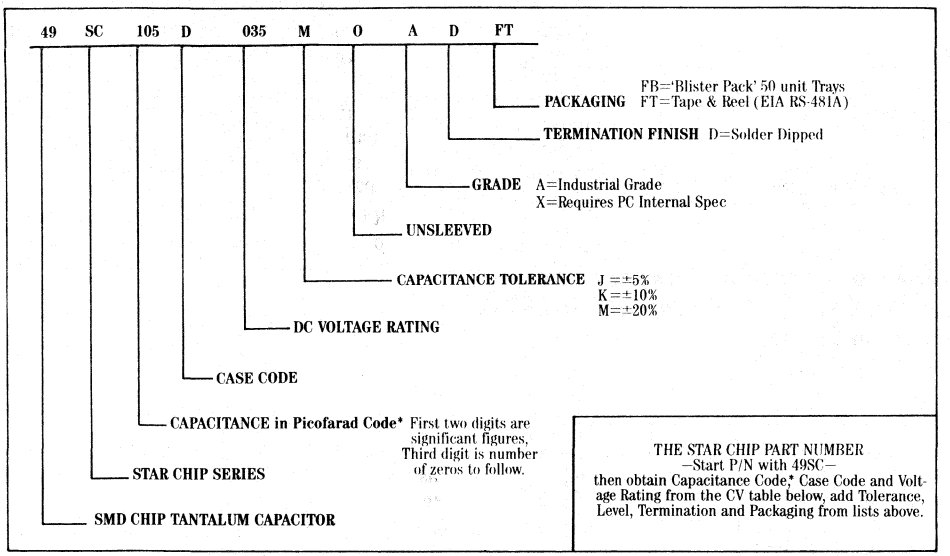
■ Philips Components manufactures the STAR CHIP products utilizing advanced Statistical Process Control methods (SPC). The use of Statistical Process Control techniques provides a very consistent and reliable produ

FEATURES

- −55°C through +85°C Operation (125°C with Voltag Derating)
- Capacitance Range: .47 μF to 100 μF
- Rated Voltages: 4 VDC to 50 VDC
- Five Standard Case Sizes D, E, F, G, H (Pad-Compatil with CWR-06)
- Low ESR in High-Frequency Applications
- Solder-Dipped Terminations Ideally Suited for Solder Reflow Techniques
- Conformally Coated Construction Provides Maximun Volumetric Efficiency
- Uniform Physical Dimensions
- Standard 12 mm Tape & Reel Packaging

PART NUMBER DESIGNATION

Philips Components Series 49SC Capacitors can be completely specified using the following designation:



PHYSICAL SPECIFICATIONS

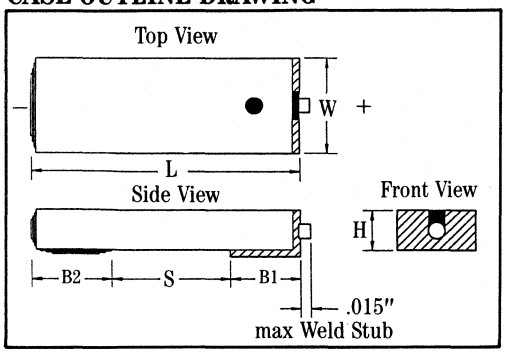
DIMENSIONS—Inches

CASE CODE	(W) WIDTH ±0.015	(L) LENGTH ±0.015	(H) HEIGHT ±0.015	(S) SPACING Typical	(B1) +PAD WIDTH ±0.010	(B2) −PAD WIDTH −.010/+.025
D	.100	.150	.050	.090	.030	.030
E	.100	.200	.050	.140	.030	.030
F	.135	.220	.070	.160	.030	.030
G	.110	.265	.110	.165	.050	.050
H	.160	.275	.110	.175	.050	.050

DIMENSIONS—mm

CASE CODE	(W) WIDTH ±0.381	(L) LENGTH ±0.381	(H) HEIGHT ±0.381	(S) SPACING Typical	(B1) +PAD WIDTH ±0.254	(B2) −PAD WIDTH −.254/+.635
D	2.54	3.81	1.27	2.29	0.76	0.76
E	2.54	5.08	1.27	3.56	0.76	0.76
F	3.43	5.59	1.78	4.06	0.76	0.76
G	2.79	6.73	2.79	4.19	1.27	1.27
H	4.06	7.25	2.79	4.44	1.27	1.27

CASE OUTLINE DRAWING



NOTES:

1. For polarity identification, when chip is in mounting position, metal "L" clip and weld stub are positive. In addition, the positive end is marked with a dot. The top negative surface is conformally coated.
2. Metric Equivalents are for general information purposes only and are based on 1"=25.4 mm.
3. Anode Riser (Weld Stub) may extend case size Length dimension by 0.015" (.38 mm) max.
4. Spacing dimension is typical distance between chip mounting terminations and therefore average distance between mounting pads on substrate.

3

49SC CAPACITANCE–VOLTAGE–CASE CODE TABLE

Select standard Capacitance/Voltage ratings and corresponding standard STAR CHIP case codes from this table.

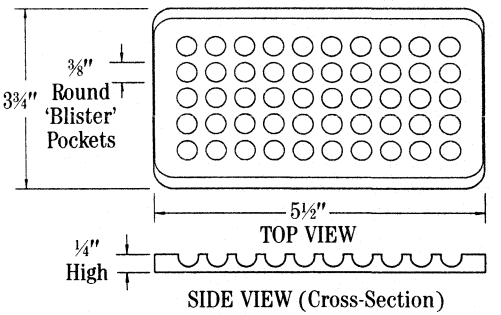
CAP μF	PICOFARAD CODE*	004 V	006 V	010 V	015 V	020 V	025 V	035 V	050 V
0.47	474	D	D	D	D	D	D	D	D
0.68	684	D	D	D	D	D	D	D	D
1.0	105	D	D	D	D	D	D	D	E
1.5	155	D	D	D	D	D	D	E	F
2.2	225	D	D	D	D	D	E	F	F
3.3	335	D	D	D	D	E	F	F	G
4.7	475	D	D	D	E	F	F	G	H
6.8	685	D	D	E	F	F	G	H	
10.0	106	D	E	F	F	G	G		
15.0	156	E	F	F	G	G	H		
22.0	226	F	F	G	G	H			
33.0	336	F	G	G	H				
47.0	476	G	G	H					
68.0	686	G	H						
100.0	107	H							

PACKAGING

BLISTER-PACK TRAYS

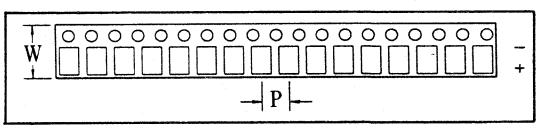
■ 49SC Series capacitors are available in 'Blister Pack' trays containing 50 pieces each in a 5 x 10 matrix configuration. The Blister Pack provides a separate pocket for each unit to prevent damage to the capacitors during shipping, handling and storage.

■ Blister Pack trays are stamped polystyrene with a clear plastic cover. Orientation of the capacitors within the pockets is random with respect to polarity and mounting surface. This packaging is ideal for hand placement of the capacitors as it takes up very little room at a work station. It is recommended that operators remove and work with the STAR CHIPs using a blunt, coated tweezer to prevent damage to the conformal coating.



TAPE & REEL

■ 49SC Series capacitors are shipped in Tape & Reel packaging to facilitate the use of automatic placement equipment. Tape & Reel is per EIA (Electronic Industries Association) specification RS-481A. Capacitor orientation within tape pockets is negative terminal toward sprocket holes and mounting side down. 12 mm width tape is used. Quantities less than minimum reel will be shipped in Blister Pack trays.



TAPE & REEL SPECIFICATIONS

49SC Case Code	(W) Tape Width	(P) Unit Pitch Ctr/Ctr	Quantity per full 7" Reel	Minimum Quantity per Reel
D	12 mm	4 mm	2,700	1,350
E	12 mm	4 mm	2,700	1,350
F	12 mm	8 mm	1,000	500
G	12 mm	8 mm	700	350
H	12 mm	8 mm	700	350

APPLICATION NOTES

CAPACITANCE

■ Capacitance shall be measured at or referred to 120 Hz at 25°C. The AC signal shall not exceed 1.0 VRMS.

■ TOLERANCE—Type 49SC are available in ±20%, ±10% and ±5% capacitance tolerances.

■ CAPACITANCE CHANGE WITH TEMPERATURE—from 25°C reading (maximum):
at −55°C −10% Δ
at +85°C +10% Δ
at +125°C +15% Δ

DC LEAKAGE CURRENT (DCL)

■ DCL shall be measured at WVDC after a 5 minute electrification period with a 1000 ohm current-limiting resistor in series.

VOLTAGE RATING

■ STAR CHIPS can be used at elevated temperatures when voltage is derated in accordance with the following:

Rated WVDC −55°C to 85°C	Derated (DC) 125°C	Surge Voltage (DC) 85°C	Surge Voltage (DC) 125°C
4	2.7	5.0	3.4
6	4.0	8.0	5.0
10	7.0	13.0	9.0
15	10.0	20.0	12.0
20	13.0	26.0	16.0
25	17.0	32.0	20.0
35	23.0	46.0	26.0
50	33.0	65.0	38.0

STAR CHIP ELECTRICAL LIMITS & CASE CODES

Cap. (nom) µF	Rated VDC 85°C	DC Leakage (max) 25°C µA	85°C µA	125°C µA	DF 120Hz %	ESR 120Hz Ω	ESR 100KHz Ω	Case Code
2.2	4	0.5	5	7	6	36	3.5	D
4.7	4	0.5	5	7	6	17	2.0	D
6.8	4	0.5	5	7	6	12	2.0	D
10	4	0.5	5	7	8	11	2.0	D
15	4	0.6	6	8	8	7	1.5	E
33	4	1.4	14	18	8	3	1.0	F
68	4	2.8	28	35	10	2	0.8	G
100	4	4.0	40	48	10	2	0.5	H
1.5	6	0.5	5	7	6	53	5.0	D
3.3	6	0.5	5	7	6	24	2.5	D
4.7	6	0.5	5	7	6	17	2.0	D
6.8	6	0.5	5	7	6	12	2.0	D
10	6	0.6	6	8	8	11	1.5	E
22	6	1.4	14	18	8	5	1.0	F
47	6	2.9	29	36	10	3	0.8	G
68	6	4.0	40	48	10	2	0.7	H
1.0	10	0.5	5	7	6	80	6.0	D
2.2	10	0.5	5	7	6	36	3.5	D
3.3	10	0.5	5	7	6	26	2.5	D
4.7	10	0.5	5	7	6	17	2.0	D
6.8	10	0.7	7	9	6	12	2.0	E
15	10	1.5	15	19	8	7	1.0	F
33	10	3.0	30	36	10	4	0.8	G
47	10	4.7	47	59	10	3	0.7	H
.68	15	0.5	5	7	6	120	8.0	D
1.5	15	0.5	5	7	6	53	5.0	D
2.2	15	0.5	5	7	6	36	3.5	D
3.3	15	0.5	5	7	6	24	2.5	D
4.7	15	0.8	8	10	6	17	2.5	E
10	15	1.5	15	19	6	8	1.5	F
22	15	3.3	33	42	8	5	1.0	G
33	15	5.0	50	60	8	3	0.8	H
.47	20	0.5	5	7	6	170	12.0	D
.68	20	0.5	5	7	6	120	8.0	D

Cap. (nom) µF	Rated VDC 85°C	DC Leakage (max) 25°C µA	85°C µA	125°C µA	DF 120Hz %	ESR 120Hz Ω	ESR 100KHz Ω	Case Code
1.0	20	0.5	5	7	6	80	8.0	D
1.5	20	0.5	5	7	6	53	5.0	D
2.2	20	0.5	5	7	6	36	3.5	D
3.3	20	0.7	7	9	6	24	3.0	E
6.8	20	1.4	14	18	6	12	2.5	F
15	20	3.0	30	36	6	6	1.0	G
22	20	4.0	40	48	6	4	1.0	H
.33	25	0.5	5	7	6	240	15.0	D
.68	25	0.5	5	7	6	120	10.0	D
1.0	25	0.5	5	7	6	80	8.0	D
1.5	25	0.5	5	7	6	53	5.0	D
2.2	25	0.6	6	8	6	36	3.5	E
4.7	25	1.2	12	15	6	17	2.5	F
6.8	25	1.7	17	22	6	12	2.0	G
10	25	2.5	25	32	6	8	1.5	G
15	25	3.8	38	48	6	6	1.0	H
.22	35	0.5	5	7	6	360	18.0	D
.47	35	0.5	5	7	6	170	10.0	D
.68	35	0.5	5	7	6	120	7.0	D
1.0	35	0.5	5	7	6	80	6.0	D
1.5	35	0.6	6	8	6	53	5.0	E
3.3	35	1.0	10	12	6	24	2.5	F
4.7	35	1.7	17	22	6	17	2.0	G
6.8	35	2.4	24	30	6	12	1.5	H
.47	50	0.5	5	7	6	170	8.0	D
.68	50	0.5	5	7	6	120	6.0	D
1.0	50	0.5	5	7	6	80	5.5	E
1.5	50	0.8	8	10	6	53	4.5	F
2.2	50	1.1	11	14	6	36	3.0	F
3.3	50	1.7	17	22	6	24	1.5	G
4.7	50	2.4	24	30	6	17	1.5	H

AC POWER DISSIPATION

CASE CODE	MAXIMUM POWER DISSIPATION IN WATTS AMBIENT TEMPERATURE		
	25°C	85°C	125°C
D	.095	.085	.038
E	.100	.090	.040
F	.125	.112	.050
G	.150	.135	.060
H	.200	.180	.080

■ Major physical factors which limit the ability of the capacitor to dissipate internally generated heat produced during AC circuit operation, include unit construction features as related to a particular capacitor design, and heat transfer characteristics of the materials used in the construction of the capacitor. Larger volumetric packages exhibiting electrical characteristics similar to those of smaller physical packages will, under similar conditions, be capable of dissipating more power. Conformally coated capacitors, such as the Star Chip series, exhibit more efficient heat dissipation capabilities, due to the absence of relatively thick thermally insulative coatings, as incorporated in "molded" tantalum chip capacitor styles.

■ Maximum power dissipation levels shown represent an empirically determined wattage level required to cause a 10 degree centigrade temperature increase above the stated temperature in "still air" as measured on the external capacitor body, utilizing a thermo-couple or other appropriate measuring device.

AC RIPPLE CURRENT

■ Circuit design and physical layout should provide "cool" circuit board locations for capacitors operating at high AC current levels. Capacitor temperature may increase due to heat transfer/absorption from the ambient environment or a "hot" component mounted in close proximity to the capacitor. The result of increased AC current is increased internal heat generation within the capacitor body. Waveform envelope is also a factor in the amount of internal heat generated within the capacitor since non-sinusoidal waveshapes produce heating effects different from those of sinusoidal waveforms.

■ The ripple current and voltage level impressed across the capacitor should not exceed the maximum power dissipation of the capacitor unless special provisions are made to increase the rate of heat dissipation from the body of the capacitor, such as by the use of a heat sink or providing air flow. Excessive power dissipation in tantalum chip capacitors may cause catastrophic failure. The I_{max} value of current must be used to determine the operating conditions.

■ The maximum permissible AC (rms) current applied across the capacitor is related to the equivalent series resistance (ESR) and the physical power dissipation capability of the capacitor. The maximum (rms) ripple current at a given frequency may be determined by:

$$I_{max}\,(rms) = \sqrt{Pdm/ESR}$$

where... Pdm = Maximum Power Dissipation in watts, at the maximum circuit operating temperature

$$ESR = \frac{1}{2\pi * \text{AC Frequency} * \text{Capacitance}} * \text{D.F.}$$

AC Frequency in Hertz
Capacitance is in Farads
Dissipation Factor is in decimal form

AC RIPPLE VOLTAGE

■ The maximum AC ripple voltage at the applied frequency must be limited to an rms value which permits only the recommended maximum power dissipation specified for a given case code.

■ The maximum AC ripple voltage may be determined by:

$$E_r\,(rms) = Z\sqrt{Pdm/ESR}$$

where... E_r = AC Ripple Voltage
Z is the Impedance in ohms
Pdm is the Maximum Power Dissipation in watts, at the maximum circuit operating temperature
ESR is the Equivalent Series Resistance in ohms

■ Both voltage and current levels at a given frequency must be maintained so as not to exceed the recommended maximum power dissipation levels at the maximum circuit operating temperature. The DC bias voltage applied in series with the AC source applied across polar style capacitors, on which the AC voltage is "riding," may be ignored when considering the heating effects of AC current on the capacitor. The positive peak AC voltage plus the DC voltage must not exceed the rated DC voltage of the capacitor. The negative peak AC voltage in combination with the DC voltage may not obtain a level which will damage the dielectric due to reverse voltage being applied across a polar solid electrolyte tantalum chip capacitor.

REVERSE VOLTAGE

■ Series 49SC hybrid capacitor will withstand momentary voltage reversals up to 15% at 25°C, 10% at 55°C and 1% at 125°C of their rated voltage.

MARKING

■ The small physical size of the STAR CHIP does not permit alpha-numeric marking on the body of the capacitor. Color dots on the body of the capacitor are available on special order, if required. Series 49SC capacitors are identified in their package container.

POLARITY

■ Series 49SC capacitors are polar devices. Proper polarity must be observed or damage to the capacitor and/or the circuit will result. Polarity is marked with a dot or stripe on the positive (anode) end.

NON-POLAR OPERATION

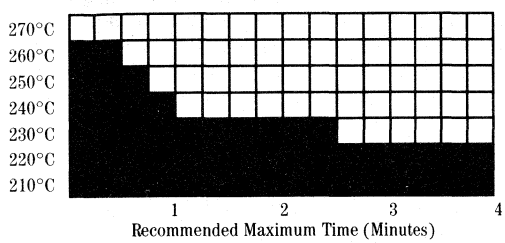
■ When two polar capacitors of the same DC voltage rating are connected back-to-back in non-polar configuration, i.e. positive-to-positive terminals or negative-to-negative terminals; the "non-polar" pair may be operated without DC bias voltage. If DC voltage is applied, the positive peak AC voltage plus the DC voltage must not exceed the rated voltage of the capacitor in either direction.

SURFACE-MOUNT APPLICATION

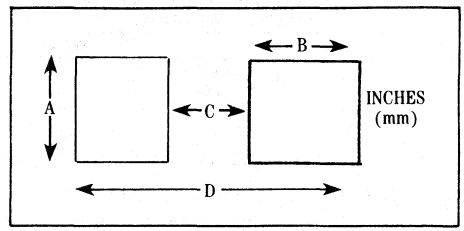
■ STAR CHIP capacitors are ideally suited for use on SMD circuit boards where circuit density requires the use of components with the highest cap/unit volume efficiency. Current solder reflow techniques such as IR (Infra-Red), Wave Soldering and Vapor Phase may be utilized with these capacitors.

REFLOW TIMES and TEMPERATURES

■ The optimum reflow profile will include a preheat cycle to provide proper fluxing prior to reflow.

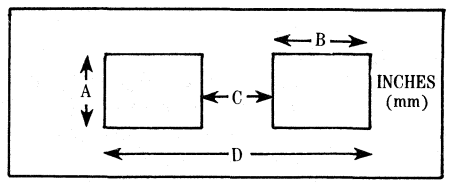


RECOMMENDED PAD DIMENSIONS FOR REFLOW SOLDERING



CASE SIZE	A MIN.	B MIN.	C NOM.	D NOM.
D	.135 (3.42)	.062 (1.58)	.080 (2.04)	.254 (6.44)
E	.135 (3.42)	.062 (1.58)	.130 (3.31)	.304 (7.71)
F	.170 (4.31)	.062 (1.58)	.150 (3.82)	.324 (8.22)
G	.145 (3.67)	.082 (2.08)	.155 (3.94)	.369 (9.36)
H	.195 (4.94)	.082 (2.08)	.165 (4.20)	.379 (9.62)

RECOMMENDED PAD DIMENSIONS FOR WAVE SOLDERING



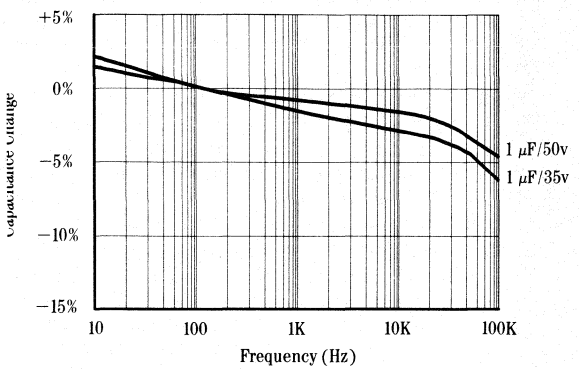
CASE SIZE	A MIN.	B MIN.	C NOM.	D NOM.
D	.077 (1.96)	.067 (1.70)	.080 (2.04)	.254 (6.44)
E	.077 (1.96)	.067 (1.70)	.130 (3.31)	.304 (7.71)
F	.101 (2.55)	.067 (1.70)	.150 (3.81)	.324 (8.22)
G	.084 (2.13)	.087 (2.21)	.155 (3.94)	.369 (9.36)
H	.117 (2.98)	.087 (2.21)	.165 (4.20)	.379 (9.62)

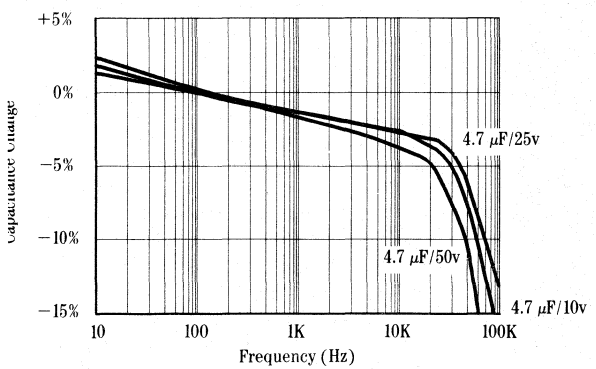
ADDITIONAL PHYSICAL STATISTICS

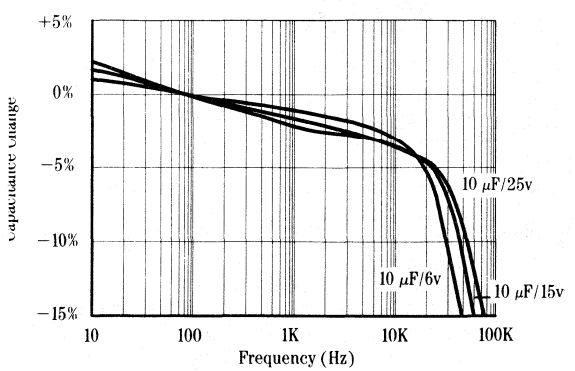
CASE CODE	PHYSICAL STATISTICS Substrate Area sq. in.	sq. cm	Typical Volume cu. in.	cu. cm	Typical Weight (grams)
D	0.01500	0.0967	0.000750	0.0123	0.07
E	0.02000	0.1290	0.001000	0.0164	0.09
F	0.02970	0.1917	0.002079	0.0341	0.18
G	0.02915	0.1878	0.003200	0.0524	0.27
H	0.04400	0.2838	0.00484	0.0792	0.44

TYPICAL CHARACTERISTICS

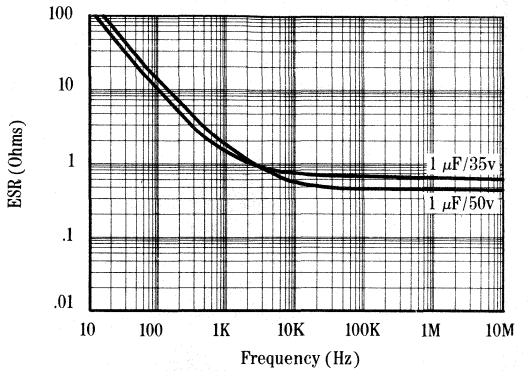
CAPACITANCE CHANGE with FREQUENCY

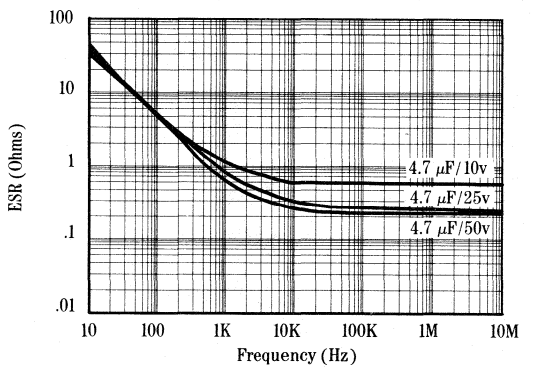


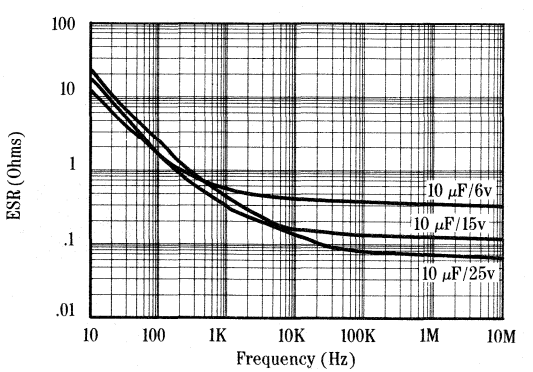




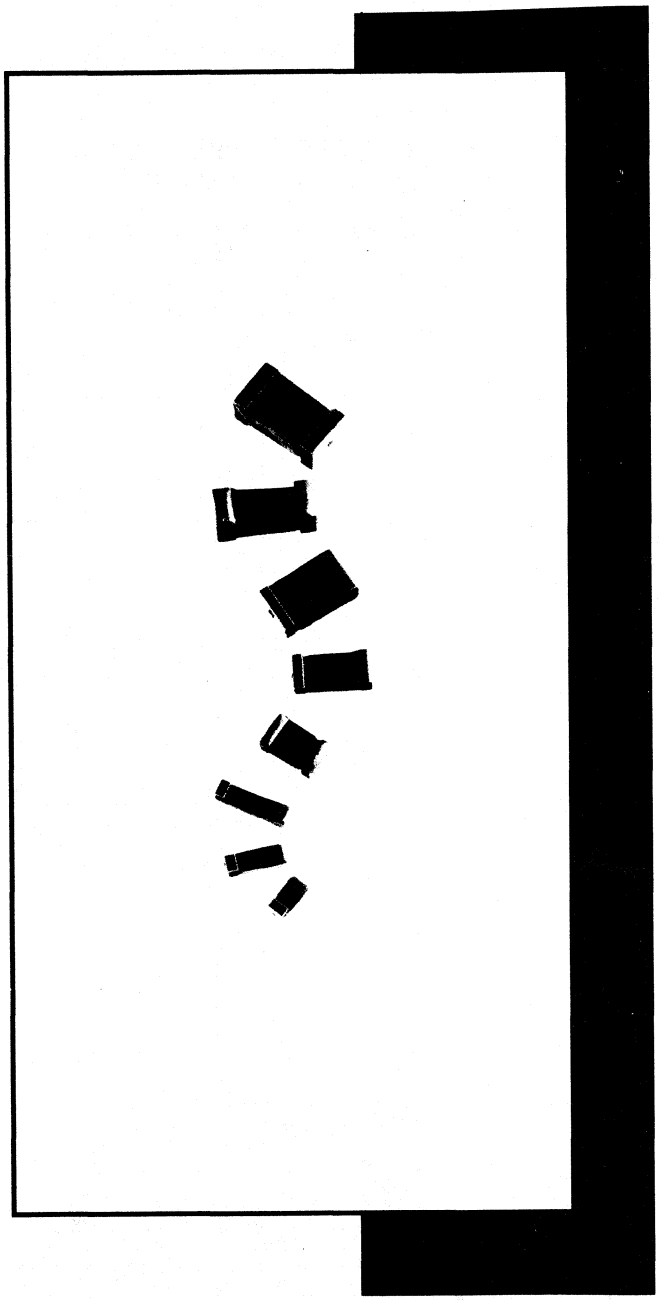
EQUIVALENT SERIES RESISTANCE vs FREQUENCY







Tantalum SMD BLUE CHIP 49 BC



DESCRIPTION

■ The 49BC BLUE CHIP Series is the original conformal coated Chip Tantalum Capacitor developed and patente in the early 1970's.

■ Electronic applications had evolved tighter and tighte requirements which demanded more reliable componen with longer life, lower electrical losses and more volumetr efficiency due to the constraints of smaller and smaller circuitry.

■ The BLUE CHIP capacitor was developed to fill those needs. It combined the long life and high reliability of a tantalum capacitor with the desirable design elements c a chip component. Low ESR, low DC leakage, low inductan and maximum volumetric efficiency are hallmarks of th BLUE CHIP capacitor's design and construction.

■ The BLUE CHIP utilizes a high CV, sintered tantalum anode and a solid electrolyte to achieve its small size. It is conformally coated with the patented Blue Seal proces The fluoropolymer/fluoroelastomer coating provides protection to the internal capacitive element while remaining flexible enough to withstand thermal stresse and adding a minimum to the overall size of the capacit Ruggedized terminal construction provides a margin of reliability not found in other styles.

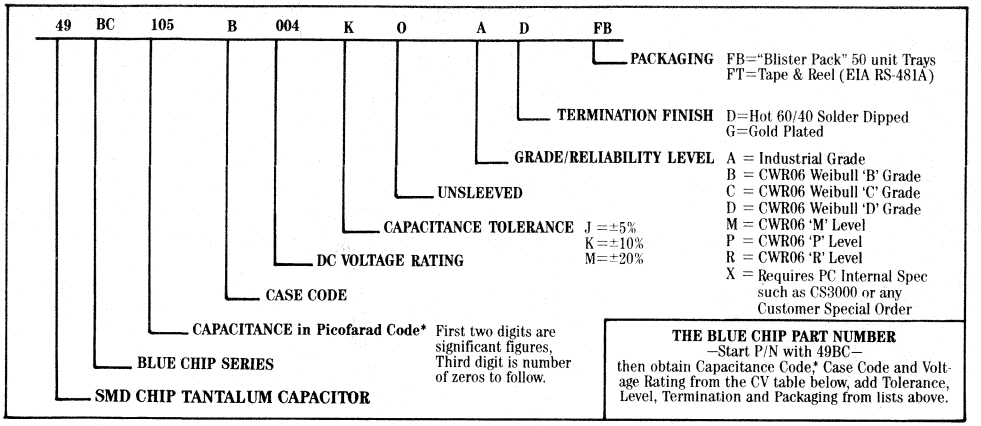
■ The BLUE CHIP has become the unquestioned indust standard of reliability in circuit assembly and performanc The product has been customer tested and proven—ove 400 million unit user test hours—in a broad range of circuit applications under severe environmental and electrical stress conditions. The CWR06 style BLUE CH is available in both military established reliability— Exponential Failure Rate Levels (M, P, and R) and Weibul Graded Failure Rate Levels (B, C, and D), per MIL-C-55365/4

■ Philips Components manufactures the BLUE CHIP products utilizing advanced Statistical Process Control methods (SPC). The use of Statistical Process Control techniques provides a very consistent and reliable produ

FEATURES

- −55°C through 85°C Operation (125°C with Voltage Derating)
- Capacitance Range: 0.1μF to 100 μF
- Rated Voltages: 4 VDC to 50 VDC
- Qualification to MIL-C-55365/4B Style CWR06 Exponent Failure Rate Levels M, P, and R and Weibull Graded Failure Rate Levels B, C, and D
- 8 Case Sizes from .050" x .050" x .100" To .110" x .150" x .285"
- Low ESR in High-Frequency Applications
- Gold Plated or Solder Dipped Terminations
- Conformally Coated Construction Provides Maximum Volumetric Efficiency (100,000 μFV/Cubic Inch)
- Tape & Reel Packaging Available in 8 & 12 mm Tape Wid

PART NUMBER DESIGNATION



49BC CAPACITANCE–VOLTAGE–CASE CODE TABLE

■ Select standard Capacitance/Voltage ratings and corresponding standard Blue Chip case codes from this table. If you require a capacitance/voltage that is not listed as a standard value, please call us. We may already be building it as a special.

CAP µF	PICOFARAD CODE*	004 V	006 V	010 V	015 V	020 V	025 V	035 V	050 V
0.10	104	B	B	B	B	B	B	B	B
0.15	154	B	B	B	B	B	B	B	B
0.22	224	B	B	B	B	B	B	B	L
0.33	334	B	B	B	B	B	B	L	L
0.47	474	B	B	B	B	B	L	L	U
0.68	684	B	B	B	B	L	L	U	E
1.0	105	B	B	B	L	L	U	E	C
1.5	155	B	B	L	L	U	E	C	H
2.2	225	B	L	L	U	E	C	H	H
3.3	335	L	L	U	E	C	H	H	I
4.7	475	L	U	E	C	H	H	I	P
6.8	685	U	E	C	H	H	I	P	–
10.0	106	E	C	H	H	I	I	–	–
15.0	156	C	H	H	I	I	P	–	–
22.0	226	H	H	I	I	P	–	–	–
33.0	336	H	I	I	P	–	–	–	–
47.0	476	I	I	P	–	–	–	–	–
68.0	686	I	P	–	–	–	–	–	–
100.0	107	P	–	–	–	–	–	–	–

PHYSICAL SPECIFICATIONS

DIMENSIONS–Inches

CASE CODE		(W) WIDTH ±0.015	(L) LENGTH ±0.015	(H) HEIGHT ±0.015	(S) SPACING Typical	(B) PAD WIDTH ±0.005
49BC	CWR06					
B	A	.050	.100	.050	.040	.030
L	B	.050	.150	.050	.090	.030
U	C	.050	.200	.050	.140	.030
E	D	.100	.150	.050	.090	.030
C	E	.100	.200	.050	.140	.030
H	F	.135	.220	.070	.160	.030
I	G	.110	.265	.110	.165	.050
P	H	.150	.285	.110	.185	.050

Tantalum SMD BLUE CHIP | 49 BC

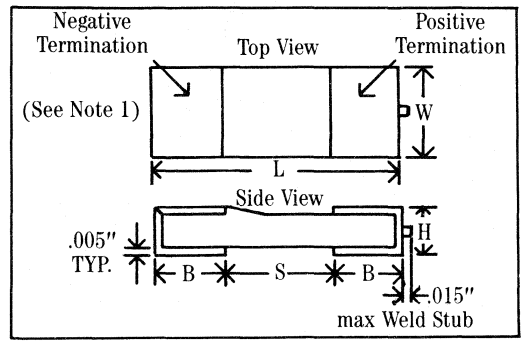
DIMENSIONS—mm

CASE CODE		(W) WIDTH ±0.381	(L) LENGTH ±0.381	(H) HEIGHT ±0.381	(S) SPACING Typical	(B) PAD WIDTH ±0.127
49BC	CWR06					
B	A	1.27	2.54	1.27	1.02	0.76
L	B	1.27	3.81	1.27	2.29	0.76
U	C	1.27	5.08	1.27	3.55	0.76
E	D	2.54	3.81	1.27	2.29	0.76
C	E	2.54	5.08	1.27	3.55	0.76
H	F	3.43	5.59	1.78	4.06	0.76
I	G	2.79	6.73	2.79	4.19	1.27
P	H	3.81	7.25	2.79	4.70	1.27

NOTES:

1. For polarity identification, when chip is in mounting position, bare metal clip and weld stub are positive. The top surface of the negative terminal is blue.
2. Metric Equivalents are for general information purposes only and are based on 1″=25.4 mm.
3. Anode Riser (Weld Stub) may extend case size Length dimension by 0.015″ (.38 mm) max.

CASE OUTLINE DRAWING

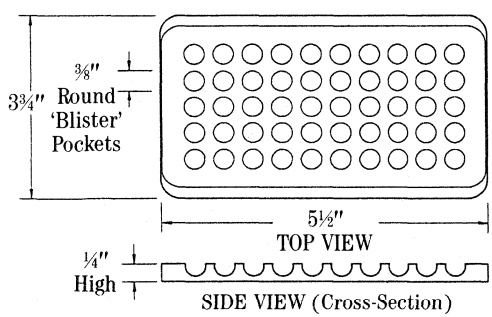


4. Dimensions given are for gold-plated terminations. For solder-dipped terminations, add +0.015″ (.38 mm) to dimension tolerances.
5. Spacing dimension is typical distance between chip mounting terminations and therefore average distance between mounting pads on substrate.

PACKAGING

BLISTER-PACK TRAYS

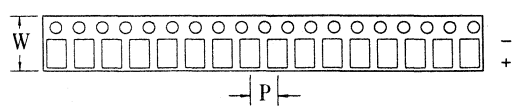
■ 49BC Series capacitors are shipped in 'Blister Pack' trays containing 50 pieces each in a 5 x 10 matrix configuration. The Blister Pack provides a separate pocket for each unit to prevent damage to the capacitors during shipping, handling and storage.



■ Blister Pack trays are stamped polystyrene with a clear plastic cover. Orientation of the capacitors within the pockets is random with respect to polarity and mounting surface. This packaging is ideal for hand placement of the capacitors as it takes up very little room at a work station. It is recommended that operators remove and work with the BLUE CHIPs using a blunt, coated tweezer to prevent damage to the Blue Seal conformal coating.

TAPE & REEL

■ 49BC Series capacitors are available in Tape & Reel packaging to facilitate the use of automatic placement equipment. Tape & Reel is per EIA (Electronic Industries Association) specification RS-481A. Capacitor orientation within tape pockets is negative terminal toward sprocket holes and mounting side down. 8 and 12 mm tape widths are used according to case size. Quantities less than minimum reel will be shipped in Blister Pack trays.



TAPE & REEL SPECIFICATIONS

49BC Case Code	CWR06 Case Code	(W) Tape Width	(P) Unit Pitch Ctr/Ctr	Quantity per full 7″ Reel	Minimum Quantity per Reel
B	A	8 mm	4 mm	3,000	1,500
L	B	12 mm	4 mm	3,000	1,500
U	C	12 mm	4 mm	3,000	1,500
E	D	12 mm	4 mm	2,700	1,350
C	E	12 mm	4 mm	2,700	1,350
H	F	12 mm	8 mm	1,000	500
I	G	12 mm	8 mm	700	350
P	H	12 mm	8 mm	700	350

BLUE CHIP CHARACTERISTICS

■ From the least expensive BLUE CHIP, the 49BC Industrial Grade, to the Established Reliability CWR06 'R' Level chips, all members of the BLUE CHIP Family of capacitors share many of the same attributes and characteristics. All BLUE CHIP capacitors share the same design and construction and utilize the same materials and manufacturing processes. The main distinction between the different grades is typically the conditioning of the capacitor, test sequences used and the acceptance criteria that apply.

■ Features and characteristics common to all grades are listed here, and differences between the grades are pointed out on the facing page in a specific discussion about each of the family members.

DESIGN and CONSTRUCTION

■ Each BLUE CHIP capacitor consists of a highly purified sintered tantalum anode body utilizing an electrolitically formed (tantalum pentoxide) dielectric and a solid (manganese dioxide) electrolyte. The shock & vibration resistant solderable terminals are attached to the capacitor body which is then protected against normal electronic equipment environments by Philips Components proprietary Blue Seal process.

■ The Blue Seal process completely insulates the BLUE CHIP from the circuit. No additional insulation need be specified. Only the mounting terminals are exposed. The terminals are made of 0.005" thick type N1 nickel that is plated with 100 micro inches of gold or hot solder dipped with 60/40 tin/lead solder. The terminals are specifically designed for all standard mounting techniques. All terminal materials meet the requirements of MIL-STD-1276 and MIL-G-45204.

MARKING

■ The small physical size of the BLUE CHIP does not permit alphanumeric marking on the body of the capacitor. Color dots on the body of the capacitor are available on special order. Series 49BC capacitors are identified on their container package.

SURFACE MOUNT APPLICATION

■ BLUE CHIP capacitors are ideally suited for use on SMT circuit boards where circuit density requires the use of components with the highest cap/unit volume efficiency. The compliant body coating permits conductive lines to be run underneath the body of the capacitor for maximum circuit density.

■ Current solder reflow techniques such as Belt Reflow, IR (Infra-Red), Wave Soldering and Vapor Phase may be utilized with these capacitors. The BLUE CHIP's unique construction enables it to withstand soldering temperatures for longer durations than other types of tantalum chip construction. Multiple reflows may be made with no degradation to the capacitor's physical or electrical characteristics.

■ All substrate materials and all common cleaning solvents used in the industry are compatible with the BLUE CHIP. Automatic placement equipment may be used by specifying Tape & Reel packaging.

CAPACITANCE—DISSIPATION FACTOR—DC LEAKAGE

■ Capacitance shall be measured at or referred to 120 Hz at 25°C. Maximum DC bias is 2.2 V. AC signal shall not exceed 1.0 VRMS.

■ Tolerance—available in 20%, 10% and 5% cap tolerances. Other tolerances are available under 'Customer Specials.'

−55°C	+85°C	125°C
−10% Δ	+10% Δ	+15% Δ

Capacitance Change with Temperature from 25°C readings (maximum change)

■ Dissipation Factor—Limits for DF are specified under Industrial Grade or CWR06. Refer to specific DF tables.

■ DC Leakage—Limits for DCL are specified under Industrial Grade or CWR06. Refer to specific DCL tables.

■ DCL shall be measured at WVDC after a 5 minute electrification period with a 1000 ohm current limiting resistor in series.

VOLTAGE RATING

■ All BLUE CHIPS can be used at elevated temperatures when the working voltage is derated in accordance with the following table:

Rated WVDC −55°C to 85°C	Derated (DC) 125°C	Surge Voltage (DC) 85°C	Surge Voltage (DC) 125°C
4	2.7	5.0	3.2
6	4.0	8.0	4.8
10	7.0	13.0	8.0
15	10.0	20.0	12.0
20	13.0	26.0	18.0
25	17.0	32.0	20.0
35	23.0	46.0	28.0
50	33.0	65.0	40.0

■ The surge voltage is the maximum DC voltage, including AC or other pulses applied for short duration.

REVERSE VOLTAGE

■ Series 49BC BLUE CHIP capacitors will withstand momentary voltage reversals up to 15% of their rated voltage at 25°C, 10% at 55°C, 5% at 85°C and 1% at 125°C.

POLARITY

■ Series 49BC capacitors are polar devices intended for applications involving D.C. circuits. Proper polarity must be observed or damage to the capacitor and/or the circuit will result. Polarity is indicated when looking at the non-mounting (top) surface by the bare metal terminal on the positive end and the Blue Seal covered terminal on the negative end.

AC POWER DISSIPATION

CASE CODE	MAXIMUM POWER DISSIPATION IN WATTS AMBIENT TEMPERATURE		
	25°C	85°C	125°C
B	.063	.056	.025
L	.075	.067	.030
U	.081	.073	.032
E	.095	.085	.038
C	.100	.090	.040
H	.125	.112	.050
I	.150	.135	.060
P	.200	.180	.080

■ Major physical factors which limit the ability of the capacitor to dissipate internally generated heat produced during AC circuit operation, include unit construction features as related to a particular capacitor design, and heat transfer characteristics of the materials used in the construction of the capacitor. Larger volumetric packages exhibiting electrical characteristics similar to those of smaller physical packages will, under similar conditions, be capable of dissipating more power. Conformally coated capacitors, such as the Blue Chip series, exhibit more efficient heat dissipation capabilities, due to the absence of relatively thick thermally insulative coatings, as incorporated in "molded" tantalum chip capacitor styles.

■ Maximum power dissipation levels shown represent an empirically determined wattage level required to cause a 10 degree centigrade temperature increase above the stated temperature in "still air" as measured on the external capacitor body, utilizing a thermo-couple or other appropriate measuring device.

AC RIPPLE CURRENT

■ Circuit design and physical layout should provide "cool" circuit board locations for capacitors operating at high AC current levels. Capacitor temperature may increase due to heat transfer/absorption from the ambient environment or a "hot" component mounted in close proximity to the capacitor. The result of increased AC current is increased internal heat generation within the capacitor body. Waveform envelope is also a factor in the amount of internal heat generated within the capacitor since non-sinusoidal waveshapes produce heating effects different than those of sinusoidal waveforms.

■ The ripple current and voltage level impressed across the capacitor should not exceed the maximum power dissipation of the capacitor unless special provisions are made to increase the rate of heat dissipation from the body of the capacitor, such as by the use of a heat sink or providing air flow. Excessive power dissipation in tantalum chip capacitors may cause catastrophic failure. The I_{max} value of current must be used to determine the operating conditions.

■ The maximum permissible AC (rms) current applied across the capacitor is related to the equivalent series resistance (ESR) and the physical power dissipation capability of the capacitor. The maximum (rms) ripple current at a given frequency may be determined by:

$$I_{max}(rms) = \sqrt{Pdm/ESR}$$

where... Pdm = Maximum Power Dissipation in watts, at the maximum circuit operating temperature

$$ESR = \frac{1}{2\pi * \text{AC Frequency} * \text{Capacitance}} * \text{D.F.}$$

AC Frequency is in Hertz
Capacitance is in Farads
Dissipation Factor is in decimal form

AC RIPPLE VOLTAGE

■ The maximum AC ripple voltage at the applied frequency must be limited to an rms value which permits only the recommended maximum power dissipation specified for a given case code.

■ The maximum AC ripple voltage may be determined by:

$$E_r(rms) = Z\sqrt{Pdm/ESR}$$

where... E_r = AC Ripple Voltage
Z is the Impedance in ohms
Pdm is the Maximum Power Dissipation in watts, at the maximum circuit operating temperature
ESR is the Equivalent Series Resistance in ohms

■ Both voltage and current levels at a given frequency must be maintained so as not to exceed the recommended maximum power dissipation levels at the maximum circuit operating temperature. The DC bias voltage applied in series with the AC source applied across polar style capacitors, on which the AC voltage is "riding," may be ignored when considering the heating effects of AC current on the capacitor. The positive peak AC voltage plus the DC voltage must not exceed the rated DC voltage of the capacitor. The negative peak AC voltage in combination with the DC voltage may not obtain a level which will damage the dielectric due to reverse voltage being applied across a polar solid electrolyte tantalum chip capacitor.

CONDITIONING

■ All BLUE CHIP capacitors are given a 100% low impedance power burn-in at 85°C prior to shipment to improve performance in low impedance circuits where high current surges may occur in the capacitor.

THE BLUE CHIP FAMILY

49BC INDUSTRIAL GRADE

■ The presence of an 'A' in the 14th position of the BLUE CHIP part number specifies an Industrial Grade capacitor. While sharing many of the characteristics of its high reliability counterparts, the conditioning of the Industrial Grade BLUE CHIP is not as extensive. Electrical limits for Industrial Grade are listed in the table below.

CS3000 HIGH RELIABILITY

■ The CS3000 High Reliability BLUE CHIP originated as a Customer Special in the mid 1970's. This variation on the Blue Chip series was developed to satisfy requirements of battery operated circuits for a capacitor that was small in size, low in DC leakage and would provide extended long term life.

■ The CS3000 is specially processed and conditioned to retain its ultra low leakage characteristics through all subsequent hybrid manufacturing processes and conditioning sequences.

■ Starting as a basic minimum with an 'M' Level CWR06 (1% per thousand hours Established Reliability Failure Rate), the CS3000 is further 100% conditioned by thermal shock and additional low impedance aging to provide an extraordinarily reliable, extremely stable capacitor.

■ From its early stages, the CS3000 has become the standard tantalum chip capacitor of choice for such diverse battery operated applications as medical electronics and satellite systems.

■ To specify CS3000 High Reliability BLUE CHIPS, use an 'X' as the 14th character of the 49BC part number (see Part Number Designation, this section) and state CS3000 after the part number.

■ Limits for Dissipation Factor and DC Leakage on CS3000 BLUE CHIPs are typically specified by the customer. When limits are not specified prior to purchase, the CWR06 electrical limit table will be used.

INDUSTRIAL GRADE BLUE CHIP ELECTRICAL LIMITS & CASE CODES

Cap. (nom) µF	Rated VDC 85°C	DC Leakage (max) 25°C µA	85°C µA	125°C µA	DF 120Hz %	ESR (max)* 120Hz Ω	100KHz Ω	Case Code
2.2	4	0.5	5	7	6	36	9.0	B
4.7	4	0.5	5	7	6	17	5.5	L
6.8	4	0.5	5	7	6	12	3.5	U
10	4	0.5	5	7	8	11	2.0	E
15	4	0.6	6	8	8	7	1.5	C
33	4	1.4	14	18	8	3	1.0	H
68	4	2.8	28	35	10	2	0.8	I
100	4	4.0	40	48	10	2	0.5	P
1.5	6	0.5	5	7	6	53	9.0	B
3.3	6	0.5	5	7	6	24	5.5	L
4.7	6	0.5	5	7	6	17	3.5	U
6.8	6	0.5	5	7	6	12	2.0	E
10	6	0.6	6	8	8	11	1.5	C
22	6	1.4	14	18	8	5	1.0	H
47	6	2.9	29	36	10	3	0.8	I
68	6	4.0	40	48	10	2	0.7	P
1.0	10	0.5	5	7	6	80	9.0	B
2.2	10	0.5	5	7	6	36	5.5	L
3.3	10	0.5	5	7	6	24	3.5	U
4.7	10	0.5	5	7	6	17	2.0	E
6.8	10	0.7	7	9	6	12	2.0	C
15	10	1.5	15	19	8	7	1.0	H
33	10	3.0	30	36	10	4	0.8	I
47	10	4.7	47	59	10	3	0.7	P
.68	15	0.5	5	7	6	120	10.0	B
1.5	15	0.5	5	7	6	53	6.0	L
2.2	15	0.5	5	7	6	36	4.0	U
3.3	15	0.5	5	7	6	24	2.5	E
4.7	15	0.8	8	10	6	17	2.5	C
10	15	1.5	15	19	6	8	1.5	H
22	15	3.3	33	42	8	5	1.0	I
33	15	5.0	50	60	8	3	0.8	P
.47	20	0.5	5	7	6	170	12.0	B
.68	20	0.5	5	7	6	120	8.0	L

Cap. (nom) µF	Rated VDC 85°C	DC Leakage (max) 25°C µA	85°C µA	125°C µA	DF 120Hz %	ESR (max)* 120Hz Ω	100KHz Ω	Case Code
1.0	20	0.5	5	7	6	80	8.0	L
1.5	20	0.5	5	7	6	53	6.0	U
2.2	20	0.5	5	7	6	36	3.5	E
3.3	20	0.7	7	9	6	24	3.0	C
6.8	20	1.4	14	18	6	12	2.5	H
15	20	3.0	30	36	6	6	1.0	I
22	20	4.0	40	48	6	4	1.0	P
.33	25	0.5	5	7	6	240	15.0	B
.68	25	0.5	5	7	6	120	10.0	L
1.0	25	0.5	5	7	6	80	8.0	U
1.5	25	0.5	5	7	6	53	5.0	E
2.2	25	0.6	6	8	6	36	3.5	C
4.7	25	1.2	12	15	6	17	2.5	H
6.8	25	1.7	17	22	6	12	2.0	I
10	25	2.5	25	32	6	8	2.0	I
15	25	3.8	38	48	6	6	1.0	P
.22	35	0.5	5	7	6	360	18.0	B
.47	35	0.5	5	7	6	170	12.0	L
.68	35	0.5	5	7	6	120	9.0	U
1.0	35	0.5	5	7	6	80	6.0	E
1.5	35	0.6	6	8	6	53	5.0	C
3.3	35	1.0	10	12	6	24	2.5	H
4.7	35	1.7	17	22	6	17	2.5	I
6.8	35	2.4	24	30	6	12	2.0	P
.10	50	0.5	5	7	6	800	20.0	B
.15	50	0.5	5	7	6	530	20.0	B
.22	50	0.5	5	7	6	360	15.0	L
.33	50	0.5	5	7	6	240	15.0	L
.47	50	0.5	5	7	6	170	10.0	U
.68	50	0.5	5	7	6	120	8.0	E
1.0	50	0.5	5	7	6	80	6.0	C
1.5	50	0.8	8	10	6	53	5.0	H
2.2	50	1.1	11	14	6	36	3.5	H
3.3	50	1.7	17	22	6	24	2.5	I
4.7	50	2.4	24	30	6	17	2.5	P

*120Hz ESR is maximum at nominal capacitance

49BC CUSTOMER SPECIALS (CS)

■ Special requests from our customers over the years for tantalum chip product that exceeds catalog specifications have given us the opportunity and the impetus to develop application specific chip tantalums with tighter limits and better operating parameters.

■ Recognizing the diverse requirements of many of our customers, Philips Components established the Technical Services Department to act as liaison between our customers and our design, applications and reliability engineering groups.

■ Typical of the design and application problems we've helped solve with product built as 'customer special':

- Low ESR at high frequency capacitors for applications such as switch-mode power supplies.
- Modular assemblies for high capacitance density.
- Adherence to rigid size restrictions far beyond normal.
- Fabrication of non-polar tantalum chips.
- Specialized cap shifts (with frequency) for wide-band amplifiers and microwave applications.
- Fibre-Optics coupling capacitors.
- Closely matched pairs for critical timing circuits.

■ Electrical parameter limits for Customer Special BLUE CHIPs are not specified here because they are not specified by us. If you have a non-standard application for tantalum chips, call us and let our Technical Services Department review it with you.

CWR06 ESTABLISHED RELIABILITY

■ Series 49BC BLUE CHIP capacitors are qualified to both Exponential Failure Rate Levels (M, P and R) and Weibull Graded Failure Rate Levels (B, C and D) under specification MIL-C-55365/4B, Style CWR06.

■ The military part numbering system and electrical parameter limits for Dissipation Factor and DC Leakage are covered on the following pages. Test information from the military specification follows that, but it is recommended that you obtain the specification and its attendant documents for further clarification of tests and procedures.

Philips Components provides all three termination styles for CWR06 Blue Chips: "A", "B" and "C". The hot solder dipped (60/40) "C" termination is the industry preferred. The "A" termination allows either solder plated or solder dipped; Philips Components provides the "A" termination as (60/40) hot solder dipped.

■ Among the industry-recognized advantages attributed to 60/40 hot soldered terminations are:

- The only form of coating to insure sufficient solder to meet solder fillet requirements of MIL-STD-883 ("C" termination only).
- A termination that should conform to steam aging (10 hours) and meet solderability requirements of MIL-STD-202, method 108.
- Allows long term storage for up to a year and still meets solderability requirements for MIL-STD-202.

ADDITIONAL BLUE CHIP PHYSICAL STATISTICS

CASE CODES		PHYSICAL STATISTICS				Typical Weight
		Substrate Area		Typical Volume		
BC	Mil	sq. in.	sq. cm.	cu. in.	cu. cm.	(grams)
B	A	0.00500	0.0323	0.000250	0.0041	0.02
L	B	0.00750	0.0484	0.000375	0.0062	0.03
U	C	0.01000	0.0645	0.000500	0.0082	0.04
E	D	0.01500	0.0967	0.000750	0.0123	0.07
C	E	0.02000	0.1290	0.001000	0.0164	0.09
H	F	0.02970	0.1930	0.001800	0.0295	0.21
I	G	0.02915	0.1880	0.003200	0.0524	0.33
P	H	0.04275	0.2760	0.004700	0.0770	0.50

STYLE CWR06 ESTABLISHED RELIABILITY
MILITARY STYLE TANTALUM CHIP CAPACITORS

MIL-C-55365/4 MILITARY PART NUMBERING SYSTEM EXAMPLE

CWR06 C B 225 K P

- **FAILURE RATE in percent per 1,000 hours** — M=1%, P=0.1%, R=0.01%; B=0.1%, C=0.01%, D=0.001%
- **CAPACITANCE TOLERANCE** — J=5%, K=10%, M=20%
- **CAPACITANCE, NOMINAL, in Picofarad Code** — First two digits are significant figures, third digit is number of zeros to follow.
- **TERMINATION FINISH** — A=Solder Coated/Plated; B=Gold Plated Nickel (100 μ" Gold); C=Hot Solder Dipped (60/40)
- **RATED VOLTAGE AT 85°C** — C=4, D=6, F=10, H=15, J=20, K=25, M=35, N=50
- **STYLE CWR06 Tantalum Chip Capacitor.**

NOTE: Military Part number does not designate case code

CWR06 ELECTRICAL LIMITS & MILITARY CASE CODES

Cap. (nom) μF	Rated VDC 85°C	DC Leakage (max) 25°C μA	85°C μA	125°C μA	Dissipation Factor (max) 25°C %	85°C 125°C	−55°C %	Case Code (Mil)
2.2	4	1.0	10	12	6	8	8	A
4.7	4	1.0	10	12	6	8	8	B
6.8	4	1.0	10	12	6	8	8	C
10	4	1.0	10	12	8	8	10	D
15	4	1.0	10	12	8	10	12	E
33	4	2.0	20	24	8	10	12	F
68	4	3.0	30	36	10	12	12	G
100	4	4.0	40	48	10	12	12	H
1.5	6	1.0	10	12	6	8	8	A
3.3	6	1.0	10	12	6	8	8	B
4.7	6	1.0	10	12	6	8	8	C
6.8	6	1.0	10	12	6	8	8	D
10	6	1.0	10	12	8	10	12	E
22	6	2.0	20	24	8	10	12	F
47	6	3.0	30	36	10	12	12	G
68	6	4.0	40	48	10	12	12	H
1.0	10	1.0	10	12	6	8	8	A
2.2	10	1.0	10	12	6	8	8	B
3.3	10	1.0	10	12	6	8	8	C
4.7	10	1.0	10	12	6	8	8	D
6.8	10	1.0	10	12	6	8	8	E
15	10	2.0	20	24	8	8	10	F
33	10	3.0	30	36	10	12	12	G
47	10	5.0	50	60	10	12	12	H
.68	15	1.0	10	12	6	8	8	A
1.5	15	1.0	10	12	6	8	8	B
2.2	15	1.0	10	12	6	8	8	C
3.3	15	1.0	10	12	6	8	8	D
4.7	15	1.0	10	12	6	8	8	E
10	15	2.0	20	24	6	8	8	F
22	15	4.0	40	48	8	8	10	G
33	15	5.0	50	60	8	8	10	H
.47	20	1.0	10	12	6	8	8	A
.68	20	1.0	10	12	6	8	8	B

Cap. (nom) μF	Rated VDC 85°C	DC Leakage (max) 25°C μA	85°C μA	125°C μA	Dissipation Factor (max) 25°C %	85°C 125°C	−55°C %	Case Code (Mil)
1.0	20	1.0	10	12	6	8	8	B
1.5	20	1.0	10	12	6	8	8	C
2.2	20	1.0	10	12	6	8	8	D
3.3	20	1.0	10	12	6	8	8	E
6.8	20	2.0	20	24	6	8	8	F
15	20	3.0	30	36	6	8	8	G
22	20	4.0	40	48	6	8	8	H
.33	25	1.0	10	12	6	8	8	A
.68	25	1.0	10	12	6	8	8	B
1.0	25	1.0	10	12	6	8	8	C
1.5	25	1.0	10	12	6	8	8	D
2.2	25	1.0	10	12	6	8	8	E
4.7	25	2.0	20	24	6	8	8	F
6.8	25	2.0	20	24	6	8	8	G
10	25	3.0	30	36	6	8	8	G
15	25	4.0	40	48	6	8	8	H
.22	35	1.0	10	12	6	8	8	A
.47	35	1.0	10	12	6	8	8	B
.68	35	1.0	10	12	6	8	8	C
1.0	35	1.0	10	12	6	8	8	D
1.5	35	1.0	10	12	6	8	8	E
3.3	35	1.0	10	12	6	8	8	F
4.7	35	2.0	20	24	6	8	8	G
6.8	35	3.0	30	36	6	8	8	H
.10	50	1.0	10	12	6	8	8	A
.15	50	1.0	10	12	6	8	8	A
.22	50	1.0	10	12	6	8	8	B
.33	50	1.0	10	12	6	8	8	B
.47	50	1.0	10	12	6	8	8	C
.68	50	1.0	10	12	6	8	8	D
1.0	50	1.0	10	12	6	8	8	E
1.5	50	1.0	10	12	6	8	8	F
2.2	50	2.0	20	24	6	8	8	F
3.3	50	2.0	20	24	6	8	8	G
4.7	50	3.0	30	36	6	8	8	H

MIL-C-55365/4—TEST AND CONDITIONS
(Excerpts from the Military Specification)

CAPACITANCE

■ Capacitors shall be tested in accordance with MIL-STD-202, method 305. The following details shall apply:

(a) Test frequency: 120 ±5 Hertz.

(b) Limit of accuracy: Measurement accuracy shall be within ±2 percent of the reading.

(c) Magnitude of polarizing voltage—Maximum DC bias shall be 2.2 volts for all AC measurements. The magnitude of the AC voltage shall be limited to 1.0 volts RMS.

DISSIPATION FACTOR

■ The dissipation factor of each capacitor shall be measured at a frequency of 120 ±5 Hertz (Hz) by means of a polarized capacitance bridge. The bridge shall provide a dial reading accuracy of 0.1% dissipation factor and a measuring accuracy of ± (2 percent of the measured dissipation factor plus 0.1%).

D.C. LEAKAGE

■ D.C. leakage shall be measured using the DC rated voltage at ±2 percent at the applicable test temperature after a maximum electrification period of 5 minutes. A 1,000-ohm resistor shall be placed in series with the capacitor to limit the charging current. A steady source of power, such as a regulated power supply, shall be used. Measurement accuracy shall be within ±2 percent or 0.02 microamps (μa), whichever is greater.

THERMAL SHOCK

■ Capacitors shall be tested in accordance with MIL-STD-202, method 107. The following details and exceptions shall apply:

(1) Mounting of specimens: Chip capacitors shall be mounted on suitable substrate. The substrate material shall be such that it shall not be cause of, nor contribute to, failure of any test for which it may be used. The capacitors shall be mounted on the substrate as follows:
  (a) A substrate shall be prepared with metalized surface land areas of proper spacing to permit mounting of chips by soldering the terminations of the chips to the "test card" land areas.
  (b) Solder paste, type "R" or "RMA" in accordance with QQ-S-571, shall be applied to terminals or substrates as applicable.
  (c) The chip shall then be placed across the metalized land areas of the substrate so as to make contact between chip and substrate land areas.
  (d) The substrate shall then be placed in or on a suitable heat transfer unit (molten solder, hot plate, tunnel oven, etc.) with the temperature maintained at 260 ±5°C for 2 minutes (+30, −0 seconds), until the solder paste melts and reflows forming a homogeneous solder bond to the metalized substrate.
  (e) All excess flux or solder shall be removed.

(2) Test condition letter: B

(3) Measurements after thermal shock: DC leakage—meet original requirement; Capacitance—shall change no more than 5% from initial measurement; Dissipation Factor—meet original requirement.

(4) Visual requirements: There shall be no evidence of harmful corrosion or mechanical damage.

VIBRATION, HIGH FREQUENCY

■ Capacitors shall be tested in accordance with MIL-STD-202, method 204, The following details and exceptions shall apply:

(a) Mounting of specimens—Capacitors shall be mounted on a substrate as specified under thermal shock.

(b) Electrical-load conditions—During the test, the specified DC rated voltage shall be applied to the capacitors.

(c) Test condition letter—D (20 G's).

(d) Duration and direction of motion—4 hours in each of two mutually perpendicular directions (total of 8 hours), one parallel and the other perpendicular to the axis.

(e) Measurements during vibration—During the last cycle, an electrical measurement shall be made to determine intermittent operation or open or short circuiting. Observations shall also be made to determine intermittent contact or arcing or open or short circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption with a duration of 0.5 ms or greater.

(f) Measurements after vibration—Not applicable.

(g) Examination after test—Capacitors shall be visually examined for evidence of mechanical damage.

RESISTANCE TO SOLDERING HEAT

■ Capacitors shall be tested in accordance with MIL-STD-202, method 210. The following details and exceptions shall apply:

(a) Mounting of specimens—Chip Capacitors shall be mounted on a substrate as specified in Thermal Shock.

(b) Test condition letter—E.

(c) Cooling time prior to measurement after test—Not applicable.

(d) Examination after test—Capacitors shall be visually examined for evidence of mechanical damage.

MOISTURE RESISTANCE

■ Capacitors shall be tested in accordance with MIL-STD-202, method 106. The following details and expections shall apply:

(a) Mounting of specimens—Capacitors shall be mounted as specified in Thermal Shock.

(b) Initial measurements—Capacitance as specified above.

(c) Number of cycles—20 continuous cycles except that steps 7a and 7b shall be omitted.

(d) Loading voltage—Not applicable.

(e) Final measurements—After removal from chamber, capacitors shall be dried for 1 hour at room temperature and, within the next hour, DC leakage, Capacitance and Dissipation Factor shall be measured as specified above.

(f) Examination after test—Capacitors shall be visually examined for evidence of corrosion and mechanical damage.

■ When tested as specified, capacitors shall meet the following requirements:

■ DC leakage—Shall not exceed 200% of the requirement specified.
■ Capacitance—Shall not change more than ±15% from the initial measured value.
■ Dissipation Factor—Shall not exceed 150% of the requirement specified.
■ Visual examination—There shall be no evidence of harmful corrosion or mechanical damage.

STABILITY AT LOW AND HIGH TEMPERATURE

■ Capacitors shall be dried at 125°C for 30 (+4, −0) minutes prior to start of test. The capacitors shall be brought to thermal stability at each test temperature. Thermal stability will have been reached when no further change in capacitance is observed between two successive measurements taken at 15, +2 −0 minute, intervals. Capacitors will meet the following requirements as applicable:

Step 1 (25°C Initial measurements):
DC Leakage—Shall not exceed the applicable value specified.
Capacitance—Shall be within tolerance of the nominal value.
Dissipation factor—Shall not exceed the requirement specified.

Step 2 (−55°C):
Capacitance—Shall be within ±10% of initial 25°C measurement.
Dissipation Factor—Shall not exceed the requirement specified.

Step 3 (25°C):
DC Leakage—Shall not exceed the applicable value specified.
Capacitance—Shall be within ±5% of initial 25°C measurement.
Dissipation Factor—Shall not exceed the requirement specified.

Step 4 (85°C):
DC Leakage—Shall not exceed the applicable value specified.
Capacitance—Shall be within ±10% of initial 25°C measurement.
Dissipation Factor—Shall not exceed the requirement specified.

Step 5 (125°C):
DC Leakage—Shall not exceed the applicable value specified.
Capacitance—Shall be within ±15% of initial 25°C measurement.
Dissipation Factor—Shall not exceed the requirement specified.

Step 6 (25°C):
DC Leakage—Shall not exceed the applicable value specified.
Capacitance—Shall be within ±5% of initial 25°C measurement.
Dissipation Factor—Shall not exceed the requirement specified.

SURGE VOLTAGE

■ Capacitors shall be subjected to 1,000 cycles of the applicable surge voltage. The ambient temperature during cycling shall be 85°C. Each cycle shall consist of a 30-second surge voltage application followed by a 30-second discharge period. Voltage application shall be made through a resistor of 33 ohms. The tolerance of the resistor shall be ±5 percent. Each surge voltage cycle shall be performed in such a manner that the capacitor is shorted terminal-to-terminal through a copper bar, or an equivalent low resistance at the end of the 30-second application. An alternative method of shorting the capacitors is discharge through the same resistance that is utilized for charging. After the final cycle, the capacitor shall be stabilized at the inspection conditions, and the DC leakage, Capacitance, and DF shall be measured. When tested as specified, capacitors shall meet the following requirements:

DC Leakage—Shall not exceed the requirement specified.
Capacitance—Shall change not more than ±5% from initial value.
Dissipation Factor—Shall not exceed the requirement specified.

LIFE TEST

A. Capacitors shall be tested in accordance with MIL-STD-202, method 108. The following details and exceptions shall apply:
   (a) Method of mounting—as detailed under thermal shock.
   (b) Test conditions
      (1) Proof Life
         2,000 hours
         125°C
         Derated voltage applied
      (2) Failure Rate Life
         10,000 hours
         85°C
         Rated voltage applied

B. Operating conditions—DC rated voltage 85°C or derated voltage at 125°C, as applicable, shall be applied gradually (not to exceed 5 minutes) either by a slow build up of the voltage or through a resistor which shall be shorted out within 5 minutes. Voltage shall be applied continuously except during measurement period. The impedance of the voltage source, as seen from the terminals of each capacitor, shall not exceed three ohms. Storage batteries or an electronic power supply capable of supplying at least one ampere when a capacitor is shorted shall be used.

C. Measurements during exposure—DC leakage, at the applicable high test temperature and voltage, shall be measured at the following intervals: 0 hours, 240 hours, 1000 hours, 2000 hours, 4000 hours*, 6000 hours*, 8000 hours*, 10,000 hours*.
   *Failure rate (85°C) life only.

D. Measurements after exposure—Capacitors shall be returned to 25°C and visually examined for evidence of harmful corrosion or mechanical damage. DC leakage, Capacitance and Dissipation Factor will then be measured as specified.

■ Following testing there shall be no evidence of harmful corrosion or mechanical damage and the capacitors will

meet the following electrical requirements:

2,000 hours:
- at 25°C DCL—initial requirement.
  △ Cap—±5% of initially measured value.
  DF—initial requirement.
- at 85°C DCL—initial requirement.
- at 125°C DCL—initial requirement.

10,000 hours:
- at 25°C DCL—200% of initial requirement.
  △ Cap—within ± 10% of initial measurement.
  DF—initial requirement.
- at 85°C DCL—200% of initial requirement.
- at 125°C DCL—200% of initial requirement.

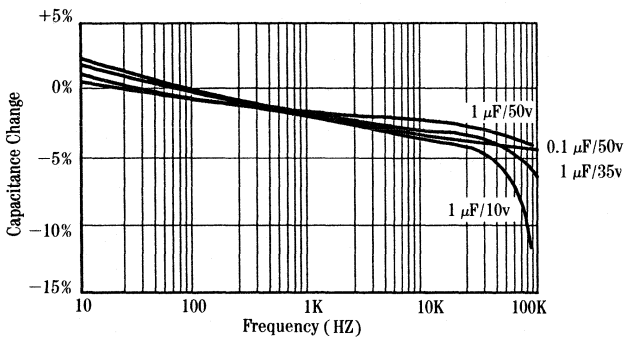
SOLDERABILITY

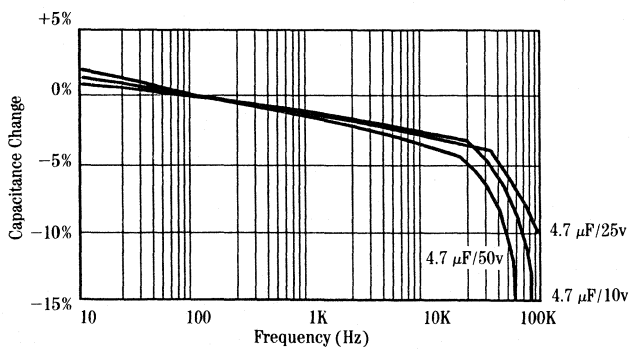
■ Capacitors shall be tested in accordance with MIL-STD-202, method 208. Mounting surfaces shall be dipped to cover the normal mounting surfaces. After the test immersed mounting surface shall be at least 75% covered with a smooth solder coating and shall exhibit no demetallization or leaching of the terminal ends. The remaining 25% may contain only small pin holes or rough spots, these shall not be concentrated in one area.

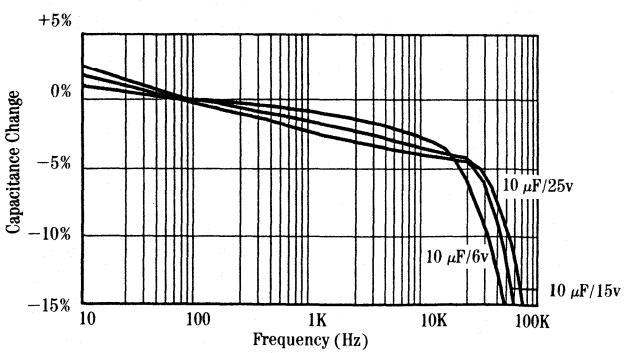
3

49BC—BLUE CHIP—TYPICAL CHARACTERISTICS

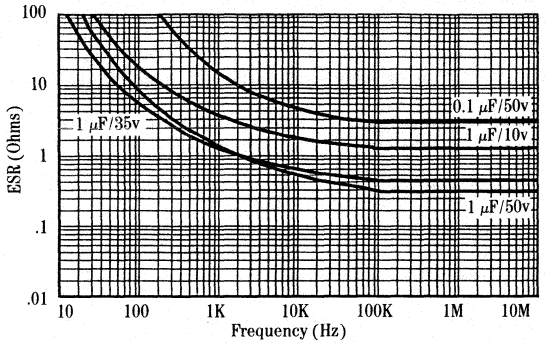
CAPACITANCE CHANGE with FREQUENCY

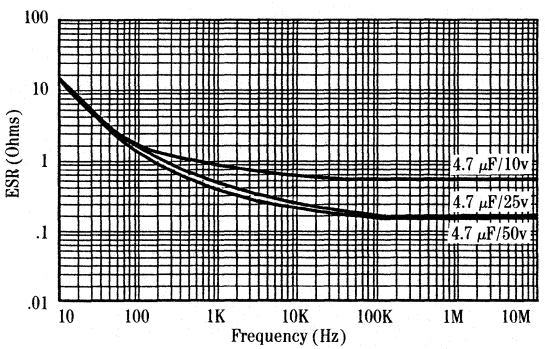


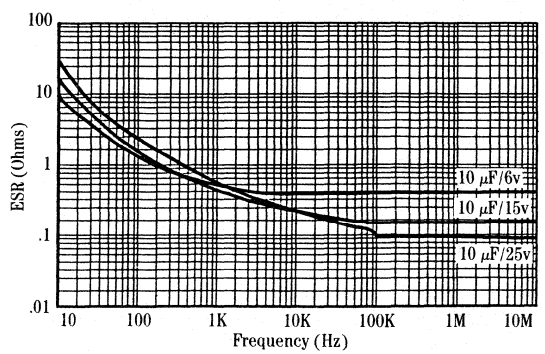




EQUIVALENT SERIES RESISTANCE vs FREQUENCY







49BC–BLUE CHIP–APPLICATION NOTES

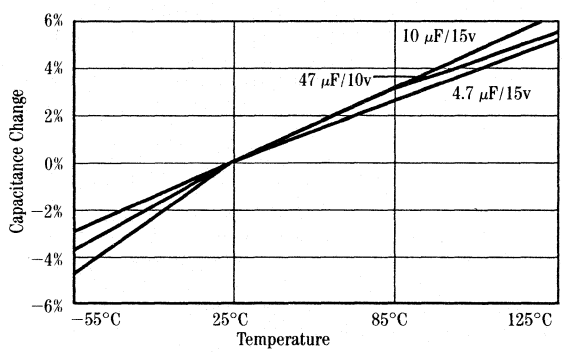
DESIGNING WITH BLUE CHIPS

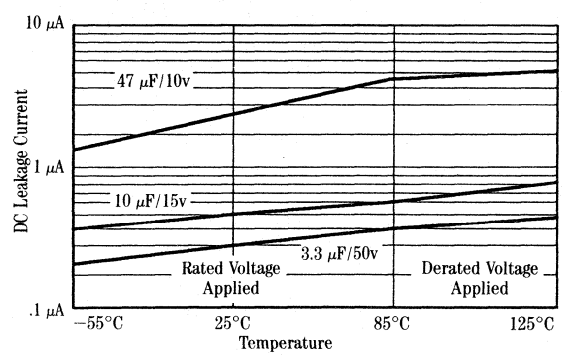
■ Philips Components BLUE CHIP Series capacitors are designed for use in thin and thick film hybrid circuits utilizing a variety of mounting techniques and in surface mount applications where soldering times and temperatures preclude the use of other styles of tantalum chip construction. BLUE CHIPs are an excellent choice for circuit applications involving filtering, coupling, decoupling, bypass and timing.

OPERATING TEMPERATURE

■ BLUE CHIP capacitors are intended for circuits operating at rated voltage between −55°C and 85°C. When linearly derated to 2/3 of working voltage, operation to 125°C is allowed.

TEMPERATURE CHARACTERISTICS



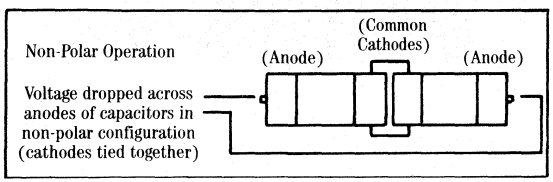


RELIABILITY DERATING

■ At normal operating temperatures, BLUE CHIP capacitors can be operated at less than rated voltage with a proportionate increase in reliability and no degradation of capacitor electrical parameters.

NON-POLAR CONFIGURATION

■ In circuits where voltage reversals exceeding 15% at 25°C occur, or where AC ripple voltages are high, BLUE CHIPs should be mounted in pairs in a cathode to cathode arrangement to effect non-polar operation.



■ In these cases, if two identical BLUE CHIPs are mounted back to back, the resulting capacitance will be ½ the value of the original devices and the voltage rating will be the same as the rating of the original devices. The positive peak AC voltage plus the DC voltage must not exceed the rated voltage of the capacitor in either direction.

HANDLING

■ Manual: The use of vacuum pencils or plastic tipped tweezers is recommended. Specify 'Blister Pack' packaging.

■ Automatic: Because BLUE CHIP capacitors are physically rugged, they can be automatically dispensed by vibration type feed bowls (specify 'Blister Pack' packaging) or by automatic tape fed placement equipment (specify Tape & Reel packaging). Other types of packaging (as specified by customer) will be considered.

MOUNTING MATERIALS

■ Most hybrid circuits use various materials in the substrate and pads which have differing coefficients of expansion. Therefore, Philips Components has designed its BLUE CHIP to be compatible with solder, epoxy and thermal compression bonding based upon the type termination specified. The "U" shaped termination and method of attachment isolates the capacitor from the substrate, making the BLUE CHIP totally compatible with all substrate materials, regardless of thermal mismatch.

■ Both conductive adhesives and solder pastes or creams lend themselves to production techniques because they can be accurately and rapidly screened onto the pads using masks. They also have a precure tackiness permitting chip placement prior to curing.

■ Conductive adhesives have the advantage of lower temperature cure mechanisms than those required for solder attachment. They do not require post attachment cleaning and defluxing cycles. Conductivity and joint strength will vary widely depending on the adhesive formulation and curing profile.

■ Soft metal solder attachment allows the widest latitude of conditions while still providing satisfactory attachment. While optimum joint strength and a low resistance connection are obtained, soldering does require a complex cleaning sequence to remove all traces of fluxes and any entrained contaminants.

■ BLUE CHIP termination materials are totally compatible with all soft metal solders which provide optimum joint strength over wide temperature excursions and all commercially available fluxing systems. Either water or solvent based fluxing systems may be used.

MOUNTING TECHNIQUES

■ WIRE BONDING—The BLUE CHIP's standard termination finish, 100 micro inches of soft gold plated over a .005" nickel clip, provides the optimum surface for either thermal compression or ultrasonic wire bonding. Gold plated terminations must be specified for these applications. In a typical application, the chip is glued down "on its back" with the mounting side up, and two wires (repetitive connections) are bonded to each of the positive and negative terminations.

■ CONDUCTIVE ADHESIVE—For mounting with conductive adhesive, gold plated terminations are recommended. (A cautionary note when working with conductive adhesives: curing the adhesive at the lowest acceptable temeprature for a longer time will minimize the possibility of forming "hairline" cracks in the adhesive during the cure.)

■ SOLDER ATTACH—For mounting by means of reflow soldering, 60/40 solder dipped terminations should be specified. The exception to soft metal soldering is the use of Indium/Lead solder, in which case gold plated terminiations should be specified. Any of the methods of solder reflow currently in use in the industry may be used with BLUE CHIP capacitors.

■ Hand Soldering—It is difficult to control soldering conditions when applying heat with a soldering iron. The solder dipped BLUE CHIP is recommended because the only requirement is to melt the solder of the termination rather than raise the temperature high enough to make a metallurgical bond to the base metal. A 600°F chisel tip iron is recommended, with application of the tip to the interface between the chip termination and the substrate pad. By minimizing the time necessary to reflow the solder, a minimum of heat is transferred to the capacitor body.

■ Hot Plate—This method has advantages over hand soldering for small quantity assembly operations. The temperature is easily controlled and all terminations are reflowed simultaneously. A reflow temperature of 230°C is recommended for alumina substrates. Higher temperatures or longer durations may be required for other substrate material. Preheating to 160°C prior to reflow will provide proper fluxing activation. Room temperature "cool-down" is all that is necessary.

■ Belt Reflow—The advantages of this method is that it provides a uniform increase in temperature to properly activate the fluxing system prior to reflow. The setting of the temperature will depend on the mass being reflowed. The belt speed and heat source should be adjusted or alignment of components should be such that one termination of any component does not reach liquidus temperature before the other. The capillary action or surface tension of the liquid solder could pull the component askew on the pads.

■ Infra-Red (IR)—The same recommendations apply to IR soldering as Belt Reflow with an additional caution that reflective surfaces will have an effect on heat absorption.

■ Wave Soldering—The same recommendations as above apply to this reflow method. Additionally, pre-heating prior to immersing the capacitors in liquid solder has to be considered a necessity rather than a recommendation in order to ensure proper flux activation. Gluing of the device to the substrate is normally required prior to wave soldering.

■ Vapor Phase—The design and construction of the BLUE CHIP and its ability to withstand longer durations at higher temperatures make it better suited for vapor phase reflow than other styles of tantalum chip construction. BLUE CHIPs will withstand the rapid rise to temperature inherent in the vapor phase system. The solid metal terminations will not de-wet.

CLEANING

■ The fluoroelastomer conformal coating prevents intrusion of any contaminates present in the cleaning process. It is compatible with most commonly used cleaning methods and solvents. This includes methods such as ultrasonic, hot and cold solvent sprays, vapor degreasing and detergent washes. All commercially available, commonly used solvents are compatible with the BLUE CHIP family of capacitors.

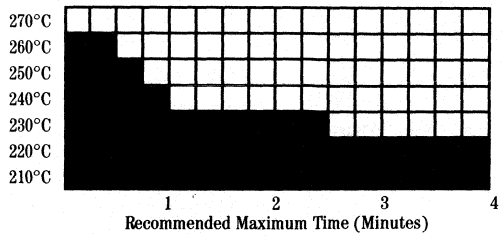
RECOMMENDED PAD DIMENSIONS FOR WAVE SOLDERING

CASE SIZE	A MIN.	B MIN.	C NOM.	D NOM.
B	.044 (1.11)	.067 (1.70)	.030 (0.77)	.204 (5.17)
L	.044 (1.11)	.067 (1.70)	.080 (2.04)	.254 (6.44)
U	.044 (1.11)	.067 (1.70)	.130 (3.31)	.304 (7.71)
E	.077 (1.96)	.067 (1.70)	.080 (2.04)	.254 (6.44)
C	.077 (1.96)	.067 (1.70)	.130 (3.31)	.304 (7.71)
H	.101 (2.55)	.067 (1.70)	.150 (3.82)	.324 (8.22)
I	.084 (2.13)	.087 (2.21)	.155 (3.94)	.369 (9.36)
P	.111 (2.81)	.087 (2.21)	.175 (4.45)	.389 (9.88)

REFLOW TIMES and TEMPERATURES

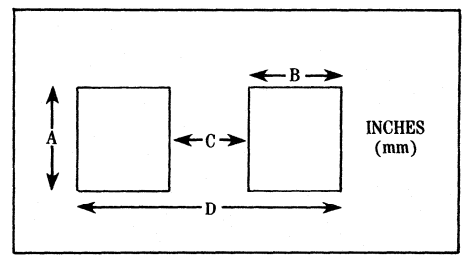
■ The optimum reflow profile will include a preheat cycle to provide proper flux activation prior to reflow.

■ It is axiomatic that the shortest time and the lowest reflow temperature will provide the greatest circuit reliability.



■ Multiple reflow passes are permissible as required in many manufacturing operations. This makes it possible to remove and/or replace other components on the board without fear of degrading the BLUE CHIP capacitors.

RECOMMENDED PAD DIMENSIONS FOR REFLOW SOLDERING

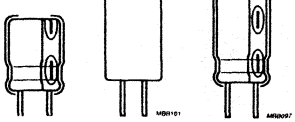


CASE SIZE	A MIN.	B MIN.	C NOM.	D NOM.
B	.085 (2.15)	.062 (1.58)	.030 (0.77)	.204 (5.17)
L	.085 (2.15)	.062 (1.58)	.080 (2.04)	.254 (6.44)
U	.085 (2.15)	.062 (1.58)	.130 (3.31)	.304 (7.71)
E	.135 (3.42)	.062 (1.58)	.080 (2.04)	.254 (6.44)
C	.135 (3.42)	.062 (1.58)	.130 (3.31)	.304 (7.71)
H	.170 (4.31)	.062 (1.58)	.150 (3.82)	.324 (8.22)
I	.145 (3.67)	.082 (2.08)	.155 (3.94)	.369 (9.36)
P	.185 (4.45)	.082 (2.08)	.175 (4.45)	.389 (9.88)

Electrolytic Capacitors

Notes

RADIAL NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS



STANDARD & MINIATURE	*SEMI-PROFESSIONAL*	*LONG-LIFE*	*EXTRA LONG-LIFE or HIGH TEMP.*
1000-3000 hours	750-1500 hours	1000-4000 hours	1500 hours / 125°C
85°C	105°C	105°C	5000 hours / 105°C
RLC 013 low leakage *Page 258*			**RHT 165** 125 °C *Page 386*
Page 230 **RS 035** *LV* **RSH 044** *HV* *Page 246*	*Page 272* **RSP 036** **RSS 045** *Page 302*	**RSL 046** *Page 358*	**RSX 164** 105 °C *Page 372*
		RLI 135 low Z *Page 330*	
RSM 037 *Page 210*	*Page 272* **RSP 036** **RMS 047** *Page 288*	*Page 316* **RLL 116** **RML 048** *Page 344*	
Page 200 **RLP7 097** *H: 7 mm* **RLP5 134** *H: 5 mm* *Page 190*			

smaller dimension ↓ *higher CU per volume*

Non-solid Al - electrolytic capacitors
Radial Low Profile, 5 mm

RLP 5 - 134

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, insulated with a blue sleeve
- Charge and discharge proof
- Very low profile, 5 mm height
- Extremely miniaturized.

APPLICATIONS

- General purpose, industrial, automotive and audio-video
- Coupling, decoupling, smoothing, filtering and timing
- Low surface demand on printed circuit board, high mounting density
- Portable and mobile equipment (very small size and very low mass), low profile equipment.

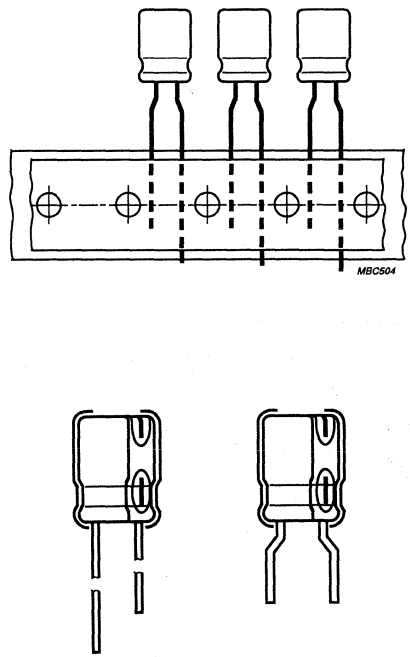


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (Ø D_{nom} x L_{nom} in mm)	3 x 5 to 6.3 x 5
Rated capacitance range, C_R	0.1 to 100 µF
Tolerance on C_R	±20%
Rated voltage range, U_R	6.3 to 50 V
Category temperature range	−40 to +85 °C
Endurance test at 85 °C	1000 hours
Useful life at 85 °C	1500 hours
Useful life at 40 °C, 1.4 I_R applied	40 000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specification	IEC 384-4/CECC 30 300, GP grade
Detail specification	similar to DIN 41259
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

Non-solid Al - electrolytic capacitors
Radial Low Profile, 5 mm

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**)

C_R (μF)	U_R(V)					
	6.3	**10**	**16**	**25**	**35**	**50**
0.10						3 x 5
0.22						3 x 5
0.47						3 x 5
1.0						3 x 5
1.5						3 x 5
2.2					3 x 5	3.5 x 5
3.3				3 x 5	3.5 x 5	4 x 5
4.7			3 x 5	3.5 x 5	4 x 5	5 x 5
6.8		3 x 5	3.5 x 5	4 x 5	5 x 5	6.3 x 5
10	3 x 5		3.5 x 5	5 x 5	5 x 5	6.3 x 5
15	3.5 x 5	4 x 5	5 x 5		6.3 x 5	
22	4 x 5		5 x 5		6.3 x 5	
33		5 x 5		6.3 x 5		
47	5 x 5		6.3 x 5			
68		6.3 x 5				
100	6.3 x 5					

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

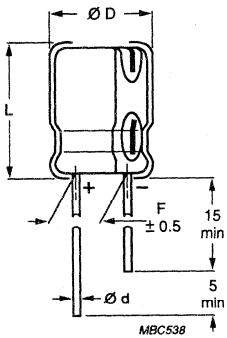
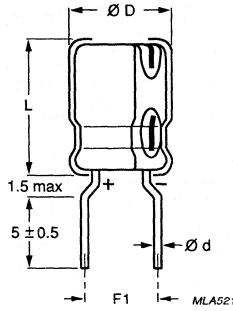


Fig.2 **Form CA**: Long leads.



Pitch 2.5 mm for Ø 3 and 3.5 mm; Pitch 5 mm for Ø 4 to 6.3 mm.

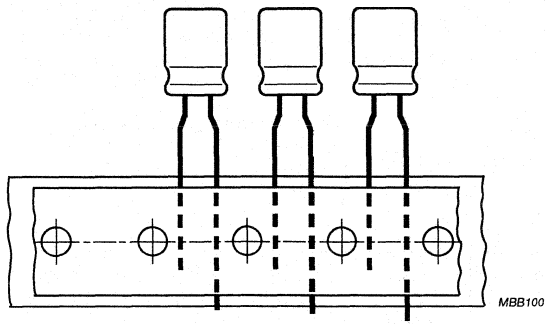
Fig.3 **Form CC**: cut leads, formed.

4

Table 2 Dimensions in mm

CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	Ød	ØD_{max}	L_{max}	F	F1	PACKING QUANTITIES		
							Form CA	Form CC	Form TFA
3 x 5	51	0.40	3.5	6.0	1.0 ±0.3	2.5 ±0.5	3000	4000	3000
3.5 x 5	52	0.40	4.0	6.0	1.0 ±0.3	2.5 ±0.5	3000	4000	3000
4 x 5	53	0.45	4.5	6.0	1.5 ±0.5	5.0 ±0.5	2000	3000	2000
5 x 5	54	0.45	5.5	6.0	2.0 ±0.5	5.0 ±0.5	2000	3000	2000
6.3 x 5	55	0.45	6.8	6.0	2.5 ±0.5	5.0 ±0.5	2000	2000	2000

Tape dimensions are specified in chapter "PACKING".



Form TFA: Taped in box, (ammopack).
Pitch 2.5 mm for ∅ 3 and 3.5 mm; Pitch 5 mm for ∅ 4 to 6.3 mm.

Fig.4 Taped with formed leads.

Non-solid Al - electrolytic capacitors
Radial Low Profile, 5 mm

RLP 5 - 134

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 120 Hz, tolerance ±20%

I_R = rated RMS ripple current at 120 Hz, 85 °C

I_{L2} = max. leakage current after 2 minutes at U_R

tan δ = max. dissipation factor at 120 Hz

ESR = equivalent series resistance at 120 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz and 100 kHz.

Table 3 Electrical data

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 85 °C 120 Hz (mA)	I_{L2} 2 min (µA)	Tan δ 120 Hz	ESR 120 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
6.3	10	3 x 5	12	3	0.24	32	17	14
	15	3.5 x 5	17	3	0.24	21	15	13
	22	4 x 5	23	3	0.24	14	12	11
	47	5 x 5	38	3	0.24	6.8	6.7	5.2
	100	6.3 x 5	60	7	0.24	3.2	4.4	3.4
10	6.8	3 x 5	11	3	0.20	39	22	20
	15	4 x 5	20	3	0.20	18	13	12
	33	5 x 5	35	4	0.20	8.0	7.7	6.0
	68	6.3 x 5	54	7	0.20	3.9	6.0	5.0
16	4.7	3 x 5	10	3	0.16	45	22	19
	6.8	3.5 x 5	14	3	0.16	31	20	18
	10	3.5 x 5	17	3	0.16	21	18	17
	15	5 x 5	26	3	0.16	14	13	11
	22	5 x 5	32	4	0.16	9.6	8.0	6.4
	47	6.3 x 5	50	8	0.16	4.5	5.2	4.2
25	3.3	3 x 5	9.5	3	0.14	56	29	24
	4.7	3.5 x 5	12	3	0.14	40	22	19
	6.8	4 x 5	16	3	0.14	27	18	16
	10	5 x 5	23	3	0.14	19	13	11
	33	6.3 x 5	45	9	0.14	5.6	6.0	4.6
35	2.2	3 x 5	8.3	3	0.12	72	48	41
	3.3	3.5 x 5	11	3	0.12	48	38	33
	4.7	4 x 5	15	3	0.12	34	31	27
	6.8	5 x 5	20	3	0.12	23	26	22
	10	5 x 5	25	4	0.12	16	21	17
	15	6.3 x 5	33	6	0.12	11	18	15
	22	6.3 x 5	40	8	0.12	7.2	13	11

Non-solid Al - electrolytic capacitors
Radial Low Profile, 5 mm

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor RLP 5 - 134
22 µF/16 V, ±20%
Case size 5 x 5; Form TFA
Catalogue number: 2222 134 35229

Table 4 Ordering information

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED IN BOX
				LONG LEADS Form CA	CUT LEADS FORMED Form CC	AMMOPACK Form TFA
6.3	10	3 x 5	51	134 53109	134 63109	134 33109
	15	3.5 x 5	52	134 53159	134 63159	134 33159
	22	4 x 5	53	134 53229	134 63229	134 33229
	47	5 x 5	54	134 53479	134 63479	134 33479
	100	6.3 x 5	55	134 53101	134 63101	134 33101
10	6.8	3 x 5	51	134 54688	134 64688	134 34688
	15	4 x 5	53	134 54159	134 64159	134 34159
	33	5 x 5	54	134 54339	134 64339	134 34339
	68	6.3 x 5	55	134 54689	134 64689	134 34689
16	4.7	3 x 5	51	134 55478	134 65478	134 35478
	6.8	3.5 x 5	52	134 55688	134 65688	134 35688
	10	3.5 x 5	52	134 55109	134 65109	134 35109
	15	5 x 5	54	134 55159	134 65159	134 35159
	22	5 x 5	54	134 55229	134 65229	134 35229
	47	6.3 x 5	55	134 55479	134 65479	134 35479
25	3.3	3 x 5	51	134 56338	134 66338	134 36338
	4.7	3.5 x 5	52	134 56478	134 66478	134 36478
	6.8	4 x 5	53	134 56688	134 66688	134 36688
	10	5 x 5	54	134 56109	134 66109	134 36109
	33	6.3 x 5	55	134 56339	134 66339	134 36339
35	2.2	3 x 5	51	134 50228	134 60228	134 30228
	3.3	3.5 x 5	52	134 50338	134 60338	134 30338
	4.7	4 x 5	53	134 50478	134 60478	134 30478
	6.8	5 x 5	54	134 50688	134 60688	134 30688
	10	5 x 5	54	134 50109	134 60109	134 30109
	15	6.3 x 5	55	134 50159	134 60159	134 30159
	22	6.3 x 5	55	134 50229	134 60229	134 30229

Non-solid Al - electrolytic capacitors
Radial Low Profile, 5 mm

RLP 5 - 134

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 85 °C 120 Hz (mA)	I_{L2} 2 min (µA)	Tan δ 120 Hz	ESR 120 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
50	0.10	3 x 5	1.3	3	0.10	1300	260	180
	0.22	3 x 5	2.9	3	0.10	600	160	120
	0.47	3 x 5	4.2	3	0.10	280	110	76
	1.0	3 x 5	6.2	3	0.10	130	70	50
	1.5	3 x 5	7.5	3	0.10	88	60	40
	2.2	3.5 x 5	10	3	0.10	60	44	33
	3.3	4 x 5	14	3	0.10	40	36	25
	4.7	5 x 5	19	3	0.10	28	29	22
	6.8	6.3 x 5	24	4	0.10	20	24	18
	10	6.3 x 5	29	5	0.10	13	19	14

Non-solid Al - electrolytic capacitors
Radial Low Profile, 5 mm

RLP 5 - 134

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED IN BOX
				LONG LEADS Form CA	CUT LEADS FORMED Form CC	AMMOPACK Form TFA
50	0.10	3 x 5	51	134 51107	134 61107	134 31107
	0.22	3 x 5	51	134 51227	134 61227	134 31227
	0.47	3 x 5	51	134 51477	134 61477	134 31477
	1.0	3 x 5	51	134 51108	134 61108	134 31108
	1.5	3 x 5	51	134 51158	134 61158	134 31158
	2.2	3.5 x 5	52	134 51228	134 61228	134 31228
	3.3	4 x 5	53	134 51338	134 61338	134 31338
	4.7	5 x 5	54	134 51478	134 61478	134 31478
	6.8	6.3 x 5	55	134 51688	134 61688	134 31688
	10	6.3 x 5	55	134 51109	134 61109	134 31109

Voltage

Surge voltage for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 2 minute at U_R	$I_{L2} \leq 0.01\ C_R \times U_R$ or 3 µA (whichever is greater)

MARKING

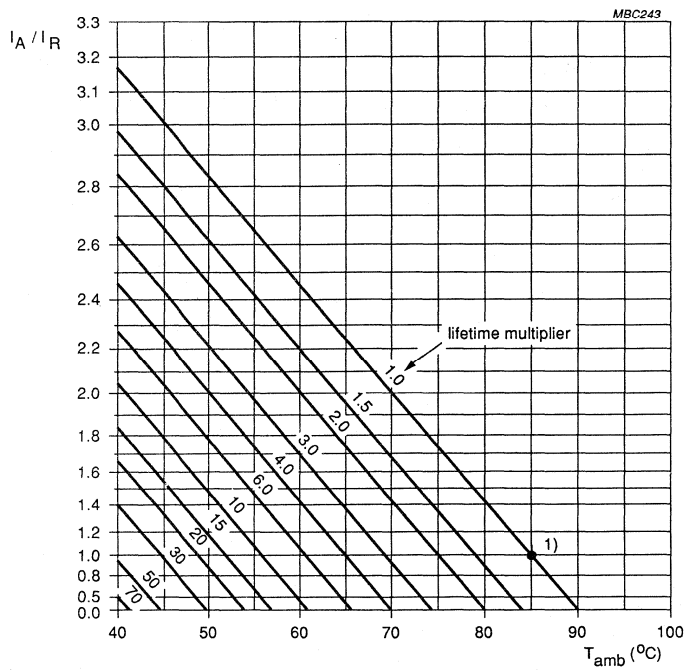
The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Rated voltage in V
- Negative terminal identification
- Group number (134)
- Code indicating factory of origin
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62.

RIPPLE CURRENT and USEFUL LIFE

Table 5 Multiplier of ripple current I_R as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.6
120	1.0
400	1.2
800	1.3
≥2000	1.4



I_A = actual ripple current at 120 Hz
I_R = rated ripple current at 120 Hz, 85 °C.

Useful life at 85 °C and I_R applied: 1500 hours.

Fig.5 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 sub clause 4.13	T_{amb} = 85 °C, U_R applied 1000 hours	ΔC/C ±20% tan δ ≤ 2 x spec. limit I_{L2} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 1500 hours	ΔC/C ±50% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L2} ≤spec. limit no short or open circuit total failure percentage: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 sub clause 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L2} ≤spec. limit

Non-solid Al - electrolytic capacitors
Radial Low Profile, 7 mm

RLP 7 - 097

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, insulated with a blue sleeve
- Charge and discharge proof
- Low profile, 7 mm height
- Miniaturized, high CU-product per unit volume.

APPLICATIONS

- General purpose; industrial, automotive and audio-video
- Coupling, decoupling, smoothing, filtering and timing
- Low surface demand on printed circuit board
- Portable and mobile equipment (small size, low mass), low profile equipment.

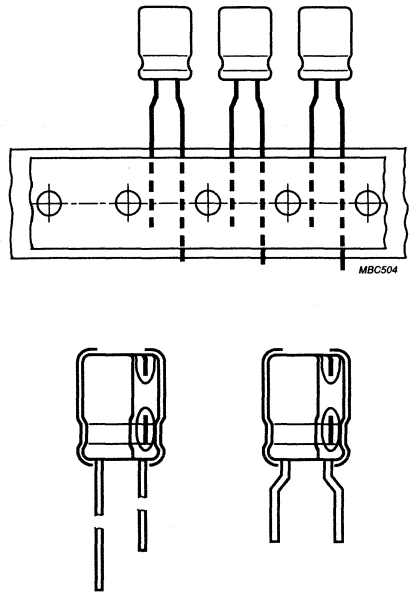


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (Ø D_{nom} x L_{nom} in mm)	4 x 7 to 7 x 7
Rated capacitance range, C_R	0.1 to 220 µF
Tolerance on C_R	±20%
Rated voltage, U_R	6.3 to 63 V
Category temperature range	–40 to +85 °C
Endurance test at 85 °C	1000 hours
Useful life at 85 °C	1500 hours
Useful life at 40 °C, 1.4 I_R applied	40 000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specification	IEC 384-4/CECC 30 300, GP grade
Detail specificaton	similar to DIN 41259
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

Non-solid Al - electrolytic capacitors
Radial Low Profile, 7 mm

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**)

C_R (μF)	U_R (V)						
	6.3	**10**	**16**	**25**	**35**	**50**	**63**
0.10							4 x 7
0.22							4 x 7
0.47							4 x 7
1.0							4 x 7
1.5							4 x 7
2.2							4 x 7
3.3						4 x 7	5 x 7
4.7					4 x 7	5 x 7	6.3 x 7
6.8			4 x 7		5 x 7	6.3 x 7	
10			4 x 7		5 x 7	6.3 x 7	7 x 7
15		4 x 7	5 x 7		6.3 x 7		
22	4 x 7		5 x 7		6.3 x 7	7 x 7	
33		5 x 7		6.3 x 7	7 x 7		
47	5 x 7		6.3 x 7	7 x 7			
68		6.3 x 7					
100		6.3 x 7	7 x 7				
220	7 x 7						

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING".

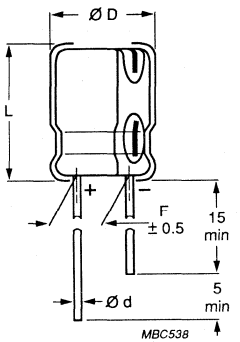


Fig.2 **Form CA**: Long leads.

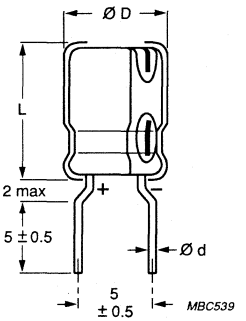
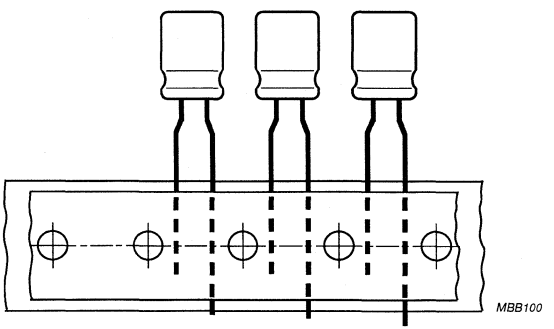


Fig.3 **Form CC**: Cut leads, formed, pitch 5 mm.



Form TR+: Taped on reel, positive leading.

Fig.4 Taped with formed leads, pitch 5 mm.

Table 2 Dimensions in mm

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	∅ d	∅D_{max}	L_{max}	F ±0.5	PACKING QUANTITIES		
						Form CA	Form CC	Form TR+
4 x 7	71	0.45	4.5	8	1.5	2000	2000	1800
5 x 7	72	0.45	5.5	8	2	1000	2000	1500
6.3 x 7	73	0.45	6.8	8	2.5	1000	1000	1000
7 x 7	74	0.45	7.5	8	2.5	1000	1000	1000

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance in μF
- Rated voltage in V
- Negative terminal identification
- Group number (097)
- Code indicating factory of origin
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62.

Non-solid Al - electrolytic capacitors
Radial Low Profile, 7 mm

RLP 7 - 097

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 120 Hz, tolerance ±20%
I_R = rated RMS ripple current at 120 Hz, 85 °C
I_{L2} = max. leakage current after 2 minutes at U_R
tan δ = max. dissipation factor at 120 Hz
ESR = equivalent series resistance at 120 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 10 kHz and 100 kHz.

Table 3 Electrical data

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 120 Hz 85 °C (mA)	I_{L2} 2 min (µA)	Tan δ 120 Hz	ESR 120 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
6.3	22	4 x 7	31	3	0.24	14	9.6	8.4
	47	5 x 7	47	3	0.24	6.8	5	4.6
	220	7 x 7	95	14	0.24	1.4	2	1.8
10	15	4 x 7	28	3	0.20	18	9.5	8.2
	33	5 x 7	43	4	0.20	8.0	4	3.7
	68	6.3 x 7	63	7	0.20	3.9	3.3	3
	100	6.3 x 7	80	10	0.20	2.7	2.3	2.2
16	6.8	4 x 7	20	3	0.16	31	18	16
	10	4 x 7	25	3	0.16	21	11	10
	15	5 x 7	31	3	0.16	14	9	7.5
	22	5 x 7	39	4	0.16	9.6	6	5
	47	6.3 x 7	59	8	0.16	4.5	4	3.5
	100	7 x 7	97	16	0.16	2.1	3	2.5
25	33	6.3 x 7	53	9	0.14	5.6	3.3	2.6
	47	7 x 7	71	12	0.14	4.0	2.5	1.9
35	4.7	4 x 7	20	3	0.12	34	12	10
	6.8	5 x 7	24	3	0.12	23	10	8
	10	5 x 7	30	4	0.12	16	6.5	5.6
	15	6.3 x 7	37	6	0.12	11	5	4.2
	22	6.3 x 7	47	8	0.12	7.2	3.3	3
	33	7 x 7	64	12	0.12	4.8	2.9	2.6
50	3.3	4 x 7	18	3	0.10	40	16	14
	4.7	5 x 7	23	3	0.10	28	12	10
	6.8	6.3 x 7	28	4	0.10	20	9	7.5
	10	6.3 x 7	34	5	0.10	13	6.2	5.5
	22	7 x 7	57	11	0.10	6.0	3.2	2.9

Non-solid Al - electrolytic capacitors
Radial Low Profile, 7 mm

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitors RLP 7 - 097
100 µF/16 V, ±20%
Case size 7 x 7; Form TR+
Catalogue number 2222 097 25101

Table 4 Ordering information

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED ON REEL
				LONG LEADS Form CA	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+
6.3	22	4 x 7	71	097 53229	097 63229	097 23229
	47	5 x 7	72	097 53479	097 63479	097 23479
	220	7 x 7	74	097 53221	097 63221	097 23221
10	15	4 x 7	71	097 54159	097 64159	097 24159
	33	5 x 7	72	097 54339	097 64339	097 24339
	68	6.3 x 7	73	097 54689	097 64689	097 24689
	100	6.3 x 7	73	097 54101	097 64101	097 24101
16	6.8	4 x 7	71	097 55688	097 65688	097 25688
	10	4 x 7	71	097 55109	097 65109	097 25109
	15	5 x 7	72	097 55159	097 65159	097 25159
	22	5 x 7	72	097 55229	097 65229	097 25229
	47	6.3 x 7	73	097 55479	097 65479	097 25479
	100	7 x 7	74	097 55101	097 65101	097 25101
25	33	6.3 x 7	73	097 56339	097 66339	097 26339
	47	7 x 7	74	097 56479	097 66479	097 26479
35	4.7	4 x 7	71	097 50478	097 60478	097 20478
	6.8	5 x 7	72	097 50688	097 60688	097 20688
	10	5 x 7	72	097 50109	097 60109	097 20109
	15	6.3 x 7	73	097 50159	097 60159	097 20159
	22	6.3 x 7	73	097 50229	097 60229	097 20229
	33	7 x 7	74	097 50339	097 60339	097 20339
50	3.3	4 x 7	71	097 51338	097 61338	097 21338
	4.7	5 x 7	72	097 51478	097 61478	097 21478
	6.8	6.3 x 7	73	097 51688	097 61688	097 21688
	10	6.3 x 7	73	097 51109	097 61109	097 21109
	22	7 x 7	74	097 51229	097 61229	097 21229

Non-solid Al - electrolytic capacitors
Radial Low Profile, 7 mm

RLP 7 - 097

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 120 Hz 85 °C (mA)	I_{L2} 2 min (µA)	Tan δ 120 Hz	ESR 120 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
63	0.10	4 x 7	1.3	3	0.08	1100	238	170
	0.22	4 x 7	2.9	3	0.08	480	138	110
	0.47	4 x 7	7.9	3	0.08	230	88	66
	1	4 x 7	11	3	0.08	110	42	36
	1.5	4 x 7	13	3	0.08	71	29	26
	2.2	4 x 7	17	3	0.08	48	22	19
	3.3	5 x 7	21	3	0.08	32	16	14
	4.7	6.3 x 7	26	3	0.08	23	12	10
	10	7 x 7	43	7	0.08	11	6.2	5.5

Non-solid Al - electrolytic capacitors
Radial Low Profile, 7 mm

RLP 7 - 097

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED ON REEL
				LONG LEADS Form CA	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+
63	0.10	4 x 7	71	097 58107	097 68107	097 28107
	0.22	4 x 7	71	097 58227	097 68227	097 28227
	0.47	4 x 7	71	097 58477	097 68447	097 28447
	1	4 x 7	71	097 58108	097 68108	097 28108
	1.5	4 x 7	71	097 58158	097 68158	097 28158
	2.2	4 x 7	71	097 58228	097 68228	097 28228
	3.3	5 x 7	72	097 58338	097 68338	097 28338
	4.7	6.3 x 7	73	097 58478	097 68478	097 28478
	10	7 x 7	74	097 58109	097 68109	097 28109

Voltage

Surge voltage for short periods	$U_s \leq 1.15\ U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

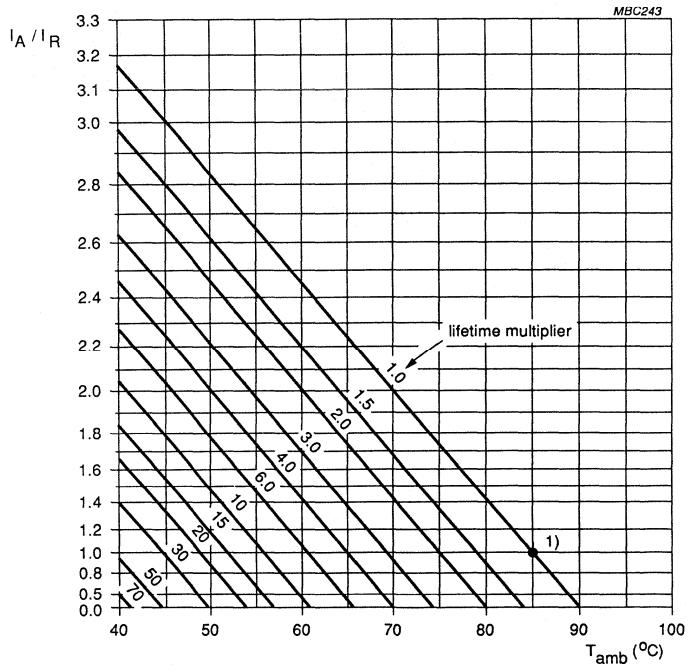
After 2 minutes at U_R	$I_{L2} \leq 0.01\ C_R \times U_R$ or 3 µA (whichever is greater)

4

RIPPLE CURRENT and USEFUL LIFE

Table 5 Multiplier of ripple current I_R as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.6
120	1.0
400	1.2
800	1.3
≥2000	1.4



I_A = actual ripple current at 120 Hz
I_R = rated ripple current at 120 Hz, 85 °C.

Useful life at 85 °C and I_R applied: 1500 hours.

Fig.5 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 sub clause 4.13	T_{amb} = 85 °C, U_R applied 1000 hours	ΔC/C ±20% tan δ ≤ 2 x spec. limit I_{L2} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 1500 hours	ΔC/C ±50% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L2} ≤spec. limit no short or open circuit total failure percentage: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 sub clause 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L2} ≤spec. limit

4

Non-solid Al - electrolytic capacitors
Radial Standard Miniature

RSM 037

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, insulated with a blue sleeve
- Charge and discharge proof
- Miniaturized, high CU-product per unit volume.

APPLICATIONS

- General purpose; industrial, automotive and audio-video
- Coupling, decoupling, timing; smoothing, filtering, buffering in SMPS
- Portable and mobile equipment (small size, low mass)
- Low surface demand on printed circuit board.

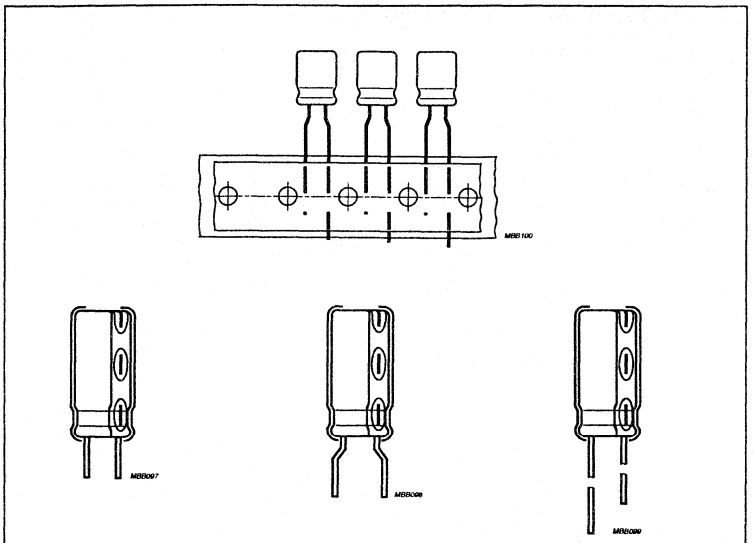


Fig.1 Component outlines.

4

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom})	5 x 11 to 16 x 31 mm
Rated capacitance range, C_R	0.1 to 10 000 µF
Tolerance on C_R	±20% (±10% on request)
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	−40 to +85 °C
Endurance test at 85 °C U_R = 6.3 to 16 V U_R = 25 to 100 V	 1000 hours 2000 hours
Useful life at 85 °C	2000 hours
Useful life at 40 °C, 1.4 I_R applied	60 000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specification	IEC 384-4/CECC 30300, GP grade
Detail specification	IEC 384-4-1/CECC 30301 similar to DIN 41259 (with reduced dimensions)
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**) * = preferred values

C_R (µF)		U_R (V)								
		6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**	**100**
0.10									5 x 11	
0.22	*								5 x 11	5 x 11
0.47	*								5 x 11	5 x 11
1.0	*								5 x 11	5 x 11
2.2	*								5 x 11	5 x 11
3.3									5 x 11	5 x 11
4.7	*								5 x 11	5 x 11
6.8									5 x 11	5 x 11
10	*							5 x 11	5 x 11	6.3 x 11
15							5 x 11		5 x 11	8 x 12
22	*					5 x 11	5 x 11	5 x 11	6.3 x 11	8 x 12
33				5 x 11		5 x 11	6.3 x 11	6.3 x 11	6.3 x 11	10 x 12
47	*		5 x 11		5 x 11		6.3 x 11	6.3 x 11	8 x 12	10 x 16
68		5 x 11		5 x 11	6.3 x 11		8 x 12	8 x 12	10 x 12	10 x 16
100	*		5 x 11	6.3 x 11	6.3 x 11		8 x 12	8 x 12	10 x 12	10 x 20
150		6.3 x 11	6.3 x 11	8 x 12	8 x 12		10 x 12		10 x 16	12.5 x 20
220	*	6.3 x 11	6.3 x 11	8 x 12	8 x 12	10 x 12		10 x 16	10 x 20	12.5 x 25
330		6.3 x 11	8 x 12	8 x 12	10 x 12	10 x 16	10 x 20	10 x 20	12.5 x 20	16 x 25
470	*	8 x 12	8 x 12	10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 20	12.5 x 25	16 x 31
680			10 x 12	10 x 16		12.5 x 20	12.5 x 25	12.5 x 25	16 x 25	
1000	*	10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 25	16 x 31	
1500		10 x 20		12.5 x 20	12.5 x 25	16 x 25	16 x 31			
2200	*	12.5 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31				
3300		12.5 x 20	12.5 x 25	16 x 25	16 x 31					
4700	*		16 x 25	16 x 31						
6800		16 x 25	16 x 31							
10 000	*	16 x 31								

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

Table 2 Dimensions in mm; mass in g

CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	Ø d	ØD_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA CB, CC	Form TR+ TR–, TN	Form TFA
5 x 11	11	0.5	5.5	12.5	2.0	0.4	1000	1000	2000
6.3 x 11	12	0.6	6.8	12.5	2.5	0.6	1000	1000	2000
8 x 12	13	0.6	8.5	13.0	3.5	1.1	1000	800	1000
10 x 12	14	0.6	10.5	13.5	5.0	1.6	1000	500	–
10 x 16	15	0.6	10.5	17.5	5.0	1.9	500	500	–
10 x 20	16	0.6	10.5	21.5	5.0	2.2	500	500	–
12.5 x 20	17	0.6	13.0	21.5	5.0	4.0	200	200	–
12.5 x 25	18	0.6	13.0	26.5	5.0	5.0	200	200	–
16 x 25	19	0.8	16.5	27.0	7.5	8.0	200	150	–
16 x 31	20	0.8	16.5	33.5	7.5	9.0	200	150	–

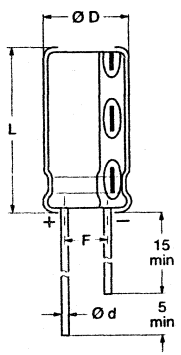


Fig.2 **Form CA**: Long leads.

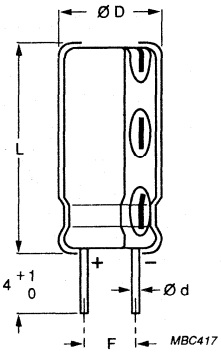


Fig.3 **Form CB**: Cut leads.

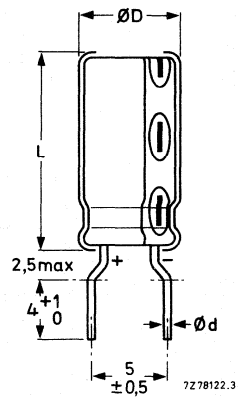
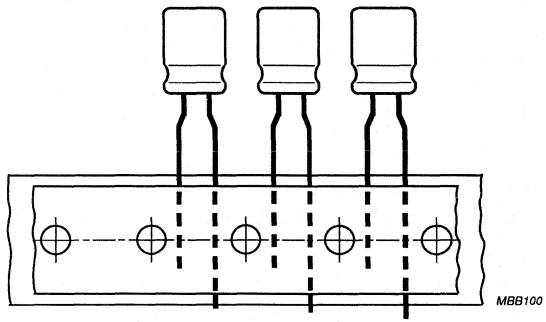


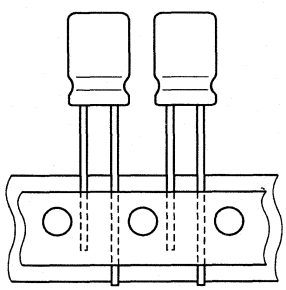
Fig.4 **Form CC**: Cut leads, formed; Ø D = 5, 6.3 and 8 mm only.

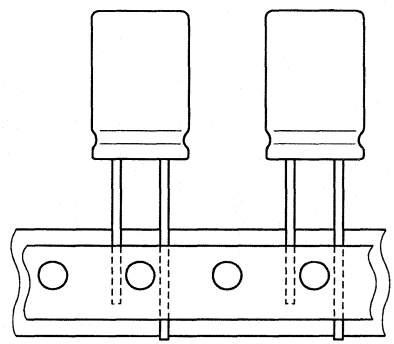
Taping dimensions are specified in chapter "PACKING",



Form TR+: Taped on reel, positive leading.
Form TR–: Taped on reel, negative leading.
Form TFA : Taped in box (ammopack).

Fig.5 Taped, formed, pitch 5 mm.





Form TN+:
ØD 5 mm: F = 2.5 mm
(leads slightly bent)
ØD 6.3 mm: F = 2.5 mm
ØD 8 mm: F = 3.5 mm

Form TR+:
ØD 10 and 12.5 mm: F = 5 mm

Form TR+:
ØD 16 mm: F = 7.5 mm

Fig.6 Taped on reel, straight leads, positive leading.

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance ± 20%
I_R = rated RMS ripple current at 100 Hz, 85 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 10 kHz.

Table 3 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
6.3	68	5 x 11	11	80	7.3	3.9	0.24	7.0	8.8
	150	6.3 x 11	12	130	12	4.9	0.24	3.2	4.0
	220	6.3 x 11	12	170	17	5.8	0.24	2.2	2.7
	330	6.3 x 11	12	240	24	7.2	0.24	1.4	1.8
	470	8 x 12	13	300	33	8.9	0.24	1.0	1.3
	1000	10 x 12	14	510	66	16	0.24	0.48	0.6
	1500	10 x 20	16	670	98	22	0.25	0.33	0.4
	2200	12.5 x 20	17	890	140	31	0.26	0.24	0.27
	3300	12.5 x 20	17	1150	210	45	0.28	0.17	0.18
	6800	16 x 25	19	1550	430	89	0.35	0.10	0.09
	10 000	16 x 31	20	1750	630	130	0.42	0.08	0.07
10	47	5 x 11	11	75	7.7	3.9	0.20	8.5	9.6
	100	5 x 11	11	110	13	5	0.20	4.0	4.5
	150	6.3 x 11	12	140	18	6	0.20	2.7	3.0
	220	6.3 x 11	12	210	25	7.4	0.20	1.8	2.0
	330	8 x 12	13	270	36	9.6	0.20	1.2	1.4
	470	8 x 12	13	350	50	12	0.20	0.85	0.96
	680	10 x 12	14	420	71	17	0.20	0.59	0.66
	1000	10 x 16	15	630	100	23	0.20	0.40	0.45
	2200	12.5 x 20	17	1050	220	47	0.22	0.20	0.20
	3300	12.5 x 25	18	1250	330	69	0.24	0.14	0.14
	4700	16 x 25	19	1450	470	97	0.28	0.12	0.10
	6800	16 x 31	20	1700	680	140	0.32	0.09	0.07

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor RSM 037
1000 µF/16 V, ±20%
Case size 10 x 20 mm; Form CA
Catalogue number: 2222 037 55102.

Table 4 Ordering information

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS	CUT LEADS	CUT LEADS FORMED	F = 5 mm positive leading	F = 5 mm negative leading	F = 2.5 mm or 3.5 mm positive leading	
		Form CA	Form CB	Form CC	Form TR+	Form TR–	Form TN+	Form TFA
6.3	68	037 53689	037 83689	037 63689	037 23689	037 43689	037 13689	037 33689
	150	037 53151	037 83151	037 63151	037 23151	037 43151	037 13151	037 33151
	220	037 53221	037 83221	037 63221	037 23221	037 43221	037 13221	037 33221
	330	037 90021	037 90022	037 90023	037 90024	037 90025	037 90026	037 90027
	470	037 53471	037 83471	037 63471	037 23471	037 43471	037 13471	037 33471
	1000	037 53102	037 63102	–	037 23102	–	–	–
	1500	037 53152	037 63152	–	037 23152	–	–	–
	2200	037 53222	037 63222	–	037 23222	–	–	–
	3300	037 53332	037 63332	–	037 23332	–	–	–
	6800	037 53682	037 63682	–	037 23682	–	–	–
	10 000	037 53103	037 63103	–	037 23103	–	–	–
10	47	037 54479	037 84479	037 64479	037 24479	037 44479	037 14479	037 34479
	100	037 54101	037 84101	037 64101	037 24101	037 44101	037 14101	037 34101
	150	037 54151	037 84151	037 64151	037 24151	037 44151	037 14151	037 34151
	220	037 90029	037 90031	037 90032	037 90012	037 90013	037 90035	037 90036
	330	037 54331	037 84331	037 64331	037 24331	037 44331	037 14331	037 34331
	470	037 54471	037 64471	–	037 24471	–	–	–
	680	037 54681	037 64681	–	037 24681	–	–	–
	1000	037 54102	037 64102	–	037 24102	–	–	–
	2200	037 54222	037 64222	–	037 24222	–	–	–
	3300	037 54332	037 64332	–	037 24332	–	–	–
	4700	037 54472	037 64472	–	037 24472	–	–	–
	6800	037 54682	037 64682	–	037 24682	–	–	–

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
16	33	5 x 11	11	70	8.3	4.1	0.16	9.6	9.7
	68	5 x 11	11	100	14	5.2	0.16	4.7	4.7
	100	6.3 x 11	12	140	19	6.2	0.16	3.2	3.2
	150	8 x 12	13	200	27	7.8	0.16	2.1	2.1
	220	8 x 12	13	240	38	10	0.16	1.4	1.5
	330	8 x 12	13	330	56	14	0.16	0.96	0.97
	470	10 x 12	14	420	78	18	0.16	0.68	0.68
	680	10 x 16	15	520	110	25	0.16	0.47	0.47
	1000	10 x 20	16	740	160	35	0.16	0.32	0.32
	1500	12.5 x 20	17	900	240	51	0.17	0.23	0.21
	2200	12.5 x 25	18	1150	360	73	0.18	0.16	0.15
	3300	16 x 25	19	1400	530	109	0.20	0.12	0.10
	4700	16 x 31	20	1650	760	150	0.24	0.10	0.07
25	47	5 x 11	11	90	15	5.4	0.14	5.9	4.7
	68	6.3 x 11	12	110	20	6.4	0.14	4.1	3.2
	100	6.3 x 11	12	170	28	8	0.14	2.8	2.2
	150	8 x 12	13	200	41	11	0.14	1.9	1.5
	220	8 x 12	13	280	58	14	0.14	1.3	1.0
	330	10 x 12	14	410	86	20	0.14	0.84	0.67
	470	10 x 16	15	510	120	26	0.14	0.59	0.47
	1000	12.5 x 20	17	890	250	53	0.14	0.28	0.22
	1500	12.5 x 25	18	1000	380	78	0.15	0.20	0.15
	2200	16 x 25	19	1300	550	110	0.16	0.14	0.10
	3300	16 x 31	20	1500	830	170	0.18	0.11	0.07
35	22	5 x 11	11	65	11	4.5	0.12	11	6.8
	33	5 x 11	11	80	15	5.3	0.12	7.2	4.5
	220	10 x 12	14	330	80	18	0.12	1.1	0.68
	330	10 x 16	15	450	120	26	0.12	0.72	0.45
	470	10 x 20	16	550	170	36	0.12	0.51	0.32
	680	12.5 x 20	17	740	240	51	0.12	0.35	0.22
	1000	12.5 x 25	18	990	350	73	0.12	0.24	0.15
	1500	16 x 25	19	1150	530	110	0.13	0.17	0.10
	2200	16 x 31	20	1400	770	160	0.14	0.13	0.07

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U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS	CUT LEADS	CUT LEADS FORMED	F = 5 mm positive leading	F = 5 mm negative leading	F = 2.5 mm or 3.5 mm positive leading	
		Form CA	Form CB	Form CC	Form TR+	Form TR–	Form TN+	Form TFA
16	33	037 55339	037 85339	037 65339	037 25339	037 45339	037 15339	037 35339
	68	037 55689	037 85689	037 65689	037 25689	037 45689	037 15689	037 35689
	100	037 55101	037 85101	037 65101	037 25101	037 45101	037 15101	037 35101
	150	037 55151	037 85151	037 65151	037 25151	037 45151	037 15151	037 35151
	220	037 55221	037 85221	037 65221	037 25221	037 45221	037 15221	037 35221
	330	037 90038	037 90039	037 90041	037 90042	037 90043	037 90044	037 90045
	470	037 55471	037 65471	–	037 25471	–	–	–
	680	037 55681	037 65681	–	037 25681	–	–	–
	1000	037 55102	037 65102	–	037 25102	–	–	–
	1500	037 55152	037 65152	–	037 25152	–	–	–
	2200	037 55222	037 65222	–	037 25222	–	–	–
	3300	037 55332	037 65332	–	037 25332	–	–	–
	4700	037 55472	037 65472	–	037 25472	–	–	–
25	47	037 56479	037 86479	037 66479	037 26479	037 46479	037 16479	037 36479
	68	037 56689	037 86689	037 66689	037 26689	037 46689	037 16689	037 36689
	100	037 90047	037 90048	037 90049	037 90051	037 90052	037 90053	037 90054
	150	037 56151	037 86151	037 66151	037 26151	037 46151	037 16151	037 36151
	220	037 56221	037 86221	037 66221	037 26221	037 46221	037 16221	037 36221
	330	037 56331	037 66331	–	037 26331	–	–	–
	470	037 56471	037 66471	–	037 26471	–	–	–
	1000	037 56102	037 66102	–	037 26102	–	–	–
	1500	037 56152	037 66152	–	037 26152	–	–	–
	2200	037 56222	037 66222	–	037 26222	–	–	–
	3300	037 56332	037 66332	–	037 26332	–	–	–
35	22	037 50229	037 80229	037 60229	037 20229	037 40229	037 10229	037 30229
	33	037 50339	037 80339	037 60339	037 20339	037 40339	037 10339	037 30339
	220	037 50221	037 60221	–	037 20221	–	–	–
	330	037 50331	037 60331	–	037 20331	–	–	–
	470	037 50471	037 60471	–	037 20471	–	–	–
	680	037 50681	037 60681	–	037 20681	–	–	–
	1000	037 50102	037 60102	–	037 20102	–	–	–
	1500	037 50152	037 60152	–	037 20152	–	–	–
	2200	037 50222	037 60222	–	037 20222	–	–	–

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
40	15	5 x 11	11	55	9	4.2	0.12	16	8.7
	22	5 x 11	11	70	12	4.8	0.12	11	5.9
	33	6.3 x 11	12	90	16	5.6	0.12	7.2	3.9
	47	6.3 x 11	12	110	22	6.8	0.12	5.1	2.8
	68	8 x 12	13	150	30	8.4	0.12	3.5	1.9
	100	8 x 12	13	190	43	11	0.12	2.4	1.3
	150	10 x 12	14	250	63	15	0.12	1.6	0.87
	330	10 x 20	16	500	140	29	0.12	0.72	0.39
	470	12.5 x 20	17	650	190	41	0.12	0.51	0.28
	680	12.5 x 25	18	810	280	57	0.12	0.35	0.19
	1000	16 x 25	19	1050	400	83	0.12	0.24	0.13
	1500	16 x 31	20	1100	600	120	0.13	0.17	0.09
50	10	5 x 11	11	47	8	4	0.10	16	9.5
	22	5 x 11	11	81	14	5.2	0.10	7.2	4.3
	33	6.3 x 11	12	100	20	6.3	0.10	4.8	2.9
	47	6.3 x 11	12	140	27	7.7	0.10	3.4	2.0
	68	8 x 12	13	160	37	10	0.10	2.3	1.4
	100	8 x 12	13	210	53	13	0.10	1.6	0.95
	220	10 x 16	15	400	110	25	0.10	0.72	0.43
	330	10 x 20	16	580	170	36	0.10	0.48	0.29
	470	12.5 x 20	17	670	240	50	0.10	0.34	0.20
	680	12.5 x 25	18	850	340	71	0.10	0.23	0.14
	1000	16 x 25	19	1100	500	100	0.10	0.16	0.10

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U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS	CUT LEADS	CUT LEADS FORMED	F = 5 mm positive leading	F = 5 mm negative leading	F = 2.5 mm or 3.5 mm positive leading	
		Form CA	Form CB	Form CC	Form TR+	Form TR–	Form TN+	Form TFA
40	15	037 57159	037 87159	037 67159	037 27159	037 47159	037 17159	037 37159
	22	037 57229	037 87229	037 67229	037 27229	037 47229	037 17229	037 37229
	33	037 57339	037 87339	037 67339	037 27339	037 47339	037 17339	037 37339
	47	037 57479	037 87479	037 67479	037 27479	037 47479	037 17479	037 37479
	68	037 57689	037 87689	037 67689	037 27689	037 47689	037 17689	037 37689
	100	037 57101	037 87101	037 67101	037 27101	037 47101	037 17101	037 37101
	150	037 57151	037 67151	–	037 27151	–	–	–
	330	037 57331	037 67331	–	037 27331	–	–	–
	470	037 57471	037 67471	–	037 27471	–	–	–
	680	037 57681	037 67681	–	037 27681	–	–	–
	1000	037 57102	037 67102	–	037 27102	–	–	–
	1500	037 57152	037 67152	–	037 27152	–	–	–
50	10	037 51109	037 81109	037 61109	037 21109	037 41109	037 11109	037 31109
	22	037 90056	037 90057	037 90058	037 90059	037 90061	037 90062	037 90063
	33	037 51339	037 81339	037 61339	037 21339	037 41339	037 11339	037 31339
	47	037 90065	037 90066	037 90067	037 90068	037 90069	037 90071	037 90072
	68	037 51689	037 81689	037 61689	037 21689	037 41689	037 11689	037 31689
	100	037 51101	037 81101	037 61101	037 21101	037 41101	037 11101	037 31101
	220	037 51221	037 61221	–	037 21221	–	–	–
	330	037 51331	037 61331	–	037 21331	–	–	–
	470	037 51471	037 61471	–	037 21471	–	–	–
	680	037 51681	037 61681	–	037 21681	–	–	–
	1000	037 51102	037 61102	–	037 21102	–	–	–

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
63	0.10	5 x 11	11	5	3.1	3	0.09	1400	800
	0.22	5 x 11	11	8	3.1	3	0.09	650	360
	0.47	5 x 11	11	11	3.3	3.1	0.09	300	170
	1.0	5 x 11	11	16	3.6	3.1	0.09	140	80
	2.2	5 x 11	11	23	4.4	3.3	0.09	65	36
	3.3	5 x 11	11	29	5.1	3.4	0.09	43	24
	4.7	5 x 11	11	35	6.0	3.6	0.09	30	17
	6.8	5 x 11	11	41	7.3	3.9	0.09	21	12
	10	5 x 11	11	50	9.3	4.3	0.09	14	8.0
	15	5 x 11	11	61	12	4.9	0.09	9.5	5.3
	22	6.3 x 11	12	85	17	5.8	0.09	6.5	3.6
	33	6.3 x 11	12	120	24	7.2	0.09	4.3	2.4
	47	8 x 12	13	150	33	8.9	0.09	3.0	1.7
	68	10 x 12	14	200	46	12	0.09	2.1	1.2
	100	10 x 12	14	260	66	16	0.09	1.4	0.80
	150	10 x 16	15	320	98	22	0.09	0.95	0.53
	220	10 x 20	16	460	140	31	0.09	0.65	0.36
	330	12.5 x 20	17	600	210	45	0.09	0.43	0.24
	470	12.5 x 25	18	830	300	62	0.09	0.30	0.17
	680	16 x 25	19	1000	430	89	0.09	0.21	0.12
	1000	16 x 31	20	1250	630	130	0.09	0.14	0.08

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U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS	CUT LEADS	CUT LEADS FORMED	F = 5 mm positive leading	F = 5 mm negative leading	F = 2.5 mm or 3.5 mm positive leading	
		Form CA	Form CB	Form CC	Form TR+	Form TR–	Form TN+	Form TFA
63	0.10	037 58107	037 88107	037 68107	037 28107	037 48107	037 18107	037 38107
	0.22	037 58227	037 88227	037 68227	037 28227	037 48227	037 18227	037 38227
	0.47	037 58477	037 88477	037 68477	037 28477	037 48477	037 18477	037 38477
	1.0	037 58108	037 88108	037 68108	037 28108	037 48108	037 18108	037 38108
	2.2	037 58228	037 88228	037 68228	037 28228	037 48228	037 18228	037 38228
	3.3	037 58338	037 88338	037 68338	037 28338	037 48338	037 18338	037 38338
	4.7	037 58478	037 88478	037 68478	037 28478	037 48478	037 18478	037 38478
	6.8	037 58688	037 88688	037 68688	037 28688	037 48688	037 18688	037 38688
	10	037 58109	037 88109	037 68109	037 28109	037 48109	037 18109	037 38109
	15	037 58159	037 88159	037 68159	037 28159	037 48159	037 18159	037 38159
	22	037 58229	037 88229	037 68229	037 28229	037 48229	037 18229	037 38229
	33	037 90074	037 90075	037 90076	037 90077	037 90078	037 90079	037 90081
	47	037 58479	037 88479	037 68479	037 28479	037 48479	037 18479	037 38479
	68	037 58689	037 68689	–	037 28689	–	–	–
	100	037 58101	037 68101	–	037 28101	–	–	–
	150	037 58151	037 68151	–	037 28151	–	–	–
	220	037 58221	037 68221	–	037 28221	–	–	–
	330	037 58331	037 68331	–	037 28331	–	–	–
	470	037 58471	037 68471	–	037 28471	–	–	–
	680	037 58681	037 68681	–	037 28681	–	–	–
	1000	037 58102	037 68102	–	037 28102	–	–	–

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
100	0.22	5 x 11	11	8	3.2	3	0.07	506	270
	0.47	5 x 11	11	12	3.5	3.1	0.07	237	130
	1.0	5 x 11	11	18	4	3.2	0.07	111	60
	2.2	5 x 11	11	27	5.2	3.4	0.07	51	27
	3.3	5 x 11	11	33	6.3	3.7	0.07	34	18
	4.7	5 x 11	11	39	7.7	3.9	0.07	24	13
	6.8	5 x 11	11	47	9.8	4.4	0.07	16	8.8
	10	6.3 x 11	12	62	13	5	0.07	11	6.0
	15	8 x 12	13	91	18	6	0.07	7.4	4.0
	22	8 x 12	13	115	25	7.4	0.07	5.1	2.7
	33	10 x 12	14	160	36	9.6	0.07	3.4	1.8
	47	10 x 16	15	210	50	12	0.07	2.4	1.3
	68	10 x 16	15	250	71	17	0.07	1.6	0.88
	100	10 x 20	16	350	100	23	0.07	1.1	0.60
	150	12.5 x 20	17	460	150	33	0.07	0.74	0.40
	220	12.5 x 25	18	580	220	47	0.07	0.51	0.27
	330	16 x 25	19	710	330	69	0.07	0.34	0.18
	470	16 x 31	20	900	470	97	0.07	0.24	0.13

4

Voltage

Surge voltage for short periods	$U_s \leq 1.15\ U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.01\ C_R \times U_R + 3\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$

Non-solid Al - electrolytic capacitors
Radial Standard Miniature

RSM 037

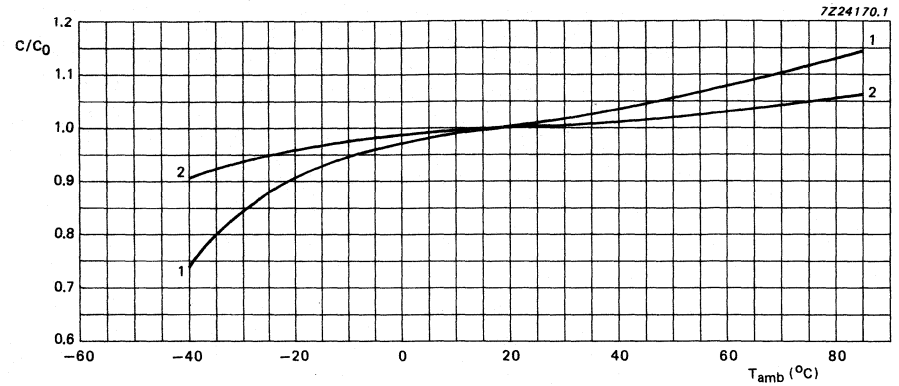
U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS	CUT LEADS	CUT LEADS FORMED	F = 5 mm positive leading	F = 5 mm negative leading	F = 2.5 mm or 3.5 mm positive leading	
		Form CA	Form CB	Form CC	Form TR+	Form TR–	Form TN+	Form TFA
100	0.22	037 59227	037 89227	037 69227	037 29227	037 49227	037 19227	037 39227
	0.47	037 59477	037 89477	037 69477	037 29477	037 49477	037 19477	037 39477
	1.0	037 59108	037 89108	037 69108	037 29108	037 49108	037 19108	037 39108
	2.2	037 59228	037 89228	037 69228	037 29228	037 49228	037 19228	037 39228
	3.3	037 59338	037 89338	037 69338	037 29338	037 49338	037 19338	037 39338
	4.7	037 59478	037 89478	037 69478	037 29478	037 49478	037 19478	037 39478
	6.8	037 59688	037 89688	037 69688	037 29688	037 49688	037 19688	037 39688
	10	037 59109	037 89109	037 69109	037 29109	037 49109	037 19109	037 39109
	15	037 59159	037 89159	037 69159	037 29159	037 49159	037 19159	037 39159
	22	037 59229	037 89229	037 69229	037 29229	037 49229	037 19229	037 39229
	33	037 59339	037 69339	–	037 29339	–	–	–
	47	037 59479	037 69479	–	037 29479	–	–	–
	68	037 59689	037 69689	–	037 29689	–	–	–
	100	037 59101	037 69101	–	037 29101	–	–	–
	150	037 59151	037 69151	–	037 29151	–	–	–
	220	037 59221	037 69221	–	037 29221	–	–	–
	330	037 59331	037 69331	–	037 29331	–	–	–
	470	037 59471	037 69471	–	037 29471	–	–	–

Marking

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Group number (037)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Negative terminal identification.

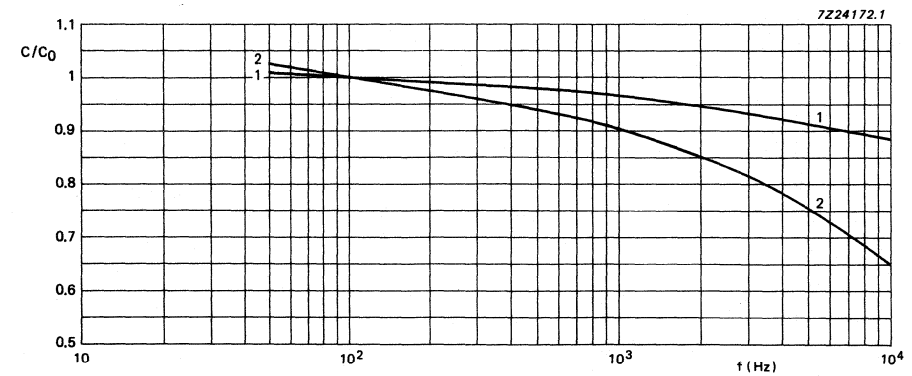
Capacitance (C)



Curve 1: 6.3 V
Curve 2: 100 V.

C_o = capacitance at 20 °C, 100 Hz.

Fig.7 Typical multiplier of capacitance (C/C_o) as a function of ambient temperature.

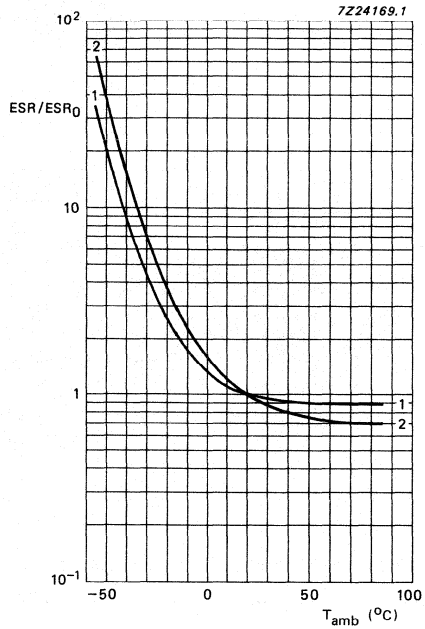


Curve 1: 100 V
Curve 2: 6.3 V.

C_o = capacitance at 20 °C, 100 Hz.

Fig.8 Typical multiplier of capacitance (C/C_o) as a function of frequency.

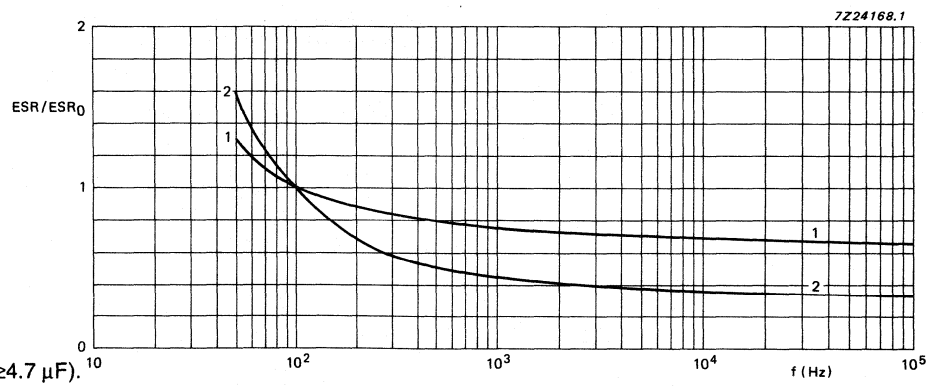
Equivalent series resistance (ESR)



Curve 1: 63 V (≥4.7 µF)
Curve 2: 10 V.

ESR_o = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR_o) as a function of ambient temperature.



Curve 1 : 6.3 V
Curve 2 : 63 V (≥4.7 µF).

ESR_o = typical ESR at 20 °C, 100 Hz.

Fig.10 Multiplier of ESR (ESR/ESR_o) as a function of frequency.

Equivalent series inductance (ESL)

case ∅ D ≤8 mm	typ. 13 nH
case ∅ D = 10 mm	typ. 16 nH
case ∅ D ≥12.5 mm	typ. 18 nH

Impedance (Z)

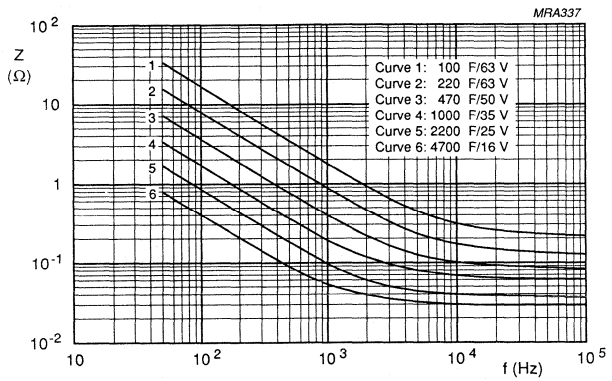
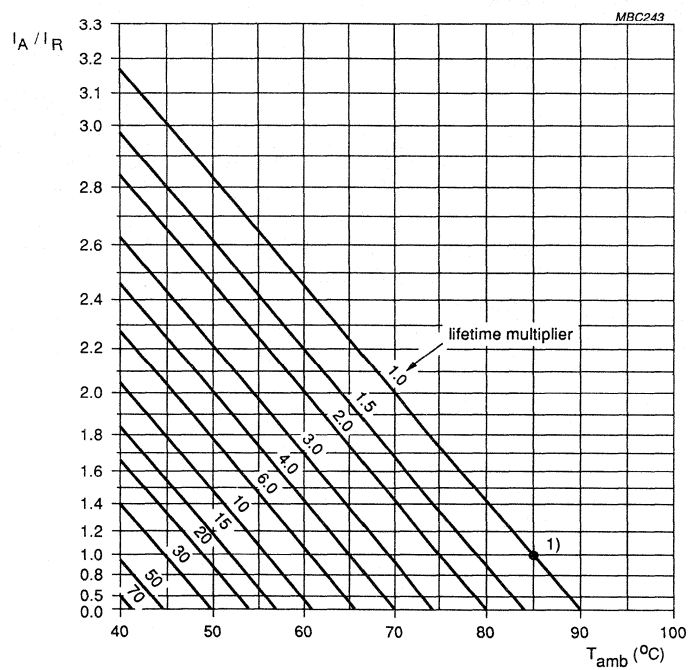


Fig.11 Typical impedance as a function of frequency at T_{amb} = 20 °C.

RIPPLE CURRENT and USEFUL LIFE

Table 5 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10 V	U_R = 16 to 35 V	U_R = 40 to 100 V
50	0.9	0.85	0.8
100	1.0	1.0	1.0
300	1.12	1.2	1.25
1000	1.2	1.3	1.4
3000	1.25	1.35	1.5
≥10 000	1.3	1.4	1.6



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied: 2000 hours.

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30301 sub clause 4.13	T_{amb} = 85 °C, U_R applied U_R = 6.3 to 16 V 1000 hours U_R = 25 to 100 V 2000 hours	U_R ≤6.3 V : ΔC/C +15/–30% U_R >6.3 V : ΔC/C ±20% tan δ ≤1.5 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 2000 hours	U_R ≤6.3 V : ΔC/C +45/–50% U_R >6.3 V : ΔC/C ±50% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30301 sub clause 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

4

Electrolytic Capacitors

Notes

Non-solid Al - electrolytic capacitors
Radial Standard

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FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, insulated with a blue sleeve
- Charge and discharge proof
- Standard dimensions.

APPLICATIONS

- General purpose, audio-video, general industrial
- Coupling, decoupling, timing, smoothing, filtering and buffering
- Low surface demand on printed circuit board.

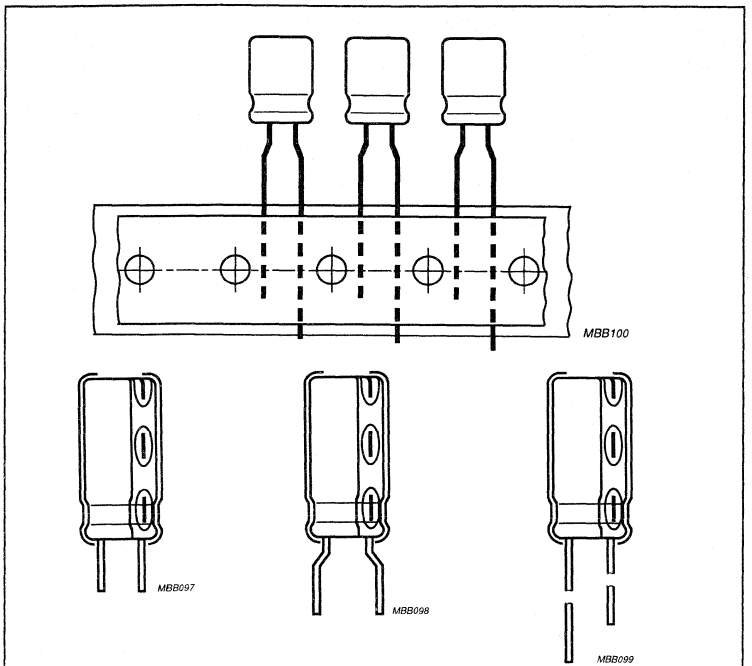

Fig.1 Component outlines.

4

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	5 x 11 to 16 x 31
Rated capacitance range, C_R	0.1 to 4700 µF
Tolerance on C_R	±20%
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	–40 to +85 °C
Endurance test at 85 °C	1000 hours
Useful life at 85 °C	2000 hours
Useful life at 40 °C, 1.4 I_R applied	60 000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specification	IEC 384-4/CECC 30 300, GP grade
Detail specification	DIN 41259
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

Non-solid Al - electrolytic capacitors
Radial Standard

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Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**) * = preferred values

C_R (µF)	U_R (V)								
	6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**	**100**
0.10								5 x 11	
0.22 *								5 x 11	5 x 11
0.47 *								5 x 11	5 x 11
1.0 *								5 x 11	5 x 11
2.2 *								5 x 11	5 x 11
3.3								5 x 11	5 x 11
4.7 *								5 x 11	6.3 x 11
6.8								5 x 11	6.3 x 11
10 *							5 x 11	6.3 x 11	8 x 12
15						5 x 11		6.3 x 11	8 x 12
22 *					5 x 11	6.3 x 11	6.3 x 11	8 x 12	10 x 12
33			5 x 11			6.3 x 11		8 x 12	10 x 16
47 *		5 x 11		6 3 x 11			8 x 12	10 x 12	10 x 20
68			6.3 x 11			8 x 12	10 x 12	10 x 16	12.5 x 20
100 *		6.3 x 11		8 x 12	10 x 12		10 x 16	10 x 20	12.5 x 25
150	6.3 x 11		8 x 12	10 x 12		10 x 16	10 x 20	12.5 x 20	12.5 x 25
220 *		8 x 12	10 x 12	10 x 16		10 x 20	12.5 x 20	12.5 x 25	16 x 25
330 *	8 x 12	10 x 12	10 x 16	10 x 20		12.5 x 20	12.5 x 25	16 x 25	16 x 31
470 *		10 x 16	10 x 20	12.5 x 20		12.5 x 25		16 x 25	
680 *	10 x 16	10 x 20	12.5 x 20	12.5 x 25		16 x 25	16 x 25	16 x 31	
1000 *	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 25		16 x 31		
1500 *	12.5 x 20	12.5 x 25	16 x 25	16 x 31					
2200 *	12.5 x 25		16 x 25	16 x 31					
3300 *	16 x 25		16 x 31						
4700 *	16 x 31								

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MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

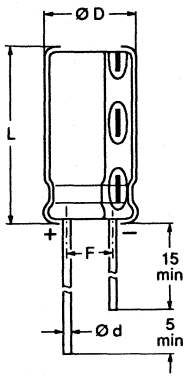


Fig.2 **Form CA**: Long leads.

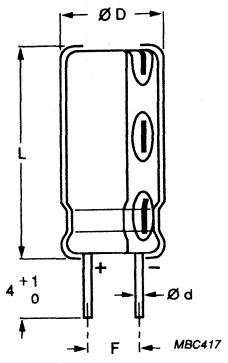


Fig.3 **Form CB**: Cut leads.

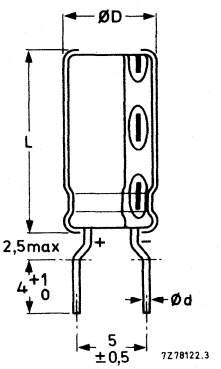
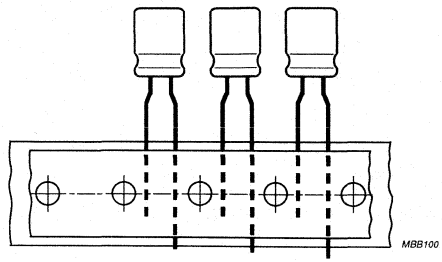


Fig.4 **Form CC**: Cut leads, formed; Ø D = 5, 6.3 and 8 mm only.

Table 2 Dimensions in mm; mass in g

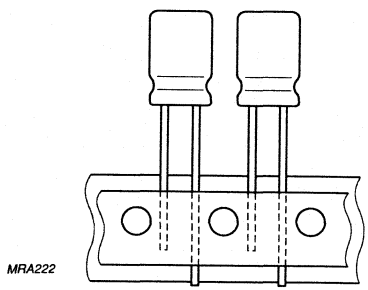
CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	Ø d	ØD_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA CB, CC	Form TR+ TR−, TN	Form TFA
5 x 11	11	0.5	5.5	12.5	2.0	0.4	1000	1000	2000
6.3 x 11	12	0.6	6.8	12.5	2.5	0.6	1000	1000	2000
8 x 12	13	0.6	8.5	13.0	3.5	1.1	1000	800	1000
10 x 12	14	0.6	10.5	13.5	5.0	1.6	1000	500	–
10 x 16	15	0.6	10.5	17.5	5.0	1.9	500	500	–
10 x 20	16	0.6	10.5	21.5	5.0	2.2	500	500	–
12.5 x 20	17	0.6	13.0	21.5	5.0	4.0	200	200	–
12.5 x 25	18	0.6	13.0	26.5	5.0	5.0	200	200	–
16 x 25	19	0.8	16.5	27.0	7.5	8.0	200	150	–
16 x 31	20	0.8	16.5	33.5	7.5	9.0	200	150	–

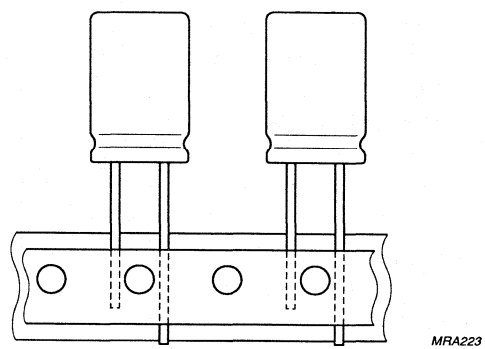
Taping dimensions are specified in chapter "PACKING".



Form TR+: Taped on reel, positive leading.
Form TR–: Taped on reel, negative leading.
Form TFA : Taped in box (ammopack).

Fig.5 Taped, formed, pitch 5 mm.





Form TN+:
ØD 5 mm: F = 2.5 mm
(leads slightly bent)
ØD 6.3 mm: F = 2.5 mm

Form TR+:
ØD 10 and 12.5 mm: F = 5 mm

Form TR+:
ØD 16 mm: F = 7.5 mm

Fig.6 Taped on reel, straight leads, positive leading.

Non-solid Al - electrolytic capacitors
Radial Standard

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance ± 20%
I_R = rated RMS ripple current at 100 Hz, 85 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R).

Table 3 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)
6.3	150	6.3 x 11	12	260	22	4.9	0.24	2.5
	330	8 x 12	13	320	45	7.2	0.24	1.2
	680	10 x 16	15	460	89	12	0.24	0.56
	1000	10 x 20	16	530	130	16	0.24	0.38
	1500	12.5 x 20	17	640	190	22	0.24	0.25
	2200	12.5 x 25	18	800	280	31	0.24	0.17
	3300	16 x 25	19	850	420	45	0.24	0.12
	4700	16 x 31	20	960	560	62	0.24	0.08
10	47	5 x 11	11	100	12	3.9	0.20	6.8
	100	6.3 x 11	12	160	23	5	0.20	3.2
	220	8 x 12	13	250	47	7.4	0.20	1.4
	330	10 x 12	14	340	69	9.6	0.20	0.96
	470	10 x 16	15	400	97	12	0.20	0.68
	680	10 x 20	16	480	140	17	0.20	0.47
	1000	12.5 x 20	17	580	200	23	0.20	0.32
	1500	12.5 x 25	18	720	300	33	0.20	0.21

Non-solid Al - electrolytic capacitors
Radial Standard

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ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor RS 035
1000 µF/16 V, ±20%
Case size 12.5 x 25 mm; Form CA
Catalogue number: 2222 035 55102.

Table 4 Ordering information

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	F = 2.5 mm positive leading Form TN+	Form TFA
6.3	150	035 53151	035 83151	035 63151	035 23151	035 43151	035 13151	035 33151
	330	035 53331	035 83331	035 63331	035 23331	035 43331	–	035 33331
	680	035 53681	035 63681	–	035 23681	–	–	–
	1000	035 53102	035 63102	–	035 23102	–	–	–
	1500	035 53152	035 63152	–	035 23152	–	–	–
	2200	035 53222	035 63222	–	035 23222	–	–	–
	3300	035 53332	035 63332	–	035 23332	–	–	–
	4700	035 53472	035 63472	–	035 23472	–	–	–
10	47	035 54479	035 84479	035 64479	035 24479	035 44479	035 14479	035 34479
	100	035 54101	035 84101	035 64101	035 24101	035 44101	035 14101	035 34101
	220	035 54221	035 84221	035 64221	035 24221	035 44221	–	035 34221
	330	035 54331	035 64331	–	035 24331	–	–	–
	470	035 54471	035 64471	–	035 24471	–	–	–
	680	035 54681	035 64681	–	035 24681	–	–	–
	1000	035 54102	035 64102	–	035 24102	–	–	–
	1500	035 54152	035 64152	–	035 24152	–	–	–

Non-solid Al - electrolytic capacitors
Radial Standard

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)
16	33	5 x 11	11	90	14	4.1	0.16	7.7
	68	6.3 x 11	12	180	25	5.2	0.16	3.7
	150	8 x 12	13	270	51	7.8	0.16	1.7
	220	10 x 12	14	320	73	10	0.16	1.2
	330	10 x 16	15	405	110	14	0.16	0.77
	470	10 x 20	16	480	150	18	0.16	0.54
	680	12.5 x 20	17	590	220	25	0.16	0.37
	1000	12.5 x 25	18	700	320	35	0.16	0.25
	1500	16 x 25	19	820	480	51	0.16	0.17
	2200	16 x 25	19	1000	710	73	0.16	0.12
	3300	16 x 31	20	1200	1100	110	0.16	0.08
25	47	6.3 x 11	12	140	27	5.4	0.14	4.7
	100	8 x 12	13	230	53	8.0	0.14	2.2
	150	10 x 12	14	330	78	11	0.14	1.5
	220	10 x 16	15	400	110	14	0.14	1.0
	330	10 x 20	16	500	170	20	0.14	0.68
	470	12.5 x 20	17	600	240	27	0.14	0.47
	680	12.5 x 25	18	710	340	37	0.14	0.33
	1000	16 x 25	19	850	500	53	0.14	0.22
	1500	16 x 31	20	1000	750	78	0.14	0.15
	2200	16 x 31	20	1200	1100	110	0.14	0.09
35	22	5 x 11	11	90	18	4.5	0.12	8.7
	100	10 x 12	14	280	73	10	0.12	1.9
	1000	16 x 25	19	1050	700	73	0.12	0.19
40	15	5 x 11	11	70	15	4.2	0.12	13
	22	6.3 x 11	12	90	21	4.8	0.12	8.7
	33	6.3 x 11	12	140	29	5.6	0.12	5.8
	68	8 x 12	13	200	57	8.4	0.12	2.8
	150	10 x 16	15	320	120	15	0.12	1.3
	220	10 x 20	16	470	180	21	0.12	0.87
	330	12.5 x 20	17	590	270	29	0.12	0.58
	470	12.5 x 25	18	800	380	41	0.12	0.41
	680	16 x 25	19	960	550	57	0.12	0.28

Non-solid Al - electrolytic capacitors
Radial Standard

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U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	F = 2.5 mm positive leading Form TN+	Form TFA
16	33	035 55339	035 85339	035 65339	035 25339	035 45339	035 15339	035 35339
	68	035 55689	035 85689	035 65689	035 25689	035 45689	035 15689	035 35689
	150	035 55151	035 85151	035 65151	035 25151	035 45151	–	035 35151
	220	035 55221	035 65221	–	035 25221	–	–	–
	330	035 55331	035 65331	–	035 25331	–	–	–
	470	035 55471	035 65471	–	035 25471	–	–	–
	680	035 55681	035 65681	–	035 25681	–	–	–
	1000	035 55102	035 65102	–	035 25102	–	–	–
	1500	035 55152	035 65152	–	035 25152	–	–	–
	2200	035 55222	035 65222	–	035 25222	–	–	–
	3300	035 55332	035 65332	–	035 25332	–	–	–
25	47	035 56479	035 86479	035 66479	035 26479	035 46479	035 16479	035 36479
	100	035 56101	035 86101	035 66101	035 26101	035 46101	–	035 36101
	150	035 56151	035 66151	–	035 26151	–	–	–
	220	035 56221	035 66221	–	035 26221	–	–	–
	330	035 56331	035 66331	–	035 26331	–	–	–
	470	035 56471	035 66471	–	035 26471	–	–	–
	680	035 56681	035 66681	–	035 26681	–	–	–
	1000	035 56102	035 66102	–	035 26102	–	–	–
	1500	035 56152	035 66152	–	035 26152	–	–	–
	2200	035 56222	035 66222	–	035 26222	–	–	–
35	22	035 90003	035 90004	035 90005	035 90034	035 90053	035 90193	035 90085
	100	035 90059	035 90081	–	035 90082	–	–	–
	1000	035 90006	035 90007	–	035 90224	–	–	–
40	15	035 57159	035 87159	035 67159	035 27159	035 47159	035 17159	035 37159
	22	035 57229	035 87229	035 67229	035 27229	035 47229	035 17229	035 37229
	33	035 57339	035 87339	035 67339	035 27339	035 47339	035 17339	035 37339
	68	035 57689	035 87689	035 67689	035 27689	035 47689	–	035 37689
	150	035 57151	035 67151	–	035 27151	–	–	–
	220	035 57221	035 67221	–	035 27221	–	–	–
	330	035 57331	035 67331	–	035 27331	–	–	–
	470	035 57471	035 67471	–	035 27471	–	–	–
	680	035 57681	035 67681	–	035 27681	–	–	–

Non-solid Al - electrolytic capacitors
Radial Standard

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)
50	10	5 x 11	11	60	13	4	0.10	16
	22	6.3 x 11	12	100	25	5.2	0.10	7.2
	47	8 x 12	13	180	50	7.7	0.10	3.4
	68	10 x 12	14	260	71	9.8	0.10	2.3
	100	10 x 16	15	320	100	13	0.10	1.6
	150	10 x 20	16	410	150	18	0.10	1.1
	220	12.5 x 20	17	500	220	25	0.10	0.72
	330	12.5 x 25	18	650	330	36	0.10	0.48
	680	16 x 25	19	980	680	71	0.10	0.23
	1000	16 x 31	20	1100	1000	100	0.10	0.16
63	0.10	5 x 11	11	3.5	3	3	0.08	1300
	0.22	5 x 11	11	6	3	3	0.08	580
	0.47	5 x 11	11	8	4	3	0.08	270
	1.0	5 x 11	11	12	4	3	0.08	130
	2.2	5 x 11	11	22	6	3.3	0.08	58
	3.3	5 x 11	11	32	7	3.4	0.08	39
	4.7	5 x 11	11	40	9	3.6	0.08	27
	6.8	5 x 11	11	55	12	3.9	0.08	19
	10	6.3 x 11	12	70	16	4.3	0.08	13
	15	6.3 x 11	12	98	22	4.9	0.08	8.5
	22	8 x 12	13	120	31	5.8	0.08	5.8
	33	8 x 12	13	160	45	7.2	0.08	3.9
	47	10 x 12	14	200	62	8.9	0.08	2.7
	68	10 x 16	15	280	89	12	0.08	1.9
	100	10 x 20	16	360	130	16	0.08	1.3
	150	12.5 x 20	17	480	190	22	0.08	0.85
	220	12.5 x 25	18	600	280	31	0.08	0.58
	330	16 x 25	19	750	420	45	0.08	0.39
	470	16 x 25	19	900	600	62	0.08	0.27
	680	16 x 31	20	1040	860	89	0.08	0.19

Non-solid Al - electrolytic capacitors
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U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	F = 2.5 mm positive leading Form TN+	Form TFA
50	10	035 90008	035 90009	035 90011	035 90035	035 90103	035 90194	035 90087
	22	035 90012	035 90013	035 90014	035 90036	035 90104	035 90195	035 90088
	47	035 90015	035 90016	035 90033	035 90037	035 90052	–	035 90038
	68	035 90017	035 90018	–	035 90039	–	–	–
	100	035 90019	035 90021	–	035 90225	–	–	–
	150	035 90022	035 90023	–	035 90226	–	–	–
	220	035 90024	035 90025	–	035 90227	–	–	–
	330	035 90026	035 90027	–	035 90228	–	–	–
	680	035 90028	035 90029	–	035 90229	–	–	–
	1000	035 90031	035 90032	–	035 90231	–	–	–
63	0.10	035 58107	035 88107	035 68107	035 28107	035 48107	035 18107	035 38107
	0.22	035 58227	035 88227	035 68227	035 28227	035 48227	035 18227	035 38227
	0.47	035 58477	035 88477	035 68477	035 28477	035 48477	035 18477	035 38477
	1.0	035 58108	035 88108	035 68108	035 28108	035 48108	035 18108	035 38108
	2.2	035 58228	035 88228	035 68228	035 28228	035 48228	035 18228	035 38228
	3.3	035 58338	035 88338	035 68338	035 28338	035 48338	035 18338	035 38338
	4.7	035 58478	035 88478	035 68478	035 28478	035 48478	035 18478	035 38478
	6.8	035 58688	035 88688	035 68688	035 28688	035 48688	035 18688	035 38688
	10	035 58109	035 88109	035 68109	035 28109	035 48109	035 18109	035 38109
	15	035 58159	035 88159	035 68159	035 28159	035 48159	035 18159	035 38159
	22	035 58229	035 88229	035 68229	035 28229	035 48229	–	035 38229
	33	035 58339	035 88339	035 68339	035 28339	035 48339	–	035 38339
	47	035 58479	035 68479	–	035 28479	–	–	–
	68	035 58689	035 68689	–	035 28689	–	–	–
	100	035 58101	035 68101	–	035 28101	–	–	–
	150	035 58151	035 68151	–	035 28151	–	–	–
	220	035 58221	035 68221	–	035 28221	–	–	–
	330	035 58331	035 68331	–	035 28331	–	–	–
	470	035 58471	035 68471	–	035 28471	–	–	–
	680	035 58681	035 68681	–	035 28681	–	–	–

Non-solid Al - electrolytic capacitors
Radial Standard

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)
100	0.22	5 x 11	11	10	3	3	0.07	510
	0.47	5 x 11	11	12	4	3	0.07	240
	1.0	5 x 11	11	15	5	3.2	0.07	110
	2.2	5 x 11	11	27	7	3.4	0.07	51
	3.3	5 x 11	11	35	10	3.7	0.07	34
	4.7	6.3 x 11	12	45	12	3.9	0.07	24
	6.8	6.3 x 11	12	59	17	4.4	0.07	16
	10	8 x 12	13	80	23	5	0.07	11
	15	8 x 12	13	105	33	6	0.07	7.4
	22	10 x 12	14	140	47	7.4	0.07	5.1
	33	10 x 16	15	180	69	9.6	0.07	3.4
	47	10 x 20	16	240	97	12	0.07	2.4
	68	12.5 x 20	17	340	140	17	0.07	1.6
	100	12.5 x 25	18	440	200	23	0.07	1.1
	150	12.5 x 25	18	630	300	33	0.07	0.74
	220	16 x 25	19	800	440	47	0.07	0.51
	330	16 x 31	20	900	660	69	0.07	0.34

4

Voltage

Surge voltage for short periods $U_s \leq 1.15\ U_R$

Reverse voltage $U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R $I_{L1} \leq 0.02\ C_R \times U_R + 3\ \mu A$

After 5 minutes at U_R $I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$

Non-solid Al - electrolytic capacitors
Radial Standard

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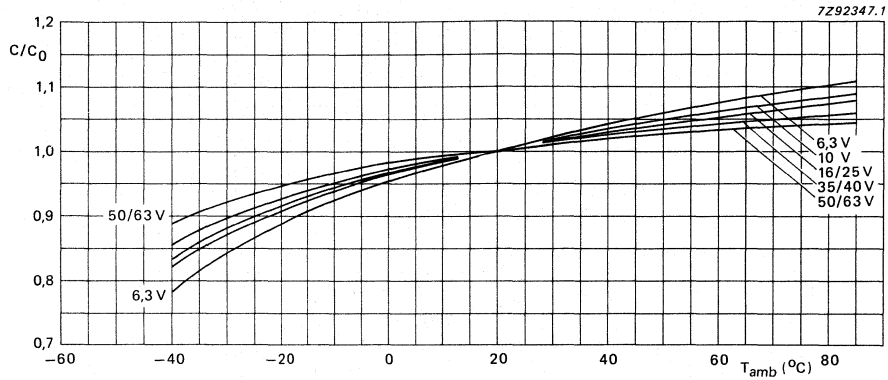
U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	F = 2.5 mm positive leading Form TN+	Form TFA
100	0.22	035 59227	035 89227	035 69227	035 29227	035 49227	035 19227	035 39227
	0.47	035 59477	035 89477	035 69477	035 29477	035 49477	035 19477	035 39477
	1.0	035 59108	035 89108	035 69108	035 29108	035 49108	035 19108	035 39108
	2.2	035 59228	035 89228	035 69228	035 29228	035 49228	035 19228	035 39228
	3.3	035 59338	035 89338	035 69338	035 29338	035 49338	035 19338	035 39338
	4.7	035 59478	035 89478	035 69478	035 29478	035 49478	035 19478	035 39478
	6.8	035 59688	035 89688	035 69688	035 29688	035 49688	035 19688	035 39688
	10	035 59109	035 89109	035 69109	035 29109	035 49109	–	035 39109
	15	035 59159	035 89159	035 69159	035 29159	035 49159	–	035 39159
	22	035 59229	035 69229	–	035 29229	–	–	–
	33	035 59339	035 69339	–	035 29339	–	–	–
	47	035 59479	035 69479	–	035 29479	–	–	–
	68	035 59689	035 69689	–	035 29689	–	–	–
	100	035 59101	035 69101	–	035 29101	–	–	–
	150	035 59151	035 69151	–	035 29151	–	–	–
	220	035 59221	035 69221	–	035 29221	–	–	–
	330	035 59331	035 69331	–	035 29331	–	–	–

Marking

The capacitors are marked (where possible) with the following information:

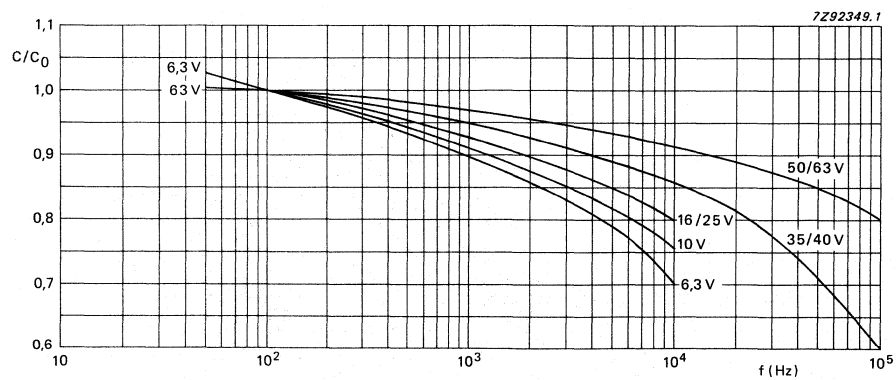
- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Group number (035)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Negative terminal identification.

Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

Fig.7 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz.

Fig.8 Typical multiplier of capacitance (C/C_0) as a function of frequency.

Non-solid Al - electrolytic capacitors
Radial Standard

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Dissipation factor (tan δ)

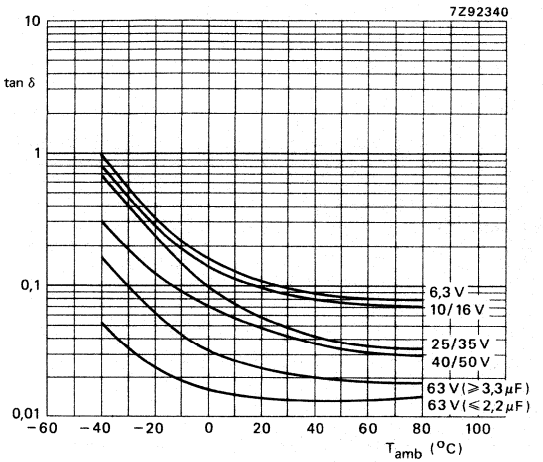


Fig.9 Typical tan δ as a function of ambient temperature at 100 Hz.

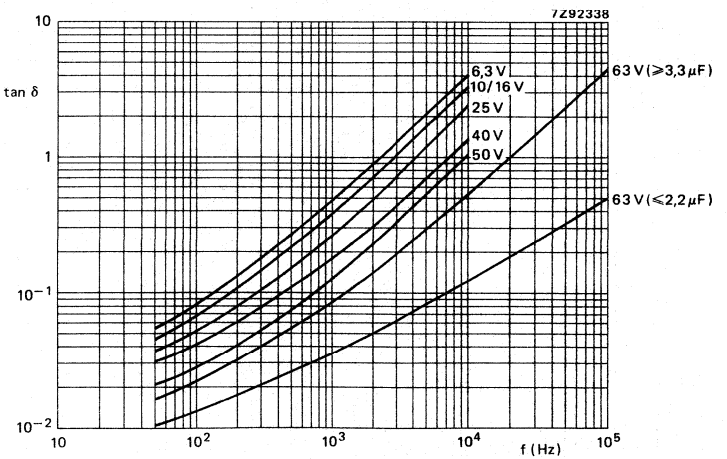


Fig.10 Typical tan δ as a function of frequency at 20 °C.

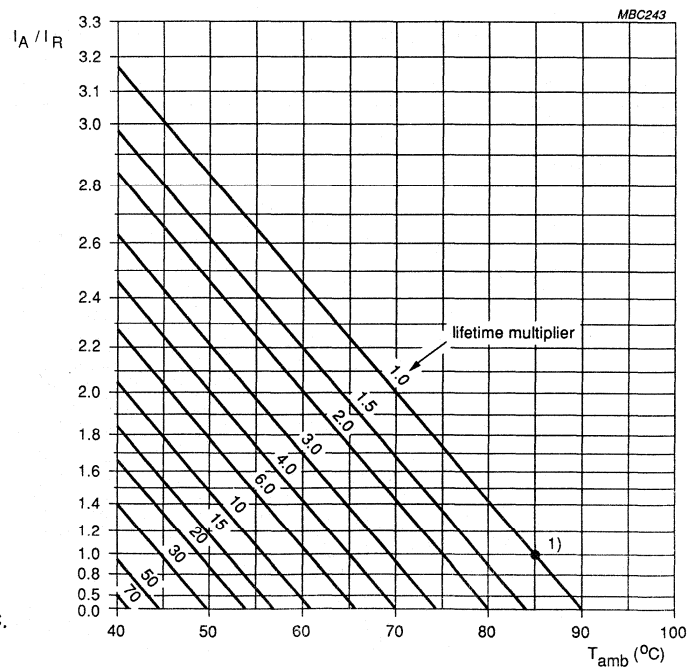
Equivalent series inductance (ESL)

case Ø D ≤8 mm	typ. 13 nH
case Ø D = 10 mm	typ. 16 nH
case Ø D ≥12.5 mm	typ. 18 nH

RIPPLE CURRENT and USEFUL LIFE

Table 5 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10	U_R = 16 to 35	U_R = 40 to 100 V
50	0.9	0.85	0.8
100	1.0	1.0	1.0
300	1.15	1.25	1.35
1000	1.3	1.45	1.6
3000	1.4	1.6	1.8
≥10 000	1.5	1.7	2



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied: 2000 hours.

Fig.11 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 sub clause 4.13	T_{amb} = 85 °C, U_R applied 1000 hours	U_R ≤6.3 V : ΔC/C +25/–40% U_R >6.3 V : ΔC/C ±30% tan δ ≤ 1.5 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 2000 hours	ΔC/C ±50% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 sub clause 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

Non-solid Al - electrolytic capacitors
Radial Standard, High Voltage

RSH 044

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, insulated with a blue sleeve
- Charge and discharge proof
- Standard dimensions
- High rated voltage .

APPLICATIONS

- General purpose, audio-video, lighting, general industrial
- Smoothing, filtering, buffering of high voltages
- Low surface demand on printed circuit board.

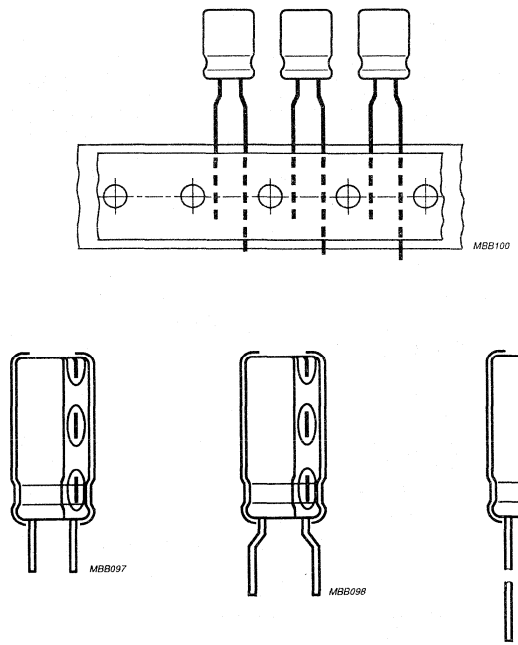


Fig.1 Component outlines.

QUICK REFERENCE DATA

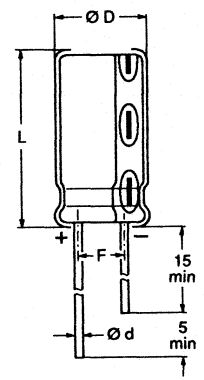
Case sizes (∅ D_{nom} x L_{nom} in mm)	8 x 12 to 16 x 31
Rated capacitance range, C_R	1.0 to 68 µF
Tolerance on C_R	±20%
Rated voltage range, U_R	160 to 385 V
Category temperature range	–25 to +85 °C
Endurance test at 85 °C	2000 hours
Useful life at 85 °C	3000 hours
Useful life at 40 °C, 1.4 I_R applied	80 000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	DIN 41240
Climatic category IEC 68 DIN 40040	 25/085/56 HPF

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm)**

C_R (μF)	U_R (V)				
	160	**200**	**250**	**350**	**385**
1.0			8 x 12		8 x 12
1.5			8 x 12		10 x 12
2.2			8 x 12	10 x 12	10 x 16
3.3			10 x 12		10 x 16
4.7		10 x 12	10 x 16	10 x 20	10 x 20
6.8		10 x 16	10 x 20	12.5 x 20	12.5 x 20
10	10 x 16	10 x 20	12.5 x 20	12.5 x 20	12.5 x 25
15	12.5 x 20	12.5 x 20	12.5 x 20	12.5 x 25	16 x 25
22	12.5 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31
33	12.5 x 25	12.5 x 25	16 x 25	16 x 31	
47	16 x 25	16 x 25	16 x 31		
68	16 x 31	16 x 31			

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.



MRA220

Fig.2 **Form CA**: Long leads.

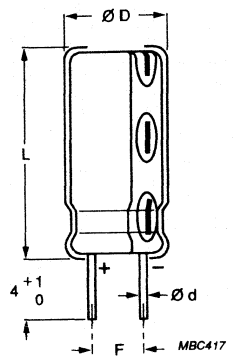


Fig.3 **Form CB**: Cut leads.

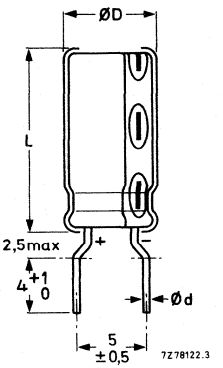
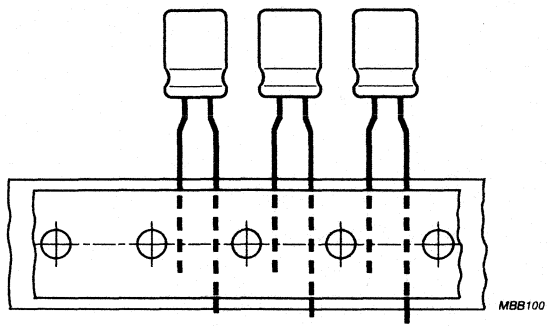


Fig.4 **Form CC**: Cut leads, formed; Ø D = 8 mm only.

Table 2 Dimensions in mm; mass in g

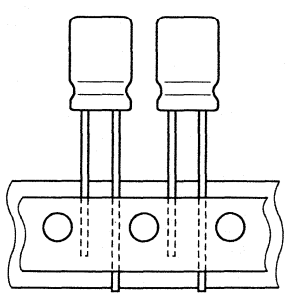
CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	Ø d	ØD_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA CB, CC	Form TR+ TR−, TN	Form TFA
8 x 12	13	0.6	8.5	13.0	3.5	1.1	1000	800	1000
10 x 12	14	0.6	10.5	14.0	5.0	1.6	1000	500	–
10 x 16	15	0.6	10.5	17.5	5.0	1.9	500	500	–
10 x 20	16	0.6	10.5	21.5	5.0	2.2	500	500	–
12.5 x 20	17	0.6	13.0	21.5	5.0	4.0	200	200	–
12.5 x 25	18	0.6	13.0	26.5	5.0	5.0	200	200	–
16 x 25	19	0.8	16.5	27.0	7.5	8.0	200	150	–
16 x 31	20	0.8	16.5	33.5	7.5	9.0	200	150	–

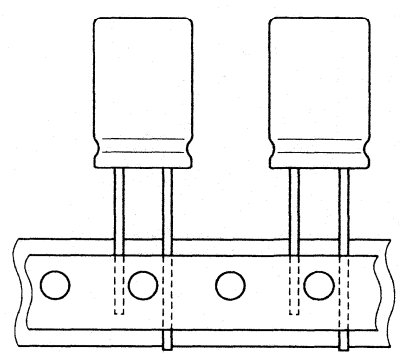
Taping dimensions are specified in chapter "PACKING".



Form TR+: Taped on reel, positive leading.
Form TR–: Taped on reel, negative leading.
Form TFA : Taped in box (ammopack).

Fig.5 Taped, formed, pitch 5 mm; ∅ D = 8 mm only.





Form TR+:
∅D 10 and 12.5 mm: F = 5 mm

Form TR+:
∅D 16 mm: F = 7.5 mm

Fig.6 Taped on reel, straight leads, positive leading.

Non-solid Al - electrolytic capacitors
Radial Standard, High Voltage

RSH 044

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance ± 20%
I_R = rated RMS ripple current at 100 Hz, 85 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 10 kHz and 20 or –25 °C.

Table 3 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz –25 °C (Ω)
160	10	10 x 16	15	75	58	14	0.12	19	12.0	180
	15	12.5 x 20	17	115	82	18	0.12	13	8.0	120
	22	12.5 x 20	17	140	120	25	0.12	8.7	5.5	82
	33	12.5 x 25	18	180	170	36	0.12	5.8	3.6	55
	47	16 x 25	19	220	240	49	0.12	4.1	2.6	38
	68	16 x 31	20	300	340	69	0.12	2.8	1.8	26
200	4.7	10 x 12	14	45	38	9.6	0.12	41	26	380
	6.8	10 x 16	15	60	51	12	0.12	28	18	260
	10	10 x 20	16	85	70	16	0.12	19	12	180
	15	12.5 x 20	17	115	100	22	0.12	13	8	120
	22	12.5 x 20	17	140	140	30	0.12	8.7	5.5	82
	33	12.5 x 25	18	180	210	44	0.12	5.8	3.6	55
	47	16 x 25	19	220	290	60	0.12	4.1	2.6	38
	68	16 x 31	20	300	420	86	0.12	2.8	1.8	26
250	1.0	8 x 12	13	20	65	23	0.20	320	120	1800
	1.5	8 x 12	13	20	78	26	0.20	210	80	1200
	2.2	8 x 12	13	25	97	32	0.20	140	55	820
	3.3	10 x 12	14	40	35	9.0	0.10	48	36	550
	4.7	10 x 16	15	50	45	11	0.10	34	26	380
	6.8	10 x 20	16	65	61	14	0.10	23	18	260
	10	12.5 x 20	17	95	85	19	0.10	16	12	180
	15	12.5 x 20	17	115	120	27	0.10	11	8	120
	22	12.5 x 25	18	160	180	37	0.10	7.2	5.5	82
	33	16 x 25	19	190	260	54	0.10	4.8	3.6	55
	47	16 x 31	20	240	360	75	0.10	3.4	2.6	38

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor RSH 044
47 µF/250 V, ±20%
Case size 16 x 31 mm; Form CA
Catalogue number: 2222 044 53479.

Table 4 Ordering information

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222					
		BULK PACKING			TAPED ON REEL		TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	Form TFA
160	10	044 51109	044 61109	–	044 21109	–	–
	15	044 51159	044 61159	–	044 21159	–	–
	22	044 51229	044 61229	–	044 21229	–	–
	33	044 51339	044 61339	–	044 21339	–	–
	47	044 51479	044 61479	–	044 21479	–	–
	68	044 51689	044 61689	–	044 21689	–	–
200	4.7	044 52478	044 62478	–	044 22478	–	–
	6.8	044 52688	044 62688	–	044 22688	–	–
	10	044 52109	044 62109	–	044 22109	–	–
	15	044 52159	044 62159	–	044 22159	–	–
	22	044 52229	044 62229	–	044 22229	–	–
	33	044 52339	044 62339	–	044 22339	–	–
	47	044 52479	044 62479	–	044 22479	–	–
	68	044 52689	044 62689	–	044 22689	–	–
250	1.0	044 90002	044 90003	044 90004	044 90005	044 90007	044 90006
	1.5	044 90008	044 90009	044 90011	044 90012	044 90014	044 90013
	2.2	044 90015	044 90016	044 90017	044 90018	044 90021	044 90019
	3.3	044 53338	044 63338	–	044 23338	–	–
	4.7	044 53478	044 63478	–	044 23478	–	–
	6.8	044 53688	044 63688	–	044 23688	–	–
	10	044 53109	044 63109	–	044 23109	–	–
	15	044 53159	044 63159	–	044 23159	–	–
	22	044 53229	044 63229	–	044 23229	–	–
	33	044 53339	044 63339	–	044 23339	–	–
	47	044 53479	044 63479	–	044 23479	–	–

Non-solid Al - electrolytic capacitors
Radial Standard, High Voltage

RSH 044

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz −25 °C (Ω)
350	2.2	10 x 12	14	30	33	8.6	0.10	72	39	550
	4.7	10 x 20	16	60	59	14	0.10	34	18	260
	6.8	12.5 x 20	17	70	81	18	0.10	23	13	180
	10	12.5 x 20	17	85	120	25	0.10	16	8.5	120
	15	12.5 x 25	18	120	170	36	0.10	11	5.7	80
	22	16 x 25	19	160	240	50	0.10	7.2	3.9	55
	33	16 x 31	20	210	360	73	0.10	4.8	2.6	36
385	1.0	8 x 12	13	20	80	27	0.25	400	85	1200
	1.5	10 x 12	14	25	27	7.5	0.10	110	57	800
	2.2	10 x 16	15	35	35	9.1	0.10	72	39	550
	3.3	10 x 16	15	45	48	12	0.10	48	26	360
	4.7	10 x 20	16	60	64	15	0.10	34	18	260
	6.8	12.5 x 20	17	70	89	20	0.10	23	13	180
	10	12.5 x 25	18	90	130	27	0.10	16	8.5	120
	15	16 x 25	19	125	180	39	0.10	11	5.7	80
	22	16 x 31	20	165	260	55	0.10	7.2	3.9	55

Non-solid Al - electrolytic capacitors
Radial Standard, High Voltage

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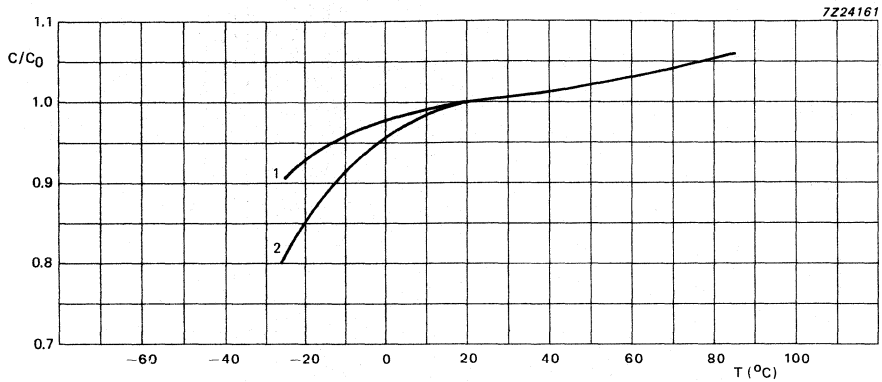
U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222					
		BULK PACKING			TAPED ON REEL		TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	Form TFA
350	2.2	044 55228	044 65228	–	044 25228	–	–
	4.7	044 55478	044 65478	–	044 25478	–	–
	6.8	044 55688	044 65688	–	044 25688	–	–
	10	044 55109	044 65109	–	044 25109	–	–
	15	044 55159	044 65159	–	044 25159	–	–
	22	044 55229	044 65229	–	044 25229	–	–
	33	044 55339	044 65339	–	044 25339	–	–
385	1.0	044 90022	044 90023	044 90024	044 90025	044 90027	044 90026
	1.5	044 58158	044 68158	–	044 28158	–	–
	2.2	044 58228	044 68228	–	044 28228	–	–
	3.3	044 58338	044 68338	–	044 28338	–	–
	4.7	044 58478	044 68478	–	044 28478	–	–
	6.8	044 58688	044 68688	–	044 28688	–	–
	10	044 58109	044 68109	–	044 28109	–	–
	15	044 58159	044 68159	–	044 28159	–	–
	22	044 58229	044 68229	–	044 28229	–	–

Marking

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Group number (044)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Negative terminal identification.

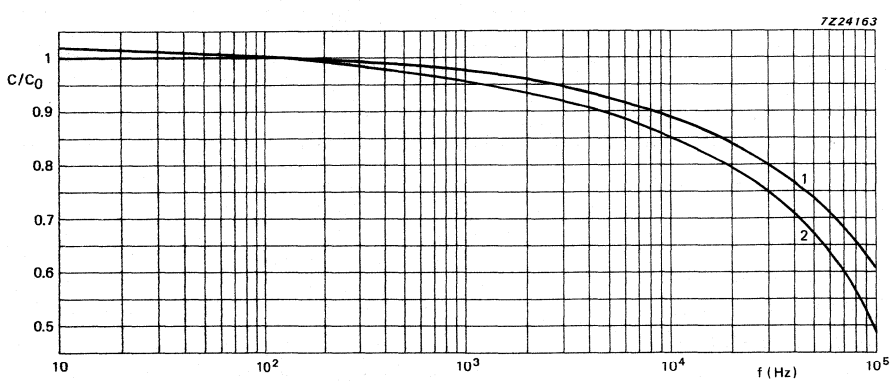
Capacitance (C)



Curve 1: 160 to 250 V
Curve 2: 350 and 385 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.7 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.



Curve 1: 160 to 250 V
Curve 2: 350 and 385 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.8 Typical multiplier of capacitance (C/C_0) as a function of frequency.

Non-solid Al - electrolytic capacitors
Radial Standard, High Voltage

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Voltage

Surge voltage for short periods	
160 to 250 V types	$U_s \leq 1.15 \times U_R$
350 and 385 V types	$U_s \leq 1.1 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R	
case size 8 x 12	$I_{L1} \leq 0.1\ C_R \times U_R + 40\ \mu A$
case sizes 10 x 12 to 16 x 31	$I_{L1} \leq 0.03\ C_R \times U_R + 10\ \mu A$
After 5 minutes at U_R	
case size 8 x 12	$I_{L5} \leq 0.03\ C_R \times U_R + 15\ \mu A$
case sizes 10 x 12 to 16 x 31	$I_{L5} \leq 0.006\ C_R \times U_R + 4\ \mu A$

Equivalent series inductance (ESL)

case ∅ D = 8 mm	typ. 13 nH
case ∅ D = 10 mm	typ. 16 nH
case ∅ D ≥12.5 mm	typ. 18 nH

Impedance (Z)

Ratio of impedance at 100 Hz:

Z at –25 °C / Z at 20 °C ≤3.

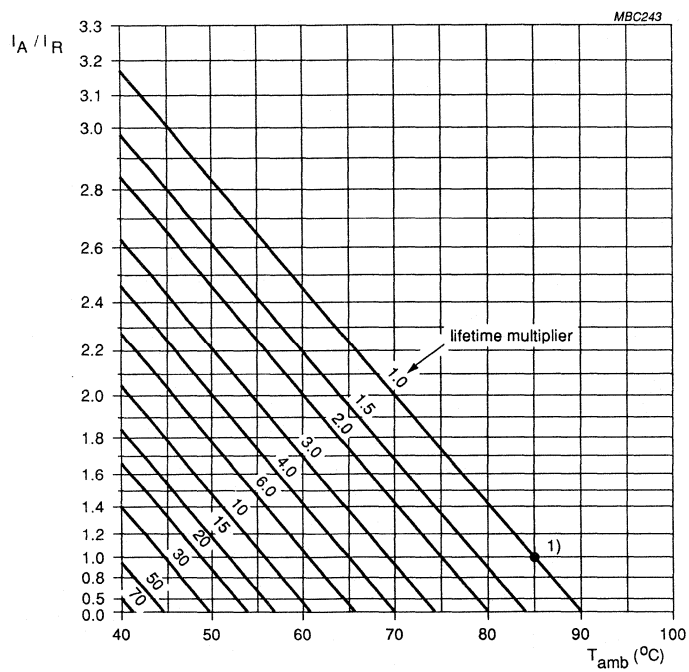
Table 5 Impedance x capacitance values at 10 kHz

T_{amb}	$z = Z \times C_R(\Omega\ \mu F)$ at 10 kHz				
	160 V	200 V	250 V	350 V	385 V
+20 °C	≤ 120	≤ 120	≤ 120	≤ 85	≤ 85
–25 °C	≤ 1800	≤ 1800	≤1800	≤ 1200	≤ 1200

RIPPLE CURRENT and USEFUL LIFE

Table 6 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.75
100	1.0
300	1.2
1000	1.35
3000	1.45
≥10 000	1.5



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied: 3000 hours.

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 7

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 sub clause 4.13	T_{amb} = 85 °C, U_R applied 2000 hours	$U_R \leq 160$ V : $\Delta C/C \pm 15\%$ $U_R > 160$ V : $\Delta C/C \pm 10\%$ tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 3000 hours	$U_R \leq 160$ V : $\Delta C/C \pm 45\%$ $U_R > 160$ V : $\Delta C/C \pm 30\%$ tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤3%
Shelf life (storage at high temp).	IEC 384-4-1/ CECC 30 301 sub clause 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

Non-solid Al - electrolytic capacitors
Radial Low Leakage Current

RLC 013

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CU-product per unit volume
- Low leakage current, low energy consumption.

APPLICATIONS

- Telecommunication, automotive, audio-video, EDP and industrial
- Coupling, decoupling, buffering, timing, energy storage
- Portable and mobile equipment
- Low surface demand on printed circuit board.

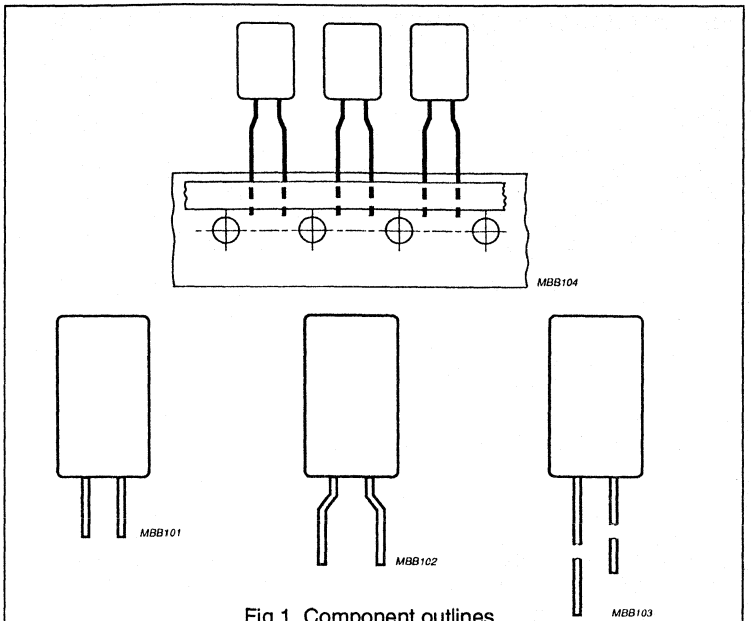


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	5 x 11 and 8.2 x 11
Rated capacitance range, C_R	0.22 to 470 µF
Tolerance on C_R	±20% (±10% on request)
Rated voltage range, U_R	6.3 to 50 V
Category temperature range	−40 to +85 °C
Leakage current after 2 minutes U_R for U_R = 6.3 to 25 V for U_R = 35 and 50 V	 0.002 C_R x U_R or 0.7 µA (whichever is greater) 0.002 C_R x U_R + 1 µA
Endurance test at 85 °C	2000 hours
Useful life at 85 °C	3000 hours
Useful life at 40 °C, 1.4 I_R applied	80 000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 41259
Climatic category IEC 68 DIN 40040	 40/085/56 GPF
Approvals	LNZ 44-04

Non-solid Al - electrolytic capacitors
Radial Low Leakage Current

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Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**) * = preferred values

C_R (µF)	U_R (V)					
	6.3	**10**	**16**	**25**	**35**	**50**
0.22				5 x 11		5 x 11
0.47 *				5 x 11		5 x 11
1.0 *				5 x 11		5 x 11
2.2 *				5 x 11		5 x 11
3.3				5 x 11		5 x 11
4.7 *				5 x 11		5 x 11
6.8				5 x 11		5 x 11
10 *				5 x 11		5 x 11
15				5 x 11		5 x 11
22 *				5 x 11		5 x 11
33			5 x 11	8.2 x 11	5 x 11	8.2 x 11
47 *		5 x 11		8.2 x 11		8.2 x 11
68		5 x 11		8.2 x 11		8.2 x 11
100 *		5 x 11	8.2 x 11		8.2 x 11	
150 *		8.2 x 11				
220 *		8.2 x 11				
330 *	8.2 x 11					
470 *	8.2 x 11					

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

Table 2 Dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	∅ d	∅D_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA CB, CC	Form TR+ TR−, TN	Form TFA
5 x 11	11	0.5	5.5	12	2.5	0.4	1000	1000	2000
8.2 x 11	13	0.6	8.7	12	5	1.1	1000	500	1000

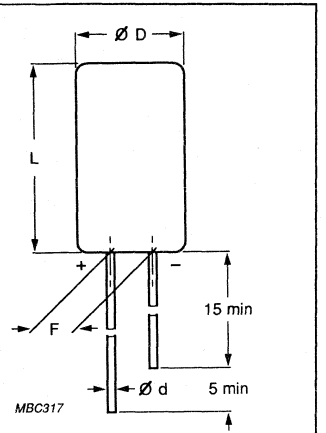


Fig.2 **Form CA**: Long leads.

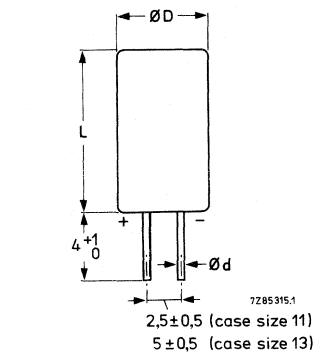


Fig.3 **Form CB**: Cut leads.

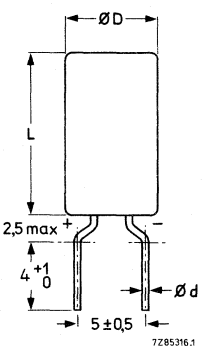
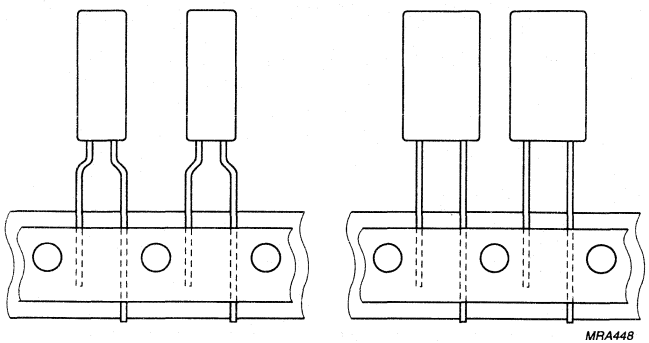


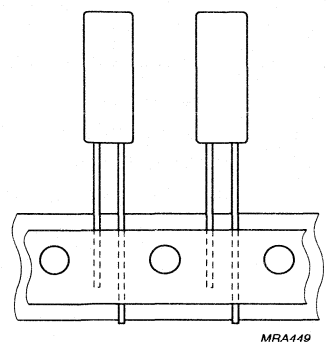
Fig.4 **Form CC**: Cut leads, formed; case size 5 x 11 only.

Tape dimensions are specified in chapter "PACKING",



Form TR+: Taped on reel, positive leading.
Form TR–: Taped on reel, negative leading.
Form TFA: Taped in box, (ammopack).

Fig.5 Taped, pitch F = 5 mm; case sizes 5 x 11 and 8.2 x 11.



Form TN+: Taped on reel positive leading.

Fig.6 Taped, pitch F=2.5 mm; case size 5 x 11 only.

Marking

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Group number (013)
- Name of manufacturer (PHILIPS)
- Date code in accordance with IEC 62
- Code indicating factory of origin
- Minus-sign to identify the negative terminal.

Non-solid Al - electrolytic capacitors
Radial Low Leakage Current

RLC 013

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance ±20%
I_R = rated RMS ripple current at 100 Hz, 85 °C
I_{L2} = max. leakage current after 2 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 10 kHz and 20, –25 or –40 °C.

Table 3 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 85 °C (mA)	I_{L2} 2 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz –25 °C (Ω)	Z 10 kHz –40 °C (Ω)
6.3	330	8.2 x 11	13	210	4.2	0.2	1.0	0.9	5.2	15
	470	8.2 x 11	13	250	5.9	0.2	0.7	0.64	3.5	10
10	47	5 x 11	11	75	1.0	0.16	5.4	2.8	15	53
	68	5 x 11	11	90	1.4	0.16	3.7	2.5	13	47
	100	5 x 11	11	110	2.0	0.16	2.5	1.7	9.0	25
	150	8.2 x 11	13	160	3.0	0.16	1.7	1.0	5.9	17
	220	8.2 x 11	13	190	4.4	0.16	1.2	0.9	5.2	15
16	33	5 x 11	11	70	1.1	0.13	6.3	2.8	14	52
	100	8.2 x 11	13	150	3.2	0.13	2.1	1.0	5.5	17
25	0.22	5 x 11	11	1.5	0.7	0.06	430	180	590	1800
	0.47	5 x 11	11	2.5	0.7	0.06	200	85	230	850
	1.0	5 x 11	11	5	0.7	0.06	95	40	130	400
	2.2	5 x 11	11	10	0.7	0.06	43	18	59	180
	3.3	5 x 11	11	18	0.7	0.06	29	12	39	120
	4.7	5 x 11	11	25	0.7	0.06	20	8.5	27	85
	6.8	5 x 11	11	38	0.7	0.06	14	5.9	19	75
	10	5 x 11	11	50	0.7	0.06	9.5	4.0	17	65
	15	5 x 11	11	60	0.8	0.08	8.5	3.0	16	60
	22	5 x 11	11	75	1.1	0.08	5.8	2.7	15	56
	33	8.2 x 11	13	110	1.7	0.06	2.9	1.4	7.0	18
	47	8.2 x 11	13	130	2.4	0.08	2.7	1.3	6.5	17
	68	8.2 x 11	13	150	3.4	0.08	1.9	1.2	6.0	17
35	33	5 x 11	11	70	3.3	0.13	6.3	2.8	14	52
	100	8.2 x 11	13	150	8.0	0.13	2.1	1.0	5.5	17

Non-solid Al - electrolytic capacitors
Radial Low Leakage Current

RLC 013

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitors RLC 013
100 µF/16 V, ±20%
Case size 8.2 x 11 mm; Form TR+
Catalogue number: 2222 013 25101.

Table 4

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	F = 2.5 mm positive leading Form TN+	Form TFA
6.3	330	013 53331	013 63331	–	013 23331	013 43331	–	013 33331
	470	013 53471	013 63471	–	013 23471	013 43471	–	013 33471
10	47	013 54479	013 84479	013 64479	013 24479	013 44479	013 14479	013 34479
	68	013 54689	013 84689	013 64689	013 24689	013 44689	013 14689	013 34689
	100	013 54101	013 84101	013 64101	013 24101	013 44101	013 14101	013 34101
	150	013 54151	013 64151	–	013 24151	013 44151	–	013 34151
	220	013 54221	013 64221	–	013 24221	013 44221	–	013 34221
16	33	013 55339	013 85339	013 65339	013 25339	013 45339	013 15339	013 35339
	100	013 55101	013 65101	–	013 25101	013 45101	–	013 35101
25	0.22	013 56227	013 86227	013 66227	013 26227	013 46227	013 16227	013 36227
	0.47	013 56477	013 86477	013 66477	013 26477	013 46477	013 16477	013 36477
	1.0	013 56108	013 86108	013 66108	013 26108	013 46108	013 16108	013 36108
	2.2	013 56228	013 86228	013 66228	013 26228	013 46228	013 16228	013 36228
	3.3	013 56338	013 86338	013 66338	013 26338	013 46338	013 16338	013 36338
	4.7	013 56478	013 86478	013 66478	013 26478	013 46478	013 16478	013 36478
	6.8	013 56688	013 86688	013 66688	013 26688	013 46688	013 16688	013 36688
	10	013 56109	013 86109	013 66109	013 26109	013 46109	013 16109	013 36109
	15	013 56159	013 86159	013 66159	013 26159	013 46159	013 16159	013 36159
	22	013 56229	013 86229	013 66229	013 26229	013 46229	013 16229	013 36229
	33	013 56339	013 66339	–	013 26339	013 46339	–	013 36339
	47	013 56479	013 66479	–	013 26479	013 46479	–	013 36479
	68	013 56689	013 66689	–	013 26689	013 46689	–	013 36689
35	33	013 50339	013 80339	013 60339	013 20339	013 40339	013 10339	013 30339
	100	013 50101	013 60101	–	013 20101	013 40101	–	013 30101

Non-solid Al - electrolytic capacitors
Radial Low Leakage Current

RLC 013

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 85 °C (mA)	I_{L2} 2 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz –25 °C (Ω)	Z 10 kHz –40 °C (Ω)
50	0.22	5 x 11	11	2.5	1.0	0.06	430	180	590	1800
	0.47	5 x 11	11	5	1.1	0.06	200	85	230	850
	1.0	5 x 11	11	10	1.1	0.06	95	40	130	400
	2.2	5 x 11	11	20	1.2	0.06	43	18	59	180
	3.3	5 x 11	11	32	1.3	0.06	29	12	39	120
	4.7	5 x 11	11	38	1.5	0.06	20	8.5	27	85
	6.8	5 x 11	11	46	1.7	0.06	14	5.9	19	75
	10	5 x 11	11	55	2.0	0.06	9.5	4.0	17	65
	15	5 x 11	11	60	2.5	0.08	8.5	3.0	16	60
	22	5 x 11	11	75	3.2	0.08	5.8	2.7	15	56
	33	8.2 x 11	13	110	4.3	0.06	2.9	1.4	7.0	18
	47	8.2 x 11	13	130	5.7	0.08	2.7	1.3	6.5	17
	68	8.2 x 11	13	150	7.8	0.08	1.9	1.2	6.0	17

Non-solid Al - electrolytic capacitors
Radial Low Leakage Current

RLC 013

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	F = 2.5 mm positive leading Form TN+	Form TFA
50	0.22	013 51227	013 81227	013 61227	013 21227	013 41227	013 11227	013 31227
	0.47	013 51477	013 81477	013 61477	013 21477	013 41477	013 11477	013 31477
	1.0	013 51108	013 81108	013 61108	013 21108	013 41108	013 11108	013 31108
	2.2	013 51228	013 81228	013 61228	013 21228	013 41228	013 11228	013 31228
	3.3	013 51338	013 81338	013 61338	013 21338	013 41338	013 11338	013 31338
	4.7	013 51478	013 81478	013 61478	013 21478	013 41478	013 11478	013 31478
	6.8	013 51688	013 81688	013 61688	013 21688	013 41688	013 11688	013 31688
	10	013 51109	013 81109	013 61109	013 21109	013 41109	013 11109	013 31109
	15	013 51159	013 81159	013 61159	013 21159	013 41159	013 11159	013 31159
	22	013 51229	013 81229	013 61229	013 21229	013 41229	013 11229	013 31229
	33	013 51339	013 61339	–	013 21339	013 41339	–	013 31339
	47	013 51479	013 61479	–	013 21479	013 41479	–	013 31479
	68	013 51689	013 61689	–	013 21689	013 41689	–	013 31689

Voltage

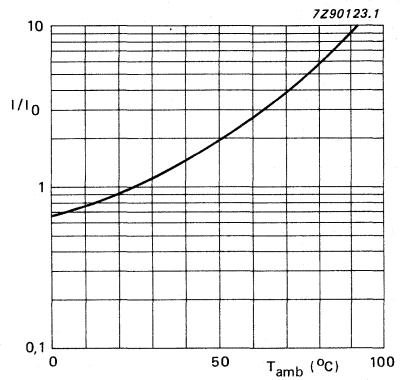
Surge voltage for short periods	$U_s \leq 1.3\ U_R$
Reverse voltage for short periods	$U_{rev} \leq 1$ V

Leakage current

After 2 minutes at U_R

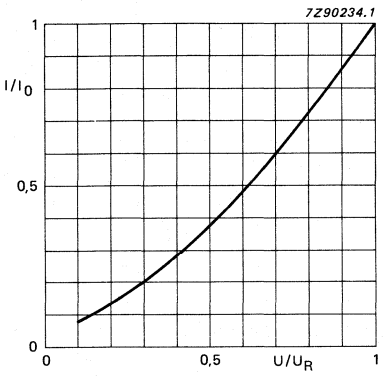
U_R 6.3 to 25 V $I_{L2} \leq 0.002\ C_R \times U_R$ or 0.7 µA (whichever is greater)

U_R 35 and 50 V $I_{L2} \leq 0.002\ C_R \times U_R + 1$ µA



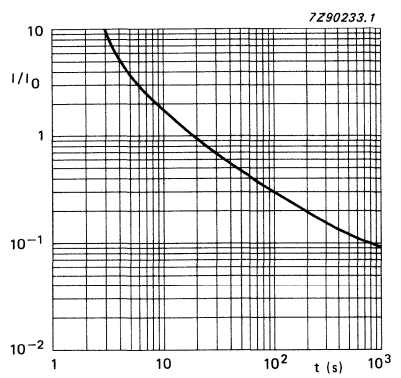
I_o = leakage current during continuous operation at 20 °C and U_R.

Fig.7 Typical multiplier of leakage current (I/I_o) as a function of ambient temperature.



I_o = leakage current during continuous operation at 20 °C and U_R.

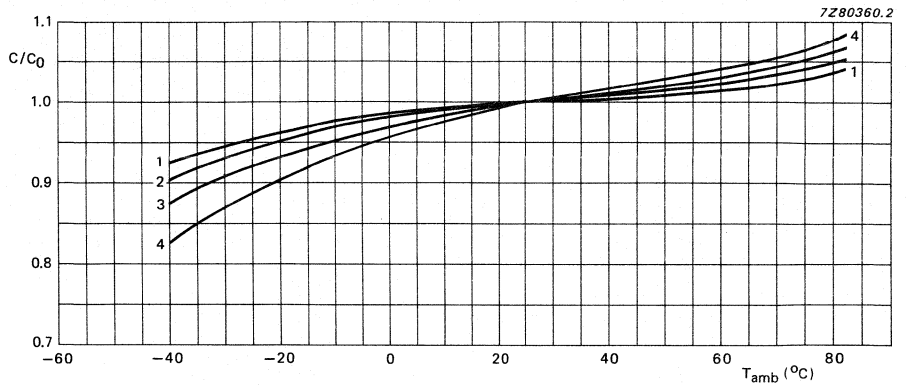
Fig.8 Typical multiplier of leakage current (I/I_o) as a function of U/U_R.



I_o = leakage current as specified in Table 3.

Fig.9 Typical multiplier of leakage current (I/I_o) as a function of time.

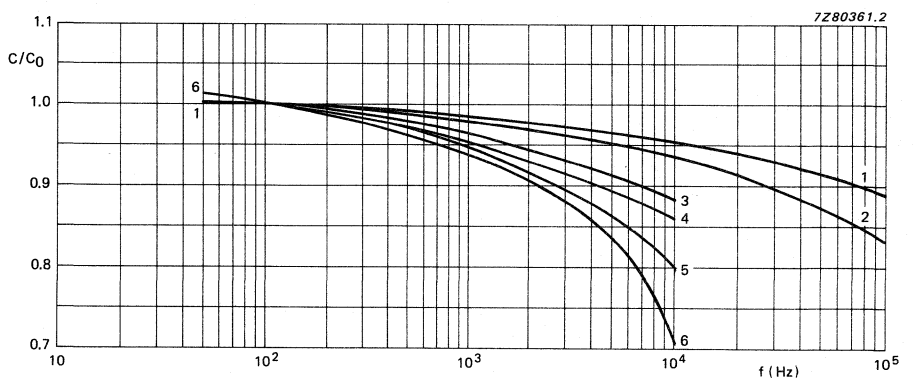
Capacitance (C)



Curve 1 : 25/50 V; 0.22 to 2.2 µF
Curve 2 : 25/50 V; 3.3 to 6.8 µF
Curve 3 : 25/50 V; 10 to 68 µF
Curve 4 : 6.3/10/16/35 V.

C_o = capacitance at 20 °C, 100 Hz.

Fig.10 Multiplier of capacitance (C/C_o) as a function of ambient temperature.

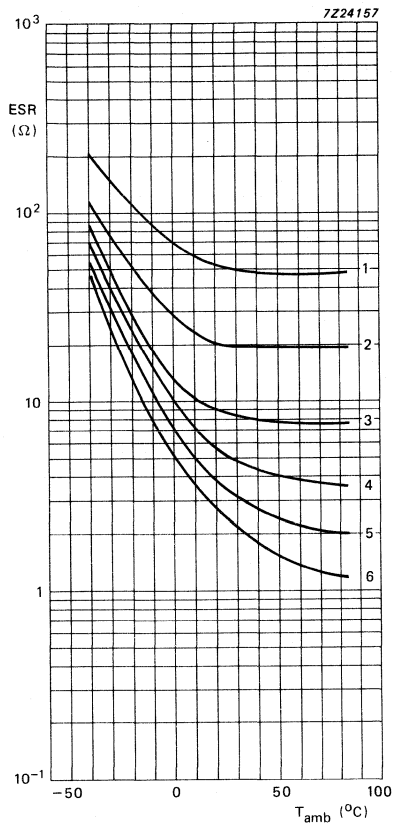


Curve 1 : 25/50 V; 0.22 to 2.2 µF
Curve 2 : 25/50 V; 3.3 to 6.8 µF
Curve 3 : 25/50 V; 10/15 µF
Curve 4 : 25/50 V; 22 to 68 µF
Curve 5 : 16/35 V
Curve 6 : 6.3/10 V.

C_o = capacitance at 20 °C, 100 Hz.

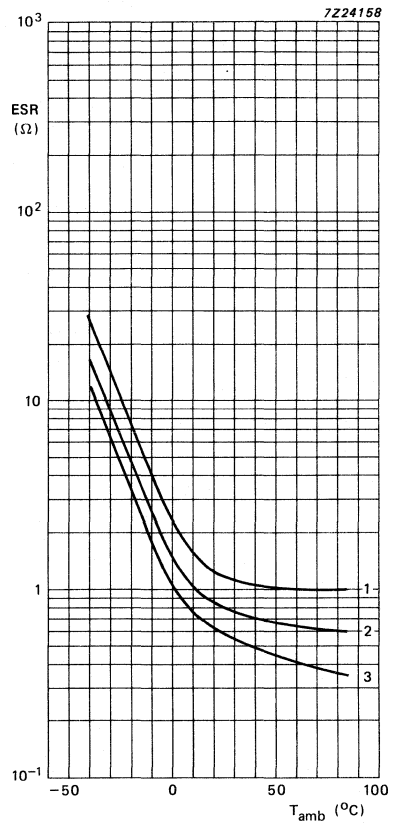
Fig.11 Multiplier of capacitance (C/C_o) as a function of frequency.

Equivalent series resistance (ESR)



Curve 1 : 0.47 µF
Curve 2 : 1.0 µF
Curve 3 : 4.7 µF
Curve 4 : 10 µF
Curve 5 : 22 µF
Curve 6 : 47 µF.

Fig.12 Typical ESR at 100 Hz as a function of ambient temperature; case size 5 x 11 mm.



Curve 1 : 47 µF
Curve 2 : 100 µF
Curve 3 : 220 µF.

Fig.13 Typical ESR at 100 Hz as a function of ambient temperature; case size 8.2 x 11 mm.

Equivalent series inductance (ESL)

case size 5 x 11	typ. 13 nH
case size 8.2 x 11	typ. 16 nH

Impedance (Z)

Curve 1 : 0.47 µF
Curve 2 : 0.68 µF
Curve 3 : 1.0 µF
Curve 4 : 1.5 µF
Curve 5 : 2.2 µF
Curve 6 : 3.3 µF
Curve 7 : 4.7 µF
Curve 8 : 6.8 µF
Curve 9 : 10 µF
Curve 10 : 15 µF
Curve 11 : 22 µF
Curve 12 : 33 µF
Curve 13 : 47 µF
Curve 14 : 68 µF.

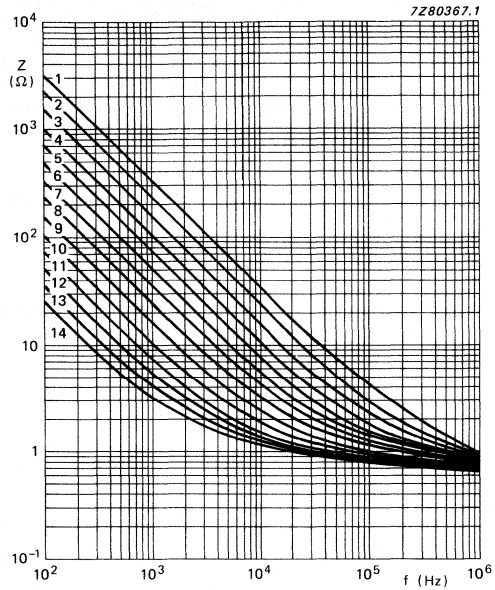


Fig.14 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 5 x 11.

Curve 1 : 33 µF
Curve 2 : 47 µF
Curve 3 : 68 µF
Curve 4 : 100 µF
Curve 5 : 150 µF
Curve 6 : 220 µF.

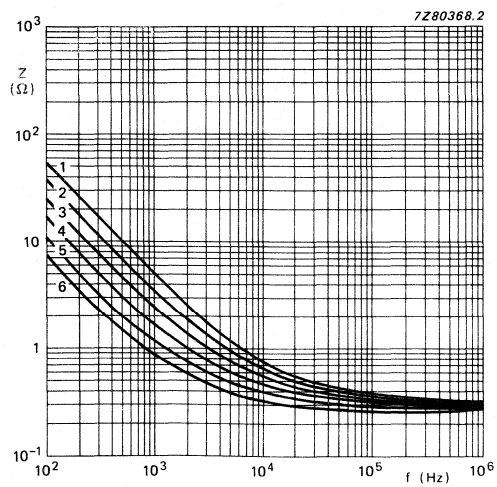
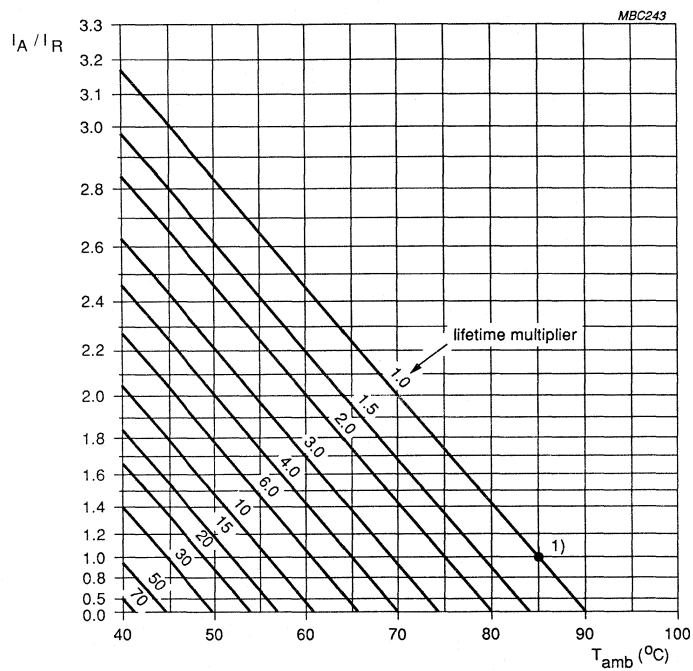


Fig.15 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 8.2 x 11.

RIPPLE CURRENT and USEFUL LIFE

Table 5 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 85 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R 6.3 V	U_R 10/16/35 V	U_R 25 and 50 V
50	0.9	0.85	0.8
100	1.0	1.0	1.0
300	1.12	1.2	1.25
1000	1.2	1.3	1.4
3000	1.25	1.35	1.5
≥10 000	1.3	1.4	1.6



I_A = actual ripple current at 100 Hz.
I_R = ripple current at 85 °C, 100 Hz.

1) Useful life at 85 °C and I_R applied: 3000 hours.

Fig.16 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30301 sub clause 4.13	T_{amb} = 85 °C, U_R applied 2000 hours	$U_R \leq 6.3$ V : $\Delta C/C$ +15/–30% $U_R > 6.3$ V : $\Delta C/C$ ±15% tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L2} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 3000 hours	$U_R \leq 6.3$ V : $\Delta C/C$ +45/–50% $U_R > 6.3$ V : $\Delta C/C$ ±45% tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit $I_{L2} \leq$ spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30301 sub clause 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L2} \leq 2$ x spec. limit

Non-solid Al - electrolytic capacitors
Radial Semi-Professional

RSP 036

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CU-product per unit volume
- Reduced leakage current.

APPLICATIONS

- Automotive, telecommunication, industrial, EDP and audio-video
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Portable and mobile equipment (small size, low mass)
- Low surface demand on printed circuit board.

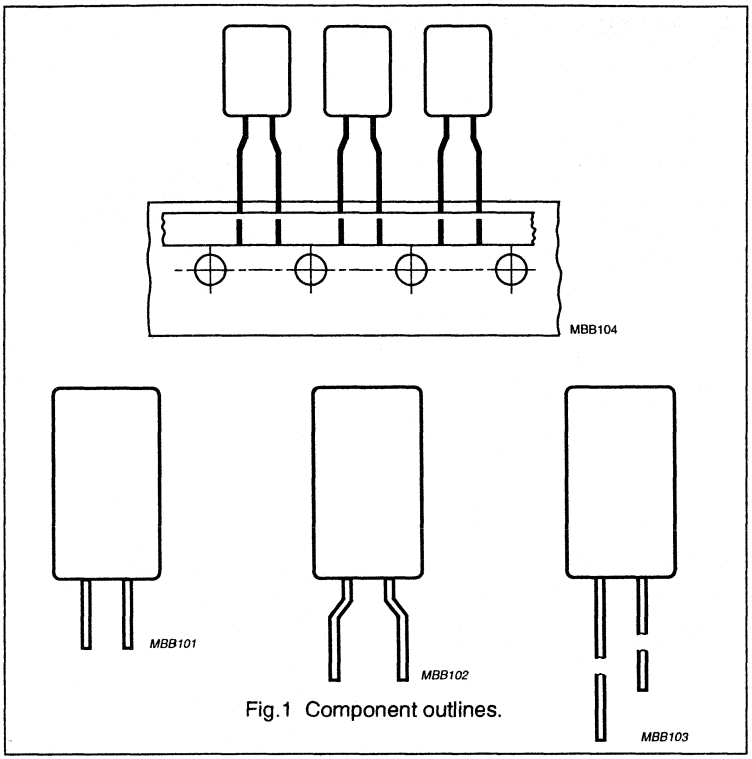


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom})	5 x 11 and 8.2 x 11 mm
Rated capacitance range, C_R	0.22 to 470 µF
Tolerance on C_R	±20% (±10% on request)
Rated voltage range, U_R	6.3 to 160 V
Category temperature range	−55 to +85 °C
Endurance test at 85 °C	2000 hours
Useful life at 105 °C	750 hours
Useful life at 85 °C	3000 hours
Useful life at 40 °C, 1.4 I_R applied	80 000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specification	IEC 384-4/CECC 30300, LL grade
Detail specification	IEC 384-4-1/CECC 30301 similar to DIN 41259 (with reduced dimensions)
Climatic category IEC 68 DIN 40040	 55/85/56 FPF
Approvals	LNZ 44-04 (COJ)

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**) * = preferred values

C_R (µF)	U_R (V)									
	6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**	**100**	**160**
0.22								5 x 11		
0.47 *								5 x 11		
1.0 *								5 x 11		
1.5								5 x 11		
2.2 *								5 x 11		8.2 x 11
3.3								5 x 11		
4.7 *								5 x 11		8.2 x 11
6.8								5 x 11		
10 *							5 x 11	5 x 11 8.2 x 11	8.2 x 11	
15						5 x 11		5 x 11		
22 *					5 x 11			5 x 11 8.2 x 11	8.2 x 11	
33			5 x 11				5 x 11	8.2 x 11		
47 *		5 x 11			5 x 11		8.2 x 11	8.2 x 11		
68		5 x 11		5 x 11		8.2 x 11		8.2 x 11		
100 *	5 x 11		5 x 11	8.2 x 11			8.2 x 11			
150		5 x 11	8.2 x 11		8.2 x 11					
220 *		8.2 x 11	8.2 x 11	8.2 x 11		For higher capacitance values see RSS 045 and RMS 047 series				
330 *	8.2 x 11		8.2 x 11							
470 *		8.2 x 11								

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

Table 2 Dimensions in mm; mass in g

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	$\varnothing d$	$\varnothing D_{max}$	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA CB, CC	Form TR+ TR–, TN	Form TFA
5 x 11	11	0.5	5.5	12	2.5	0.4	1000	1000	2000
8.2 x 11	13	0.6	8.7	12	5	1.1	1000	500	1000

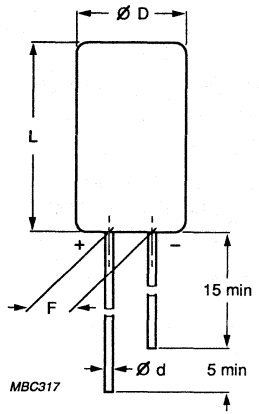


Fig.2 **Form CA**: Long leads.

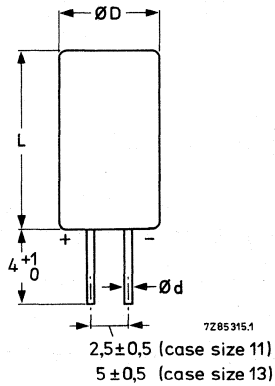


Fig.3 **Form CB**: Cut leads.

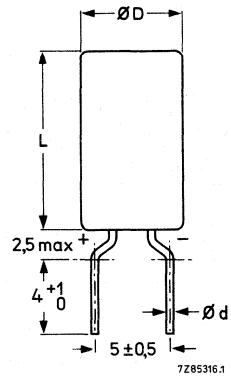
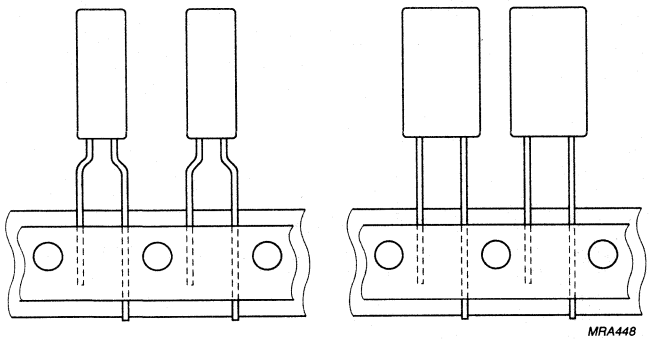


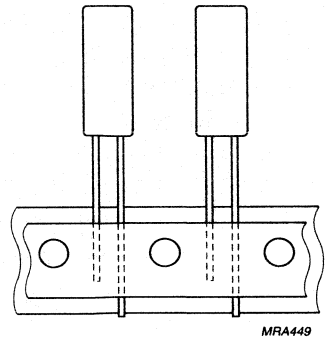
Fig.4 **Form CC**: Cut leads, formed; case size 5 x 11 only.

Tape dimensions are specified in chapter "PACKING",



Form TR+: Taped on reel, positive leading.
Form TR–: Taped on reel, negative leading.
Form TFA : Taped in box (ammopack).

Fig.5 Taped, pitch F = 5 mm; case sizes 5 x 11 and 8.2 x 11.



Form TN+: Taped on reel, positive leading.

Fig.6 Taped, pitch F = 2.5 mm; case size 5 x 11 only.

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance in μF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Group number (036)
- Name of manufacturer (PHILIPS)
- Date code in accordance with IEC 62
- Code indicating factory of origin
- Minus-sign to identify the negative terminal.

Non-solid Al - electrolytic capacitors
Radial Semi-Professional

RSP 036

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance ± 20%
I_R = rated RMS ripple current at 100 Hz, 85 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 10 kHz and 20, –25 or –40 °C.

Table 3 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz –25 °C (Ω)	Z 10 kHz –40 °C (Ω)
6.3	100	5 x 11	11	130	7	3.6	0.20	3.2	1.7	9.0	25
	330	8.2 x 11	13	300	16	5.1	0.20	1.0	0.52	2.7	7.6
10	47	5 x 11	11	95	6	3.5	0.16	5.4	2.8	12	32
	68	5 x 11	11	110	7	3.7	0.16	3.7	1.9	8.2	22
	150	5 x 11	11	150	12	4.5	0.20	2.1	1.3	8.0	21
	220	8.2 x 11	13	260	17	5.2	0.16	1.2	0.59	2.6	6.8
	470	8.2 x 11	13	400	31	7.7	0.20	0.68	0.43	2.6	6.8
16	33	5 x 11	11	90	7	3.5	0.14	6.8	2.7	12	33
	100	5 x 11	11	160	13	4.6	0.16	2.5	1.6	7.5	20.0
	150	8.2 x 11	13	230	18	5.4	0.14	1.5	0.6	2.7	7.3
	220	8.2 x 11	13	280	24	6.5	0.16	1.2	0.55	2.5	6.8
	330	8.2 x 11	13	390	35	8.3	0.16	0.7	0.48	2.3	6.1
25	68	5 x 11	11	140	13	4.7	0.14	3.3	1.8	8.2	22
	100	8.2 x 11	13	210	18	5.5	0.12	1.9	0.7	3.0	9.0
	220	8.2 x 11	13	310	36	8.5	0.14	1	0.55	2.6	6.8
35	22	5 x 11	11	87	8	3.8	0.10	7.2	2.7	11	34
	47	5 x 11	11	130	13	4.6	0.12	4.1	1.9	8.5	23
	150	8.2 x 11	13	270	35	8.3	0.12	1.3	0.6	2.7	7.3
40	15	5 x 11	11	72	7	3.6	0.10	11	3.7	15	47
	68	8.2 x 11	13	180	20	5.7	0.10	2.3	0.81	3.2	10
50	10	5 x 11	11	60	6	3.5	0.08	13	4.5	16	58
	33	5 x 11	11	110	13	4.7	0.10	4.8	2.1	9.1	27
	47	8.2 x 11	13	160	18	5.4	0.08	2.7	0.96	3.4	12
	100	8.2 x 11	13	250	33	8.0	0.10	1.6	0.7	3.0	9.0

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitors RSP 036
100 µF/16 V, ±20%
Case size 5 x 11 mm; Form TR+
Catalogue number: 2222 036 25101.

Table 4 Ordering information

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	F = 2.5 mm positive leading Form TN+	Form TFA
6.3	100	036 53101	036 83101	036 63101	036 23101	036 90221	036 13101	036 33101
	330	036 53331	036 63101	–	036 23331	036 90308	–	036 33331
10	47	036 54479	036 84479	036 64479	036 24479	036 90078	036 14479	036 34479
	68	036 54689	036 84689	036 64689	036 24689	036 90309	036 14689	036 34689
	150	036 54151	036 84151	036 64151	036 24151	036 90311	036 14151	036 34151
	220	036 54221	036 64221	–	036 24221	036 90126	–	036 34221
	470	036 54471	036 64471	–	036 24471	036 90182	–	036 34471
16	33	036 55339	036 85339	036 55339	036 25339	036 90312	036 15339	036 35339
	100	036 55101	036 85101	036 55101	036 25101	036 90184	036 15101	036 35101
	150	036 55151	036 55151	–	036 25151	036 90313	–	036 35151
	220	036 55221	036 55221	–	036 25221	036 90223	–	036 35221
	330	036 55331	036 55331	–	036 25331	036 90314	–	036 35331
25	68	036 56689	036 86689	036 66689	036 26689	036 90315	036 16689	036 36689
	100	036 56101	036 66101	–	036 26101	036 90071	–	036 36101
	220	036 56221	036 66221	–	036 26221	036 90224	–	036 36221
35	22	036 90001	036 90002	036 90003	036 90016	036 90065	036 90164	036 90027
	47	036 90094	036 90095	036 90096	036 90097	036 90131	036 90198	036 90098
	150	036 90099	036 90101	–	036 90102	036 90316	–	036 90103
40	15	036 57159	036 87159	036 67159	036 27159	036 90317	036 17159	036 37159
	68	036 57689	036 67689	–	036 27689	036 90318	–	036 37689
50	10	036 90004	036 90005	036 90006	036 90017	036 90066	036 90228	036 90028
	33	036 90104	036 90105	036 90106	036 90107	036 90319	036 90321	036 90108
	47	036 90011	036 90012	–	036 90019	036 90091	–	036 90031
	100	036 90109	036 90111	–	036 90112	036 90225	–	036 90113

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz −25 °C (Ω)	Z 10 kHz −40 °C (Ω)
63	0.22	5 x 11	11	2.5	4	3	0.06	430	180	590	1800
	0.47	5 x 11	11	5	4	3	0.06	200	85	280	850
	1.0	5 x 11	11	11	4	3.1	0.06	95	40	130	400
	1.5	5 x 11	11	16	4	3.1	0.06	64	27	87	270
	2.2	5 x 11	11	25	4	3.1	0.06	43	18	59	180
	3.3	5 x 11	11	38	5	3.2	0.06	29	12	39	120
	4.7	5 x 11	11	45	5	3.3	0.06	20	8.5	27	85
	6.8	5 x 11	11	55	6	3.4	0.06	14	5.9	19	59
	10	5 x 11	11	70	7	3.6	0.06	9.5	4.0	13	40
	10	8.2 x 11	13	120	7	3.6	0.04	6.5	2.8	7	19
	15	5 x 11	11	80	9	3.9	0.07	7.4	3.1	12	36
	22	5 x 11	11	100	11	4.4	0.08	5.8	2.7	10	32
	22	8.2 x 11	13	150	11	4.4	0.05	3.6	1.4	5.1	15
	33	8.2 x 11	13	160	16	5.1	0.06	2.9	1.2	3.9	12
	47	8.2 x 11	13	190	21	6.0	0.07	2.4	1.0	3.5	11
	68	8.2 x 11	13	210	29	7.3	0.08	1.9	0.88	3.2	10
100	10	8.2 x 11	13	80	9	4	0.07	11	3.8	20	60
	22	8.2 x 11	13	110	16	5.2	0.08	5.8	2.9	17	50
160	2.2	8.2 x 11	13	45	75	15	0.05	36	14	70	170
	4.7	8.2 x 11	13	62	115	21	0.07	24	9.6	60	150

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U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	F = 2.5 mm positive leading Form TN+	Form TFA
63	0.22	036 58227	036 88227	036 68227	036 28227	036 90226	036 18227	036 38227
	0.47	036 58477	036 88477	036 68477	036 28477	036 90068	036 18477	036 38477
	1.0	036 58108	036 88108	036 68108	036 28108	036 90067	036 18108	036 38108
	1.5	036 58158	036 88158	036 68158	036 28158	036 90322	036 18158	036 38158
	2.2	036 58228	036 88228	036 68228	036 28228	036 90077	036 18228	036 38228
	3.3	036 58338	036 88338	036 68338	036 28338	036 90323	036 18338	036 38338
	4.7	036 58478	036 88478	036 68478	036 28478	036 90064	036 18478	036 38478
	6.8	036 58688	036 88688	036 68688	036 28688	036 90324	036 18688	036 38688
	10	036 58109	036 88109	036 68109	036 28109	036 90325	036 18109	036 38109
	10	036 90036	036 90041	–	036 90233	036 90188	–	036 90181
	15	036 58159	036 88159	036 68159	036 28159	036 90326	036 18159	036 38159
	22	036 58229	036 88229	036 68229	036 28229	036 90119	036 18229	036 38229
	22	036 90117	036 90118	–	036 90138	036 90327	–	036 90139
	33	036 58339	036 68339	–	036 28339	036 90328	–	036 38339
	47	036 58479	036 68479	–	036 28479	036 90144	–	036 38479
	68	036 58689	036 68689	–	036 28689	036 90329	–	036 38689
100	10	036 59109	036 69109	–	036 29109	036 90331	–	036 39109
	22	036 59229	036 69229	–	036 29229	036 90332	–	036 39229
160	2.2	036 90333	036 90334	–	036 90294	036 90335	–	036 90336
	4.7	036 90337	036 90338	–	036 90302	036 90339	–	036 90341

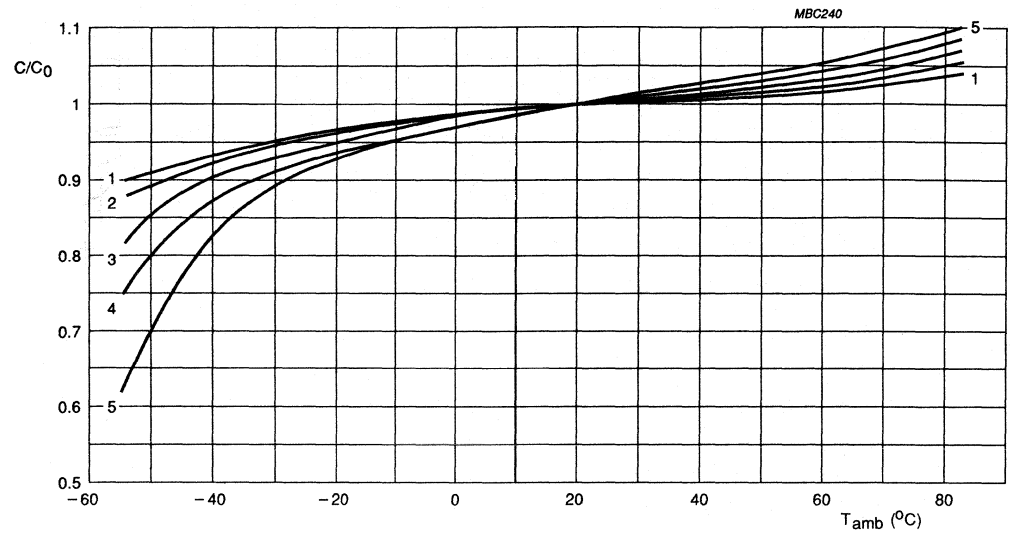
Voltage

Surge voltage for short periods	$U_s \leq 1.15\ U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R	
U_R 6.3 to 100 V	$I_{L1} \leq 0.006\ C_R \times U_R + 3\ \mu A$
U_R 160 V	$I_{L1} \leq 0.1\ C_R \times U_R + 40\ \mu A$
After 5 minutes at U_R	
U_R 6.3 to 100 V	$I_{L5} \leq 0.001\ C_R \times U_R + 3\ \mu A$
U_R 160 V	$I_{L5} \leq 0.015\ C_R \times U_R + 10\ \mu A$

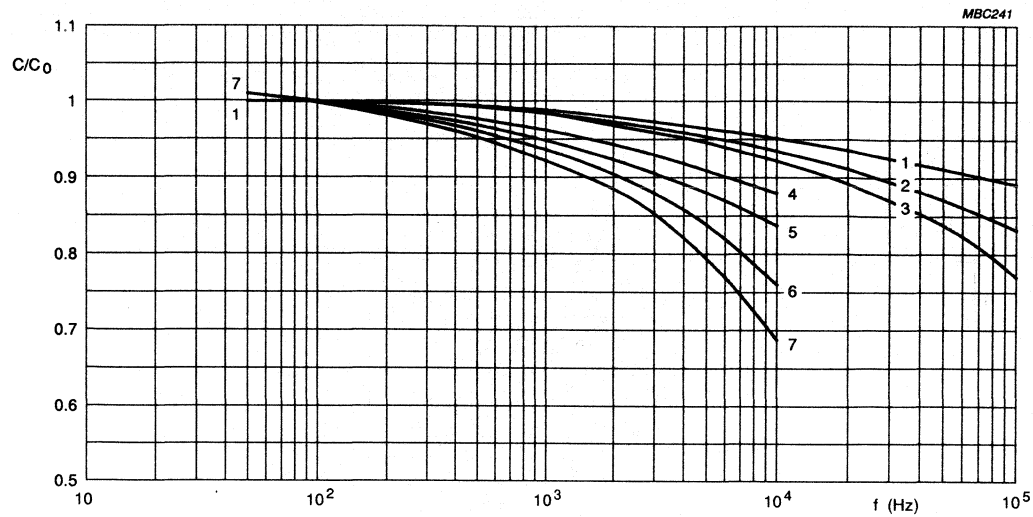
Capacitance (C)



Curve 1: 63 V
Curve 2: 50 V
Curve 3: 35/40 V and 100/160 V
Curve 4: 16/25 V
Curve 5: 6.3/10 V.

C_o = capacitance at 20 °C, 100 Hz.

Fig.7 Multiplier of capacitance (C/C_o) as a function of ambient temperature.

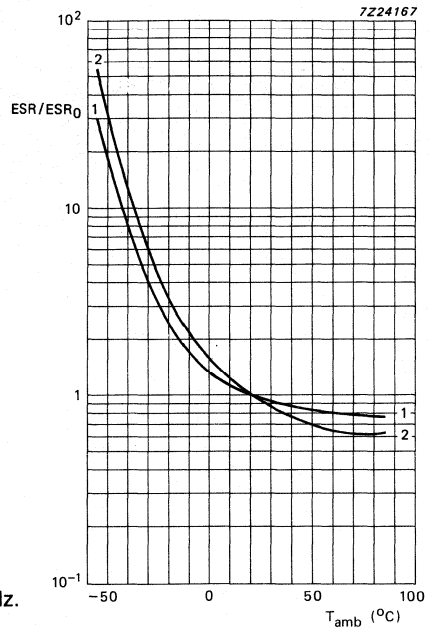


Curve 1: 63 V (≤2.2 μF)
Curve 2: 63 V (>2.2 μF)
Curve 3: 50 V
Curve 4: 35/40 V and 100/160 V
Curve 5: 25 V
Curve 6: 16 V
Curve 7: 6.3/10 V.

C_o = capacitance at 20 °C, 100 Hz.

Fig.8 Multiplier of capacitance (C/C_o) as a function of frequency.

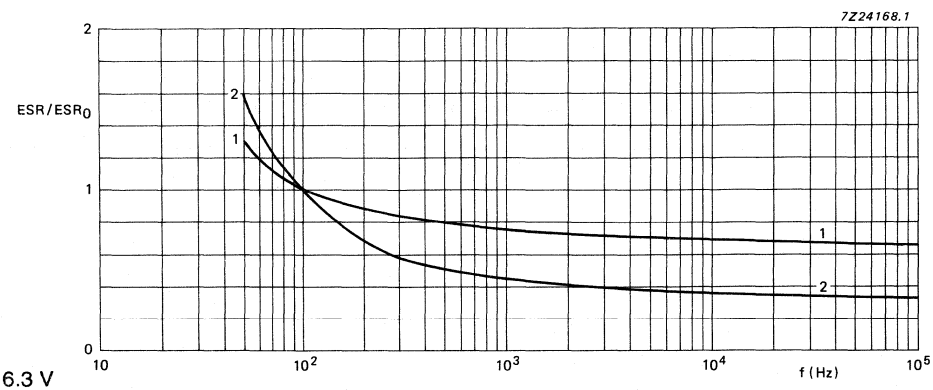
Equivalent series resistance (ESR)



Curve 1 : 63 V (≥10 µF)
Curve 2 : 6.3 V and 100/160 V.

ESR$_o$ = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR$_o$) as a function of ambient temperature.



Curve 1 : 6.3 V
Curve 2 : 63 V (≥10 µF) and 100/160 V.

ESR$_o$ = typical ESR at 20 °C, 100 Hz.

Fig.10 Multiplier of ESR (ESR/ESR$_o$) as a function of frequency.

Equivalent series inductance (ESL)

case size 5 x 11	typ. 13 nH
case size 8.2 x 11	typ. 16 nH

Impedance (Z)

Curve 1 : 0.47 µF
Curve 2 : 0.68 µF
Curve 3 : 1.0 µF
Curve 4 : 1.5 µF
Curve 5 : 2.2 µF
Curve 6 : 3.3 µF
Curve 7 : 4.7 µF
Curve 8 : 6.8 µF
Curve 9 : 10 µF
Curve 10 : 15 µF
Curve 11 : 22 µF
Curve 12 : 33 µF
Curve 13 : 47 µF
Curve 14 : 68 µF
Curve 15 : 100 µF
Curve 16 : 150 µF.

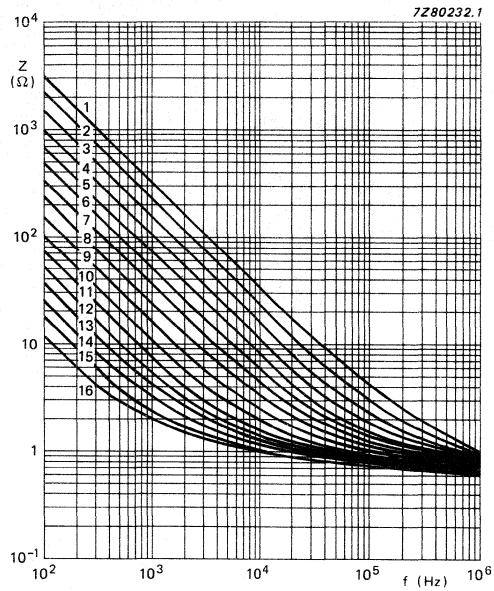


Fig.11 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 5 x 11.

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Curve 1 : 2.2 µF
Curve 2 : 4.7 µF
Curve 3 : 10 µF - 100 V
Curve 4 : 10 µF - 63 V
Curve 5 : 22 µF - 63 V
Curve 6 : 33 µF
Curve 7 : 47 µF
Curve 8 : 68 µF
Curve 9 : 100 µF
Curve 10 : 150 µF
Curve 11 : 220 µF
Curve 12 : 330 µF
Curve 13 : 470 µF.

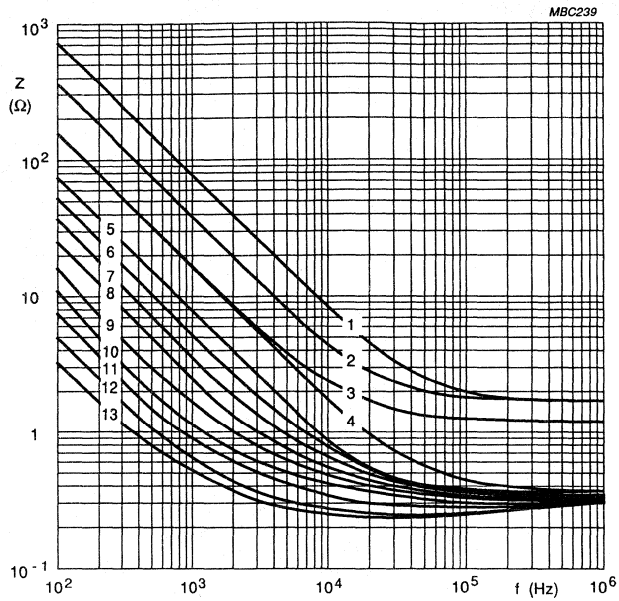


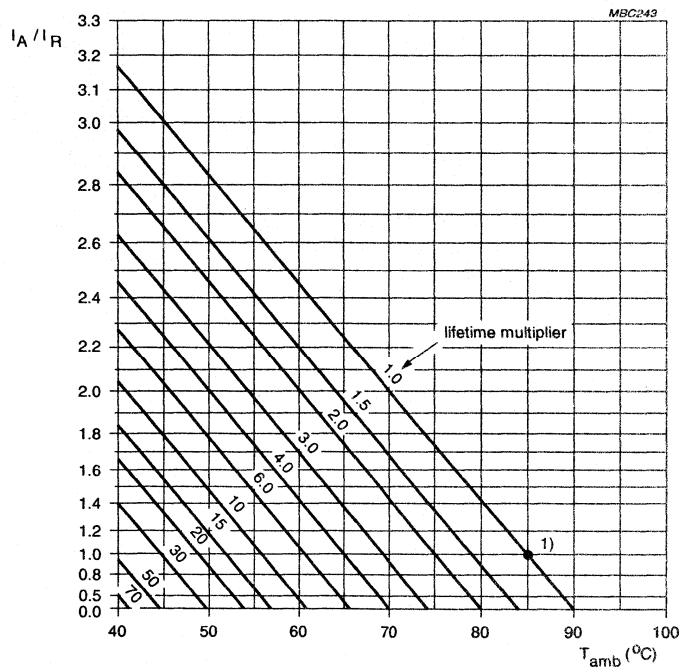
Fig.12 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 8.2 x 11.

4

RIPPLE CURRENT and USEFUL LIFE

Table 5 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10 V	U_R = 16 to 35 V	U_R = 40 to 160 V
50	0.9	0.85	0.8
100	1.0	1.0	1.0
300	1.12	1.2	1.25
1000	1.2	1.3	1.4
3000	1.25	1.35	1.5
≥10 000	1.3	1.4	1.6



I_A = actual ripple current at 100 Hz.

I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied: 3000 hours.

Fig.13 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30301 sub clause 4.13	T_{amb} = 85 °C, U_R applied 2000 hours	$U_R \leq 6.3$ V : $\Delta C/C$ +15/–30% $U_R > 6.3$ V : $\Delta C/C$ ±15% tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 3000 hours	$U_R \leq 6.3$ V : $\Delta C/C$ +45/–50% $U_R > 6.3$ V : $\Delta C/C$ ±45% tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30301 sub clause 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above I_{L5} ≤spec. limit

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FEATURES

- Polarized aluminium electrolytic capacitors, non solid
- Radial leads, cylindrical aluminium case with safety vent insulated with a blue sleeve
- Charge and discharge proof
- Long useful life 1500 h/105 °C
- Miniaturized, high CU product per unit volume

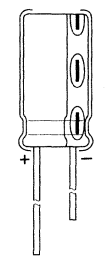

Fig.1 Component outline

APPLICATIONS

- EDB, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass)
- Low PCB surface demand

4

QUICK REFERENCE DATA

Case size, $\varnothing D_{nom}$ x L_{nom} in mm	10 x 12 to 18 x 40
Rated capacitance range, C_R	68 to 10000 µF
Tolerance on C_R	±20 %
Rated voltage range, U_R	16 to 63 V
Category temperature range	–40 to +105 °C
Endurance test at 105 °C	1000 hours
Useful life at 105 °C	1500 hours
Useful life at 40 °C, 1,3 I_R applied	150000 hours
Shelf life at 0 V, 105 °C	500 hours
Basic specification	IEC 384-4, L.L. grade, CECC 30 300
Detail specification	similar to DIN 41 259
Climatic category IEC 68	40/105/56
Climatic category DIN 40 040	GMF

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Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (diameter x length in mm)

C_R	U_R (V)					
µF	**16**	**25**	**35**	**40**	**50**	**63**
68	For lower capacitance values see RSP 036 series					10 x 12
100 *						10 x 12
150				10 x 12		10 x 16
220 *			10 x 12		10 x 16	10 x 20
330	10 x 12		10 x 16	10 x 20		12.5 x 20
470 *	10 x 12	10 x 16	10 x 20		12.5 x 20	12,5 x 25
680	10 x 16		12.5 x 20		12.5 x 25	16 x 25
1000 *	10 x 20	12.5 x 20	12.5 x 25		16 x 25	16 x 31
1500	12.5 x 20	12.5 x 25	16 x 25		16 x 35	18 x 35
2200 *	12.5 x 25	16 x 25	16 x 31	16 x 35	18 x 35	18 x 40
3300	16 x 25	16 x 31	■	18 x 35	18 x 40	
4700 *	16 x 31	■	18 x 40			
6800	16 x 35	18 x 40				
10000 *	18 x 40					

* E3 values = preferred values
■ 16 x 35 under consideration

MECHANICAL DATA Dimensions (in mm)

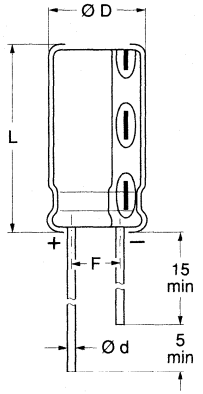


Fig. 2 **Form CA**, long leads;
see Table 2 for dimensions.

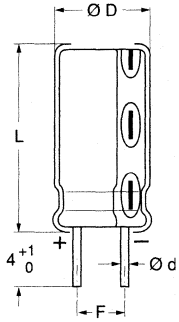
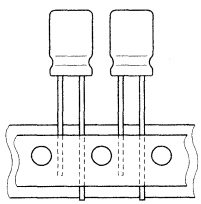
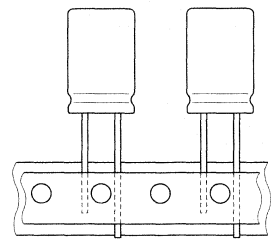


Fig. 3 **Form CB**, cut leads;
see Table 2 for dimensions.



øD = 10 mm and 12.5 mm



øD = 16 mm

Fig. 4 **Form TR+**, case sizes up to ø16 x 31 taped on reel, positive leading.
See Introduction for taping dimensions.

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MARKING

The capacitors are marked with the following information:

- Rated capacitance value
- Tolerance on rated capacitance (M for ±20 %)
- Rated voltage
- Negative terminal identification
- Upper category temperature (105 °C)
- Group number (047)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62

Table 2 Dimensions (in mm)

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	RADIAL				MASS
		$\varnothing d$	$\varnothing D_{max}$	L_{max}	$F \pm 0,5$	(g)
10 x 12	14	0.6	10.5	13.5	5.0	1.6
10 x 16	15	0.6	10.5	17.5	5.0	1.9
10 x 20	16	0.6	10.5	21.5	5.0	2.2
12.5 x 20	17	0.6	13.0	21.5	5.0	4.0
12.5 x 25	18	0.6	13.0	26.5	5.0	5.0
16 x 25	19	0.8	16.5	27.0	7.5	8.0
16 x 31	20	0.8	16.5	33.0	7.5	9.0
16 x 35	21	0.8	16.5	37.0	7.5	11.5
18 x 35	22	0.8	18.5	37.0	7.5	14.5
18 x 40	23	0.8	18.5	42.0	7.5	16.0

PACKING

Capacitors of Form CA and Form CB are supplied in boxes, those of Form TR+ taped on reel.
The numbers per box and per reel are given in Table 3.

Table 3 Packing quantities

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	NUMBER OF CAPACITORS		
		FORM CA per Box	FORM CB per Box	FORM TR+ per Reel
10 x 12	14	1000	1000	500
10 x 16	15	500	500	500
10 x 20	16	500	500	500
12.5 x 20	17	200	200	200
12.5 x 25	18	200	200	200
16 x 25	19	200	200	150
16 x 31	20	200	200	150
16 x 35	21	150	150	
18 x 35	22	100	100	
18 x 40	23	100	100	

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ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 4 apply at an ambient temperature of 20 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75 %.

C_R = rated capacitance at 100 Hz, tolerance ±20 %

I_R = rated RMS ripple current at 100 Hz, 105 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz (100 kHz in preparation)

Table 4 Electrical data

U_R	C_R	CASE SIZE	I_R	I_{L1}	I_{L5}	tan δ	ESR	Z	
		$øD_{nom}$ x L_{nom}						at 10 kHz	at 100 kHz
(V)	(μF)	(mm)	(mA)	(μA)	(μA)		(Ω)	(Ω)	(Ω)
16	330	10 x 12	270	110	14	0.16	0.73	0.97	
	470	10 x 12	330	150	18	0.16	0.51	0.68	
	680	10 x 16	400	220	25	0.16	0.36	0.47	
	1000	10 x 20	540	320	35	0.16	0.24	0.32	
	1500	12.5 x 20	680	480	51	0.18	0.18	0.22	
	2200	12.5 x 25	830	710	73	0.20	0.14	0.15	
	3300	16 x 25	1100	1100	110	0.22	0.10	0.11	
	4700	16 x 31	1300	1500	150	0.24	0.08	0.08	
	6800	16 x 35	1600	2200	220	0.28	0.06	0.06	
	10000	18 x 40	1800	3200	320	0.36	0.05	0.05	
25	470	10 x 16	360	240	27	0.14	0.45	0.47	
	1000	12.5 x 20	630	500	53	0.14	0.21	0.22	
	1500	12.5 x 25	780	750	78	0.16	0.16	0.15	
	2200	16 x 25	990	1100	110	0.18	0.12	0.11	
	3300	16 x 31	1200	1700	170	0.20	0.09	0.07	
	6800	18 x 40	1700	3400	340	0.26	0.06	0.04	
35	220	10 x 12	270	160	18	0.12	0.83	0.68	
	330	10 x 16	350	230	26	0.12	0.55	0.45	
	470	10 x 20	450	330	36	0.12	0.39	0.32	
	680	12.5 x 20	580	480	51	0.12	0.27	0.22	
	1000	12.5 x 25	780	700	73	0.12	0.18	0.15	
	1500	16 x 25	970	1100	110	0.14	0.14	0.10	
	2200	16 x 31	1200	1500	160	0.16	0.11	0.07	
	4700	18 x 40	1800	3300	330	0.20	0.06	0.04	

Non-solid Al - electrolytic capacitors
Radial Miniature Semiprofessional

RMS 047

ORDERING EXAMPLE

Electrolytic capacitors RMS 047
1000 µF/35 V, ±20 %
12.5 x 25, taped on reel, Form TR+
Catalogue number 2222 047 20102

Ordering information

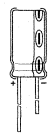
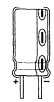
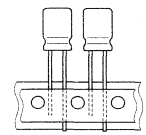
U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$\varnothing D_{nom}$ x L_{nom}			
(V)	(µF)	(mm)	Form CA	Form CB	Form TR+
16	330	10 x 12	047 55331	047 65331	047 25331
	470	10 x 12	55471	65471	25471
	680	10 x 16	55681	65681	25681
	1000	10 x 20	55102	65102	25102
	1500	12.5 x 20	55152	65152	25152
	2200	12.5 x 25	55222	65222	25222
	3300	16 x 25	55332	65332	25332
	4700	16 x 31	55472	65472	25472
	6800	18 x 35	55682	65682	
	10000	18 x 40	55103	65103	
25	470	10 x 16	047 56471	047 66471	047 26471
	1000	12.5 x 20	56102	66102	26102
	1500	12.5 x 25	56152	66152	26152
	2200	16 x 25	56222	66222	26222
	3300	16 x 31	56332	66332	26332
	6800	18 x 40	56682	66682	
35	220	10 x 12	047 50221	047 60221	047 20221
	330	10 x 16	50331	60331	20331
	470	10 x 20	50471	60471	20471
	680	12.5 x 20	50681	60681	20681
	1000	12.5 x 25	50102	60102	20102
	1500	16 x 25	50152	60152	20152
	2200	16 x 31	50222	60222	20222
	4700	18 x 40	50472	60472	

Table 4 Electrical data (continued)

U_R	C_R	CASE SIZE $øD_{nom}$ x L_{nom}	I_R	I_{L1}	I_{L5}	tan δ	ESR	Z	
								at 10 kHz	at 100 kHz
(V)	(μF)	(mm)	(mA)	(μA)	(μA)		(Ω)	(Ω)	(Ω)
40	150	10 x 12	230	120	15	0.12	1.20	0.87	
	330	10 x 20	380	270	29	0.12	0.55	0.39	
	2200	16 x 35	1200	1800	180	0.16	0.11	0.06	
	3300	18 x 35	1500	2600	270	0.18	0.08	0.04	
50	220	10 x 16	310	220	25	0.10	0.69	0.43	
	470	12.5 x 20	540	470	50	0.10	0.32	0.20	
	680	12.5 x 25	710	680	71	0.10	0.22	0.14	
	1000	16 x 25	940	1000	100	0.10	0.15	0.10	
	1500	16 x 35	1200	1500	150	0.12	0.12	0.07	
	2200	18 x 35	1400	2200	220	0.14	0.10	0.05	
	3300	18 x 40	1600	3300	330	0.16	0.07	0.03	
63	68	10 x 12	180	89	12	0.09	2.00	1.20	
	100	10 x 12	210	130	16	0.09	1.40	0.80	
	150	10 x 16	270	190	22	0.09	0.91	0.53	
	220	10 x 20	350	280	31	0.09	0.62	0.36	
	330	12.5 x 20	470	420	45	0.09	0.41	0.24	
	470	12.5 x 25	620	600	62	0.09	0.29	0.17	
	680	16 x 25	810	860	89	0.09	0.20	0.12	
	1000	16 x 31	1100	1300	130	0.09	0.14	0.08	
	1500	18 x 35	1300	1900	190	0.11	0.11	0.06	
	2200	18 x 40	1500	2800	280	0.13	0.09	0.04	

Voltage

Surge voltage for short periods	$U_s \leq 1.15\ U_R$
Reverse voltage	$U_{rev} \leq 1\ V$

Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.02\ C_R\ U_R + 3\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R\ U_R + 3\ \mu A$

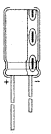
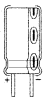
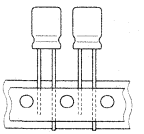
Equivalent series inductance (ESL)

Case diameter = 10 mm	typ. 16 nH
Case diameter ≥ 12,5 mm	typ. 18 nH

Non-solid Al - electroilytic capacitors
Radial Miniature Semiprofessional

RMS 047

Ordering information (continued)

U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$øD_{nom}$ x L_{nom}			
(V)	(µF)	(mm)	Form CA	Form CB	Form TR+
40	150	10 x 12	047 57151	047 67151	047 27151
	330	10 x 20	57331	67331	27331
	2200	16 x 35	57222	67222	
	3300	18 x 35	57332	67332	
50	220	10 x 16	047 51221	047 61221	047 21221
	470	12.5 x 20	51471	61471	21471
	680	12.5 x 25	51681	61681	21681
	1000	16 x 25	51102	61102	21102
	1500	16 x 35	51152	61152	
	2200	18 x 35	51222	61222	
	3300	18 x 40	51332	61332	
63	68	10 x 12	047 58689	047 68689	047 28689
	100	10 x 12	58101	68101	28101
	150	10 x 16	58151	68151	28151
	220	10 x 20	58221	68221	28221
	330	12.5 x 20	58331	68331	28331
	470	12.5 x 25	58471	68471	28471
	680	16 x 25	58681	68681	28681
	1000	16 x 31	58102	68102	28102
	1500	18 x 35	58152	68152	
	2200	18 x 40	58222	68222	

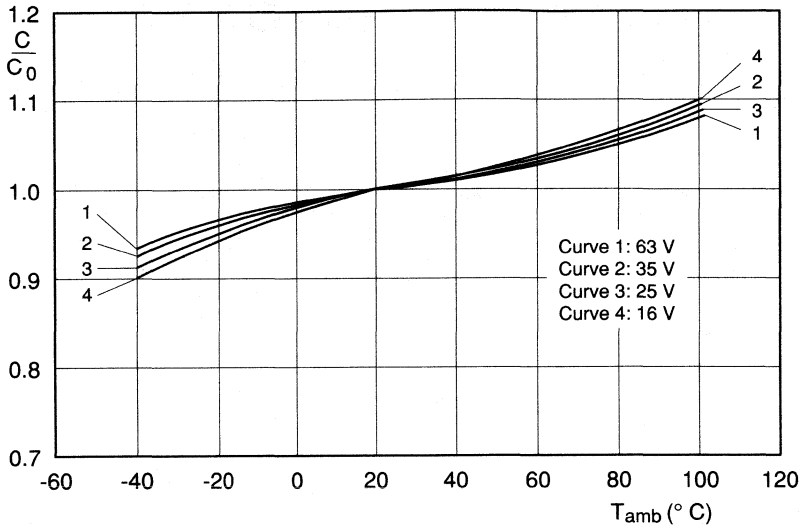


Fig. 5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature; C_0 = Capacitance at 20 °C, 100 Hz.

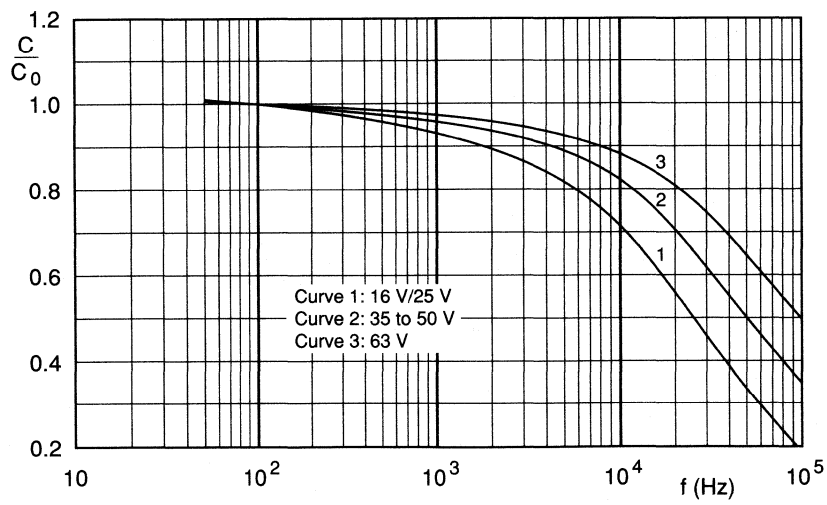


Fig. 6 Typical multiplier of capacitance (C/C_0) as a function of frequency; C_0 = Capacitance at 20 °C, 100 Hz.

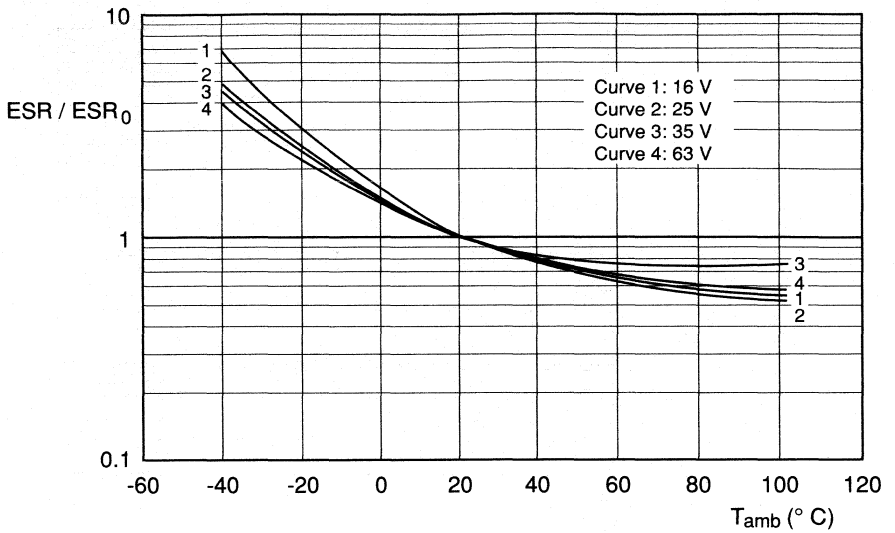


Fig. 7 Multiplier of ESR (ESR/ESR$_0$) as a function of ambient temperature;
ESR$_0$ = typical ESR at 20 °C, 100 Hz.

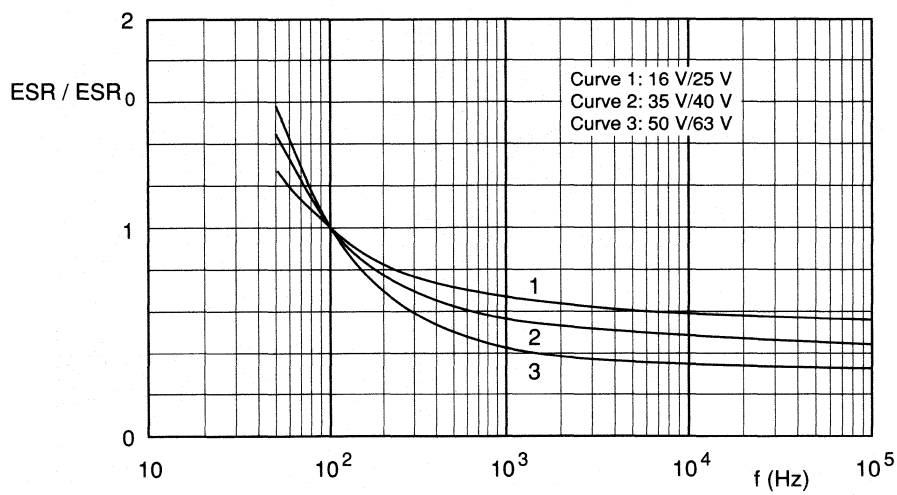


Fig. 8 Multiplier of ESR (ESR/ESR$_0$) as a function of frequency;
ESR$_0$ = typical ESR at 20 °C, 100 Hz.

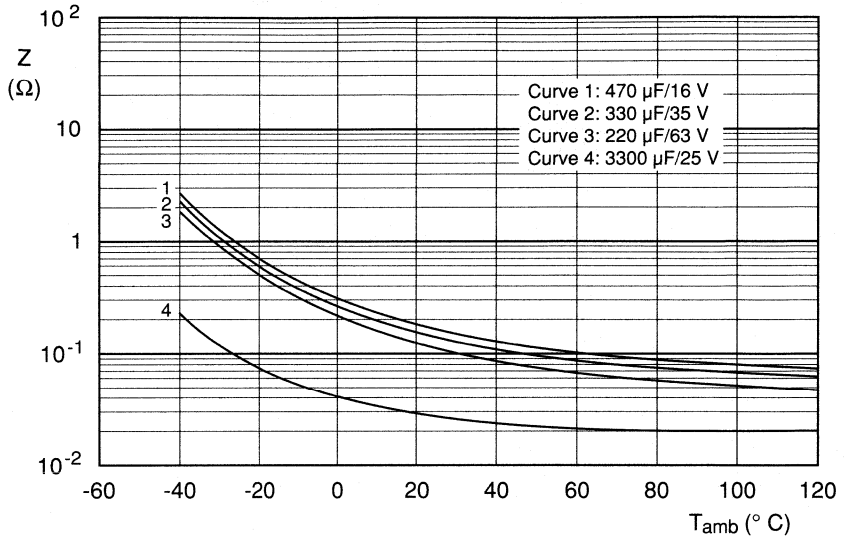


Fig. 9 Typical impedance at 10 kHz as a function of ambient temperature.

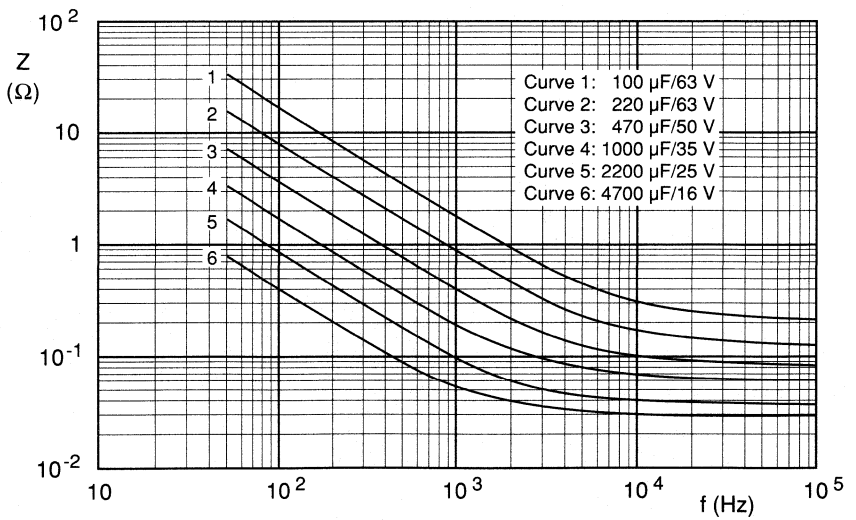


Fig. 10 Typical impedance at 20 °C as a function of frequency.

USEFUL LIFE

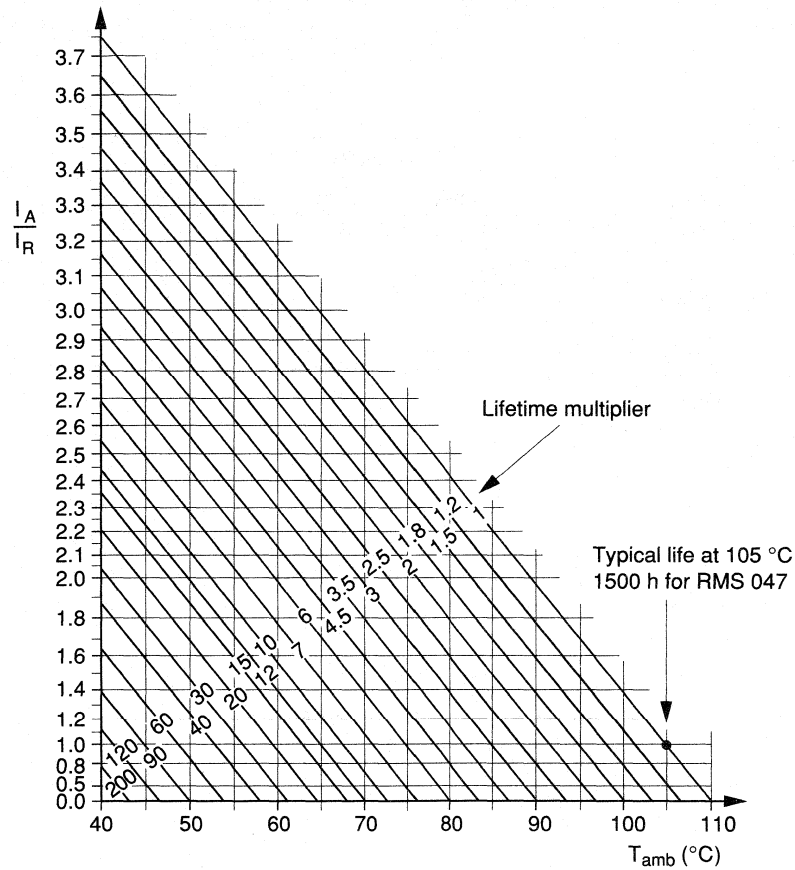


Fig. 11 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.
I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 105 °C

Table 5 Multiplier of ripple current I_R as a function of frequency

FREQUENCY	I_R-MULTIPLIER		
	U_R = 16 and 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50 Hz	0.95	0.85	0.80
100 Hz	1.00	1.00	1.00
300 Hz	1.07	1.20	1.25
1000 Hz	1.12	1.30	1.40
3000 Hz	1.15	1.35	1.50
≥ 10000 Hz	1.20	1.40	1.60

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 6

TEST		PROCEDURE	SPECIFIC REQUIREMENTS
Name of test	**Reference**	**(quick reference)**	
Endurance	IEC 384-4-1/ CECC 30 301, group C 3, 4.13	T_{amb} = 105 °C, U_R applied 1000 hours	$\Delta C/C \leq \pm 15$ % tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301, amendment 2640, sub clause 1.8.1	T_{amb} = 105 °C, U_R and I_R applied 1500 hours	$\Delta C/C \leq \pm 45$ % tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 105 °C, no voltage applied 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L5} \leq 2$ x spec. limit

Electrolytic Capacitors

Notes

Non-solid Al - electrolytic capacitors
Radial Standard Semiprofessional

RSS 045

FEATURES

- Polarized aluminium electrolytic capacitors, non solid
- Radial leads, cylindrical aluminium case with safety vent insulated with a blue sleeve
- Charge and discharge proof
- Long useful life 1500 h/105 °C
- High ripple current capability, low impedance

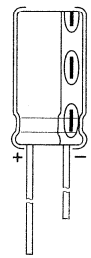


Fig.1 Component outline

APPLICATIONS

- EDP, telecommunication, industrial and audio-video
- Smoothing, filtering, buffering in SMPS
- Low PCB surface demand

4

QUICK REFERENCE DATA

Case size, $\varnothing D_{nom}$ x L_{nom} in mm	10 x 12 to 18 x 40
Rated capacitance range, C_R	47 to 6800 µF
Tolerance on C_R	±20 %
Rated voltage range, U_R	16 to 63 V
Category temperature range	–40 to +105 °C
Endurance test at 105 °C	1000 hours
Useful life at 105 °C	1500 hours
Useful life at 40 °C, 1,3 I_R applied	150000 hours
Shelf life at 0 V, 105 °C	500 hours
Basic specification	IEC 384-4, L.L. grade, CECC 30 300
Detail specification	DIN 41 259
Climatic category IEC 68	40/105/56
Climatic category DIN 40 040	GMF

Non-solid Al - electrolytic capacitors
Radial Standard Semiprofessional

RSS 045

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (diameter x length in mm)

C_R	U_R (V)					
µF	16	25	35	40	50	63
47 *	For lower capacitance values see RSP 036 series					10 x 12
68					10 x 12	10 x 16
100 *				10 x 12	10 x 16	10 x 20
150			10 x 12	10 x 16	10 x 20	12.5 x 20
220 *	10 x 12		10 x 16	10 x 20	12.5 x 20	12.5 x 25
330	10 x 16		10 x 20	12.5 x 20	12.5 x 25	16 x 25
470 *	10 x 20		12.5 x 20	12.5 x 25		16 x 25
680	12.5 x 20		12.5 x 25		16 x 25	16 x 31
1000 *	12.5 x 25		16 x 25		16 x 31	18 x 35
1500	16 x 25		16 x 31	16 x 35	18 x 35	18 x 40
2200 *	16 x 25	16 x 31	18 x 35	18 x 35	18 x 40	
3300	16 x 31	18 x 35		18 x 40		
4700 *	18 x 35	18 x 40				
6800	18 x 40					

* E3 values = preferred values

Non -solid Al - electrolytic capacitors
Radial Standard Semiprofessional

RSS 045

MECHANICAL DATA Dimensions (in mm)

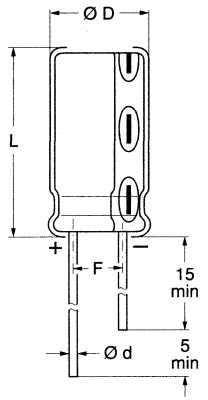


Fig. 2 **Form CA**, long leads;
see Table 2 for dimensions.

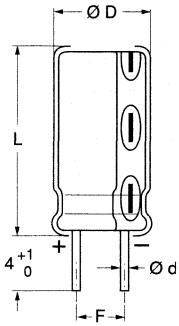
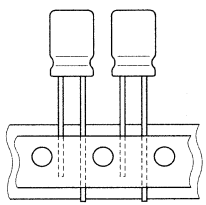
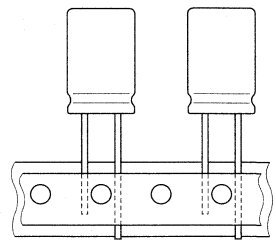


Fig. 3 **Form CB**, cut leads;
see Table 2 for dimensions.



øD = 10 mm and 12.5 mm



øD = 16 mm

Fig. 4 **Form TR+**, case sizes up to ø16 x 31 taped on reel, positive leading.
See Introduction for taping dimensions.

4

MARKING

The capacitors are marked with the following information:

- Rated capacitance value
- Tolerance on rated capacitance (M for ±20 %)
- Rated voltage
- Negative terminal identification
- Upper category temperature (105 °C)
- Group number (045)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62

Table 2 Dimensions (in mm)

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	RADIAL				MASS
		$\varnothing d$	$\varnothing D_{max}$	L_{max}	$F \pm 0,5$	(g)
10 x 12	14	0.6	10.5	13.5	5.0	1.6
10 x 16	15	0.6	10.5	17.5	5.0	1.9
10 x 20	16	0.6	10.5	21.5	5.0	2.2
12.5 x 20	17	0.6	13.0	21.5	5.0	4.0
12.5 x 25	18	0.6	13.0	26.5	5.0	5.0
16 x 25	19	0.8	16.5	27.0	7.5	8.0
16 x 31	20	0.8	16.5	33.0	7.5	9.0
16 x 35	21	0.8	16.5	37.0	7.5	11.5
18 x 35	22	0.8	18.5	37.0	7.5	14.5
18 x 40	23	0.8	18.5	42.0	7.5	16.0

PACKING

Capacitors of Form CA and Form CB are supplied in boxes, those of Form TR+ taped on reel.
The numbers per box and per reel are given in Table 3.

Table 3 Packing quantities

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	NUMBER OF CAPACITORS		
		FORM CA per Box	FORM CB per Box	FORM TR+ per Reel
10 x 12	14	1000	1000	500
10 x 16	15	500	500	500
10 x 20	16	500	500	500
12.5 x 20	17	200	200	200
12.5 x 25	18	200	200	200
16 x 25	19	200	200	150
16 x 31	20	200	200	150
16 x 35	21	150	150	
18 x 35	22	100	100	
18 x 40	23	100	100	

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 4 apply at an ambient temperature of 20 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75 %.

C_R = rated capacitance at 100 Hz, tolerance ±20 %
I_R = rated RMS ripple current at 100 Hz, 105 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 10 kHz or 100 kHz

Table 4 Electrical data

U_R	C_R	CASE SIZE	I_R	I_{L1}	I_{L5}	tan δ	ESR	Z	
		$øD_{nom}$ x L_{nom}						at 10 kHz	at 100 kHz
(V)	(μF)	(mm)	(mA)	(μA)	(μA)		(Ω)	(Ω)	(Ω)
16	220	10 x 12	230	73	10	0.16	1.00		0.59
	330	10 x 16	290	110	14	0.16	0.69		0.39
	470	10 x 20	380	150	18	0.16	0.49		0.28
	680	12.5 x 20	490	220	25	0.16	0.34		0.19
	1000	12.5 x 25	650	320	35	0.16	0.23		0.13
	1500	16 x 25	830	480	51	0.18	0.17	0.10	
	2200	16 x 25	950	710	73	0.20	0.13	0.07	
	3300	16 x 31	1200	1100	110	0.22	0.10	0.05	
	4700	18 x 35	1500	1500	150	0.24	0.07	0.04	
	6800	18 x 40	1700	2200	220	0.28	0.06	0.03	
25	2200	16 x 31	1100	1100	110	0.18	0.12	0.05	
	3300	18 x 35	1300	1700	170	0.20	0.09	0.04	
	4700	18 x 40	1600	2400	240	0.22	0.07	0.03	
35	150	10 x 12	240	110	14	0.12	1.10		0.57
	220	10 x 16	290	160	18	0.12	0.78		0.39
	330	10 x 20	390	230	26	0.12	0.52		0.26
	470	12.5 x 20	500	330	36	0.12	0.37		0.18
	680	12.5 x 25	660	480	51	0.12	0.25		0.13
	1000	16 x 25	880	700	73	0.12	0.17		0.09
	1500	16 x 31	1100	1100	110	0.13	0.12	0.07	
	2200	18 x 35	1400	1500	160	0.14	0.09	0.05	

Non-solid Al - electrolytic capacitors
Radial Standard Semiprofessional

RSS 045

ORDERING EXAMPLE

Electrolytic capacitors RSS 045
1000 µF/35 V, ±20 %
16 x 25, taped on reel, Form TR+
Catalogue number 2222 045 20102

Ordering information

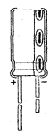
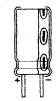
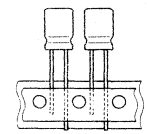
U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$øD_{nom}$ x L_{nom}			
(V)	(µF)	(mm)	Form CA	Form CB	Form TR+
16	220	10 x 12	045 55221	045 65221	045 25221
	330	10 x 16	55331	65331	25331
	470	10 x 20	55471	65471	25471
	680	12.5 x 20	55681	65681	25681
	1000	12.5 x 25	55102	65102	25102
	1500	16 x 25	55152	65152	25152
	2200	16 x 25	55222	65222	25222
	3300	16 x 31	55332	65332	25332
	4700	18 x 35	55472	65472	
	6800	18 x 40	55682	65682	
25	2200	16 x 31	045 56222	045 66222	045 26222
	3300	18 x 35	56332	66332	
	4700	18 x 40	56472	66472	
35	150	10 x 12	045 50151	045 60151	045 20151
	220	10 x 16	50221	60221	20221
	330	10 x 20	50331	60331	20331
	470	12.5 x 20	50471	60471	20471
	680	12.5 x 25	50681	60681	20681
	1000	16 x 25	50102	60102	20102
	1500	16 x 31	50152	60152	20152
	2200	18 x 35	50222	60222	

Table 4 Electrical data (continued)

U_R	C_R	CASE SIZE $øD_{nom}$ x L_{nom}	I_R	I_{L1}	I_{L5}	tan δ	ESR	Z	
								at 10 kHz	at 100 kHz
(V)	(μF)	(mm)	(mA)	(μA)	(μA)		(Ω)	(Ω)	(Ω)
40	100	10 x 12	190	83	13	0.12	1.70		0.80
	150	10 x 16	250	120	15	0.12	1.10		0.53
	220	10 x 20	320	180	21	0.12	0.78		0.36
	330	12.5 x 20	420	270	29	0.12	0.52		0.24
	470	12.5 x 25	540	380	41	0.12	0.37		0.17
	1500	16 x 35	1200	1200	130	0.13	0.12	0.06	
	2200	18 x 35	1400	1800	180	0.14	0.09	0.04	
	3300	18 x 40	1700	2600	270	0.15	0.07	0.03	
50	68	10 x 12	170	71	11	0.10	2.10		0.96
	100	10 x 16	220	100	13	0.10	1.40		0.65
	150	10 x 20	280	150	18	0.10	0.96		0.43
	220	12,5 x 20	380	220	25	0.10	0.65		0.30
	330	12,5 x 25	510	330	36	0.10	0.43		0.20
	680	16 x 25	800	680	71	0.10	0.21		0.10
	1000	16 x 31	1100	1000	100	0.10	0.14		0.07
	1500	18 x 35	1300	1500	150	0.11	0.11	0.05	
	2200	18 x 40	1600	2200	220	0.12	0.08	0.03	
63	47	10 x 12	150	62	9	0.08	2.60		1.30
	68	10 x 16	190	89	12	0.08	1.80		0.88
	100	10 x 20	250	130	16	0.08	1.20		0.60
	150	12,5 x 20	340	190	22	0.08	0.81		0.40
	220	12,5 x 25	450	280	31	0.08	0.55		0.27
	330	16 x 25	600	420	45	0.08	0.37		0.18
	470	16 x 25	710	600	62	0.08	0.26		0.13
	680	16 x 31	930	860	89	0.08	0.18		0.09
	1000	18 x 35	1200	1300	130	0.08	0.12		0.06
	1500	18 x 40	1500	1900	190	0.09	0.09	0.04	

Voltage

Surge voltage for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.02\ C_R\ U_R + 3$ μA
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R\ U_R + 3$ μA

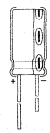
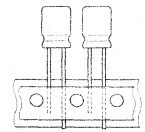
Equivalent series inductance (ESL)

Case diameter = 10 mm	typ. 16 nH
Case diameter ≥ 12,5 mm	typ. 18 nH

Non-solid Al - electrolytic capacitors
Radial Standard Semiprofessional

RSS 045

Ordering information (continued)

U_R (V)	C_R (µF)	CASE SIZE $øD_{nom}$ x L_{nom} (mm)	CATALOGUE NUMBER 2222 ... . Form CA 	Form CB 	Form TR+ 
40	100	10 x 12	045 57101	045 67101	045 27101
	150	10 x 16	57151	67151	27151
	220	10 x 20	57221	67221	27221
	330	12.5 x 20	57331	67331	27331
	470	12.5 x 25	57471	67471	27471
	1500	16 x 35	57152	67152	
	2200	18 x 35	57222	67222	
	3300	18 x 40	57332	67332	
50	68	10 x 12	045 51689	045 61689	045 21689
	100	10 x 16	51101	61101	21101
	150	10 x 20	51151	61151	21151
	220	12,5 x 20	51221	61221	21221
	330	12,5 x 25	51331	61331	21331
	680	16 x 25	51681	61681	21681
	1000	16 x 31	51102	61102	21102
	1500	18 x 35	51152	61152	
	2200	18 x 40	51222	61222	
63	47	10 x 12	045 58479	045 68479	045 28479
	68	10 x 16	58689	68689	28689
	100	10 x 20	58101	68101	28101
	150	12,5 x 20	58151	68151	28151
	220	12,5 x 25	58221	68221	28221
	330	16 x 25	58331	68331	28331
	470	16 x 25	58471	68471	28471
	680	16 x 31	58681	68681	28681
	1000	18 x 35	58102	68102	
	1500	18 x 40	58152	68152	

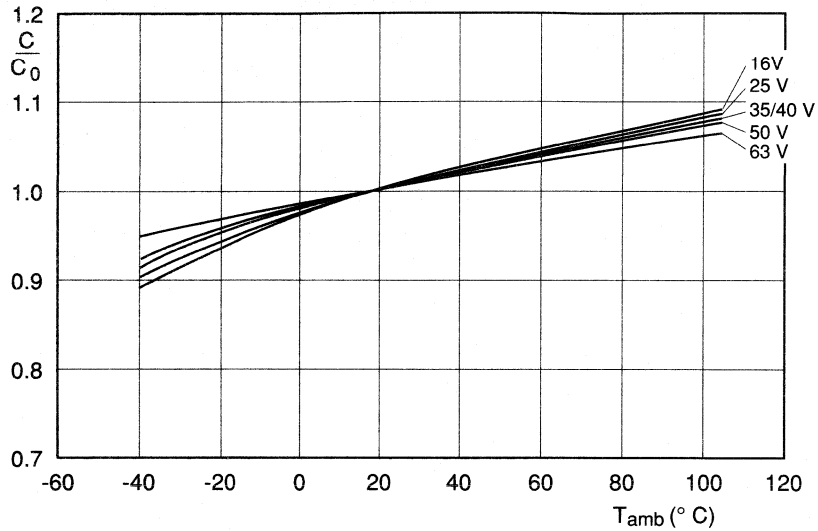


Fig. 5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature; C_0 = Capacitance at 20 °C, 100 Hz.

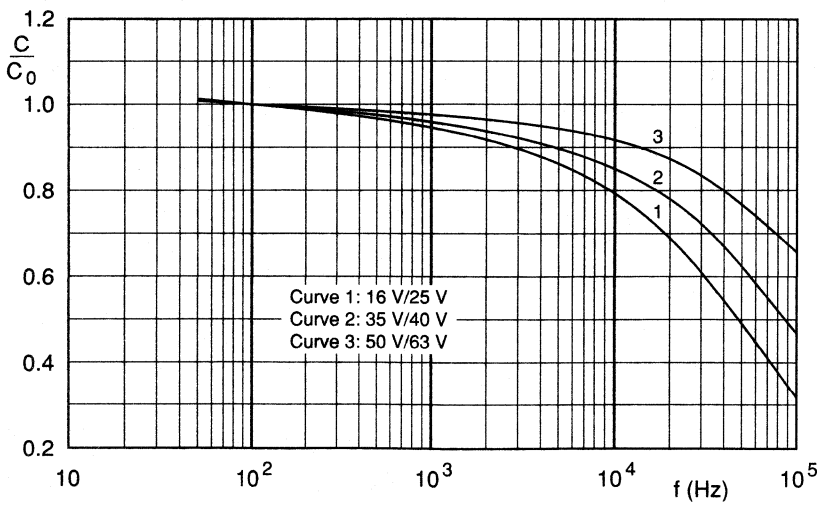


Fig. 6 Typical multiplier of capacitance (C/C_0) as a function of frequency; C_0 = Capacitance at 20 °C, 100 Hz.

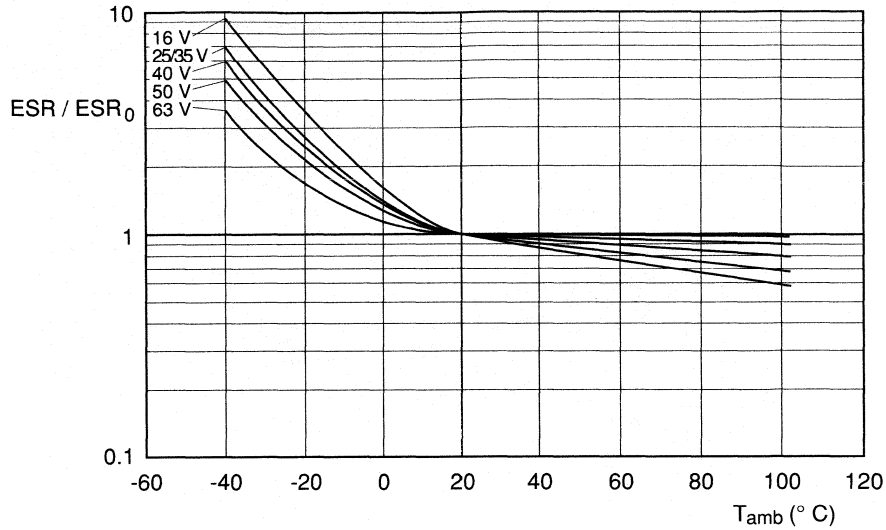


Fig. 7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; ESR_0 = typical ESR at 20 °C, 100 Hz.

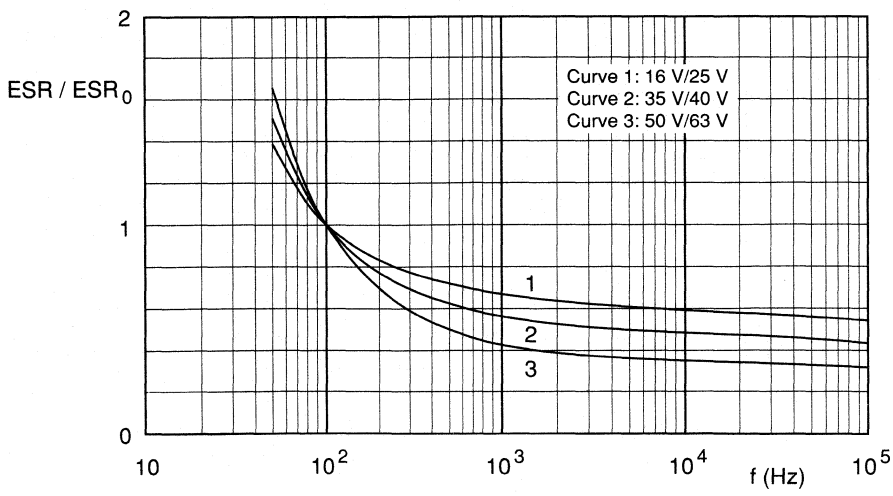


Fig. 8 Multiplier of ESR (ESR/ESR_0) as a function of frequency; ESR_0 = typical ESR at 20 °C, 100 Hz.

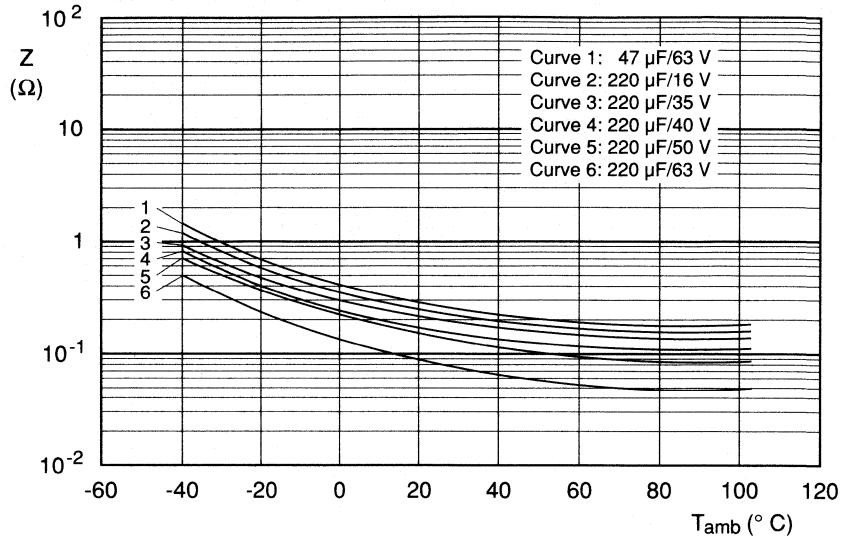


Fig. 9 Typical impedance at 100 kHz as a function of ambient temperature.

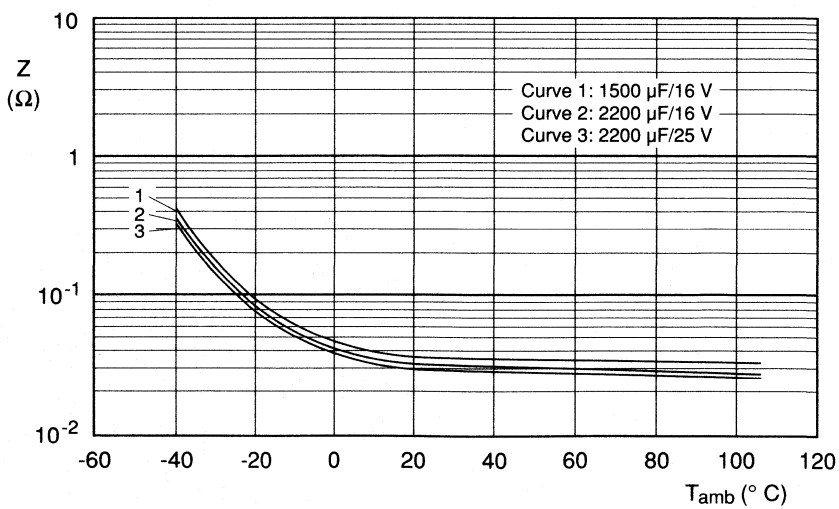


Fig. 10 Typical impedance at 10 kHz as a function of ambient temperature.

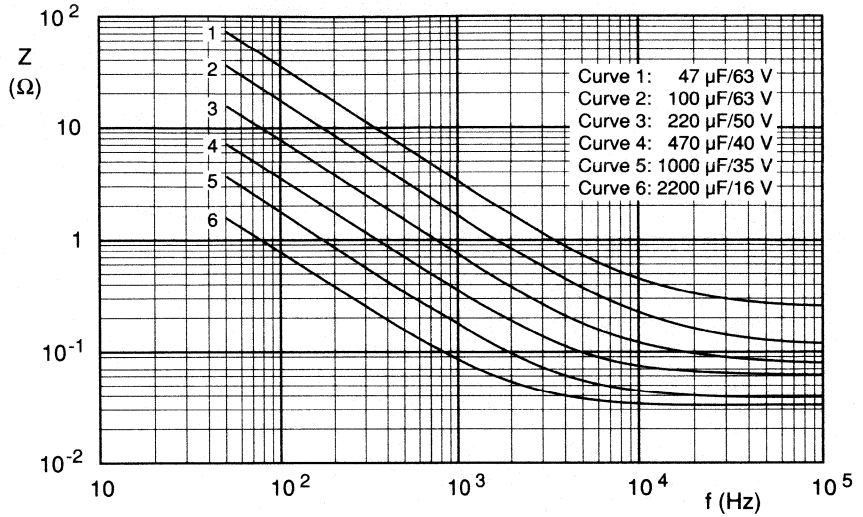


Fig. 11 Typical impedance as a function of frequency at T_{amb} = 20 °C.

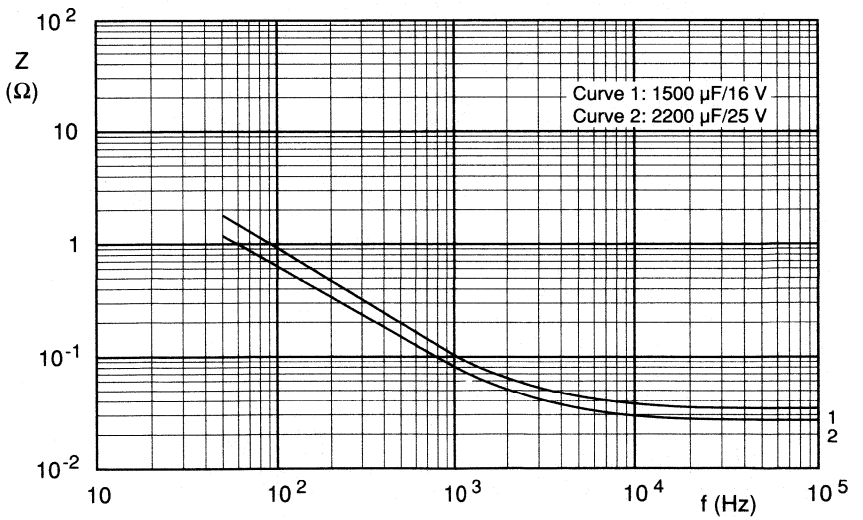


Fig. 12 Typical impedance as a function of frequency at T_{amb} = 20 °C.

USEFUL LIFE

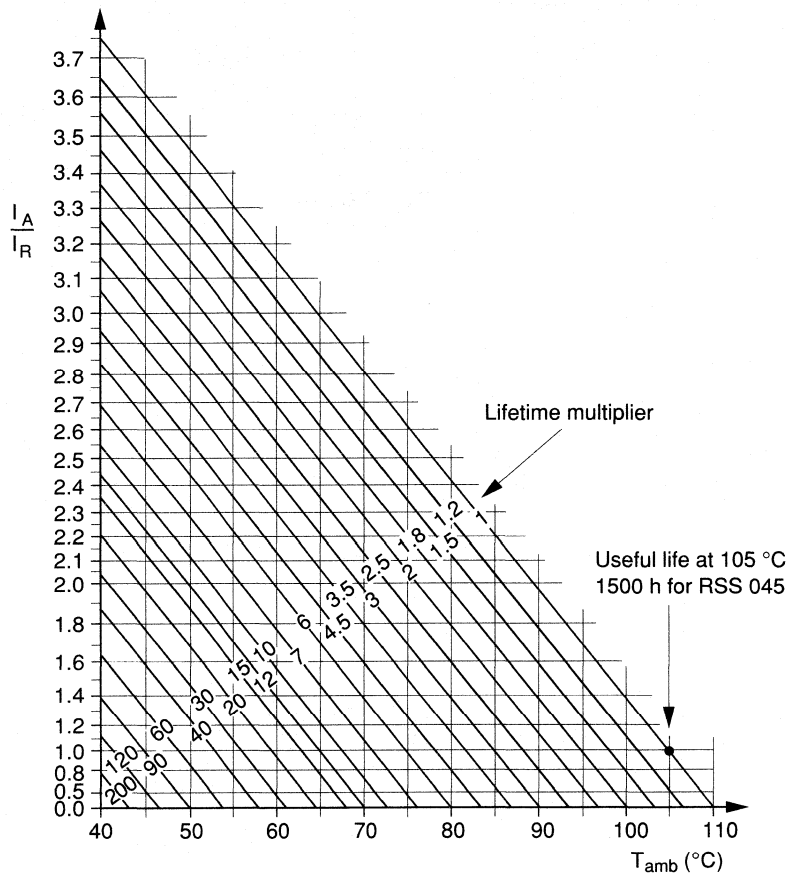


Fig. 13 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.
I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 105 °C

Table 5 Multiplier of ripple current I_R as a function of frequency

FREQUENCY	I_R-MULTIPLIER		
	U_R = 16 and 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50 Hz	0.85	0.80	0.75
100 Hz	1.00	1.00	1.00
300 Hz	1.20	1.25	1.30
1000 Hz	1.30	1.40	1.50
3000 Hz	1.35	1.50	1.65
≥ 10000 Hz	1.40	1.60	1.80

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 6

TEST		PROCEDURE	SPECIFIC REQUIREMENTS
Name of test	**Reference**	**(quick reference)**	
Endurance	IEC 384-4-1/ CECC 30 301, group C 3, 4.13	T_{amb} = 105 °C, U_R applied 1000 hours	$\Delta C/C \leq \pm 15$ % tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301, amendment 2640, sub clause 1.8.1	T_{amb} = 105 °C, U_R and I_R applied 1500 hours	$\Delta C/C \leq \pm 45$ % tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 105 °C, no voltage applied 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L5} \leq 2$ x spec. limit

Non-solid Al - electrolytic capacitors
Radial Long-Life

RLL 116

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CU-product per unit volume
- Long useful life: 2000 hours at 105 °C, high reliability.

APPLICATIONS

- Automotive, telecommunication, industrial and EDP
- Stand-by applications in audio and video equipment
- Coupling, decoupling, timing; smoothing, filtering and buffering in DC-DC converters
- Portable and mobile equipment (small size, low mass)
- Low surface demand on printed circuit board.

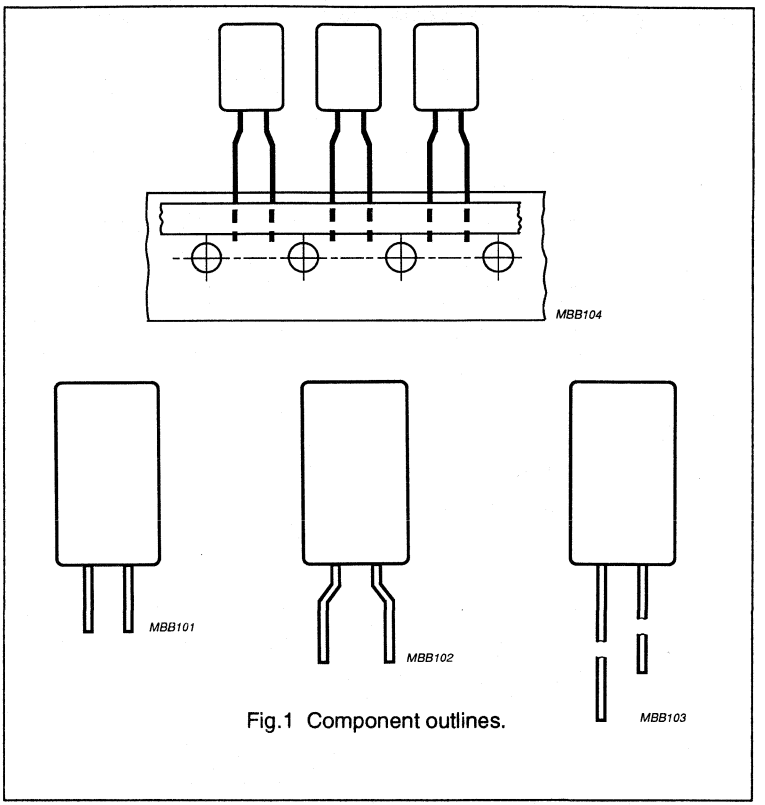


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom})	5 x 11 and 8.2 x 11 mm
Rated capacitance range, C_R	0.47 to 470 µF
Tolerance on C_R	±20%
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	–55 to +105 °C
Endurance test at 105 °C	1500 hours
Endurance test at 85 °C	5000 hours
Useful life at 105 °C	2000 hours
Useful life at 40 °C, 1.3 I_R applied	200 000 hours
Shelf life at 0 V, 105 °C	1500 hours
Basic specification	IEC 384-4/CECC 30300, LL grade
Detail specification	IEC 384-4-1/CECC 30301 similar to DIN 41259 (with reduced dimensions)
Climatic category IEC 68 DIN 40040	 55/105/56 FMF

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**) * = preferred values

C_R (µF)	U_R (V)								
	6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**	**100**
0.47 *							5 x 11		
1.0 *							5 x 11		
1.5							5 x 11		
2.2 *							5 x 11		8.2 x 11
3.3							5 x 11		
4.7 *							5 x 11		8.2 x 11
6.8							5 x 11		
10 *							5 x 11 8.2 x 11		8.2 x 11
15							5 x 11		
22 *							5 x 11 8.2 x 11	8.2 x 11	
33					5 x 11	5 x 11	8.2 x 11		
47 *				5 x 11			8.2 x 11		
68			5 x 11				8.2 x 11		
100 *		5 x 11			8.2 x 11	8.2 x 11			
150	5 x 11			8.2 x 11					
220 *			8.2 x 11			For higher capacitance values see RSL 046 and RML 048 series			
330 *		8.2 x 11							
470 *	8.2 x 11								

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

Table 2 Dimensions in mm; mass in g

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	$\varnothing d$	$\varnothing D_{max}$	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA CB, CC	Form TR+ TR−, TN	Form TFA
5 x 11	11	0.5	5.5	12	2.5	0.4	1000	1000	2000
8.2 x 11	13	0.6	8.7	12	5	1.1	1000	500	1000

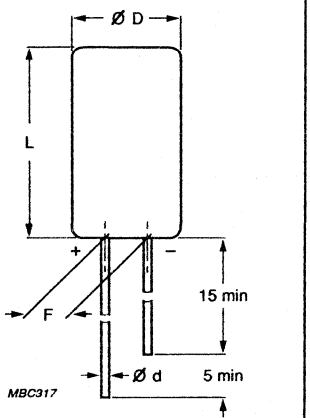


Fig.2 **Form CA**: Long leads.

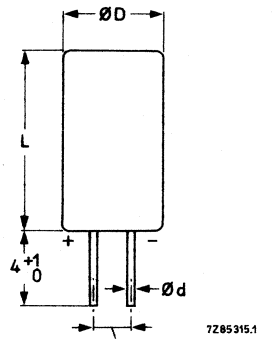


Fig.3 **Form CB**: Cut leads.

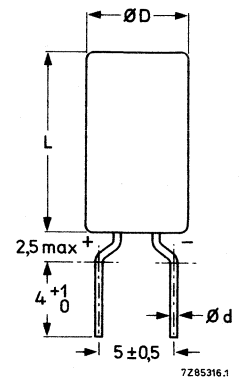
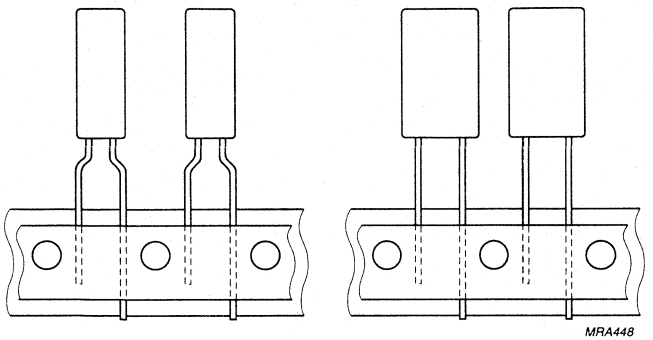


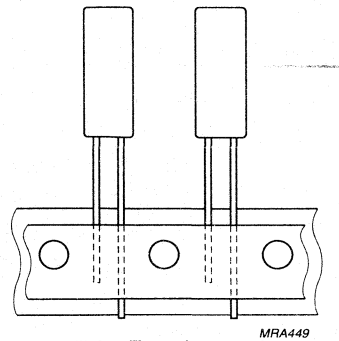
Fig.4 **Form CC**: Cut leads, formed; case size 5 x 11 only.

Tape dimensions are specified in chapter "PACKING",



Form TR+: Taped on reel, positive leading.
Form TR–: Taped on reel, negative leading.
Form TFA : Taped in box (ammopack).

Fig.5 Taped, pitch F = 5 mm; case sizes 5 x 11 and 8.2 x 11.



Form TN+: Taped on reel, positive leading.

Fig.6 Taped, pitch F = 2.5 mm; case size 5 x 11 only.

4

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Group number (116)
- Grade indication (LL)
- Name of manufacturer (PHILIPS)
- Date code in accordance with IEC 62
- Code indicating factory of origin
- Minus-sign to identify the negative terminal.

Non-solid Al - electrolytic capacitors
Radial Long-Life

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance ± 20%
I_R = rated RMS ripple current at 100 Hz, 105 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 10 kHz and 20, –25 or –40 °C.

Table 3 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 105 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz –25 °C (Ω)	Z 10 kHz –40 °C (Ω)
6.3	150	5 x 11	11	100	8.7	3.9	0.25	2.7	2	12	32
	470	8.2 x 11	13	230	21	6	0.25	0.8	0.64	3.8	10
10	100	5 x 11	11	95	9	4	0.2	3.2	2	12	32
	330	8.2 x 11	13	210	23	6.3	0.2	1.0	0.61	3.6	9.7
16	68	5 x 11	11	90	9.5	4.1	0.16	3.7	2.4	11	29
	220	8.2 x 11	13	200	24	6.5	0.16	1.2	0.73	3.4	9.1
25	47	5 x 11	11	80	10	4.2	0.14	4.7	2.6	12	32
	150	8.2 x 11	13	180	26	6.8	0.14	1.5	0.8	3.7	10
35	33	5 x 11	11	75	9.9	4.2	0.12	5.8	2.7	12	33
	100	8.2 x 11	13	160	24	6.5	0.12	1.9	0.9	4	11
40	33	5 x 11	11	75	10.9	4.3	0.12	5.8	2.7	12	33
	100	8.2 x 11	13	160	27	7	0.12	1.9	0.9	4	11

Non-solid Al - electrolytic capacitors
Radial Long-Life

RLL 116

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor RLL 116
100 µF/40 V, ±20%
Case size 8.2 x 11; Form TR+
Catalogue number: 2222 116 27101.

Table 4

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	F = 2.5 mm positive leading Form TN+	Form TFA
6.3	150	116 53151	116 83151	116 63151	116 23151	116 43151	116 13151	116 33151
	470	116 53471	116 63471	–	116 23471	116 43471	–	116 33471
10	100	116 54101	116 84101	116 64101	116 24101	116 44101	116 14101	116 34101
	330	116 54331	116 64331	–	116 24331	116 44331	–	116 34331
16	68	116 55689	116 85689	116 65689	116 25689	116 45689	116 15689	116 35689
	220	116 55221	116 65221	–	116 25221	116 45221	–	116 35221
25	47	116 56479	116 86479	116 66479	116 26479	116 46479	116 16479	116 36479
	150	116 56151	116 66151	–	116 26151	116 46151	–	116 36151
35	33	116 50339	116 80339	116 60339	116 20339	116 40339	116 10339	116 30339
	100	116 50101	116 60101	–	116 20101	116 40101	–	116 30101
40	33	116 57339	116 87339	116 67339	116 27339	116 47339	116 17339	116 37339
	100	116 57101	116 67101	–	116 27101	116 47101	–	116 37101

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 105 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz −25 °C (Ω)	Z 10 kHz −40 °C (Ω)
50	0.47	5 x 11	11	7	3.1	3	0.09	300	150	640	1900
	1.0	5 x 11	11	12	3.3	3.1	0.09	140	70	300	900
	1.5	5 x 11	11	16	3.5	3.1	0.09	95	47	200	600
	2.2	5 x 11	11	22	3.7	3.1	0.09	65	32	135	410
	3.3	5 x 11	11	26	4	3.2	0.09	43	21	91	270
	4.7	5 x 11	11	31	4.4	3.2	0.09	30	15	64	190
	6.8	5 x 11	11	38	5	3.3	0.09	21	10	44	130
	10	5 x 11	11	45	6	3.5	0.09	14	7	30	90
	10	8.2 x 11	13	100	6	3.5	0.05	8.0	3.6	14	40
	15	5 x 11	11	55	7.5	3.8	0.09	9.5	4.7	20	60
	22	5 x 11	11	70	9.6	4.1	0.09	6.5	3.2	13.5	41
	22	8.2 x 11	13	110	9.6	4.1	0.06	4.4	2.2	9.8	29
	33	8.2 x 11	13	120	13	4.7	0.09	4.3	2.1	9.1	27
	47	8.2 x 11	13	130	17	5.4	0.09	3.0	1.5	6.4	19
	68	8.2 x 11	13	150	23	6.4	0.09	2.1	1.0	4.4	13
63	22	8.2 x 11	13	90	11	4.4	0.08	5.8	3.5	22	65
100	2.2	8.2 x 11	13	35	4.3	3.2	0.06	43	18	80	190
	4.7	8.2 x 11	13	45	5.8	3.5	0.07	24	12	70	170
	10	8.2 x 11	13	60	9	4	0.08	13	4.5	28	70

Non-solid Al - electrolytic capacitors
Radial Long-Life

RLL 116

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL			TAPED IN BOX F = 5 mm
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 5 mm negative leading Form TR–	F = 2.5 mm positive leading Form TN+	Form TFA
50	0.47	116 51477	116 81477	116 61477	116 21477	116 41477	116 11477	116 31477
	1.0	116 51108	116 81108	116 61108	116 21108	116 41108	116 11108	116 31108
	1.5	116 51158	116 81158	116 61158	116 21158	116 41158	116 11158	116 31158
	2.2	116 51228	116 81228	116 61228	116 21228	116 41228	116 11228	116 31228
	3.3	116 51338	116 81338	116 61338	116 21338	116 41338	116 11338	116 31338
	4.7	116 51478	116 81478	116 61478	116 21478	116 41478	116 11478	116 31478
	6.8	116 51688	116 81688	116 61688	116 21688	116 41688	116 11688	116 31688
	10	116 51109	116 81109	116 61109	116 21109	116 41109	116 11109	116 31109
	10	116 90084	116 90085	–	116 90055	116 90016	–	116 90036
	15	116 51159	116 81159	116 61159	116 21159	116 41159	116 11159	116 31159
	22	116 51229	116 81229	116 61229	116 21229	116 41229	116 11229	116 31229
	22	116 90025	116 90086	–	116 90057	116 90018	–	116 90039
	33	116 51339	116 61339	–	116 21339	116 41339	–	116 31339
	47	116 51479	116 61479	–	116 21479	116 41479	–	116 31479
	68	116 51689	116 61689	–	116 21689	116 41689	–	116 31689
63	22	116 58229	116 68229	–	116 28229	116 48229	–	116 38229
100	2.2	116 59228	116 69228	–	116 29228	116 49228	–	116 39228
	4.7	116 59478	116 69478	–	116 29478	116 49478	–	116 39478
	10	116 59109	116 69109	–	116 29109	116 49109	–	116 39109

Voltage

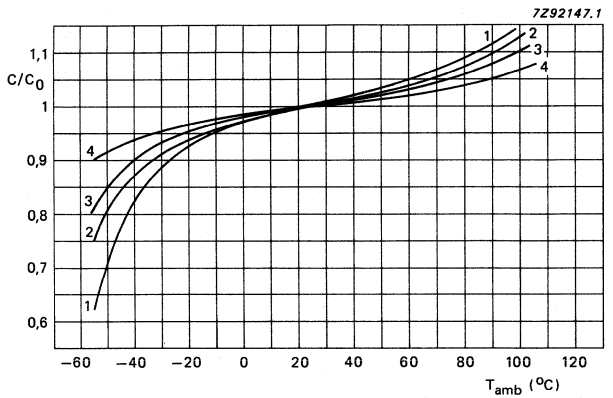
Surge voltage for short periods	$U_s \leq 1.3\ U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 3\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.001\ C_R \times U_R + 3\ \mu A$

4

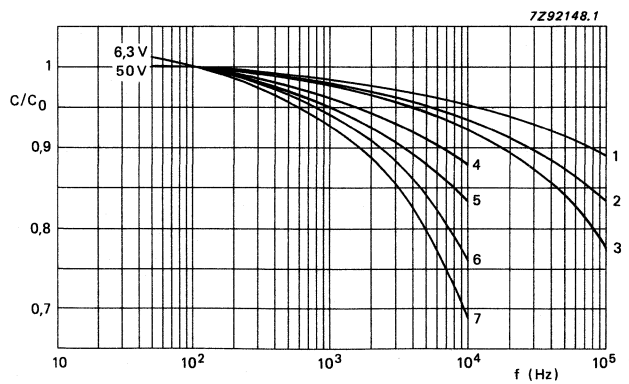
Capacitance (C)



Curve 1: 6.3 V
Curve 2: 10/16 V
Curve 3: 35/40 V and 63/100 V
Curve 4: 50 V.

C_o = capacitance at 20 °C, 100 Hz.

Fig.7 Multiplier of capacitance (C/C_o) as a function of ambient temperature.

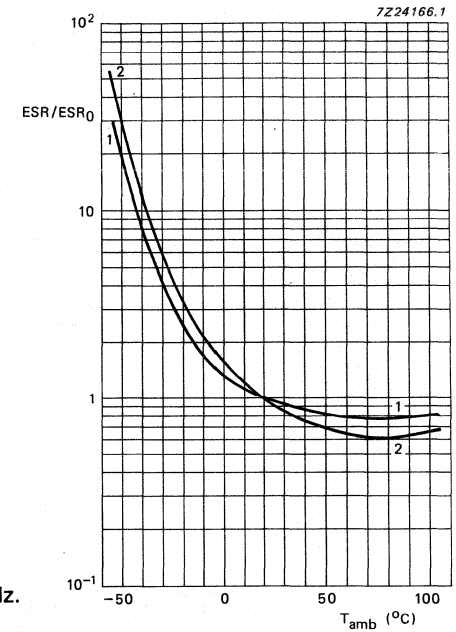


Curve 1: 50 V (≤2.2 µF)
Curve 2: 50 V (>2.2 µF)
Curve 3: 50 V (≥15 µF)
Curve 4: 35/40 V and 63/100 V
Curve 5: 25 V
Curve 6: 16 V
Curve 7: 6.3/10 V.

C_o = capacitance at 20 °C, 100 Hz.

Fig.8 Multiplier of capacitance (C/C_o) as a function of frequency.

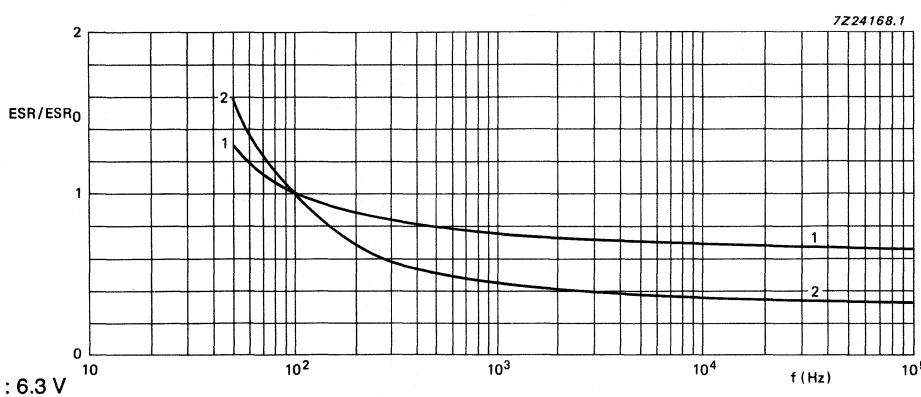
Equivalent series resistance (ESR)



Curve 1 : 50 V (≥10 µF)
Curve 2 : 6.3 V and 63/100 V.

ESR$_o$ = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR$_o$) as a function of ambient temperature.



Curve 1 : 6.3 V
Curve 2 : 50 V (≥10 µF) and 63/100 V.

ESR$_o$ = typical ESR at 20 °C, 100 Hz.

Fig.10 Multiplier of ESR (ESR/ESR$_o$) as a function of frequency.

Equivalent series inductance (ESL)

case size 5 x 11	typ. 13 nH
case size 8.2 x 11	typ. 16 nH

Impedance (Z)

Curve 1 : 0.47 µF
Curve 2 : 0.68 µF
Curve 3 : 1.0 µF
Curve 4 : 1.5 µF
Curve 5 : 2.2 µF
Curve 6 : 3.3 µF
Curve 7 : 4.7 µF
Curve 8 : 6.8 µF
Curve 9 : 10 µF
Curve 10 : 15 µF
Curve 11 : 22 µF
Curve 12 : 33 µF
Curve 13 : 47 µF
Curve 14 : 68 µF
Curve 15 : 100 µF
Curve 16 : 150 µF.

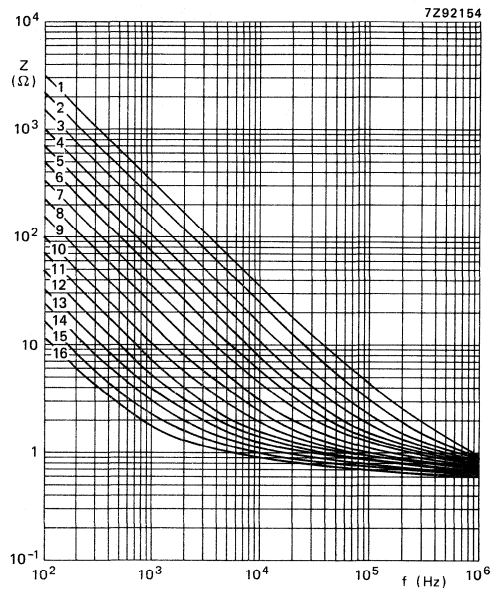


Fig.11 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 5 x 11.

Curve 1 : 2.2 µF
Curve 2 : 4.7 µF
Curve 3 : 10 µF/100 V
Curve 4 : 10 µF/50 V
Curve 5 : 22 µF/50 V
Curve 6 : 33 µF
Curve 7 : 47 µF
Curve 8 : 68 µF
Curve 9 : 100 µF
Curve 10 : 150 µF
Curve 11 : 220 µF
Curve 12 : 330 µF
Curve 13 : 470 µF.

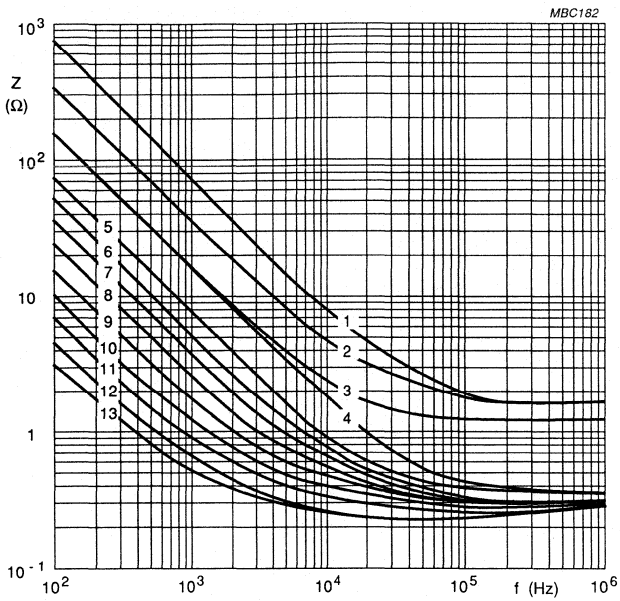
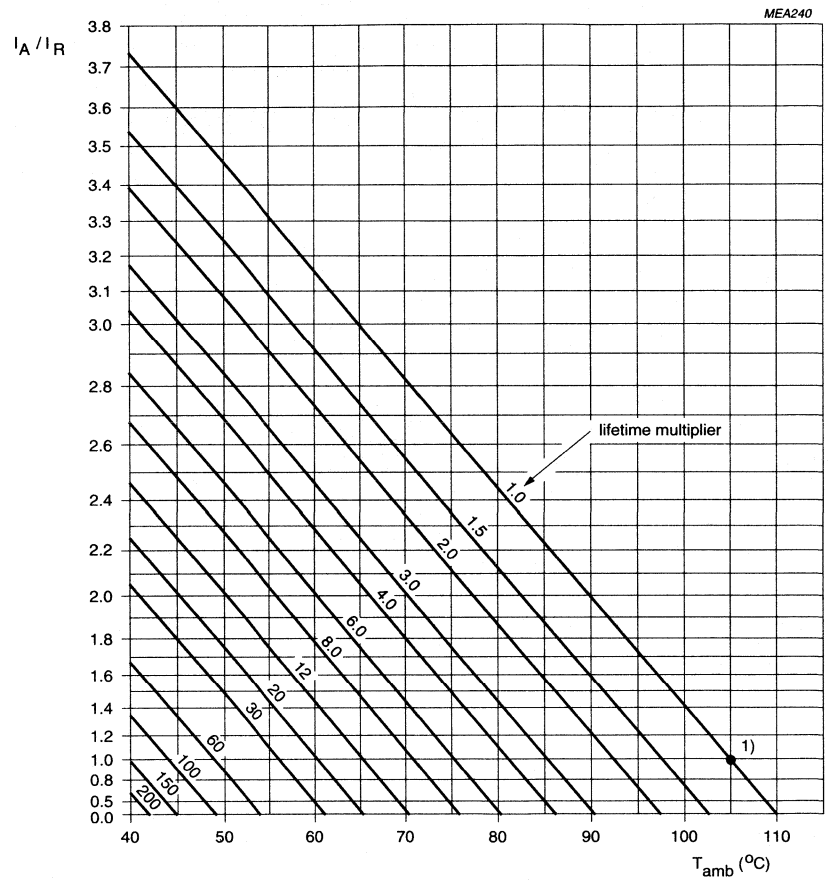


Fig.12 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 8.2 x 11.

RIPPLE CURRENT and USEFUL LIFE



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 105 °C.

1) Useful life at 105 °C and I_R applied: 2000 hours.

Fig.13 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

Table 5 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10 V	U_R = 16 to 35 V	U_R = 40 to 100 V
50	0.9	0.85	0.8
100	1.0	1.0	1.0
300	1.12	1.2	1.25
1000	1.2	1.3	1.4
3000	1.25	1.35	1.5
≥10 000	1.3	1.4	1.6

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	Reference		
Endurance	IEC 384-4-1/ CECC 30301 sub clause 4.13	T_{amb} = 105 °C, U_R applied 1500 hours	U_R ≤6.3 V : ΔC/C +15/–30% U_R >6.3 V : ΔC/C ±15% tan δ ≤1.3 x spec. limit Z ≤2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 105 °C, U_R and I_R applied 2000 hours	U_R ≤6.3 V : ΔC/C +45/–50% U_R >6.3 V : ΔC/C ±45% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤2 x spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30301 sub clause 4.17	T_{amb} = 105 °C, no voltage applied 1500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

4

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

RLI 135

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, insulated with a blue sleeve
- Charge and discharge proof
- Miniaturized, high CU-product per unit volume
- Long useful life: 1000 to 2000 hours at 105 °C
- Low ESR, low impedance, high ripple current capability.

APPLICATIONS

- General industrial, EDP, telecommunication and audio-video
- Smoothing, filtering, buffering in SMPS and DC/DC converters
- Portable and mobile equipment (small size, low mass)
- Low surface demand on printed circuit board.

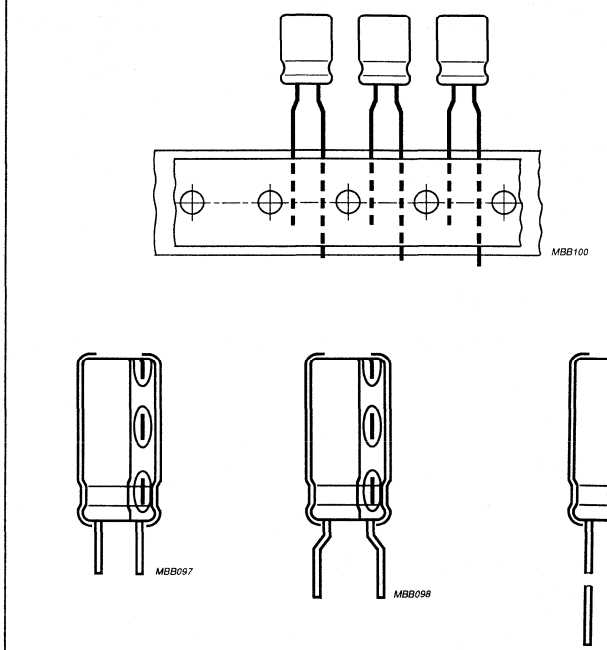


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	8 x 12 to 8 x 20	10 x 12 to 18 x 40
Rated capacitance range, C_R	22 to 10 000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	6.3 to 100 V	
Category temperature range	–55 to +105 °C	
Endurance test at 105 °C	1000 hours	2000 hours
Useful life at 105 °C	1000 hours	2000 hours
Useful life at 40 °C, 1.3 I_R applied	100 000 hours	200 000 hours
Shelf life at 0 V, 105 °C	500 hours	500 hours
Basic specification	IEC 384-4/CECC 30 300	
Detail specification	similar to DIN 41259 (with reduced dimensions)	
Climatic category IEC 68 DIN 40040	55/105/56 FMF	

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

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Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**)

C_R (µF)	U_R (V)							
	6.3	**10**	**16**	**25**	**35**	**50**	**63**	**100**
22								8 x 12
47							8 x 12	
100					8 x 12	10 x 15		12.5 x 20
220			8 x 12	8 x 15	8 x 20		12.5 x 20	16 x 25
330		8 x 12	8 x 15		10 x 20	12.5 x 20		16 x 30 18 x 25
470	10 x 12.5	8 x 15	8 x 20	10 x 20		12.5 x 25 18 x 15	16 x 25	16 x 40
680	10 x 15		10 x 20		12.5 x 25		16 x 30	18 x 40
1000		12.5 x 15	10 x 30	12.5 x 25	12.5 x 30 16 x 20	16 x 30	16 x 40	
1200					16 x 25			
1500		10 x 30	12.5 x 25	12.5 x 30	12.5 x 40	16 x 40		
2200	12.5 x 20	12.5 x 25 18 x 15	12.5 x 30 16 x 20	12.5 x 40 18 x 20	16 x 35 18 x 30	18 x 40		
3300		12.5 x 35 16 x 20		16 x 35 18 x 30	18 x 40			
4700	12.5 x 35	16 x 30 18 x 25	16 x 35 18 x 30	18 x 40				
6800	16 x 30	16 x 35 18 x 30	18 x 35					
10 000	18 x 30	18 x 40						

4

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

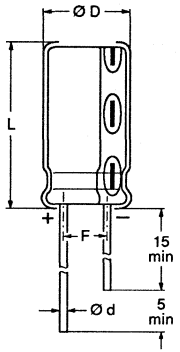


Fig.2 **Form CA**: Long leads.

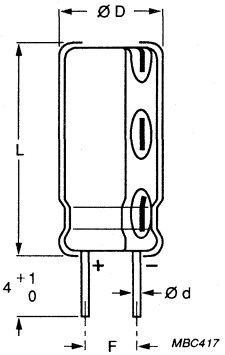


Fig.3 **Form CB**: Cut leads.

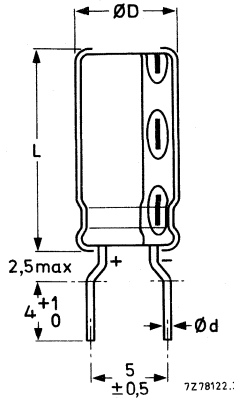
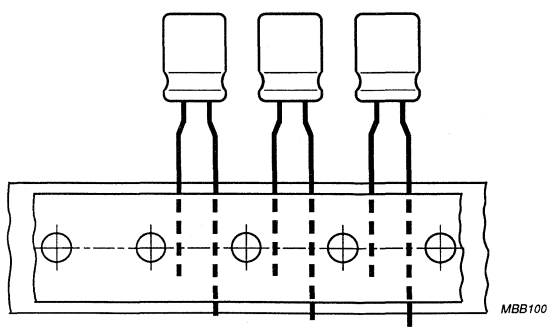


Fig.4 **Form CC**: Cut leads, formed; Ø D = 8 mm only.

Taping dimensions are specified in chapter "PACKING".



Form TR+: Taped on reel, positive leading.
Form TFA : Taped in box (ammopack).

Fig.5 Taped, formed, pitch 5 mm.

Table 2 Dimensions in mm

CASE SIZE ∅ D_{nom} x L_{nom}	∅ d	∅D_{max}	L_{max}	F ±0.5	PACKING QUANTITIES		
					Form CA CB, CC	Form TR+	Form TFA
8 x 12	0.6	8.5	13	3.5	1000	800	1000
8 x 15	0.6	8.5	16	3.5	1000	–	1000
8 x 20	0.6	8.5	21	3.5	1000	–	1000
10 x 12.5	0.6	10.5	13.5	5	2000	–	1500
10 x 15	0.6	10.5	16	5	2000	–	1500
10 x 20	0.6	10.5	21	5	2000	–	1500
10 x 30	0.6	10.5	31	5	2000	–	1000
12.5 x 15	0.6	13	16	5	1000	–	1500
12.5 x 20	0.6	13	21	5	1000	–	1500
12.5 x 25	0.6	13	26	5	1000	–	1500
12.5 x 30	0.6	13	31	5	1000	–	1000
12.5 x 35	0.6	13	36	5	1000	–	1000
12.5 x 40	0.6	13	41	5	1000	–	1000
16 x 20	0.8	16.5	21	7.5	500	–	800
16 x 25	0.8	16.5	26	7.5	500	–	800
16 x 30	0.8	16.5	31	7.5	500	–	600
16 x 35	0.8	16.5	36	7.5	500	–	600
16 x 40	0.8	16.5	41	7.5	500	–	600
18 x 15	0.8	18.5	16	7.5	500	–	600
18 x 20	0.8	18.5	21	7.5	500	–	600
18 x 25	0.8	18.5	26	7.5	500	–	600
18 x 30	0.8	18.5	31	7.5	250	–	600
18 x 35	0.8	18.5	36	7.5	250	–	600
18 x 40	0.8	18.5	41	7.5	250	–	450

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

RLI 135

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 120 Hz, tolerance ± 20%
I_R = rated RMS ripple current at 120 Hz, 105 °C
I_{RH} = rated RMS ripple current at 100 kHz, 105 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L2} = max. leakage current after 2 minutes at U_R
tan δ = max. dissipation factor at 120 Hz
ESR = equivalent series resistance at 120 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 100 kHz and 20 or −10 °C.

Table 3 Electrical data

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 120 Hz 105 °C (mA)	I_{RH} 100 kHz 105 °C (mA)	I_{L1} 1 min (µA)	I_{L2} 2 min (µA)	Tan δ 120 Hz	ESR 120 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz −10 °C (Ω)
6.3	470	10 x 12.5	410	510	89	30	0.22	0.78	0.28	0.73
	680	10 x 15	510	640	129	43	0.22	0.54	0.22	0.57
	2200	12.5 x 20	1000	1100	416	140	0.24	0.19	0.089	0.23
	4700	12.5 x 35	1600	1800	888	300	0.28	0.099	0.053	0.15
	6800	16 x 30	1600	1800	1290	430	0.32	0.078	0.055	0.14
	10 000	18 x 30	1800	2000	1890	630	0.40	0.066	0.047	0.12
10	330	8 x 12	280	400	99	33	0.19	0.96	0.33	0.86
	470	8 x 15	400	500	141	47	0.19	0.68	0.24	0.62
	1000	12.5 x 15	780	970	300	100	0.19	0.32	0.12	0.31
	1500	10 x 30	1000	1200	450	150	0.19	0.21	0.093	0.24
	2200	12.5 x 25	1200	1300	660	220	0.21	0.16	0.073	0.19
	2200	18 x 15	1200	1300	660	220	0.21	0.16	0.080	0.21
	3300	12.5 x 35	1600	1800	990	330	0.23	0.12	0.052	0.14
	3300	16 x 20	1200	1400	990	330	0.23	0.12	0.075	0.20
	4700	16 x 30	1600	1800	1410	470	0.25	0.089	0.054	0.14
	4700	18 x 25	1700	1800	1410	470	0.25	0.089	0.053	0.14
	6800	16 x 35	1800	2000	2040	680	0.29	0.071	0.046	0.12
	6800	18 x 30	1800	2000	2040	680	0.29	0.071	0.046	0.12
	10 000	18 x 40	2200	2500	3000	1000	0.37	0.062	0.037	0.096

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor RLI 135
1000 µF/16 V, ±20%
Case size 10 x 30 mm; Form CB
Catalogue number: 2222 135 65102.

Table 4 Ordering information

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CATALOGUE NUMBER 2222				
			BULK PACKING			TAPED ON REEL F = 5 mm positive leading Form TR+	TAPED IN BOX F = 5 mm Form TFA
			LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC		
6.3	470	10 x 12.5	135 53471	135 63471	–	–	–
	680	10 x 15	135 53681	135 63681	–	–	–
	2200	12.5 x 20	135 53222	135 63222	–	–	–
	4700	12.5 x 35	135 53472	135 63472	–	–	–
	6800	16 x 30	135 53682	135 63682	–	–	–
	10 000	18 x 30	135 53103	135 63103	–	–	–
10	330	8 x 12	135 54331	135 84331	135 64331	135 24331	135 34331
	470	8 x 15	135 54471	135 84471	135 64471	–	–
	1000	12.5 x 15	135 54102	135 64102	–	–	–
	1500	10 x 30	135 54152	135 64152	–	–	–
	2200	12.5 x 25	135 54222	135 64222	–	–	–
	2200	18 x 15	135 90001	135 90002	–	–	–
	3300	12.5 x 35	135 54332	135 64332	–	–	–
	3300	16 x 20	135 90025	135 90026	–	–	–
	4700	16 x 30	135 54472	135 64472	–	–	–
	4700	18 x 25	135 90003	135 90004	–	–	–
	6800	16 x 35	135 54682	135 64682	–	–	–
	6800	18 x 30	135 90005	135 90006	–	–	–
	10 000	18 x 40	135 54103	135 64103	–	–	–

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

RLI 135

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 120 Hz 105 °C (mA)	I_{RH} 100 kHz 105 °C (mA)	I_{L1} 1 min (µA)	I_{L2} 2 min (µA)	Tan δ 120 Hz	ESR 120 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz −10 °C (Ω)
16	220	8 x 12	220	400	106	35	0.16	1.21	0.33	0.86
	330	8 x 15	350	500	158	53	0.16	0.81	0.23	0.60
	470	8 x 20	520	650	226	75	0.16	0.57	0.18	0.47
	680	10 x 20	690	860	326	110	0.16	0.40	0.14	0.36
	1000	10 x 30	920	1200	480	160	0.16	0.27	0.091	0.24
	1500	12.5 x 25	1200	1300	720	240	0.16	0.18	0.072	0.19
	2200	12.5 x 30	1400	1500	1060	350	0.18	0.14	0.063	0.16
	2200	16 x 20	1200	1400	1060	350	0.18	0.14	0.073	0.19
	4700	16 x 35	1800	2000	2260	750	0.22	0.078	0.046	0.12
	4700	18 x 30	1800	2000	2260	750	0.22	0.078	0.046	0.12
	6800	18 x 35	2000	2200	3260	1100	0.26	0.064	0.040	0.10
25	220	8 x 15	350	500	165	55	0.14	1.06	0.23	0.60
	470	10 x 20	690	860	353	120	0.14	0.50	0.14	0.36
	1000	12.5 x 25	1100	1300	750	250	0.14	0.24	0.071	0.18
	1500	12.5 x 30	1400	1500	1125	380	0.14	0.16	0.062	0.16
	2200	12.5 x 40	1800	2000	1650	550	0.16	0.13	0.044	0.11
	2200	18 x 20	1400	1600	1650	550	0.16	0.13	0.060	0.16
	3300	16 x 35	1800	2000	2475	830	0.18	0.091	0.045	0.12
	3300	18 x 30	1800	2000	2475	830	0.18	0.091	0.045	0.12
	4700	18 x 40	2200	2500	3525	1200	0.20	0.071	0.036	0.94
35	100	8 x 12	280	400	105	35	0.12	2.00	0.32	0.83
	220	8 x 20	460	650	231	77	0.12	0.91	0.18	0.47
	330	10 x 20	610	860	347	120	0.12	0.61	0.13	0.34
	680	12.5 x 25	1100	1300	714	240	0.12	0.30	0.070	0.18
	1000	12.5 x 30	1400	1500	1050	350	0.12	0.20	0.061	0.16
	1000	16 x 20	1100	1370	1050	350	0.12	0.20	0.071	0.18
	1200	16 x 25	1400	1600	1260	420	0.12	0.17	0.062	0.16
	1500	12.5 x 40	1800	2000	1575	530	0.12	0.14	0.043	0.11
	2200	16 x 35	1800	2000	2310	770	0.14	0.11	0.044	0.11
	2200	18 x 30	1800	2000	2310	770	0.14	0.11	0.044	0.11
	3300	18 x 40	2200	2500	3465	1200	0.16	0.081	0.035	0.091

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

RLI 135

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CATALOGUE NUMBER 2222				
			BULK PACKING			TAPED ON REEL F = 5 mm positive leading Form TR+	TAPED IN BOX F = 5 mm Form TFA
			LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC		
16	220	8 x 12	135 55221	135 85221	135 65221	135 25221	135 35221
	330	8 x 15	135 55331	135 85331	135 65331	–	–
	470	8 x 20	135 55471	135 85471	135 65471	–	–
	680	10 x 20	135 55681	135 65681	–	–	–
	1000	10 x 30	135 55102	135 65102	–	–	–
	1500	12.5 x 25	135 55152	132 65152	–	–	–
	2200	12.5 x 30	135 55222	132 65222	–	–	–
	2200	16 x 20	135 90007	135 90008	–	–	–
	4700	16 x 35	135 55472	135 65472	–	–	–
	4700	18 x 30	135 90009	135 90011	–	–	–
	6800	18 x 35	135 55682	135 65682	–	–	–
25	220	8 x 15	135 56221	135 86221	135 66221	–	–
	470	10 x 20	135 56471	135 66471	–	–	–
	1000	12.5 x 25	135 56102	135 66102	–	–	–
	1500	12.5 x 30	135 56152	135 66152	–	–	–
	2200	12.5 x 40	135 56222	135 66222	–	–	–
	2200	18 x 20	135 90012	135 90013	–	–	–
	3300	16 x 35	135 56332	135 66332	–	–	–
	3300	18 x 30	135 90014	135 90015	–	–	–
	4700	18 x 40	135 56472	135 66472	–	–	–
35	100	8 x 12	135 50101	135 80101	135 60101	135 20101	135 30101
	220	8 x 20	135 50221	135 80221	135 60221	–	–
	330	10 x 20	135 50331	135 60331	–	–	–
	680	12.5 x 25	135 50681	135 60681	–	–	–
	1000	12.5 x 30	135 50102	135 60102	–	–	–
	1000	16 x 20	135 90016	135 90017	–	–	–
	1200	16 x 25	135 50122	135 60122	–	–	–
	1500	12.5 x 40	135 50152	135 60152	–	–	–
	2200	16 x 35	135 50222	135 60222	–	–	–
	2200	18 x 30	135 90018	135 90019	–	–	–
	3300	18 x 40	135 50332	135 60332	–	–	–

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

RLI 135

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 120 Hz 105 °C (mA)	I_{RH} 100 kHz 105 °C (mA)	I_{L1} 1 min (µA)	I_{L2} 2 min (µA)	Tan δ 120 Hz	ESR 120 Hz (Ω)	Z 10 kHz 20 °C (Ω)	Z 10 kHz −10 °C (Ω)
50	100	10 x 15	450	640	150	50	0.10	1.66	0.20	0.52
	330	12.5 x 20	790	1100	495	170	0.10	0.51	0.081	0.22
	470	12.5 x 25	1100	1300	705	240	0.10	0.36	0.068	0.19
	470	18 x 15	1000	1300	705	240	0.10	0.36	0.074	0.19
	1000	16 x 30	1500	1800	1500	500	0.10	0.17	0.050	0.13
	1500	16 x 40	2100	2300	2250	750	0.10	0.12	0.035	0.091
	2200	18 x 40	2200	2500	3300	1100	0.12	0.091	0.034	0.091
63	47	8 x 12	220	300	89	30	0.08	2.83	0.56	1.5
	220	12.5 x 20	630	890	416	140	0.08	0.61	0.16	0.42
	470	16 x 25	1200	1400	888	300	0.08	0.29	0.091	0.25
	680	16 x 30	1400	1800	1285	430	0.08	0.20	0.065	0.18
	1000	16 x 40	1800	2200	1890	630	0.08	0.14	0.049	0.13
100	22	8 x 12	120	310	66	22	0.07	5.28	0.53	1.4
	100	12.5 x 20	630	890	300	100	0.07	1.17	0.15	0.40
	220	16 x 25	1000	1400	660	220	0.07	0.53	0.086	0.23
	330	16 x 30	1300	1800	990	330	0.07	0.36	0.062	0.17
	330	18 x 25	1200	1700	990	330	0.07	0.36	0.074	0.20
	470	16 x 40	1800	2200	1410	470	0.07	0.25	0.047	0.13
	680	18 x 40	1900	2400	2040	680	0.07	0.18	0.043	0.12

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

RLI 135

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CATALOGUE NUMBER 2222				
			BULK PACKING			TAPED ON REEL F = 5 mm positive leading Form TR+	TAPED IN BOX F = 5 mm Form TFA
			LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC		
50	100	10 x 15	135 51101	135 61101	–	–	–
	330	12.5 x 20	135 51331	135 61331	–	–	–
	470	12.5 x 25	135 51471	135 61471	–	–	–
	470	18 x 15	135 90021	135 90022	–	–	–
	1000	16 x 30	135 51102	135 61102	–	–	–
	1500	16 x 40	135 51152	135 61152	–	–	–
	2200	18 x 40	135 51222	135 61222	–	–	–
63	47	8 x 12	135 58479	135 88479	135 68479	135 28479	135 38479
	220	12.5 x 20	135 58221	135 68221	–	–	–
	470	16 x 25	135 58471	135 68471	–	–	–
	680	16 x 30	135 58681	135 68681	–	–	–
	1000	16 x 40	135 58102	135 68102	–	–	–
100	22	8 x 12	135 59229	135 89229	135 69229	135 29229	135 39229
	100	12.5 x 20	135 59101	135 69101	–	–	–
	220	16 x 25	135 59221	135 69221	–	–	–
	330	16 x 30	135 59331	135 69331	–	–	–
	330	18 x 25	135 90023	135 90024	–	–	–
	470	16 x 40	135 59471	135 69471	–	–	–
	680	18 x 40	135 59681	135 69681	–	–	–

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Group number (135)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Negative terminal identification.

Voltage

Surge voltage for short periods	$U_s \leq 1.15\ U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.03\ C_R \times U_R$ µA
After 2 minutes at U_R	$I_{L2} \leq 0.01\ C_R \times U_R$ µA

Capacitance (C)

Ratio of capacitance at 120 Hz:

$C_{-55\ °C} / C_{20\ °C} \geq 0.7$ for $U_R = 6.3$ V
$C_{-55\ °C} / C_{20\ °C} \geq 0.8$ for $U_R = 10$ to 100 V.

Impedance (Z)

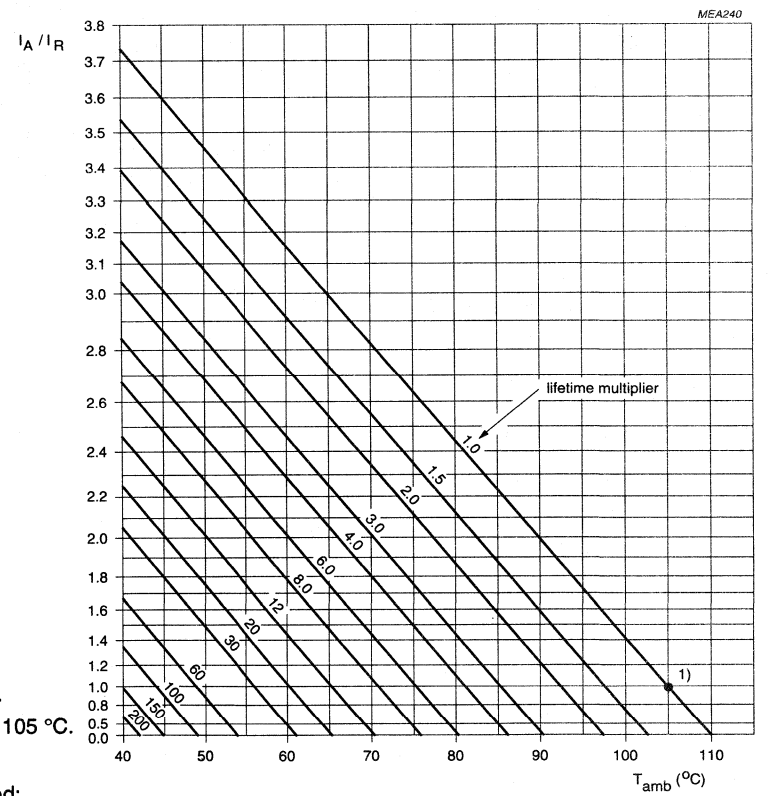
Ratio of impedance at 120 kHz:

$Z_{-55\ °C} / Z_{20\ °C} \leq 3$.

RIPPLE CURRENT and USEFUL LIFE

Table 5 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 100 kHz

FREQUENCY (Hz)	I_R MULTIPLIER			
	22 µF	33 to 330 µF	470 to 1000 µF	>1000 µF
50	0.4	0.6	0.65	0.8
120	0.5	0.7	0.8	0.9
300	0.6	0.8	0.9	0.95
1000	0.8	0.9	0.98	0.98
10 000	0.9	0.95	1.0	1.0
100 000	1.0	1.0	1.0	1.0



I_A = actual ripple current at 100 kHz.
I_R = rated ripple current at 100 kHz, 105 °C.

1) Useful life at 105 °C and I_R applied:
- ∅ D = 8 mm: 1000 hours
- ∅ D = 10 to 18 mm: 2000 hours.

Fig.6 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 105 °C, U_R applied Ø D = 8 mm: 1000 hours Ø D = 10 to 18 mm: 2000 hours	ΔC/C ±20% tan δ ≤2 x spec. limit I_{L2} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 105 °C, U_R and I_R applied Ø D = 8 mm: 1000 hours Ø D = 10 to 18 mm: 2000 hours	ΔC/C ±50% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L2} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 105 °C, no voltage applied 1000 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C ±20% tan δ ≤1.5 x spec. limit I_{L2} ≤spec. limit

4

Electrolytic Capacitors

Notes

Non-solid Al - electrolytic capacitors
Radial Miniature Long-Life

RML 048

FEATURES

- Polarized aluminium electrolytic capacitors, non solid
- Radial leads, cylindrical aluminium case with safety vent insulated with a blue sleeve
- Charge and discharge proof
- Miniaturized, high CU product per unit volume
- Very long useful life, 3000/4000 h at 105 °C, high reliability

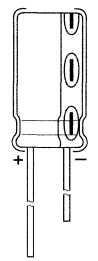


Fig.1 Component outline

APPLICATIONS

- EDP, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass)
- Low PCB surface demand

4

QUICK REFERENCE DATA

Case size, øD_{nom} x L_{nom} in mm	10 x 12 to 18 x 40
Rated capacitance range, C_R	68 to 15000 µF
Tolerance on C_R	±20 %
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	–40 to +105 °C
Endurance test at 105 °C	2000 hours
Useful life at 105 °C, case ø 10 and 12.5 mm case ø 16 and 18 mm	3000 hours 4000 hours
Useful life at 40 °C, 1.6 I_R applied case ø 10 and 12.5 mm case ø 16 and 18 mm	 200000 hours 260000 hours
Shelf life at 0 V, 105 °C	1000 hours
Basic specification	IEC 384-4, L.L. grade, CECC 30 300
Detail specification	similar to DIN 41 259 (reduced dimensions)
Climatic category IEC 68	40/105/56
Climatic category DIN 40 040	GMF

Non-solid Al - electrolytic capacitors
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Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (diameter x length in mm)

C_R	U_R (V)							
µF	**6.3**	**10**	**16**	**25**	**35**	**40**	**50**	**63**
68	For lower capacitance values see RLL 116 series							10 x 12
100 *								10 x 12
150						10 x 12		10 x 16
220 *					10 x 12		10 x 16	10 x 20
330			10 x 12		10 x 16	10 x 20		12.5 x 20
470 *			10 x 12	10 x 16	10 x 20		12.5 x 20	12.5 x 25
680		10 x 12	10 x 16		12.5 x 20		12.5 x 25	16 x 25
1000 *		10 x 16	10 x 20	12.5 x 20	12.5 x 25		16 x 25	16 x 31
1500	10 x 20		12.5 x 20	12.5 x 25	16 x 25		16 x 35	18 x 35
2200 *		12.5 x 20	12.5 x 25	16 x 25	16 x 31	16 x 35	18 x 35	18 x 40
3300		12.5 x 25	16 x 25	16 x 31	18 x 35	18 x 35	18 x 40	
4700 *		16 x 25	16 x 31	18 x 35	18 x 40			
6800	16 x 25	16 x 31	16 x 35	18 x 40				
10000 *	16 x 35	18 x 35	18 x 40					
15000	18 x 40							

* E3 values = preferred values

Non-solid Al - electrolytic capacitors
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MECHANICAL DATA Dimensions (in mm)

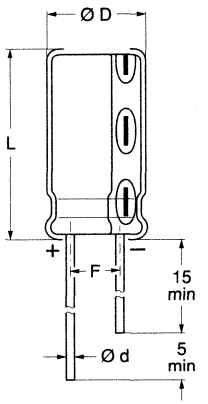


Fig. 2 **Form CA**, long leads;
see Table 2 for dimensions.

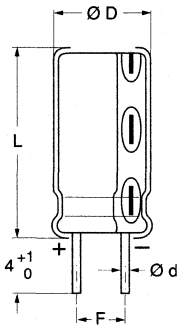
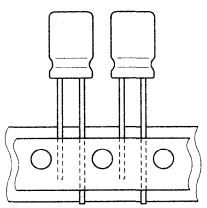
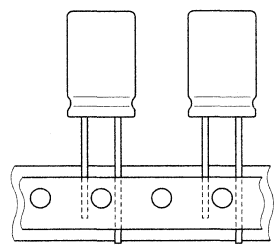


Fig. 3 **Form CB**, cut leads;
see Table 2 for dimensions.



øD = 10 mm and 12.5 mm



øD = 16 mm

Fig. 4 **Form TR+**, case sizes up to ø16 x 31 taped on reel, positive leading.
See Introduction for taping dimensions.

MARKING

The capacitors are marked with the following information:

- Rated capacitance value
- Tolerance on rated capacitance (M for ±20 %)
- Rated voltage
- Negative terminal identification
- Upper category temperature (105 °C)
- Group number (048)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62

Table 2 Dimensions (in mm)

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	RADIAL				MASS
		$\varnothing d$	$\varnothing D_{max}$	L_{max}	$F \pm 0,5$	(g)
10 x 12	14	0.6	10.5	13.5	5.0	1.6
10 x 16	15	0.6	10.5	17.5	5.0	1.9
10 x 20	16	0.6	10.5	21.5	5.0	2.2
12.5 x 20	17	0.6	13.0	21.5	5.0	4.0
12.5 x 25	18	0.6	13.0	26.5	5.0	5.0
16 x 25	19	0.8	16.5	27.0	7.5	8.0
16 x 31	20	0.8	16.5	33.0	7.5	9.0
16 x 35	21	0.8	16.5	37.0	7.5	11.5
18 x 35	22	0.8	18.5	37.0	7.5	14.5
18 x 40	23	0.8	18.5	42.0	7.5	16.0

PACKING

Capacitors of Form CA and Form CB are supplied in boxes, those of Form TR+ taped on reel.
The numbers per box and per reel are given in Table 3.

Table 3 Packing quantities

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	NUMBER OF CAPACITORS		
		FORM CA per Box	FORM CB per Box	FORM TR+ per Reel
10 x 12	14	1000	1000	500
10 x 16	15	500	500	500
10 x 20	16	500	500	500
12.5 x 20	17	200	200	200
12.5 x 25	18	200	200	200
16 x 25	19	200	200	150
16 x 31	20	200	200	150
16 x 35	21	150	150	
18 x 35	22	100	100	
18 x 40	23	100	100	

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ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 4 apply at an ambient temperature of 20 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75 %.

C_R = rated capacitance at 100 Hz, tolerance ±20 %

I_R = rated RMS ripple current at 100 Hz, 105 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz (100 kHz in preparation)

Table 4 Electrical data

U_R	C_R	CASE SIZE $øD_{nom}$ x L_{nom}	I_R	I_{L1}	I_{L5}	tan δ	ESR	Z	
								at 10 kHz	at 100 kHz
(V)	(μF)	(mm)	(mA)	(μA)	(μA)		(Ω)	(Ω)	(Ω)
6.3	1500	10 x 20	500	190	22	0.26	0.28	0.41	
	6800	16 x 25	1200	860	89	0.36	0.08	0.11	
	10000	16 x 35	1500	1300	130	0.44	0.07	0.09	
	15000	18 x 40	1800	1900	190	0.54	0.06	0.07	
10	680	10 x 12	340	140	17	0.20	0.47	0.66	
	1000	10 x 16	430	200	23	0.20	0.32	0.45	
	2200	12.5 x 20	700	440	47	0.24	0.17	0.22	
	3300	12.5 x 25	870	660	69	0.26	0.13	0.15	
	4700	16 x 25	1100	940	97	0.28	0.10	0.11	
	6800	16 x 31	1400	1400	140	0.32	0.07	0.09	
	10000	18 x 35	1600	2000	200	0.40	0.06	0.07	
16	330	10 x 12	280	110	14	0.16	0.69	0.97	
	470	10 x 12	330	150	18	0.16	0.49	0.68	
	680	10 x 16	420	220	25	0.16	0.34	0.47	
	1000	10 x 20	550	320	35	0.16	0.23	0.32	
	1500	12.5 x 20	700	480	51	0.18	0.17	0.22	
	2200	12.5 x 25	870	710	73	0.20	0.13	0.15	
	3300	16 x 25	1100	1100	110	0.22	0.10	0.11	
	4700	16 x 31	1400	1500	150	0.24	0.07	0.08	
	6800	16 x 35	1600	2200	220	0.28	0.06	0.06	
	10000	18 x 40	1800	3200	320	0.36	0.05	0.05	

Non-solid Al - electrolytic capacitors
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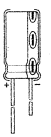
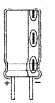
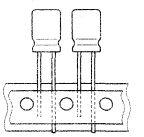
ORDERING EXAMPLE

Electrolytic capacitors RML 048
2200 µF/16 V, ±20 %
12.5 x 25, taped on reel, Form TR+
Catalogue number 2222 048 25222

Ordering information

U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$øD_{nom}$ x L_{nom}			
V	µF	mm	Form CA	Form CB	Form TR+
6.3	1500	10 x 20	048 53152	048 63152	048 23152
	6800	16 x 25	53682	63682	23682
	10000	16 x 35	53103	63103	
	15000	18 x 40	53153	63153	
10	680	10 x 12	048 54681	048 64681	048 24681
	1000	10 x 16	54102	64102	24102
	2200	12.5 x 20	54222	64222	24222
	3300	12.5 x 25	54332	64332	24332
	4700	16 x 25	54472	64472	24472
	6800	16 x 31	54682	64682	24682
	10000	18 x 35	54103	64103	
16	330	10 x 12	048 55331	048 65331	048 25331
	470	10 x 12	55471	65471	25471
	680	10 x 16	55681	65681	25681
	1000	10 x 20	55102	65102	25102
	1500	12.5 x 20	55152	65152	25152
	2200	12.5 x 25	55222	65222	25222
	3300	16 x 25	55332	65332	25332
	4700	16 x 31	55472	65472	25472
	6800	16 x 35	55682	65682	
	10000	18 x 40	55103	65103	

Non-solid Al - electrolytic capacitors
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Table 4 Electrical data (continued)

U_R (V)	C_R (μF)	CASE SIZE $øD_{nom}$ x L_{nom} (mm)	I_R (mA)	I_{L1} (μA)	I_{L5} (μA)	tan δ	ESR (Ω)	Z at 10 kHz (Ω)	Z at 100 kHz (Ω)
25	470	10 x 16	370	240	27	0.14	0.43	0.47	
	1000	12.5 x 20	640	500	53	0.14	0.20	0.22	
	1500	12.5 x 25	810	750	78	0.16	0.15	0.15	
	2200	16 x 25	990	1100	110	0.18	0.12	0.11	
	3300	16 x 31	1300	1700	170	0.20	0.09	0.07	
	4700	18 x 35	1500	2400	240	0.22	0.07	0.06	
	6800	18 x 40	1800	3400	340	0.26	0.06	0.04	
35	220	10 x 12	260	160	18	0.12	0.78	0.68	
	330	10 x 16	340	230	26	0.12	0.52	0.45	
	470	10 x 20	430	330	36	0.12	0.37	0.32	
	680	12.5 x 20	570	480	51	0.12	0.25	0.22	
	1000	12.5 x 25	760	700	73	0.12	0.17	0.15	
	1500	16 x 25	950	1100	110	0.14	0.13	0.10	
	2200	16 x 31	1200	1500	160	0.16	0.10	0.07	
	3300	18 x 35	1400	2300	230	0.18	0.08	0.05	
	4700	18 x 40	1700	3300	330	0.20	0.06	0.04	
40	150	10 x 12	220	120	15	0.12	1.10	0.87	
	330	10 x 20	360	270	29	0.12	0.52	0.39	
	2200	16 x 35	1200	1800	180	0.16	0.10	0.06	
	3300	18 x 35	1400	2600	270	0.18	0.08	0.04	
50	220	10 x 16	300	220	25	0.10	0.65	0.43	
	470	12.5 x 20	520	470	50	0.10	0.30	0.20	
	680	12.5 x 25	680	680	71	0.10	0.21	0.14	
	1000	16 x 25	920	1000	100	0.10	0.14	0.10	
	1500	16 x 35	1200	1500	150	0.12	0.11	0.07	
	2200	18 x 35	1300	2200	220	0.14	0.09	0.05	
	3300	18 x 40	1600	3300	330	0.16	0.07	0.03	
63	68	10 x 12	170	89	12	0.09	1.90	1.20	
	100	10 x 12	200	130	16	0.09	1.30	0.80	
	150	10 x 16	260	190	22	0.09	0.86	0.53	
	220	10 x 20	340	280	31	0.09	0.59	0.36	
	330	12.5 x 20	460	420	45	0.09	0.39	0.24	
	470	12.5 x 25	600	600	62	0.09	0.27	0.17	
	680	16 x 25	790	860	89	0.09	0.19	0.12	
	1000	16 x 31	1000	1300	130	0.09	0.13	0.08	
	1500	18 x 35	1200	1900	190	0.11	0.11	0.06	
	2200	18 x 40	1400	2800	280	0.13	0.09	0.04	

Non-solid Al - electrolytic capacitors
Radial Miniature Long-Life

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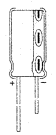
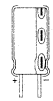
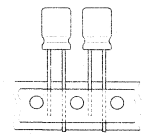
Ordering information (continued)

U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$øD_{nom}$ x L_{nom}			
(V)	(µF)	(mm)	Form CA	Form CB	Form TR+
25	470	10 x 16	048 56471	048 66471	048 26471
	1000	12.5 x 20	56102	66102	26102
	1500	12.5 x 25	56152	66152	26152
	2200	16 x 25	56222	66222	26222
	3300	16 x 31	56332	66332	26332
	4700	18 x 35	56472	66472	
	6800	18 x 40	56682	66682	
35	220	10 x 12	048 50221	048 60221	048 20221
	330	10 x 16	50331	60331	20331
	470	10 x 20	50471	60471	20471
	680	12.5 x 20	50681	60681	20681
	1000	12.5 x 25	50102	60102	20102
	1500	16 x 25	50152	60152	20152
	2200	16 x 31	50222	60222	20222
	3300	18 x 35	50332	60332	
	4700	18 x 40	50472	60472	
40	150	10 x 12	048 57151	048 67151	048 27151
	330	10 x 20	57331	67331	27331
	2200	16 x 35	57222	67222	
	3300	18 x 35	57332	67332	
50	220	10 x 16	048 51221	048 61221	048 21221
	470	12,5 x 20	51471	61471	21471
	680	12.5 x 25	51681	61681	21681
	1000	16 x 25	51102	61102	21102
	1500	16 x 35	51152	61152	
	2200	18 x 35	51222	61222	
	3300	18 x 40	51332	61332	
63	68	10 x 12	048 58689	048 68689	048 28689
	100	10 x 12	58101	68101	28101
	150	10 x 16	58151	68151	28151
	220	10 x 20	58221	68221	28221
	330	12.5 x 20	58331	68331	28331
	470	12.5 x 25	58471	68471	28471
	680	16 x 25	58681	68681	28681
	1000	16 x 31	58102	68102	28102
	1500	18 x 35	58152	68152	
	2200	18 x 40	58222	68222	

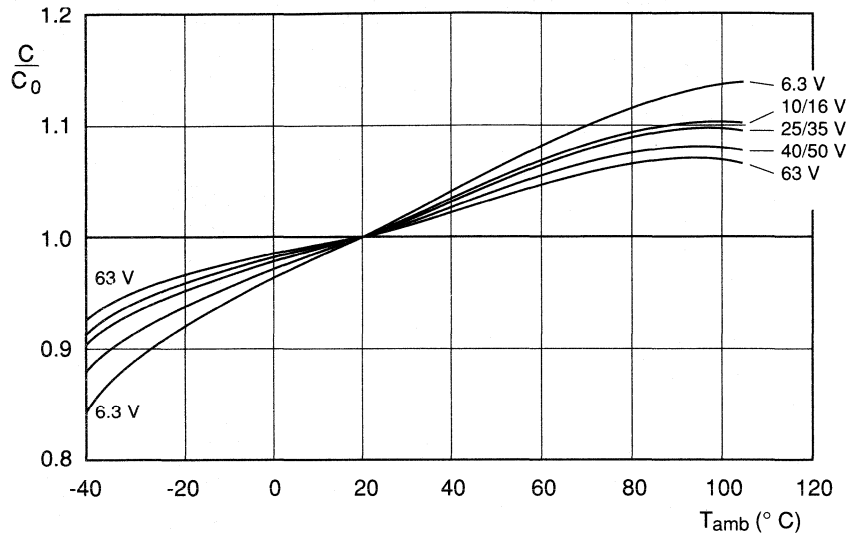


Fig. 5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature; C_0 = Capacitance at 20 °C, 100 Hz.

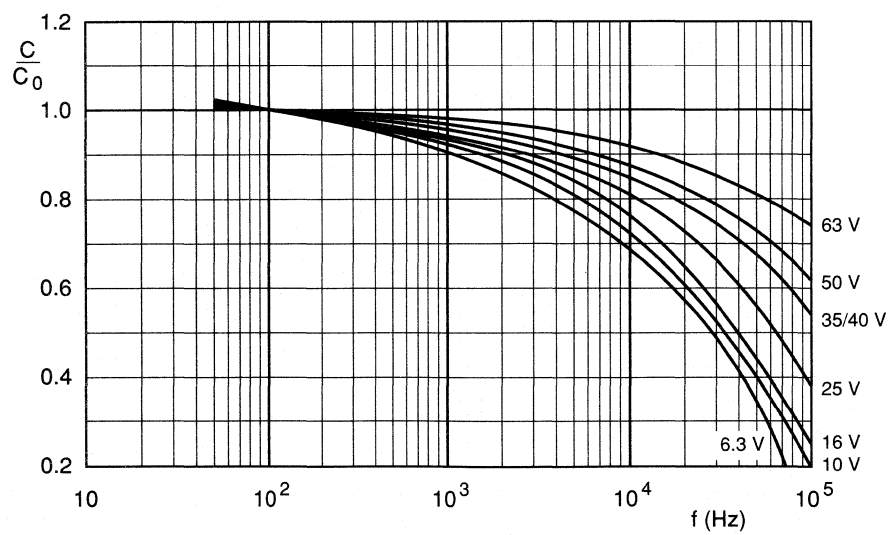


Fig. 6 Typical multiplier of capacitance (C/C_0) as a function of frequency; C_0 = Capacitance at 20 °C, 100 Hz.

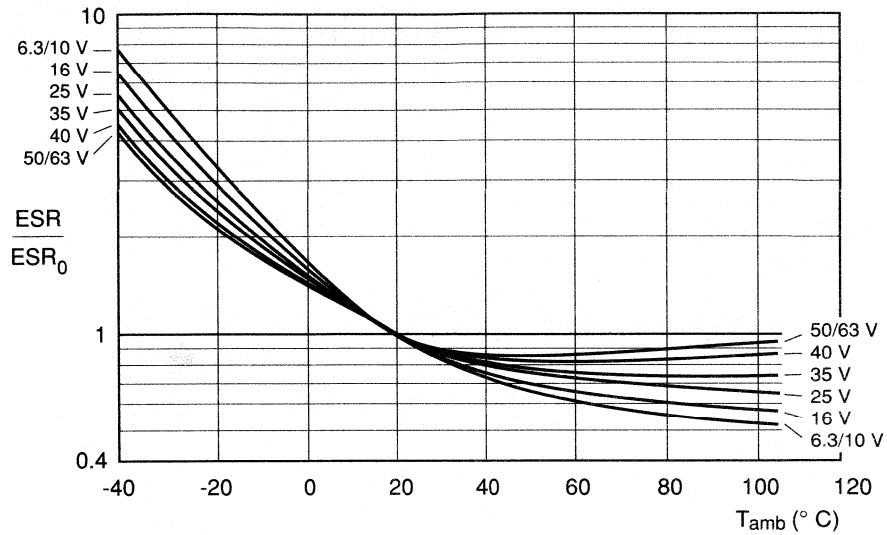


Fig. 7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature;
ESR_0 = typical ESR at 20 °C, 100 Hz.

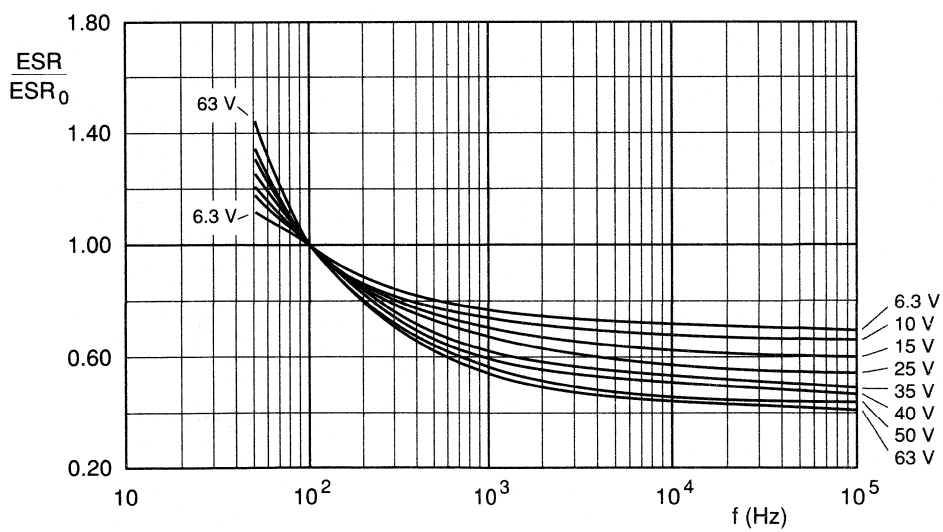


Fig. 8 Multiplier of ESR (ESR/ESR_0) as a function of frequency;
ESR_0 = typical ESR at 20 °C, 100 Hz.

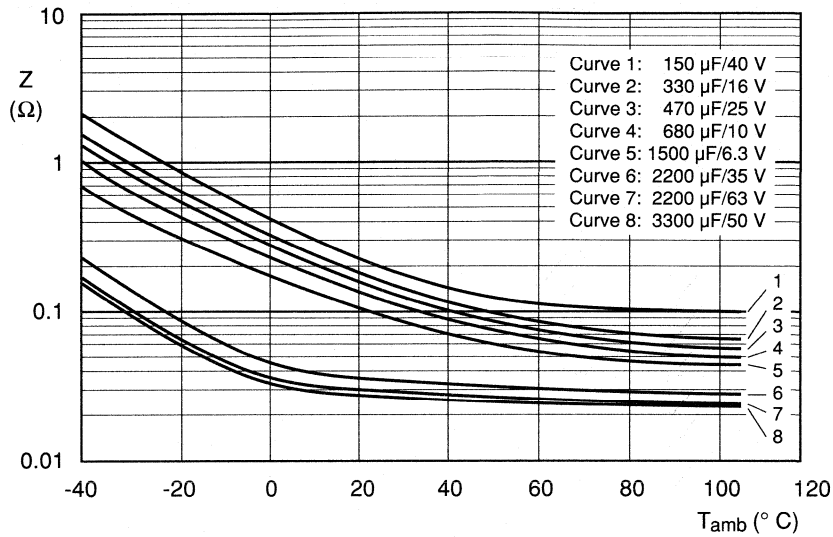


Fig. 9 Typical impedance at 10 kHz as a function of ambient temperature.

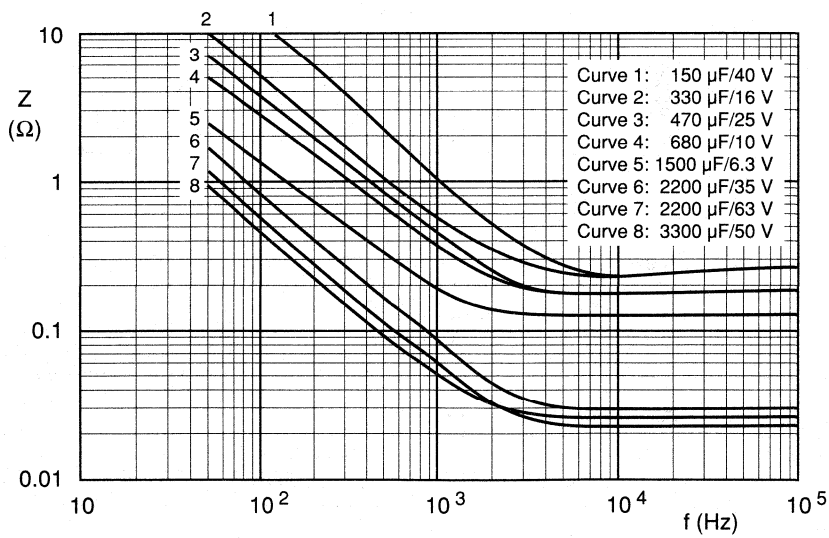


Fig. 10 Typical impedance at 20 °C as a function of frequency.

USEFUL LIFE

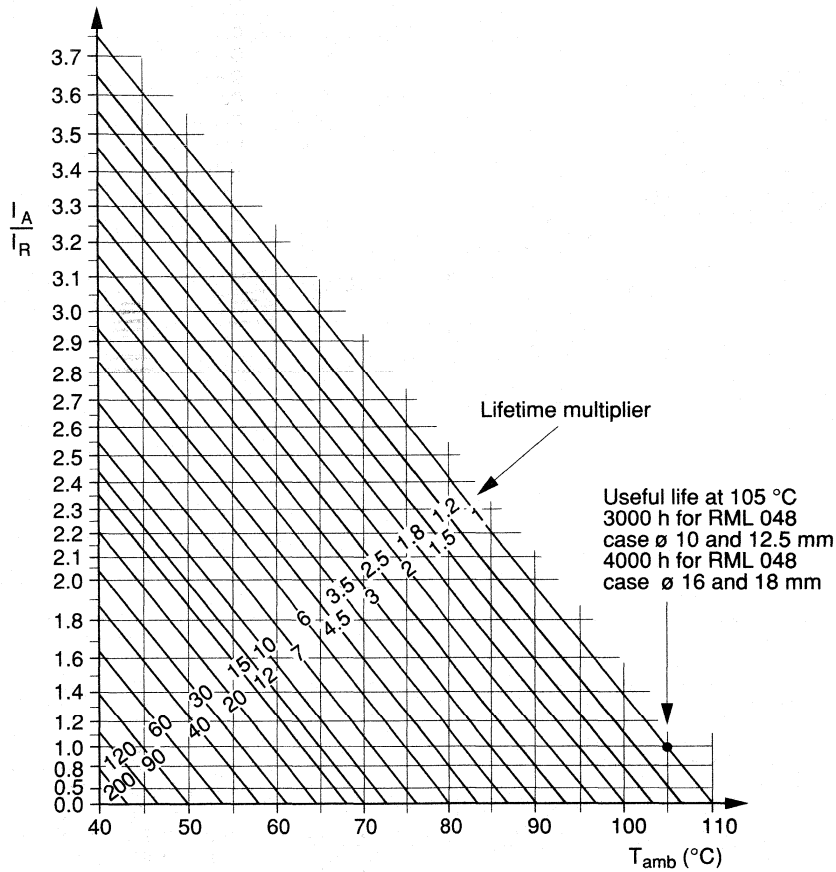


Fig. 11 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.
I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 105 °C

Table 5 Multiplier of ripple current I_R as a function of frequency

FREQUENCY	I_R-MULTIPLIER		
	U_R = 6.3 to 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50 Hz	0.95	0.85	0.80
100 Hz	1.00	1.00	1.00
300 Hz	1.07	1.20	1.25
1000 Hz	1.12	1.30	1.40
3000 Hz	1.15	1.35	1.50
≥ 10000 Hz	1.20	1.40	1.60

Voltage	
Surge voltage for short periods	$U_s \leq 1.15\ U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current	
After 1 minute at U_R	$I_{L1} \leq 0.02\ C_R\ U_R + 3\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R\ U_R + 3\ \mu A$

Equivalent series inductance (ESL)	
Case diameter = 10 mm	typ. 16 nH
Case diameter ≥ 12,5 mm	typ. 18 nH

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

4

Table 6

TEST		PROCEDURE	SPECIFIC REQUIREMENTS
Name of test	Reference	(quick reference)	
Endurance	IEC 384-4-1/ CECC 30 301 group C 3, 4.13	T_{amb} = 105 °C, U_R applied 2000 hours	U_R = 6.3 V: $\Delta C/C \leq$ +15/–30 % U_R > 6.3 V: $\Delta C/C \leq \pm 15$ % tan $\delta \leq$ 1.3 x spec. limit $Z \leq$ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640, sub clause 1.8.1	T_{amb} = 105 °C, U_R and I_R applied 3000 hours case ø 10 and 12.5 mm 4000 hours case ø 16 and 18 mm	U_R = 6.3 V: $\Delta C/C \leq$ +45/–50 % U_R > 6.3 V: $\Delta C/C \leq \pm 45$ % tan $\delta \leq$ 3 x spec. limit $Z \leq$ 3 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 105 °C, no voltage applied 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L5} \leq$ 2 x spec. limit

Electrolytic Capacitors

Notes

Non-solid Al - electrolytic capacitors
Radial Standard Long-Life

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FEATURES

- Polarized aluminium electrolytic capacitors, non solid
- Radial leads, cylindrical aluminium case with safety vent insulated with a blue sleeve
- Charge and discharge proof
- Very long useful life, 3000/4000 h at 105 °C, high reliability
- High ripple current capability, low impedance

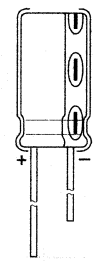

Fig.1 Component outline

APPLICATIONS

- Power supplies, EDP, telecommunication, industrial and audio-video
- Smoothing, filtering, buffering in SMPS
- Low PCB surface demand

4

QUICK REFERENCE DATA

Case size, øD_{nom} x L_{nom} in mm	10 x 12 to 18 x 40
Rated capacitance range, C_R	47 to 10000 µF
Tolerance on C_R	±20 %
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	–40 to +105 °C
Endurance test at 105 °C	2000 hours
Useful life at 105 °C, case ø 10 and 12.5 mm case ø 16 and 18 mm	3000 hours 4000 hours
Useful life at 40 °C, 1.6 I_R applied case ø 10 and 12.5 mm case ø 16 and 18 mm	 200000 hours 260000 hours
Shelf life at 0 V, 105 °C	1000 hours
Basic specification	IEC 384-4, L.L. grade, CECC 30 300
Detail specification	DIN 41 259
Climatic category IEC 68	40/105/56
Climatic category DIN 40 040	GMF

Non-solid Al - electrolytic capacitors
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Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (diameter x length in mm)

C_R	U_R (V)							
µF	**6.3**	**10**	**16**	**25**	**35**	**40**	**50**	**63**
47 *	For lower capacitance values see RLL 116 series							10 x 12
68							10 x 12	10 x 16
100 *						10 x 12	10 x 16	10 x 20
150					10 x 12	10 x 16	10 x 20	12.5 x 20
220 *			10 x 12		10 x 16	10 x 20	12.5 x 20	12.5 x 25
330		10 x 12	10 x 16		10 x 20	12.5 x 20	12.5 x 25	16 x 25
470 *	10 x 12	10 x 16	10 x 20		12.5 x 20	12.5 x 25		16 x 25
680	10 x 16	10 x 20	12.5 x 20		12.5 x 25		16 x 25	16 x 31
1000 *	10 x 20	12.5 x 20	12.5 x 25		16 x 25		16 x 31	18 x 35
1500	12.5 x 20	12.5 x 25	16 x 25		16 x 31	16 x 35	18 x 35	18 x 40
2200 *	12.5 x 25		16 x 25	16 x 31	18 x 35	18 x 35	18 x 40	
3300	16 x 25		16 x 31	18 x 35		18 x 40		
4700 *	16 x 31	16 x 35	18 x 35	18 x 40				
6800	16 x 35	18 x 35	18 x 40					
10000 *	18 x 35	18 x 40						

* E3 values = preferred values

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MECHANICAL DATA Dimensions (in mm)

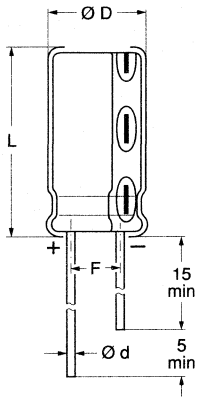


Fig. 2 **Form CA**, long leads;
see Table 2 for dimensions.

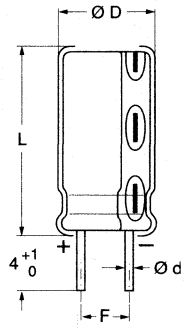
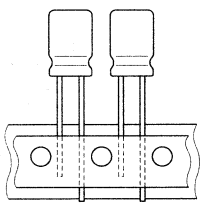
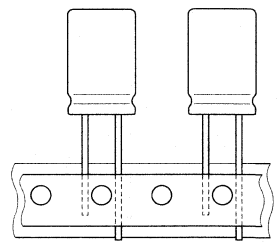


Fig. 3 **Form CB**, cut leads;
see Table 2 for dimensions.



øD = 10 mm and 12.5 mm



øD = 16 mm

Fig. 4 **Form TR+**, case sizes up to ø16 x 31 taped on reel, positive leading.
See Introduction for taping dimensions.

MARKING

The capacitors are marked with the following information:

- Rated capacitance value
- Tolerance on rated capacitance (M for ±20 %)
- Rated voltage
- Negative terminal identification
- Upper category temperature (105 °C)
- Group number (046)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62

Table 2 Dimensions (in mm)

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	RADIAL				MASS
		$\varnothing d$	$\varnothing D_{max}$	L_{max}	F ± 0,5	(g)
10 x 12	14	0.6	10.5	13.5	5.0	1.6
10 x 16	15	0.6	10.5	17.5	5.0	1.9
10 x 20	16	0.6	10.5	21.5	5.0	2.2
12.5 x 20	17	0.6	13.0	21.5	5.0	4.0
12.5 x 25	18	0.6	13.0	26.5	5.0	5.0
16 x 25	19	0.8	16.5	27.0	7.5	8.0
16 x 31	20	0.8	16.5	33.0	7.5	9.0
16 x 35	21	0.8	16.5	37.0	7.5	11.5
18 x 35	22	0.8	18.5	37.0	7.5	14.5
18 x 40	23	0.8	18.5	42.0	7.5	16.0

PACKING

Capacitors of Form CA and Form CB are supplied in boxes, those of Form TR+ taped on reel.
The numbers per box and per reel are given in Table 3.

Table 3 Packing quantities

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	NUMBER OF CAPACITORS		
		FORM CA per Box	FORM CB per Box	FORM TR+ per Reel
10 x 12	14	1000	1000	500
10 x 16	15	500	500	500
10 x 20	16	500	500	500
12.5 x 20	17	200	200	200
12.5 x 25	18	200	200	200
16 x 25	19	200	200	150
16 x 31	20	200	200	150
16 x 35	21	150	150	
18 x 35	22	100	100	
18 x 40	23	100	100	

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ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 4 apply at an ambient temperature of 20 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75 %.

C_R = rated capacitance at 100 Hz, tolerance ±20 %

I_R = rated RMS ripple current at 100 Hz, 105 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz or 100 kHz

Table 4 Electrical data

U_R	C_R	CASE SIZE	I_R	I_{L1}	I_{L5}	tan δ	ESR	Z	
		$øD_{nom}$ x L_{nom}						at 10 kHz	at 100 kHz
(V)	(μF)	(mm)	(mA)	(μA)	(μA)		(Ω)	(Ω)	(Ω)
6.3	470	10 x 12	280	62	9	0.19	0.64		0.34
	680	10 x 16	350	89	12	0.19	0.44		0.24
	1000	10 x 20	460	130	16	0.19	0.30		0.16
	1500	12.5 x 20	580	190	22	0.21	0.22	0.16	
	2200	12.5 x 25	720	280	31	0.23	0.17	0.12	
	3300	16 x 25	940	420	45	0.25	0.12	0.08	
	4700	16 x 31	1200	600	62	0.27	0.09	0.06	
	6800	16 x 35	1400	860	89	0.31	0.07	0.05	
	10000	18 x 35	1500	1300	130	0.39	0.06	0.04	
10	330	10 x 12	270	69	10	0.15	0.65		0.39
	470	10 x 16	340	97	12	0.15	0.46		0.28
	680	10 x 20	440	140	17	0.15	0.32		0.19
	1000	12.5 x 20	590	200	23	0.15	0.21		0.13
	1500	12.5 x 25	740	300	33	0.17	0.16	0.12	
	4700	16 x 35	1400	940	97	0.23	0.07	0.04	
	6800	18 x 35	1600	1400	140	0.27	0.06	0.03	
	10000	18 x 40	1800	2000	200	0.35	0.05	0.03	
16	220	10 x 12	260	73	10	0.13	0.80		0.45
	330	10 x 16	330	110	14	0.13	0.53		0.30
	470	10 x 20	430	150	18	0.13	0.37		0.21
	680	12.5 x 20	560	220	25	0.13	0.26		0.15
	1000	12.5 x 25	740	320	35	0.13	0.18		0.10
	1500	16 x 25	920	480	51	0.15	0.14	0.09	
	2200	16 x 25	1100	710	73	0.17	0.10	0.06	
	3300	16 x 31	1300	1100	110	0.19	0.08	0.04	
	4700	18 x 35	1600	1500	150	0.21	0.06	0.03	
	6800	18 x 40	1900	2200	220	0.25	0.05	0.03	

Non-solid Al - electrolytic capacitors
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ORDERING EXAMPLE

Electrolytic capacitors RSL 046
2200 µF/16 V, ±20 %
16 x 25, taped on reel, Form TR+
Catalogue number 2222 046 25222

Ordering information

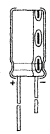
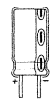
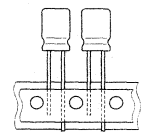
U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$øD_{nom}$ x L_{nom}			
(V)	(µF)	(mm)	Form CA	Form CB	Form TR+
6.3	470	10 x 12	046 53471	046 63471	046 23471
	680	10 x 16	53681	63681	23681
	1000	10 x 20	53102	63102	23102
	1500	12.5 x 20	53152	63152	23152
	2200	12.5 x 25	53222	63222	23222
	3300	16 x 25	53332	63332	23332
	4700	16 x 31	53472	63472	23472
	6800	16 x 35	53682	63682	
	10000	18 x 35	53103	63103	
10	330	10 x 12	046 54331	046 64331	046 24331
	470	10 x 16	54471	64471	24471
	680	10 x 20	54681	64681	24681
	1000	12.5 x 20	54102	64102	24102
	1500	12.5 x 25	54152	64152	24152
	4700	16 x 35	54472	64472	
	6800	18 x 35	54682	64682	
	10000	18 x 40	54103	64103	
16	220	10 x 12	046 55221	046 65221	046 25221
	330	10 x 16	55331	65331	25331
	470	10 x 20	55471	65471	25471
	680	12.5 x 20	55681	65681	25681
	1000	12.5 x 25	55102	65102	25102
	1500	16 x 25	55152	65152	25152
	2200	16 x 25	55222	65222	25222
	3300	16 x 31	55332	65332	25332
	4700	18 x 35	55472	65472	
	6800	18 x 40	55682	65682	

Table 4 Electrical data (continued)

U_R	C_R	CASE SIZE $øD_{nom}$ x L_{nom}	I_R	I_{L1}	I_{L5}	tan δ	ESR	Z	
								at 10 kHz	at 100 kHz
(V)	(μF)	(mm)	(mA)	(μA)	(μA)		(Ω)	(Ω)	(Ω)
25	2200	16 x 31	1200	1100	110	0.15	0.09	0.05	
	3300	18 x 35	1500	1700	170	0.17	0.07	0.03	
	4700	18 x 40	1800	2400	240	0.19	0.06	0.03	
35	150	10 x 12	250	110	14	0.10	0.90		0.40
	220	10 x 16	320	160	18	0.10	0.62		0.27
	330	10 x 20	420	230	26	0.10	0.41		0.18
	470	12.5 x 20	550	330	36	0.10	0.29		0.13
	680	12.5 x 25	720	480	51	0.10	0.20		0.09
	1000	16 x 25	940	700	73	0.10	0.14		0.06
	1500	16 x 31	1200	1100	110	0.11	0.10	0.06	
	2200	18 x 35	1500	1500	160	0.12	0.07	0.04	
40	100	10 x 12	220	83	11	0.09	1.20		0.55
	150	10 x 16	280	120	15	0.09	0.81		0.37
	220	10 x 20	360	180	21	0.09	0.55		0.25
	330	12.5 x 20	480	270	29	0.09	0.37		0.17
	470	12.5 x 25	630	380	41	0.09	0.26		0.12
	1500	16 x 35	1300	1200	120	0.10	0.09	0.05	
	2200	18 x 35	1600	1800	180	0.11	0.07	0.04	
	3300	18 x 40	1900	2600	270	0.12	0.05	0.03	
50	68	10 x 12	200	71	10	0.07	1.40		0.74
	100	10 x 16	260	100	13	0.07	0.95		0.50
	150	10 x 20	340	150	18	0.07	0.63		0.33
	220	12.5 x 20	450	220	25	0.07	0.43		0.23
	330	12.5 x 25	600	330	36	0.07	0.29		0.15
	680	16 x 25	940	680	71	0.07	0.14		0.07
	1000	16 x 31	1200	1000	100	0.07	0.10		0.05
	1500	18 x 35	1500	1500	150	0.08	0.07	0.04	
	2200	18 x 40	1800	2200	220	0.09	0.06	0.03	
63	47	10 x 12	180	62	9	0.06	1.90		0.85
	68	10 x 16	230	89	12	0.06	1.30		0.59
	100	10 x 20	290	130	16	0.06	0.91		0.40
	150	12.5 x 20	390	190	22	0.06	0.61		0.27
	220	12.5 x 25	520	280	31	0.06	0.41		0.18
	330	16 x 25	690	420	45	0.06	0.28		0.12
	470	16 x 25	840	600	62	0.06	0.19		0.09
	680	16 x 31	1100	860	89	0.06	0.13		0.06
	1000	18 x 35	1400	1300	130	0.06	0.09		0.04
	1500	18 x 40	1700	1900	190	0.07	0.07	0.04	

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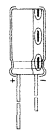
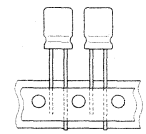
Ordering information (continued)

U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$øD_{nom}$ x L_{nom}			
(V)	(µF)	(mm)	Form CA	Form CB	Form TR+
25	2200	16 x 31	046 56222	046 66222	046 26222
	3300	18 x 35	56332	66332	
	4700	18 x 40	56472	66472	
35	150	10 x 12	046 50151	046 60151	046 20151
	220	10 x 16	50221	60221	20221
	330	10 x 20	50331	60331	20331
	470	12.5 x 20	50471	60471	20471
	680	12.5 x 25	50681	60681	20681
	1000	16 x 25	50102	60102	20102
	1500	16 x 31	50152	60152	20152
	2200	18 x 35	50222	60222	
40	100	10 x 12	046 57101	046 67101	046 27101
	150	10 x 16	57151	67151	27151
	220	10 x 20	57221	67221	27221
	330	12,5 x 20	57331	67331	27331
	470	12,5 x 25	57471	67471	27471
	1500	16 x 35	57152	67152	
	2200	18 x 35	57222	67222	
	3300	18 x 40	57332	67332	
50	68	10 x 12	046 51689	046 61689	046 21689
	100	10 x 16	51101	61101	21101
	150	10 x 20	51151	61151	21151
	220	12,5 x 20	51221	61221	21221
	330	12.5 x 25	51331	61331	21331
	680	16 x 25	51681	61681	21681
	1000	16 x 31	51102	61102	21102
	1500	18 x 35	51152	61152	
	2200	18 x 40	51222	61222	
63	47	10 x 12	046 58479	046 68479	046 28479
	68	10 x 16	58689	68689	28689
	100	10 x 20	58101	68101	28101
	150	12.5 x 20	58151	68151	28151
	220	12.5 x 25	58221	68221	28221
	330	16 x 25	58331	68331	28331
	470	16 x 25	58471	68471	28471
	680	16 x 31	58681	68681	28681
	1000	18 x 35	58102	68102	
	1500	18 x 40	58152	68152	

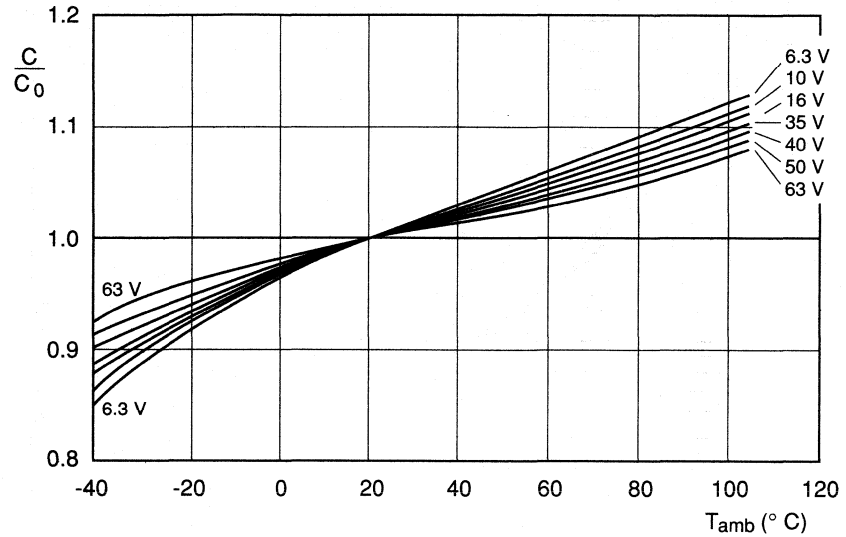


Fig. 5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature; C_0 = Capacitance at 20 °C, 100 Hz.

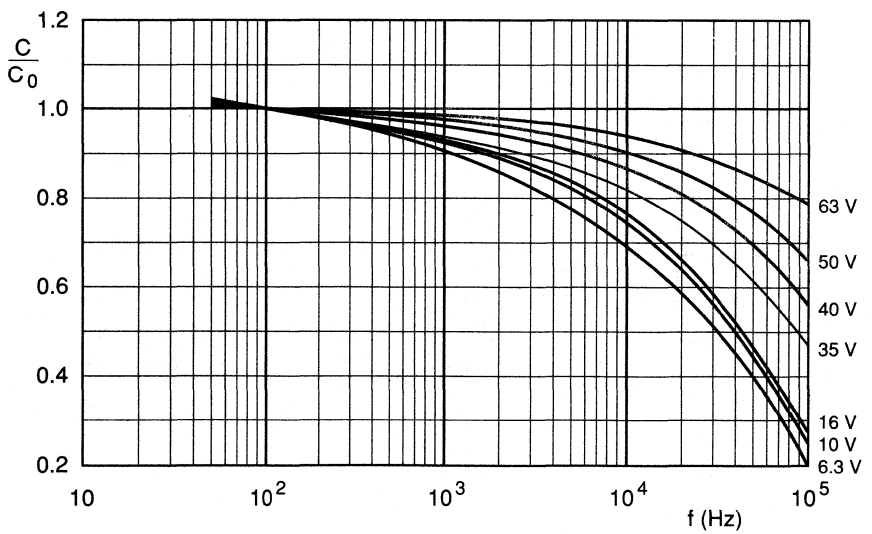


Fig. 6 Typical multiplier of capacitance (C/C_0) as a function of frequency; C_0 = Capacitance at 20 °C, 100 Hz.

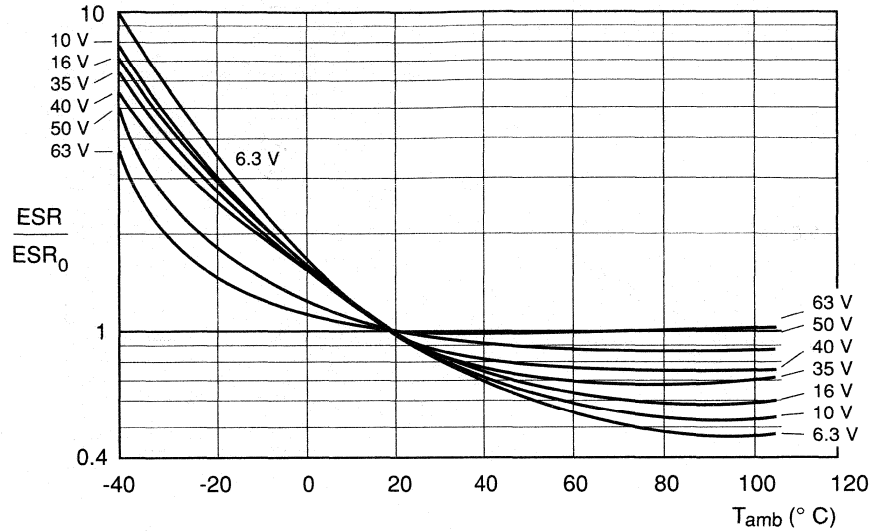


Fig. 7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; ESR_0 = typical ESR at 20 °C, 100 Hz.

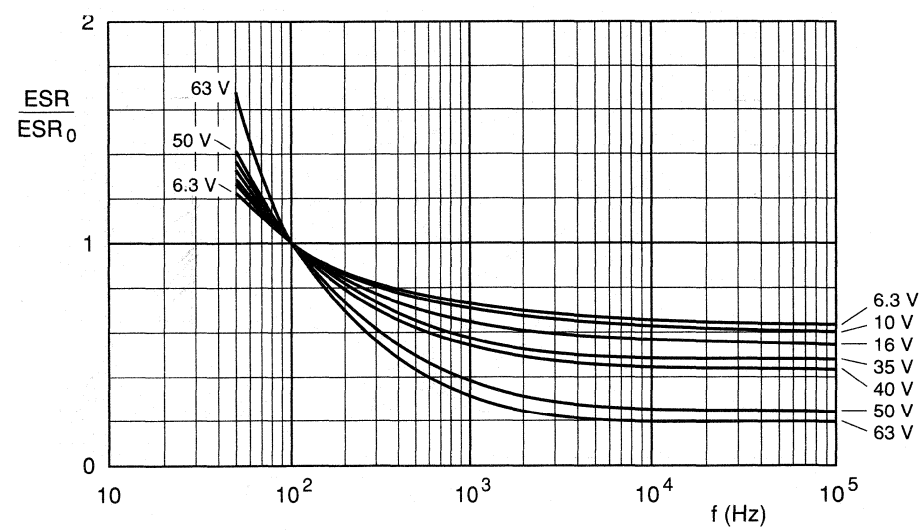


Fig. 8 Multiplier of ESR (ESR/ESR_0) as a function of frequency; ESR_0 = typical ESR at 20 °C, 100 Hz.

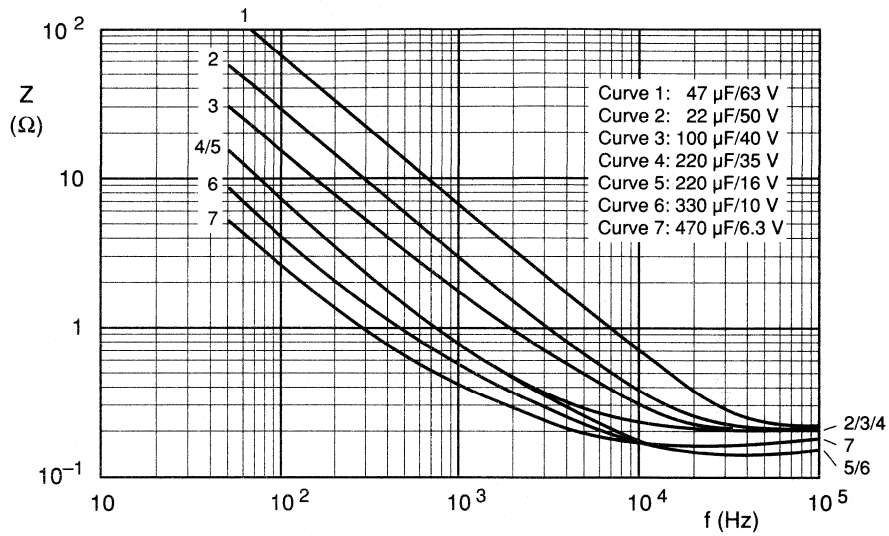


Fig. 9 Typical impedance at 20 °C as a function of frequency.

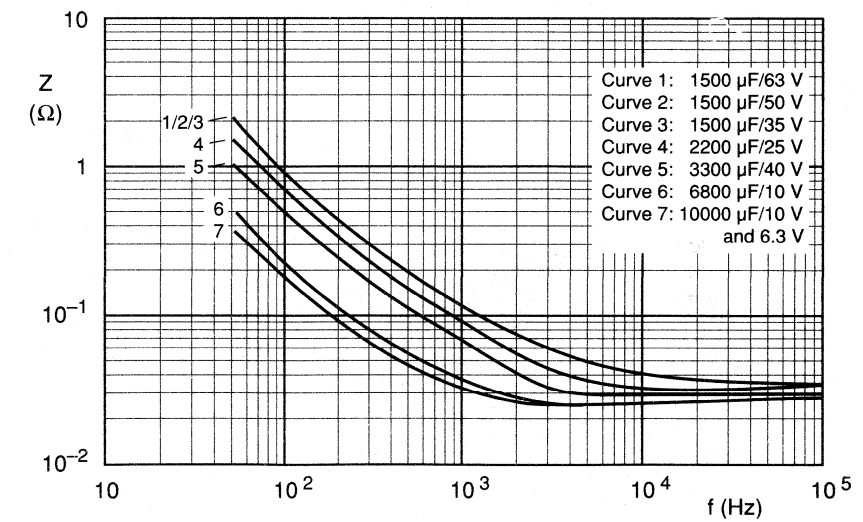


Fig. 10 Typical impedance at 20 °C as a function of frequency.

USEFUL LIFE

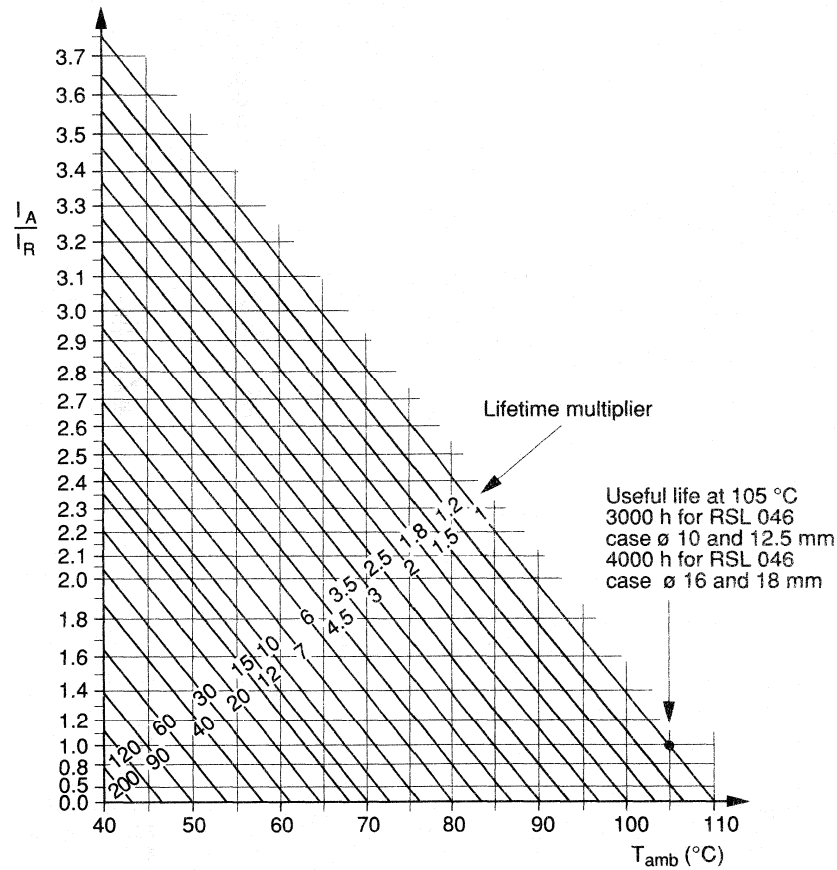


Fig. 11 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.
I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 105 °C

Table 5 Multiplier of ripple current I_R as a function of frequency

FREQUENCY	I_R-MULTIPLIER		
	U_R = 6.3 to 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50 Hz	0.82	0.80	0.75
100 Hz	1.00	1.00	1.00
300 Hz	1.12	1.25	1.30
1000 Hz	1.20	1.40	1.50
3000 Hz	1.25	1.50	1.65
≥ 10000 Hz	1.30	1.60	1.80

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Voltage	
Surge voltage for short periods	$U_s \leq 1.15\ U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current	
After 1 minute at U_R	$I_{L1} \leq 0.02\ C_R\ U_R + 3\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R\ U_R + 3\ \mu A$

Equivalent series inductance (ESL)	
Case diameter = 10 mm	typ. 16 nH
Case diameter ≥ 12,5 mm	typ. 18 nH

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

4

Table 6

TEST		PROCEDURE	SPECIFIC REQUIREMENTS
Name of test	Reference	(quick reference)	
Endurance	IEC 384-4-1/ CECC 30 301 group C 3, 4.13	T_{amb} = 105 °C, U_R applied 2000 hours	U_R = 6.3 V: $\Delta C/C \leq$ +15/–30 % U_R > 6.3 V: $\Delta C/C \leq \pm 15$ % tan $\delta \leq$ 1.3 x spec. limit $Z \leq$ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640, sub clause 1.8.1	T_{amb} = 105 °C, U_R and I_R applied 3000 hours case ø 10 and 12.5 mm 4000 hours case ø 16 and 18 mm	U_R = 6.3 V: $\Delta C/C \leq$ +45/–50 % U_R > 6.3 V: $\Delta C/C \leq \pm 45$ % tan $\delta \leq$ 3 x spec. limit $Z \leq$ 3 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 105 °C, no voltage applied 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L5} \leq$ 2 x spec. limit

Electrolytic Capacitors

Notes

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FEATURES

- Polarized aluminium electrolytic capacitors, non solid
- Radial leads, cylindrical aluminium case with safety vent insulated with a blue sleeve
- Charge and discharge proof
- Extended useful life, 5000/6000 h at 105 °C, high reliability
- High ripple current capability, low impedance

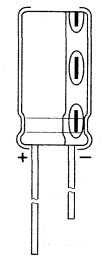

Fig.1 Component outline

APPLICATIONS

- Power supplies, EDP, telecommunication, industrial and audio-video
- Smoothing, filtering, buffering in SMPS
- Low PCB surface demand

4

QUICK REFERENCE DATA

Case size, $\varnothing D_{nom}$ x L_{nom} in mm	10 x 12 to 18 x 40
Rated capacitance range, C_R	47 to 10000 µF
Tolerance on C_R	±20 %
Rated voltage range, U_R	10 to 63 V
Category temperature range	–40 to +105 °C
Endurance test at 105 °C	3000 hours
Useful life at 105 °C, case ø 10 and 12.5 mm case ø 16 and 18 mm	5000 hours 6000 hours
Useful life at 40 °C, 1.8 I_R applied case ø 10 and 12.5 mm case ø 16 and 18 mm	 240000 hours 280000 hours
Shelf life at 0 V, 105 °C	2000 hours
Basic specification	IEC 384-4, L.L. grade, CECC 30 300
Detail specification	similar to DIN 41 259
Climatic category IEC 68	40/105/56
Climatic category DIN 40 040	GMF

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Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (diameter x length in mm)

C_R	U_R (V)						
µF	**10**	**16**	**25**	**35**	**40**	**50**	**63**
47 *							10 x 12
68						10 x 12	10 x 16
100 *					10 x 12	10 x 16	10 x 20
150				10 x 12	10 x 16	10 x 20	12.5 x 20
220 *		10 x 12		10 x 16	10 x 20	12.5 x 20	12.5 x 25
330	10 x 12	10 x 16		10 x 20	12.5 x 20	12.5 x 25	16 x 25
470 *	10 x 16	10 x 20		12.5 x 20	12.5 x 25		16 x 25
680	10 x 20	12.5 x 20		12.5 x 25		16 x 25	16 x 31
1000 *	12.5 x 20	12.5 x 25		16 x 25		16 x 31	18 x 35
1500	12.5 x 25	16 x 25		16 x 31	16 x 35	18 x 35	18 x 40
2200 *		16 x 25	16 x 31	18 x 35	18 x 35	18 x 40	
3300		16 x 31	18 x 35		18 x 40		
4700 *	16 x 35	18 x 35	18 x 40				
6800	18 x 35	18 x 40					
10000 *	18 x 40						

* E3 values = preferred values

MECHANICAL DATA Dimensions (in mm)

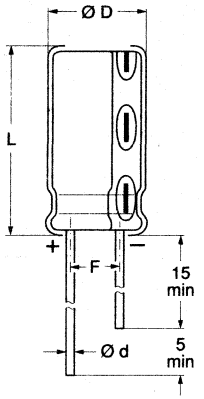


Fig. 2 **Form CA**, long leads;
see Table 2 for dimensions.

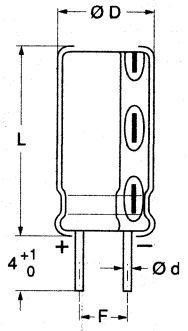
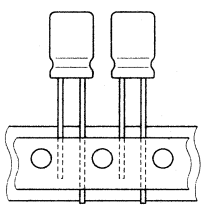
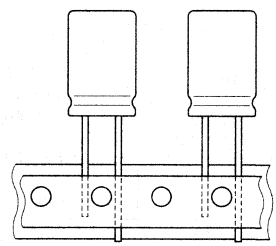


Fig. 3 **Form CB**, cut leads;
see Table 2 for dimensions.



øD = 10 mm and 12.5 mm



øD = 16 mm

Fig. 4 **Form TR+**, case sizes up to ø16 x 31 taped on reel, positive leading.
See Introduction for taping dimensions.

MARKING

The capacitors are marked with the following information:

- Rated capacitance value
- Tolerance on rated capacitance (M for ±20 %)
- Rated voltage
- Negative terminal identification
- Upper category temperature (105 °C)
- Group number (164)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62

Table 2 Dimensions (in mm)

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	RADIAL				MASS
		$\varnothing d$	$\varnothing D_{max}$	L_{max}	$F \pm 0,5$	(g)
10 x 12	14	0.6	10.5	13.5	5.0	1.6
10 x 16	15	0.6	10.5	17.5	5.0	1.9
10 x 20	16	0.6	10.5	21.5	5.0	2.2
12.5 x 20	17	0.6	13.0	21.5	5.0	4.0
12.5 x 25	18	0.6	13.0	26.5	5.0	5.0
16 x 25	19	0.8	16.5	27.0	7.5	8.0
16 x 31	20	0.8	16.5	33.0	7.5	9.0
16 x 35	21	0.8	16.5	37.0	7.5	11.5
18 x 35	22	0.8	18.5	37.0	7.5	14.5
18 x 40	23	0.8	18.5	42.0	7.5	16.0

PACKING

Capacitors of Form CA and Form CB are supplied in boxes, those of Form TR+ taped on reel.
The numbers per box and per reel are given in Table 3.

Table 3 Packing quantities

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	NUMBER OF CAPACITORS		
		FORM CA per Box	FORM CB per Box	FORM TR+ per Reel
10 x 12	14	1000	1000	500
10 x 16	15	500	500	500
10 x 20	16	500	500	500
12.5 x 20	17	200	200	200
12.5 x 25	18	200	200	200
16 x 25	19	200	200	150
16 x 31	20	200	200	150
16 x 35	21	150	150	
18 x 35	22	100	100	
18 x 40	23	100	100	

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ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 4 apply at an ambient temperature of 20 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75 %.

C_R = rated capacitance at 100 Hz, tolerance ±20 %

I_R = rated RMS ripple current at 100 Hz, 105 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz or 100 kHz

Table 4 Electrical data

U_R	C_R	CASE SIZE $øD_{nom}$ x L_{nom}	I_R	I_{L1}	I_{L5}	tan δ	ESR	Z	
								at 10 kHz	at 100 kHz
(V)	(μF)	(mm)	(mA)	(μA)	(μA)		(Ω)	(Ω)	(Ω)
10	330	10 x 12	270	69	10	0.15	0.65		0.39
	470	10 x 16	340	97	12	0.15	0.46		0.28
	680	10 x 20	440	140	17	0.15	0.32		0.19
	1000	12.5 x 20	590	200	23	0.15	0.21		0.13
	1500	12.5 x 25	740	300	33	0.17	0.16	0.12	
	4700	16 x 35	1400	940	97	0.23	0.07	0.04	
	6800	18 x 35	1600	1400	140	0.27	0.06	0.03	
	10000	18 x 40	1800	2000	200	0.35	0.05	0.03	
16	220	10 x 12	250	73	10	0.13	0.85		0.45
	330	10 x 16	320	110	14	0.13	0.56		0.30
	470	10 x 20	420	150	18	0.13	0.40		0.21
	680	12.5 x 20	550	220	25	0.13	0.27		0.15
	1000	12.5 x 25	720	320	35	0.13	0.19		0.10
	1500	16 x 25	920	480	51	0.15	0.14	0.09	
	2200	16 x 25	1000	710	73	0.17	0.11	0.06	
	3300	16 x 31	1300	1100	110	0.19	0.08	0.04	
	4700	18 x 35	1600	1500	150	0.21	0.06	0.03	
	6800	18 x 40	1800	2200	220	0.25	0.05	0.03	
25	2200	16 x 31	1200	1100	110	0.15	0.09	0.05	
	3300	18 x 35	1500	1700	170	0.17	0.07	0.03	
	4700	18 x 40	1800	2400	240	0.19	0.06	0.03	

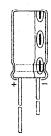
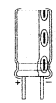
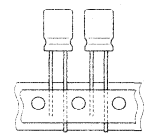
Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

ORDERING EXAMPLE

Electrolytic capacitors RSX 164
1000 µF/16 V, ±20 %
12.5 x 25, taped on reel, Form TR+
Catalogue number 2222 164 25102

Ordering information

U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$øD_{nom}$ x L_{nom}			
(V)	(µF)	(mm)	Form CA	Form CB	Form TR+
10	330	10 x 12	164 54331	164 64331	164 24331
	470	10 x 16	54471	64471	24471
	680	10 x 20	54681	64681	24681
	1000	12.5 x 20	54102	64102	24102
	1500	12.5 x 25	54152	64152	24152
	4700	16 x 35	54472	64472	
	6800	18 x 35	54682	64682	
	10000	18 x 40	54103	64103	
16	220	10 x 12	164 55221	164 65221	164 25221
	330	10 x 16	55331	65331	25331
	470	10 x 20	55471	65471	25471
	680	12.5 x 20	55681	65681	25681
	1000	12.5 x 25	55102	65102	25102
	1500	16 x 25	55152	65152	25152
	2200	16 x 25	55222	65222	25222
	3300	16 x 31	55332	65332	25332
	4700	18 x 35	55472	65472	
	6800	18 x 40	55682	65682	
25	2200	16 x 31	164 56222	164 66222	164 26222
	3300	18 x 35	56332	66332	
	4700	18 x 40	56472	66472	

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

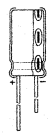
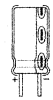
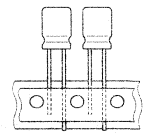
Table 4 Electrical data (continued)

U_R	C_R	CASE SIZE $øD_{nom}$ x L_{nom}	I_R	I_{L1}	I_{L5}	tan δ	ESR	Z	
								at 10 kHz	at 100 kHz
(V)	(μF)	(mm)	(mA)	(μA)	(μA)		(Ω)	(Ω)	(Ω)
35	150	10 x 12	250	110	14	0.10	0.90		0.40
	220	10 x 16	320	160	18	0.10	0.62		0.27
	330	10 x 20	420	230	26	0.10	0.41		0.18
	470	12.5 x 20	550	330	36	0.10	0.29		0.13
	680	12.5 x 25	720	480	51	0.10	0.20		0.09
	1000	16 x 25	940	700	73	0.10	0.14		0.06
	1500	16 x 31	1200	1100	110	0.11	0.10	0.06	
	2200	18 x 35	1500	1500	160	0.12	0.07	0.04	
40	100	10 x 12	220	83	11	0.09	1.20		0.55
	150	10 x 16	280	120	15	0.09	0.81		0.37
	220	10 x 20	360	180	21	0.09	0.55		0.25
	330	12.5 x 20	480	270	29	0.09	0.37		0.17
	470	12.5 x 25	630	380	41	0.09	0.26		0.12
	1500	16 x 35	1300	1200	120	0.10	0.09	0.05	
	2200	18 x 35	1600	1800	180	0.11	0.07	0.04	
	3300	18 x 40	1900	2600	270	0.12	0.05	0.03	
50	68	10 x 12	210	71	10	0.07	1.30		0.74
	100	10 x 16	260	100	13	0.07	0.89		0.50
	150	10 x 20	350	150	18	0.07	0.59		0.33
	220	12.5 x 20	460	220	25	0.07	0.41		0.23
	330	12.5 x 25	620	330	36	0.07	0.27		0.15
	680	16 x 25	980	680	71	0.07	0.13		0.07
	1000	16 x 31	1300	1000	100	0.07	0.09		0.05
	1500	18 x 35	1600	1500	150	0.08	0.07	0.04	
	2200	18 x 40	1900	2200	220	0.09	0.05	0.03	
63	47	10 x 12	200	62	9	0.06	1.60		0.85
	68	10 x 16	250	89	12	0.06	1.10		0.59
	100	10 x 20	320	130	16	0.06	0.76		0.40
	150	12.5 x 20	430	190	22	0.06	0.51		0.27
	220	12.5 x 25	560	280	31	0.06	0.35		0.18
	330	16 x 25	760	420	45	0.06	0.23		0.12
	470	16 x 25	910	600	62	0.06	0.16		0.09
	680	16 x 31	1200	860	89	0.06	0.11		0.06
	1000	18 x 35	1500	1300	130	0.06	0.08		0.04
	1500	18 x 40	1800	1900	190	0.07	0.06	0.04	

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

Ordering information (continued)

U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$\varnothing D_{nom} \times L_{nom}$			
(V)	(µF)	(mm)	Form CA	Form CB	Form TR+
35	150	10 x 12	164 50151	164 60151	164 20151
	220	10 x 16	50221	60221	20221
	330	10 x 20	50331	60331	20331
	470	12.5 x 20	50471	60471	20471
	680	12.5 x 25	50681	60681	20681
	1000	16 x 25	50102	60102	20102
	1500	16 x 31	50152	60152	20152
	2200	18 x 35	50222	60222	
40	100	10 x 12	164 57101	164 67101	164 27101
	150	10 x 16	57151	67151	27151
	220	10 x 20	57221	67221	27221
	330	12.5 x 20	57331	67331	27331
	470	12.5 x 25	57471	67471	27471
	1500	16 x 35	57152	67152	
	2200	18 x 35	57222	67222	
	3300	18 x 40	57332	67332	
50	68	10 x 12	164 51689	164 61689	164 21689
	100	10 x 16	51101	61101	21101
	150	10 x 20	51151	61151	21151
	220	12.5 x 20	51221	61221	21221
	330	12.5 x 25	51331	61331	21331
	680	16 x 25	51681	61681	21681
	1000	16 x 31	51102	61102	21102
	1500	18 x 35	51152	61152	
	2200	18 x 40	51222	61222	
63	47	10 x 12	164 58479	164 68479	164 28479
	68	10 x 16	58689	68689	28689
	100	10 x 20	58101	68101	28101
	150	12.5 x 20	58151	68151	28151
	220	12.5 x 25	58221	68221	28221
	330	16 x 25	58331	68331	28331
	470	16 x 25	58471	68471	28471
	680	16 x 31	58681	68681	28681
	1000	18 x 35	58102	68102	
	1500	18 x 40	58152	68152	

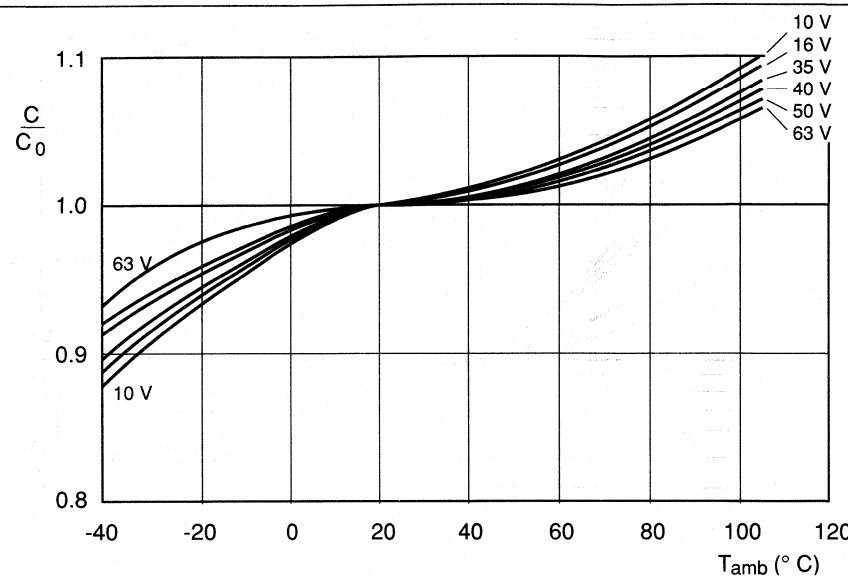


Fig. 5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature; C_0 = Capacitance at 20 °C, 100 Hz.

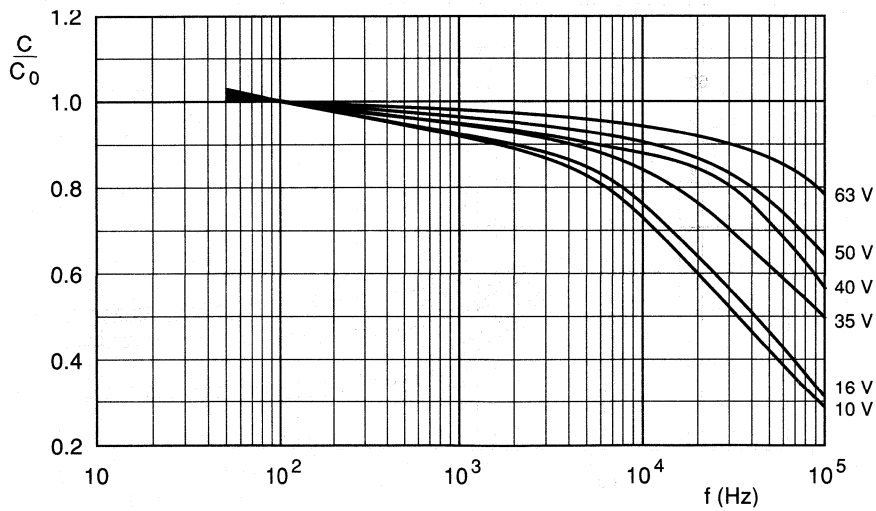


Fig. 6 Typical multiplier of capacitance (C/C_0) as a function of frequency; C_0 = Capacitance at 20 °C, 100 Hz.

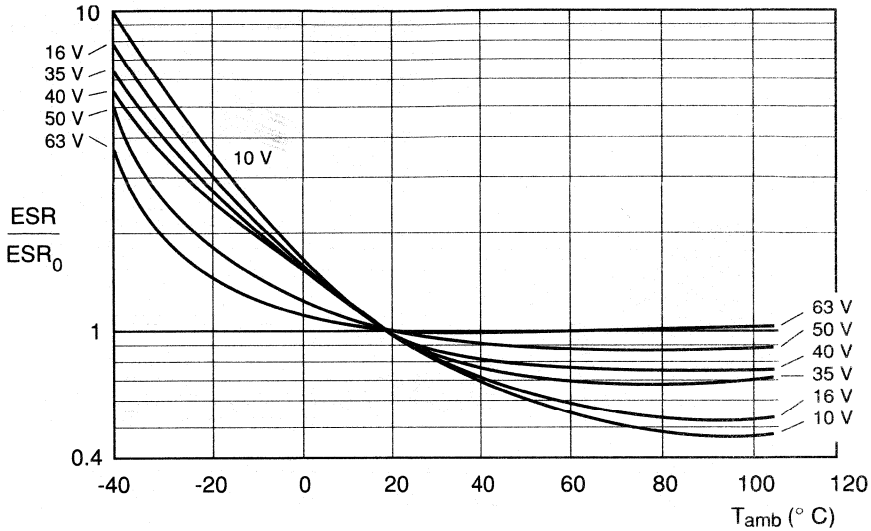


Fig. 7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature;
ESR_0 = typical ESR at 20 °C, 100 Hz.

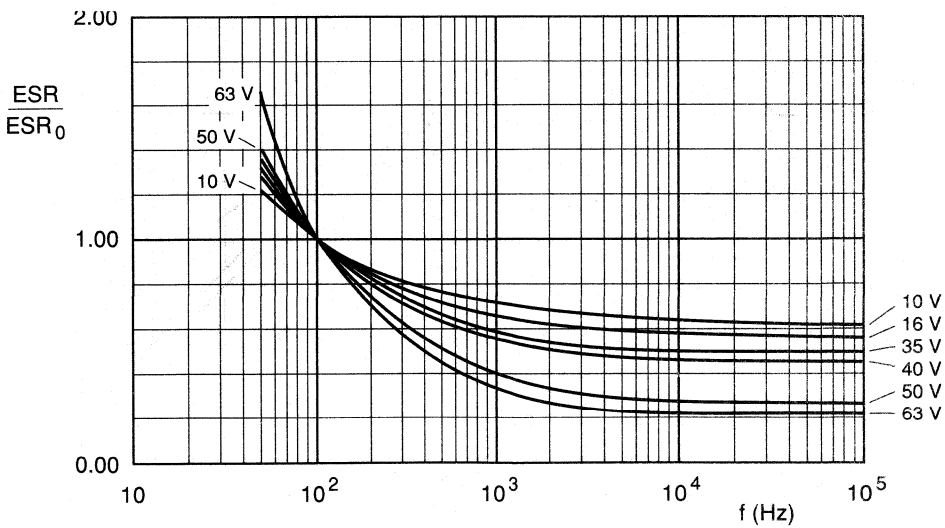


Fig. 8 Multiplier of ESR (ESR/ESR_0) as a function of frequency;
ESR_0 = typical ESR at 20 °C, 100 Hz.

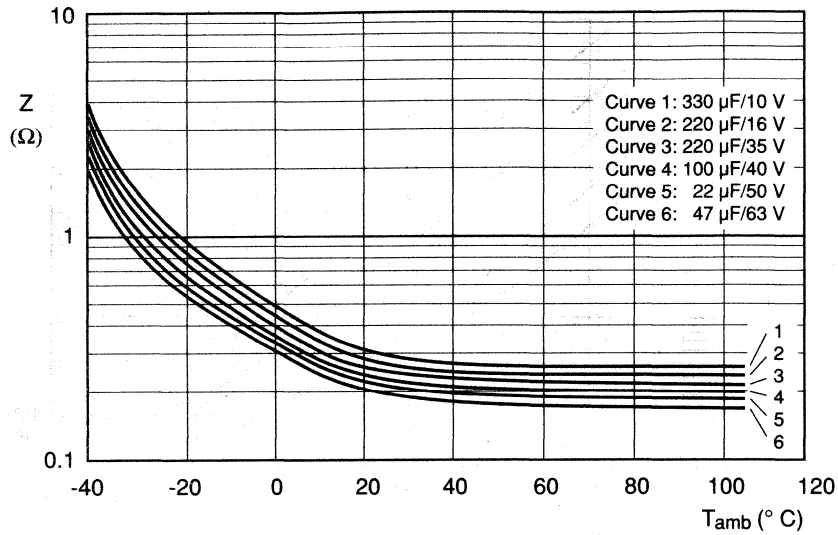


Fig. 9 Typical impedance at 100 kHz as a function of ambient temperature.

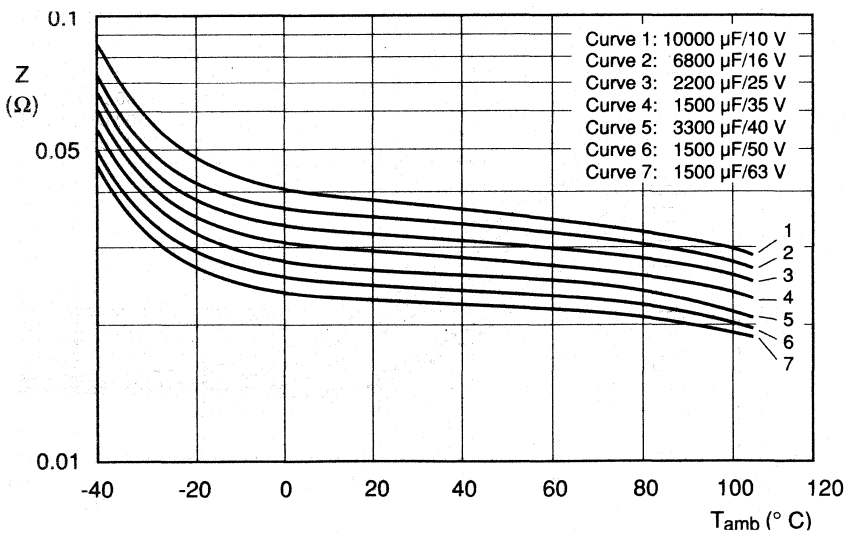


Fig. 10 Typical impedance at 10 kHz as a function of ambient temperature.

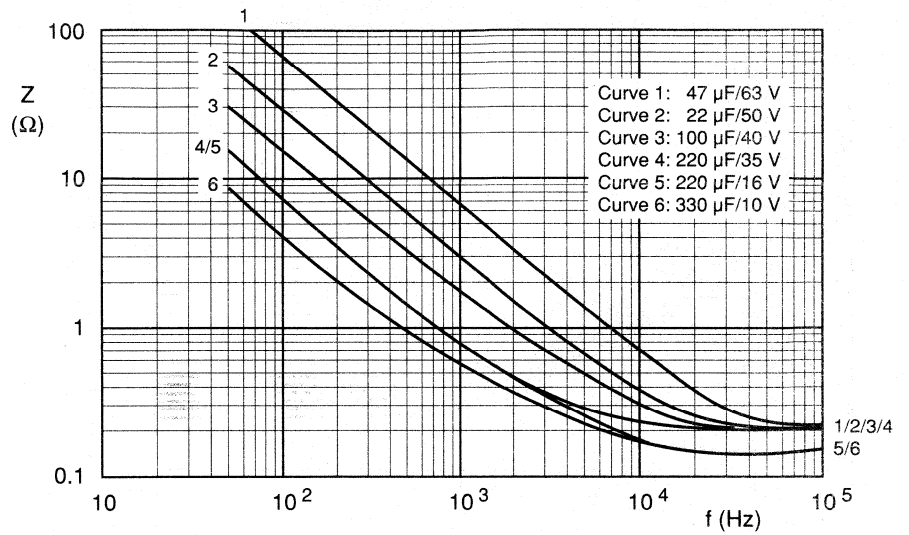


Fig. 11 Typical impedance as a function of frequency at T_{amb} = 20 °C.

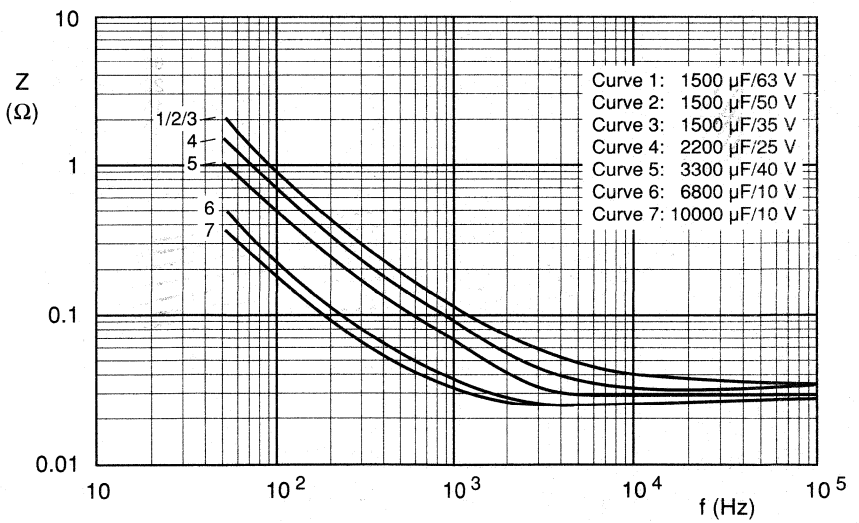


Fig. 12 Typical impedance as a function of frequency at T_{amb} = 20 °C.

USEFUL LIFE

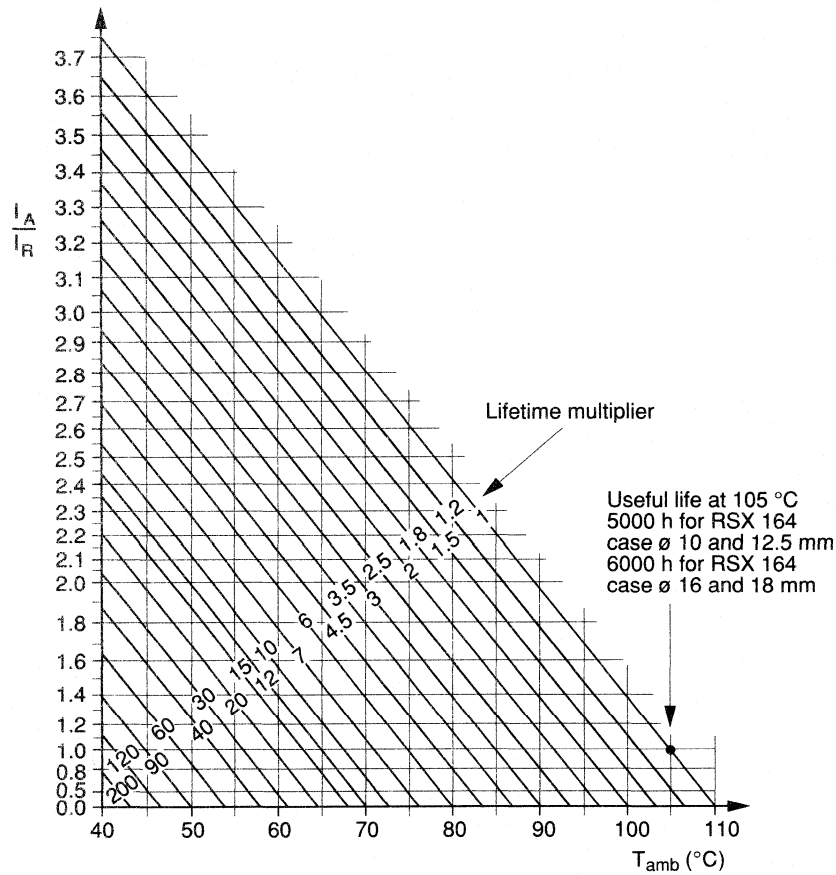


Fig. 13 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.
I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 105 °C

Table 5 Multiplier of ripple current I_R as a function of frequency

FREQUENCY	I_R-MULTIPLIER		
	U_R = 10 to 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50 Hz	0.85	0.80	0.75
100 Hz	1.00	1.00	1.00
300 Hz	1.20	1.25	1.30
1000 Hz	1.30	1.40	1.50
3000 Hz	1.35	1.50	1.65
≥ 10000 Hz	1.40	1.60	1.80

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

Voltage	
Surge voltage for short periods	$U_s \leq 1.15\ U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current	
After 1 minute at U_R	$I_{L1} \leq 0.02\ C_R\ U_R + 3\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R\ U_R + 3\ \mu A$

Equivalent series inductance (ESL)	
Case diameter = 10 mm	typ. 16 nH
Case diameter ≥ 12,5 mm	typ. 18 nH

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 6

TEST		PROCEDURE	SPECIFIC REQUIREMENTS
Name of test	Reference	(quick reference)	
Endurance	IEC 384-4-1/ CECC 30 301 group C 3, 4.13	T_{amb} = 105 °C, U_R applied 3000 hours	$\Delta C/C \leq \pm 15$ % tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640, sub clause 1.8.1	T_{amb} = 105 °C, U_R and I_R applied 5000 hours case ø 10 and 12.5 mm 6000 hours case ø 16 and 18 mm	$\Delta C/C \leq \pm 45$ % tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 105 °C, no voltage applied 2000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L5} \leq 2$ x spec. limit

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

FEATURES

- Polarized aluminium electrolytic capacitors, non solid
- Radial leads, cylindrical aluminium case with safety vent insulated with a blue sleeve
- Charge and discharge proof
- Very long useful life, high stability, high reliability
- Extended temperature range 125 °C
- High ripple current capability

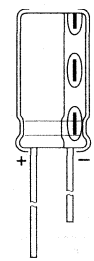


Fig.1 Component outline

APPLICATIONS

- EDB, telecommunication, industrial, automotive and military
- Smoothing, filtering, buffering in SMPS
- High ambient temperature environments
- Low PCB surface demand

4

QUICK REFERENCE DATA

Case size, $\varnothing D_{nom}$ x L_{nom} in mm	10 x 12 to 18 x 40
Rated capacitance range, C_R	33 to 4700 µF
Tolerance on C_R	±20 %
Rated voltage range, U_R	10 to 50 V
Category temperature range	–40 to +125 °C
Endurance test at 125 °C	1000 hours
Useful life at 125 °C	1500 hours
Useful life at 40 °C, 1.6 I_R applied	300000 hours
Shelf life at 0 V, 125 °C	500 hours
Basic specification	IEC 384-4, L.L. grade, CECC 30 300
Detail specification	similar to DIN 41 259
Climatic category IEC 68	40/125/56
Climatic category DIN 40 040	GKF

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (diameter x length in mm)

C_R	U_R (V)					
µF	**10**	**16**	**25**	**35**	**40**	**50**
33						10 x 12
47 *					10 x 12	10 x 16
68				10 x 12	10 x 16	10 x 20
100 *			10 x 12	10 x 16	10 x 20	12.5 x 20
150		10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 25
220 *	10 x 12	10 x 16	10 x 20		12.5 x 20	16 x 25
330	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31
470 *	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31	16 x 35
680	12.5 x 20	12.5 x 25	16 x 25	16 x 31	16 x 35	18 x 35
1000 *		12.5 x 25	16 x 31		16 x 35	18 x 40
1500	16 x 25	16 x 31	16 x 35	18 x 35		
2200 *	16 x 31	16 x 35	18 x 40			
3300	16 x 35	18 x 40				
4700 *	18 x 40					

* E3 values = preferred values

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

MECHANICAL DATA Dimensions (in mm)

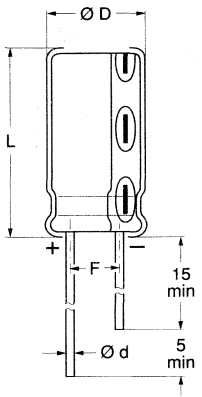


Fig. 2 **Form CA**, long leads;
see Table 2 for dimensions.

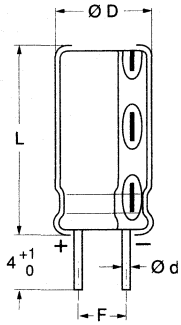
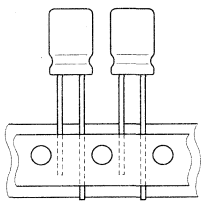
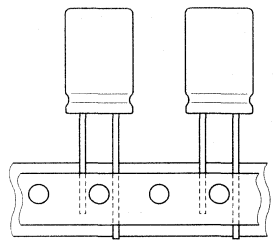


Fig. 3 **Form CB**, cut leads;
see Table 2 for dimensions.



øD = 10 mm and 12.5 mm



øD = 16 mm

Fig. 4 **Form TR+**, case sizes up to ø16 x 31 taped on reel, positive leading.
See Introduction for taping dimensions.

4

MARKING

The capacitors are marked with the following information:

- Rated capacitance value
- Tolerance on rated capacitance (M for ±20 %)
- Rated voltage
- Negative terminal identification
- Upper category temperature (125 °C)
- Group number (165)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62

Table 2 Dimensions (in mm)

CASE SIZE $\varnothing D_{nom}$ x L_{nom}	CASE CODE	RADIAL				MASS
		$\varnothing d$	$\varnothing D_{max}$	L_{max}	F ± 0,5	(g)
10 x 12	14	0.6	10.5	13.5	5.0	1.6
10 x 16	15	0.6	10.5	17.5	5.0	1.9
10 x 20	16	0.6	10.5	21.5	5.0	2.2
12.5 x 20	17	0.6	13.0	21.5	5.0	4.0
12.5 x 25	18	0.6	13.0	26.5	5.0	5.0
16 x 25	19	0.8	16.5	27.0	7.5	8.0
16 x 31	20	0.8	16.5	33.0	7.5	9.0
16 x 35	21	0.8	16.5	37.0	7.5	11.5
18 x 35	22	0.8	18.5	37.0	7.5	14.5
18 x 40	23	0.8	18.5	42.0	7.5	16.0

PACKING

Capacitors of Form CA and Form CB are supplied in boxes, those of Form TR+ taped on reel.
The numbers per box and per reel are given in Table 3.

Table 3 Packing quantities

CASE SIZE $\varnothing D_{nom}$ x L_{nom}	CASE CODE	NUMBER OF CAPACITORS		
		FORM CA per Box	FORM CB per Box	FORM TR+ per Reel
10 x 12	14	1000	1000	500
10 x 16	15	500	500	500
10 x 20	16	500	500	500
12.5 x 20	17	200	200	200
12.5 x 25	18	200	200	200
16 x 25	19	200	200	150
16 x 31	20	200	200	150
16 x 35	21	150	150	
18 x 35	22	100	100	
18 x 40	23	100	100	

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 4 apply at an ambient temperature of 20 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75 %.

C_R = rated capacitance at 100 Hz, tolerance ±20 %

I_R = rated RMS ripple current at 100 Hz, 125 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz or 100 kHz

Table 4 Electrical data

U_R	C_R	CASE SIZE $øD_{nom}$ x L_{nom}	I_R	I_{L1}	I_{L5}	tan δ	ESR	Z	
								at 10 kHz	at 100 kHz
(V)	(µF)	(mm)	(mA)	(µA)	(µA)		(Ω)	(Ω)	(Ω)
10	220	10 x 12	200	47	7	0.20	1.30		0.55
	330	10 x 16	260	69	10	0.20	0.87		0.36
	470	10 x 20	340	97	12	0.20	0.61		0.26
	680	12.5 x 20	440	140	17	0.20	0.42		0.18
	1500	16 x 25	750	300	33	0.22	0.21	0.10	
	2200	16 x 31	930	440	47	0.24	0.16	0.07	
	3300	16 x 35	1200	660	69	0.26	0.11	0.05	
	4700	18 x 40	1400	940	97	0.28	0.09	0.04	
16	150	10 x 12	190	51	8	0.16	1.50		0.63
	220	10 x 16	240	73	10	0.16	1.00		0.43
	330	10 x 20	320	110	14	0.16	0.69		0.29
	470	12.5 x 20	410	150	18	0.16	0.49		0.20
	680	12.5 x 25	540	220	25	0.16	0.34		0.14
	1000	12.5 x 25	650	320	35	0.16	0.23		0.10
	1500	16 x 31	910	480	51	0.18	0.17	0.07	
	2200	16 x 35	1100	710	73	0.20	0.13	0.05	
	3300	18 x 40	1400	1100	110	0.22	0.10	0.04	
25	100	10 x 12	170	53	8	0.14	2.00		0.70
	150	10 x 16	210	78	11	0.14	1.30		0.47
	220	10 x 20	280	110	14	0.14	0.91		0.32
	330	12.5 x 20	370	170	20	0.14	0.61		0.21
	470	12.5 x 25	480	240	27	0.14	0.43		0.15
	680	16 x 25	630	340	37	0.14	0.30		0.10
	1000	16 x 31	830	500	53	0.14	0.20		0.07
	1500	16 x 35	1000	750	78	0.16	0.15	0.06	
	2200	18 x 40	1200	1100	110	0.18	0.12	0.04	

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

ORDERING EXAMPLE

Electrolytic capacitors RHT 165
1500 µF/16 V, ±20 %
16 x 31, taped on reel, Form TR+
Catalogue number 2222 165 25152

Ordering information

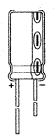
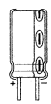
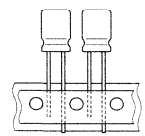
U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$\varnothing D_{nom}$ x L_{nom}			
(V)	(µF)	(mm)	Form CA	Form CB	Form TR+
10	220	10 x 12	165 54221	165 64221	165 24221
	330	10 x 16	54331	64331	24331
	470	10 x 20	54471	64471	24471
	680	12.5 x 20	54681	64681	24681
	1500	16 x 25	54152	64152	24152
	2200	16 x 31	54222	64222	24222
	3300	16 x 35	54332	64332	
	4700	18 x 40	54472	64472	
16	150	10 x 12	165 55151	165 65151	165 25151
	220	10 x 16	55221	65221	25221
	330	10 x 20	55331	65331	25331
	470	12.5 x 20	55471	65471	25471
	680	12.5 x 25	55681	65681	25681
	1000	12.5 x 25	55102	65102	25102
	1500	16 x 31	55152	65152	25152
	2200	16 x 35	55222	65222	
	3300	18 x 40	55332	65332	
25	100	10 x 12	165 56101	165 66101	165 26101
	150	10 x 16	56151	66151	26151
	220	10 x 20	56221	66221	26221
	330	12.5 x 20	56331	66331	26331
	470	12.5 x 25	56471	66471	26471
	680	16 x 25	56681	66681	26681
	1000	16 x 31	56102	66102	26102
	1500	16 x 35	56152	66152	
	2200	18 x 40	56222	66222	

Table 4 Electrical data (continued)

U_R (V)	C_R (µF)	CASE SIZE $øD_{nom}$ x L_{nom} (mm)	I_R (mA)	I_{L1} (µA)	I_{L5} (µA)	tan δ	ESR (Ω)	Z at 10 kHz (Ω)	Z at 100 kHz (Ω)
35	68	10 x 12	160	51	8	0.12	2.50		0.96
	100	10 x 16	200	73	10	0.12	1.70		0.65
	150	10 x 20	270	110	14	0.12	1.10		0.43
	330	12.5 x 25	460	230	26	0.12	0.52		0.20
	470	16 x 25	600	330	36	0.12	0.37		0.14
	680	16 x 31	790	480	51	0.12	0.25		0.10
	1500	18 x 35	1200	1100	110	0.13	0.12	0.05	
40	47	10 x 12	130	41	7	0.12	3.70		1.30
	68	10 x 16	160	57	8	0.12	2.50		0.88
	100	10 x 20	210	83	11	0.12	1.70		0.60
	150	12.5 x 20	290	120	15	0.12	1.10		0.40
	220	12.5 x 20	340	180	21	0.12	0.78		0.27
	330	16 x 25	510	270	29	0.12	0.52		0.18
	470	16 x 31	650	380	41	0.12	0.37		0.13
	680	16 x 35	830	550	57	0.12	0.25		0.09
	1000	16 x 35	1000	800	83	0.12	0.17		0.06
50	33	10 x 12	120	36	6	0.10	4.30		1.50
	47	10 x 16	150	50	8	0.10	3.00		1.10
	68	10 x 20	190	71	10	0.10	2.10		0.74
	100	12.5 x 20	260	100	13	0.10	1.40		0.50
	150	12.5 x 25	340	150	18	0.10	0.96		0.33
	220	16 x 25	450	220	25	0.10	0.65		0.23
	330	16 x 31	600	330	36	0.10	0.43		0.15
	470	16 x 35	760	470	50	0.10	0.30		0.11
	680	18 x 35	920	680	71	0.10	0.21		0.07
	1000	18 x 40	1200	1000	100	0.10	0.14		0.05

Voltage

Surge voltage for short periods	$U_s \leq 1.5\ U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.02\ C_R\ U_R + 3$ µA
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R\ U_R + 3$ µA

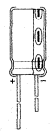
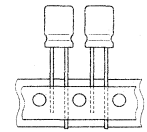
Equivalent series inductance (ESL)

Case diameter = 10 mm	typ. 16 nH
Case diameter ≥ 12,5 mm	typ. 18 nH

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

Ordering information (continued)

U_R	C_R	CASE SIZE	CATALOGUE NUMBER 2222		
		$øD_{nom} \times L_{nom}$			
(V)	(µF)	(mm)	Form CA	Form CB	Form TR+
35	68	10 x 12	165 50689	165 60689	165 20689
	100	10 x 16	50101	60101	20101
	150	10 x 20	50151	60151	20151
	330	12.5 x 25	50331	60331	20331
	470	16 x 25	50471	60471	20471
	680	16 x 31	50681	60681	20681
	1500	18 x 35	50152	60152	
40	47	10 x 12	165 57479	165 67479	165 27479
	68	10 x 16	57689	67689	27689
	100	10 x 20	57101	67101	27101
	150	12.5 x 20	57151	67151	27151
	220	12.5 x 20	57221	67221	27221
	330	16 x 25	57331	67331	27331
	470	16 x 31	57471	67471	27471
	680	16 x 35	57681	67681	
	1000	16 x 35	57102	67102	
50	33	10 x 12	165 51339	165 61339	165 21339
	47	10 x 16	51479	61479	21479
	68	10 x 20	51689	61689	21689
	100	12.5 x 20	51101	61101	21101
	150	12.5 x 25	51151	61151	21151
	220	16 x 25	51221	61221	21221
	330	16 x 31	51331	61331	21331
	470	16 x 35	51471	61471	
	680	18 x 35	51681	61681	
	1000	18 x 40	51102	61102	

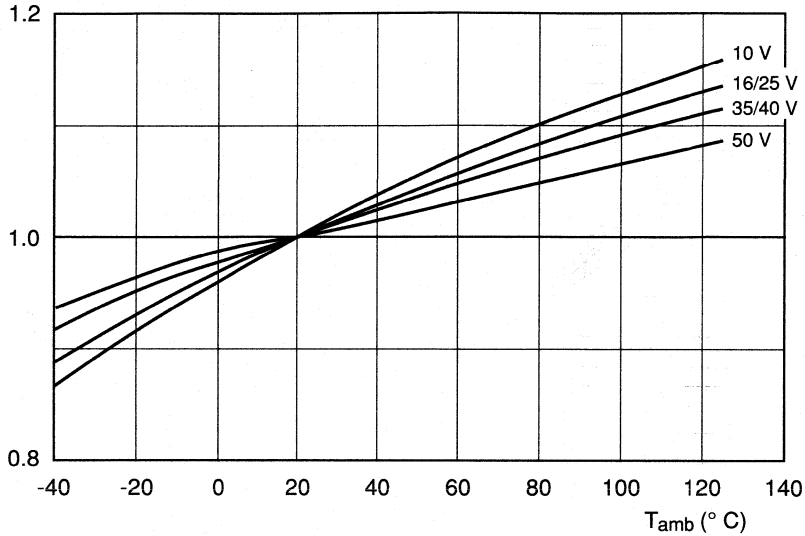


Fig. 5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature;
C_0 = Capacitance at 20 °C, 100 Hz.

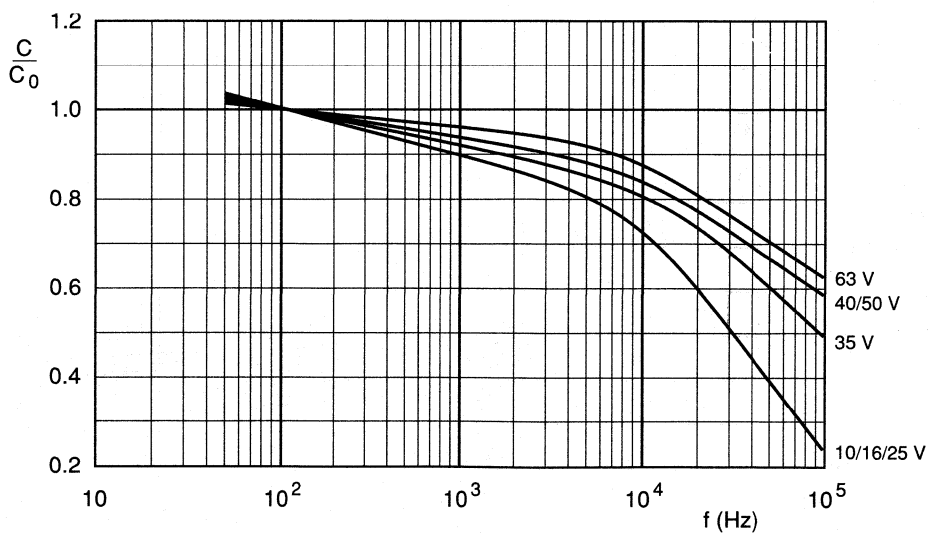


Fig. 6 Typical multiplier of capacitance (C/C_0) as a function of frequency;
C_0 = Capacitance at 20 °C, 100 Hz.

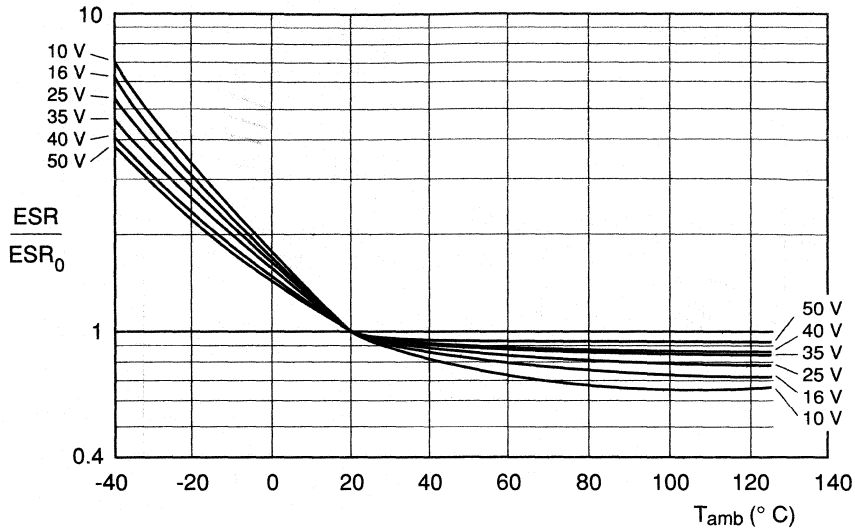


Fig. 7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; ESR_0 = typical ESR at 20 °C, 100 Hz.

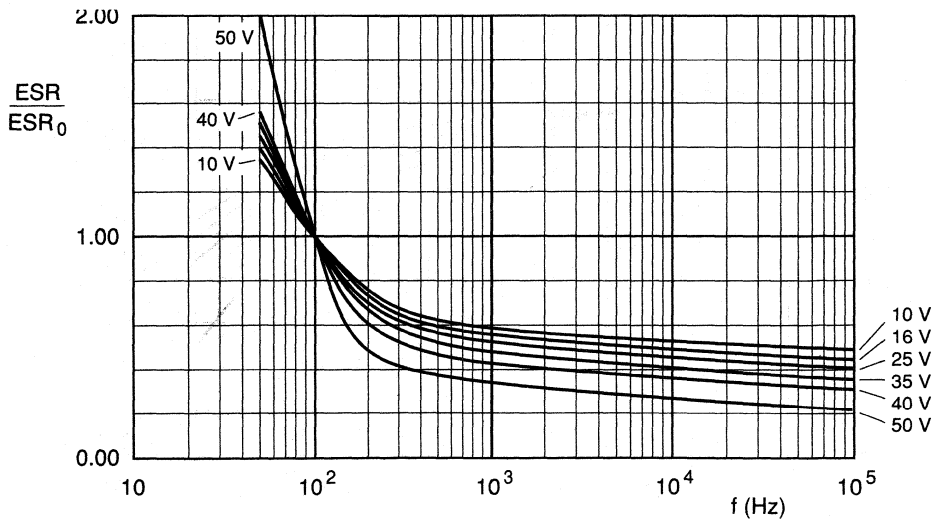


Fig. 8 Multiplier of ESR (ESR/ESR_0) as a function of frequency; ESR_0 = typical ESR at 20 °C, 100 Hz.

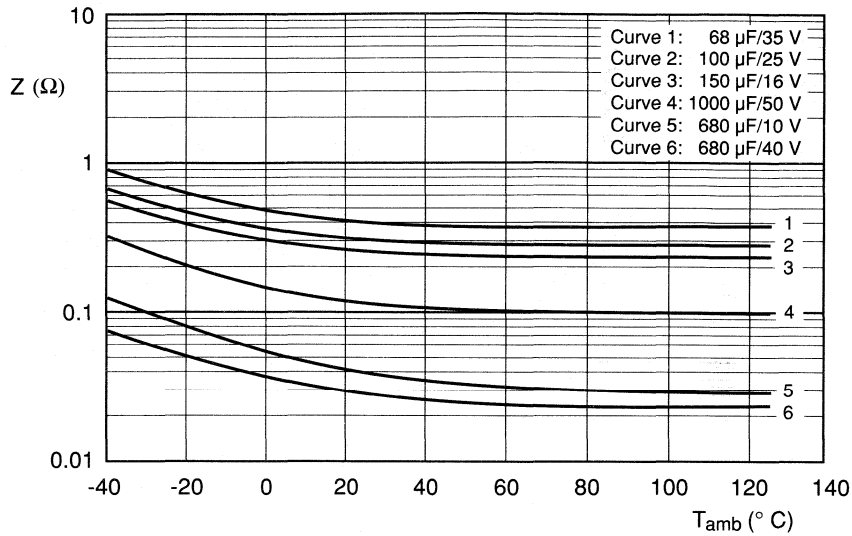


Fig. 9 Typical impedance at 100 kHz as a function of ambient temperature.

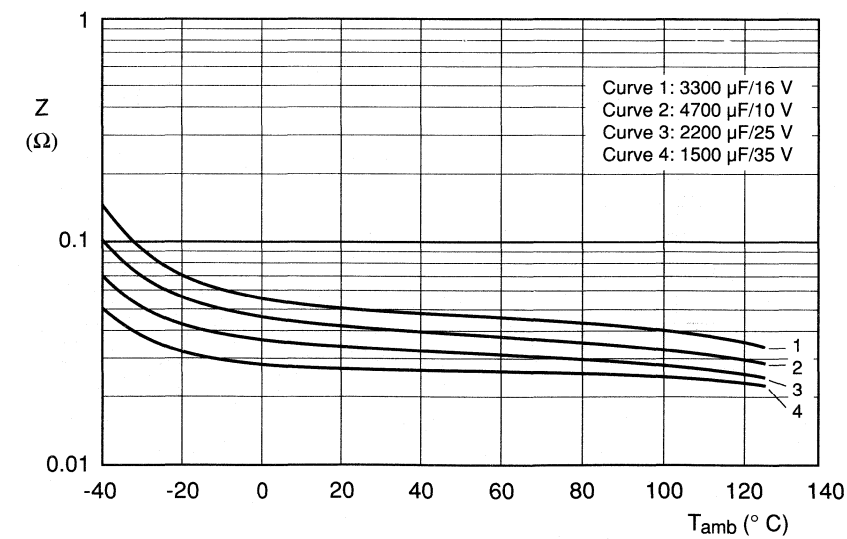


Fig. 10 Typical impedance at 10 kHz as a function of ambient temperature.

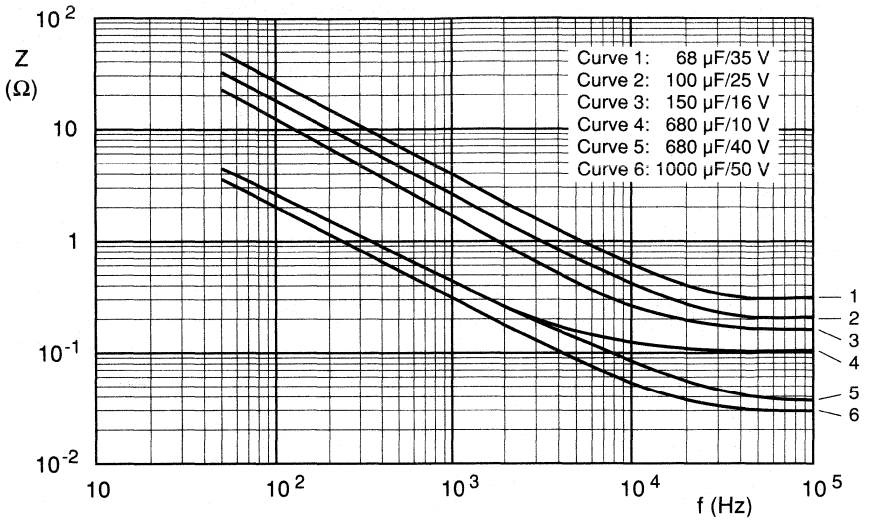


Fig. 11 Typical impedance as a function of frequency at T_{amb} = 20 °C.

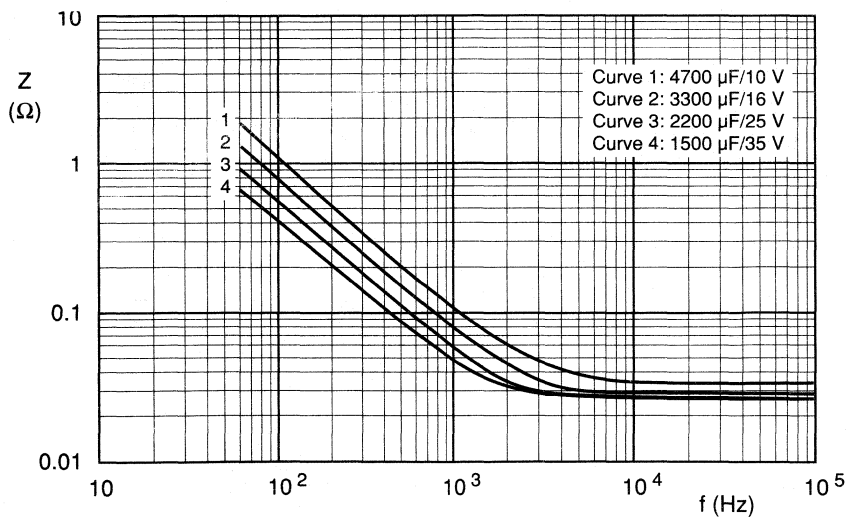


Fig. 12 Typical impedance as a function of frequency at T_{amb} = 20 °C.

USEFUL LIFE

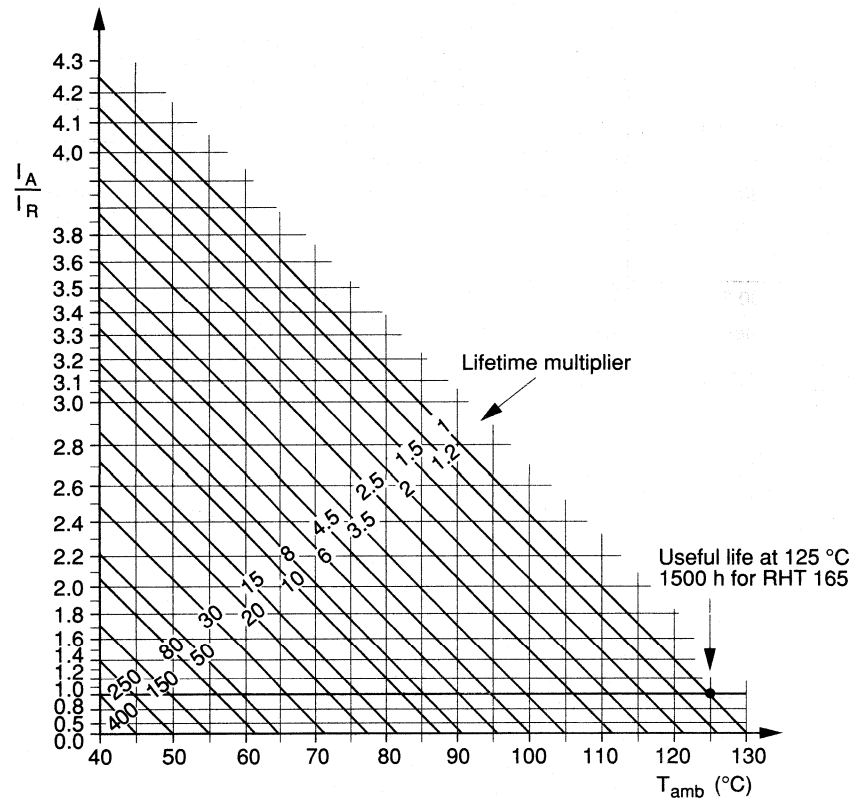


Fig. 13 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.
I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 125 °C

Table 5 Multiplier of ripple current I_R as a function of frequency

FREQUENCY	I_R-MULTIPLIER		
	U_R = 10 to 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50 Hz	0.85	0.80	0.75
100 Hz	1.00	1.00	1.00
300 Hz	1.20	1.25	1.30
1000 Hz	1.30	1.40	1.50
3000 Hz	1.35	1.50	1.65
≥ 10000 Hz	1.40	1.60	1.80

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

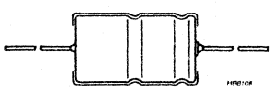
Table 6

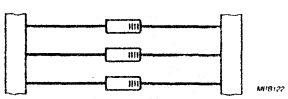
TEST		PROCEDURE	SPECIFIC REQUIREMENTS
Name of test	**Reference**	**(quick reference)**	
Endurance	IEC 384-4-1/ CECC 30 301, group C 3, 4.13	T_{amb} = 125 °C, U_R applied 1000 hours	$\Delta C/C \leq \pm 15$ % tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301, amendment 2640, sub clause 1.8.1	T_{amb} = 125 °C, U_R and I_R applied 1500 hours	$\Delta C/C \leq \pm 45$ % tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 125 °C, no voltage applied 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L5} \leq 2$ x spec. limit

Electrolytic Capacitors

Notes

AXIAL NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS





dimension (smaller)

CU per volume (higher)

MINIATURE	*STANDARD & SEMI-PROFESSIONAL*	*LONG-LIFE*	*EXTRA LONG-LIFE or HIGH TEMP.*
1500-2000 hours	2500-8000 hours	10-15 000 hours / 85°C	4000 hours
85°C	85°C	2-3000 hours / 105°C	125°C
	ALC 065 *low leakage* *Page 454*	**ALL-IEC 108** *maintenance* *Page 548*	
	Page 466 **AS 030-033** *LV* **ASH 041-043** *HV* *Page 490*	**ALL-DIN 132** *LV* **ALL-DIN 133** *HV* *Page 528*	**AHT-DIN 119** *Page 584*
Page 466 **AS 030** Ø D = 3.3 mm **ASD 117** *Page 402*	**ASM 021** *Page 428*	**AML 138** *Page 506*	**AHT 118** *Page 560*
	ASC 049 *Page 412*		

Non-solid Al - electrolytic capacitors Axial, Smallest Diameter

ASD 117

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Taped for automatic insertion
- Charge and discharge proof
- Ultra miniature, diameter 3.3 mm.

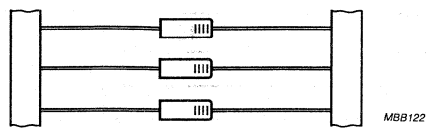


Fig.1 Component outlines.

APPLICATIONS

- General purpose, low profile and lightweight equipment
- Smoothing, filtering, buffering, decoupling, timing
- Boards with restricted mounting height.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	3.3 x 8 and 3.3 x 11
Rated capacitance range, C_R	0.1 to 22 µF
Tolerance on C_R	–10 to +50% (±20% to special order)
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	–40 to +85 °C
Endurance test at 85 °C	1500 hours
Useful life at 85 °C	2000 hours
Useful life at 40 °C, 1.4 I_R applied	60 000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specification	IEC 384-4/CECC 30 300 GP grade
Detail specification	DIN 41322 type II
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

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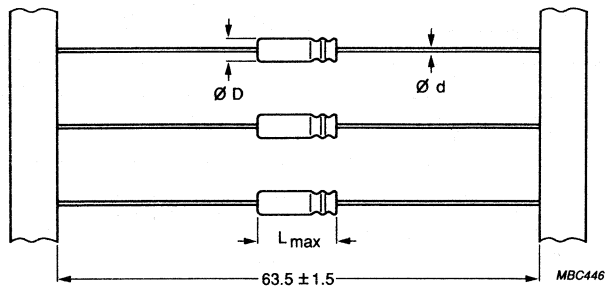
Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (Ø **D x L** in **mm**)

C_R (µF)	U_R (V)					
	6.3	**10**	**16**	**25**	**40**	**63**
0.1						3.3 x 8
0.22						3.3 x 8
0.47						3.3 x 8
1.0						3.3 x 8
1.5						3.3 x 8
2.2					3.3 x 8	3.3 x 11
3.3				3.3 x 8		3.3 x 11
4.7			3.3 x 8		3.3 x 11	
6.8		3.3 x 8		3.3 x 11		
10	3.3 x 8		3.3 x 11			
15		3.3 x 11				
22	3.3 x 11					

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING".



Form BR: Taped on reel.
Form BA: Taped in box.

Fig.2 Case sizes 3.3 x 8 and 3.3 x 11, insulated with a blue plastic sleeve.

Table 2 Dimensions in mm; mass in g

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	AXIAL: Form BA and BR				APPROX. MASS	PACKING QUANTITIES	
		Ød	$\varnothing D_{max}$	L_{max}	F_{min}		Form BA	Form BR
3.3 x 8	1a	0.6	3.5	9	12.5	0.3	1000	4000
3.3 x 11	1	0.6	3.5	12	15	0.35	1000	4000

5

Non-solid Al - electrolytic capacitors
Axial, Smallest Diameter

ASD 117

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance −10 to +50%

I_R = rated RMS ripple current at 100 Hz, 85 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz.

Ordering Example

Electrolytic Capacitor ASD 117
10 µF/16 V, −10/+50%
Case size 3.3 x 11; Form BR
Catalogue number:
2222 117 25109.

Table 3 Electrical data and ordering information

U_R	C_R 100 Hz	NOMINAL CASE SIZE ∅ D x L	CASE CODE	I_R 100 Hz 85 °C	I_{L1} 1 min	I_{L5} 5 min	Tan δ 100 Hz	ESR 100 Hz	Z 10 kHz	CATALOGUE NUMBER 2222	
										ON REEL Form BR	IN BOX Form BA
(V)	(µF)	(mm)		(mA)	(µA)	(µA)		(Ω)	(Ω)		
6.3	10	3.3 x 8	1a	11	4	3	0.30	48	20	117 23109	117 33109
	22	3.3 x 11	1	20	6	3	0.30	22	9	117 23229	117 33229
10	6.8	3.3 x 8	1a	10	4	3	0.25	59	24	117 24688	117 34688
	15	3.3 x 11	1	18	6	3	0.25	27	11	117 24159	117 34159
16	4.7	3.3 x 8	1a	9	5	3	0.20	68	26	117 25478	117 35478
	10	3.3 x 11	1	16	6	3	0.20	32	12	117 25109	117 35109
25	3.3	3.3 x 8	1a	8	5	3	0.18	87	27	117 26338	117 36338
	6.8	3.3 x 11	1	14	6	3	0.18	42	13	117 26688	117 36688
40	2.2	3.3 x 8	1a	7	5	3	0.16	120	32	117 27228	117 37228
	4.7	3.3 x 11	1	13	7	3	0.16	54	15	117 27478	117 37478
63	0.1	3.3 x 8	1a	2	4	3	0.10	1600	550	117 28107	117 38107
	0.22	3.3 x 8	1a	3	4	3	0.10	720	250	117 28227	117 38227
	0.47	3.3 x 8	1a	4	4	3	0.10	340	120	117 28477	117 38477
	1	3.3 x 8	1a	6	4	3	0.12	190	55	117 28108	117 38108
	1.5	3.3 x 8	1a	7	5	3	0.14	150	37	117 28158	117 38158
	2.2	3.3 x 11	1	11	6	3	0.14	87	25	117 28228	117 38228
	3.3	3.3 x 11	1	13	7	3	0.14	68	17	117 28338	117 38338

Non-solid Al - electrolytic capacitors
Axial, Smallest Diameter

ASD 117

Marking

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Rated voltage in V
- Group number (117)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Band to identify the negative terminal.

Voltage

Surge voltage for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

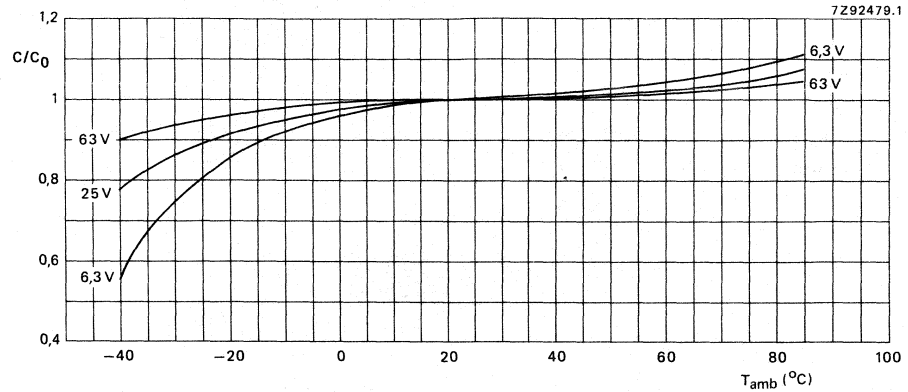
After 1 minute at U_R	$I_{L1} \leq 0.02\ C_R \times U_R + 3\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$

Equivalent series inductance (ESL)

Table 4 Equivalent series inductance, typical values

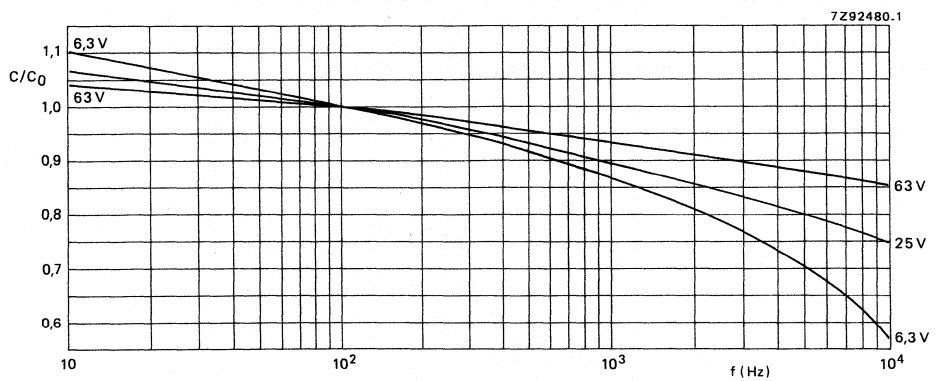
CASE SIZE (∅ x L) (mm)	TYP. ESL (nH)
3.3 x 8	13
3.3 x 11	15

Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

Fig.3 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz.

Fig.4 Multiplier of capacitance (C/C_0) as a function of frequency.

Dissipation factor (tan δ)

Curve 1: 6.3 V
Curve 2: 10 V
Curve 3: 16 V
Curve 4: 25 V
Curve 5: 40 V
Curve 6: 63 V, 1.5 to 3.3 µF
Curve 7: 63 V, 1 µF
Curve 8: 63 V, 0.22 to 0.47 µF
Curve 9: 0.1 µF.

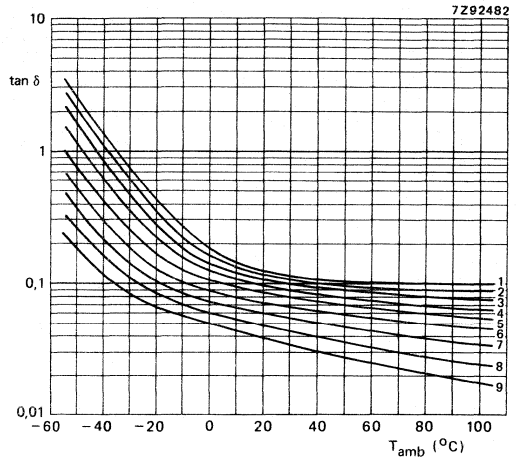


Fig.5 Typical tan δ as a function of ambient temperature at 100 Hz.

Curve 1: 6.3 V
Curve 2: 10 V
Curve 3: 16 V
Curve 4: 25 V
Curve 5: 40 V
Curve 6: 63 V, 1.5 to 3.3 µF
Curve 7: 63 V, 1 µF
Curve 8: 63 V, 0.22 to 0.47 µF
Curve 9: 0.1 µF.

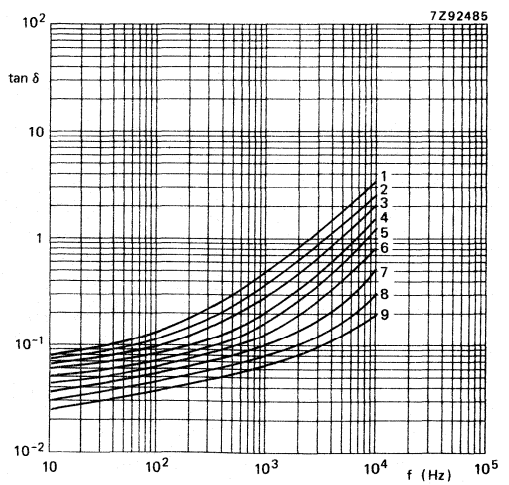
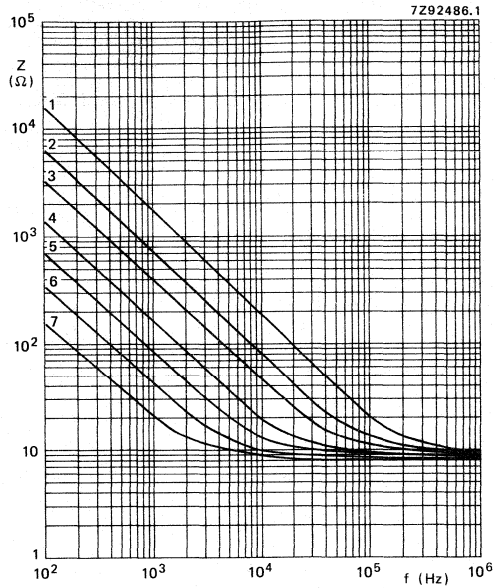


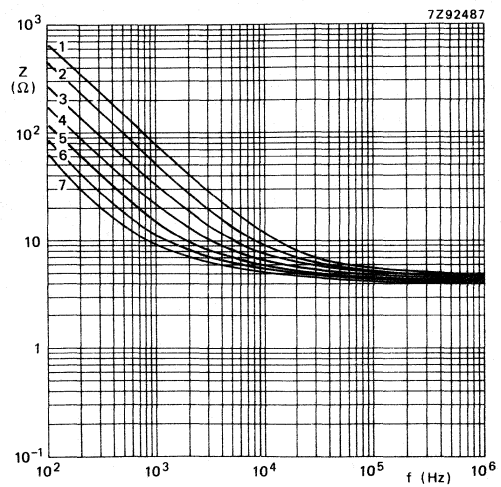
Fig.6 Typical tan δ as a function of frequency at 20 °C.

Impedance (Z)



Curve 1: 0.1 µF
Curve 2: 0.22 µF
Curve 3: 0.47 µF
Curve 4: 1 µF
Curve 5: 2.2 µF
Curve 6: 4.7 µF
Curve 7: 10 µF.

Fig.7 Typical impedance as a function of frequency at 20 °C; case size 3.3 x 8.



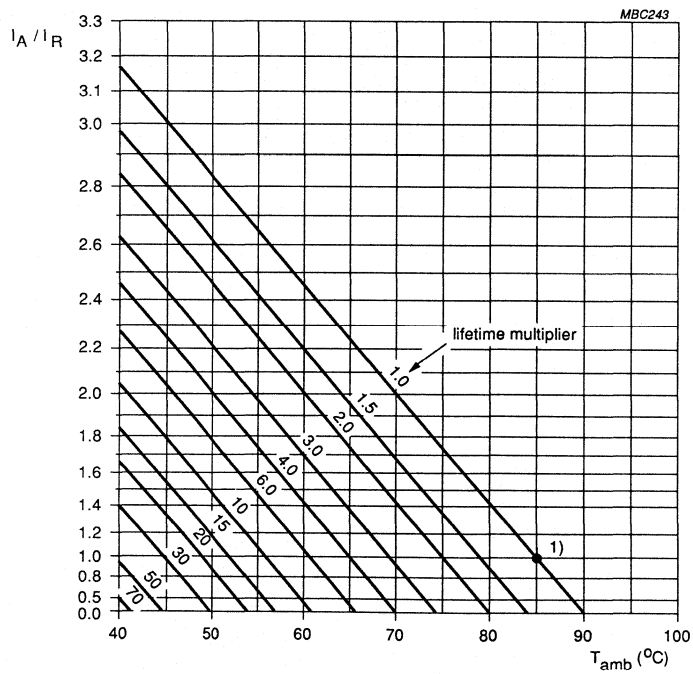
Curve 1: 2.2 µF
Curve 2: 3.3 µF
Curve 3: 4.7 µF
Curve 4: 6.8 µF
Curve 5: 10 µF
Curve 6: 15 µF
Curve 7: 22 µF.

Fig.8 Typical impedance as a function of frequency at 20 °C; case size 3.3 x 11.

RIPPLE CURRENT and USEFUL LIFE

Table 5 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 85 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 16 V	U_R = 25 to 40 V	U_R = 63 V
50	0.8	0.75	0.7
100	1.0	1.0	1.0
300	1.2	1.3	1.55
1000	1.35	1.55	1.9
3000	1.45	1.7	2.3
≥10 000	1.5	1.8	2.5



I_A = actual ripple current at 100 Hz.

I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied: 2000 hours.

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied 1500 hours	ΔC/C ±20% tan δ ≤2 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 2000 hours	ΔC/C ±50% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

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FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case with safety vent, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Taped version up to 15 x 30 available for automatic insertion
- Charge and discharge proof
- Useful life: 5000 hours at 85 °C
- Highly miniaturized, extremely high CU-product per unit volume.

APPLICATIONS

- Audio-video, automotive and telecommunication
- Smoothing, filtering, buffering, timing
- Portable and mobile equipment (small size, low mass)
- Boards with restricted mounting height, vibration and shock resistant
- Equipment in compact design.

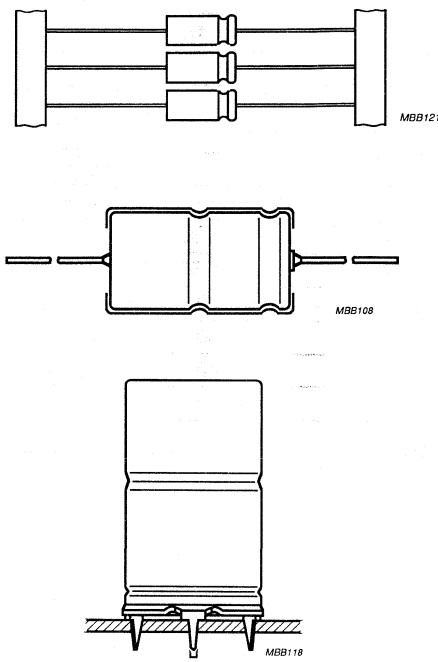


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	10 x 30 to 21 x 40
Rated capacitance range, C_R	330 to 22 000 µF
Tolerance on C_R	±20%
Rated voltage range, U_R	10 to 63 V
Category temperature range	–40 to +85 °C
Endurance test at 85 °C	2000 hours
Useful life at 85 °C	5000 hours
Useful life at 40 °C, 1.4 I_R applied	120 000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 41316 (with reduced dimensions)
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**)

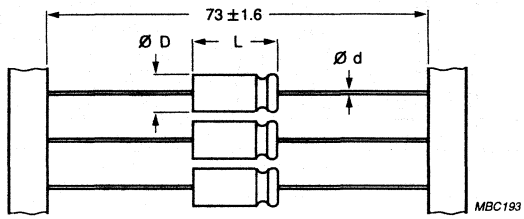
C_R (µF)	U_R (V)					
	10	**16**	**25**	**40**	**50**	**63**
330						10 x 30
470	for smaller CV - values see ASM 021 series				10 x 30	12.5 x 30
680				10 x 30	12.5 x 30	12.5 x 30
1000			10 x 30	12.5 x 30	12.5 x 30 [1]	15 x 30
1500		10 x 30	12.5 x 30	15 x 30	15 x 30 [1]	18 x 30
2200	10 x 30	12.5 x 30	12.5 x 30	15 x 30 [1]	18 x 30	18 x 40
3300	12.5 x 30	12.5 x 30	15 x 30	18 x 30 [1]	18 x 40	21 x 40
4700	12.5 x 30	15 x 30	18 x 30	18 x 40	21 x 40	
6800	15 x 30	18 x 30	18 x 40	21 x 40		
10 000	18 x 30	18 x 40	21 x 40			
15 000	18 x 40	21 x 40				
22 000	21 x 40					

Note

[1] Available to special order.

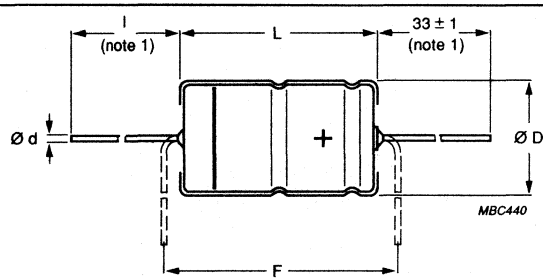
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING",



Form BR: Taped on reel.

Fig.2 Case sizes 10 x 30 to 15 x 30.



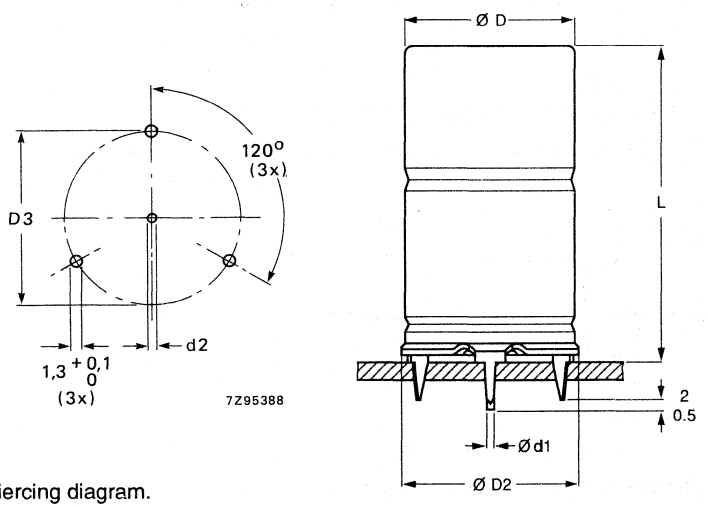
Form AA: Axial in box.
For case sizes 18 x 40 and 21 x 40, the stated L may be exceeded by 0.7 mm.

Fig.3 Case sizes 10 x 30 to 21 x 40.

5

Table 2 Axial, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	AXIAL: Form AA and BR					APPROX. MASS	PACKING QUANTITIES	
		∅d	l	∅D_{max}	L_{max}	F_{min}		Form AA	Form BR
10 x 30	00	0.8	55 ±1	10.5	30.5	35	4.8	200	500
12.5 x 30	01	0.8	55 ±1	13.0	30.5	35	7.4	200	400
15 x 30	02	0.8	55 ±1	15.5	30.5	35	11.7	200	250
18 x 30	03	0.8	55 ±1	18.5	30.5	35	12.9	200	–
18 x 40	04	0.8	34 ±1	18.5	41.5	45	19.4	100	–
21 x 40	05	0.8	34 ±1	21.5	41.5	45	24.7	100	–



Piercing diagram.

Form MR: case not insulated (insulation on request).
Especially for applications with severe shocks and vibrations.

Fig.4 Case sizes 15 x 30 to 21 x 40, single ended with mounting ring and pins.

Table 3 Single ended, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	SINGLE ENDED WITH MOUNTING RING: Form MR						APPROX. MASS	PACKING QUANTITIES
		∅d_1	∅d_2	∅D_{max}	∅$D2_{max}$	D3	L_{max}		
15 x 30	02	0.8	1.0 +0.1	15.5	17.5	16.5 ±0.2	33	11.7	200
18 x 30	03	0.8	1.0 +0.1	18.5	19.5	18.5 ±0.2	33	12.9	200
18 x 40	04	1.0	1.3 +0.1	18.5	19.5	18.5 ±0.2	45	19.4	100
21 x 40	05	1.0	1.3 +0.1	21.5	22.5	21.5 ±0.2	45	24.7	100

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance ±20%
I_R = rated RMS ripple current at 100 Hz, 85 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = max. equivalent series resistance at 100 Hz
Z = max. impedance at 10 kHz

Table 4 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)
10	2200	10 x 30	595	136	48	0.31	225	150
	3300	12.5 x 30	920	202	70	0.28	155	105
	4700	12.5 x 30	900	286	98	0.50	184	155
	6800	15 x 30	1120	412	140	0.43	100	75
	10 000	18 x 30	1370	604	204	0.51	81	56
	15 000	18 x 40	1770	904	304	0.59	63	44
	22 000	21 x 40	2160	1320	444	0.69	50	38
16	1500	10 x 30	580	148	52	0.22	238	150
	2200	12.5 x 30	880	215	74	0.20	145	105
	3300	12.5 x 30	850	321	110	0.36	189	155
	4700	15 x 30	1120	455	153	0.30	100	69
	6800	18 x 30	1430	657	222	0.32	75	56
	10 000	18 x 40	1770	964	323	0.39	63	44
	15 000	21 x 40	2160	1440	484	0.47	50	38
25	1000	10 x 30	540	154	54	0.17	275	150
	1500	12.5 x 30	780	229	79	0.16	170	105
	2200	12.5 x 30	750	334	114	0.25	203	155
	3300	15 x 30	1080	499	169	0.22	106	69
	4700	18 x 30	1370	709	239	0.24	81	56
	6800	18 x 40	1690	1020	344	0.29	69	44
	10 000	21 x 40	1840	1500	504	0.43	69	38

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor ASC 049
4700 µF/16 V, ±20%
Case size 15 x 30; Form BR
Catalogue number: 2222 049 25472.

Table 5 Ordering information

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				AXIAL		SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	MOUNTING RING Form MR
10	2200	10 x 30	00	049 14222	049 24222	–
	3300	12.5 x 30	01	049 14332	049 24332	–
	4700	12.5 x 30	01	049 14472	049 24472	–
	6800	15 x 30	02	049 14682	049 24682	049 44682
	10 000	18 x 30	03	049 14103	–	049 44103
	15 000	18 x 40	04	049 14153	–	049 44153
	22 000	21 x 40	05	049 14223	–	049 44223
16	1500	10 x 30	00	049 15152	049 25152	–
	2200	12.5 x 30	01	049 15222	049 25222	–
	3300	12.5 x 30	01	049 15332	049 25332	–
	4700	15 x 30	02	049 15472	049 25472	049 45472
	6800	18 x 30	03	049 15682	–	049 45682
	10 000	18 x 40	04	049 15103	–	049 45103
	15 000	21 x 40	05	049 15153	–	049 45153
25	1000	10 x 30	00	049 16102	049 26102	–
	1500	12.5 x 30	01	049 16152	049 26152	–
	2200	12.5 x 30	01	049 16222	049 26222	–
	3300	15 x 30	02	049 16332	049 26332	049 46332
	4700	18 x 30	03	049 16472	–	049 46472
	6800	18 x 40	04	049 16682	–	049 46682
	10 000	21 x 40	05	049 16103	–	049 46103

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)
40	680	10 x 30	450	167	59	0.17	400	263
	1000	12.5 x 30	730	244	84	0.14	220	150
	1500	15 x 30	960	364	124	0.14	140	90
	2200 [1]	15 x 30	920	532	180	0.22	175	119
	3300 [1]	18 x 30	1100	796	268	0.24	125	94
	4700	18 x 40	1360	1130	380	0.29	106	75
	6800	21 x 40	1690	1640	548	0.43	81	63
50	470	10 x 30	480	145	51	0.10	345	178
	680	12.5 x 30	620	208	72	0.11	264	146
	1000 [1]	12.5 x 30	600	304	104	0.23	390	325
	1500 [1]	15 x 30	695	454	154	0.23	265	220
	2200	18 x 30	925	664	224	0.24	185	160
	3300	18 x 40	1270	994	334	0.24	125	110
	4700	21 x 40	1560	1410	474	0.26	98	85
63	330	10 x 30	440	129	46	0.09	419	250
	470	12.5 x 30	610	182	63	0.09	280	165
	680	12.5 x 30	550	261	90	0.19	475	400
	1000	15 x 30	815	382	130	0.12	188	119
	1500	18 x 30	1050	571	193	0.13	139	94
	2200	18 x 40	1360	836	280	0.15	106	75
	3300	21 x 40	1690	1250	420	0.17	81	56

Note

[1] Available to special order.

Non-solid Al - electrolytic capacitors
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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				AXIAL		SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	MOUNTING RING Form MR
40	680	10 x 30	00	049 17681	049 27681	–
	1000	12.5 x 30	01	049 17102	049 27102	–
	1500	15 x 30	02	049 17152	049 27152	049 47152
	2200 [1]	15 x 30	02	049 17222	049 27222	049 47222
	3300 [1]	18 x 30	03	049 17332	–	049 47332
	4700	18 x 40	04	049 17472	–	049 47472
	6800	21 x 40	05	049 17682	–	049 47682
50	470	10 x 30	00	049 11471	049 21471	–
	680	12.5 x 30	01	049 11681	049 21681	–
	1000 [1]	12.5 x 30	01	049 11102	049 21102	–
	1500 [1]	15 x 30	02	049 11152	049 21152	049 41152
	2200	18 x 30	03	049 11222	–	049 41222
	3300	18 x 40	04	049 11332	–	049 41332
	4700	21 x 40	05	049 11472	–	049 41472
63	330	10 x 30	00	049 18331	049 28331	–
	470	12.5 x 30	01	049 18471	049 28471	–
	680	12.5 x 30	01	049 18681	049 28681	–
	1000	15 x 30	02	049 18102	049 28102	049 48102
	1500	18 x 30	03	049 18152	–	049 48152
	2200	18 x 40	04	049 18222	–	049 48222
	3300	21 x 40	05	049 18332	–	049 48332

Note

[1] Available to special order.

Marking

The capacitors are marked (where possible) with the following information:

- Rated capacitance in μF
- Tolerance on rated capacitance
- Rated voltage in V
- Group number (049)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Band to identify the negative terminal
- "+" - signs to identify the positive terminal.

Voltage

Surge voltage for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

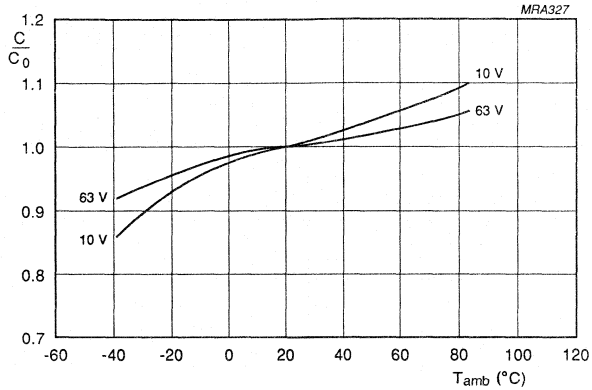
After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

Equivalent series inductance (ESL)

Table 6 Equivalent series inductance, typical values

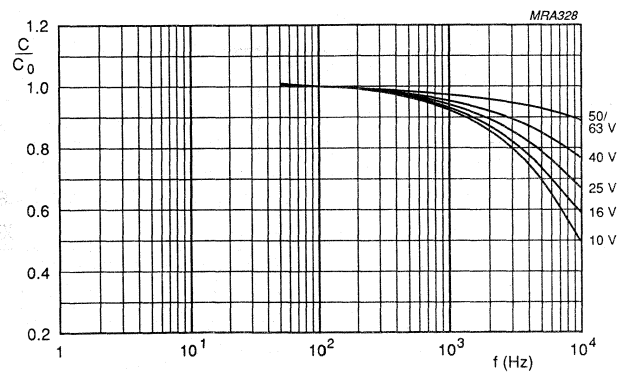
CASE SIZE (∅ x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)
10 x 30	38	–
12.5 x 30	46	–
15 x 30	48	39
18 x 30	50	39
18 x 40	54	39
21 x 40	59	39

Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

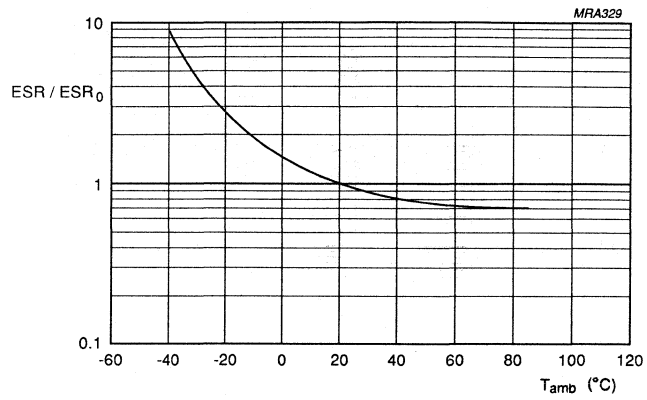
Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz.

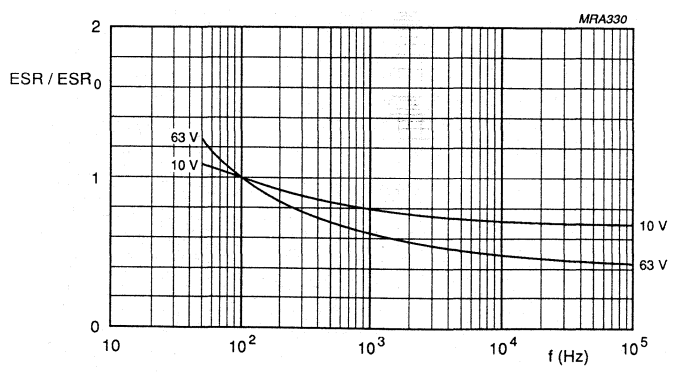
Fig.6 Multiplier of capacitance (C/C_0) as a function of frequency.

Equivalent series resistance (ESR)



ESR_0 = typical ESR at 20 °C, 100 Hz.

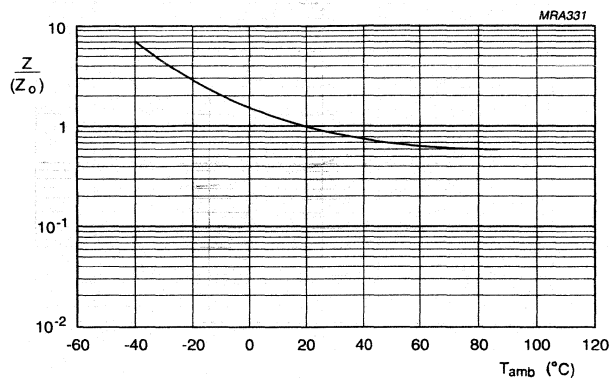
Fig.7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.8 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

Impedance (Z)



Z_0 = impedance at 20 °C, 10 kHz.

Fig.9 Multiplier of impedance (Z/Z_0) as a function of ambient temperature.

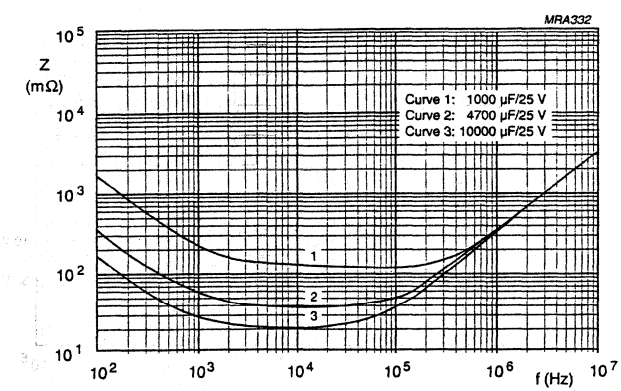


Fig.10 Typical impedance as a function of frequency at 20 °C.

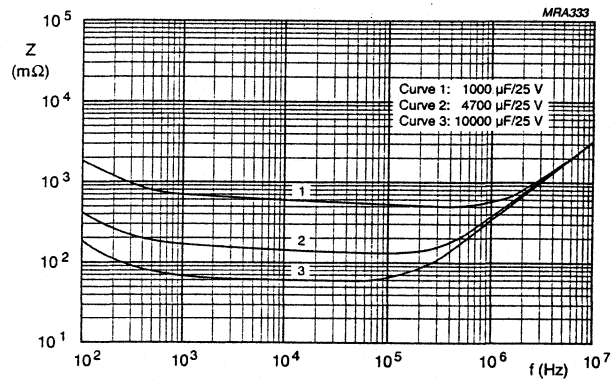


Fig.11 Typical impedance as a function of frequency at –25 °C.

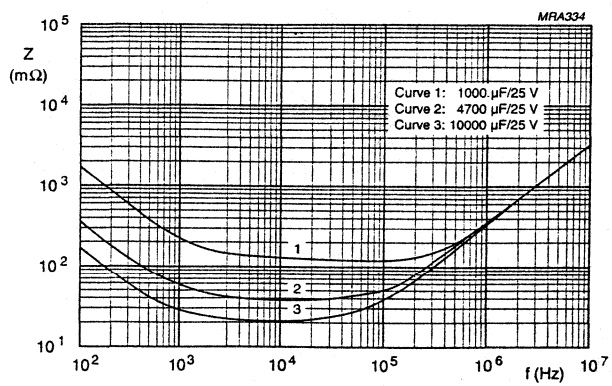
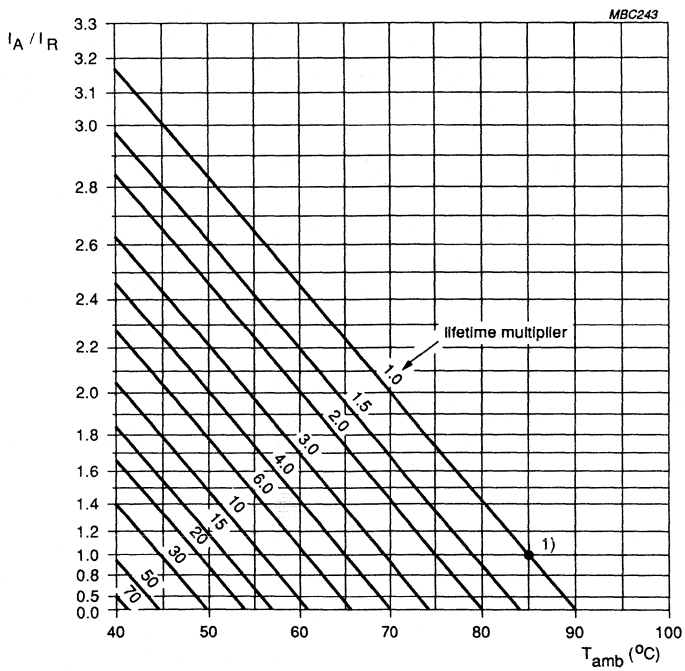


Fig.12 Typical impedance as a function of frequency at –40 °C.

RIPPLE CURRENT and USEFUL LIFE

Table 7 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 85 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10 and 16 V	U_R = 25 and 40 V	U_R = 50 and 63 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥10 000	1.2	1.3	1.4



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied: 5000 hours.

Fig.13 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 8

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied 2000 hours	ΔC/C ±15% tan δ ≤1.3 x spec. limit Z ≤2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 5000 hours	ΔC/C ±45% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

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Electrolytic Capacitors

Notes

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FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case sizes 10 x 30 to 21 x 40 with safety vent
- Charge and discharge proof
- Taped versions up to 15 x 30 available for automatic insertion
- Miniaturized, high CU-product per unit volume.
- Low mounting height, vibration and shock resistant.

APPLICATIONS

- General purpose, industrial, automotive, audio-video
- Coupling, decoupling, smoothing, filtering, buffering and timing
- Portable and mobile equipment (small size, low mass)

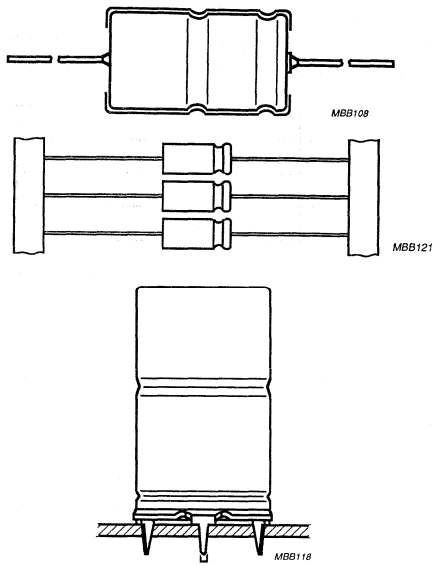

Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes ($\varnothing D_{nom}$ x L_{nom} in mm)	4.5 x 10 to 10 x 25	10 x 30 to 21 x 40
Rated capacitance range, C_R	0.22 to 15 000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	6.3 to 100 V	
Category temperature range	−40 to +85 °C	
Endurance test at 85 °C U_R = 6.3 to 25 V U_R = 40 to 100 V	 1000 hours 2000 hours	 5000 hours 5000 hours
Useful life at 85 °C	2500 hours	8000 hours
Useful life at 40 °C, 1.4 x I_R applied	70 000 hours	200 000 hours
Shelf life at 0 V, 85 °C	500 hours	500 hours
Basic specifications U_R = 6.3 to 25 V U_R = 40 to 100 V	IEC 384-4/CECC 30 300 GP grade LL grade	IEC 384-4/CECC 30 300 LL grade LL grade
Detail specifications	similar to DIN 41316 (with reduced dimensions)	
Climatic category IEC 68 DIN 40040	40/085/56 GPF	

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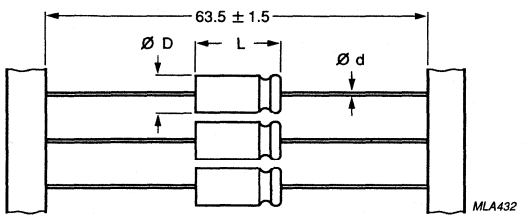
Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**) * = preferred values

C_R (μF)	U_R (V)						
	6.3	**10**	**16**	**25**	**40**	**63**	**100**
0.22						4.5 x 10*	
0.47						4.5 x 10*	
1						4.5 x 10*	4.5 x 10*
1.5						4.5 x 10	
2.2						4.5 x 10*	4.5 x 10*
3.3						4.5 x 10	
4.7						4.5 x 10*	4.5 x 10*
6.8						4.5 x 10	4.5 x 10
10						4.5 x 10*	6 x 10*
15						4.5 x 10	8 x 11 6.5 x 18
22					4.5 x 10*	6 x 10*	8 x 11* 6.5 x 18*
33						6 x 10	6.5 x 18
47				4.5 x 10*	6 x 10*	8 x 11* 6.5 x 18*	8 x 18* 6.5 x 25*
68			4.5 x 10			8 x 11 6.5 x 18	10 x 18
100		4.5 x 10*		6 x 10*	8 x 11* 6.5 x 18*	8 x 18* 6.5 x 25*	10 x 25* 10 x 30*
150			6 x 10	8 x 11 6.5 x 18	8 x 18 6.5 x 25	10 x 18	12.5 x 30
220		6 x 10*	8 x 11*	6.5 x 18*	10 x 18*	10 x 25* 10 x 30*	12.5 x 30*
330		8 x 11*	6.5 x 18*	8 x 18* 6.5 x 25*	10 x 25*	12.5 x 30*	15 x 30*
470	8 x 11*	6.5 x 18*	8 x 18* 6.5 x 25*	10 x 18*	10 x 25* 10 x 30*	12.5 x 30*	18 x 30*
680		8 x 18 6.5 x 25	10 x 18	10 x 25* 10 x 30*	12.5 x 30*	15 x 30*	18 x 40*
1000	8 x 18* 6.5 x 25*	10 x 18*	10 x 25* 10 x 30*	12.5 x 30*	12.5 x 30*	18 x 30*	21 x 40*
1500		10 x 25* 10 x 30*	12.5 x 30*	12.5 x 30*	15 x 30*	18 x 40*	
2200	10 x 25*	12.5 x 30*	12.5 x 30*	15 x 30*	18 x 30*	21 x 40*	
3300		12.5 x 30*	15 x 30*	18 x 30*	18 x 40*		
4700		15 x 30*	18 x 30*	18 x 40*	21 x 40*		
6800		18 x 30*	18 x 40*	21 x 40*			
10 000		18 x 40*	21 x 40*				
15 000		21 x 40*					

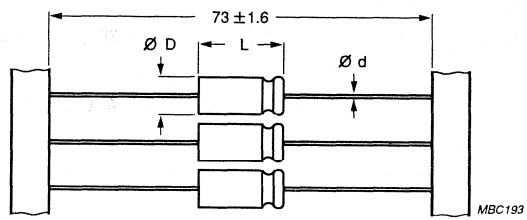
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING",



Form BR: Taped on reel.
Form BA: Taped in box (ammopack).

Fig.2 Case sizes 4.5 x 10 to 8 x 11.



Form BR: Taped on reel,
case sizes 6.5 x 18 to 15 x 30.
Form BA: Taped in box (ammopack),
case sizes 6.5 x 18 to 10 x 25.

Fig.3 Case sizes 6.5 x 18 to 15 x 30.

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Table 2 Axial, dimensions in mm; mass in g

CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	AXIAL: Form AA, BA, and BR					APPROX. MASS	PACKING QUANTITIES		
		Ød	l	ØD_{max}	L_{max}	F_{min}		Form AA	Form BA	Form BR
4.5 x 10	2	0.6	–	5.0	10.5	15	0.50	–	1000	3000
6 x 10	3	0.6	–	6.3	10.5	15	0.70	–	1000	1000
8 x 11	5a	0.6	–	8.5	11.5	15	1.1	–	500	500
6.5 x 18	4	0.8	–	6.9	18.5	25	1.3	–	1000	1000
8 x 18	5	0.8	–	8.5	18.5	25	1.7	–	500	500
6.5 x 25	4L	0.8	–	6.9	25.0	30	1.9	–	1000	1000
10 x 18	6	0.8	–	10.5	18.5	25	2.5	–	500	500
10 x 25	7	0.8	–	10.5	25.0	30	3.3	–	500	500
10 x 30	00	0.8	55 ±1	10.5	30.5	35	4.8	200	–	500
12.5 x 30	01	0.8	55 ±1	13.0	30.5	35	7.4	200	–	400
15 x 30	02	0.8	55 ±1	15.5	30.5	35	11.7	200	–	250
18 x 30	03	0.8	55 ±1	18.5	30.5	35	12.9	200	–	–
18 x 40	04	0.8	34 ±1	18.5	41.5	45	19.4	100	–	–
21 x 40	05	0.8	34 ±1	21.5	41.5	45	24.7	100	–	–

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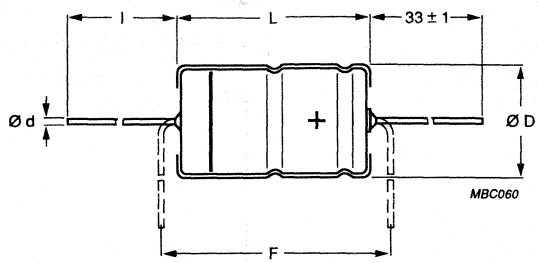
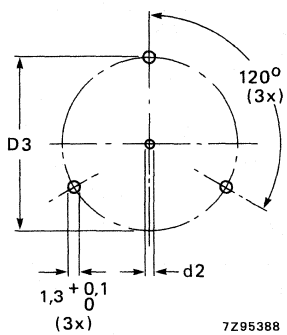
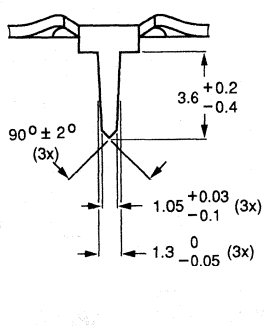


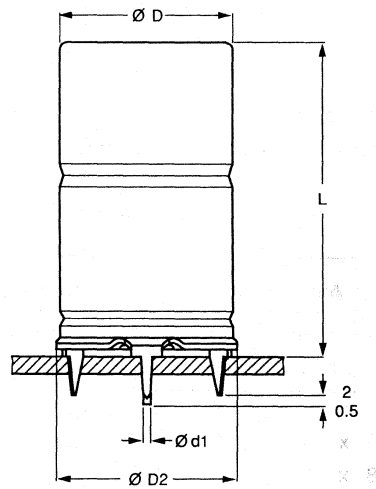
Form AA: Axial in box.

For case sizes 18 x 40 and 21 x 40, the stated L may be exceeded by 0.7 mm.

Fig.4 Case sizes 10 x 30 to 21 x 40.







Piercing diagram.

Form MR: case not insulated (insulation on request).

Especially for applications with severe shocks and vibrations.

Fig.5 Case sizes 15 x 30 to 21 x 40, single ended with mounting ring and pins.

Table 3 Single ended, dimensions in mm; mass in g

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	SINGLE ENDED WITH MOUNTING RING: Form MR					APPROX. MASS	PACKING QUANTITIES
		$\varnothing d_1$	$\varnothing d_2$	$\varnothing D2_{max}$	D3	L_{max}		
15 x 30	02	0.8	1.0 +0.1	17.5	16.5 ±0.2	33	11.7	200
18 x 30	03	0.8	1.0 +0.1	19.5	18.5 ±0.2	33	12.9	200
18 x 40	04	1.0	1.3 +0.1	19.5	18.5 ±0.2	45	19.4	100
21 x 40	05	1.0	1.3 +0.1	22.5	21.5 ±0.2	45	24.7	100

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance ±20%
I_R = rated RMS ripple current at 100 Hz, 85 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ max. and C_R)
Z = max. impedance at 10 kHz.

Table 4 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
6.3	470	8 x 11	260	22	10	0.25	0.85	0.64
	1000	8 x 18	440	42	17	0.25	0.4	0.5
	1000	6.5 x 25	420	42	17	0.30	0.48	0.5
	2200	10 x 25	710	87	32	0.29	0.21	0.16
10	100	4.5 x 10	100	10	6	0.20	3.2	2.0
	220	6 x 10	160	17	8.4	0.20	1.5	0.91
	330	8 x 11	230	24	11	0.20	1.0	0.61
	470	6.5 x 18	310	32	13	0.20	0.68	0.43
	680	8 x 18	400	45	18	0.20	0.47	0.29
	680	6.5 x 25	420	45	18	0.20	0.47	0.29
	1000	10 x 18	550	64	24	0.20	0.32	0.20
	1500	10 x 25	690	94	34	0.23	0.25	0.18
	1500	10 x 30	740	94	34	0.23	0.245	0.18
	2200	12.5 x 30	800	136	48	0.25	0.177	0.095
	3300	12.5 x 30	1000	202	70	0.27	0.128	0.095
	4700	15 x 30	1180	286	98	0.29	0.100	0.07
	6800	18 x 30	1480	412	140	0.34	0.079	0.065
	10 000	18 x 40	1860	604	204	0.40	0.064	0.04
	15 000	21 x 40	2250	904	304	0.50	0.054	0.035

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ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor ASM 021
1000 µF/16 V, ±20%
Case size 10 x 25; Form BR
Catalogue number: 2222 021 90517

Table 5

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
6.3	470	8 x 11	5a	–	021 23471	021 33471	–
	1000	8 x 18	5	–	021 23102	021 33102	–
	1000	6.5 x 25	4L	–	021 90592	021 90593	–
	2200	10 x 25	7	–	021 90588	021 90589	–
10	100	4.5 x 10	2	–	021 24101	021 34101	–
	220	6 x 10	3	–	021 24221	021 34221	–
	330	8 x 11	5a	–	021 24331	021 34331	–
	470	6.5 x 18	4	–	021 24471	021 34471	–
	680	8 x 18	5	–	021 24681	021 34681	–
	680	6.5 x 25	4L	–	021 90594	021 90595	–
	1000	10 x 18	6	–	021 24102	021 34102	–
	1500	10 x 25	7	–	021 90524	021 90525	–
	1500	10 x 30	00	021 14152	021 24152	–	–
	2200	12.5 x 30	01	021 14222	021 24222	–	–
	3300	12.5 x 30	01	021 14332	021 24332	–	–
	4700	15 x 30	02	021 14472	021 24472	–	021 44472
	6800	18 x 30	03	021 14682	–	–	021 44682
	10 000	18 x 40	04	021 14103	–	–	021 44103
	15 000	21 x 40	05	021 14153	–	–	021 44153

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
16	68	4.5 x 10	90	11	6.2	0.16	3.8	2.4
	150	6 x 10	140	18	8.8	0.16	1.7	1.1
	220	8 x 11	210	25	11	0.16	1.2	0.73
	330	6.5 x 18	290	36	15	0.16	0.77	0.48
	470	8 x 18	380	49	19	0.16	0.55	0.34
	470	6.5 x 25	400	49	19	0.16	0.55	0.34
	680	10 x 18	500	69	26	0.16	0.38	0.24
	1000	10 x 25	660	100	36	0.16	0.26	0.18
	1000	10 x 30	700	100	36	0.16	0.260	0.175
	1500	12.5 x 30	740	148	52	0.19	0.205	0.095
	2200	12.5 x 30	890	216	74	0.21	0.150	0.095
	3300	15 x 30	1130	321	110	0.23	0.111	0.07
	4700	18 x 30	1410	455	154	0.25	0.087	0.065
	6800	18 x 40	1780	656	222	0.30	0.070	0.04
	10 000	21 x 40	2170	964	324	0.36	0.058	0.035
25	47	4.5 x 10	80	11	6.4	0.14	4.8	2.6
	100	6 x 10	150	19	9	0.14	2.3	1.2
	150	8 x 11	190	27	12	0.14	1.5	0.80
	150	6.5 x 18	210	27	12	0.14	1.5	0.80
	220	6.5 x 18	250	37	15	0.14	1.0	0.55
	330	8 x 18	340	54	21	0.14	0.68	0.36
	330	6.5 x 25	350	54	21	0.14	0.68	0.36
	470	10 x 18	450	75	28	0.14	0.48	0.26
	680	10 x 25	560	106	38	0.14	0.33	0.18
	680	10 x 30	640	106	38	0.14	0.323	0.175
	1000	12.5 x 30	720	154	54	0.14	0.220	0.095
	1500	12.5 x 30	790	229	79	0.17	0.179	0.095
	2200	15 x 30	1030	334	114	0.19	0.132	0.07
	3300	18 x 30	1310	499	169	0.21	0.099	0.065
	4700	18 x 40	1680	709	239	0.23	0.079	0.04
	6800	21 x 40	2070	1024	344	0.28	0.064	0.035

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
16	68	4.5 x 10	2	–	021 25689	021 35689	–
	150	6 x 10	3	–	021 25151	021 35151	–
	220	8 x 11	5a	–	021 25221	021 35221	–
	330	6.5 x 18	4	–	021 25331	021 35331	–
	470	8 x 18	5	–	021 25471	021 35471	–
	470	6.5 x 25	4L	–	021 90596	021 90597	–
	680	10 x 18	6	–	021 25681	021 35681	–
	1000	10 x 25	7	–	021 90517	021 90518	–
	1000	10 x 30	00	021 15102	021 25102	–	–
	1500	12.5 x 30	01	021 15152	021 25152	–	–
	2200	12.5 x 30	01	021 15222	021 25222	–	–
	3300	15 x 30	02	021 15332	021 25332	–	021 45332
	4700	18 x 30	03	021 15472	–	–	021 45472
	6800	18 x 40	04	021 15682	–	–	021 45682
	10 000	21 x 40	05	021 15103	–	–	021 45103
25	47	4.5 x 10	2	–	021 26479	021 36479	–
	100	6 x 10	3	–	021 26101	021 36101	–
	150	8 x 11	5a	–	021 90534	021 90535	–
	150	6.5 x 18	4	–	021 26151	021 36151	–
	220	6.5 x 18	4	–	021 26221	021 36221	–
	330	8 x 18	5	–	021 26331	021 36331	–
	330	6.5 x 25	4L	–	021 90598	021 90599	–
	470	10 x 18	6	–	021 26471	021 36471	–
	680	10 x 25	7	–	021 90527	021 90528	–
	680	10 x 30	00	021 16681	021 26681	–	–
	1000	12.5 x 30	01	021 16102	021 26102	–	–
	1500	12.5 x 30	01	021 16152	021 26152	–	–
	2200	15 x 30	02	021 16222	021 26222	–	021 46222
	3300	18 x 30	03	021 16332	–	–	021 46332
	4700	18 x 40	04	021 16472	–	–	021 46472
	6800	21 x 40	05	021 16682	–	–	021 46682

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
40	22	4.5 x 10	60	9	5.8	0.11	8.0	3.2
	47	6 x 10	110	15	7.8	0.11	3.8	1.5
	100	8 x 11	170	28	12	0.11	1.8	0.70
	100	6.5 x 18	190	28	12	0.11	1.8	0.70
	150	8 x 18	250	40	16	0.11	1.1	0.47
	150	6.5 x 25	260	40	16	0.11	1.1	0.47
	220	10 x 18	330	57	22	0.11	0.8	0.32
	330	10 x 25	430	83	30	0.11	0.53	0.21
	470	10 x 25	520	117	42	0.11	0.37	0.18
	470	10 x 30	570	117	42	0.12	0.404	0.175
	680	12.5 x 30	620	167	58	0.12	0.297	0.095
	1000	12.5 x 30	770	244	84	0.12	0.190	0.095
	1500	15 x 30	930	364	124	0.15	0.159	0.07
	2200	18 x 30	1200	532	180	0.17	0.118	0.065
	3300	18 x 40	1550	796	268	0.19	0.090	0.04
	4700	21 x 40	1880	1132	380	0.21	0.072	0.035

Non-solid Al - electrolytic capacitors
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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
40	22	4.5 x 10	2	–	021 27229	021 37229	–
	47	6 x 10	3	–	021 27479	021 37479	–
	100	8 x 11	5a	–	021 90537	021 90538	–
	100	6.5 x 18	4	–	021 27101	021 37101	–
	150	8 x 18	5	–	021 27151	021 37151	–
	150	6.5 x 25	4L	–	021 90601	021 90602	–
	220	10 x 18	6	–	021 27221	021 37221	–
	330	10 x 25	7	–	021 27331	021 37331	–
	470	10 x 25	7	–	021 90514	021 90515	–
	470	10 x 30	00	021 17471	021 27471	–	–
	680	12.5 x 30	01	021 17681	021 27681	–	–
	1000	12.5 x 30	01	021 17102	021 27102	–	–
	1500	15 x 30	02	021 17152	021 27152	–	021 47152
	2200	18 x 30	03	021 17222	–	–	021 47222
	3300	18 x 40	04	021 17332	–	–	021 47332
	4700	21 x 40	05	021 17472	–	–	021 47472

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
63	0.22	4.5 x 10	5	4.1	4	0.09	650	250
	0.47	4.5 x 10	8	4.2	4.1	0.09	310	120
	1	4.5 x 10	12	4.4	4.1	0.09	150	55
	1.5	4.5 x 10	12	4.6	4.2	0.09	100	37
	2.2	4.5 x 10	21	4.8	4.3	0.09	65	25
	3.3	4.5 x 10	25	5.2	4.4	0.09	44	17
	4.7	4.5 x 10	31	5.8	4.6	0.09	31	12
	6.8	4.5 x 10	31	6.6	4.9	0.09	21	8.1
	10	4.5 x 10	50	7.8	5.3	0.08	13	5.5
	15	4.5 x 10	55	9.5	5.9	0.08	8.5	3.7
	22	6 x 10	90	12	6.8	0.08	5.8	2.5
	33	6 x 10	100	16	8.2	0.08	3.9	1.7
	47	8 x 11	140	22	10	0.08	2.7	1.2
	47	6.5 x 18	150	22	10	0.08	2.7	1.2
	68	8 x 11	160	30	13	0.08	1.9	0.81
	68	6.5 x 18	170	30	13	0.08	1.9	0.81
	100	8 x 18	250	42	17	0.08	1.3	0.55
	100	6.5 x 25	260	42	17	0.08	1.3	0.55
	150	10 x 18	320	61	23	0.08	0.85	0.37
	220	10 x 25	430	88	32	0.08	0.60	0.25
	220	10 x 30	480	88	32	0.08	0.614	0.20
	330	12.5 x 30	530	129	46	0.08	0.409	0.14
	470	12.5 x 30	630	182	63	0.08	0.287	0.10
	680	15 x 30	830	261	90	0.08	0.199	0.080
	1000	18 x 30	1120	382	130	0.08	0.135	0.065
	1500	18 x 40	1350	571	193	0.11	0.122	0.04
	2200	21 x 40	1780	836	281	0.13	0.099	0.035

Non-solid Al - electrolytic capacitors
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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
63	0.22	4.5 x 10	2	–	021 28227	021 38227	–
	0.47	4.5 x 10	2	–	021 28477	021 38477	–
	1	4.5 x 10	2	–	021 28108	021 38108	–
	1.5	4.5 x 10	2	–	021 28158	021 38158	–
	2.2	4.5 x 10	2	–	021 28228	021 38228	–
	3.3	4.5 x 10	2	–	021 28338	021 38338	–
	4.7	4.5 x 10	2	–	021 28478	021 38478	–
	6.8	4.5 x 10	2	–	021 28688	021 38688	–
	10	4.5 x 10		–	021 28109	021 38109	–
	15	4.5 x 10	2	–	021 28159	021 38159	–
	22	6 x 10	3	–	021 28229	021 38229	–
	33	6 x 10	3	–	021 28339	021 38339	–
	47	8 x 11	5a	–	021 90541	021 90542	–
	47	6.5 x 18	4	–	021 28479	021 38479	–
	68	8 x 11	5a	–	021 90544	021 90545	–
	68	6.5 x 18	4	–	021 28689	021 38689	–
	100	8 x 18	5	–	021 28101	021 38101	–
	100	6.5 x 25	4L	–	021 90603	021 90604	–
	150	10 x 18	6	–	021 28151	021 38151	–
	220	10 x 25	7	–	021 90511	021 90512	–
	220	10 x 30	00	021 18221	021 28221	–	–
	330	12.5 x 30	01	021 18331	021 28331	–	–
	470	12.5 x 30	01	021 18471	021 28471	–	–
	680	15 x 30	02	021 18681	021 28681	–	021 48681
	1000	18 x 30	03	021 18102	–	–	021 48102
	1500	18 x 40	04	021 18152	–	–	021 48152
	2200	21 x 40	05	021 18222	–	–	021 48222

Non-solid Al - electrolytic capacitors
Axial Standard Miniature

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
100	1	4.5 x 10	14	4.6	4.6	0.08	130	90
	2.2	4.5 x 10	20	5.3	5.3	0.08	58	41
	4.7	4.5 x 10	30	7	7	0.08	27	19
	6.8	4.5 x 10	35	8	8	0.08	19	13
	10	6 x 10	65	10	10	0.08	13	9
	15	8 x 11	77	13	13	0.08	8.5	6
	15	6.5 x 18	85	13	13	0.08	8.5	6
	22	8 x 11	95	17	17	0.08	5.8	4.1
	22	6.5 x 18	100	17	17	0.08	5.8	4.1
	33	6.5 x 18	120	24	24	0.08	3.9	2.7
	47	8 x 18	160	32	32	0.08	2.7	1.9
	47	6.5 x 25	170	32	32	0.08	2.7	1.9
	68	10 x 18	220	45	45	0.08	1.9	1.3
	100	10 x 25	300	64	64	0.08	1.3	0.9
	100	10 x 30	360	64	64	0.07	1.150	1.0
	150	12.5 x 30	420	94	94	0.07	0.645	0.61
	220	12.5 x 30	460	136	136	0.08	0.610	0.56
	330	15 x 30	580	202	202	0.09	0.420	0.40
	470	18 x 30	740	286	286	0.09	0.310	0.29
	680	18 x 40	1050	412	412	0.09	0.195	0.18
	1000	21 x 40	1260	604	604	0.10	0.160	0.15

Non-solid Al - electrolytic capacitors
Axial Standard Miniature

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
100	1	4.5 x 10	2	–	021 29108	021 39108	–
	2.2	4.5 x 10	2	–	021 29228	021 39228	–
	4.7	4.5 x 10	2	–	021 29478	021 39478	–
	6.8	4.5 x 10	2	–	021 29688	021 39688	–
	10	6 x 10	3	–	021 29109	021 39109	–
	15	8 x 11	5a	–	021 90547	021 90548	–
	15	6.5 x 18	4	–	021 29159	021 39159	–
	22	8 x 11	5a	–	021 90551	021 90552	–
	22	6.5 x 18	4	–	021 29229	021 39229	–
	33	6.5 x 18	4	–	021 29339	021 39339	–
	47	8 x 18	5	–	021 29479	021 39479	–
	47	6.5 x 25	4L	–	021 90605	021 90606	–
	68	10 x 18	6	–	021 29689	021 39689	–
	100	10 x 25	7	–	021 90531	021 90532	–
	100	10 x 30	00	021 19101	021 29101	–	–
	150	12.5 x 30	01	021 19151	021 29151	–	–
	220	12.5 x 30	01	021 19221	021 29221	–	–
	330	15 x 30	02	021 19331	021 29331	–	021 49331
	470	18 x 30	03	021 19471	–	–	021 49471
	680	18 x 40	04	021 19681	–	–	021 49681
	1000	21 x 40	05	021 19102	–	–	021 49102

Non-solid Al - electrolytic capacitors
Axial Standard Miniature

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MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on nominal capacitance (in accordance with IEC 62)
- Rated voltage (in V)
- Group number (021)
- Name of manufacturer (PHILIPS)
- Date code in accordance with IEC 62
- Code for factory of origin
- Band to identify the negative terminal
- "+" - signs to identify the positive terminal (not for case sizes L <18 mm).

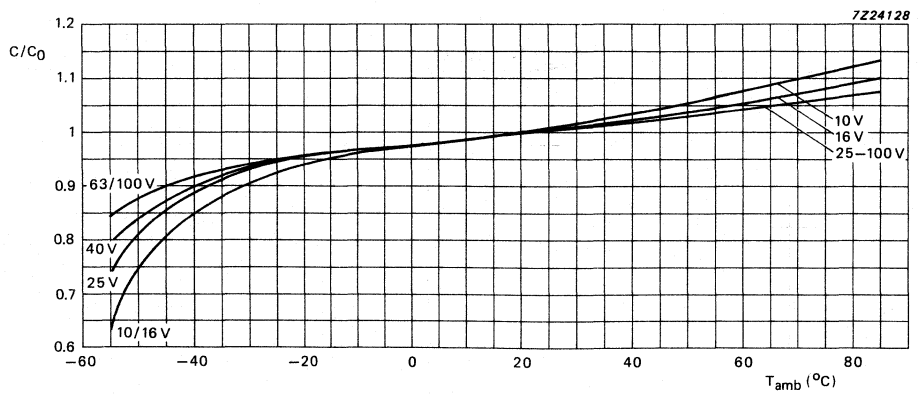
Voltage

Surge voltage for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

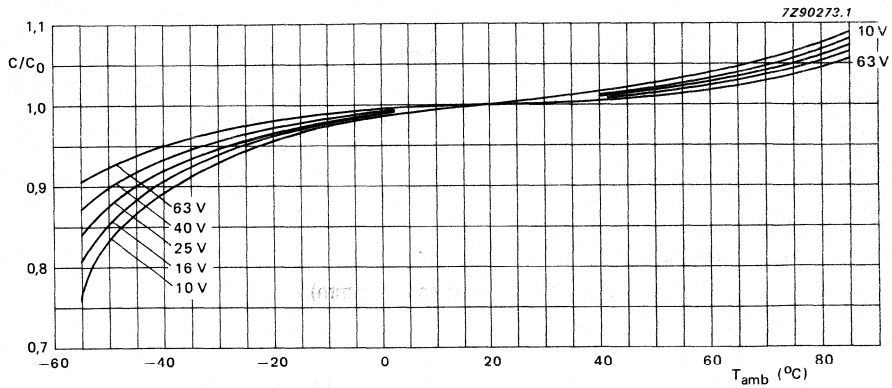
After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA
After 5 minutes at:	
U_R (6.3 to 63 V)	$I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA
U_R (100 V)	$I_{L5} \leq 0.006\ C_R \times U_R + 4$ µA

Capacitance (C)



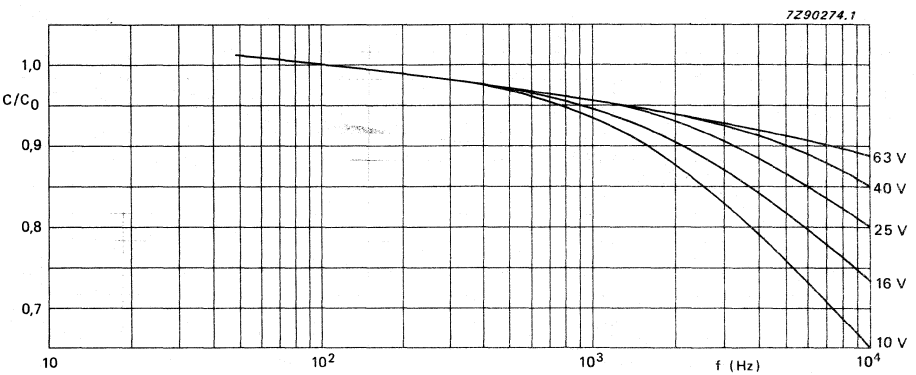
C_0 = capacitance at 20 °C, 100 Hz.
Case sizes 4.5 x 10 to 10 x 25.

Fig.6 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz.
Case sizes 10 x 30 to 21 x 40.

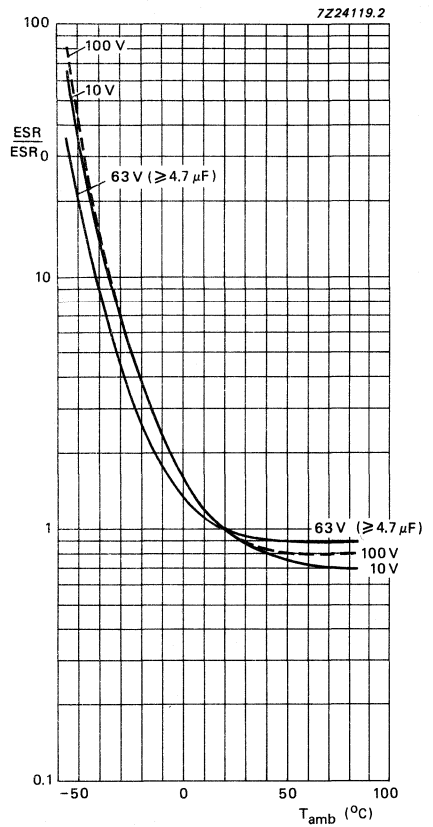
Fig.7 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



C_0 = capacitance at 20 °C; 100 Hz.

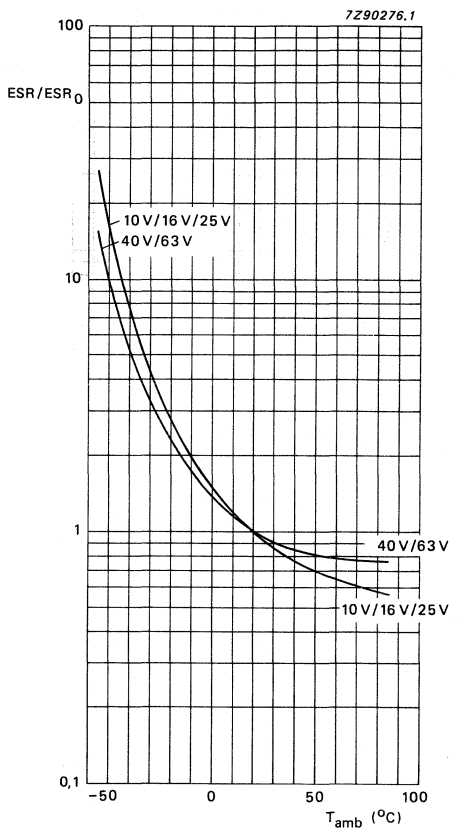
Fig.8 Multiplier of capacitance (C/C_0) as a function of frequency.

Equivalent series resistance (ESR)



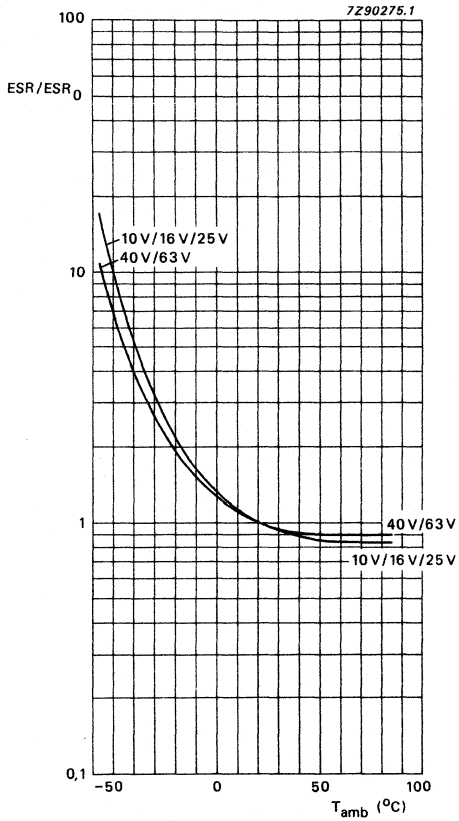
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case sizes 4.5 x 10 to 10 x 25.

Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



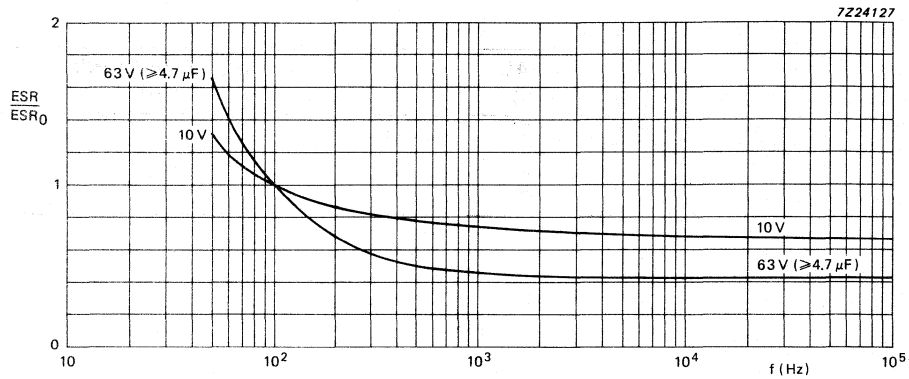
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case sizes 10 x 30, 12.5 x 30 and 15 x 30.

Fig.10 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



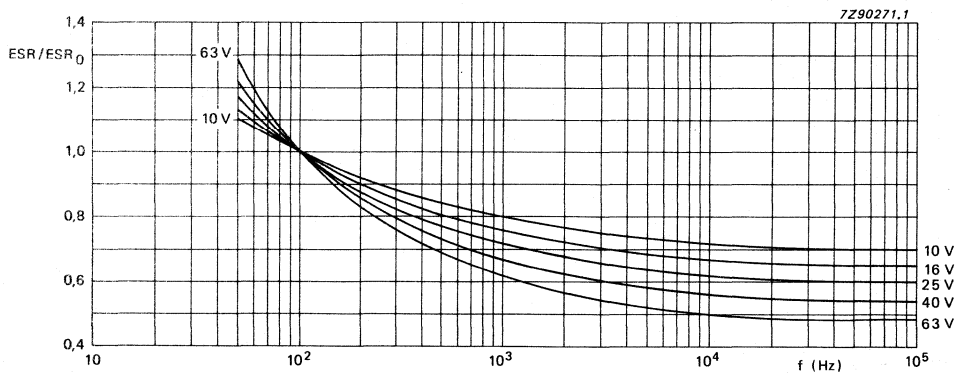
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case sizes 18 x 30, 18 x 40 and 21 x 40.

Fig.11 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



ESR_0 = typical ESR at 20 °C, 100 Hz.
Case sizes 4.5 x 10 to 10 x 25.

Fig.12 Multiplier of ESR (ESR/ESR_0) as a function of frequency.



ESR_0 = typical ESR at 20 °C, 100 Hz.
Case sizes 10 x 30 to 21 x 40.

Fig.13 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

5

Equivalent series inductance (ESL)

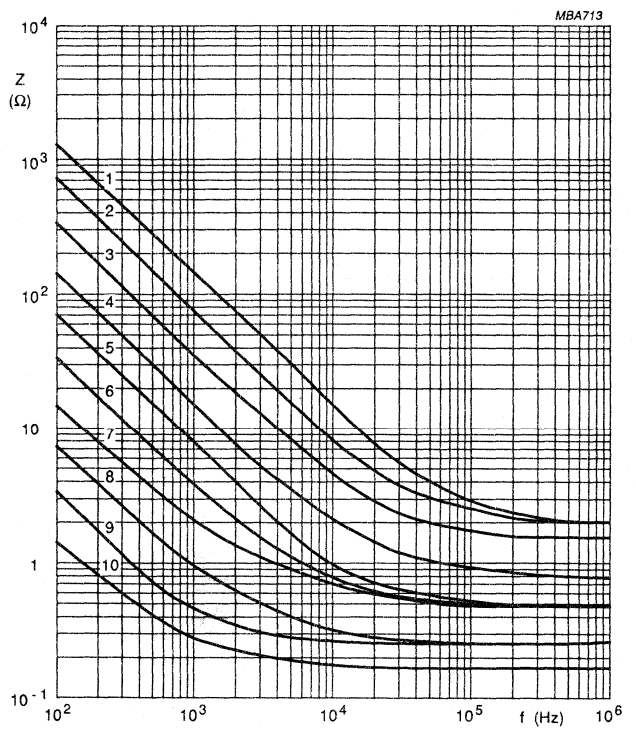
Table 6 Equivalent series inductance, typical values

CASE SIZE (ØD x L in mm)	AXIAL (nH)	MOUNTING RING (nH)
4.5 x 10	10	–
6 x 10	22	–
8 x 11	85	–
6.5 x 18	25	–
8 x 18	40	–
6.5 x 25	40	–
10 x 18	61	–
10 x 25	38	–
10 x 30	38	–
12.5 x 30	46	–
15 x 30	48	39
18 x 30	50	39
18 x 40	54	39
21 x 40	59	39

Impedance (Z)

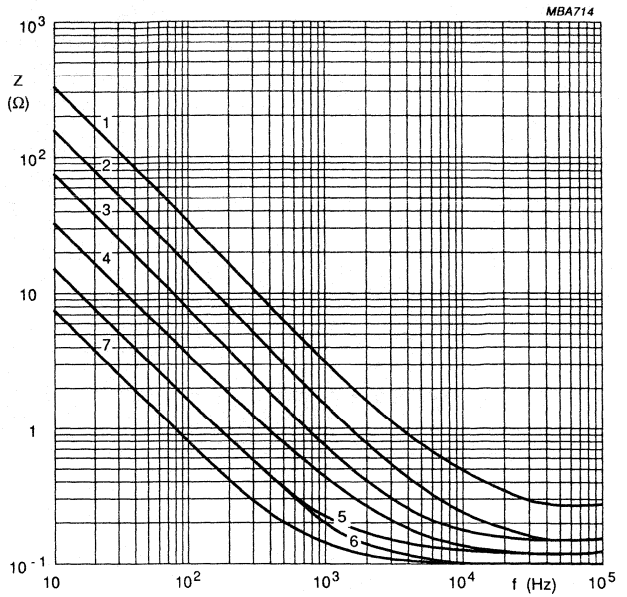
Table 7 Impedance x capacitance values (case sizes 4.5 x 10 to 10 x 25 mm)

T_{amb}	$z = Z \times C_R(\Omega\ \mu F)$ at 10 kHz						
	6.3 V	10 V	16 V	25 V	40 V	63 V	100 V
+20 °C	≤ 300	≤ 200	≤ 160	≤ 120	≤ 70	≤ 55	≤ 90
–25 °C	≤2000	≤1200	≤ 750	≤ 560	≤ 300	≤ 180	≤ 600
–40 °C	≤5500	≤3200	≤2000	≤1500	≤ 900	≤ 500	≤1600



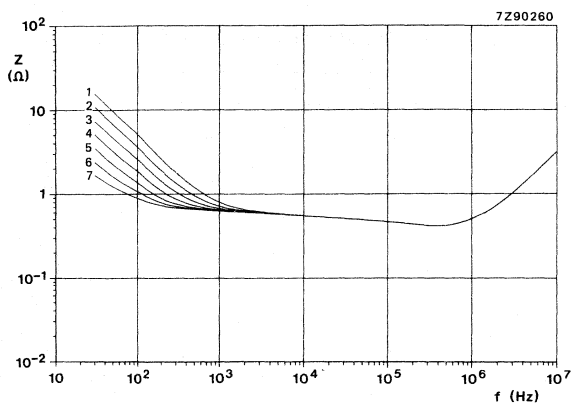
Curve 1 : 1μF-63 V; 4.5 x 10
Curve 2 : 2.2μF- 63 V; 4.5 x 10
Curve 3 : 4.7μF-63 V; 4.5 x 10
Curve 4 : 10μF-63 V; 4.5 x 10
Curve 5 : 22μF-63 V; 6 x 10
Curve 6 : 47μF-40 V; 6 x 10
Curve 7 : 100μF-25 V; 6 x 10
Curve 8 : 220μF-25 V; 6.5 x 18
Curve 9 : 470μF-10 V; 6.5 x 18
Curve 10 : 1000μF-6.3 V; 6.5 x 25.

Fig.14 Typical impedance as a function of frequency; case sizes 4.5 x 10 to 6.5 x 25.



Curve 1 : 47µF-63 V; 8 x 11
Curve 2 : 100µF-63 V; 8 x 18
Curve 3 : 220µF-40 V; 10 x 18
Curve 4 : 470µF-25 V; 10 x 18
Curve 5 : 1000µF-10 V; 10 x 18
Curve 6 : 1000µF-16 V; 10 x 25
Curve 7 : 2200µF-6.3 V; 10 x 25.

Fig.15 Typical impedance as a function of frequency; case sizes 8 x 11 to 10 x 25.



Curve 1 : 330µF-63 V
Curve 2 : 470 µF-63 V
Curve 3 : 680 µF-40 V
Curve 4 : 1000 µF-25 V and 40 V
Curve 5 : 1500 µF-16 V and 25 V
Curve 6 : 2200 µF-10 V and 16 V
Curve 7 : 3300 µF-10 V.

Fig.16 Typical impedance as a function of frequency at T_{amb} = –40 °C, case size 12.5 x 30.

Curve 1 : 330µF-63 V
Curve 2 : 470 µF-63 V
Curve 3 : 680 µF-40 V
Curve 4 : 1000 µF-25 V and 40 V
Curve 5 : 1500 µF-16 V and 25 V
Curve 6 : 2200 µF-10 V and 16 V
Curve 7 : 3300 µF-10 V.

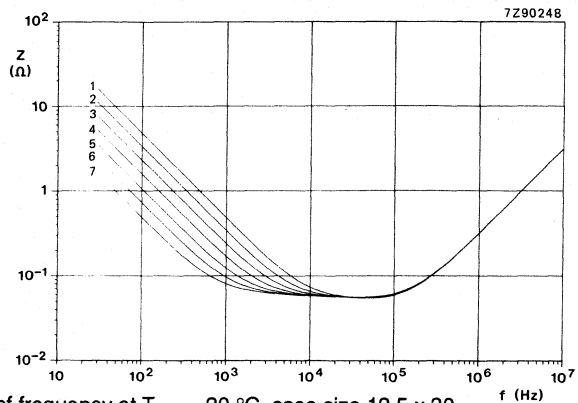


Fig.17 Typical impedance as a function of frequency at T_{amb} = 20 °C, case size 12.5 x 30.

Curve 1 : 1000 µF-63 V
Curve 2 : 2200 µF-40 V
Curve 3 : 3300 µF-25 V
Curve 4 : 4700 µF-16 V
Curve 5 : 6800 µF-10 V.

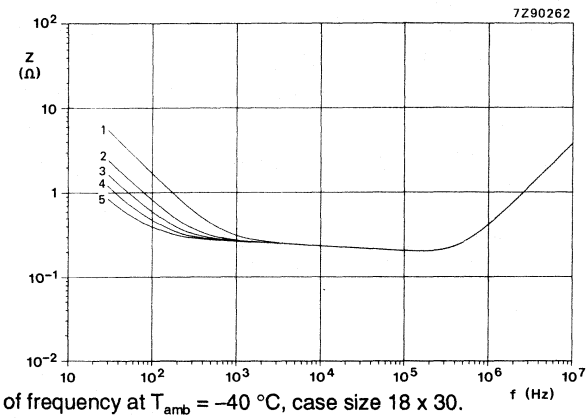


Fig.18 Typical impedance as a function of frequency at T_{amb} = –40 °C, case size 18 x 30.

Curve 1 : 1000 µF-63 V
Curve 2 : 2200 µF-40 V
Curve 3 : 3300 µF-25 V
Curve 4 : 4700 µF-16 V
Curve 5 : 6800 µF-10 V.

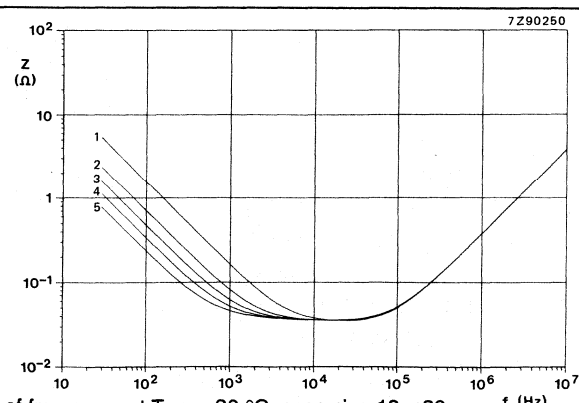
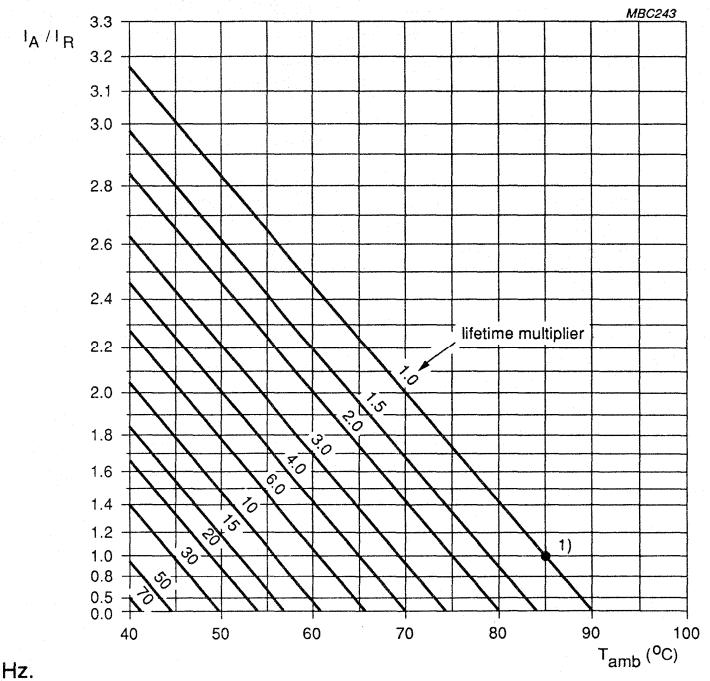


Fig.19 Typical impedance as a function of frequency at T_{amb} = 20 °C, case size 18 x 30.

RIPPLE CURRENT and USEFUL LIFE

Table 8 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency (I_{RO} = rated ripple current at 100 Hz and 85 °C)

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 16 V	U_R = 25 to 40 V	U_R = 63 to 100 V
50	0.95	0.9	0.85
100	1	1	1
300	1.07	1.12	1.2
1 000	1.12	1.2	1.3
3 000	1.15	1.25	1.35
≥10 000	1.2	1.3	1.4



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 85 °C.

Useful life at 85 °C and I_R applied:
case sizes 4.5 x 10 to 10 x 25: 2500 hours
case sizes 10 x 30 to 21 x 40: 8000 hours.

Fig.20 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 9

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied case sizes: 4.5 x 10 to 10 x 25 U_R = 6.3 to 25 V: 1000 hours U_R = 40 to 100 V: 2000 hours 10 x 30 to 21 x 40 U_R = 6.3 to 100 V: 5000 hours	$U_R \leq 6.3$ V : $\Delta C/C$ +15/–30% $U_R > 6.3$ V : $\Delta C/C$ ±15% tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied case sizes: 4.5 x 10 to 10 x 25: 2500 hours 10 x 30 to 21 x 40: 8000 hours	$U_R \leq 6.3$ V : $\Delta C/C$ +45/–50% $U_R > 6.3$ V : $\Delta C/C$ ±45% tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 85 °C, no voltage applied 500 hours	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above

5

Electrolytic Capacitors

Notes

Non-solid Al - electrolytic capacitors Axial, Low Leakage Current

ALC 065

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Taped for automatic insertion
- Charge and discharge proof
- Low leakage current, low energy consumption.

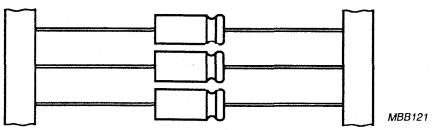


Fig.1 Component outlines.

APPLICATIONS

- Telecommunication, automotive, audio-video, EDP and general industrial
- Coupling, decoupling, buffering, timing, energy storage
- Boards with restricted mounting height, vibration and shock resistant.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	4.5 x 10 and 6 x 10
Rated capacitance range, C_R	0.33 to 68 µF
Tolerance on C_R	−10 to +50% or ±20%
Rated voltage range, U_R	6.3 to 25 V
Category temperature range	−55 to +85 °C
Leakage current after 2 minutes U_R	0.002 C_R x U_R or 0.7 µA (whichever is greater)
Endurance test at 85 °C	2000 hours
Useful life at 85 °C	3000 hours
Useful life at 40 °C, 1.4 I_R applied	80 000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	DIN 41316
Climatic category IEC 68 DIN 40040	 55/085/56 FPF

Non-solid Al - electrolytic capacitors
Axial, Low Leakage Current

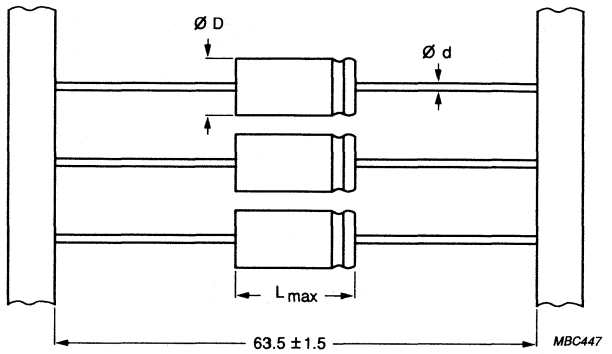
ALC 065

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**)

C_R (µF)	U_R (V)			
	6.3	**10**	**16**	**25**
0.47				4.5 x 10
1.0				4.5 x 10
2.2				4.5 x 10
3.3				4.5 x 10
4.7				4.5 x 10
6.8			4.5 x 10	4.5 x 10
10		4.5 x 10	4.5 x 10	6 x 10
15	4.5 x 10		4.5 x 10	6 x 10
22		4.5 x 10	6 x 10	
33	4.5 x 10		6 x 10	
47		6 x 10	larger capacitance	
68	6 x 10		values on request	

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING".



Form BR: Taped on reel.

Fig.2 Case sizes 4.5 x 10 and 6.5 x 10, insulated with a blue plastic sleeve.

Table 2 Dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	AXIAL: Form BR				APPROX. MASS	PACKING QUANTITIES
		Ød	$ØD_{max}$	L_{max}	F_{min}		Form BR
4.5 x 10	2	0.6	5.0	10.5	15	0.5	3000
6 x 10	3	0.6	6.3	10.5	15	0.7	1000

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Non-solid Al - electrolytic capacitors
Axial, Low Leakage Current

ALC 065

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance −10 to +50% or ±20%

I_R = rated RMS ripple current at 100 Hz, 85 °C

I_{L2} = max. leakage current after 2 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz.

Ordering Example

Electrolytic Capacitor ALC 065
10 µF/16 V, −10/+50%
Case size 4.5 x 10; Form BR
Catalogue number:
2222 065 25109.

Table 3 Electrical data and ordering information

U_R	C_R 100 Hz	NOMINAL CASE SIZE ∅ D x L	CASE CODE	I_R 100 Hz 85 °C	I_{L2} 2 min	Tan δ 100 Hz	ESR 100 Hz	Z 10 kHz	CATALOGUE NUMBER 2222	
									−10/+50% Form BR	±20% Form BR
(V)	(µF)	(mm)		(mA)	(µA)		(Ω)	(Ω)		
6.3	15	4.5 x 10	2	26.5	0.7	0.16	17	8	065 23159	065 63159
	33	4.5 x 10	2	39	0.7	0.16	7.7	3.6	065 23339	065 63339
	68	6 x 10	3	67	0.9	0.16	3.7	1.8	065 23689	065 63689
10	10	4.5 x 10	2	23	0.7	0.14	22	9	065 24109	065 64109
	22	4.5 x 10	2	34	0.7	0.14	10	4.1	065 24229	065 64229
	47	6 x 10	3	60	0.9	0.14	4.7	1.9	065 24479	065 64479
16	6.8	4.5 x 10	2	21	0.7	0.12	28	10	065 25688	065 65688
	10	4.5 x 10	2	25	0.7	0.12	19	7	065 25109	065 65109
	15	4.5 x 10	2	31	0.7	0.12	13	4.7	065 25159	065 65159
	22	6 x 10	3	44	0.7	0.12	8.7	3.2	065 25229	065 65229
	33	6 x 10	3	54	1.1	0.12	5.8	2.1	065 25339	065 65339
25	0.47	4.5 x 10	2	6.6	0.7	0.08	270	120	065 26477	065 66477
	1.0	4.5 x 10	2	9.7	0.7	0.08	130	55	065 26108	065 66108
	2.2	4.5 x 10	2	13.5	0.7	0.09	65	25	065 26228	065 66228
	3.3	4.5 x 10	2	16.6	0.7	0.09	43	17	065 26338	065 66338
	4.7	4.5 x 10	2	20	0.7	0.09	30	12	065 26478	065 66478
	6.8	4.5 x 10	2	24	0.7	0.09	21	8.1	065 26688	065 66688
	10	6 x 10	3	34	0.7	0.09	14	5.5	065 26109	065 66109
	15	6 x 10	3	42	0.8	0.09	9.5	3.7	065 26159	065 66159

Non-solid Al - electrolytic capacitors Axial, Low Leakage Current

ALC 065

Marking

The capacitors are marked (where possible) with the following information:

- Rated capacitance in μF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Group number (065)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Band to identify the negative terminal.

Voltage

Surge voltage for short periods	$U_s \leq 1.6 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

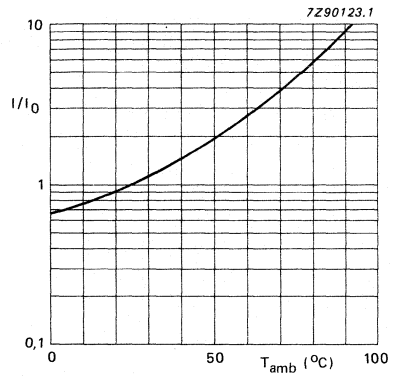
Non-solid Al - electrolytic capacitors
Axial, Low Leakage Current

ALC 065

Leakage current

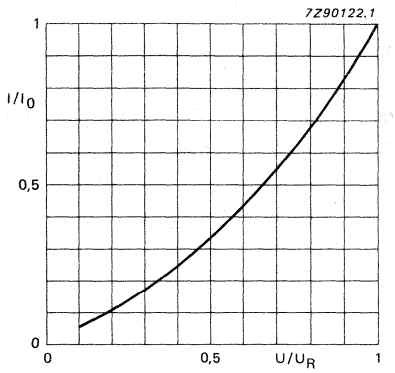
After 2 minutes at U_R

$I_{L2} \leq 0.002\ C_R \times U_R$ or 0.7 μA (whichever is greater)



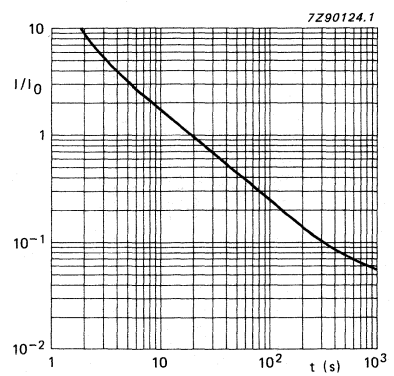
I_0 = leakage current during continuous operation at 20 °C and U_R.

Fig.3 Typical multiplier of leakage current (I/I_0) as a function of ambient temperature.



I_0 = leakage current during continuous operation at 20 °C and U_R.

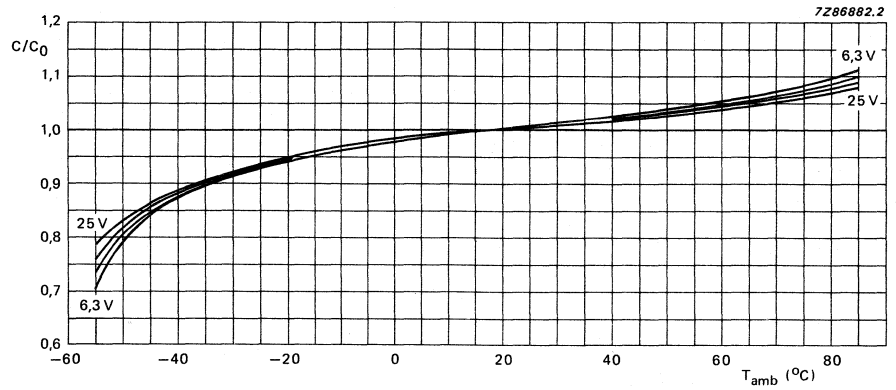
Fig.4 Typical multiplier of leakage current (I/I_0) as a function of U/U_R.



I_0 = leakage current as specified in Table 3.

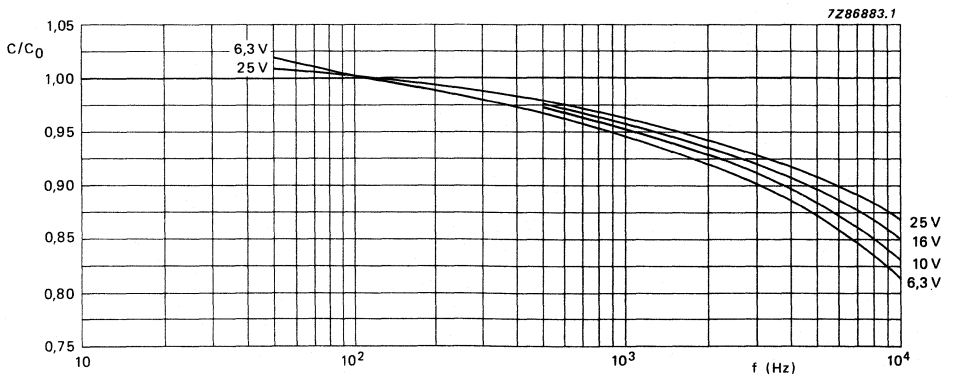
Fig.5 Typical multiplier of leakage current (I/I_0) as a function of time.

Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

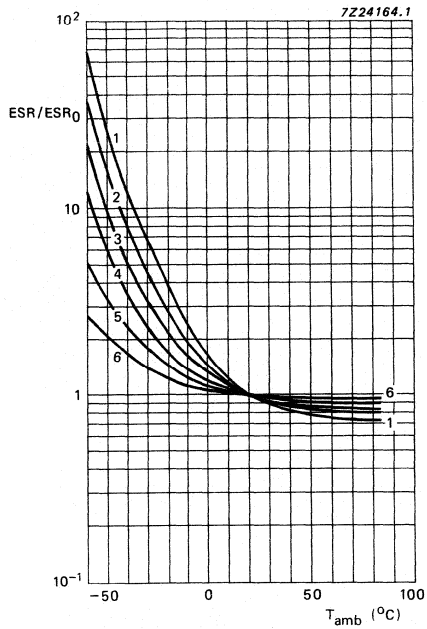
Fig.6 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz.

Fig.7 Multiplier of capacitance (C/C_0) as a function of frequency.

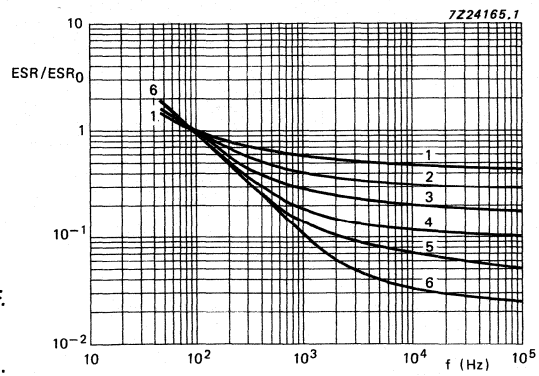
Equivalent series resistance (ESR)



Curve 1: 6.3 and 10 V
Curve 2: 16 V
Curve 3: 25 V, ≥6.8 µF
Curve 4: 25 V, 2.2 to 4.7 µF
Curve 5: 25 V, 0.68 to 1.5 µF
Curve 6: 25 V, 0.33 to 0.47 µF.

ESR_0 = ESR at 20 °C, 100 Hz.

Fig.8 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



Curve 1: 6.3 and 10 V
Curve 2: 16 V
Curve 3: 25 V, ≥6.8 µF
Curve 4: 25 V, 2.2 to 4.7 µF
Curve 5: 25 V, 0.68 to 1.5 µF
Curve 6: 25 V, 0.33 to 0.47 µF.

ESR_0 = ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

Equivalent series inductance (ESL)

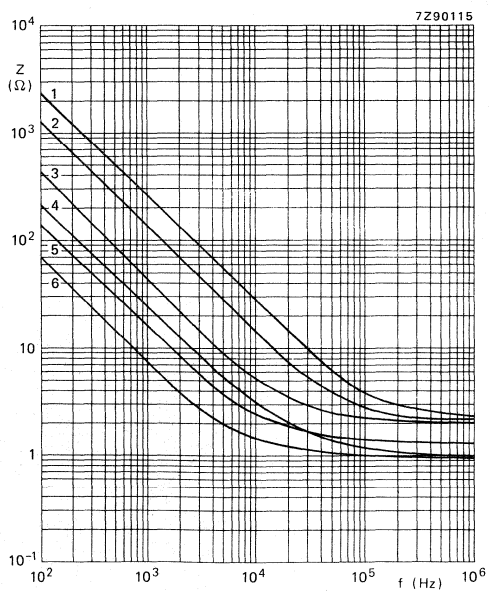
Table 4 Equivalent series inductance, typical values

CASE SIZE (∅ x L) (mm)	TYP. ESL (nH)
4.5 x 10	17
6 x 10	30

Impedance (Z)

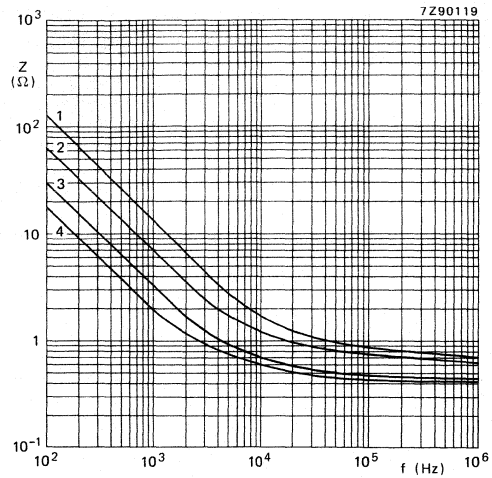
Table 5 Impedance x capacitance values at 10 kHz

T_{amb}	$z = Z \times C_R(\Omega\,\mu F)$ at 10 kHz			
	6.3 V	10 V	16 V	25 V
+20 °C	≤ 120	≤ 90	≤ 70	≤ 55
−25 °C	≤ 560	≤ 400	≤300	≤180
−40 °C	≤1500	≤1100	≤900	≤500



Curve 1: 0.47 µF
Curve 2: 1 µF
Curve 3: 3.3 µF
Curve 4: 6.8 µF
Curve 5: 10 µF
Curve 6: 22 µF.

Fig.10 Typical impedance as a function of frequency at 20 °C; case size 4.5 x 10.



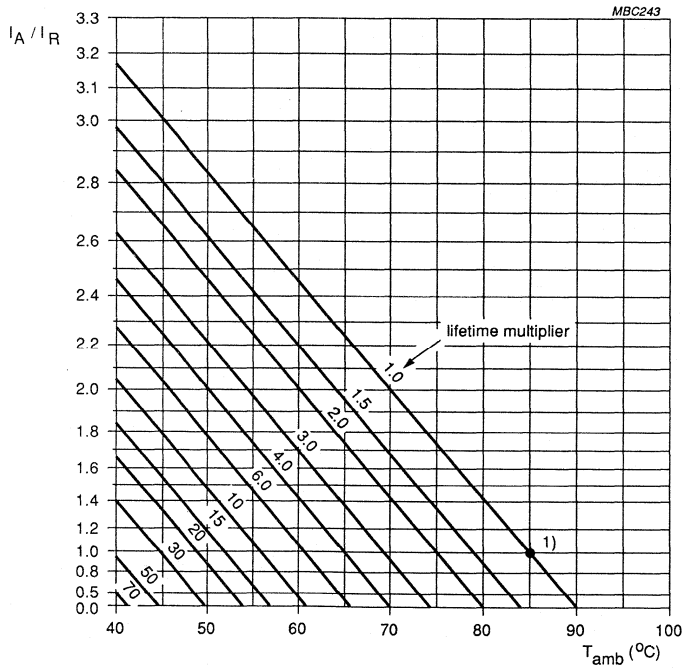
Curve 1: 10 µF
Curve 2: 22 µF
Curve 3: 47 µF
Curve 4: 68 µF.

Fig.11 Typical impedance as a function of frequency at 20 °C; case size 6 x 10.

RIPPLE CURRENT and USEFUL LIFE

Table 6 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 85 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 and 10 V	U_R = 16 V	U_R = 25 V
50	0.9	0.8	0.7
100	1.0	1.0	1.0
300	1.4	1.5	1.7
1000	1.75	2.0	2.2
3000	1.9	2.2	2.4
≥10 000	2	2.3	2.5



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied: 3000 hours.

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 7

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 sub clause 4.13	T_{amb} = 85 °C, U_R applied 2000 hours	$U_R \leq 6.3$ V : $\Delta C/C$ +15/–25% $U_R > 6.3$ V : $\Delta C/C$ ±15% tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit I_{L2} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 3000 hours	$U_R \leq 6.3$ V : $\Delta C/C$ +45/–50% $U_R > 6.3$ V : $\Delta C/C$ ±45% tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L2} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 sub clause 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L2} \leq 2$ x spec. limit

Non-solid Al - electrolytic capacitors
Axial Standard

AS 030-033

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case sizes 10 x 30 to 21 x 40 with safety vent
- Taped version available for automatic insertion up to 15 x 30
- Charge and discharge proof
- Useful life: 3000/8000 hours at 85 °C (case ∅ 3.3 mm: 1500 hours)
- Standard dimensions.

APPLICATIONS

- General purpose and industrial, automotive, telecommunication, audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- Boards with restricted mounting height, vibration and shock resistant.

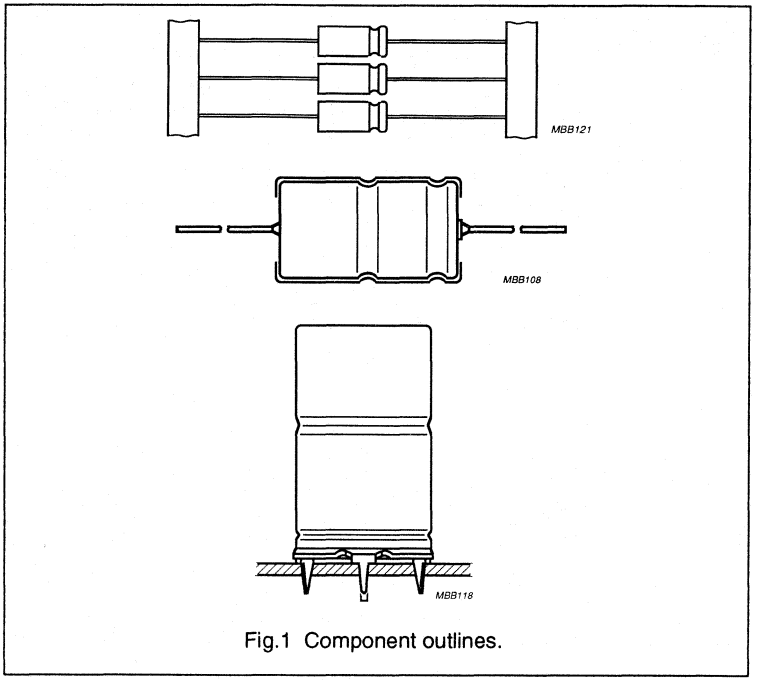


Fig.1 Component outlines.

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QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	3.3 x 11	4.5 x 10 to 10 x 25	10 x 30 to 21 x 40
Rated capacitance range, C_R	0.33 to 15 000 µF		
Tolerance on C_R	−10 to +50%		
Rated voltage range, U_R	6.3 to 100 V		
Category temperature range	−40 to +85 °C		
Endurance test at 85 °C	1000 hours	2000 hours	5000 hours
Useful life at 85 °C	1500 hours	3000 hours	8000 hours
Useful life at 40 °C, 1.4 I_R applied	40 000 hours	80 000 hours	200 000 hours
Shelf life at 0 V, 85 °C	500 hours		
Basic specification	IEC 384-4/ CECC 30 300 GP grade	IEC 384-4/CECC 30 300, LL grade	
Detail specification	DIN 41316 (6.3 to 63 V), DIN 41332 (100 V)		
Climatic category IEC 68 DIN 40040	40/085/56 GPF		
Approvals		LNZ 44-04	

Non-solid Al - electrolytic capacitors
Axial Standard

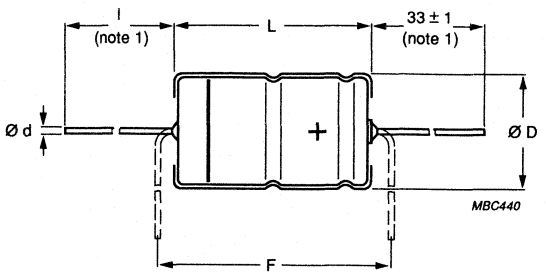
AS 030-033

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (Ø **D x L** in **mm**) * = preferred values

C_R (µF)	U_R (V)						
	6.3	**10**	**16**	**25**	**40**	**63**	**100**
0.33						4.5 x 10	
0.47						4.5 x 10* 3.3 x 11	4.5 x 10*
1.0						4.5 x 10* 3.3 x 11	4.5 x 10*
1.5						4.5 x 10	
2.2					3.3 x 11*	4.5 x 10*	4.5 x 10*
3.3				3.3 x 11		4.5 x 10	4.5 x 10
4.7			3.3 x 11*			4.5 x 10*	6 x 10*
6.8		3.3 x 11			4.5 x 10	4.5 x 10	6 x 10
10	3.3 x 11*			4.5 x 10*	4.5 x 10*	6 x 10*	8 x 11* 6.5 x 18*
15			4.5 x 10		4.5 x 10	6 x 10	
22		4.5 x 10*		4.5 x 10*	6 x 10*	8 x 11* 6.5 x 18*	8 x 18*
33	4.5 x 10		4.5 x 10		6 x 10		10 x 18
47		4.5 x 10*		6 x 10*	8 x 11* 6.5 x 18*	8 x 18*	10 x 25*
68	4.5 x 10		6 x 10			10 x 18	10 x 30
100		6 x 10*		8 x 11* 6.5 x 18*	8 x 18*	10 x 25*	12.5 x 30*
150	6 x 10		8 x 11 6.5 x 18	8 x 18	10 x 18	10 x 30	15 x 30
220		8 x 11* 6.5 x 18*	8 x 18*	10 x 18*	10 x 25* 10 x 30*	12.5 x 30*	18 x 30*
330		8 x 18*	10 x 18*	10 x 25*	12.5 x 30*	15 x 30*	18 x 40*
470	8 x 18*	10 x 18*	10 x 25*	10 x 30*	12.5 x 30*	15 x 30*	21 x 40*
680	10 x 18*	10 x 25*	10 x 30*	12.5 x 30*	15 x 30*	18 x 30*	21 x 40*
1000	10 x 25*	10 x 30*	12.5 x 30*	15 x 30*	18 x 30*	21 x 40*	
1500	10 x 30*	12.5 x 30*	15 x 30*	18 x 30*	18 x 40*	21 x 40*	
2200	12.5 x 30*	15 x 30*	18 x 30*	18 x 40*	21 x 40*		
3300	15 x 30*	18 x 30*	18 x 40*	21 x 40*	21 x 40*		
4700	18 x 30*	18 x 40*	21 x 40*	21 x 40*			
6800	18 x 40*	21 x 40*	21 x 40*				
10 000	21 x 40*	21 x 40*					
15 000	21 x 40*						

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.



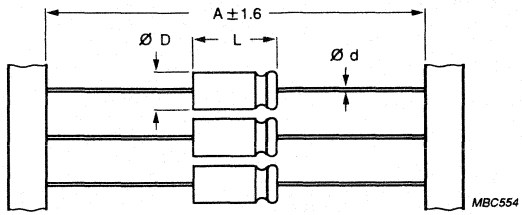
For case sizes 18 x 40 and 21 x 40, the stated L may be exceeded by 0.7 mm.

Fig.2 Case sizes 10 x 30 to 21 x 40 **Form AA**: axial; for dimensions see Table 2.

Table 2 Axial, dimensions in mm; mass in g

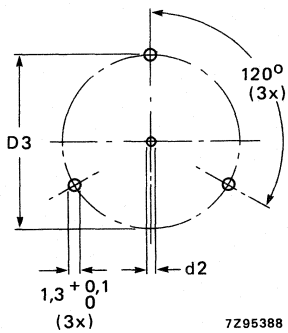
CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	AXIAL: Form AA, BA, and BR						APPROX. MASS	PACKING QUANTITIES		
		∅d	l	A	∅D_{max}	L_{max}	F_{min}		Form AA	Form BA	Form BR
3.3 x 11	1	0.6	–	63.5 ±1.5	3.5	12	17.5	0.35	–	1000	4000
4.5 x 10	2	0.6	–	63.5 ±1.5	5.0	10.5	15	0.5	–	1000	3000
6 x 10	3	0.6	–	63.5 ±1.5	6.3	10.5	15	0.7	–	1000	1000
8 x 11	5a	0.6	–	63.5 ±1.5	8.5	11.5	15	1.1	–	500	500
6.5 x 18	4	0.8	–	73 ±1.6	6.9	18.5	25	1.3	–	1000	1000
8 x 18	5	0.8	–	73 ±1.6	8.5	18.5	25	1.7	–	500	500
10 x 18	6	0.8	–	73 ±1.6	10.5	18.5	25	2.5	–	500	500
10 x 25	7	0.8	–	73 ±1.6	10.5	25.0	30	3.3	–	500	500
10 x 30	00	0.8	55 ±1	73 ±1.6	10.5	30.5	35	4.8	200	–	500
12.5 x 30	01	0.8	55 ±1	73 ±1.6	13.0	30.5	35	7.4	200	–	400
15 x 30	02	0.8	55 ±1	73 ±1.6	15.5	30.5	35	11.7	200	–	250
18 x 30	03	0.8	55 ±1	–	18.5	30.5	35	12.9	200	–	–
18 x 40 [1]	04	0.8	34 ±1	–	18.5	41.5	45	19.4	100	–	–
21 x 40 [1]	05	0.8	34 ±1	–	21.5	41.5	45	24.7	100	–	–

Tape dimensions are specified in chapter "PACKING",

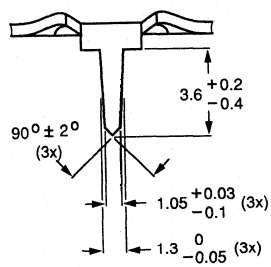


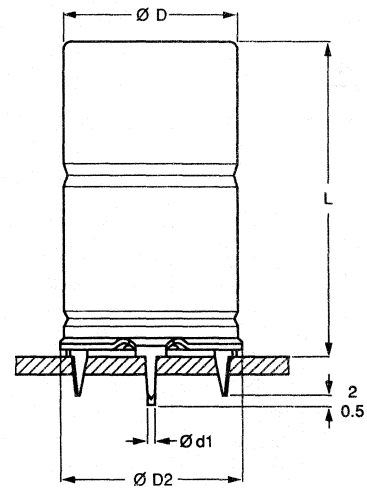
Form BR: Taped on reel, case sizes 3.3 x 11 to 15 x 30.
Form BA: Taped in box (ammopack), case sizes 3.3 x 11 to 10 x 25.

Fig.3 Case sizes 3.3 x 11 to 15 x 30, axial.



Piercing diagram.





Form MR: case not insulated (insulation on request).
Especially for applications with severe shocks and vibrations.

Fig.4 Case sizes 15 x 30 to 21 x 40, single ended with mounting ring and pins.

Table 3 Single ended, dimensions in mm; mass in g

CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	SINGLE ENDED WITH MOUNTING RING: Form MR						APPROX. MASS	PACKING QUANTITIES
		Ød_1	Ød_2	ØD_{max}	Ø$D2_{max}$	D3	L_{max}		
15 x 30	02	0.8	1.0 +0.1	15.5	17.5	16.5 ±0.2	33	11.7	200
18 x 30	03	0.8	1.0 +0.1	18.5	19.5	18.5 ±0.2	33	12.9	200
18 x 40	04	1.0	1.3 +0.1	18.5	19.5	18.5 ±0.2	45	19.4	100
21 x 40	05	1.0	1.3 +0.1	21.5	22.5	21.5 ±0.2	45	24.7	100

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance −10 to +50%
I_R = RMS ripple current at 100 Hz, 85 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 1 kHz or 10 kHz.

Table 4 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 1 kHz (Ω)	Z 10 kHz (Ω)
6.3	10	3.3 x 11	15	5	5	0.30	47.8		20
	33	4.5 x 10	50	11	5.4	0.25	12.1		6.1
	68	4.5 x 10	75	22	5.9	0.25	5.86		2.9
	150	6 x 10	120	10	6.9	0.25	2.66		1.3
	470	8 x 18	330	22	11	0.25	0.85		0.43
	680	10 x 18	430	30	14	0.25	0.59		0.29
	1000	10 x 25	560	42	18	0.25	0.40		0.20
	1500	10 x 30	450	61	24	0.28	0.30	0.23	
	2200	12.5 x 30	610	88	33	0.29	0.21	0.16	
	3300	15 x 30	790	129	47	0.32	0.15	0.11	
	4700	18 x 30	1000	182	64	0.34	0.12	0.07	
	6800	18 x 40	1280	261	91	0.39	0.09	0.05	
	10 000	21 x 40	1570	382	131	0.45	0.07	0.05	
	15 000	21 x 40	1600	571	194	0.67	0.07	0.05	

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitors AS 030-033
1000 µF/10 V, −10/+50%
Case size 10 x 30; Form BR
Catalogue number: 2222 032 24102.

Table 5 Ordering information

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
6.3	10	3.3 x 11	1	–	030 23109	030 33109	–
	33	4.5 x 10	2	–	030 23339	030 33339	–
	68	4.5 x 10	2	–	030 23689	030 33689	–
	150	6 x 10	3	–	030 23151	030 33151	–
	470	8 x 18	5	–	031 23471	031 33471	–
	680	10 x 18	6	–	031 23681	031 33681	–
	1000	10 x 25	7	–	031 23102	031 33102	–
	1500	10 x 30	00	032 13152	032 23152	–	–
	2200	12.5 x 30	01	032 13222	032 23222	–	–
	3300	15 x 30	02	032 13332	032 23332	–	032 43332
	4700	18 x 30	03	032 13472	–	–	032 43472
	6800	18 x 40	04	033 13682	–	–	033 43682
	10 000	21 x 40	05	033 13103	–	–	033 43103
	15 000	21 x 40	05	033 13153	–	–	033 43153

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 1 kHz (Ω)	Z 10 kHz (Ω)
10	6.8	3.3 x 11	15	5	5	0.25	58.6		24
	22	4.5 x 10	45	11	5.4	0.20	14.5		7.3
	47	4.5 x 10	70	24	5.9	0.20	6.78		3.4
	100	6 x 10	110	110	7	0.20	3.19		1.6
	220	8 x 11	210	18	9.4	0.20	1.45		0.73
	220	6.5 x 18	210	18	9.4	0.20	1.45		0.73
	330	8 x 18	310	24	12	0.20	0.97		0.48
	470	10 x 18	410	33	14	0.20	0.68		0.34
	680	10 x 25	510	45	19	0.20	0.47		0.24
	1000	10 x 30	430	64	25	0.20	0.32		0.20
	1500	12.5 x 30	570	94	35	0.23	0.25	0.20	
	2200	15 x 30	740	136	49	0.24	0.18	0.14	
	3300	18 x 30	950	202	71	0.27	0.13	0.09	
	4700	18 x 40	1220	286	99	0.29	0.10	0.06	
	6800	21 x 40	1500	412	141	0.34	0.08	0.04	
	10 000	21 x 40	1520	604	205	0.49	0.08	0.05	
16	4.7	3.3 x 11	15	5	5	0.20	67.8		26
	15	4.5 x 10	55	12	5.5	0.16	17.0		8
	33	4.5 x 10	65	27	6.1	0.16	7.72		3.6
	68	6 x 10	110	11	7.2	0.16	3.75		1.8
	150	8 x 11	200	19	9.8	0.16	1.70		0.80
	150	6.5 x 18	200	19	9.8	0.16	1.70		0.80
	220	8 x 18	270	26	12	0.16	1.16		0.55
	330	10 x 18	410	36	16	0.16	0.78		0.36
	470	10 x 25	480	49	20	0.16	0.55		0.26
	680	10 x 30	400	70	27	0.16	0.38		0.18
	1000	12.5 x 30	550	100	37	0.16	0.26		0.12
	1500	15 x 30	680	148	53	0.19	0.21	0.17	
	2200	18 x 30	880	216	75	0.20	0.15	0.13	
	3300	18 x 40	1160	321	111	0.23	0.11	0.08	
	4700	21 x 40	1430	455	155	0.25	0.09	0.06	
	6800	21 x 40	1460	657	223	0.36	0.08	0.06	

Non-solid Al - electrolytic capacitors
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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
10	6.8	3.3 x 11	1	–	030 24688	030 34688	–
	22	4.5 x 10	2	–	030 24229	030 34229	–
	47	4.5 x 10	2	–	030 24479	030 34479	–
	100	6 x 10	3	–	030 24101	030 34101	–
	220	8 x 11	5a	–	030 24221	030 34221	–
	220	6.5 x 18	4	–	031 24221	031 34221	–
	330	8 x 18	5	–	031 24331	031 34331	–
	470	10 x 18	6	–	031 24471	031 34471	–
	680	10 x 25	7	–	031 24681	031 34681	–
	1000	10 x 30	00	032 14102	032 24102	–	–
	1500	12.5 x 30	01	032 14152	032 24152	–	–
	2200	15 x 30	02	032 14222	032 24222	–	032 44222
	3300	18 x 30	03	032 14332	–	–	032 44332
	4700	18 x 40	04	033 14472	–	–	033 44472
	6800	21 x 40	05	033 14682	–	–	033 44682
	10 000	21 x 40	05	033 14103	–	–	033 44103
16	4.7	3.3 x 11	1	–	030 25478	030 35478	–
	15	4.5 x 10	2	–	030 25159	030 35159	–
	33	4.5 x 10	2	–	030 25339	030 35339	–
	68	6 x 10	3	–	030 25689	030 35689	–
	150	8 x 11	5a	–	030 25151	030 35151	–
	150	6.5 x 18	4	–	031 25151	031 35151	–
	220	8 x 18	5	–	031 25221	031 35221	–
	330	10 x 18	6	–	031 25331	031 35331	–
	470	10 x 25	7	–	031 25471	031 35471	–
	680	10 x 30	00	032 15681	032 25681	–	–
	1000	12.5 x 30	01	032 15102	032 25102	–	–
	1500	15 x 30	02	032 15152	032 25152	–	032 45152
	2200	18 x 30	03	032 15222	–	–	032 45222
	3300	18 x 40	04	033 15332	–	–	033 45332
	4700	21 x 40	05	033 15472	–	–	033 45472
	6800	21 x 40	05	033 15682	–	–	033 45682

Non-solid Al - electrolytic capacitors
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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 1 kHz (Ω)	Z 10 kHz (Ω)
25	3.3	3.3 x 11	15	5	5	0.18	86.9		27
	10	4.5 x 10	50	13	5.5	0.14	22.3		9
	22	4.5 x 10	60	28	6.1	0.14	10.2		4.1
	47	6 x 10	100	12	7.4	0.14	4.8		1.9
	100	8 x 11	160	19	10	0.14	2.23		0.90
	100	6.5 x 18	160	19	10	0.14	2.23		0.90
	150	8 x 18	240	27	13	0.14	1.49		0.60
	220	10 x 18	350	37	16	0.14	1.02		0.41
	330	10 x 25	460	54	22	0.14	0.68		0.27
	470	10 x 30	360	75	29	0.14	0.47		0.19
	680	12.5 x 30	500	106	39	0.14	0.32		0.13
	1000	15 x 30	660	154	55	0.14	0.22		0.09
	1500	18 x 30	810	229	80	0.17	0.18	0.15	
	2200	18 x 40	1060	334	115	0.18	0.13	0.10	
	3300	21 x 40	1340	499	170	0.21	0.10	0.07	
	4700	21 x 40	1370	709	240	0.28	0.10	0.06	
40	2.2	3.3 x 11	15	5	5	0.15	109		32
	6.8	4.5 x 10	45	14	5.5	0.11	25.8		10
	10	4.5 x 10	50	20	5.8	0.11	17.6		7
	15	4.5 x 10	55	30	6.2	0.11	11.7		4.7
	22	6 x 10	75	9	6.8	0.11	8.0		3.2
	33	6 x 10	95	12	7.7	0.11	5.31		2.1
	47	8 x 11	150	16	8.8	0.11	3.73		1.5
	47	6.5 x 18	150	16	8.8	0.11	3.73		1.5
	100	8 x 18	220	28	13	0.11	1.75		0.70
	150	10 x 18	300	40	17	0.11	1.17		0.47
	220	10 x 25	430	57	23	0.11	0.80		0.32
	220	10 x 30	260	57	23	0.12	0.86		0.32
	330	12.5 x 30	370	84	31	0.12	0.58		0.21
	470	12.5 x 30	440	117	43	0.12	0.40		0.15
	680	15 x 30	580	167	59	0.12	0.28		0.10
	1000	18 x 30	780	244	85	0.12	0.19		0.07
	1500	18 x 40	970	364	125	0.15	0.16	0.13	
	2200	21 x 40	1220	532	181	0.16	0.12	0.09	
	3300	21 x 40	1284	796	269	0.24	0.11	0.07	

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Non-solid Al - electrolytic capacitors
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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
25	3.3	3.3 x 11	1	–	030 26338	030 36338	–
	10	4.5 x 10	2	–	030 26109	030 36109	–
	22	4.5 x 10	2	–	030 26229	030 36229	–
	47	6 x 10	3	–	030 26479	030 36479	–
	100	8 x 11	5a	–	030 26101	030 36101	–
	100	6.5 x 18	4	–	031 26101	031 36101	–
	150	8 x 18	5	–	031 26151	031 36151	–
	220	10 x 18	6	–	031 26221	031 36221	–
	330	10 x 25	7	–	031 26331	031 36331	–
	470	10 x 30	00	032 16471	032 26471	–	–
	680	12.5 x 30	01	032 16681	032 26681	–	–
	1000	15 x 30	02	032 16102	032 26102	–	032 46102
	1500	18 x 30	03	032 16152	–	–	032 46152
	2200	18 x 40	04	033 16222	–	–	033 46222
	3300	21 x 40	05	033 16332	–	–	033 46332
	4700	21 x 40	05	033 16472	–	–	033 46472
40	2.2	3.3 x 11	1	–	030 27228	030 37228	–
	6.8	4.5 x 10	2	–	030 27688	030 37688	–
	10	4.5 x 10	2	–	030 27109	030 37109	–
	15	4.5 x 10	2	–	030 27159	030 37159	–
	22	6 x 10	3	–	030 27229	030 37229	–
	33	6 x 10	3	–	030 27339	030 37339	–
	47	8 x 11	5a	–	030 27479	030 37479	–
	47	6.5 x 18	4	–	031 27479	031 37479	–
	100	8 x 18	5	–	031 27101	031 37101	–
	150	10 x 18	6	–	031 27151	031 37151	–
	220	10 x 25	7	–	031 27221	031 37221	–
	220	10 x 30	00	032 17221	032 27221	–	–
	330	12.5 x 30	01	032 17331	032 27331	–	–
	470	12.5 x 30	01	032 17471	032 27471	–	–
	680	15 x 30	02	032 17681	032 27681	–	032 47681
	1000	18 x 30	03	032 17102	–	–	032 47102
	1500	18 x 40	04	033 17152	–	–	033 47152
	2200	21 x 40	05	033 17222	–	–	033 47222
	3300	21 x 40	05	033 17332	–	–	033 47332

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 1 kHz (Ω)	Z 10 kHz (Ω)
63	0.33	4.5 x 10	4	5	5	0.09	435		167
	0.47	3.3 x 11	6	5	5	0.10	339		117
	0.47	4.5 x 10	6	5	5	0.09	305		117
	1.0	3.3 x 11	10	5	5	0.12	191		55
	1.0	4.5 x 10	13	5	5	0.09	143		55
	1.5	4.5 x 10	17	5	5	0.09	95.6		37
	2.2	4.5 x 10	25	7	5.3	0.09	65.2		25
	3.3	4.5 x 10	35	11	5.4	0.09	46.5		17
	4.7	4.5 x 10	40	15	5.6	0.09	30.5		12
	6.8	4.5 x 10	46	22	5.9	0.09	21.1		8.1
	10	6 x 10	70	7	6.3	0.08	12.8		5.5
	15	6 x 10	79	10	6.9	0.08	8.5		3.7
	22	8 x 11	110	13	7.8	0.08	5.79		2.5
	22	6.5 x 18	110	13	7.8	0.08	5.79		2.5
	47	8 x 18	190	22	11	0.08	2.71		1.2
	68	10 x 18	250	30	14	0.08	1.88		0.81
	100	10 x 25	300	42	18	0.08	1.28		0.55
	150	10 x 30	260	61	24	0.08	0.90		0.37
	220	12.5 x 30	350	88	33	0.08	0.61		0.25
	330	15 x 30	480	129	47	0.08	0.41		0.17
	470	15 x 30	570	182	64	0.08	0.29		0.15
	680	18 x 30	770	261	91	0.08	0.20		0.08
	1000	21 x 40	1140	382	131	0.08	0.14		0.06
	1500	21 x 40	1110	571	194	0.12	0.15	0.15	

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Non-solid Al - electrolytic capacitors
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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
63	0.33	4.5 x 10	2	–	030 28337	030 38337	–
	0.47	4.5 x 10	2	–	030 28477	030 38477	–
	0.47	3.3 x 11	1	–	030 90065	030 90098	–
	1.0	4.5 x 10	2	–	030 28108	030 38108	–
	1.0	3.3 x 11	1	–	030 90067	030 90068	–
	1.5	4.5 x 10	2	–	030 28158	030 38158	–
	2.2	4.5 x 10	2	–	030 28228	030 38228	–
	3.3	4.5 x 10	2	–	030 28338	030 38338	–
	4.7	4.5 x 10	2	–	030 28478	030 38478	–
	6.8	4.5 x 10	2	–	030 28688	030 38688	–
	10	6 x 10	3	–	030 28109	030 38109	–
	15	6 x 10	3	–	030 28159	030 38159	–
	22	8 x 11	5a	–	030 28229	030 38229	–
	22	6.5 x 18	4	–	031 28229	031 38229	–
	47	8 x 18	5	–	031 28479	031 38479	–
	68	10 x 18	6	–	031 28689	031 38689	–
	100	10 x 25	7	–	031 28101	031 38101	–
	150	10 x 30	00	032 18151	032 28151	–	–
	220	12.5 x 30	01	032 18221	032 28221	–	–
	330	15 x 30	02	032 18331	032 28331	–	032 48331
	470	15 x 30	02	032 18471	032 28471	–	032 48471
	680	18 x 30	03	032 18681	–	–	032 48681
	1000	21 x 40	05	033 18102	–	–	033 48102
	1500	21 x 40	05	033 18152	–	–	033 48152

Non-solid Al - electrolytic capacitors
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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 1 kHz (Ω)	Z 10 kHz (Ω)
100	0.47	4.5 x 10	9	5	5	0.08	271		96
	1.0	4.5 x 10	20	5	5	0.08	128		45
	2.2	4.5 x 10	30	11	11	0.08	57.9		21
	3.3	4.5 x 10	40	17	17	0.08	38.6		14
	4.7	6 x 10	50	22	22	0.07	23.7		9.6
	6.8	6 x 10	70	34	34	0.07	16.4		6.6
	10	8 x 11	90	50	50	0.07	11.2		4.5
	10	6.5 x 18	90	50	50	0.07	11.2		4.5
	22	8 x 18	120	80	80	0.07	5.07		2.1
	33	10 x 18	200	119	119	0.07	3.38		1.4
	47	10 x 25	260	33	33	0.07	2.37		0.96
	68	10 x 30	130	45	45	0.15	3.53		2.0
	100	12.5 x 30	190	64	64	0.15	2.40		1.2
	150	15 x 30	250	94	94	0.15	1.60		0.85
	220	18 x 30	330	136	136	0.15	1.09		0.60
	330	18 x 40	460	202	202	0.15	0.73		0.50
	470	21 x 40	600	286	286	0.15	0.51		0.35
	680	21 x 40	650	412	412	0.15	0.42		0.35

5

Voltage

Surge voltage for short periods: $U_s \leq 1.15 \times U_R$

Reverse voltage: $U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R
- case sizes 3.3 x 11 and 4.5 x 10: $I_{L1} \leq 0.05\ C_R \times U_R$ or 5 µA, whichever is greater
- case sizes 6 x 10 to 21 x 40: I_{L1} for CU ≤ 1000 µC: ≤ $0.01\ C_R \times U_R$ or 1 µA, whichever is greater; I_{L1} for CU > 1000 µC: ≤ $0.006\ C_R \times U_R + 4$ µA

After 5 minutes at U_R
- 6.3 to 63 V: $I_{L5} \leq 0.002\ C_R \times U_R + 5$ µA
- 100 V: $I_{L5} \leq 0.006\ C_R \times U_R + 4$ µA

Non-solid Al - electrolytic capacitors
Axial Standard

AS 030-033

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
100	0.47	4.5 x 10	2	–	030 29477	030 39477	–
	1.0	4.5 x 10	2	–	030 29108	030 39108	–
	2.2	4.5 x 10	2	–	030 29228	030 39228	–
	3.3	4.5 x 10	2	–	030 29338	030 39338	–
	4.7	6 x 10	3	–	030 29478	030 39478	–
	6.8	6 x 10	3	–	030 29688	030 39688	–
	10	8 x 11	5a	–	030 29109	030 39109	–
	10	6.5 x 18	4	–	031 29109	031 39109	–
	22	8 x 18	5	–	031 29229	031 39229	–
	33	10 x 18	6	–	031 29339	031 39339	–
	47	10 x 25	7	–	031 29479	031 39479	–
	68	10 x 30	00	032 19689	032 29689	–	–
	100	12.5 x 30	01	032 19101	032 29101	–	–
	150	15 x 30	02	032 19151	032 29151	–	032 49151
	220	18 x 30	03	032 19221	–	–	032 49221
	330	18 x 40	04	033 19331	–	–	033 49331
	470	21 x 40	05	033 19471	–	–	033 49471
	680	21 x 40	05	033 19681	–	–	033 49681

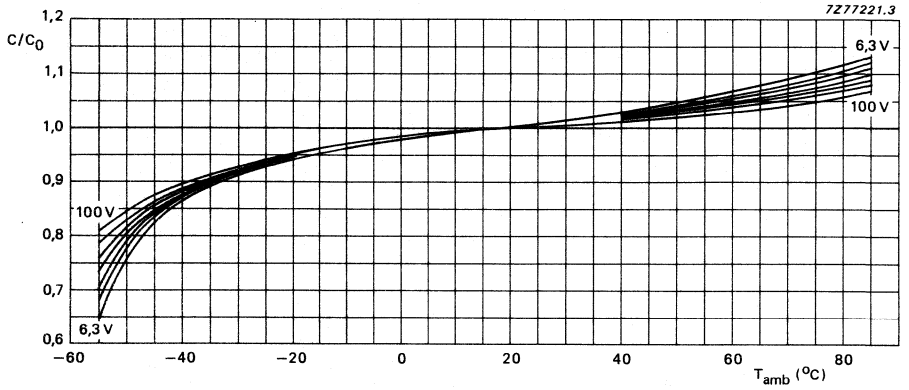
5

MARKING

The capacitors are marked (where possible) with the following information:

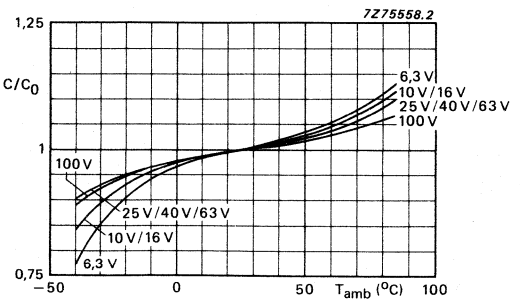
- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62 (not for case size 1)
- Rated voltage in V
- Group number (030, 031, 032 or 033)
- Code indicating factory of origin
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Band to identify the negative terminal
- "+" - signs to identify the positive terminal (not for case sizes L <18 mm).

Capacitance (C)



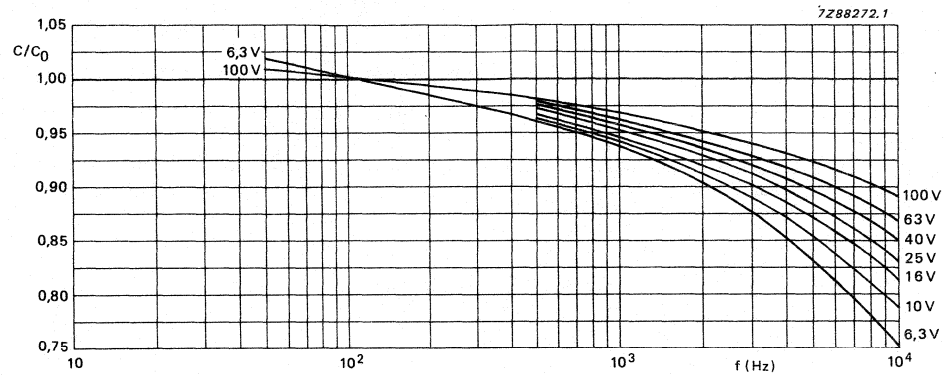
C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 3.3 x 11 to 10 x 25.



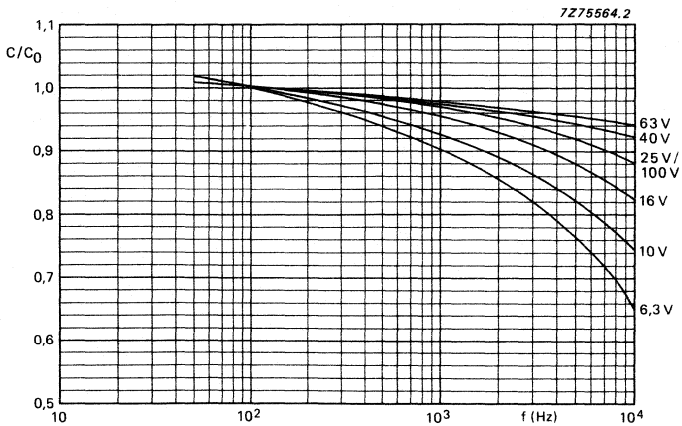
C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 10 x 30 to 21 x 40.



C_0 = capacitance at 20 °C, 100 Hz.

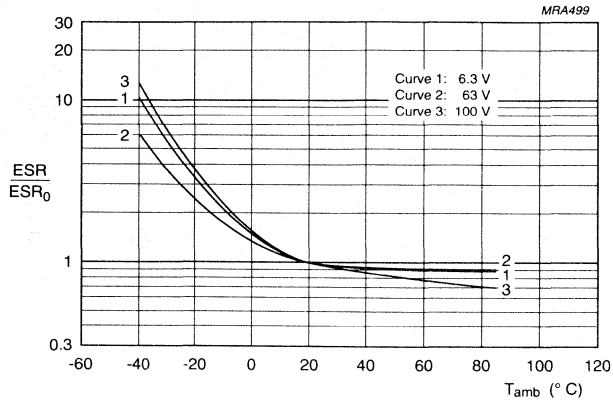
Fig.7 Multiplier of capacitance (C/C_0) as a function of frequency; case sizes 3.3 x 11 to 10 x 25.



C_0 = capacitance at 20 °C, 100 Hz.

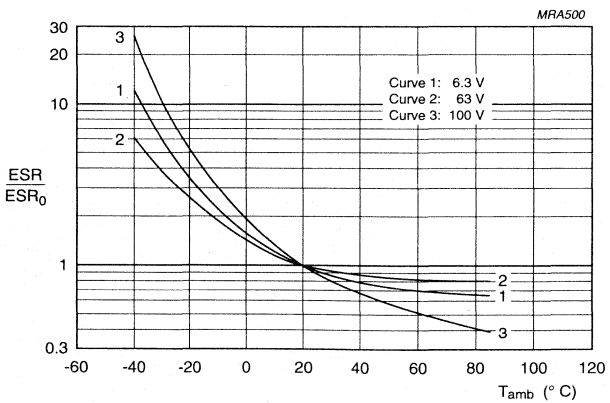
Fig.8 Multiplier of capacitance (C/C_0) as a function of frequency; case sizes 10 x 30 to 21 x 40.

Equivalent series resistance (ESR)



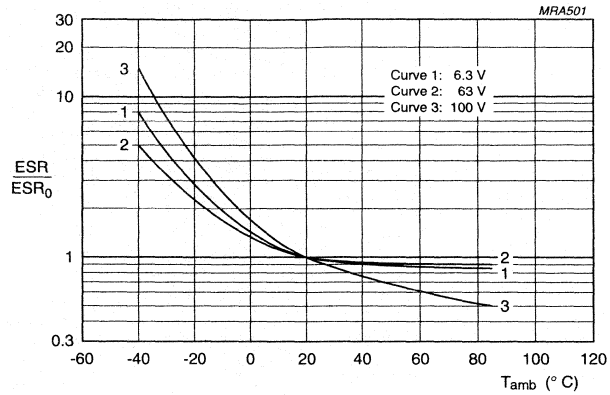
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 3.3 x 11 to 10 x 25.



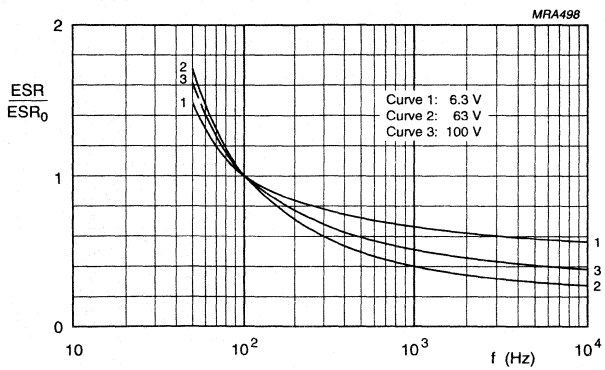
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.10 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 10 x 30, 12.5 x 30 and 15 x 30.



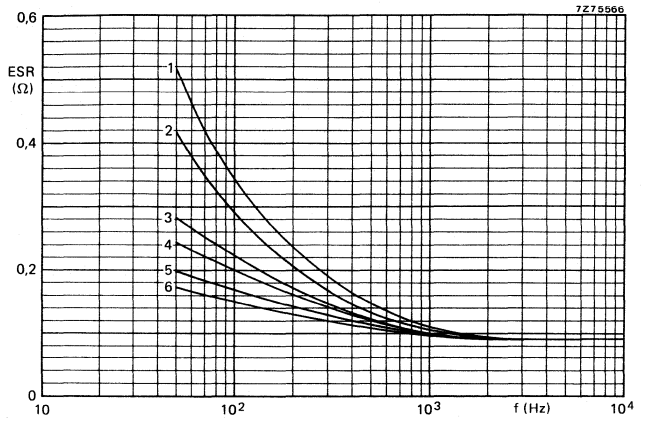
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.11 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 18 x 30, 18 x 40 and 21 x 40.



ESR_0 = typical ESR at 20 °C, 100 Hz.

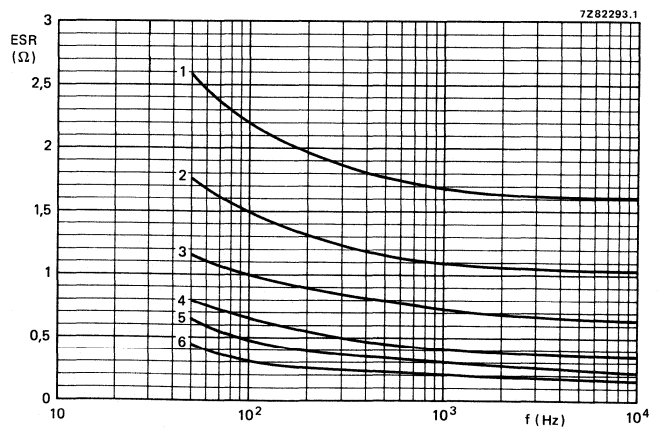
Fig.12 Multiplier of ESR (ESR/ESR_0) as a function of frequency; case sizes 3.3 x 11 to 10 x 25.



Curve 1: 220 µF - 63 V
Curve 2: 330 µF - 40 V
Curve 3: 470 µF - 40 V
Curve 4: 680 µF - 25 V
Curve 5: 1000 µF - 16 V
Curve 6: 1500 µF - 10 V and 2200 µF - 6.3 V.

Fig.13 Typical ESR as a function of frequency at 20 °C; case size 12.5 x 30; 6.3 to 63 V types.

5



Curve 1: 68 µF - case size 10 x 30
Curve 2: 100 µF - case size 12.5 x 30
Curve 3: 150 µF - case size 15 x 30
Curve 4: 220 µF - case size 18 x 30
Curve 5: 330 µF - case size 18 x 40
Curve 6: 470 µF and 680 µF - case size 21 x 40.

Fig.14 Typical ESR as a function of frequency at 20 °C; 100 V types.

Equivalent series inductance (ESL)

Table 6 Equivalent series inductance, typical values

CASE SIZE (∅ x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)
3.3 x 11	11	
4.5 x 10	10	
6 x 10	22	
8 x 11	85	
6.5 x 18	25	
8 x 18	40	
10 x 18	61	
10 x 25	38	
10 x 30	38	
12.5 x 30	46	
15 x 30	48	39
18 x 30	50	39
18 x 40	54	39
21 x 40	59	39

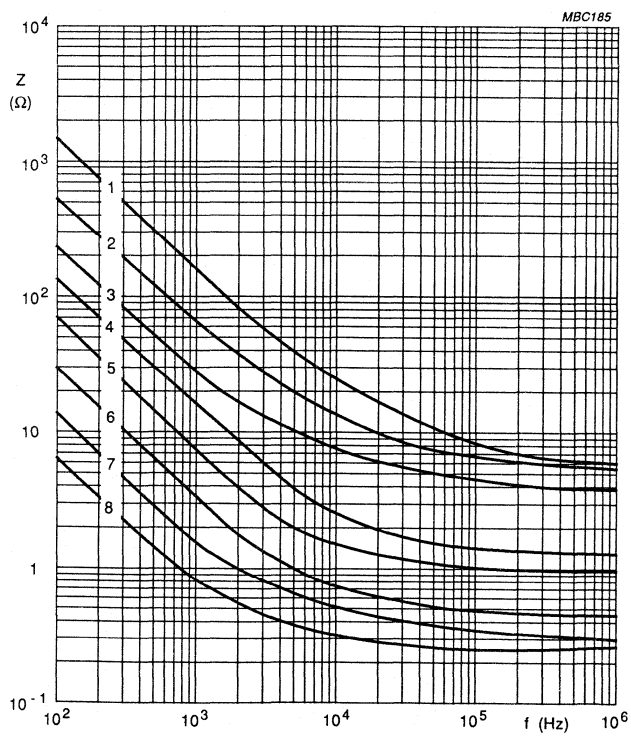
Impedance (Z)

Table 7 Impedance x capacitance values at 10 kHz

T_{amb}	$z = Z \times C_R(\Omega\ \mu F)$ at 10 kHz						
	6.3 V	10 V	16 V	25 V	40 V	63 V	100 V
+20 °C	≤ 200	≤ 160	≤ 120	≤ 90	≤ 70	≤ 55	≤ 45
–25 °C	≤1200	≤ 750	≤ 560	≤ 400	≤ 300	≤ 180	≤ 130
–40 °C	≤3200	≤2000	≤1500	≤1100	≤ 900	≤ 500	≤ 350

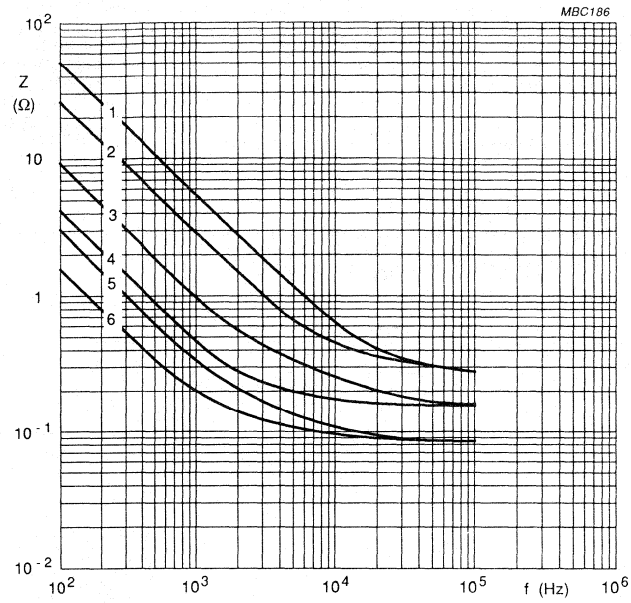
Table 8 Impedance x capacitance values at 1 kHz

T_{amb}	$z = Z \times C_R(\Omega\ \mu F)$ at 1 kHz						
	6.3 V	10 V	16 V	25 V	40 V	63 V	100 V
+20 °C	≤ 350	≤ 300	≤ 250	≤ 220	≤ 200	≤ 180	≤ 175
–25 °C	≤1700	≤1100	≤ 800	≤ 570	≤ 430	≤ 330	≤ 300
–40 °C	≤4500	≤2800	≤2000	≤1400	≤1100	≤ 800	–



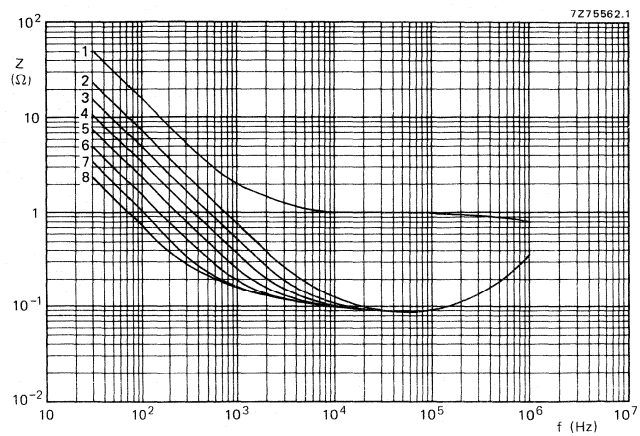
Curve 1: 1 µF - 63 V - case size 3.3 x 11
Curve 2: 2.2 µF - 40 V
Curve 3: 4.7 µF - 16 V
Curve 4: 10 µF - 25 V
Curve 5: 22 µF - 25 V
Curve 6: 47 µF - 25 V
Curve 7: 100 µF - 25 V - case size 6.5 x 18
Curve 8: 220 µF - 10 V - case size 6.5 x 18.

Fig.15 Typical impedance as a function of frequency at 20 °C; case sizes 3.3 x 11 to 6.5 x 18.



Curve 1: 22 µF - 63 V - case size 8 x 11
Curve 2: 47 µF - 40 V - case size 8 x 11
Curve 3: 150 µF - 25 V
Curve 4: 330 µF - 16 V
Curve 5: 470 µF - 16 V
Curve 6: 1000 µF - 6.3 V.

Fig.16 Typical impedance as a function of frequency at 20 °C; case sizes 8 x 11 to 10 x 25.



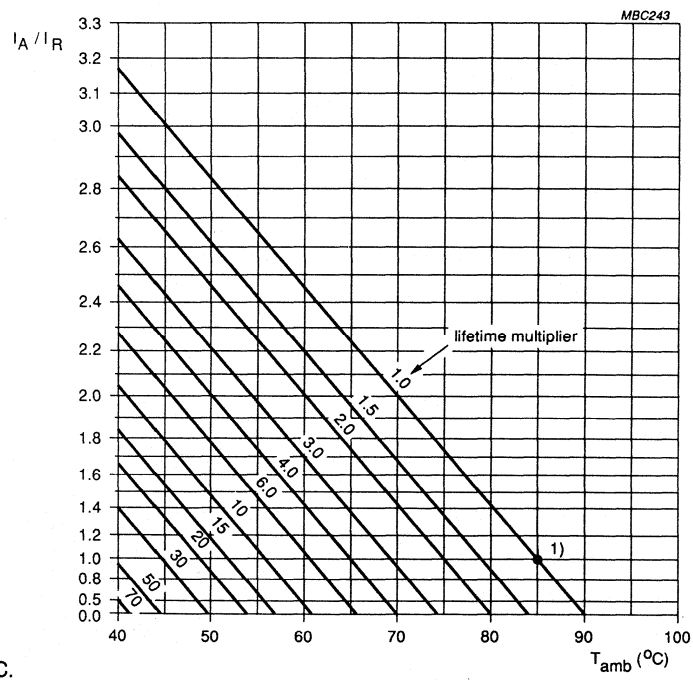
Curve 1: 100 µF - 100 V
Curve 2: 220 µF - 63 V
Curve 3: 330 µF - 40 V
Curve 4: 470 µF - 40 V
Curve 5: 680 µF - 25 V
Curve 6: 1000 µF - 16 V
Curve 7: 1500 µF - 10 V
Curve 8: 2200 µF - 6.3 V.

Fig.17 Typical impedance as a function of frequency at 20 °C; case size 12.5 x 30.

RIPPLE CURRENT and USEFUL LIFE

Table 9 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 85 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10 V	U_R = 16 to 25 V	U_R = 40 to 100 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥10 000	1.2	1.3	1.4



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied:
case size 3.3 x 11; 1500 hours
case size 4.5 x 10 to 10 x 25; 3000 hours
case size 10 x 30 to 21 x 40; 8000 hours.

Fig.18 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 10 Case size 3.3 x 11

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied 1000 hours	ΔC/C ±20% tan δ ≤2 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 1500 hours	ΔC/C ±50% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

Table 11 Case sizes 4.5 x 10 to 21 x 40

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied case sizes: 4.5 x 10 to 10 x 25: 2000 hours 10 x 30 to 21 x 40: 5000 hours	U_R ≤6.3 V : ΔC/C +15/–30% U_R >6.3 V : ΔC/C ±15% tan δ ≤1.3 x spec. limit Z ≤2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied case sizes: 4.5 x 10 to 10 x 25: 3000 hours 10 x 30 to 21 x 40: 8000 hours	U_R ≤6.3 V : ΔC/C +45/–50% U_R >6.3 V : ΔC/C ±45% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

ASH 041-043

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case sizes 10 x 30 to 21 x 40 with safety vent
- Taped versions up to 15 x 30 available for automatic insertion
- Charge and discharge proof
- Useful life: 5000/10 000 hours at 85 °C
- High rated voltage: up to 450 V.

APPLICATIONS

- General purpose, industrial, power supply, audio-video and lighting
- Smoothing, filtering, buffering at high voltages
- Boards with restricted mounting height, vibration and shock resistant.

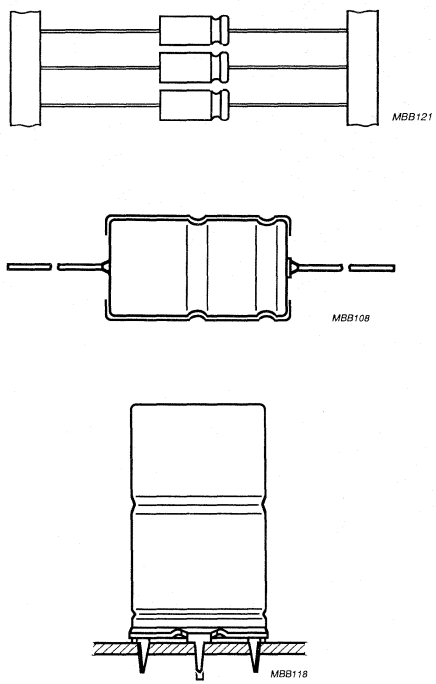


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	6.5 x 18 to 10 x 25	10 x 30 to 21 x 40
Rated capacitance range, C_R	1 to 220 µF	
Tolerance on C_R	–10 to +50%	
Rated voltage range, U_R	160 to 450 V	
Category temperature range	–40 to +85 °C	
Endurance test at 85 °C	2000 hours	5000 hours
Useful life at 85 °C	5000 hours	10 000 hours
Useful life at 40 °C, 1.4 I_R applied	120 000 hours	250 000 hours
Shelf life at 0 V, 85 °C	500 hours	500 hours
Basic specification	IEC 384-4/CECC 30 300, LL grade	
Detail specification	DIN 41240	
Climatic category IEC 68 DIN 40040	40/085/56 GPF	

Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

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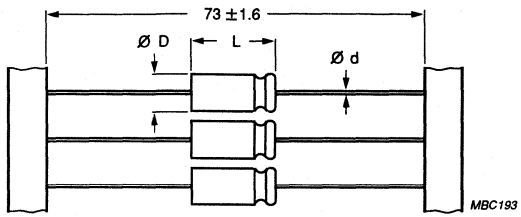
Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**) * = preferred values

C_R (µF)		U_R (V)					
		160	**250**	**350**	**385**	**400**	**450**
1.0	*				6.5 x 18		
2.2	*		6.5 x 18		8 x 18		
4.7	*	6.5 x 18	8 x 18	10 x 18	10 x 25		
6.8				10 x 30	10 x 30	10 x 30	10 x 30
10	*	8 x 18	10 x 25 10 x 30	12.5 x 30	12.5 x 30	12.5 x 30	12.5 x 30
15			12.5 x 30	12.5 x 30	15 x 30	15 x 30	12.5 x 30
22	*	10 x 25 10 x 30	12.5 x 30	15 x 30	18 x 30	18 x 30	15 x 30
33		12.5 x 30	15 x 30	18 x 30	18 x 40	18 x 40	18 x 30
47	*	15 x 30	18 x 30	18 x 40	18 x 40	18 x 40	18 x 40
68		15 x 30	18 x 40	21 x 40	21 x 40	21 x 40	21 x 40
100	*	18 x 30	21 x 40				
150		18 x 40					
220	*	21 x 40					

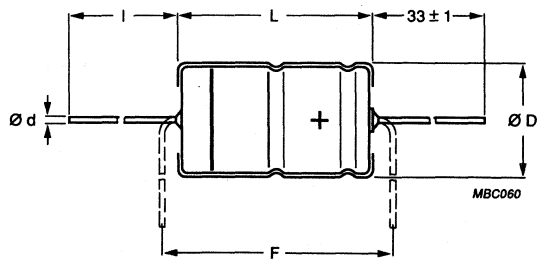
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING".



Form BR: Taped on reel, case sizes 6.5 x 18 to 15 x 30.
Form BA: Taped in box (ammopack), case sizes 6.5 x 18 to 10 x 25.

Fig.2 Case sizes 6.5 x 18 to 15 x 30.

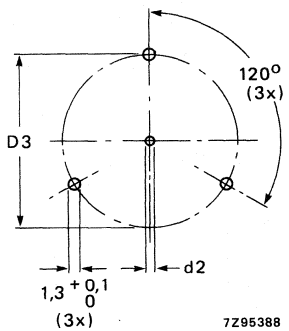


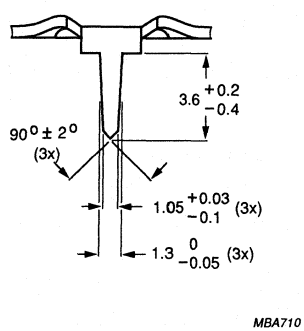
Form AA: Axial in box.
For case sizes 18 x 40 and 21 x 40, the stated L may be exceeded by 0.7 mm.

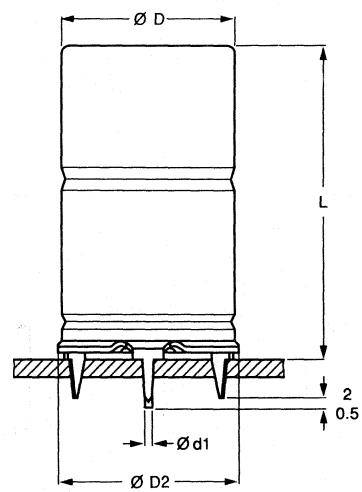
Fig.3 Case sizes 10 x 30 to 21 x 40.

Table 2 Axial, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	AXIAL: Form AA, BA, and BR					APPROX. MASS	PACKING QUANTITIES		
		∅d	l	∅D_{max}	L_{max}	F_{min}		Form AA	Form BA	Form BR
6.5 x 18	4	0.8		6.9	18.5	25	1.3	–	1000	1000
8 x 18	5	0.8		8.5	18.5	25	1.7	–	500	500
10 x 18	6	0.8		10.5	18.5	25	2.5	–	500	500
10 x 25	7	0.8		10.5	25.0	30	3.3	–	500	500
10 x 30	00	0.8	55 ±1	10.5	30.5	35	4.8	200	–	500
12.5 x 30	01	0.8	55 ±1	13.0	30.5	35	7.4	200	–	400
15 x 30	02	0.8	55 ±1	15.5	30.5	35	11.7	200	–	250
18 x 30	03	0.8	55 ±1	18.5	30.5	35	12.9	200	–	–
18 x 40	04	0.8	34 ±1	18.5	41.5	45	19.4	100	–	–
21 x 40	05	0.8	34 ±1	21.5	41.5	45	24.7	100	–	–







Piercing diagram.

Form MR: case not insulated (insulation on request).
Especially for applications with severe shocks and vibrations.

Fig.4 Case sizes 15 x 30 to 21 x 40, single ended with mounting ring and pins.

Table 3 Single ended, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	SINGLE ENDED WITH MOUNTING RING: Form MR						APPROX. MASS	PACKING QUANTITIES
		∅d_1	∅d_2	∅D_{max}	∅$D2_{max}$	D3	L_{max}		
15 x 30	02	0.8	1.0 +0.1	15.5	17.5	16.5 ±0.2	33	11.7	200
18 x 30	03	0.8	1.0 +0.1	18.5	19.5	18.5 ±0.2	33	12.9	200
18 x 40	04	1.0	1.3 +0.1	18.5	19.5	18.5 ±0.2	45	19.4	100
21 x 40	05	1.0	1.3 +0.1	21.5	22.5	21.5 ±0.2	45	24.7	100

Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

ASH 041-043

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance –10 to +50%

I_R = rated RMS ripple current at 100 Hz, 85 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz.

Table 4 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
160	4.7	6.5 x 18	50	38	8	0.15	51	26
	10	8 x 18	70	68	14	0.15	24	12
	22	10 x 25	150	130	25	0.15	11	5.5
	22	10 x 30	110	42	25	0.10	7.2	4.5
	33	12.5 x 30	150	58	36	0.10	4.8	3.1
	47	15 x 30	190	78	49	0.10	3.4	2.1
	68	15 x 30	230	110	69	0.10	2.3	1.4
	100	18 x 30	310	150	100	0.10	1.6	1.0
	150	18 x 40	430	230	150	0.10	1.1	0.7
	220	21 x 40	570	330	220	0.10	0.7	0.5
250	2.2	6.5 x 18	35	28	6	0.10	72	50
	4.7	8 x 18	55	55	11	0.10	34	23
	10	10 x 25	90	95	19	0.10	16	11
	10	10 x 30	72	33	19	0.10	16	11
	15	12.5 x 30	100	44	27	0.10	11	7.4
	22	12.5 x 30	120	60	37	0.10	7.2	5.0
	33	15 x 30	160	84	54	0.10	4.8	3.4
	47	18 x 30	220	120	75	0.10	3.4	2.4
	68	18 x 40	290	160	110	0.10	2.3	1.7
	100	21 x 40	390	240	150	0.10	1.6	1.1

Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

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ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor ASH 041-043
10 µF/250 V, −10/+50%
Case size 10 x 25; Form BR
Catalogue number: 2222 041 23109.

Table 5 Ordering information

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
160	4.7	6.5 x 18	4	–	041 21478	041 31478	–
	10	8 x 18	5	–	041 21109	041 31109	–
	22	10 x 25	7	–	041 21229	041 31229	–
	22	10 x 30	00	042 11229	042 21229	–	–
	33	12.5 x 30	01	042 11339	042 21339	–	–
	47	15 x 30	02	042 11479	042 21479	–	042 41479
	68	15 x 30	02	042 11689	042 21689	–	042 41689
	100	18 x 30	03	042 11101	–	–	042 41101
	150	18 x 40	04	043 11151	–	–	043 41151
	220	21 x 40	05	043 11221	–	–	043 41221
250	2.2	6.5 x 18	4	–	041 23228	041 33228	–
	4.7	8 x 18	5	–	041 23478	041 33478	–
	10	10 x 25	7	–	041 23109	041 33109	–
	10	10 x 30	00	042 13109	042 23109	–	–
	15	12.5 x 30	01	042 13159	042 23159	–	–
	22	12.5 x 30	01	042 13229	042 23229	–	–
	33	15 x 30	02	042 13339	042 23339	–	042 43339
	47	18 x 30	03	042 13479	–	–	042 43479
	68	18 x 40	04	043 13689	–	–	043 43689
	100	21 x 40	05	043 13101	–	–	043 43101

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
350	4.7	10 x 18	60	69	14	0.10	34	22
	6.8	10 x 30	60	32	18	0.10	23	14
	10	12.5 x 30	81	42	25	0.10	16	10
	15	12.5 x 30	100	57	36	0.10	11	6.7
	22	15 x 30	130	79	50	0.10	7.2	4.5
	33	18 x 30	160	110	73	0.10	4.8	3.1
	47	18 x 40	240	160	100	0.10	3.4	2.1
	68	21 x 40	320	220	150	0.10	2.3	1.4
385	1	6.5 x 18	20	19	4	0.10	160	100
	2.2	8 x 18	40	42	8	0.10	72	45
	4.7	10 x 25	70	71	15	0.10	34	22
	6.8	10 x 30	60	34	20	0.10	23	14
	10	12.5 x 30	81	45	27	0.10	16	10
	15	15 x 30	110	62	39	0.10	11	6.7
	22	18 x 30	150	86	55	0.10	7.2	4.5
	33	18 x 40	200	120	80	0.10	4.8	3.1
	47	18 x 40	240	170	110	0.10	3.4	2.1
	68	21 x 40	320	250	160	0.10	2.3	1.4
400	6.8	10 x 30	82	220	110	0.055	13	7.3
	10	12.5 x 30	130	240	110	0.055	8.8	4.6
	15	15 x 30	160	250	110	0.055	5.8	3.1
	22	18 x 30	210	280	120	0.055	4.0	2.1
	33	18 x 40	290	320	130	0.055	2.7	1.4
	47	18 x 40	330	370	140	0.055	1.9	1.1
	68	21 x 40	430	440	150	0.055	1.3	0.7
450	6.8	10 x 30	61	230	110	0.12	28	17
	10	12.5 x 30	83	240	110	0.12	19	12
	15	12.5 x 30	100	260	110	0.12	13	8
	22	15 x 30	140	290	120	0.12	8.7	5.4
	33	18 x 30	190	330	130	0.12	5.8	3.6
	47	18 x 40	250	390	140	0.12	4.1	2.5
	68	21 x 40	330	480	160	0.12	2.8	1.8

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
350	4.7	10 x 18	6	–	041 25478	041 35478	–
	6.8	10 x 30	00	042 15688	042 25688	–	–
	10	12.5 x 30	01	042 15109	042 25109	–	–
	15	12.5 x 30	01	042 15159	042 25159	–	–
	22	15 x 30	02	042 15229	042 25229	–	042 45229
	33	18 x 30	03	042 15339	–	–	042 45339
	47	18 x 40	04	043 15479	–	–	043 45479
	68	21 x 40	05	043 15689	–	–	043 45689
385	1	6.5 x 18	4	–	041 28108	041 38108	–
	2.2	8 x 18	5	–	041 28228	041 38228	–
	4.7	10 x 25	7	–	041 28478	041 38478	–
	6.8	10 x 30	00	042 18688	042 28688	–	–
	10	12.5 x 30	01	042 18109	042 28109	–	–
	15	15 x 30	02	042 18159	042 28159	–	042 48159
	22	18 x 30	03	042 18229	–	–	042 48229
	33	18 x 40	04	043 18339	–	–	043 48339
	47	18 x 40	04	043 18479	–	–	043 48479
	68	21 x 40	05	043 18689	–	–	043 48689
400	6.8	10 x 30	00	042 16688	042 26688	–	–
	10	12.5 x 30	01	042 16109	042 26109	–	–
	15	15 x 30	02	042 16159	042 26159	–	042 46159
	22	18 x 30	03	042 16229	–	–	042 46229
	33	18 x 40	04	043 16339	–	–	043 46339
	47	18 x 40	04	043 16479	–	–	043 46479
	68	21 x 40	05	043 16689	–	–	043 46689
450	6.8	10 x 30	00	042 17688	042 27688	–	–
	10	12.5 x 30	01	042 17109	042 27109	–	–
	15	12.5 x 30	01	042 17159	042 27159	–	–
	22	15 x 30	02	042 17229	042 27229	–	042 47229
	33	18 x 30	03	042 17339	–	–	042 47339
	47	18 x 40	04	043 17479	–	–	043 47479
	68	21 x 40	05	043 17689	–	–	043 47689

Marking

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Group number (041, 042 or 043)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Band to identify the negative terminal
- "+" - signs to identify the positive terminal.

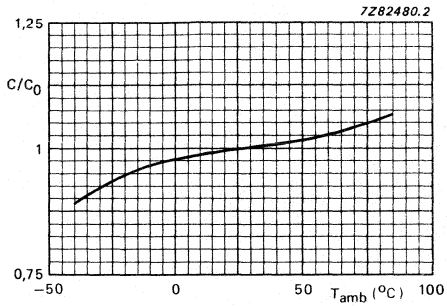
Voltage

Surge voltage for short periods	
160 and 250 V types	$U_s \leq 1.15 \times U_R$
350 to 450 V types	$U_s \leq 1.1 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R	
case sizes 6.5 x 18 to 10 x 25	for CU ≤ 1000 µC: $I_{L1} \leq 0.05\ C_R \times U_R$ or 5 µA, whichever is greater for CU > 1000 µC: $I_{L1} \leq 0.03\ C_R \times U_R + 20$ µA
case sizes 10 x 30 to 21 x 40	160 to 385 V: $I_{L1} \leq 0.009\ C_R \times U_R + 10$ µA 400 and 450 V: $I_{L1} \leq 0.009\ C_R \times U_R + 200$ µA
After 5 minutes at U_R	
160 to 385 V	for CU ≤ 1000 µC: $I_{L5} \leq 0.01\ C_R \times U_R$ or 1 µA, whichever is greater for CU > 1000 µC: $I_{L5} \leq 0.006\ C_R \times U_R + 4$ µA
400 and 450 V	$I_{L5} \leq 0.002\ C_R \times U_R + 100$ µA

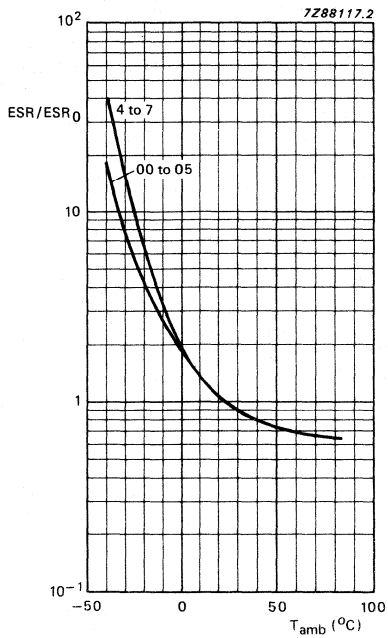
Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

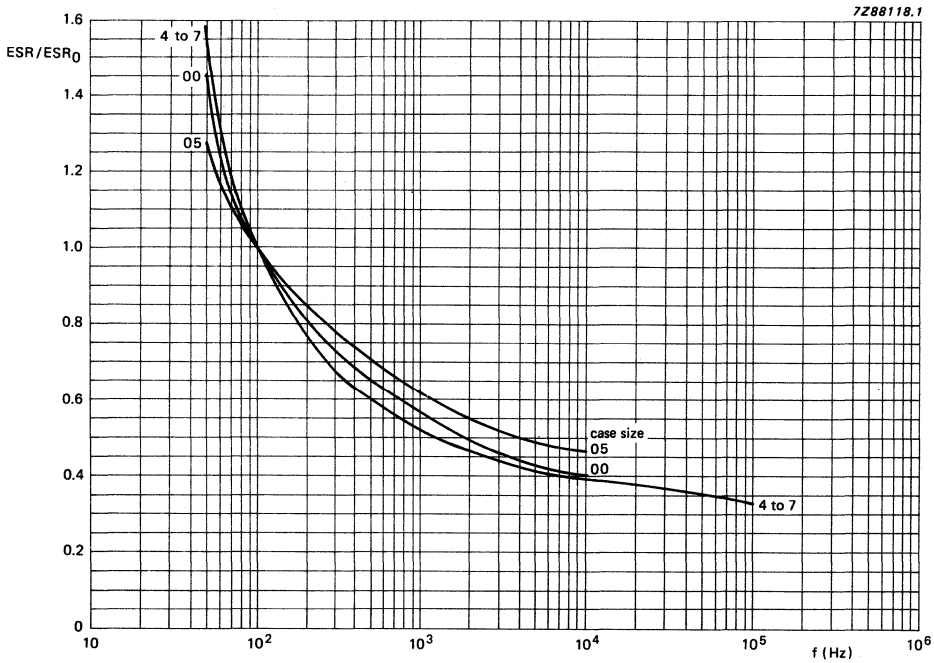
Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature.

Equivalent series resistance (ESR)



4 to 7:
case sizes 6.5 x 18 to 10 x 25.
00 to 05:
case sizes 10 x 30 to 21 x 40.
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.6 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



4 to 7:
case sizes 6.5 x 18 to 10 x 25.
00: case size 10 x 30.
05: case size 21 x 40.
ESR_0 = typical ESR at 20 °C, 100 Hz.

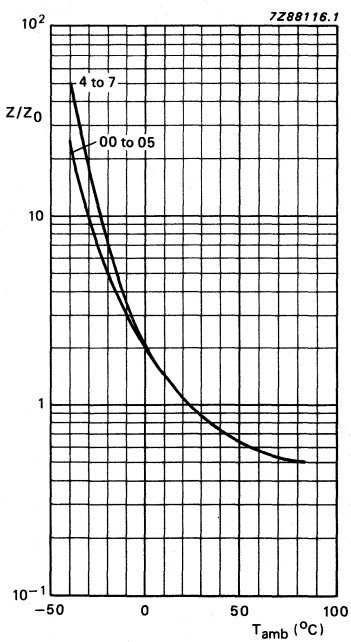
Fig.7 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

Equivalent series inductance (ESL)

Table 6 Equivalent series inductance, typical values

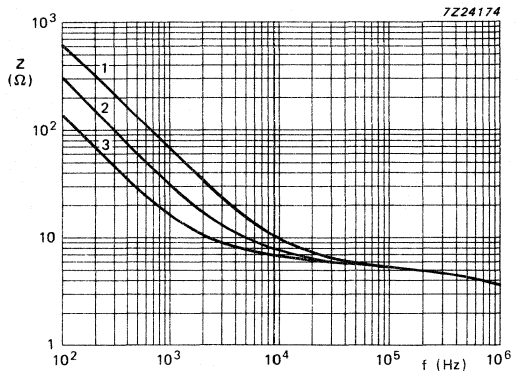
CASE SIZE (∅ x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)		CASE SIZE (∅ x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)
6.5 x 18	15	–		12.5 x 30	46	–
8 x 18	35	–		15 x 30	48	39
10 x 18	69	–		18 x 30	50	39
10 x 25	38	–		18 x 40	54	39
10 x 30	38	–		21 x 40	59	39

Impedance (Z)



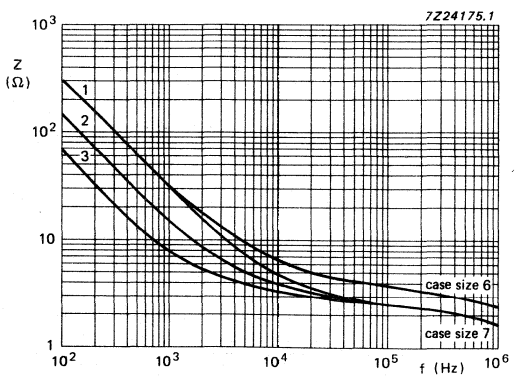
4 to 7:
case sizes 6.5 x 18 to 10 x 25.
00 to 05:
case sizes 10 x 30 to 21 x 40.
Z_0 = impedance at 20 °C, 10 kHz.

Fig.8 Multiplier of impedance (Z/Z_0) as a function of ambient temperature.



Curve 1: 2.2 µF
Curve 2: 4.7 µF
Curve 3: 10 µF.

Fig.9 Typical impedance as a function of frequency at 20 °C; case size 8 x 18.



Curve 1: 4.7 µF
Curve 2: 10 µF
Curve 3: 22 µF.

Fig.10 Typical impedance as a function of frequency at 20 °C; case sizes 10 x 18 (case size 6) and 10 x 25 (case size 7).

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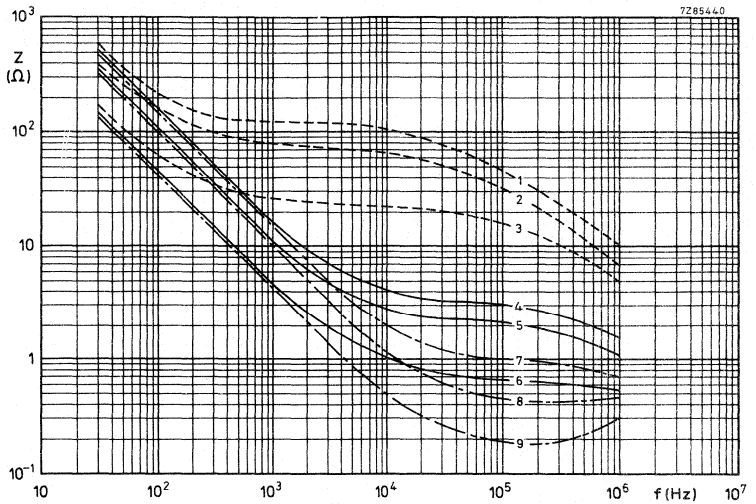


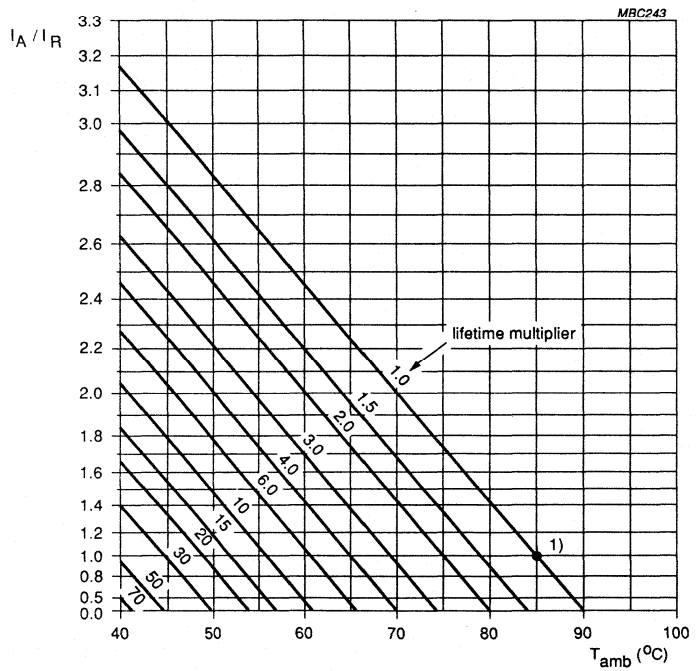
Curve 1: 10 µF - 350/385 V; –40 °C
Curve 2: 15 µF - 250 V; –40 °C
Curve 3: 33 µF - 160 V; –40 °C
Curve 4: 10 µF - 350/385 V; 20 °C
Curve 5: 15 µF - 250 V; 20 °C
Curve 6: 33 µF - 160 V; 20 °C
Curve 7: 10 µF - 350/385 V; 85 °C
Curve 8: 15 µF - 250 V; 85 °C
Curve 9: 33 µF - 160 V; 85 °C.

Fig.11 Typical impedance as a function of frequency at different temperatures; case size 12.5 x 30.

RIPPLE CURRENT and USEFUL LIFE

Table 7 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 85 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.75
100	1.0
300	1.15
1000	1.3
3000	1.4
≥10 000	1.5



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied.
case sizes 6.5 x 18 to 10 x 25: 5000 hours
case sizes 10 x 30 to 21 x 40: 10 000 hours.

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 8

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied case sizes: 6.5 x 18 to 10 x 25: 2000 hours 10 x 30 to 21 x 40: 5000 hours	U_R 160 V: $\Delta C/C$ ±15% U_R 250 to 450 V: $\Delta C/C$ ±10% tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied case sizes: 6.5 x 18 to 10 x 25: 5000 hours 10 x 30 to 21 x 40: 10 000 hours	U_R 160 V : $\Delta C/C$ ±45% U_R 250 to 450 V: $\Delta C/C$ ±30% tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

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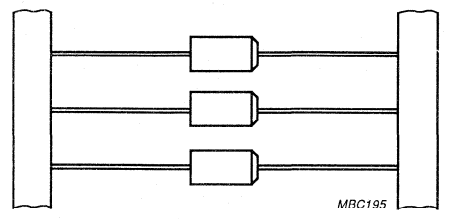
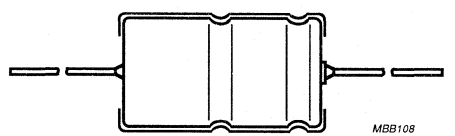
FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve (sizes 6.3 x 12.7 and 7.7 x 12.7 are moulded with flame retardant plastic material)
- Mounting ring version (single ended) not insulated
- Case sizes 10 x 30 to 21 x 40 with safety vent
- Taped versions up to 15 x 30 available for automatic insertion
- Charge and discharge proof
- Long useful life: 2000/5000 hours at 105 °C, high reliability
- High ripple current capability
- Miniaturized, high CU-product per unit volume.

APPLICATIONS

- Industrial, automotive, EDP and telecommunication
- Smoothing, filtering, buffering in SMPS; coupling, decoupling, timing
- Portable and mobile equipment (small size, low mass)
- Low mounting height boards, vibration and shock resistant
- Stand-by applications.





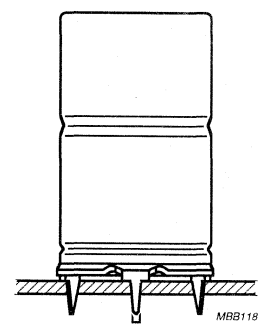


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	6.3 x 12.7 to 10 x 25	10 x 30 to 21 x 40
Rated capacitance range, C_R	0.22 to 15 000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	6.3 to 100 V	
Category temperature range	–40 to +105 °C	
Endurance test at 105 °C	1000 hours	2000 hours
Useful life at 105 °C	2000 hours	5000 hours
Useful life at 40 °C, I_R applied	1.3 I_R applied: 200 000 hours	1.7 I_R applied: 200 000 hours
Shelf life at 0 V, 105 °C	500 hours	500 hours
Basic specification	IEC 384-4/CECC 30300	
Detail specification	similar to DIN 41257 (with reduced dimensions)	
Climatic category IEC 68 DIN 40040	40/105/56 GMF	

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

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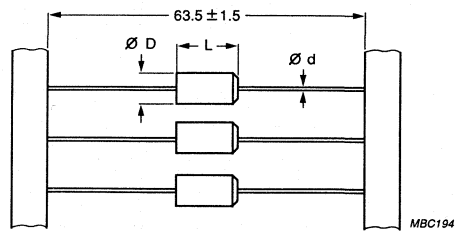
Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in mm) * = preferred values

C_R (µF)	U_R (V)							
	6.3	**10**	**16**	**25**	**40**	**50**	**63**	**100**
0.22							6.3 x 12.7	6.3 x 12.7
0.47							6.3 x 12.7*	6.3 x 12.7*
1.0							6.3 x 12.7*	6.3 x 12.7*
1.5							6.3 x 12.7	
2.2							6.3 x 12.7*	6.3 x 12.7*
3.3							6.3 x 12.7	7.7 x 12.7
4.7							6.3 x 12.7*	7.7 x 12.7*
6.8						6.3 x 12.7	7.7 x 12.7	
10				6.3 x 12.7*		6.3 x 12.7*	7.7 x 12.7*	6.5 x 18*
15					6.3 x 12.7	7.7 x 12.7		
22			6.3 x 12.7*	6.3 x 12.7*		7.7 x 12.7*	6.5 x 18 *	8 x 18 *
33		6.3 x 12.7		6.3 x 12.7	7.7 x 12.7			
47	6.3 x 12.7*		6.3 x 12.7*	7.7 x 12.7*	6.5 x 18 *		8 x 18 *	10 x 25 *
68		6.3 x 12.7						10 x 30
100	6.3 x 12.7*		7.7 x 12.7*	6.5 x 18*	8 x 18 *	10 x 18*	10 x 25 *	12.5 x 30 *
150		7.7 x 12.7					10 x 30	15 x 30
220	7.7 x 12.7*	6.5 x 18 *	8 x 18 *	10 x 18 *	10 x 25 *	10 x 30 *	12.5 x 30 *	15 x 30 *
330					10 x 30 *	12.5 x 30 *	12.5 x 30 *	18 x 30 *
470	6.5 x 18 *	8 x 18 *	10 x 18 *	10 x 25 *	12.5 x 30 *	12.5 x 30 *	15 x 30 *	18 x 40 *
680				10 x 30	12.5 x 30	15 x 30	18 x 30	21 x 40
1000	10 x 18 *	10 x 25 *	10 x 30 *	12.5 x 30 *	15 x 30 *	18 x 30 *	18 x 40 *	
1500		10 x 30	12.5 x 30	15 x 30	18 x 30	18 x 40	21 x 40	
2200	10 x 25 *	12.5 x 30 *	15 x 30 *	18 x 30 *	18 x 40 *	21 x 40 *		
3300		15 x 30 *	18 x 30 *	18 x 40 *	21 x 40 *			
4700		18 x 30 *	18 x 30 *	18 x 40 *				
6800		18 x 40 *	18 x 40 *	21 x 40 *				
10 000		18 x 40 *	21 x 40 *					
15 000		21 x 40 *						

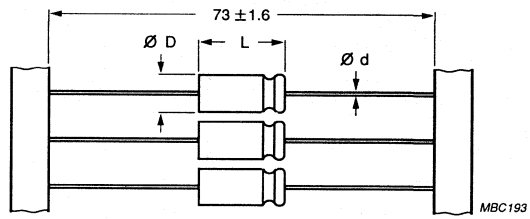
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING",



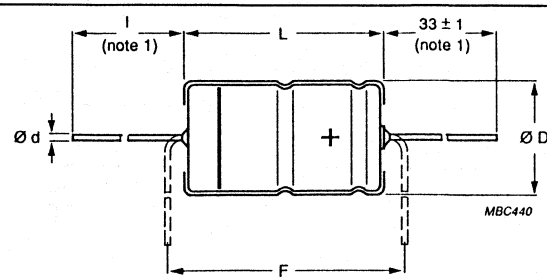
Form BR: Taped on reel.
Form BA: Taped in box (ammopack).

Fig.2 Case sizes 6.3 x 12.7 and 7.7 x 12.7, moulded with flame retardant plastic material.



Form BR: Taped on reel, case sizes 6.5 x 18 to 15 x 30.
Form BA: Taped in box (ammopack), case sizes 6.5 x 18 to 10 x 25.

Fig.3 Case sizes 6.5 x 18 to 15 x 30, insulated with a blue plastic sleeve.

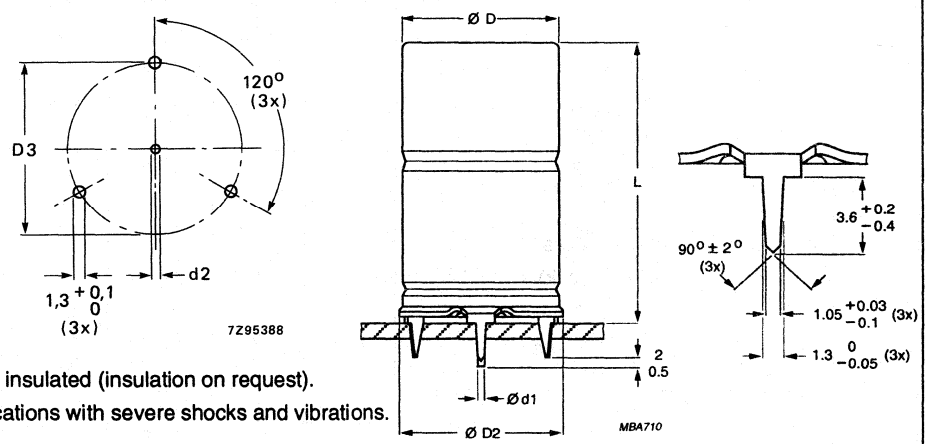


Form AA: Axial in box.
For case sizes 18 x 40 and 21 x 40, the stated L may be exceeded by 0.7 mm.

Fig.4 Case sizes 10 x 30 to 21 x 40, insulated with a blue plastic sleeve.

Table 2 Axial, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	AXIAL: Form AA, BA, and BR					APPROX. MASS	PACKING QUANTITIES		
		∅d	l	∅D_{max}	L_{max}	F_{min}		Form AA	Form BA	Form BR
6.3 x 12.7	(2)	0.6		6.5	12.9	17.5	1.1	–	1000	1000
7.7 x 12.7	(3)	0.6		7.9	12.9	17.5	1.3	–	500	500
6.5 x 18	4	0.8		6.9	18.5	25	1.3	–	1000	1000
8 x 18	5	0.8		8.5	18.5	25	1.7	–	500	500
10 x 18	6	0.8		10.5	18.5	25	2.5	–	500	500
10 x 25	7	0.8		10.5	25.0	30	3.3	–	500	500
10 x 30	00	0.8	55 ±1	10.5	30.5	35	4.8	200	–	500
12.5 x 30	01	0.8	55 ±1	13.0	30.5	35	7.4	200	–	400
15 x 30	02	0.8	55 ±1	15.5	30.5	35	11.7	200	–	250
18 x 30	03	0.8	55 ±1	18.5	30.5	35	12.9	200	–	–
18 x 40	04	0.8	34 ±1	18.5	41.5	45	19.4	100	–	–
21 x 40	05	0.8	34 ±1	21.5	41.5	45	24.7	100	–	–



Form MR: case not insulated (insulation on request).
Especially for applications with severe shocks and vibrations.

Fig.5 Case sizes 15 x 30 to 21 x 40, single ended with mounting ring and pins.

Table 3 Single ended, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	SINGLE ENDED WITH MOUNTING RING: Form MR						APPROX. MASS	PACKING QUANTITIES
		∅d_1	∅d_2	∅D_{max}	∅$D2_{max}$	D3	L_{max}		
15 x 30	02	0.8	1.0 +0.1	15.5	17.5	16.5 ±0.2	33	11.7	200
18 x 30	03	0.8	1.0 +0.1	18.5	19.5	18.5 ±0.2	33	12.9	200
18 x 40	04	1.0	1.3 +0.1	18.5	19.5	18.5 ±0.2	45	19.4	100
21 x 40	05	1.0	1.3 +0.1	21.5	22.5	21.5 ±0.2	45	24.7	100

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance ±20%

I_R = rated RMS ripple current at 100 Hz, 105 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = max. impedance at 10 kHz or 100 kHz.

Table 4 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
6.3	47	6.3 x 12.7	74	9	4.6	0.16	5.4	6.4	2.5
	100	6.3 x 12.7	99	16	5.3	0.24	3.8	3.0	1.8
	220	7.7 x 12.7	160	31	6.8	0.24	1.7	1.4	0.95
	470	6.5 x 18	250	22	9.9	0.24	0.81	0.64	0.5
	1000	10 x 18	430	42	17	0.24	0.38	0.30	0.24
	2200	10 x 25	640	87	32	0.29	0.21	0.18	0.15
10	33	6.3 x 12.7	66	10	4.7	0.14	6.8	6.1	2.5
	68	6.3 x 12.7	89	17	5.4	0.2	4.7	2.9	1.8
	150	7.7 x 12.7	140	33	7.0	0.2	2.1	1.3	0.95
	220	6.5 x 18	190	17	8.4	0.2	1.4	0.91	0.5
	470	8 x 18	300	32	13	0.2	0.68	0.43	0.35
	1000	10 x 25	520	64	24	0.2	0.32	0.20	0.16
	1500	10 x 30	560	94	34	0.22	0.24	0.17	0.15
	2200	12.5 x 30	750	140	48	0.24	0.17	0.12	0.12
	3300	15 x 30	990	200	70	0.26	0.12	0.088	0.094
	4700	18 x 30	1200	290	98	0.28	0.10	0.072	0.083
	6800	18 x 40	1700	410	140	0.30	0.07	0.049	0.069
	10 000	18 x 40	1900	600	200	0.33	0.053	0.042	0.065
	15 000	21 x 40	2200	900	300	0.44	0.047	0.038	0.063

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ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor AML 138
1000 µF/10 V, ±20%
Case size 10 x 25; Form BR
Catalogue number: 2222 138 24102.

Table 5 Ordering information

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
6.3	47	6.3 x 12.7	(2)	–	138 23479	138 33479	–
	100	6.3 x 12.7	(2)	–	138 23101	138 33101	–
	220	7.7 x 12.7	(3)	–	138 23221	138 33221	–
	470	6.5 x 18	4	–	138 23471	138 33471	–
	1000	10 x 18	6	–	138 23102	138 33102	–
	2200	10 x 25	7	–	138 23222	138 33222	–
10	33	6.3 x 12.7	(2)	–	138 24339	138 34339	–
	68	6.3 x 12.7	(2)	–	138 24689	138 34689	–
	150	7.7 x 12.7	(3)	–	138 24151	138 34151	–
	220	6.5 x 18	4	–	138 24221	138 34221	–
	470	8 x 18	5	–	138 24471	138 34471	–
	1000	10 x 25	7	–	138 24102	138 34102	–
	1500	10 x 30	00	138 14152	138 24152	–	–
	2200	12.5 x 30	01	138 14222	138 24222	–	–
	3300	15 x 30	02	138 14332	138 24332	–	138 44332
	4700	18 x 30	03	138 14472	–	–	138 44472
	6800	18 x 40	04	138 14682	–	–	138 44682
	10 000	18 x 40	04	138 14103	–	–	138 44103
	15 000	21 x 40	05	138 14153	–	–	138 44153

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
16	22	6.3 x 12.7	58	10	4.7	0.12	8.7	7.3	2.7
	47	6.3 x 12.7	83	18	5.5	0.16	5.4	3.4	1.9
	100	7.7 x 12.7	130	35	7.2	0.16	2.5	1.6	1.0
	220	8 x 18	230	25	11	0.16	1.2	0.73	0.35
	470	10 x 18	360	49	19	0.16	0.54	0.34	0.25
	1000	10 x 30	530	100	36	0.17	0.27	0.18	0.16
	1500	12.5 x 30	730	150	52	0.18	0.19	0.13	0.12
	2200	15 x 30	950	210	74	0.19	0.14	0.093	0.097
	3300	18 x 30	1200	320	110	0.21	0.10	0.072	0.083
	4700	18 x 30	1400	450	150	0.24	0.082	0.062	0.077
	6800	18 x 40	1800	660	220	0.24	0.055	0.042	0.065
	10 000	21 x 40	2100	960	320	0.30	0.048	0.038	0.063
25	10	6.3 x 12.7	46	8	4.5	0.09	14	12	2.8
	22	6.3 x 12.7	61	14	5.1	0.14	10	5.5	2.5
	33	6.3 x 12.7	74	20	5.7	0.14	6.8	3.6	1.9
	47	7.7 x 12.7	96	27	6.4	0.14	4.7	2.6	1.0
	100	6.5 x 18	160	19	9.0	0.13	2.1	1.2	0.55
	220	10 x 18	270	37	15	0.13	0.94	0.55	0.27
	470	10 x 25	440	75	28	0.13	0.44	0.26	0.17
	680	10 x 30	500	110	38	0.13	0.31	0.18	0.16
	1000	12.5 x 30	670	150	54	0.14	0.22	0.13	0.12
	1500	15 x 30	890	230	79	0.15	0.16	0.093	0.097
	2200	18 x 30	1200	330	110	0.16	0.12	0.072	0.083
	3300	18 x 40	1600	500	170	0.17	0.08	0.049	0.069
	4700	18 x 40	1800	710	240	0.18	0.062	0.042	0.065
	6800	21 x 40	2100	1000	340	0.23	0.053	0.040	0.064

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
16	22	6.3 x 12.7	(2)	–	138 25229	138 35229	–
	47	6.3 x 12.7	(2)	–	138 25479	138 35479	–
	100	7.7 x 12.7	(3)	–	138 25101	138 35101	–
	220	8 x 18	5	–	138 25221	138 35221	–
	470	10 x 18	6	–	138 25471	138 35471	–
	1000	10 x 30	00	138 15102	138 25102	–	–
	1500	12.5 x 30	01	138 15152	138 25152	–	–
	2200	15 x 30	02	138 15222	138 25222	–	138 45222
	3300	18 x 30	03	138 15332	–	–	138 45332
	4700	18 x 30	03	138 15472	–	–	138 45472
	6800	18 x 40	04	138 15682	–	–	138 45682
	10 000	21 x 40	05	138 15103	–	–	138 45103
25	10	6.3 x 12.7	(2)	–	138 26109	138 36109	–
	22	6.3 x 12.7	(2)	–	138 26229	138 36229	–
	33	6.3 x 12.7	(2)	–	138 26339	138 36339	–
	47	7.7 x 12.7	(3)	–	138 26479	138 36479	–
	100	6.5 x 18	4	–	138 26101	138 36101	–
	220	10 x 18	6	–	138 26221	138 36221	–
	470	10 x 25	7	–	138 26471	138 36471	–
	680	10 x 30	00	138 16681	138 26681	–	–
	1000	12.5 x 30	01	138 16102	138 26102	–	–
	1500	15 x 30	02	138 16152	138 26152	–	138 46152
	2200	18 x 30	03	138 16222	–	–	138 46222
	3300	18 x 40	04	138 16332	–	–	138 46332
	4700	18 x 40	04	138 16472	–	–	138 46472
	6800	21 x 40	05	138 16682	–	–	138 46682

Non-solid Al - electrolytic capacitors
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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
40	15	6.3 x 12.7	56	15	5.2	0.11	12	6	2.6
	33	7.7 x 12.7	91	29	6.6	0.11	5.3	2.7	1.0
	47	6.5 x 18	120	15	7.8	0.10	3.4	1.9	0.65
	100	8 x 18	180	28	12	0.10	1.6	0.9	0.40
	220	10 x 25	350	57	22	0.10	0.72	0.41	0.20
	330	10 x 30	410	83	30	0.10	0.45	0.23	0.19
	470	12.5 x 30	550	120	42	0.10	0.33	0.17	0.14
	680	12.5 x 30	650	170	58	0.10	0.23	0.13	0.11
	1000	15 x 30	840	240	84	0.11	0.17	0.10	0.097
	1500	18 x 30	1100	360	120	0.12	0.13	0.08	0.087
	2200	18 x 40	1500	530	180	0.13	0.09	0.055	0.070
	3300	21 x 40	1700	800	270	0.15	0.075	0.052	0.069
50	6.8	6.3 x 12.7	42	10	4.7	0.09	21	10	3.0
	10	6.3 x 12.7	51	13	5.0	0.09	14	7	2.7
	15	7.7 x 12.7	68	18	5.5	0.09	9.5	4.7	1.3
	22	7.7 x 12.7	82	25	6.2	0.09	6.5	3.2	1.1
	100	10 x 18	230	34	14	0.08	1.3	0.7	0.30
	220	10 x 30	360	70	26	0.08	0.59	0.28	0.22
	330	12.5 x 30	500	100	37	0.08	0.40	0.19	0.15
	470	12.5 x 30	580	140	51	0.09	0.29	0.14	0.12
	680	15 x 30	760	210	72	0.09	0.21	0.11	0.10
	1000	18 x 30	970	300	100	0.10	0.16	0.09	0.09
	1500	18 x 40	1300	450	150	0.10	0.11	0.06	0.072
	2200	21 x 40	1600	660	220	0.12	0.085	0.052	0.069

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
40	15	6.3 x 12.7	(2)	–	138 27159	138 37159	–
	33	7.7 x 12.7	(3)	–	138 27339	138 37339	–
	47	6.5 x 18	4	–	138 27479	138 37479	–
	100	8 x 18	5	–	138 27101	138 37101	–
	220	10 x 25	7	–	138 27221	138 37221	–
	330	10 x 30	00	138 17331	138 27331	–	–
	470	12.5 x 30	01	138 17471	138 27471	–	–
	680	12.5 x 30	01	138 17681	138 27681	–	–
	1000	15 x 30	02	138 17102	138 27102	–	138 47102
	1500	18 x 30	03	138 17152	–	–	138 47152
	2200	18 x 40	04	138 17222	–	–	138 47222
	3300	21 x 40	05	138 17332	–	–	138 47332
50	6.8	6.3 x 12.7	(2)	–	138 21688	138 31688	–
	10	6.3 x 12.7	(2)	–	138 21109	138 31109	–
	15	7.7 x 12.7	(3)	–	138 21159	138 31159	–
	22	7.7 x 12.7	(3)	–	138 21229	138 31229	–
	100	10 x 18	6	–	138 21101	138 31101	–
	220	10 x 30	00	138 11221	138 21221	–	–
	330	12.5 x 30	01	138 11331	138 21331	–	–
	470	12.5 x 30	01	138 11471	138 21471	–	–
	680	15 x 30	02	138 11681	138 21681	–	138 41681
	1000	18 x 30	03	138 11102	–	–	138 41102
	1500	18 x 40	04	138 11152	–	–	138 41152
	2200	21 x 40	05	138 11222	–	–	138 41222

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
63	0.22	6.3 x 12.7	2.5	4	4	0.09	650	160	16
	0.47	6.3 x 12.7	5	4	4	0.09	300	95	10
	1.0	6.3 x 12.7	11	4	4	0.09	140	55	9
	1.5	6.3 x 12.7	16	5	4.2	0.09	95	37	8
	2.2	6.3 x 12.7	21	6	4.3	0.09	65	25	7
	3.3	6.3 x 12.7	29	7	4.4	0.09	43	21	6
	4.7	6.3 x 12.7	35	9	4.6	0.09	30	17	5
	6.8	7.7 x 12.7	49	12	4.9	0.08	19	11	2.5
	10	7.7 x 12.7	59	16	5.3	0.08	13	8	1.8
	22	6.5 x 18	100	12	6.8	0.07	5.1	3.6	0.85
	47	8 x 18	150	22	9.9	0.07	2.4	1.7	0.50
	100	10 x 25	280	42	17	0.07	1.1	0.8	0.27
	150	10 x 30	340	61	23	0.11	0.73	0.41	0.31
	220	12.5 x 30	470	88	32	0.11	0.50	0.28	0.22
	330	12.5 x 30	570	130	46	0.12	0.37	0.22	0.18
	470	15 x 30	730	180	63	0.12	0.26	0.15	0.14
	680	18 x 30	930	260	90	0.12	0.19	0.12	0.11
	1000	18 x 40	1300	380	130	0.12	0.13	0.08	0.09
	1500	21 x 40	1600	570	190	0.13	0.10	0.07	0.08
100	0.22	6.3 x 12.7	4	4	4	0.09	650	160	19
	0.47	6.3 x 12.7	8	4	4	0.09	300	95	12
	1.0	6.3 x 12.7	16	5	4.2	0.09	140	55	10
	2.2	6.3 x 12.7	24	7	4.4	0.09	65	25	8
	3.3	7.7 x 12.7	34	10	4.7	0.08	39	21	6
	4.7	7.7 x 12.7	40	12	4.9	0.08	27	17	5
	10	6.5 x 18	67	10	6.0	0.07	11	8	2.4
	22	8 x 18	100	17	8.4	0.07	5.1	3.6	1.4
	47	10 x 25	190	32	13	0.07	2.4	1.7	0.67
	68	10 x 30	220	45	18	0.07	1.7	1.1	0.97
	100	12.5 x 30	290	64	24	0.07	1.1	0.77	0.67
	150	15 x 30	390	94	34	0.07	0.78	0.52	0.46
	220	15 x 30	470	140	48	0.07	0.54	0.37	0.33
	330	18 x 30	620	200	70	0.08	0.38	0.27	0.24
	470	18 x 40	840	290	98	0.08	0.27	0.19	0.17
	680	21 x 40	1100	410	140	0.09	0.21	0.14	0.14

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
63	0.22	6.3 x 12.7	(2)	–	138 28227	138 38227	–
	0.47	6.3 x 12.7	(2)	–	138 28477	138 38477	–
	1.0	6.3 x 12.7	(2)	–	138 28108	138 38108	–
	1.5	6.3 x 12.7	(2)	–	138 28158	138 38158	–
	2.2	6.3 x 12.7	(2)	–	138 28228	138 38228	–
	3.3	6.3 x 12.7	(2)	–	138 28338	138 38338	–
	4.7	6.3 x 12.7	(2)	–	138 28478	138 38478	–
	6.8	7.7 x 12.7	(3)	–	138 28688	138 38688	–
	10	7.7 x 12.7	(3)	–	138 28109	138 38109	–
	22	6.5 x 18	4	–	138 28229	138 38229	–
	47	8 x 18	5	–	138 28479	138 38479	–
	100	10 x 25	7	–	138 28101	138 38101	–
	150	10 x 30	00	138 18151	138 28151	–	–
	220	12.5 x 30	01	138 18221	138 28221	–	–
	330	12.5 x 30	01	138 18331	138 28331	–	–
	470	15 x 30	02	138 18471	138 28471	–	138 48471
	680	18 x 30	03	138 18681	–	–	138 48681
	1000	18 x 40	04	138 18102	–	–	138 48102
	1500	21 x 40	05	138 18152	–	–	138 48152
100	0.22	6.3 x 12.7	(2)	–	138 29227	138 39227	–
	0.47	6.3 x 12.7	(2)	–	138 29477	138 39477	–
	1.0	6.3 x 12.7	(2)	–	138 29108	138 39108	–
	2.2	6.3 x 12.7	(2)	–	138 29228	138 39228	–
	3.3	7.7 x 12.7	(3)	–	138 29338	138 39338	–
	4.7	7.7 x 12.7	(3)	–	138 29478	138 39478	–
	10	6.5 x 18	4	–	138 29109	138 39109	–
	22	8 x 18	5	–	138 29229	138 39229	–
	47	10 x 25	7	–	138 29479	138 39479	–
	68	10 x 30	00	138 19689	138 29689	–	–
	100	12.5 x 30	01	138 19101	138 29101	–	–
	150	15 x 30	02	138 19151	138 29151	–	138 49151
	220	15 x 30	02	138 19221	138 29221	–	138 49221
	330	18 x 30	03	138 19331	–	–	138 49331
	470	18 x 40	04	138 19471	–	–	138 49471
	680	21 x 40	05	138 19681	–	–	138 49681

Marking

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Upper category temperature (105 °C)
- Group number (138)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Band to identify the negative terminal
- "+" - signs to identify the positive terminal (not for case sizes L <18 mm).

Voltage

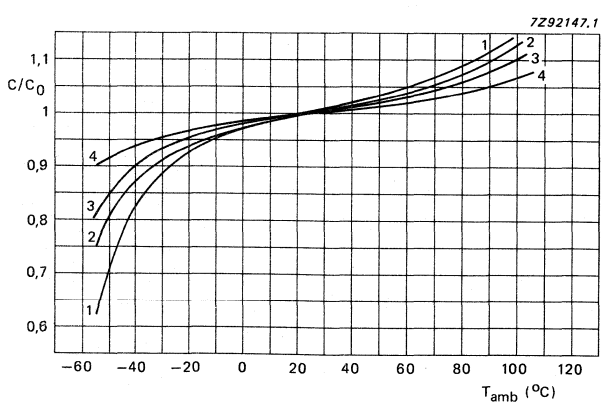
Surge voltage for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R	
case sizes 6.3 x 12.7 and 7.7 x 12.7	$I_{L1} \leq 0.02\ C_R \times U_R + 3$ µA
case sizes 6.5 x 18 to 21 x 40	$I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA

5

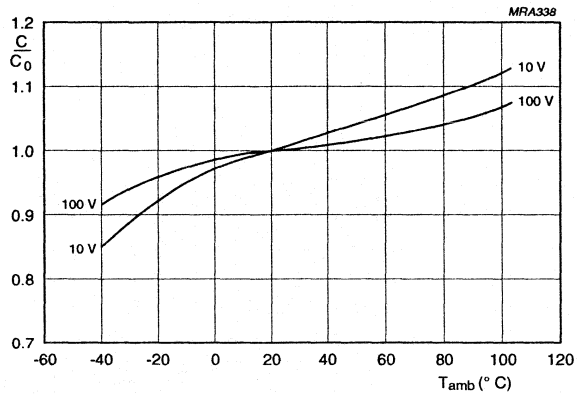
Capacitance (C)



Curve 1: 6.3 and 10 V
Curve 2: 16 to 40 V
Curve 3: 50 and 63 V
Curve 4: 100 V.

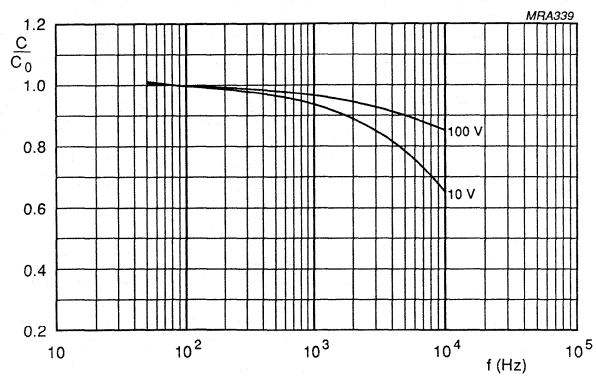
C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 6.3 x 12.7 to 10 x 25.



C_0 = capacitance at 20 °C, 100 Hz.

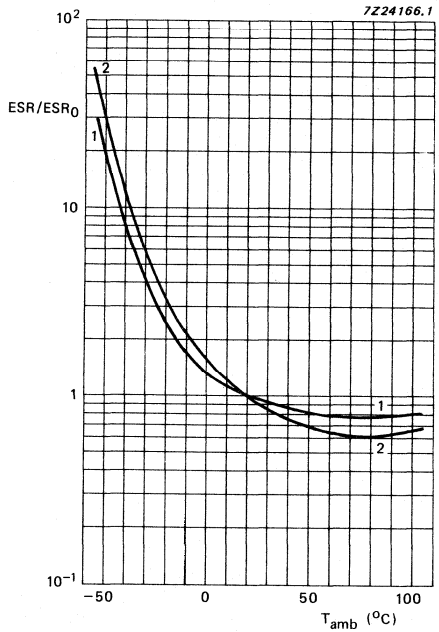
Fig.7 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 10 x 30 to 21 x 40.



C_0 = capacitance at 20 °C, 100 Hz.

Fig.8 Multiplier of capacitance (C/C_0) as a function of frequency.

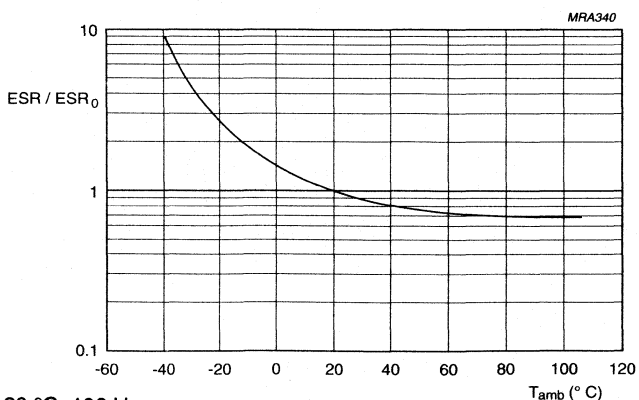
Equivalent series resistance (ESR)



Curve 1: 50 V
Curve 2: 6.3, 63 and 100 V.

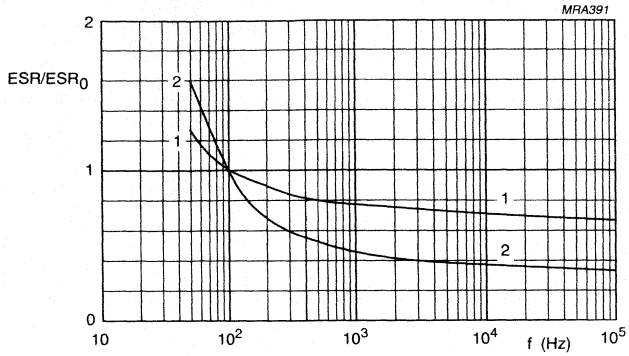
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 6.3 x 12.7 to 10 x 25.



ESR_0 = typical ESR at 20 °C, 100 Hz.

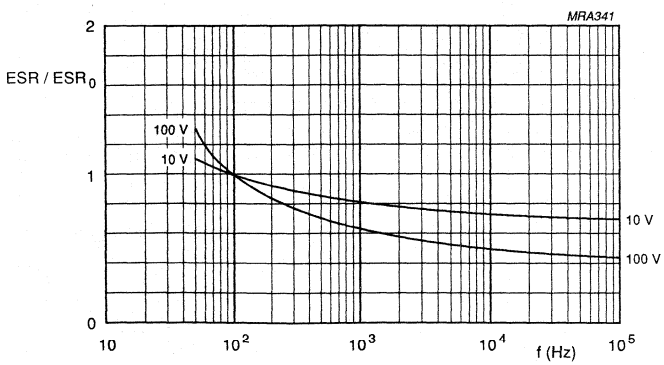
Fig.10 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 10 x 30 to 21 x 40.



Curve 1: 6.3 V
Curve 2: 100 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.11 Multiplier of ESR (ESR/ESR_0) as a function of frequency; case sizes 6.3 x 12.7 to 10 x 25.



ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.12 Multiplier of ESR (ESR/ESR_0) as a function of frequency; case sizes 10 x 30 to 21 x 40.

Equivalent series inductance (ESL)

Table 6 Equivalent series inductance, typical values

CASE SIZE (∅ x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)	CASE SIZE (∅ x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)
6.3 x 12.7	20	–	10 x 30	38	–
7.7 x 12.7	30	–	12.5 x 30	46	–
6.5 x 18	15	–	15 x 30	48	39
8 x 18	35	–	18 x 30	50	39
10 x 18	69	–	18 x 40	54	39
10 x 25	38	–	21 x 40	59	39

Impedance (Z)

Table 7 Impedance x capacitance values (case sizes 6.3 x 12.7 to 10 x 25 mm)

T_{amb}	$z = Z \times C_R$ (Ω µF) at 10 kHz							
	6.3 V	10 V	16 V	25 V	40 V	50 V	63 V	100 V
+20 °C	≤ 300	≤ 200	≤ 160	≤ 120	≤ 90	≤ 70	≤ 80	≤ 80
–25 °C	≤2000	≤1200	≤ 750	≤ 560	≤ 450	≤ 300	≤ 550	≤ 550
–40 °C	≤5500	≤3200	≤2000	≤1500	≤1200	≤ 900	≤1500	≤1500

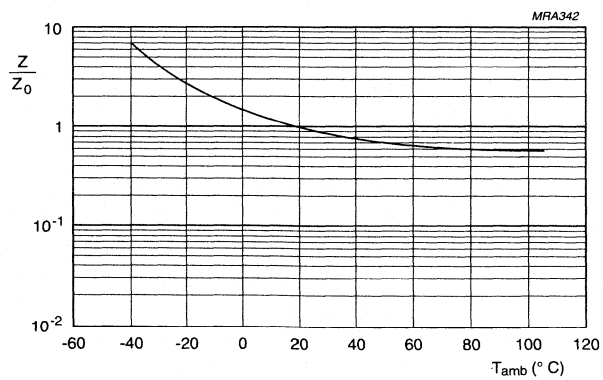
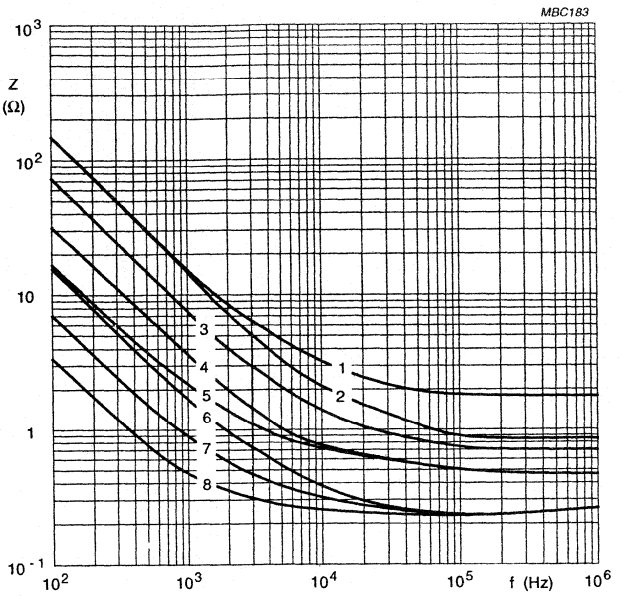
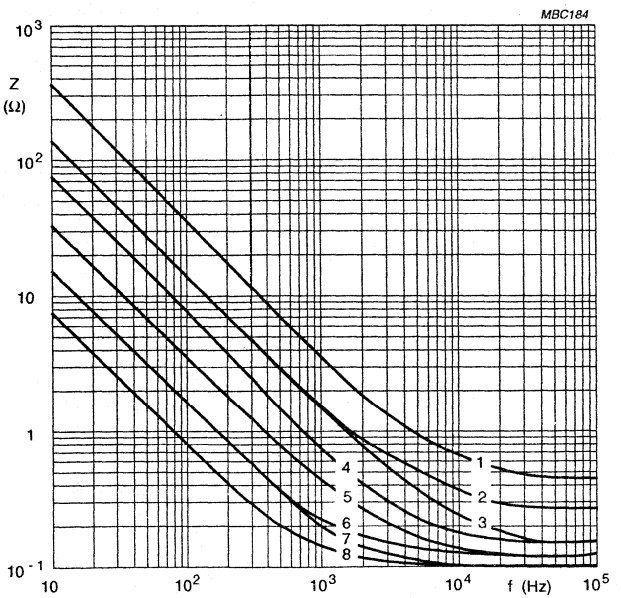


Fig.13 Multiplier of impedance (Z/Z_o) as a function of ambient temperature at 10 kHz; case sizes 10 x 30 to 21 x 40.



Curve 1: 10 µF - 63 V
Curve 2: 10 µF - 50 V
Curve 3: 22 µF - 63 V
Curve 4: 47 µF - 25 V
Curve 5: 100 µF - 16 V
Curve 6: 100 µF - 25 V
Curve 7: 220 µF - 10 V
Curve 8: 470 µF - 6.3 V.

Fig.14 Typical impedance as a function of frequency at 20 °C; case sizes 6.3 x 12.7 to 6.5 x 18.



Curve 1: 47 µF - 63 V
Curve 2: 100 µF - 63 V
Curve 3: 100 µF - 50 V
Curve 4: 220 µF - 16 V
Curve 5: 470 µF - 16 V
Curve 6: 1000 µF - 6.3 V
Curve 7: 1000 µF - 10 V
Curve 8: 2200 µF - 6.3 V.

Fig.15 Typical impedance as a function of frequency at 20 °C; case sizes 8 x 18 to 10 x 25.

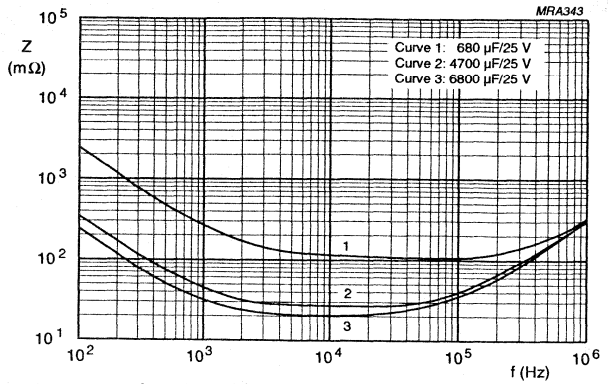


Fig.16 Typical impedance as a function of frequency at 20 °C; case sizes 10 x 30 to 21 x 40.

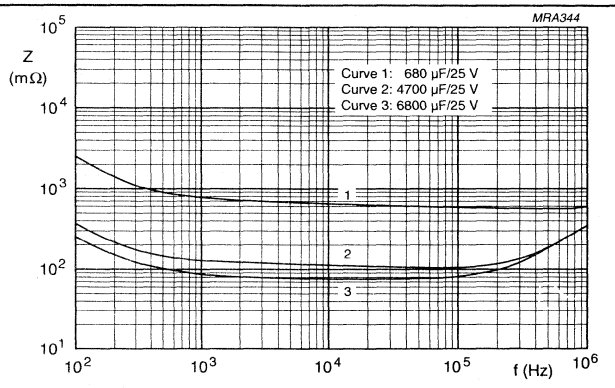


Fig.17 Typical impedance as a function of frequency at –25 °C; case sizes 10 x 30 to 21 x 40.

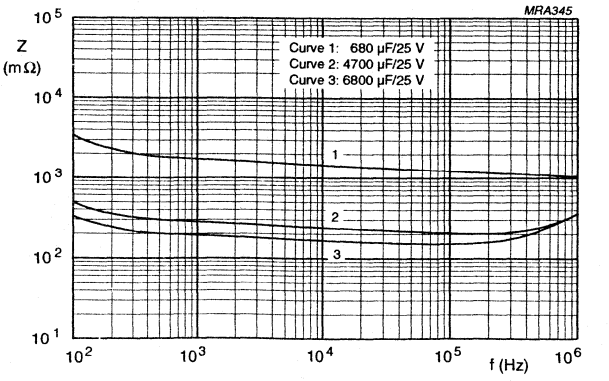
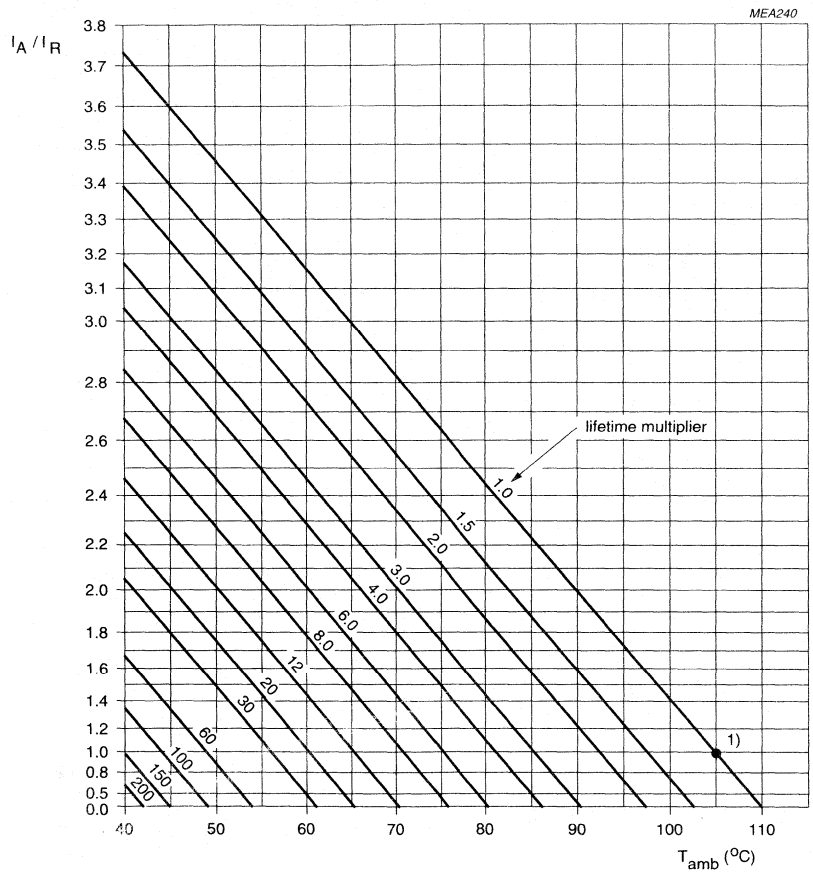


Fig.18 Typical impedance as a function of frequency at –40 °C; case sizes 10 x 30 to 21 x 40.

RIPPLE CURRENT and USEFUL LIFE



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 105 °C.

1) Useful life at 105 °C and I_R applied.
case sizes 6.3 x 12.7 to 10 x 25: 2000 hours
case sizes 10 x 30 to 21 x 40: 5000 hours.

Fig.19 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

Table 8 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 105 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10 V	U_R = 16 to 25 V	U_R = 40 to 100 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥10 000	1.2	1.3	1.4

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 9

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	Reference		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 105 °C, U_R applied case sizes: 6.3 x 12.7 to 10 x 25: 1000 hours 10 x 30 to 21 x 40: 2000 hours	U_R ≤6.3 V : ΔC/C +15/–30% U_R >6.3 V : ΔC/C ±15% tan δ ≤1.3 x spec. limit Z ≤2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 105 °C, U_R and I_R applied case sizes: 6.3 x 12.7 to 10 x 25: 2000 hours 10 x 30 to 21 x 40: 5000 hours	U_R ≤6.3 V : ΔC/C +45/–50% U_R >6.3 V : ΔC/C ±45% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 105 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

5

Electrolytic Capacitors

Notes

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case sizes 10 x 30 to 21 x 40 with safety vent
- Taped versions up to 15 x 30 available for automatic insertion
- Charge and discharge proof
- Long useful life: 10 000/15 000 hours at 85 °C, high reliability
- High ripple current capability.
- Boards with restricted mounting height, vibration and shock resistant.

APPLICATIONS

- General industrial, telecommunication, EDP, power supplies
- Coupling, decoupling, timing; smoothing, filtering and buffering in SMPS

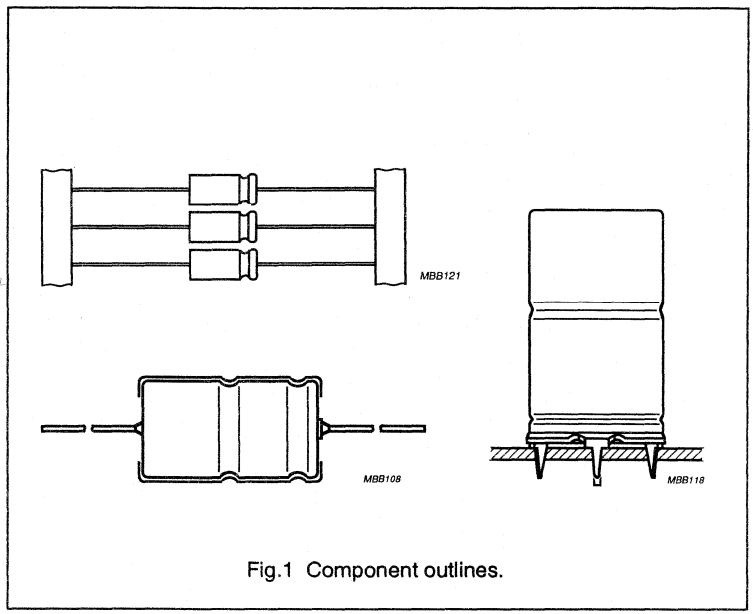


Fig.1 Component outlines.

QUICK REFERENCE DATA

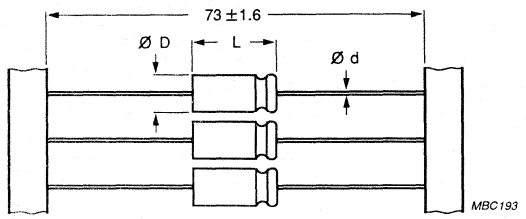
Case sizes (∅ D_{nom} x L_{nom} in mm)	6.5 x 18 and 8 x 18	10 x 18 and 10 x 25	10 x 30 to 21 x 40
Rated capacitance range, C_R	1 to 4700 µF		
Tolerance on C_R	−10 to +50%		
Rated voltage range, U_R	10 to 400 V		
Category temperature range	−40 to +85 °C		
Endurance test at 105 °C	2000 hours	2000 hours	–
Endurance test at 85 °C	6000 hours	8000 hours	8000 hours
Useful life at 105 °C	3000 hours	3000 hours	–
Useful life at 85 °C	10 000 hours	15 000 hours	15 000 hours
Useful life at 40 °C, 1.8 I_R applied	160 000 hours	240 000 hours	240 000 hours
Shelf life at 0 V, 85 °C	500 hours		
Basic specification	IEC 384-4/CECC 30 300, LL grade		
Detail specification	DIN 45910 - T 123 (DIN 41257)		
Climatic category IEC 68 DIN 40040	40/085/56 GPF		
Approvals	CECC 30 301-056		CECC 30 301-801 UTE CO31/CO33

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**) * = preferred values

C_R (µF)	U_R (V)									
	10	**16**	**25**	**40**	**63**	**100**	**160**	**250**	**350**	**385 400**
1.0*						6.5 x 18			6.5 x 18	
2.2*						6.5 x 18	6.5 x 18	8 x 18	8 x 18	
4.7*					6.5 x 18	6.5 x 18	8 x 18	10 x 18	10 x 18	
6.8					6.5 x 18	8 x 18	10 x 18	10 x 25		10 x 30
10*					6.5 x 18	8 x 18	10 x 18	10 x 25	12.5 x 30	12.5 x 30
15				6.5 x 18	8 x 18	10 x 18	10 x 25			15 x 30
22*			6.5 x 18		8 x 18	10 x 18	10 x 25 10 x 30	12.5 x 30	15 x 30	18 x 30
33			6.5 x 18	8 x 18	10 x 18	10 x 25				18 x 40
47*		6.5 x 18		8 x 18	10 x 18	10 x 25 10 x 30	15 x 30	18 x 30	18 x 40	18 x 40
68		6.5 x 18	8 x 18	10 x 18	10 x 25 10 x 30	12.5 x 30				21 x 40
100*		8 x 18		10 x 18	10 x 30	15 x 30	18 x 30	21 x 40		
150		8 x 18	10 x 18	10 x 25 12.5 x 30	15 x 30	18 x 30				
220*	8 x 18	10 x 18	10 x 25 12.5 x 30	12.5 x 30	15 x 30	18 x 40	21 x 40			
330		10 x 25 12.5 x 30	12.5 x 30	15 x 30	18 x 30	18 x 40				
470*	12.5 x 30	10 x 25 12.5 x 30	12.5 x 30	15 x 30	18 x 40	21 x 40				
680	12.5 x 30	15 x 30	18 x 30	18 x 30	21 x 40					
1000*	15 x 30	15 x 30	18 x 30	18 x 40	21 x 40					
1500*	18 x 30	18 x 30	18 x 40	21 x 40						
2200*	18 x 30	18 x 40	21 x 40	21 x 40						
3300*	18 x 40	21 x 40								
4700*	21 x 40	21 x 40								

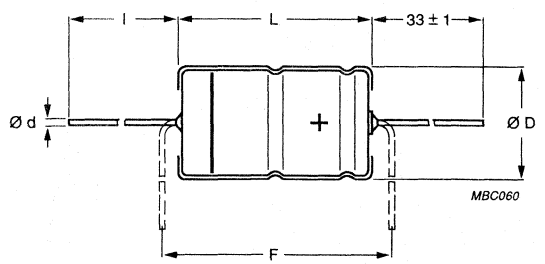
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING".



Form BR: Taped on reel, case sizes 6.5 x 18 to 15 x 30.
Form BA: Taped in box (ammopack), case sizes 6.5 x 18 to 10 x 25.

Fig.2 Case sizes 6.5 x 18 to 15 x 30.



Form AA: Axial in box.
For case sizes 18 x 40 and 21 x 40, the stated L may be exceeded by 0.7 mm.

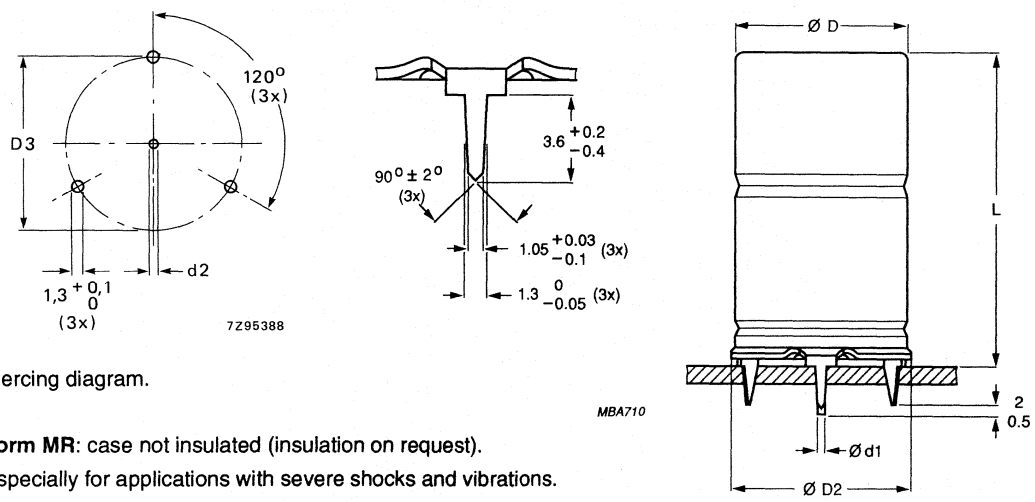
Fig.3 Case sizes 10 x 30 to 21 x 40.

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

Table 2 Axial, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	AXIAL: Form AA, BA, and BR					APPROX. MASS	PACKING QUANTITIES		
		∅d	l	∅D_{max}	L_{max}	F_{min}		Form AA	Form BA	Form BR
6.5 x 18	4	0.8	–	6.9	18.5	25	1.3	–	1000	1000
8 x 18	5	0.8	–	8.5	18.5	25	1.7	–	500	500
10 x 18	6	0.8	–	10.5	18.5	25	2.5	–	500	500
10 x 25	7	0.8	–	10.5	25.0	30	3.3	–	500	500
10 x 30	00	0.8	55 ±1	10.5	30.5	35	4.8	200	–	500
12.5 x 30	01	0.8	55 ±1	13.0	30.5	35	7.4	200	–	400
15 x 30	02	0.8	55 ±1	15.5	30.5	35	11.7	200	–	250
18 x 30	03	0.8	55 ±1	18.5	30.5	35	12.9	200	–	–
18 x 40	04	0.8	34 ±1	18.5	41.5	45	19.4	100	–	–
21 x 40	05	0.8	34 ±1	21.5	41.5	45	24.7	100	–	–



Piercing diagram.

Form MR: case not insulated (insulation on request).
Especially for applications with severe shocks and vibrations.

Fig.4 Case sizes 15 x 30 to 21 x 40, single ended with mounting ring and pins.

Table 3 Single ended, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	SINGLE ENDED WITH MOUNTING RING: Form MR						APPROX. MASS	PACKING QUANTITIES
		∅d_1	∅d_2	∅D_{max}	∅$D2_{max}$	D3	L_{max}		
15 x 30	02	0.8	1.0 +0.1	15.5	17.5	16.5 ±0.2	33	11.7	200
18 x 30	03	0.8	1.0 +0.1	18.5	19.5	18.5 ±0.2	33	12.9	200
18 x 40	04	1.0	1.3 +0.1	18.5	19.5	18.5 ±0.2	45	19.4	100
21 x 40	05	1.0	1.3 +0.1	21.5	22.5	21.5 ±0.2	45	24.7	100

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance −10 to +50%
I_R = rated RMS ripple current at 100 Hz, 85 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 10 kHz or 100 kHz

Table 4 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
10	220	8 x 18	190	25	8.4	0.18	1.3	0.73	0.70
	470	12.5 x 30	350	32	9.4	0.18	0.77	0.26	0.60
	680	12.5 x 30	460	45	13.6	0.18	0.53	0.20	0.40
	1000	15 x 30	640	64	20	0.18	0.36	0.12	–
	1500	18 x 30	800	94	30	0.22	0.29	0.10	–
	2200	18 x 30	1100	140	44	0.22	0.20	0.09	–
	3300	18 x 40	1300	200	66	0.27	0.16	0.05	–
	4700	21 x 40	1800	290	94	0.27	0.12	0.05	–
16	47	6.5 x 18	95	11	5.5	0.14	4.7	2.6	2.2
	68	6.5 x 18	110	14	6.2	0.14	3.3	1.8	1.6
	100	8 x 18	150	19	7.2	0.14	2.2	1.2	1.1
	150	8 x 18	190	27	8.8	0.14	1.5	0.80	0.80
	220	10 x 18	250	38	11	0.14	1.0	0.55	0.55
	330	10 x 25	320	56	14.6	0.14	0.67	0.36	0.36
	330	12.5 x 30	320	36	10.6	0.14	0.80	0.36	0.60
	470	10 x 25	450	78	19	0.14	0.55	0.26	0.26
	470	12.5 x 30	450	49	15	0.14	0.55	0.26	0.40
	680	15 x 30	550	69	22	0.14	0.39	0.14	–
	1000	15 x 30	780	100	32	0.14	0.26	0.12	–
	1500	18 x 30	950	150	48	0.15	0.19	0.10	–
	2200	18 x 40	1300	220	70	0.15	0.12	0.06	–
	3300	21 x 40	1600	320	110	0.15	0.09	0.05	–
	4700	21 x 40	2300	460	150	0.15	0.08	0.05	–

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor ALL-DIN 132-133
100 µF/40 V, −10/+50%
Case size 10 x 18; Form BR
Catalogue number: 2222 132 27101.

Table 5 Ordering information

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
10	220	8 x 18	5	–	132 24221	132 34221	–
	470	12.5 x 30	01	132 14471	132 24471	–	–
	680	12.5 x 30	01	132 14681	132 24681	–	–
	1000	15 x 30	02	132 14102	132 24102	–	132 44102
	1500	18 x 30	03	132 14152	–	–	132 44152
	2200	18 x 30	03	132 14222	–	–	132 44222
	3300	18 x 40	04	132 14332	–	–	132 44332
	4700	21 x 40	05	132 14472	–	–	132 44472
16	47	6.5 x 18	4	–	132 25479	132 35479	–
	68	6.5 x 18	4	–	132 25689	132 35689	–
	100	8 x 18	5	–	132 25101	132 35101	–
	150	8 x 18	5	–	132 25151	132 35151	–
	220	10 x 18	6	–	132 25221	132 35221	–
	330	10 x 25	7	–	132 90508	132 90509	–
	330	12.5 x 30	01	132 15331	132 25331	–	–
	470	10 x 25	7	–	132 90507	132 90502	–
	470	12.5 x 30	01	132 15471	132 25471	–	–
	680	15 x 30	02	132 15681	132 25681	–	132 45681
	1000	15 x 30	02	132 15102	132 25102	–	132 45102
	1500	18 x 30	03	132 15152	–	–	132 45152
	2200	18 x 40	04	132 15222	–	–	132 45222
	3300	21 x 40	05	132 15332	–	–	132 45332
	4700	21 x 40	05	132 15472	–	–	132 45472

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
25	22	6.5 x 18	60	8.5	5.1	0.11	8.0	4.1	2.9
	33	6.5 x 18	80	11	5.7	0.11	5.3	2.7	2.3
	68	8 x 18	140	20	7.4	0.11	2.6	1.3	1.1
	150	10 x 18	230	41	11.5	0.11	1.2	0.60	0.60
	220	10 x 25	340	58	15	0.11	0.8	0.40	0.40
	220	12.5 x 30	340	37	11	0.11	1.0	0.40	0.60
	330	12.5 x 30	410	54	16.5	0.11	0.63	0.30	0.40
	470	12.5 x 30	560	75	24	0.11	0.47	0.20	–
	680	18 x 30	700	106	34	0.11	0.32	0.10	–
	1000	18 x 30	1000	150	50	0.11	0.22	0.10	–
	1500	18 x 40	1100	230	75	0.12	0.16	0.06	–
	2200	21 x 40	1850	330	110	0.13	0.12	0.05	–
40	15	6.5 x 18	60	9	5.2	0.09	9.5	5	3.2
	33	8 x 18	100	16	6.6	0.09	4.3	2.3	1.9
	47	8 x 18	120	22	7.8	0.09	3.0	1.6	1.4
	68	10 x 18	170	30	9.4	0.09	2.1	1.1	1.0
	100	10 x 18	210	43	12	0.09	1.4	0.75	0.75
	150	10 x 25	310	63	16	0.09	0.95	0.50	0.50
	150	12.5 x 30	310	40	12	0.09	1.27	0.50	0.60
	220	12.5 x 30	410	57	17.5	0.09	0.86	0.34	0.40
	330	15 x 30	550	83	26	0.09	0.58	0.20	–
	470	15 x 30	700	120	38	0.09	0.40	0.16	–
	680	18 x 30	900	170	54	0.09	0.28	0.10	–
	1000	18 x 40	1200	240	80	0.09	0.19	0.08	–
	1500	21 x 40	1500	360	120	0.10	0.14	0.06	–
	2200	21 x 40	1900	530	180	0.10	0.10	0.05	–

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
25	22	6.5 x 18	4	–	132 26229	132 36229	–
	33	6.5 x 18	4	–	132 26339	132 36339	–
	68	8 x 18	5	–	132 26689	132 36689	–
	150	10 x 18	6	–	132 26151	132 36151	–
	220	10 x 25	7	–	132 90503	132 90504	–
	220	12.5 x 30	01	132 16221	132 26221	–	–
	330	12.5 x 30	01	132 16331	132 26331	–	–
	470	12.5 x 30	01	132 16471	132 26471	–	–
	680	18 x 30	03	132 16681	–	–	132 46681
	1000	18 x 30	03	132 16102	–	–	132 46102
	1500	18 x 40	04	132 16152	–	–	132 46152
	2200	21 x 40	05	132 16222	–	–	132 46222
40	15	6.5 x 18	4	–	132 27159	132 37159	–
	33	8 x 18	5	–	132 27339	132 37339	–
	47	8 x 18	5	–	132 27479	132 37479	–
	68	10 x 18	6	–	132 27689	132 37689	–
	100	10 x 18	6	–	132 27101	132 37101	–
	150	10 x 25	7	–	132 90511	132 90512	–
	150	12.5 x 30	01	132 17151	132 27151	–	–
	220	12.5 x 30	01	132 17221	132 27221	–	–
	330	15 x 30	02	132 17331	132 27331	–	132 47331
	470	15 x 30	02	132 17471	132 27471	–	132 47471
	680	18 x 30	03	132 17681	–	–	132 47681
	1000	18 x 40	04	132 17102	–	–	132 47102
	1500	21 x 40	05	132 17152	–	–	132 47152
	2200	21 x 40	05	132 17222	–	–	132 47222

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
63	4.7	6.5 x 18	38	6.0	4.6	0.07	24	12	5
	6.8	6.5 x 18	45	7.3	4.9	0.07	16	8.1	4
	10	6.5 x 18	64	9.3	5.3	0.07	11	5.5	3.3
	15	8 x 18	80	12	5.9	0.07	7.4	3.7	2.5
	22	8 x 18	100	17	6.8	0.07	5.1	2.5	2.1
	33	10 x 18	140	24	8.2	0.07	3.4	1.7	1.5
	47	10 x 18	170	33	9.9	0.07	2.4	1.2	1.2
	68	10 x 25	210	46	12.6	0.07	1.6	0.81	0.60
	68	10 x 30	210	30	8.6	0.07	1.9	0.80	0.60
	100	10 x 30	300	42	12.6	0.07	1.3	0.60	0.40
	150	15 x 30	350	61	19	0.07	0.87	0.37	–
	220	15 x 30	520	87	28	0.07	0.58	0.25	–
	330	18 x 30	600	130	42	0.07	0.40	0.15	–
	470	18 x 40	970	180	59	0.07	0.27	0.12	–
	680	21 x 40	1000	260	86	0.07	0.19	0.08	–
	1000	21 x 40	1600	380	130	0.07	0.13	0.06	–
100	1	6.5 x 18	20	4.0	4.0	0.06	95	45	6
	2.2	6.5 x 18	30	5.2	4.4	0.06	43	20	5
	4.7	6.5 x 18	48	7.7	4.9	0.06	20	9.6	4
	6.8	8 x 18	60	9.8	5.4	0.06	14	6.6	3.5
	10	8 x 18	73	13	6	0.06	9.5	4.5	2.8
	15	10 x 18	100	18	7	0.06	6.4	3	1.8
	22	10 x 18	130	25	8.4	0.06	4.3	2	1.3
	33	10 x 25	170	36	10.6	0.06	2.9	1.4	1.1
	47	10 x 25	220	50	13.4	0.06	2.0	1	0.90
	47	10 x 30	220	32	9.4	0.06	2.4	1	0.90
	68	12.5 x 30	250	45	13.5	0.06	1.7	0.80	–
	100	15 x 30	380	64	20	0.06	1.1	0.50	–
	150	18 x 30	400	94	30	0.06	0.75	0.35	–
	220	18 x 40	660	140	44	0.06	0.5	0.20	–
	330	18 x 40	700	200	66	0.06	0.34	0.15	–
	470	21 x 40	1200	290	94	0.06	0.24	0.10	–

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
63	4.7	6.5 x 18	4	–	132 28478	132 38478	–
	6.8	6.5 x 18	4	–	132 28688	132 38688	–
	10	6.5 x 18	4	–	132 28109	132 38109	–
	15	8 x 18	5	–	132 28159	132 38159	–
	22	8 x 18	5	–	132 28229	132 38229	–
	33	10 x 18	6	–	132 28339	132 38339	–
	47	10 x 18	6	–	132 28479	132 38479	–
	68	10 x 25	6	–	132 90513	132 90514	–
	68	10 x 30	00	132 18689	132 28689	–	–
	100	10 x 30	00	132 18101	132 28101	–	–
	150	15 x 30	02	132 18151	132 28151	–	132 48151
	220	15 x 30	02	132 18221	132 28221	–	132 48221
	330	18 x 30	03	132 18331	–	–	132 48331
	470	18 x 40	04	132 18471	–	–	132 48471
	680	21 x 40	05	132 18681	–	–	132 48681
	1000	21 x 40	05	132 18102	–	–	132 48102
100	1	6.5 x 18	4	–	132 29108	132 39108	–
	2.2	6.5 x 18	4	–	132 29228	132 39228	–
	4.7	6.5 x 18	4	–	132 29478	132 39478	–
	6.8	8 x 18	5	–	132 29688	132 39688	–
	10	8 x 18	5	–	132 29109	132 39109	–
	15	10 x 18	6	–	132 29159	132 39159	–
	22	10 x 18	6	–	132 29229	132 39229	–
	33	10 x 25	7	–	132 29339	132 39339	–
	47	10 x 25	7	–	132 90505	132 90506	–
	47	10 x 30	00	132 19479	132 49479	–	–
	68	12.5 x 30	01	132 19689	132 29689	–	–
	100	15 x 30	02	132 19101	132 29101	–	132 49101
	150	18 x 30	03	132 19151	–	–	132 49151
	220	18 x 40	04	132 19221	–	–	132 49221
	330	18 x 40	04	132 19331	–	–	132 49331
	470	21 x 40	05	132 19471	–	–	132 49471

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
160	2.2	6.5 x 18	22	50	20	0.10	72	55	30
	4.7	8 x 18	37	50	20	0.10	34	26	20
	6.8	10 x 18	50	50	20	0.10	23	18	16
	10	10 x 18	61	50	20	0.10	16	12	10
	15	10 x 25	85	50	20	0.10	11	8	6
	22	10 x 25	120	50	20	0.10	7.2	5.5	2.5
	22	10 x 30	120	25	7	0.10	6.8	5.5	2.5
	47	15 x 30	180	50	15	0.10	3.2	2.6	–
	100	18 x 30	350	100	32	0.10	1.5	1.2	–
	220	21 x 40	610	220	70	0.10	0.7	0.60	–
250	2.2	8 x 18	25	50	20	0.10	72	50	30
	4.7	10 x 18	37	50	20	0.10	34	23	16
	6.8	10 x 25	55	50	20	0.10	23	16	12
	10	10 x 25	66	50	20	0.10	16	11	9
	22	12.5 x 30	130	37	11	0.10	6.8	5	–
	47	18 x 30	200	75	24	0.10	3.2	2.3	–
	100	21 x 40	370	150	50	0.10	1.5	1.1	–
350	1	6.5 x 18	15	50	20	0.10	160	100	40
	2.2	8 x 18	25	50	20	0.10	72	45	28
	4.7	10 x 18	43	50	20	0.10	34	21	15
	10	12.5 x 30	90	25	7	0.10	15	10	–
	22	15 x 30	140	50	15.5	0.10	6.8	4.5	–
	47	18 x 40	270	100	33	0.10	3.2	2.1	–
385	6.8	10 x 30	60	20	10	0.10	22	14	13.6
	10	12.5 x 30	90	27	12	0.10	15	10	8.5
	15	15 x 30	110	39	16	0.10	10	6	5.7
	22	18 x 30	147	55	21	0.10	6.8	4.1	3.9
	33	18 x 40	203	80	30	0.10	4.5	2.7	2.6
	47	18 x 40	242	110	41	0.10	3.2	2.1	2.0
	68	21 x 40	317	160	57	0.10	2.2	1.4	1.4

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
160	2.2	6.5 x 18	4	–	133 21228	133 31228	–
	4.7	8 x 18	5	–	133 21478	133 31478	–
	6.8	10 x 18	6	–	133 21688	133 31688	–
	10	10 x 18	6	–	133 21109	133 31109	–
	15	10 x 25	7	–	133 21159	133 31159	–
	22	10 x 25	7	–	133 90502	133 90503	–
	22	10 x 30	00	133 11229	133 21229	–	–
	47	15 x 30	02	133 11479	133 21479	–	133 41479
	100	18 x 30	03	133 11101	–	–	133 41101
	220	21 x 40	05	133 11221	–	–	133 41221
250	2.2	8 x 18	5	–	133 23228	133 33228	–
	4.7	10 x 18	6	–	133 23478	133 33478	–
	6.8	10 x 25	7	–	133 23688	133 33688	–
	10	10 x 25	7	–	133 23109	133 33109	–
	22	12.5 x 30	01	133 13229	133 23229	–	–
	47	18 x 30	03	133 13479	–	–	133 43479
	100	21 x 40	05	133 13101	–	–	133 43101
350	1	6.5 x 18	4	–	133 25108	133 35108	–
	2.2	8 x 18	5	–	133 25228	133 35228	–
	4.7	10 x 18	6	–	133 25478	133 35478	–
	10	12.5 x 30	01	133 15109	133 25109	–	–
	22	15 x 30	02	133 15229	133 25229	–	133 45229
	47	18 x 40	04	133 14479	–	–	133 44479
385	6.8	10 x 30	00	133 18688	133 28688	–	–
	10	12.5 x 30	01	133 18109	133 28109	–	–
	15	15 x 30	02	133 18159	133 28159	–	133 48159
	22	18 x 30	03	133 18229	–	–	133 48229
	33	18 x 40	04	133 18339	–	–	133 48339
	47	18 x 40	04	133 18479	–	–	133 48479
	68	21 x 40	05	133 18689	–	–	133 47689

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
400	6.8	10 x 30	82	220	110	0.055	11.5	7.3	6.4
	10	12.5 x 30	128	240	110	0.055	7.5	4.6	4.0
	15	15 x 30	155	250	110	0.055	5.0	3.1	2.7
	22	18 x 30	206	280	120	0.055	3.5	2.1	1.8
	33	18 x 40	286	320	130	0.055	2.3	1.4	1.2
	47	18 x 40	333	370	140	0.055	1.7	1.1	0.9
	68	21 x 40	431	440	160	0.055	1.2	0.7	0.6

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
400	6.8	10 x 30	00	133 16688	133 26688	–	–
	10	12.5 x 30	01	133 16109	133 26109	–	–
	15	15 x 30	02	133 16159	133 26159	–	133 46159
	22	18 x 30	03	133 16229	–	–	133 46229
	33	18 x 40	04	133 16339	–	–	133 46339
	47	18 x 40	04	133 16479	–	–	133 46479
	68	21 x 40	05	133 16689	–	–	133 46689

Voltage

Surge voltage for short periods
10 to 250 V types $U_s \leq 1.15 \times U_R$
350 to 400 V types $U_s \leq 1.1 \times U_R$
Reverse voltage $U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R
case sizes 6.5 x 18 to 10 x 25
10 to 100 V types: $I_{L1} \leq 0.01\ C_R \times U_R + 3\ \mu A$
160 to 400 V types: $I_{L1} \leq 50\ \mu A$
case sizes 10 x 30 to 21 x 40
10 to 385 V types: $I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
400 V types: $I_{L1} \leq 0.009\ C_R \times U_R + 200\ \mu A$

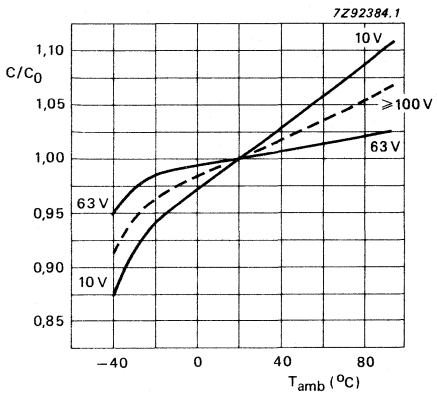
After 5 minutes at U_R
case sizes 6.5 x 18 to 10 x 25
10 to 100 V types: $I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$
160 to 400 V types: $I_{L5} \leq 20\ \mu A$
case sizes 10 x 30 to 21 x 40
10 to 385 V types: $I_{L5} \leq 0.002\ C_R \times U_R\ \mu A$
400 V types: $I_{L5} \leq 0.002\ C_R \times U_R + 100\ \mu A$

Marking

The capacitors are marked (where possible) with the following information:

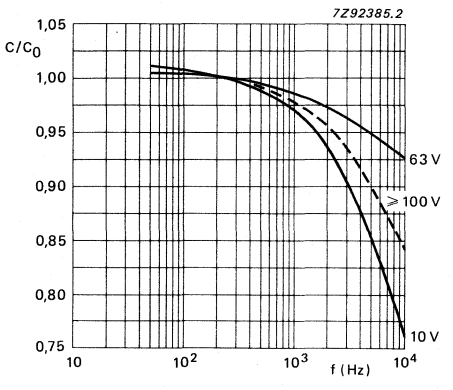
- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Upper category temperature (85 °C)
- Group number (132 or 133)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Band to identify the negative terminal
- "+" - signs to identify the positive terminal.

Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz.

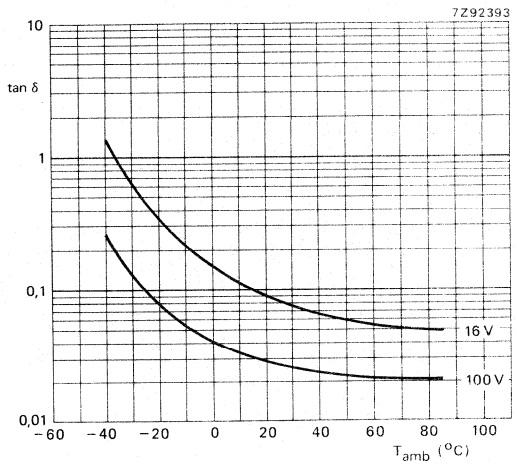
Fig.6 Multiplier of capacitance (C/C_0) as a function of frequency.

Equivalent series inductance (ESL)

Table 6 Equivalent series inductance, typical values

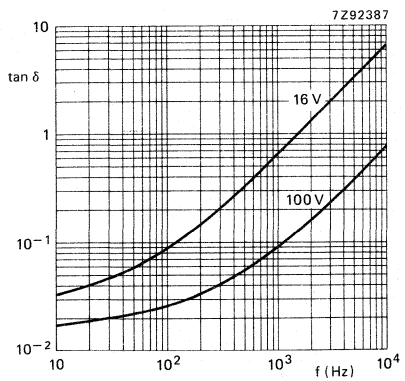
CASE SIZE (∅ x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)		CASE SIZE (∅ x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)
6.5 x 18	15	–		12.5 x 30	46	–
8 x 18	35	–		15 x 30	48	39
10 x 18	69	–		18 x 30	50	39
10 x 25	38	–		18 x 40	54	39
10 x 30	38	–		21 x 40	59	39

Dissipation factor (tan δ)



Frequency = 100 Hz.

Fig.7 Typical tan δ as a function of ambient temperature, case sizes 6.5 x 18 to 10 x 25.



Ambient temperature = 20 °C.

Fig.8 Typical tan δ as a function of frequency, case sizes 6.5 x 18 to 10 x 25.

Impedance (Z)

Curve 1: 4.7 µF - 100 V
Curve 2: 47 µF - 16 V
Curve 3: 150 µF - 16 V
Curve 4: 220 µF - 16 V
Curve 5: 470 µF - 16 V

Frequency = 10 kHz.

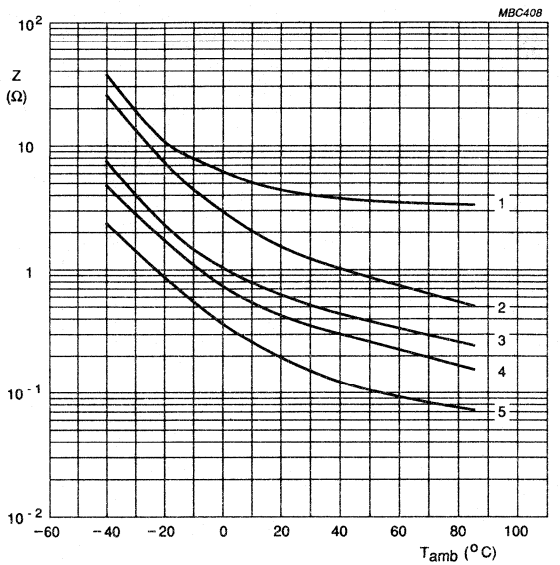


Fig.9 Typical impedance as a function of ambient temperature; case sizes 6.5 x 18 to 10 x 25.

Curve 1: 4.7 µF - 100 V
Curve 2: 47 µF - 16 V
Curve 3: 150 µF - 16 V
Curve 4: 220 µF - 16 V
Curve 5: 470 µF - 16 V

Ambient temperature = 20 °C.

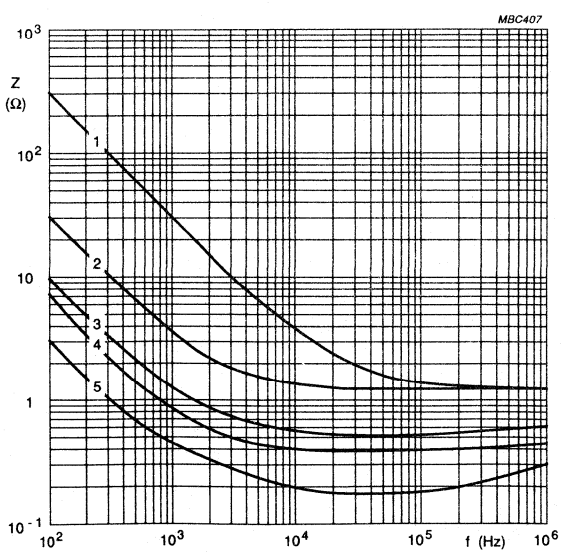
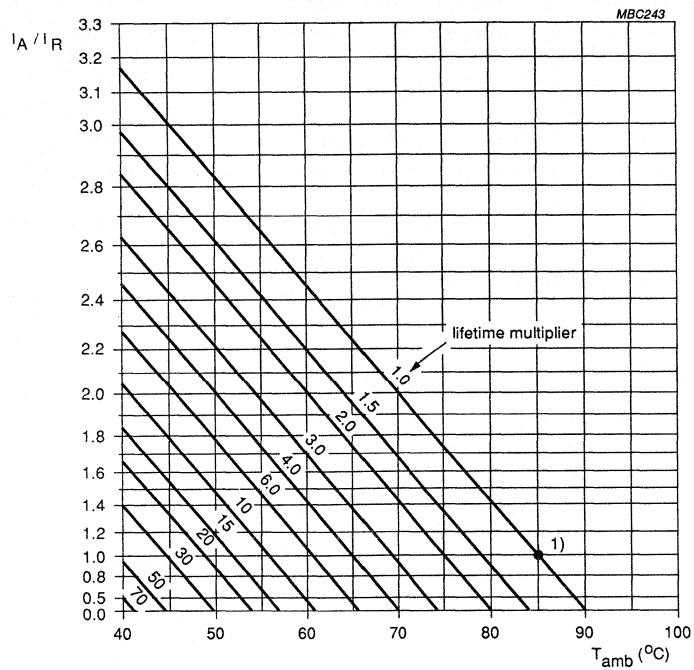


Fig.10 Typical impedance as a function of frequency; case sizes 6.5 x 18 to 10 x 25.

RIPPLE CURRENT and USEFUL LIFE

Table 7 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 85 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10 to 16 V	U_R = 25 to 63 V	U_R = 100 to 400 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥10 000	1.2	1.3	1.4



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied.
case sizes 6.5 x 18 and 8 x 18: 10 000 hours
case sizes 10 x 18 to 21 x 40: 15 000 hours.

Fig.11 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 8

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied case sizes: 6.5 x 18 and 8 x 18: 6000 hours 10 x 18 to 21 x 40: 8000 hours	U_R 10 to 160 V: $\Delta C/C$ ±15% U_R 250 to 400 V: $\Delta C/C$ ±10% tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied case sizes: 6.5 x 18 and 8 x 18: 10 000 hours 10 x 18 to 21 x 40: 15 000 hours	U_R 10 to 160 V : $\Delta C/C$ ±45% U_R 250 to 400 V: $\Delta C/C$ ±30% tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit

Electrolytic Capacitors

Notes

Non-solid Al - electrolytic capacitors
Axial Long Life, IEC-based

ALL-IEC 108

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Case sizes 10 x 30 to 18 x 30 with safety vent
- Taped versions up to 15 x 30 available for automatic insertion
- Charge and discharge proof
- Long useful life: 6000/15 000 hours at 85 °C.

APPLICATIONS

- Industrial, EDP and telecommunication
- Smoothing, filtering, buffering in SMPS; coupling, decoupling, timing
- Boards with restricted mounting height, vibration and shock resistant.

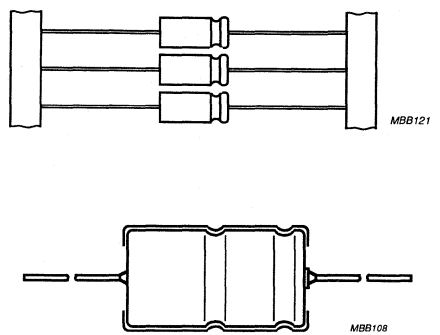


Fig.1 Component outlines.

5

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	8 x 18 to 10 x 18	10 x 30 to 18 x 30
Rated capacitance range, C_R	2.2 to 2200 µF	
Tolerance on C_R	−10 to +50%	
Rated voltage range, U_R	6.3 to 100 V	
Category temperature range	−40 to +85 °C	
Endurance test at 85 °C	5000 hours	
Useful life at 85 °C	6000 hours	15 000 hours
Useful life at 40 °C, 1.4 I_R applied	160 000 hours	300 000 hours
Shelf life at 0 V, 85 °C	500 hours	
Basic specification	IEC 384-4/CECC 30 300 LL grade	
Detail specification	DIN 41240 (IA) NF C93-110 (type 1)	
Climatic category IEC 68 DIN 40040 NF C93-001	 40/085/56 GPF 554	
Approvals (6.3 to 63 V)	CECC 30 301-027	

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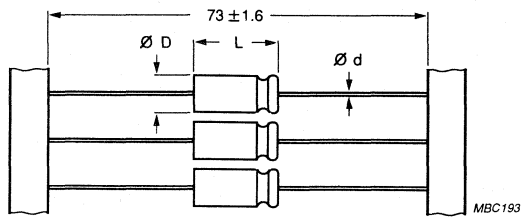
Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**)

C_R (µF)	U_R (V)						
	6.3	**10**	**16**	**25**	**40**	**63**	**100**
2.2						8 x 18	
3.3						8 x 18	
4.7						8 x 18	8 x 18
6.8						8 x 18	8 x 18
10						8 x 18	8 x 18
15					8 x 18	10 x 18	10 x 18
22					8 x 18	10 x 18	10 x 18
33				8 x 18	10 x 18	10 x 30	10 x 30
47				8 x 18	10 x 18	10 x 30	10 x 30
68			8 x 18		10 x 30	12.5 x 30	12.5 x 30
100		8 x 18		10 x 18	12.5 x 30	15 x 30	15 x 30
150	8 x 18		10 x 18	10 x 30	12.5 x 30	18 x 30	18 x 30
220		10 x 18	10 x 30	12.5 x 30	15 x 30		
330	10 x 18	10 x 30			18 x 30		
470	10 x 30		12.5 x 30	15 x 30			
680		12.5 x 30	15 x 30	18 x 30			
1000	12.5 x 30	15 x 30	18 x 30				
1500	15 x 30	18 x 30					
2200	18 x 30						

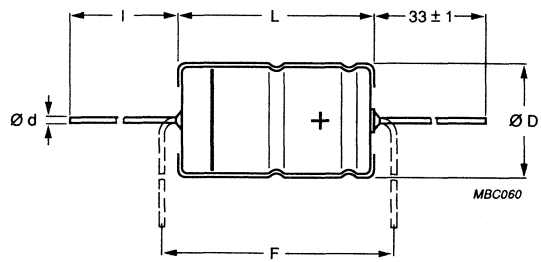
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING".



Form BR: Taped on reel, case sizes 10 x 30 to 15 x 30.
Form BA: Taped in box (ammopack), case sizes 8 x 18 and 10 x 18.

Fig.2 Case sizes 8 x 18 to 15 x 30.



Form AA: Axial in box.

Fig.3 Case sizes 10 x 30 to 18 x 30.

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Table 2 Axial, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	AXIAL: Form AA, BA, and BR					APPROX. MASS	PACKING QUANTITIES		
		∅d	l	∅D_{max}	L_{max}	F_{min}		Form AA	Form BA	Form BR
8 x 18	5	0.8		8.5	18.5	25	1.7	–	500	–
10 x 18	6	0.8		10.5	18.5	25	2.5	–	500	–
10 x 30	00	0.8	55 ±1	10.5	30.5	35	4.8	200	–	500
12.5 x 30	01	0.8	55 ±1	13.0	30.5	35	7.4	200	–	400
15 x 30	02	0.8	55 ±1	15.5	30.5	35	11.7	200	–	250
18 x 30	03	0.8	55 ±1	18.5	30.5	35	12.9	200	–	–

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ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance −10 to +50%

I_R = rated RMS ripple current at 100 Hz, 85 °C

I_{L1} = max. leakage current after 1 minute at U_R

tan δ = max. dissipation factor at 100 Hz

ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)

Z = impedance at 100 kHz, typical and maximum value.

Ordering Example

Electrolytic Capacitor
ALL-IEC 108
470 µF/16 V, −10/+50%
Case size 12.5 x 30; Form BR
Catalogue number:
2222 108 25471.

Table 3 Electrical data and ordering information

U_R	C_R 100 Hz	NOMINAL CASE SIZE ∅ D x L	CASE CODE	I_R 100 Hz 85 °C	I_{L1} 1 min	Tan δ 100 Hz	ESR 100 Hz	Z 100 kHz typ.	Z 100 kHz max.	CATALOGUE NUMBER 2222	
										IN BOX Form AA, BA	ON REEL Form BR
(V)	(µF)	(mm)		(mA)	(µA)		(Ω)	(Ω)	(Ω)		
6.3	150	8 x 18	5	130	10	0.20	1.06	0.7	1.6	108 33151	–
	330	10 x 18	6	220	17	0.20	0.49	0.36	0.84	108 33331	–
	470	10 x 30	00	325	22	0.20	0.34	0.18	0.42	108 33471	108 23471
	1000	12.5 x 30	01	470	42	0.20	0.16	0.13	0.30	108 33102	108 23102
	1500	15 x 30	02	630	60	0.20	0.11	0.10	0.22	108 33152	108 23152
	2200	18 x 30	03	920	85	0.20	0.09	0.09	0.19	108 33222	–
10	100	8 x 18	5	120	10	0.15	1.27	0.70	1.60	108 34101	–
	220	10 x 18	6	205	17	0.15	0.57	0.36	0.84	108 34221	–
	330	10 x 30	00	325	24	0.15	0.38	0.18	0.42	108 34331	108 24331
	680	12.5 x 30	01	470	45	0.15	0.19	0.13	0.30	108 34681	108 24681
	1000	15 x 30	02	630	65	0.15	0.13	0.10	0.22	108 34102	108 24102
	1500	18 x 30	03	920	95	0.15	0.09	0.09	0.19	108 34152	–
16	68	8 x 18	5	110	11	0.12	1.40	0.70	1.60	108 35689	–
	150	10 x 18	6	190	18	0.12	0.63	0.36	0.84	108 35151	–
	220	10 x 30	00	270	25	0.12	0.44	0.18	0.42	108 35221	108 25221
	470	12.5 x 30	01	360	50	0.12	0.21	0.13	0.30	108 35471	108 25471
	680	15 x 30	02	500	70	0.12	0.14	0.10	0.22	108 35681	108 25681
	1000	18 x 30	03	650	100	0.12	0.10	0.09	0.19	108 35102	–
25	33	8 x 18	5	85	8	0.10	2.41	0.70	1.60	108 36339	–
	47	8 x 18	5	100	11	0.10	1.70	0.70	1.60	108 36479	–
	100	10 x 18	6	170	19	0.10	0.80	0.36	0.84	108 36101	–
	150	10 x 30	00	270	26	0.10	0.53	0.18	0.42	108 36151	108 26151
	220	12.5 x 30	01	360	37	0.10	0.36	0.13	0.30	108 36221	108 26221
	470	15 x 30	02	500	75	0.10	0.17	0.10	0.22	108 36471	108 26471
	680	18 x 30	03	650	105	0.10	0.12	0.09	0.19	108 36681	–

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz typ. (Ω)	Z 100 kHz max. (Ω)	CATALOGUE NUMBER 2222 . . . . . IN BOX Form AA, BA	CATALOGUE NUMBER 2222 . . . . . ON REEL Form BR
40	15	8 x 18	5	65	6	0.08	4.24	1.70	1.60	108 37159	–
	22	8 x 18	5	80	9	0.08	2.89	0.70	1.60	108 37229	–
	33	10 x 18	6	110	12	0.08	1.93	0.36	0.84	108 37339	–
	47	10 x 18	6	130	15	0.08	1.36	0.36	0.84	108 37479	–
	68	10 x 30	00	195	20	0.08	0.93	0.18	0.42	108 37689	108 27689
	100	12.5 x 30	01	245	28	0.08	0.63	0.13	0.30	108 37101	108 27101
	150	12.5 x 30	01	280	40	0.08	0.43	0.13	0.30	108 37151	108 27151
	220	15 x 30	02	360	55	0.08	0.34	0.10	0.22	108 37221	108 27221
	330	18 x 30	03	495	85	0.08	0.20	0.09	0.19	108 37331	–
63	2.2	8 x 18	5	25	1.5	0.08	28.9	0.70	1.60	108 38228	–
	3.3	8 x 18	5	30	2	0.08	19.3	0.70	1.60	108 38338	–
	4.7	8 x 18	5	35	3	0.08	13.5	0.70	1.60	108 38478	–
	6.8	8 x 18	5	45	4	0.08	9.36	0.70	1.60	108 38688	–
	10	8 x 18	5	50	6	0.08	6.37	0.70	1.60	108 38109	–
	15	10 x 18	6	75	10	0.08	2.90	0.36	0.84	108 38159	–
	22	10 x 18	6	90	12	0.08	4.25	0.36	0.84	108 38229	–
	33	10 x 30	00	125	17	0.08	1.93	0.18	0.42	108 38339	108 28339
	47	10 x 30	00	150	22	0.08	1.36	0.18	0.42	108 38479	108 28479
	68	12.5 x 30	01	195	30	0.08	0.93	0.13	0.30	108 38689	108 28689
	100	15 x 30	02	275	42	0.08	0.63	0.10	0.22	108 38101	108 28101
	150	18 x 30	03	355	60	0.08	0.43	0.09	0.19	108 38151	–
100	4.7	8 x 18	5	40	5	0.07	8.5	0.8	1.6	108 39478	–
	6.8	8 x 18	5	50	7	0.07	5.9	0.8	1.6	108 39688	–
	10	8 x 18	5	60	10	0.07	4.0	0.8	1.6	108 39109	–
	15	10 x 18	6	80	13	0.07	2.7	0.4	0.84	108 39159	–
	22	10 x 18	6	90	17	0.07	1.8	0.4	0.84	108 39229	–
	33	10 x 30	00	105	24	0.15	4.8	0.9	1.9	108 39339	108 29339
	47	10 x 30	00	125	33	0.15	3.4	0.9	1.9	108 39479	108 29479
	68	12.5 x 30	01	165	45	0.15	2.4	0.7	1.6	108 39689	108 29689
	100	15 x 30	02	225	64	0.15	1.6	0.5	1.3	108 39101	108 29101
	150	18 x 30	03	300	94	0.15	1.1	0.3	0.9	108 39151	–

Non-solid Al - electrolytic capacitors
Axial Long Life, IEC-based

Marking

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V
- Upper category temperature (85 °C)
- Group number (108.3)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Band to identify the negative terminal
- "+" - signs to identify the positive terminal.

Voltage

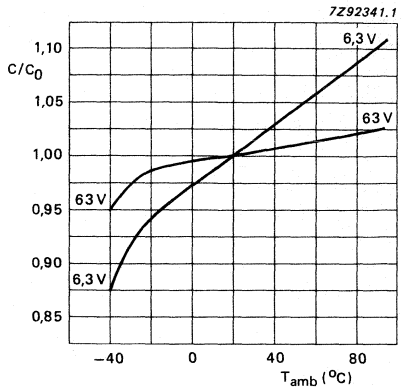
Surge voltage for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Equivalent series inductance (ESL)

Table 4 Equivalent series inductance, typical values

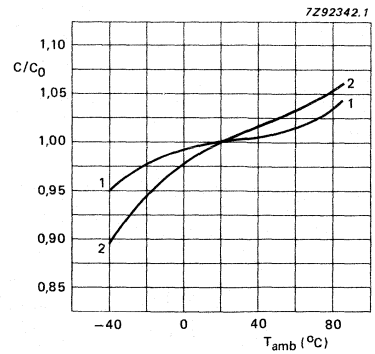
CASE SIZE (∅ x L) (mm)	TYP. ESL (nH)
8 x 18	40
10 x 18	50
10 x 30	50
12.5 x 30	50
15 x 30	55
18 x 30	60

Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

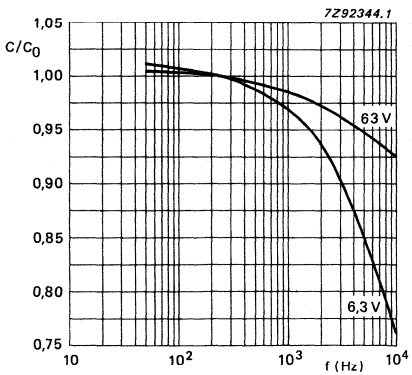
Fig.4 Multiplier of capacitance (C/C_0) as a function of ambient temperature; 6.3 to 63 V types.



Curve 1: case sizes 8 x 18 and 10 x 18
Curve 2: case sizes 10 x 30 to 18 x 30.

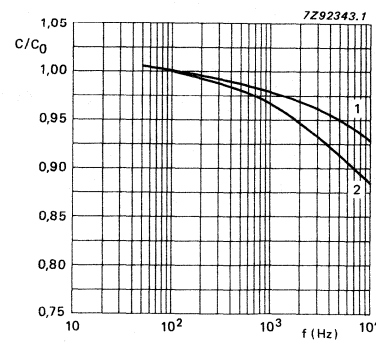
C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature; 100 V types.



C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Multiplier of capacitance (C/C_0) as a function of frequency; 6.3 to 63 V types.

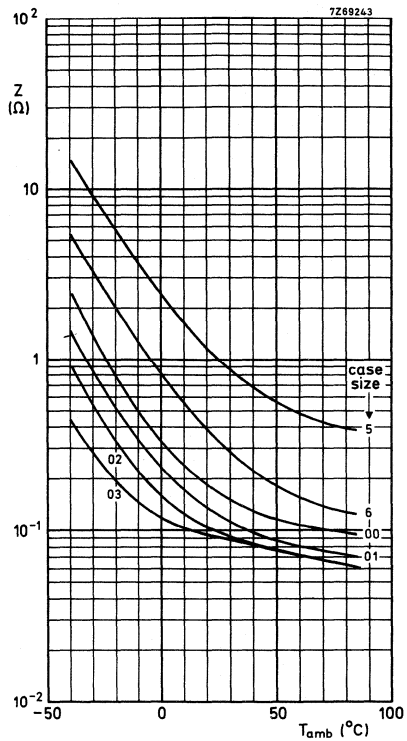


Curve 1: case sizes 8 x 18 and 10 x 18
Curve 2: case sizes 10 x 30 to 18 x 30.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.7 Multiplier of capacitance (C/C_0) as a function of frequency; 100 V types.

Impedance (Z)



Case size 5: 8 x 18 mm
Case size 6: 10 x 18 mm
Case size 00: 10 x 30 mm
Case size 01: 12.5 x 30 mm
Case size 02: 15 x 30 mm
Case size 03: 18 x 30 mm

Fig.8 Typical impedance as a function of ambient temperature at 100 kHz; 6.3 to 63 V types.

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Case size 5: 8 x 18 mm
Case size 6: 10 x 18 mm
Case size 00: 10 x 30 mm
Case size 01: 12.5 x 30 mm
Case size 02: 15 x 30 mm
Case size 03: 18 x 30 mm

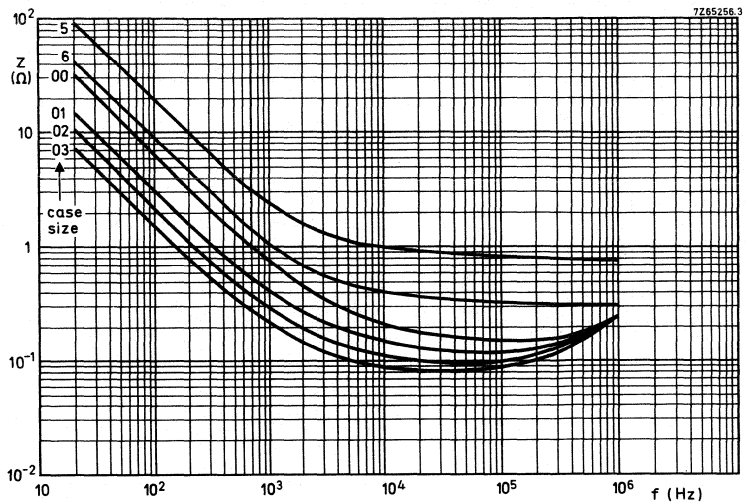
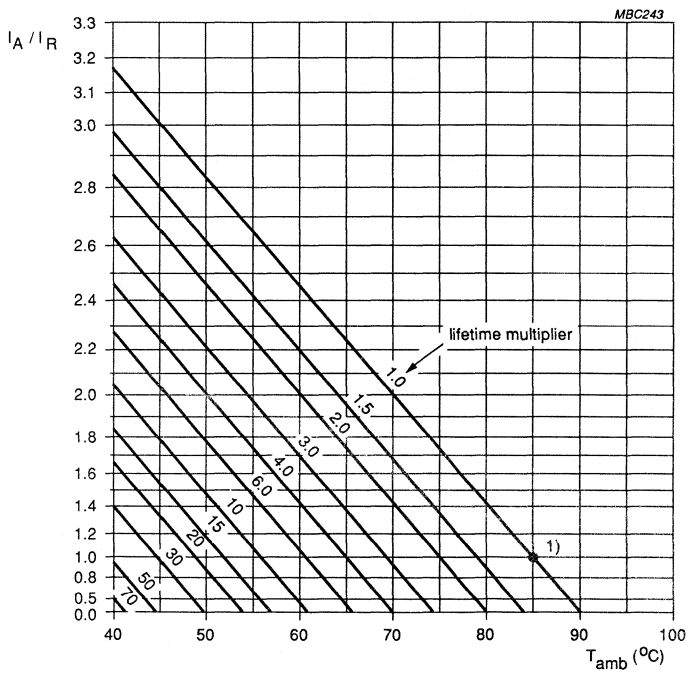


Fig.9 Typical impedance as a function of frequency at 20 °C; 16 V types.

RIPPLE CURRENT and USEFUL LIFE

Table 5 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 85 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 10 V, 100 V	U_R = 16 to 40 V	U_R = 63 V
50	0.9	0.75	0.6
100	1.0	1.0	1.0
300	1.12	1.3	1.7
1000	1.2	1.55	2.3
3000	1.25	1.7	2.7
≥10 000	1.3	1.8	3.0



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 85 °C.

1) Useful life at 85 °C and I_R applied:
case sizes 8 x 18 and 10 x 16: 6000 hours
case sizes 10 x 30 to 18 x 30: 15 000 hours.

Fig.10 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

Non-solid Al - electrolytic capacitors Axial Long Life, IEC-based

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SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R and I_R applied 5000 hours	$U_R \leq 6.3$ V : $\Delta C/C$ +15/–30% $U_R > 6.3$ V : $\Delta C/C$ ±15% tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied case sizes: 8 x 18 and 10 x 18: 6000 hours 10 x 30 to 18 x 30: 15 000 hours	$U_R \leq 6.3$ V : $\Delta C/C$ +45/–50% $U_R > 6.3$ V : $\Delta C/C$ ±45% tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301, group C 5a, 4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L5} \leq 2$ x spec. limit

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FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case sizes 10 x 30 to 21 x 40 with safety vent
- Taped versions up to 15 x 30 available for automatic insertion
- Charge and discharge proof
- Extra long useful life: 4000 hours at 125 °C, high reliability
- Extended temperature range: 125 °C (usable up to 150 °C)
- Miniaturized, high CU-product per unit volume.

APPLICATIONS

- Automotive, industrial and telecommunication
- Smoothing, filtering, coupling, decoupling, timing
- For use after very long storage (10 years) without voltage applied
- Portable and mobile equipment (small size, low mass)
- Low mounting height boards, vibration and shock resistant
- Outdoor applications, e.g. aerial amplifiers.

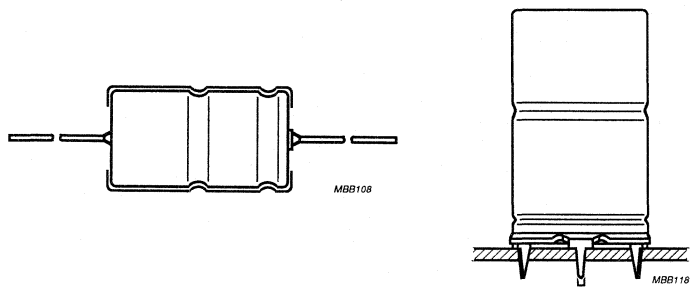

Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	6.5 x 18 to 10 x 25	10 x 30 to 21 x 40
Rated capacitance range, C_R	1 to 15 000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	6.3 to 200 V	
Category temperature range	–40 to +125 °C	–55 to +125 °C
Endurance test at 150 °C	500 hours	1000 hours
Endurance test at 125 °C	2000 hours	3000 hours
Useful life at 125 °C	4000 hours	4000 hours
Useful life at 40 °C, 1.8 I_R applied	500 000 hours	500 000 hours
Shelf life at 0 V, 125 °C 6.3 to 63 V types 100 and 200 V types	 500 hours 100 hours	
Basic specification	IEC 384-4/CECC 30 300, LL grade	
Detail specification	similar to DIN 41257 (with reduced dimensions)	
Climatic category IEC 68 DIN 40040	 40/125/56 GKD	 55/125/56 FKD

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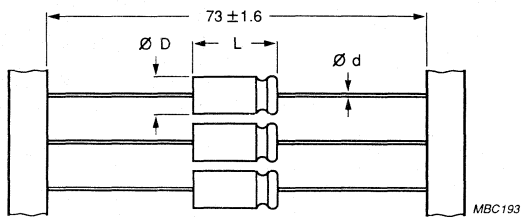
Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**) * = preferred values

C_R (µF)	U_R (V)							
	6.3	**10**	**16**	**25**	**40**	**63**	**100**	**200**
1.0						6.5 x 18*		
2.2						6.5 x 18*		6.5 x 18*
4.7						6.5 x 18*	6.5 x 18*	8 x 18*
10						6.5 x 18*	6.5 x 18*	10 x 25*
15						6.5 x 18	8 x 18	10 x 30
22						6.5 x 18*	8 x 18*	12 5 x 30*
33						8 x 18	10 x 25	15 x 30
47					6.5 x 18*	8 x 18*	10 x 25* 10 x 30*	18 x 30*
68					8 x 18	10 x 18	12.5 x 30	18 x 40
100				6.5 x 18*	8 x 18*	10 x 25* 10 x 30*	12.5 x 30*	21 x 40*
150			6.5 x 18	8 x 18	10 x 18	12.5 x 30	15 x 30	
220		6.5 x 18*	8 x 18*	10 x 18*	10 x 25* 10 x 30*	12.5 x 30*	18 x 30*	
330	6.5 x 18*	8 x 18*	10 x 18*	10 x 25*	12.5 x 30*	15 x 30*	18 x 40*	
470		8 x 18*	10 x 18*	10 x 25* 10 x 30*	12.5 x 30*	18 x 30*	21 x 40*	
680		10 x 18*	10 x 25* 10 x 30*	12.5 x 30*	15 x 30*	18 x 40*		
1000	10 x 18*	10 x 25* 10 x 30*	12.5 x 30*	12.5 x 30*	18 x 30*	21 x 40*		
1500	10 x 25* 10 x 30*	12.5 x 30*	12.5 x 30*	15 x 30*	18 x 40*			
2200	12.5 x 30*	12.5 x 30*	15 x 30*	18 x 30*	21 x 40*			
3300	12.5 x 30*	15 x 30 *	18 x 30*	18 x 40*				
4700	15 x 30*	18 x 30*	18 x 40*	21 x 40*				
6800	18 x 30*	18 x 40*	21 x 40*					
10 000	18 x 40*	21 x 40*						
15 000	21 x 40*							

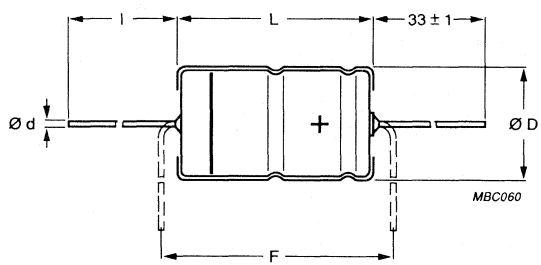
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING",



Form BR: Taped on reel, case sizes 6.5 x 18 to 15 x 30.
Form BA: Taped in box (ammopack), case sizes 6.5 x 18 to 10 x 25.

Fig.2 Case sizes 6.5 x 18 to 15 x 30.



Form AA: Axial in box.

Fig.3 Case sizes 10 x 30 to 21 x 40.

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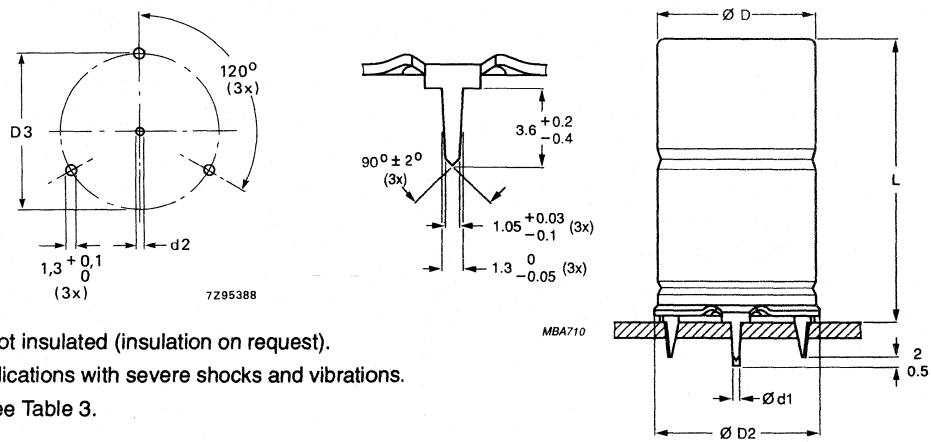
Table 2 Axial, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	AXIAL: Form AA, BA, and BR					APPROX. MASS	PACKING QUANTITIES		
		∅d	l	∅D_{max}	L_{max}	F_{min}		Form AA	Form BA	Form BR
6.5 x 18	4	0.8		6.9	18.5	25	1.3	–	1000	1000
8 x 18	5	0.8		8.5	18.5	25	1.7	–	500	500
10 x 18	6	0.8		10.5	18.5	25	2.5	–	500	500
10 x 25	7	0.8		10.5	25.0	30	3.3	–	500	500
10 x 30	00	0.8	55 ±1	10.5	30.5	35	4.8	200	–	500
12.5 x 30	01	0.8	55 ±1	13.0	30.5	35	7.4	200	–	400
15 x 30	02	0.8	55 ±1	15.5	30.5	35	11.7	200	–	250
18 x 30	03	0.8	55 ±1	18.5	30.5	35	12.9	200	–	–
18 x 40 (note 1)	04	0.8	34 ±1	18.5	41.5	45	19.4	100	–	–
21 x 40 (note 1)	05	0.8	34 ±1	21.5	41.5	45	24.7	100	–	–

Note

1. For case sizes 18 x 40 and 21 x 40, the stated L_{max} may be exceeded by 0.7 mm.



Piercing diagram.

Form MR: case not insulated (insulation on request).
Especially for applications with severe shocks and vibrations.
For dimensions see Table 3.

Fig.4 Case sizes 15 x 30 to 21 x 40, single ended with mounting ring and pins.

Table 3 Single ended, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	SINGLE ENDED WITH MOUNTING RING: Form MR						APPROX. MASS	PACKING QUANTITIES
		∅d_1	∅d_2	∅D_{max}	∅$D2_{max}$	D3	L_{max}		
15 x 30	02	0.8	1.0 +0.1	15.5	17.5	16.5 ±0.2	33	8.6	200
18 x 30	03	0.8	1.0 +0.1	18.5	19.5	18.5 ±0.2	33	11.5	200
18 x 40	04	1.0	1.3 +0.1	18.5	19.5	18.5 ±0.2	45	14.5	100
21 x 40	05	1.0	1.3 +0.1	21.5	22.5	21.5 ±0.2	45	19.7	100

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance ±20%
I_R = rated RMS ripple current at 100 Hz, 125 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 10 kHz

Table 4 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
6.3	330	6.5 x 18	112	20	8.2	0.50	2.41	2.1
	1000	10 x 18	251	42	17	0.50	0.79	0.8
	1500	10 x 25	352	61	23	0.50	0.53	0.53
	1500	10 x 30	416	61	23	0.46	0.485	0.45
	2200	12.5 x 30	590	87	32	0.46	0.305	0.28
	3300	12.5 x 30	648	129	46	0.58	0.280	0.27
	4700	15 x 30	826	182	63	0.58	0.185	0.18
	6800	18 x 30	1040	261	90	0.66	0.155	0.15
	10 000	18 x 40	1417	382	130	0.66	0.098	0.10
	15 000	21 x 40	1707	571	193	0.77	0.082	0.10
10	220	6.5 x 18	109	20	8.4	0.35	2.53	2.1
	330	8 x 18	150	24	11	0.35	1.69	1.4
	470	8 x 18	179	32	13	0.35	1.19	1.0
	680	10 x 18	247	45	18	0.35	0.82	0.81
	1000	10 x 25	343	64	24	0.35	0.56	0.55
	1000	10 x 30	409	64	24	0.32	0.505	0.45
	1500	12.5 x 30	590	94	34	0.32	0.285	0.28
	2200	12.5 x 30	634	136	48	0.40	0.290	0.27
	3300	15 x 30	826	202	70	0.40	0.190	0.18
	4700	18 x 30	1035	286	98	0.46	0.155	0.15
	6800	18 x 40	1395	412	140	0.53	0.100	0.10
	10 000	21 x 40	1674	604	200	0.53	0.084	0.10

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ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor AHT 118
1000 µF/10 V, ±20%
Case size 10 x 30; Form BR
Catalogue number: 2222 118 24102.

Table 5 Ordering Information

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
6.3	330	6.5 x 18	4	–	118 23331	118 33331	–
	1000	10 x 18	6	–	118 23102	118 33102	–
	1500	10 x 25	7	–	118 90502	118 90503	–
	1500	10 x 30	00	118 13152	118 23152	–	–
	2200	12.5 x 30	01	118 13222	118 23222	–	–
	3300	12.5 x 30	01	118 13332	118 23332	–	–
	4700	15 x 30	02	118 13472	118 23472	–	118 43472
	6800	18 x 30	03	118 13682	–	–	118 43682
	10 000	18 x 40	04	118 13103	–	–	118 43103
	15 000	21 x 40	05	118 13153	–	–	118 43153
10	220	6.5 x 18	4	–	118 24221	118 34221	–
	330	8 x 18	5	–	118 24331	118 34331	–
	470	8 x 18	5	–	118 24471	118 34471	–
	680	10 x 18	6	–	118 24681	118 34681	–
	1000	10 x 25	7	–	118 90504	118 90505	–
	1000	10 x 30	00	118 14102	118 24102	–	–
	1500	12.5 x 30	01	118 14152	118 24152	–	–
	2200	12.5 x 30	01	118 14222	118 24222	–	–
	3300	15 x 30	02	118 14332	118 24332	–	118 44332
	4700	18 x 30	03	118 14472	–	–	118 44472
	6800	18 x 40	04	118 14682	–	–	118 44682
	10 000	21 x 40	05	118 14103	–	–	118 44103

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
16	150	6.5 x 18	106	20	8.8	0.25	2.65	2.2
	220	8 x 18	145	25	11	0.25	1.81	1.5
	330	10 x 18	204	36	15	0.25	1.21	1.2
	470	10 x 18	243	49	19	0.25	0.85	0.83
	680	10 x 25	335	69	30	0.25	0.58	0.57
	680	10 x 30	389	69	30	0.22	0.525	0.45
	1000	12.5 x 30	557	100	36	0.22	0.345	0.28
	1500	12.5 x 30	609	148	52	0.29	0.305	0.27
	2200	15 x 30	790	215	74	0.29	0.205	0.18
	3300	18 x 30	1008	321	110	0.34	0.165	0.15
	4700	18 x 40	1363	455	150	0.34	0.105	0.10
	6800	21 x 40	1627	657	220	0.38	0.088	0.10
25	100	6.5 x 18	102	20	9	0.18	2.86	2.3
	150	8 x 18	141	27	12	0.18	1.91	1.55
	220	10 x 18	196	37	15	0.18	1.30	1.25
	330	10 x 25	274	54	21	0.18	0.87	0.82
	470	10 x 25	327	75	28	0.18	0.61	0.57
	470	10 x 30	366	75	28	0.18	0.61	0.50
	680	12.5 x 30	515	106	38	0.18	0.42	0.30
	1000	12.5 x 30	531	154	54	0.24	0.375	0.28
	1500	15 x 30	691	229	79	0.25	0.263	0.22
	2200	18 x 30	919	334	110	0.26	0.185	0.17
	3300	18 x 40	1280	499	170	0.26	0.12	0.11
	4700	21 x 40	1464	709	240	0.28	0.095	0.10
40	47	6.5 x 18	89.8	20	7.8	0.11	3.72	2.8
	68	8 x 18	121	20	9.4	0.11	2.57	1.9
	100	8 x 18	147	28	12	0.11	1.75	1.3
	150	10 x 18	207	40	16	0.11	1.17	1.0
	220	10 x 25	287	57	22	0.11	0.80	0.68
	220	10 x 30	338	57	22	0.10	0.70	0.55
	330	12.5 x 30	484	83	30	0.10	0.43	0.33
	470	12.5 x 30	522	117	42	0.11	0.38	0.30
	680	15 x 30	695	167	58	0.11	0.255	0.23
	1000	18 x 30	852	244	84	0.13	0.205	0.18
	1500	18 x 40	1196	364	120	0.13	0.13	0.11
	2200	21 x 40	1403	532	180	0.15	0.105	0.10

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
16	150	6.5 x 18	4	–	118 25151	118 35151	–
	220	8 x 18	5	–	118 25221	118 35221	–
	330	10 x 18	6	–	118 25331	118 35331	–
	470	10 x 18	6	–	118 25471	118 35471	–
	680	10 x 25	7	–	118 90506	118 90507	–
	680	10 x 30	00	118 15681	118 25681	–	–
	1000	12.5 x 30	01	118 15102	118 25102	–	–
	1500	12.5 x 30	01	118 15152	118 25152	–	–
	2200	15 x 30	02	118 15222	118 25222	–	118 45222
	3300	18 x 30	03	118 15332	–	–	118 45332
	4700	18 x 40	04	118 15472	–	–	118 45472
	6800	21 x 40	05	118 15682	–	–	118 45682
25	100	6.5 x 18	4	–	118 26101	118 36101	–
	150	8 x 18	5	–	118 26151	118 36151	–
	220	10 x 18	6	–	118 26221	118 36221	–
	330	10 x 25	7	–	118 26331	118 36331	–
	470	10 x 25	7	–	118 90508	118 90509	–
	470	10 x 30	00	118 16471	118 26471	–	–
	680	12.5 x 30	01	118 16681	118 26681	–	–
	1000	12.5 x 30	01	118 16102	118 26102	–	–
	1500	15 x 30	02	118 16152	118 26152	–	118 46152
	2200	18 x 30	03	118 16222	–	–	118 46222
	3300	18 x 40	04	118 16332	–	–	118 46332
	4700	21 x 40	05	118 16472	–	–	118 46472
40	47	6.5 x 18	4	–	118 27479	118 37479	–
	68	8 x 18	5	–	118 27689	118 37689	–
	100	8 x 18	5	–	118 27101	118 37101	–
	150	10 x 18	6	–	118 27151	118 37151	–
	220	10 x 25	7	–	118 90511	118 90512	–
	220	10 x 30	00	118 17221	118 27221	–	–
	330	12.5 x 30	01	118 17331	118 27331	–	–
	470	12.5 x 30	01	118 17471	118 27471	–	–
	680	15 x 30	02	118 17681	118 27681	–	118 47681
	1000	18 x 30	03	118 17102	–	–	118 47102
	1500	18 x 40	04	118 17152	–	–	118 47152
	2200	21 x 40	05	118 17222	–	–	118 47222

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
63	1.0	6.5 x 18	16.4	20	4.1	0.07	110	22
	2.2	6.5 x 18	24.3	20	4.3	0.07	51	15
	4.7	6.5 x 18	35.6	20	4.6	0.07	24	8.9
	10	6.5 x 18	51.9	20	5.3	0.07	11	5.6
	15	6.5 x 18	63.6	20	5.9	0.07	7.4	4.2
	22	6.5 x 18	77.0	20	6.8	0.07	5.1	3.2
	33	8 x 18	106	20	8.2	0.07	3.4	2.1
	47	8 x 18	126	22	9.9	0.07	2.4	1.5
	68	10 x 18	175	30	13	0.07	1.6	1.1
	100	10 x 25	243	42	17	0.07	1.1	0.7
	100	10 x 30	262	42	17	0.07	1.1	1.0
	150	12.5 x 30	415	61	23	0.07	0.65	0.61
	220	12.5 x 30	454	87	32	0.08	0.61	0.56
	330	15 x 30	544	129	46	0.09	0.42	0.40
	470	18 x 30	695	182	63	0.09	0.31	0.33
	680	18 x 40	971	261	90	0.09	0.2	0.18
	1000	21 x 40	1161	383	130	0.10	0.16	0.15
100	4.7	6.5 x 18	36	20	4.9	0.07	24	19
	10	6.5 x 18	52	20	6.0	0.07	11	9.0
	15	8 x 18	79	20	7.0	0.07	7.4	6.0
	22	8 x 18	91	20	8.4	0.07	5.1	4.0
	33	10 x 25	140	24	11	0.07	3.4	2.7
	47	10 x 25	170	33	13	0.07	2.6	2.0
	47	10 x 30	178	33	13	0.08	2.6	2.0
	68	12.5 x 30	278	45	18	0.08	1.8	1.2
	100	12.5 x 30	303	64	24	0.09	1.4	1.15
	150	15 x 30	368	94	34	0.10	0.94	0.78
	220	18 x 30	481	136	48	0.10	0.66	0.55
	330	18 x 40	694	202	70	0.10	0.45	0.37
	470	21 x 40	833	286	98	0.10	0.33	0.28

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
63	1.0	6.5 x 18	4	–	118 28108	118 38108	–
	2.2	6.5 x 18	4	–	118 28228	118 38228	–
	4.7	6.5 x 18	4	–	118 28478	118 38478	–
	10	6.5 x 18	4	–	118 28109	118 38109	–
	15	6.5 x 18	4	–	118 28159	118 38159	–
	22	6.5 x 18	4	–	118 28229	118 38229	–
	33	8 x 18	5	–	118 28339	118 38339	–
	47	8 x 18	5	–	118 28479	118 38479	–
	68	10 x 18	6	–	118 28689	118 38689	–
	100	10 x 25	7	–	118 90513	118 90514	–
	100	10 x 30	00	118 18101	118 28101	–	–
	150	12.5 x 30	01	118 18151	118 28151	–	–
	220	12.5 x 30	01	118 18221	118 28221	–	–
	330	15 x 30	02	118 18331	118 28331	–	118 48331
	470	18 x 30	03	118 18471	–	–	118 48471
	680	18 x 40	04	118 18681	–	–	118 48681
	1000	21 x 40	05	118 18102	–	–	118 48102
100	4.7	6.5 x 18	4	–	118 29478	118 39478	–
	10	6.5 x 18	4	–	118 29109	118 39109	–
	15	8 x 18	5	–	118 29159	118 39159	–
	22	8 x 18	5	–	118 29229	118 39229	–
	33	10 x 25	7	–	118 29339	118 39339	–
	47	10 x 25	7	–	118 90535	118 90536	–
	47	10 x 30	00	118 19479	118 29479	–	–
	68	12.5 x 30	01	118 19689	118 29689	–	–
	100	12.5 x 30	01	118 19101	118 29101	–	–
	150	15 x 30	02	118 19151	118 29151	–	118 49151
	220	18 x 30	03	118 19221	–	–	118 49221
	330	18 x 40	04	118 19331	–	–	118 49331
	470	21 x 40	05	118 19471	–	–	118 49471

Non-solid Al - electrolytic capacitors
Axial High Temperature

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
200	2.2	6.5 x 18	27	20	4.9	0.06	44	23
	4.7	8 x 18	46	20	5.9	0.06	21	11
	10	10 x 25	85	20	8.0	0.06	9.4	5.0
	15	10 x 30	129	22	10	0.046	4.76	3.75
	22	12.5 x 30	198	31	13	0.046	3.17	2.22
	33	15 x 30	242	44	17	0.046	2.11	1.11
	47	18 x 30	317	61	23	0.046	1.48	0.60
	68	18 x 40	428	86	31	0.046	1.02	0.42
	100	21 x 40	551	124	44	0.046	0.96	0.39

Non-solid Al - electrolytic capacitors
Axial High Temperature

AHT 118

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
200	2.2	6.5 x 18	4	–	118 90537	118 90538	–
	4.7	8 x 18	5	–	118 90539	118 90541	–
	10	10 x 25	7	–	118 90542	118 90543	–
	15	10 x 30	00	118 92159	118 90012	–	–
	22	12.5 x 30	01	118 92229	118 90013	–	–
	33	15 x 30	02	118 92339	118 90014	–	118 90002
	47	18 x 30	03	118 92479	–	–	118 90003
	68	18 x 40	04	118 92689	–	–	118 90004
	100	21 x 40	05	118 92101	–	–	118 90006

Marking

The capacitors are marked (where possible) with the following information:

- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V (at 125 °C and at 85 °C)
- Group number (118)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Band to identify the negative terminal
- "+" - signs to identify the positive terminal.

Non-solid Al - electrolytic capacitors
Axial High Temperature

Voltage

Surge voltage for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Note

For applications at ambient temperatures of ≤85 °C, the rated voltage (U_R) may be raised to U_{R2} in accordance with Table 6.

Table 6 Uprating values at reduced ambient temperature

U_R at T_{amb} 85 to 125 °C	6.3 V	10 V	16 V	25 V	40 V	63 V	100 V	200 V
U_{R2} at T_{amb} ≤85 °C	10 V	16 V	25 V	40 V	63 V	100 V	125 V	250 V

Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$ or 20 μA (whichever is greater)
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

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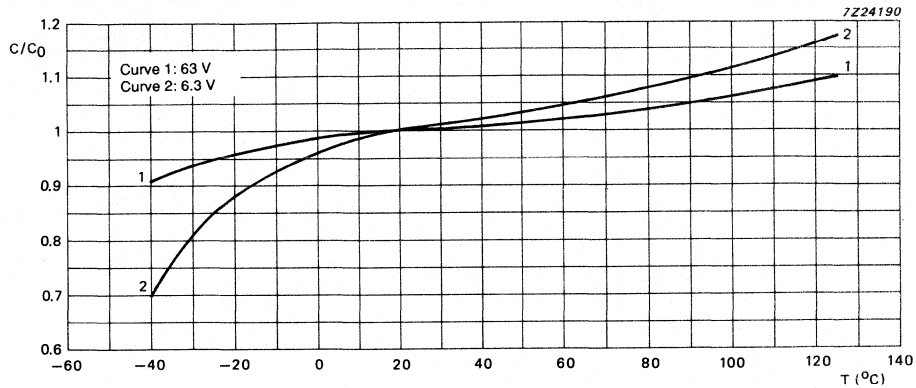
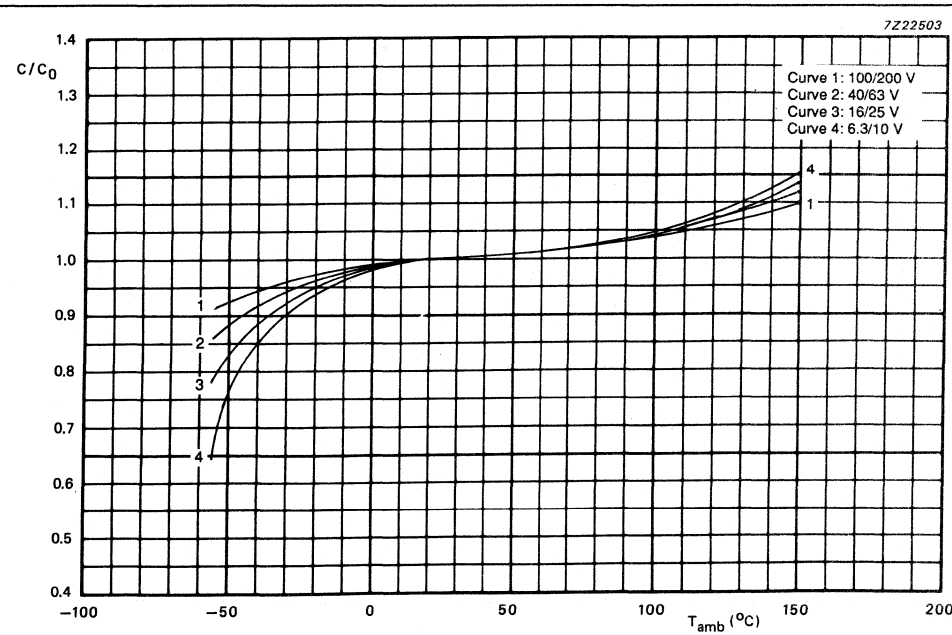
Capacitance (C)



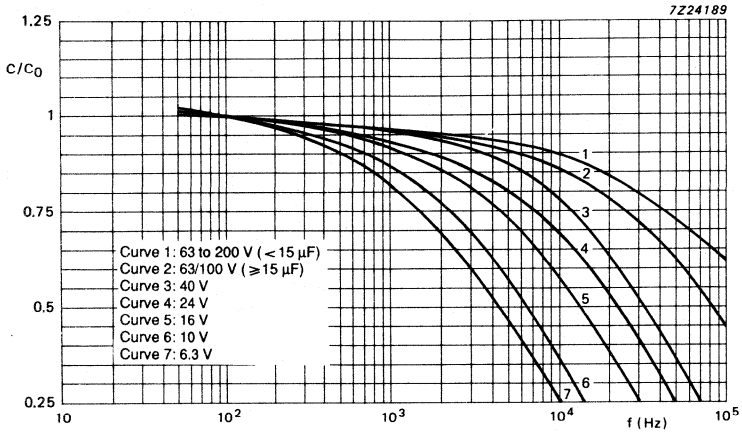
C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 6.5 x 18 to 10 x 25.



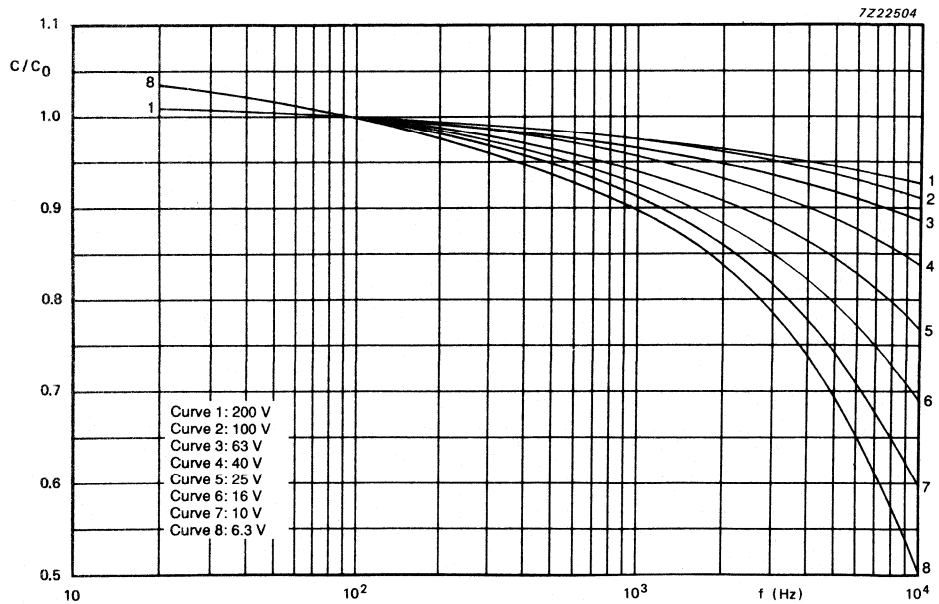
C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 10 x 30 to 21 x 40.



C_0 = capacitance at 20 °C; 100 Hz.

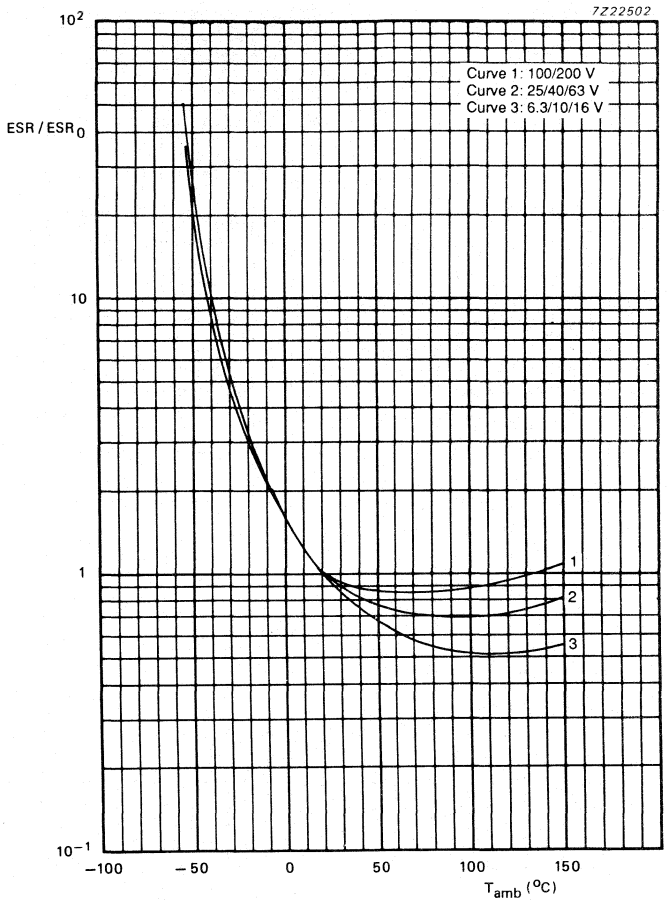
Fig.7 Multiplier of capacitance (C/C_0) as a function of frequency; case sizes 6.5 x 18 to 10 x 25.



C_0 = capacitance at 20 °C; 100 Hz.

Fig.8 Multiplier of capacitance (C/C_0) as a function of frequency; case sizes 10 x 30 to 21 x 40.

Equivalent series resistance (ESR)



ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 6.5 x 18 to 15 x 30 mm.

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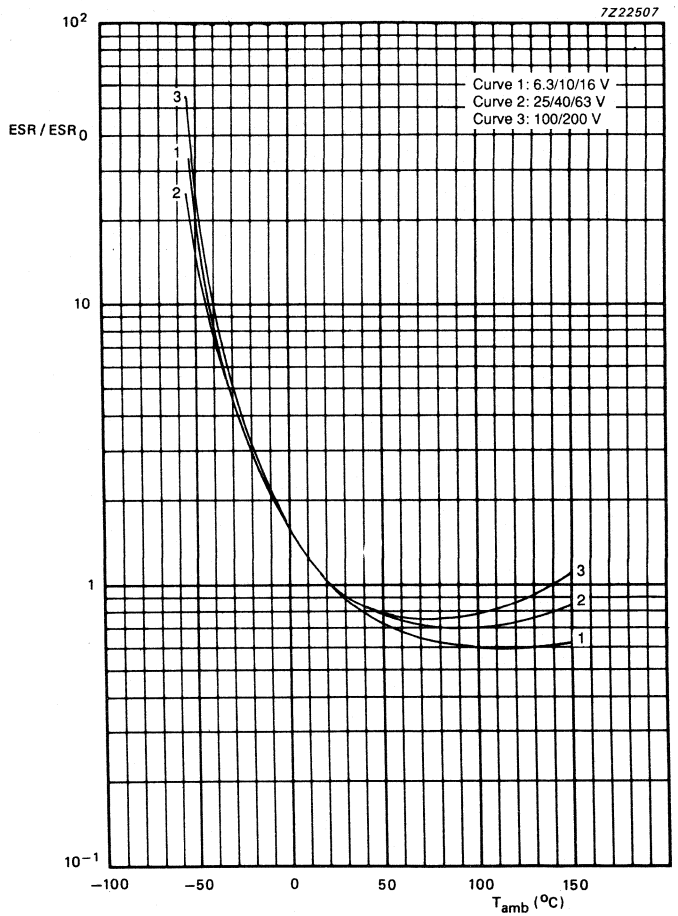
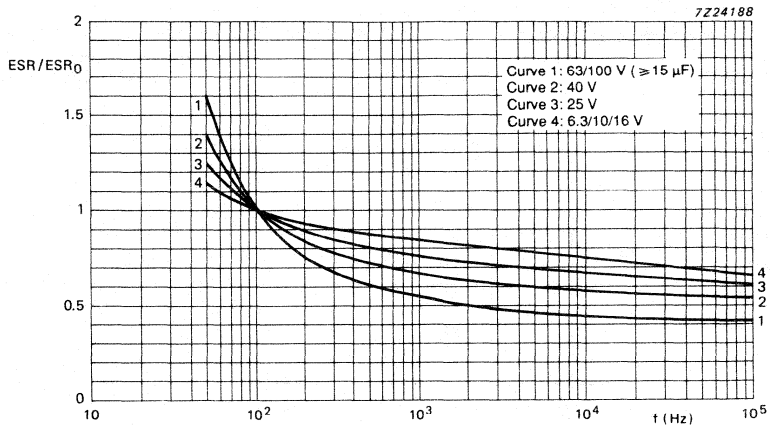


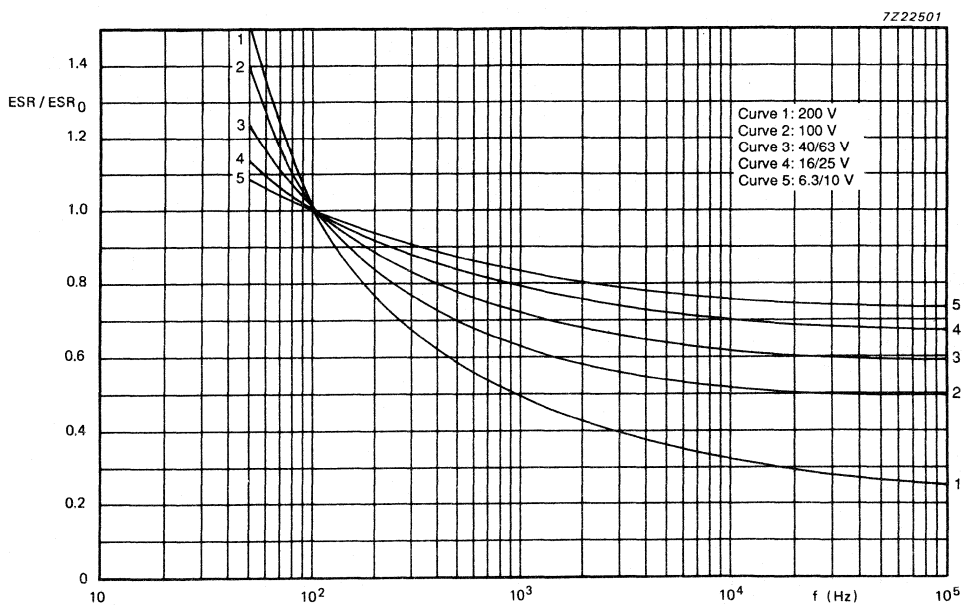
ESR$_0$ = typical ESR at 20 °C, 100 Hz.

Fig.10 Multiplier of ESR (ESR/ESR$_0$) as a function of ambient temperature; case sizes 18 x 30 mm to 21 x 40 mm.



ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.11 Multiplier of ESR (ESR/ESR_0) as a function of frequency; case sizes 6.5 x 18 to 10 x 25 mm.



ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.12 Multiplier of ESR (ESR/ESR_0) as a function of frequency; case sizes 10 x 30 to 21 x 40 mm.

Equivalent series inductance (ESL)

Table 7 Equivalent series inductance, typical values

CASE SIZE ∅ x L (mm)	AXIAL (nH)	SINGLE ENDED (nH)
6.5 x 18	15	–
8 x 18	35	–
10 x 18	69	–
10 x 25	38	–
10 x 30	38	–
12.5 x 30	46	–
15 x 30	48	39
18 x 30	50	39
18 x 40	54	39
21 x 40	59	39

Impedance (Z)

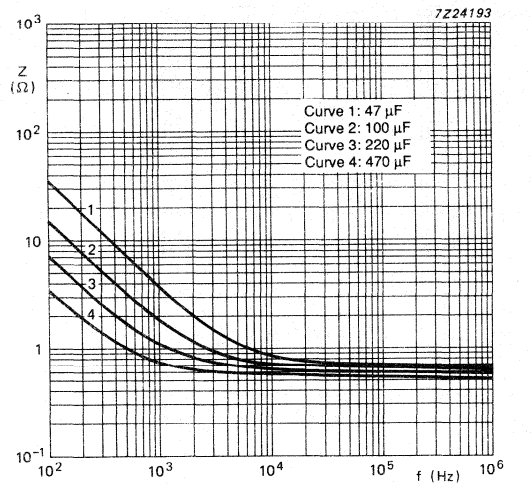


Fig.13 Typical impedance as a function of frequency at 20 °C; case size 8 x 18.

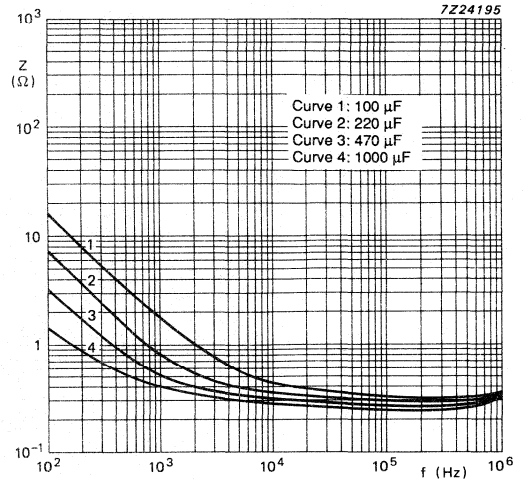


Fig.14 Typical impedance as a function of frequency at 20 °C; case size 10 x 25.

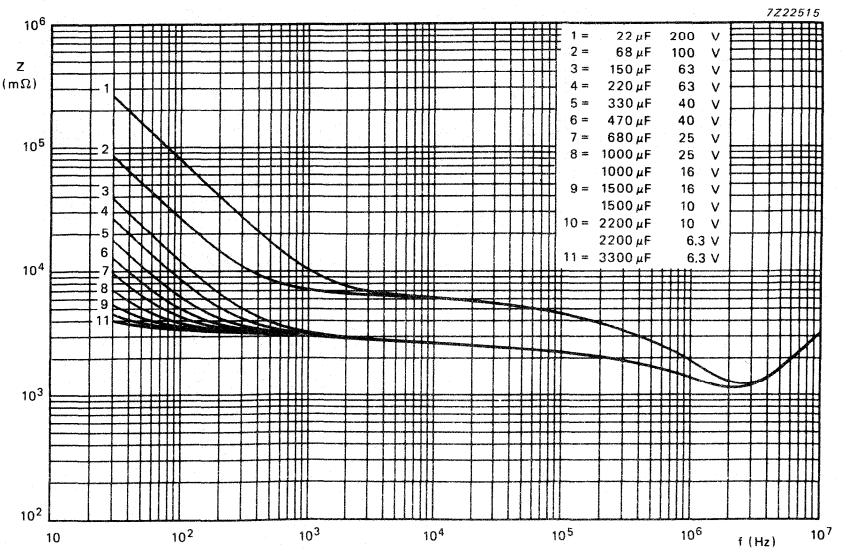


Fig.15 Typical impedance as a function of frequency at −40 °C; case size 12.5 x 30.

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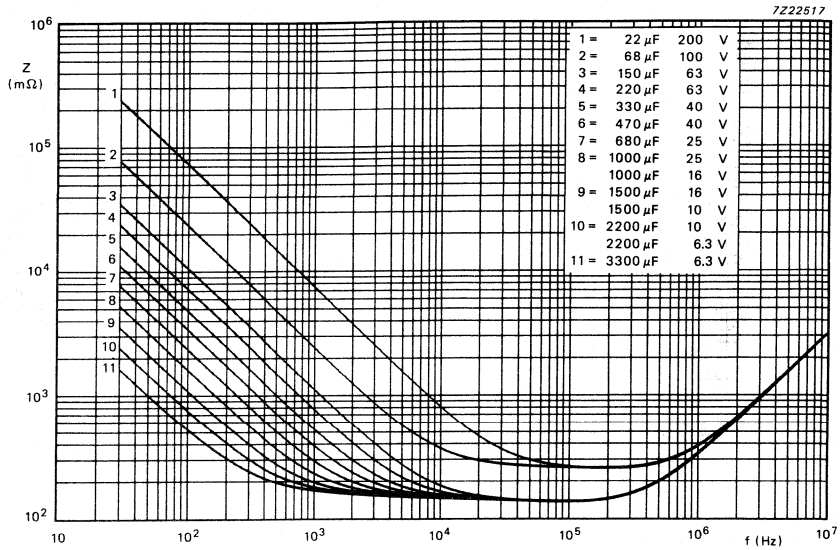

Fig.16 Typical impedance as a function of frequency at 20 °C; case size 12.5 x 30.

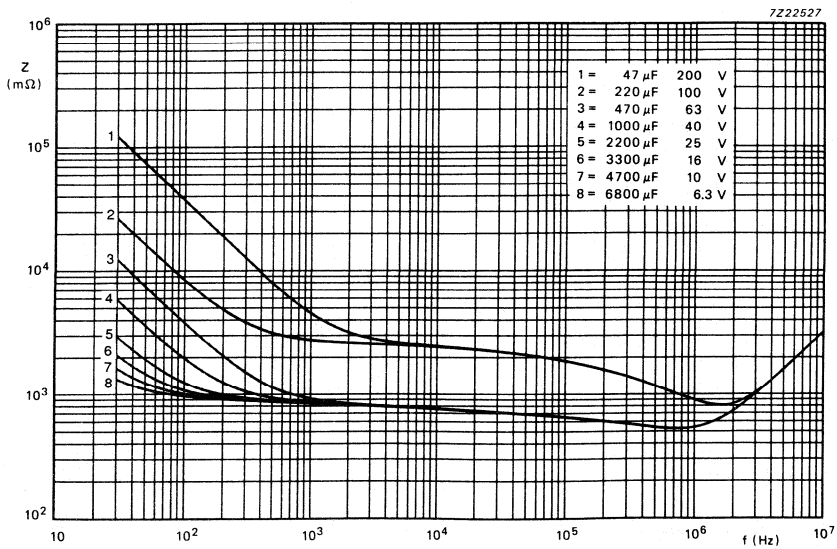

Fig.17 Typical impedance as a function of frequency at –40 °C; case size 18 x 30.

Non-solid Al - electrolytic capacitors
Axial High Temperature

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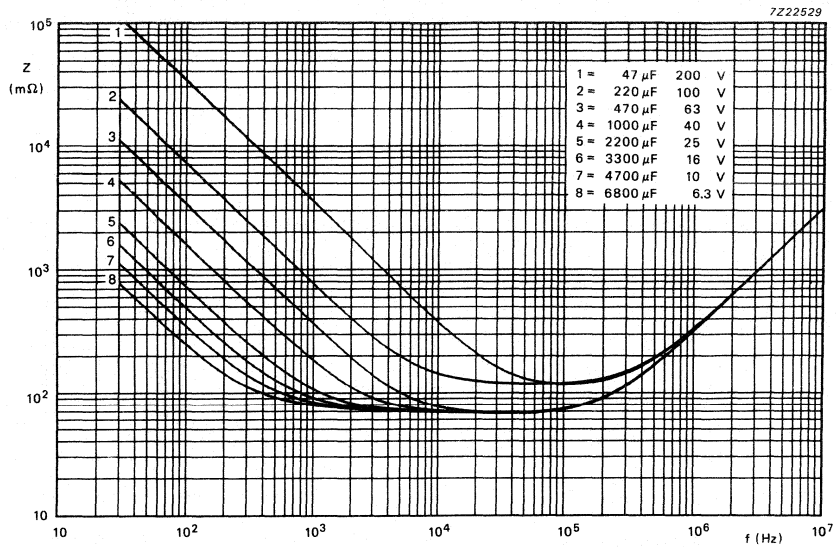
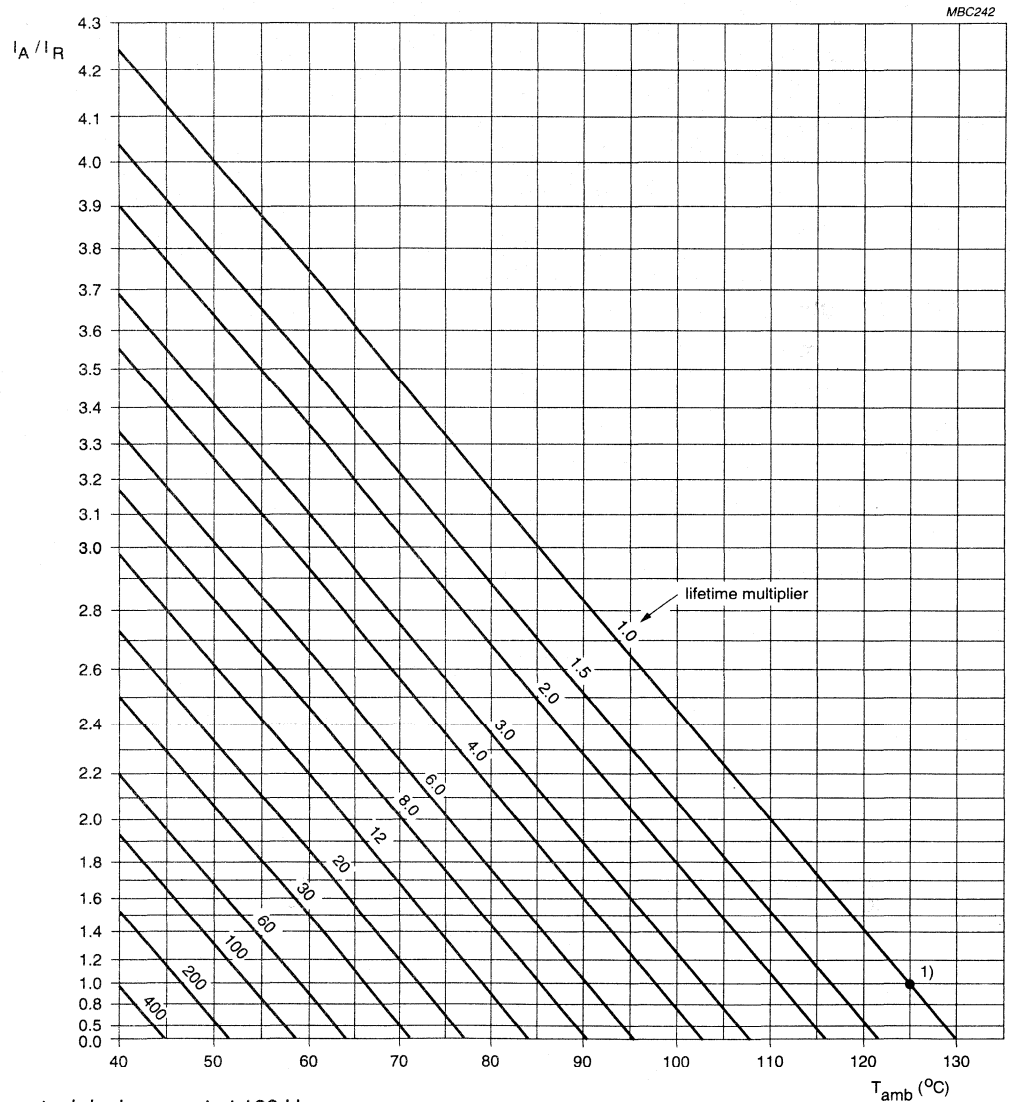


Fig.18 Typical impedance as a function of frequency at 20 °C; case size 18 x 30.

RIPPLE CURRENT and USEFUL LIFE



I_A = actual ripple current at 100 Hz.

I_R = rated ripple current at 100 Hz, 125 °C.

1) Useful life at 125 °C and I_R applied: 4000 hours.

Fig.19 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

Table 8 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 125 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 25 V	U_R = 40 to 63 V	U_R = 100 to 200 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥10 000	1.2	1.3	1.4

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 9

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	Reference		
Endurance	IEC 384-4-1/ CECC 30 301 group C 3, 4.13	T_{amb} = 125 °C, U_R applied case sizes: 6.5 x 18 to 10 x 25: 2000 hours 10 x 30 to 21 x 40: 3000 hours	U_R ≤6.3 V : ΔC/C +15/–30% U_R >6.3 V : ΔC/C ±15% tan δ ≤1.3 x spec. limit Z ≤2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 125 °C, U_R and I_R applied 4000 hours	U_R ≤6.3 V : ΔC/C +45/–50% U_R >6.3 V : ΔC/C ±45% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (Storage at high temp.)	IEC 384-4-1/ CECC 30 301 group C 5a, 4.17	T_{amb} = 125 °C, no voltage applied U_R 6.3 to 63 V: 500 hours U_R 100 and 200 V: 100 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit
Reverse voltage	IEC 384-4-1/ CECC 30 301 sub clause 4.15	T_{amb} = 125 °C: 125 hours at U = –1 V followed by 125 hours at U_R	ΔC/C ±20% tan δ ≤spec. limit I_{L5} ≤spec. limit

Non-solid Al - electrolytic capacitors Axial High Temperature, DIN-based

AHT-DIN 119

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case sizes 10 x 30 to 21 x 40 with safety vent
- Taped versions up to 15 x 30 available for automatic insertion
- Charge and discharge proof
- Extra long useful life: 4000 hours at 125 °C, high stability, high reliability
- Extended temperature range: 125 °C (usable up to 150 °C)
- High ripple current capability.

APPLICATIONS

- Military, industrial control, EDP and telecommunication
- Smoothing, filtering, buffering in SMPS; coupling, decoupling
- For use after very long storage (10 years), without voltage
- Low mounting height boards, vibration and shock resistant.

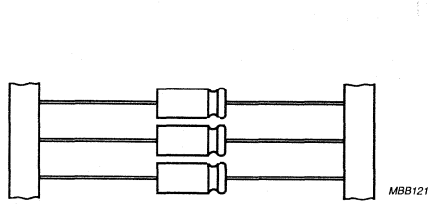


Fig.1 Component outlines.

5

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	6.5 x 18 to 10 x 25	10 x 30 to 21 x 40
Rated capacitance range, C_R	1 to 4700 µF	
Tolerance on C_R	−10/+50%	
Rated voltage range, U_R	10 to 200 V	
Category temperature range	−55 to +125 °C	
Endurance test at 150 °C	500 hours	1000 hours
Endurance test at 125 °C	2000 hours	4000 hours
Useful life at 125 °C	4000 hours	4000 hours
Useful life at 40 °C, 1.8 I_R applied	500 000 hours	500 000 hours
Shelf life at 0 V, 125 °C 10 to 63 V types 100 and 200 V types	500 hours 100 hours	
Basic specification	IEC 384-4/CECC 30 301, LL grade	
Detail specification	similar to DIN 41257	
Climatic category IEC 68 DIN 40040	55/125/56 FKD	
Approvals	CECC 30 301-055 (values ≥4.7 µF)	CECC 30 301-802 (axial version 10 to 63 V types)

Non-solid Al - electrolytic capacitors
Axial High Temperature, DIN-based

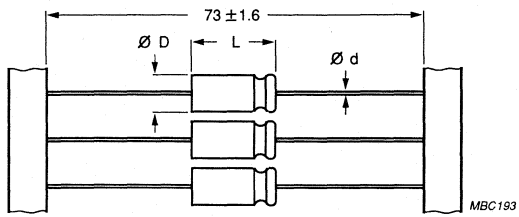
AHT-DIN 119

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**) * = preferred values

C_R (μF)	U_R (V)						
	10	**16**	**25**	**40**	**63**	**100**	**200**
1.0					6.5 x 18 *		
2.2					6.5 x 18 *		
4.7					6.5 x 18 *	6.5 x 18*	10 x 18 *
10					6.5 x 18 *	8 x 18*	10 x 25 *
15				6.5 x 18	8 x 18	10 x 18	
22			6.5 x 18 *		8 x 18 *	10 x 18 *	
33				8 x 18	10 x 18		
47		6.5 x 18 *		8 x 18 *	10 x 18 *	10 x 25 * 10 x 30 *	
68				10 x 18	10 x 25 10 x 30	12.5 x 30	
100	6.5 x 18 *	8 x 18 *	10 x 18 *	10 x 25 *	10 x 30 *	15 x 30 *	
150		10 x 18	10 x 25	12.5 x 30	15 x 30	15 x 30	
220	10 x 18 *	10 x 25 *	10 x 25 * 12.5 x 30 *	12.5 x 30 *	15 x 30 *	18 x 30 *	
330	10 x 25 *	12.5 x 30 *	12.5 x 30 *	15 x 30 *	18 x 30 *	18 x 40 *	
470	10 x 25 * 12.5 x 30 *	12.5 x 30 *	12.5 x 30 *	15 x 30 *	18 x 40 *	21 x 40 *	
680	12.5 x 30 *	15 x 30 *	18 x 30 *	18 x 30 *	21 x 40 *		
1000	15 x 30 *	15 x 30 *	18 x 30 *	18 x 40 *	21 x 40 *		
1500	18 x 30 *	18 x 30 *	18 x 40 *	21 x 40 *			
2200	18 x 30 *	18 x 40 *	21 x 40 *	21 x 40 *			
3300	18 x 40 *	21 x 40 *					
4700	21 x 40 *	21 x 40 *					

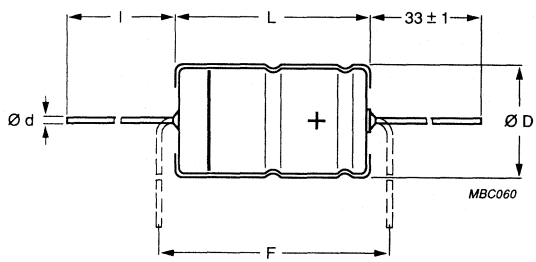
MECHANICAL DATA, PACKING QUANTITIES and AVAILABLE FORMS

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING",



Form BR: Taped on reel, case sizes 6.5 x 18 to 15 x 30.
Form BA: Taped in box (ammopack), case sizes 6.5 x 18 to 10 x 25.

Fig.2 Case sizes 6.5 x 18 to 15 x 30.



Form AA: Axial in box.

Fig.3 Case sizes 10 x 30 to 21 x 40.

5

Non-solid Al - electrolytic capacitors
Axial High Temperature, DIN-based

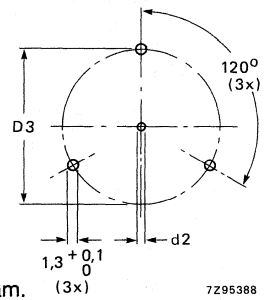
AHT-DIN 119

Table 2 Axial, dimensions in mm; mass in g

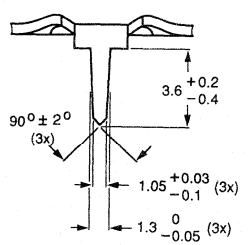
CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	AXIAL: Form AA, BA, and BR					APPROX. MASS	PACKING QUANTITIES		
		∅d	l	∅D_{max}	L_{max}	F_{min}		Form AA	Form BA	Form BR
6.5 x 18	4	0.8	–	6.9	18.5	25	1.3	–	1000	1000
8 x 18	5	0.8	–	8.5	18.5	25	1.7	–	500	500
10 x 18	6	0.8	–	10.5	18.5	25	2.5	–	500	500
10 x 25	7	0.8	–	10.5	25.0	30	3.3	–	500	500
10 x 30	00	0.8	55 ±1	10.5	30.5	35	4.8	200	–	500
12.5 x 30	01	0.8	55 ±1	13.0	30.5	35	7.4	200	–	400
15 x 30	02	0.8	55 ±1	15.5	30.5	35	11.7	200	–	250
18 x 30	03	0.8	55 ±1	18.5	30.5	35	12.9	200	–	–
18 x 40 (note 1)	04	0.8	34 ±1	18.5	41.5	45	19.4	100	–	–
21 x 40 (note 1)	05	0.8	34 ±1	21.5	41.5	45	24.7	100	–	–

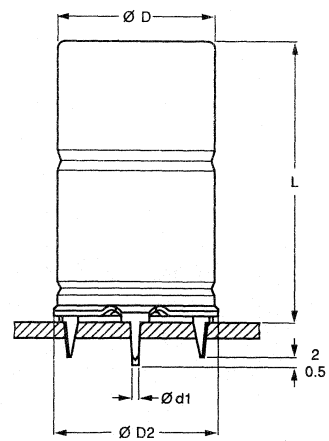
Note

1. For case sizes 18 x 40 and 21 x 40, the stated L_{max} may be exceeded by 0.7 mm.



Piercing diagram.





Form MR: case not insulated (insulation on request).
Especially for applications with severe shocks and vibrations .
For dimensions see Table 3.

MBA710

Fig.4 Case sizes 15 x 30 to 21 x 40, single ended with mounting ring and pins.

Table 3 Single ended, dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	CASE CODE	SINGLE ENDED WITH MOUNTING RING: Form MR						APPROX. MASS	PACKING QUANTITIES
		∅d_1	∅d_2	∅D_{max}	∅$D2_{max}$	D3	L_{max}		
15 x 30	02	0.8	1.0 +0.1	15.5	17.5	16.5 ±0.2	33	8.6	200
18 x 30	03	0.8	1.0 +0.1	18.5	19.5	18.5 ±0.2	33	11.5	200
18 x 40	04	1.0	1.3 +0.1	18.5	19.5	18.5 ±0.2	45	14.5	100
21 x 40	05	1.0	1.3 +0.1	21.5	22.5	21.5 ±0.2	45	19.7	100

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz, tolerance −10/+50%
I_R = rated RMS ripple current at 100 Hz, 125 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z = max. impedance at 10 kHz.

Table 4 Electrical data

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
10	100	6.5 x 18	130	10	6	0.2	3.5	2.2
	220	10 x 18	240	17	8.4	0.18	1.3	1.0
	330	10 x 25	320	24	11	0.18	0.87	0.67
	470	10 x 25	380	32	13	0.18	0.61	0.49
	470	12.5 x 30	550	32	13	0.16	0.54	0.38
	680	12.5 x 30	590	45	18	0.20	0.47	0.38
	1000	15 x 30	715	64	24	0.20	0.32	0.24
	1500	18 x 30	945	94	34	0.22	0.23	0.17
	2200	18 x 30	1025	136	48	0.26	0.19	0.17
	3300	18 x 40	1405	202	70	0.27	0.13	0.10
	4700	21 x 40	1700	286	90	0.30	0.10	0.09
16	47	6.5 x 18	110	10	5.5	0.13	4.4	2.2
	100	8 x 18	170	14	7.2	0.13	2.1	1.3
	150	10 x 18	230	18	8.8	0.13	1.4	1.0
	220	10 x 25	300	25	11	0.13	0.94	0.55
	330	12.5 x 30	510	36	15	0.13	0.63	0.38
	470	12.5 x 30	565	50	19	0.15	0.51	0.38
	680	15 x 30	680	69	26	0.15	0.35	0.24
	1000	15 x 30	735	100	36	0.19	0.30	0.24
	1500	18 x 30	970	148	52	0.20	0.21	0.17
	2200	18 x 40	1310	215	74	0.20	0.14	0.10
	3300	21 x 40	1650	321	110	0.22	0.11	0.09
	4700	21 x 40	1700	455	154	0.28	0.09	0.09

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor AHT-DIN 119
470 µF/16 V, −10/+50%
Case size 12.5 x 30; Form BR
Catalogue number: 2222 119 25471.

Table 5 Ordering Information

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
10	100	6.5 x 18	4	–	119 24101	119 34101	–
	220	10 x 18	6	–	119 24221	119 34221	–
	330	10 x 25	7	–	119 24331	119 34331	–
	470	10 x 25	7	–	119 90501	119 90502	–
	470	12.5 x 30	01	119 14471	119 24471	–	–
	680	12.5 x 30	01	119 14681	119 24681	–	–
	1000	15 x 30	02	119 14102	119 24102	–	119 44102
	1500	18 x 30	03	119 14152	–	–	119 44152
	2200	18 x 30	03	119 14222	–	–	119 44222
	3300	18 x 40	04	119 14332	–	–	119 44332
	4700	21 x 40	05	119 14472	–	–	119 44472
16	47	6.5 x 18	4	–	119 25479	119 35479	–
	100	8 x 18	5	–	119 25101	119 35101	–
	150	10 x 18	6	–	119 25151	119 35151	–
	220	10 x 25	7	–	119 25221	119 35221	–
	330	12.5 x 30	01	119 15331	119 25331	–	–
	470	12.5 x 30	01	119 15471	119 25471	–	–
	680	15 x 30	02	119 15681	119 25681	–	119 45681
	1000	15 x 30	02	119 15102	119 25102	–	119 45102
	1500	18 x 30	03	119 15152	–	–	119 45152
	2200	18 x 40	04	119 15222	–	–	119 45222
	3300	21 x 40	05	119 15332	–	–	119 45332
	4700	21 x 40	05	119 15472	–	–	119 45472

Non-solid Al - electrolytic capacitors
Axial High Temperature, DIN-based

AHT-DIN 119

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
25	22	6.5 x 18	85	10	5.1	0.10	7.2	3.2
	100	10 x 18	210	19	9	0.10	1.6	1.0
	150	10 x 25	290	26	12	0.10	1.1	0.70
	220	10 x 25	350	37	15	0.10	0.72	0.58
	220	12.5 x 30	500	37	15	0.09	0.65	0.38
	330	12.5 x 30	555	54	21	0.11	0.53	0.38
	470	12.5 x 30	610	75	28	0.13	0.44	0.38
	680	18 x 30	810	106	38	0.13	0.30	0.17
	1000	18 x 30	980	154	54	0.13	0.21	0.17
	1500	18 x 40	1345	229	79	0.13	0.14	0.10
	2200	21 x 40	1640	334	114	0.13	0.11	0.09
40	15	6.5 x 18	78	10	5.2	0.08	8.5	5.0
	33	8 x 18	130	12	6.6	0.08	3.9	2.1
	47	8 x 18	150	15	7.8	0.08	2.7	1.5
	68	10 x 18	200	20	9.4	0.08	1.9	1.0
	100	10 x 25	260	28	12	0.08	1.3	0.7
	150	12.5 x 30	440	40	16	0.08	0.85	0.51
	220	12.5 x 30	500	57	22	0.09	0.65	0.48
	330	15 x 30	615	83	30	0.09	0.43	0.37
	470	15 x 30	630	117	42	0.12	0.41	0.37
	680	18 x 30	845	167	58	0.12	0.28	0.22
	1000	18 x 40	1140	244	84	0.12	0.19	0.14
	1500	21 x 40	1400	364	124	0.14	0.15	0.12
	2200	21 x 40	1490	532	180	0.18	0.13	0.11

Non-solid Al - electrolytic capacitors
Axial High Temperature, DIN-based

AHT-DIN 119

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
25	22	6.5 x 18	4	–	119 26229	119 36229	–
	100	10 x 18	6	–	119 26101	119 36101	–
	150	10 x 25	7	–	119 26151	119 36151	–
	220	10 x 25	7	–	119 90503	119 90504	–
	220	12.5 x 30	01	119 16221	119 26221	–	–
	330	12.5 x 30	01	119 16331	119 26331	–	–
	470	12.5 x 30	01	119 16471	119 26471	–	–
	680	18 x 30	03	119 16681	–	–	119 46681
	1000	18 x 30	03	119 16102	–	–	119 46102
	1500	18 x 40	04	119 16152	–	–	119 46152
	2200	21 x 40	05	119 16222	–	–	119 46222
40	15	6.5 x 18	4	–	119 27159	119 37159	–
	33	8 x 18	5	–	119 27339	119 37339	–
	47	8 x 18	5	–	119 27479	119 37479	–
	68	10 x 18	6	–	119 27689	119 37689	–
	100	10 x 25	7	–	119 27101	119 37101	–
	150	12.5 x 30	01	119 17151	119 27151	–	–
	220	12.5 x 30	01	119 17221	119 27221	–	–
	330	15 x 30	02	119 17331	119 27331	–	119 47331
	470	15 x 30	02	119 17471	119 27471	–	119 47471
	680	18 x 30	03	119 17681	–	–	119 47681
	1000	18 x 40	04	119 17102	–	–	119 47102
	1500	21 x 40	05	119 17152	–	–	119 47152
	2200	21 x 40	05	119 17222	–	–	119 47222

Non-solid Al - electrolytic capacitors
Axial High Temperature, DIN-based

AHT-DIN 119

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
63	1.0	6.5 x 18	12	20	4.1	0.07	110	22.0
	2.2	6.5 x 18	25	20	4.3	0.07	51	15.0
	4.7	6.5 x 18	47	20	4.6	0.07	24	9.0
	10	6.5 x 18	68	20	5.3	0.07	11	5.6
	15	8 x 18	91	20	5.9	0.07	7.4	3.7
	22	8 x 18	110	20	6.7	0.07	5.1	2.8
	33	10 x 18	150	20	8.2	0.07	3.4	1.7
	47	10 x 18	180	22	9.9	0.07	2.4	1.3
	68	10 x 25	230	30	13	0.07	1.6	1.0
	68	10 x 30	250	30	13	0.07	1.6	0.92
	100	10 x 30	285	42	17	0.08	1.3	0.75
	150	15 x 30	440	61	23	0.08	0.85	0.37
	220	15 x 30	530	87	32	0.08	0.58	0.37
	330	18 x 30	680	129	46	0.09	0.43	0.23
	470	18 x 40	905	182	63	0.09	0.30	0.15
	680	21 x 40	1175	261	90	0.09	0.21	0.12
	1000	21 x 40	1385	382	130	0.10	0.16	0.11
100	4.7	6.5 x 18	44	20	10	0.08	27	10
	10	8 x 18	70	20	10	0.08	13	6.0
	15	10 x 18	93	20	10	0.08	8.5	5.0
	22	10 x 18	112	20	10	0.08	5.8	3.5
	47	10 x 25	178	32	13	0.08	2.7	2.0
	47	10 x 30	178	32	13	0.08	2.7	2.0
	68	12.5 x 30	278	45	18	0.08	1.9	1.2
	100	15 x 30	365	64	24	0.09	1.4	0.96
	150	15 x 30	368	94	34	0.10	1.1	0.78
	220	18 x 30	481	136	48	0.10	0.72	0.55
	330	18 x 40	694	202	70	0.10	0.48	0.37
	470	21 x 40	833	266	98	0.10	0.34	0.28
200	4.7	10 x 18	52	20	10	0.08	27	10
	10	10 x 25	82	20	10	0.08	13	5.0

Non-solid Al - electrolytic capacitors
Axial High Temperature, DIN-based

AHT-DIN 119

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX Form AA	TAPED ON REEL Form BR	TAPED IN BOX Form BA	MOUNTING RING Form MR
63	1.0	6.5 x 18	4	–	119 28108	119 38108	–
	2.2	6.5 x 18	4	–	119 28228	119 38228	–
	4.7	6.5 x 18	4	–	119 28478	119 38478	–
	10	6.5 x 18	4	–	119 28109	119 38109	–
	15	8 x 18	5	–	119 28159	119 38159	–
	22	8 x 18	5	–	119 28229	119 38229	–
	33	10 x 18	6	–	119 28339	119 38339	–
	47	10 x 18	6	–	119 28479	119 38479	–
	68	10 x 25	7	–	119 90505	119 90506	–
	68	10 x 30	00	119 18689	119 28689	–	–
	100	10 x 30	00	119 18101	119 28101	–	–
	150	15 x 30	02	119 18151	119 28151	–	119 48151
	220	15 x 30	02	119 18221	119 28221	–	119 48221
	330	18 x 30	03	119 18331	–	–	119 48331
	470	18 x 40	04	119 18471	–	–	119 48471
	680	21 x 40	05	119 18681	–	–	119 48681
	1000	21 x 40	05	119 18102	–	–	119 48102
100	4.7	6.5 x 18	4	–	119 29478	119 39478	–
	10	8 x 18	5	–	119 29109	119 39109	–
	15	10 x 18	6	–	119 29159	119 39159	–
	22	10 x 18	6	–	119 29229	119 39229	–
	47	10 x 25	7	–	119 90518	119 90519	–
	47	10 x 30	00	119 19479	119 29479	–	–
	68	12.5 x 30	01	119 19689	119 29689	–	–
	100	15 x 30	02	119 19101	119 29101	–	119 49101
	150	15 x 30	02	119 19151	119 29151	–	119 49151
	220	18 x 30	03	119 19221	–	–	119 49221
	330	18 x 40	04	119 19331	–	–	119 49331
	470	21 x 40	05	119 19471	–	–	119 49471
200	4.7	10 x 18	6	–	119 90507	119 90508	–
	10	10 x 25	7	–	119 90509	119 90511	–

Voltage

Surge voltage for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Note

For applications at ambient temperatures of ≤85 °C, the rated voltage (U_R) may be raised to U_{R2} in accordance with Table 6.

Table 6 Uprating values at reduced ambient temperature

U_R at T_{amb} 85 to 125 °C	10 V	16 V	25 V	40 V	63 V	100 V	200 V
U_{R2} at T_{amb} ≤85 °C	16 V	25 V	40 V	63 V	100 V	125 V	250 V

Leakage current

After 1 minute at U_R

10 to 40 V	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$, or 10 µA (whichever is greater)
63 to 200 V	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$, or 20 µA (whichever is greater)

After 5 minutes at U_R

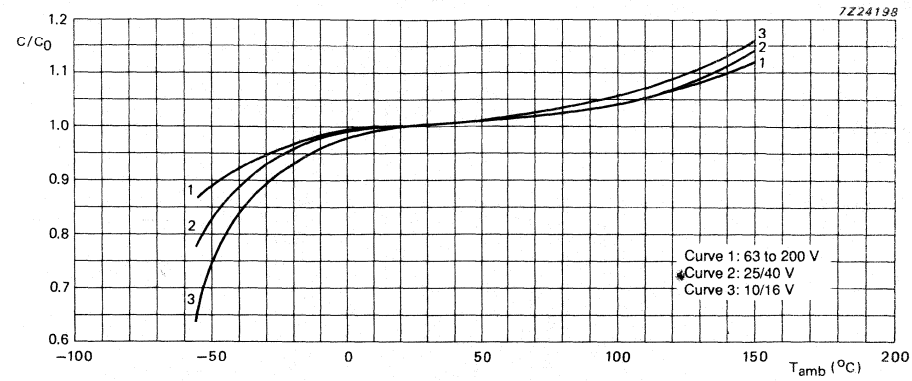
10 to 63 V	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$
100 and 200 V	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$, or 10 µA (whichever is greater)

Marking

The capacitors are marked (where possible) with the following information:

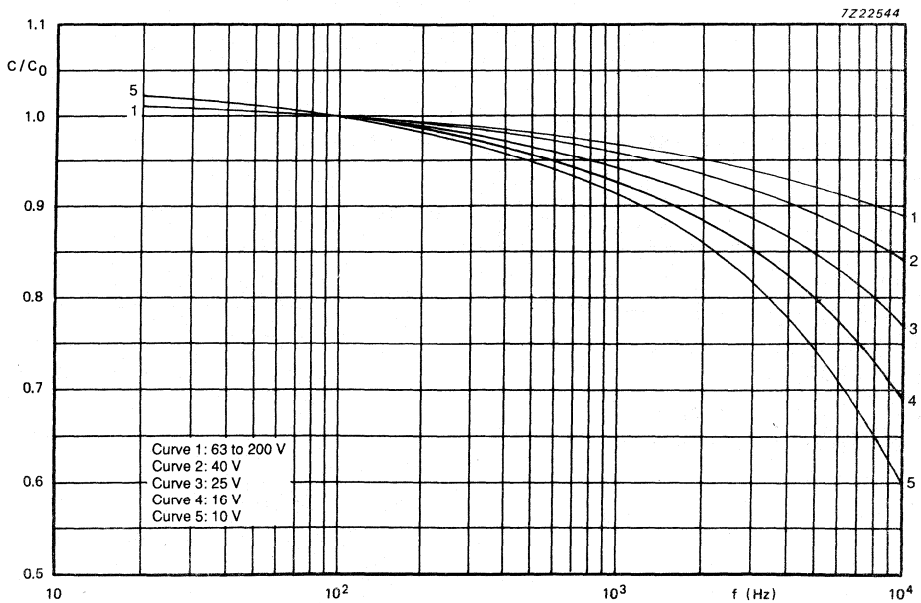
- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62
- Rated voltage in V (at 125 °C and at 85 °C)
- Group number (119)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with IEC 62
- Code indicating factory of origin
- Band to identify the negative terminal
- "+" - signs to identify the positive terminal.

Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

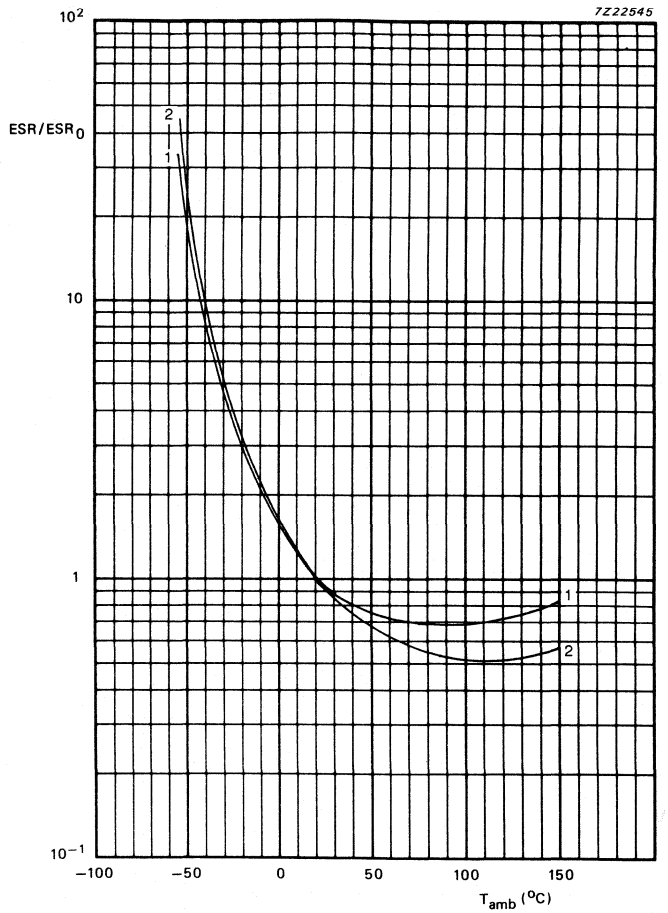
Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



C_0 = capacitance at 20 °C; 100 Hz.

Fig.6 Multiplier of capacitance (C/C_0) as a function of frequency.

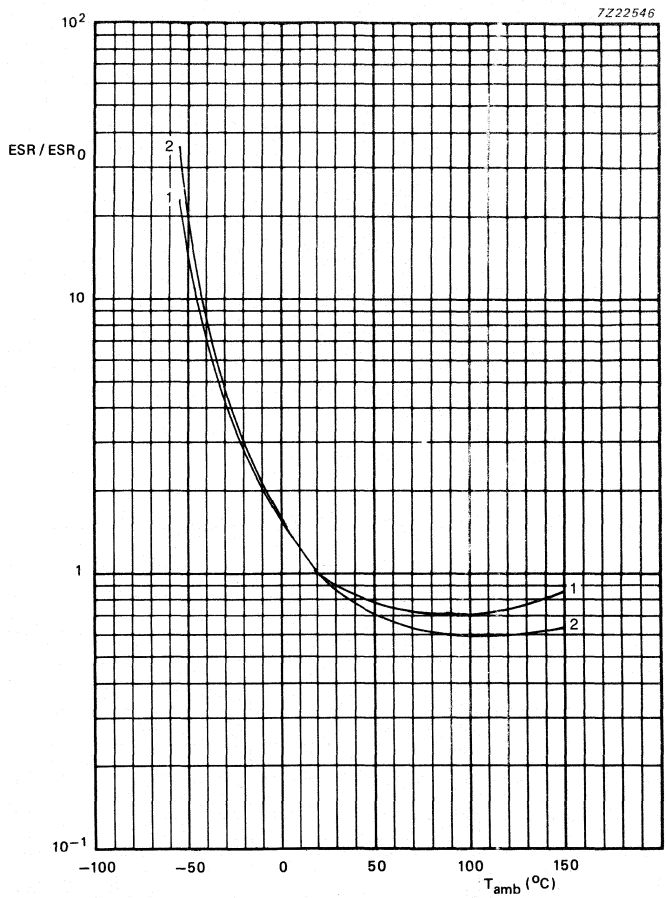
Equivalent series resistance (ESR)



Curve 1: 25 to 200 V
Curve 2: 10 and 16 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

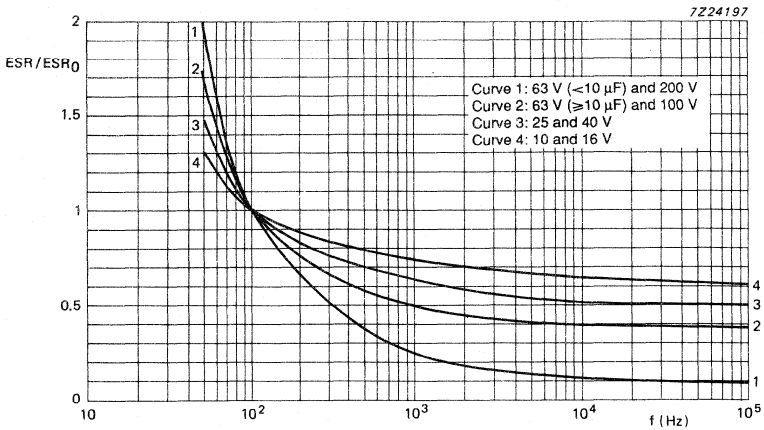
Fig.7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 6.5 x 18 to 15 x 30 mm.



Curve 1: 25 to 100 V
Curve 2: 10 and 16 V.

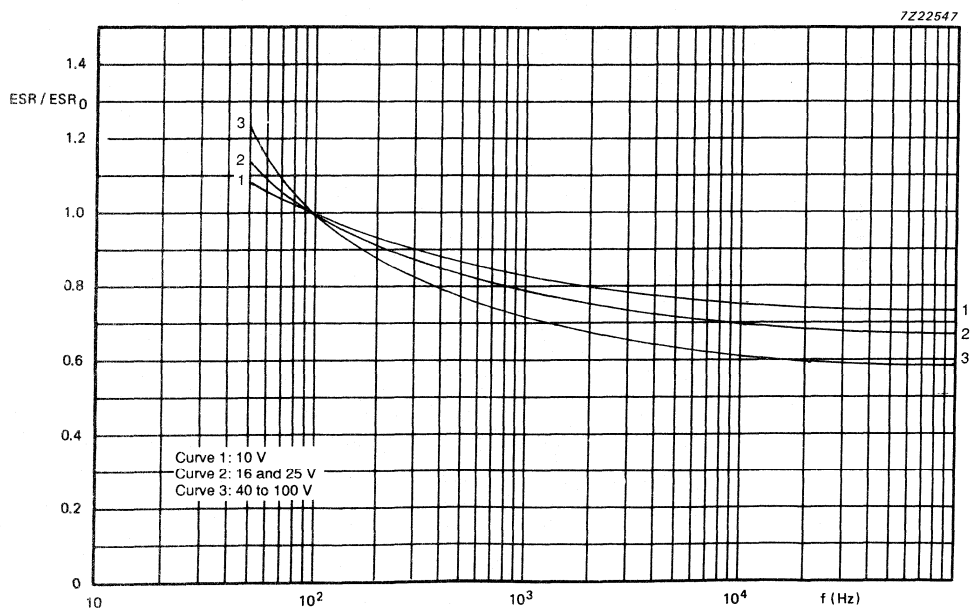
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.8 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 18 x 30 mm to 21 x 40 mm.



ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of frequency; case sizes 6.5 x 18 to 10 x 25 mm.



ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.10 Multiplier of ESR (ESR/ESR_0) as a function of frequency; case sizes 10 x 30 to 21 x 40 mm.

Equivalent series inductance (ESL)

Table 7 Equivalent series inductance, typical values

CASE SIZE ∅ x L (mm)	AXIAL (nH)	SINGLE ENDED (nH)
6.5 x 18	15	–
8 x 18	35	–
10 x 18	69	–
10 x 25	38	–
10 x 30	38	–
12.5 x 30	46	–
15 x 30	48	39
18 x 30	50	39
18 x 40	54	39
21 x 40	59	39

Impedance (Z)

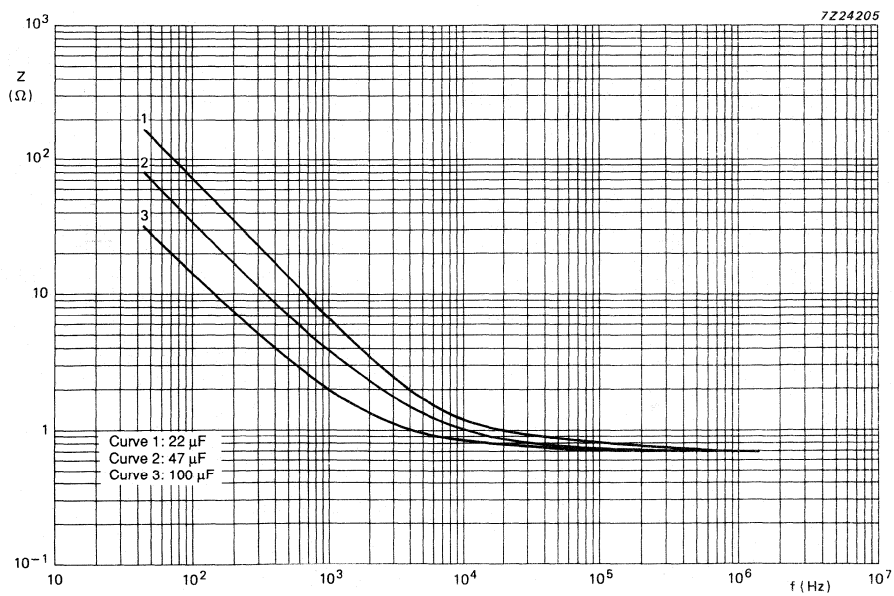


Fig.11 Typical impedance as a function of frequency at 20 °C; case size 8 x 18.

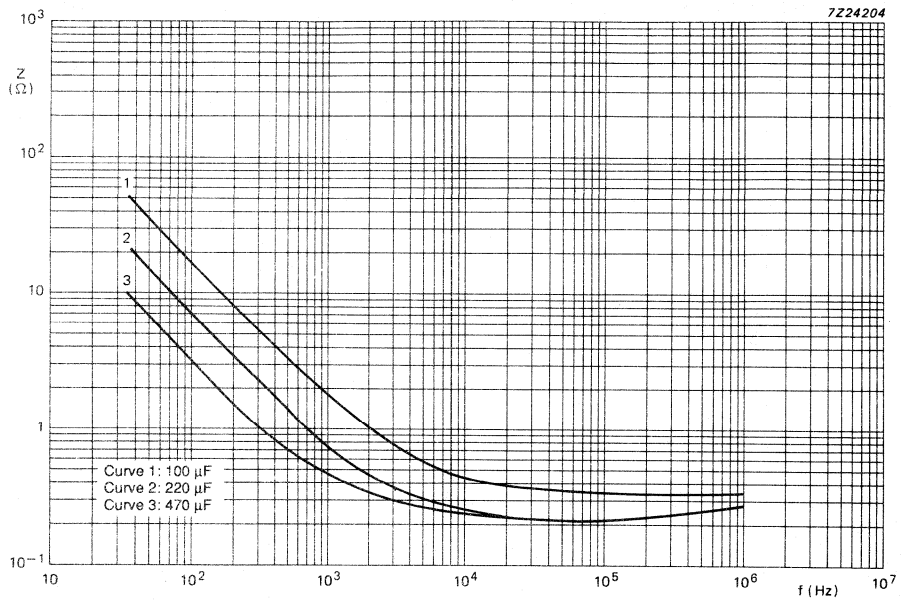


Fig.12 Typical impedance as a function of frequency at 20 °C; case size 10 x 25.

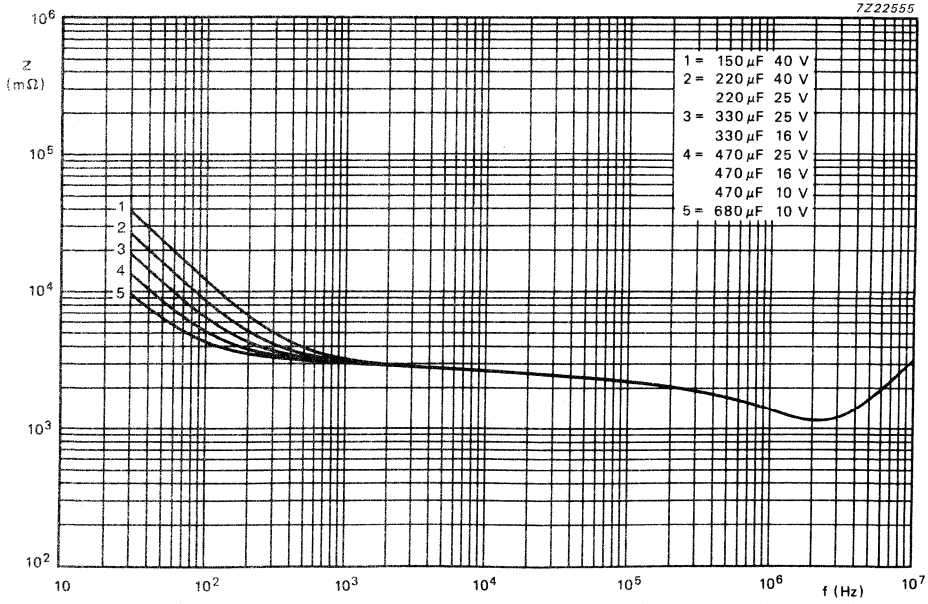


Fig.13 Typical impedance as a function of frequency at –40 °C; case size 12.5 x 30.

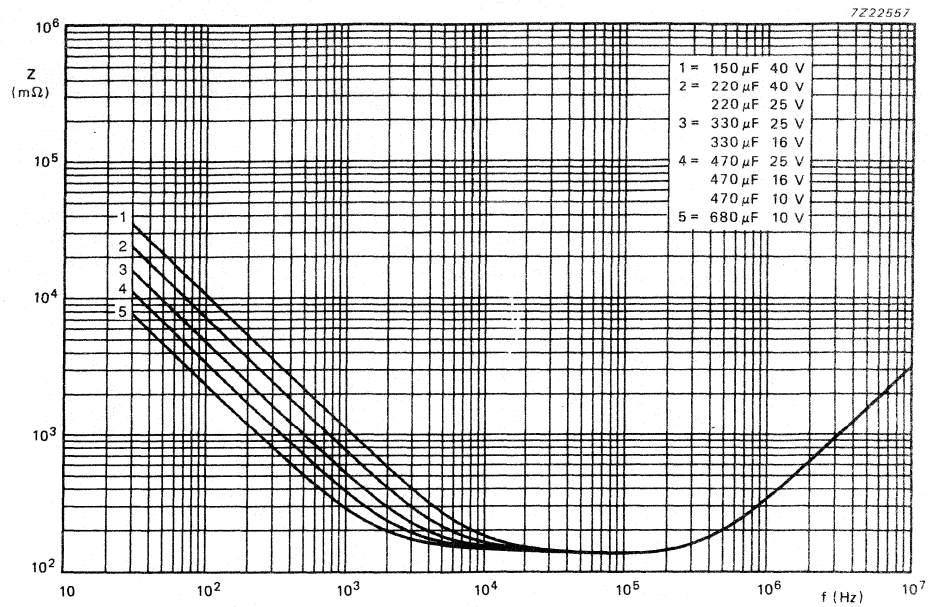


Fig.14 Typical impedance as a function of frequency at 20 °C; case size 12.5 x 30.

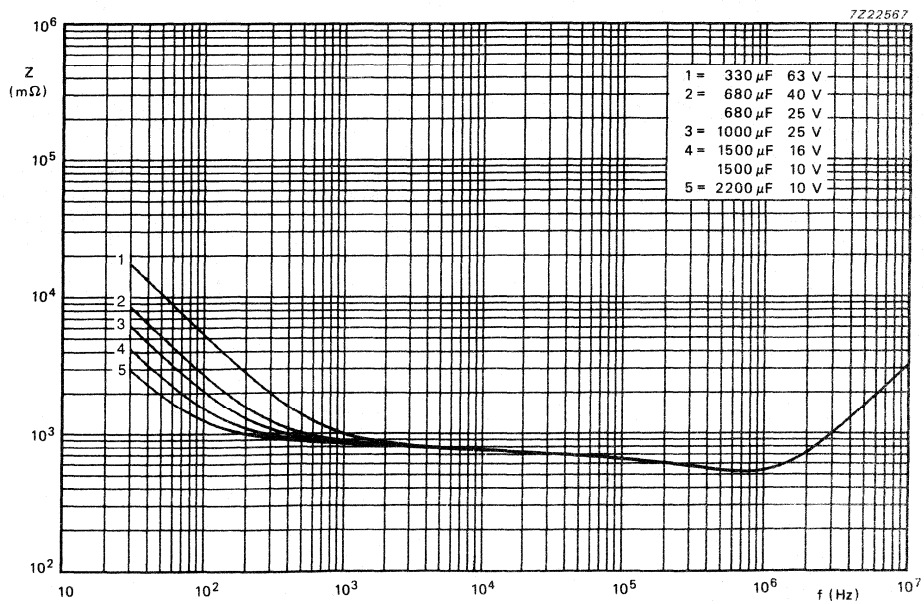


Fig.15 Typical impedance as a function of frequency at –40 °C; case size 18 x 30.

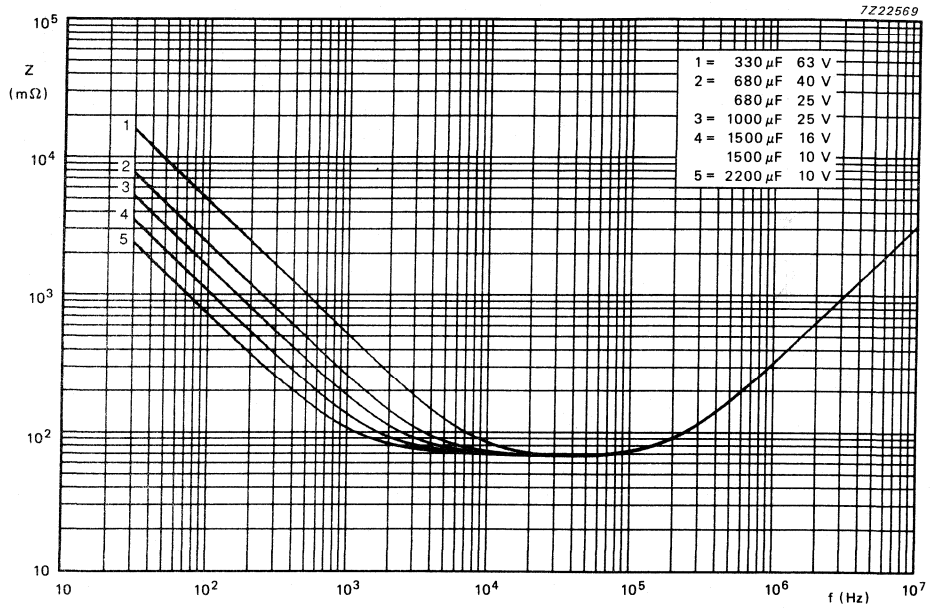


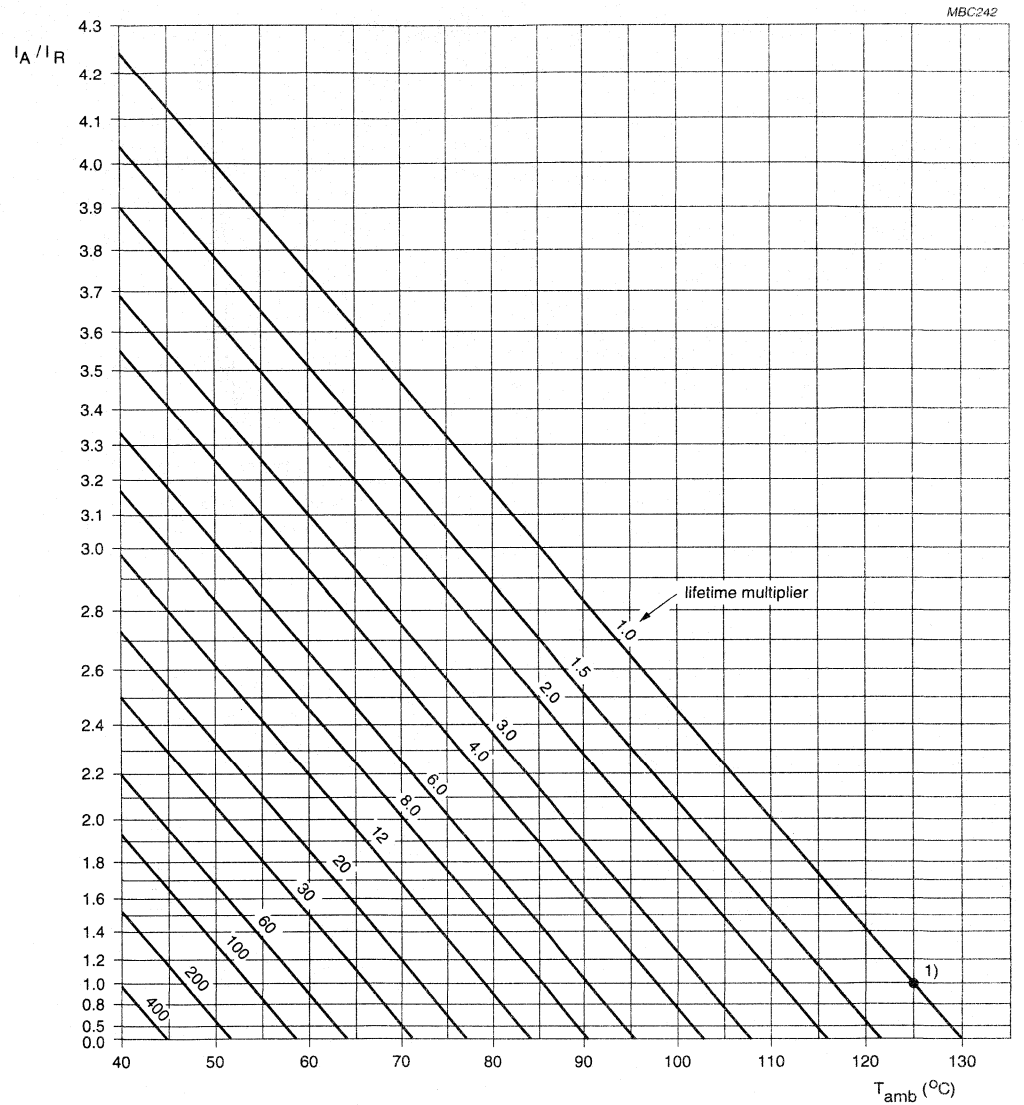
Fig.16 Typical impedance as a function of frequency at 20 °C; case size 18 x 30.

5

RIPPLE CURRENT and USEFUL LIFE

Table 8 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 125 °C, 100 Hz.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10 and 16 V	U_R = 25 and 40 V	U_R = 63 to 200 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥10 000	1.2	1.3	1.4



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz, 125 °C.

1) Useful life at 125 °C and I_R applied: 4000 hours.

Fig.17 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

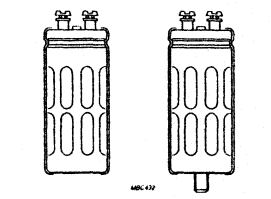
SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 9

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C 3, 4.13	T_{amb} = 125 °C, U_R applied case sizes: 6.5 x 18 to 10 x 25: 2000 hours 10 x 30 to 21 x 40: 4000 hours	ΔC/C ±15% tan δ ≤1.3 x spec. limit Z ≤2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 125 °C, U_R and I_R applied 4000 hours	ΔC/C ±45% tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (Storage at high temp.)	IEC 384-4-1/ CECC 30 301 group C 5a, 4.17	T_{amb} = 125 °C, no voltage applied U_R 10 to 63 V: 500 hours U_R 100 and 200 V: 100 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see Endurance test above I_{L5} ≤2 x spec. limit
Reverse voltage	IEC 384-4-1/ CECC 30 301 sub clause 4.15	T_{amb} = 125 °C: 125 hours at U = −1 V followed by 125 hours at U_R	ΔC/C ±20% tan δ ≤spec. limit I_{L5} ≤spec. limit

POWER ELECTROLYTIC CAPACITORS



MINIATURE	*ECONOMY*	*EURO-DIN*	*LONG-LIFE*
10 000 hours	12 000 hours	15-20 000 hours	5-10 000 hours
85 °C	85 °C	85 °C	105 °C
	PEC-ST **PEC-STB** **154-155** *Page 718*	**PED-ST** **PED-STB** **114-115** *Page 728*	
PSM-PW on request *Page 606*	**PEC-PW** **PEC-SL** **PEC-SLB** **051-053** *Page 662*	**PED-PW** **PED-SL** **PED-SLB** **050-052** *Page 682*	**PLL-PW** **PLL-SL** **PLL-SLB** **162-163** *Page 704*
PSM-SI **056-057** *Page 606*	**PEC-SI** **054-055** Maintenance *Page 626*		**PLL-SI** **058-059** *Page 642*

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

PSM-SI 056/057

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Safety vent in the bottom of the aluminium case
- Charge and discharge proof
- Long useful life: 10 000 hours/85 °C
- High ripple current capability.

APPLICATIONS

- General purpose, industrial and audio/video systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.

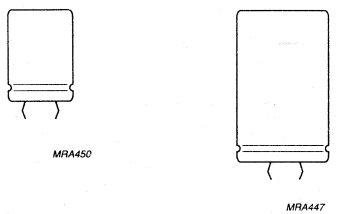


Fig.1 Component outlines.

QUICK REFERENCE DATA

	056	057
Case size ($\varnothing D_{nom}$ x L_{nom} in mm)	22 x 25 to 35 x 50	
Rated capacitance range (E6/E12 series), C_R	47 to 68 000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	10 V to 100 V	200 V to 450 V
Category temperature range	–40 to +85 °C	
Endurance test at 85 °C	5000 hours	
Useful life at 85 °C	10 000 hours	
Useful life at U_R, 40 °C and 1.4 x I_R applied	175 000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Basic specifications	IEC 384-4-1, CECC 30 301, LL grade	
Climatic category IEC 68 DIN 40040	40/085/56 GPF	

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**∅D x L in mm**) for 056 series

C_R (µF)	U_R (V)							
	10	**16**	**25**	**35**	**40**	**50**	**63**	**100**
470								22 x 25
680								22 x 30
1000							22 x 25	25 x 30 22 x 40
1500						22 x 25	22 x 30	30 x 30 25 x 40
2200				22 x 25	22 x 25	22 x 30	25 x 30 22 x 40	30 x 40 25 x 50
3300			22 x 25	22 x 30	22 x 30	25 x 30 22 x 40	30 x 30 25 x 40	35 x 40 30 x 50
4700		22 x 25	22 x 30	25 x 30 22 x 40	25 x 30 22 x 40	30 x 30 25 x 40	30 x 40 25 x 50	35 x 50
6800	22 x 25	22 x 30	25 x 30 22 x 40	30 x 30 25 x 40	30 x 30 25 x 40	30 x 40 25 x 50	35 x 40 30 x 50	
10 000	22 x 30	25 x 30 22 x 40	30 x 30 25 x 40	30 x 40 25 x 50	30 x 40 25 x 50	35 x 40 30 x 50	35 x 50	
15 000	25 x 30 22 x 40	30 x 30 25 x 40	30 x 40 25 x 50	35 x 40 30 x 50	35 x 40 30 x 50	35 x 50		
22 000	30 x 30 25 x 40	30 x 40 25 x 50	35 x 40 30 x 50	35 x 50	35 x 50			
33 000	30 x 40 25 x 50	35 x 40 30 x 50	35 x 50					
47 000	35 x 40 30 x 50	35 x 50						
68 000	35 x 50							

Table 2 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD x L** in **mm**) for 057 series

C_R (µF)	U_R (V)				
	200	**250**	**385**	**400**	**450**
47			22 x 25	22 x 25	22 x 25
68			22 x 30	22 x 30	22 x 30
82					22 x 35
100		22 x 25	25 x 30 22 x 40 22 x 35	25 x 30 22 x 40 22 x 35	30 x 30 22 x 40 25 x 35
120			25 x 35	25 x 35	25 x 40
150	22 x 25	22 x 30	30 x 30 25 x 40	30 x 30 25 x 40	30 x 40 25 x 50 25 x 45 30 x 35
180		22 x 35	25 x 45	25 x 45	35 x 30
220	22 x 30	25 x 30 22 x 40	30 x 40 25 x 50 30 x 35	30 x 40 25 x 50 30 x 35 35 x 30	35 x 40 30 x 50 30 x 45 35 x 35
270	22 x 35	25 x 35	35 x 30	30 x 45 35 x 35	
330	25 x 30 22 x 40	30 x 30 25 x 40	35 x 40 30 x 50 30 x 45 35 x 35	35 x 40 30 x 50	35 x 50 35 x 45
390	25 x 35	25 x 45 30 x 35		35 x 45	
470	30 x 30 25 x 40	30 x 40 25 x 50 35 x 30	35 x 50 35 x 45	35 x 50	
560	25 x 45 30 x 35	35 x 35 30 x 45			
680	30 x 40 25 x 50 35 x 30	35 x 40 30 x 50			
820	30 x 45 35 x 35	35 x 45			
1000	35 x 40 30 x 50	35 x 50			
1200	35 x 45				
1500	35 x 50				

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

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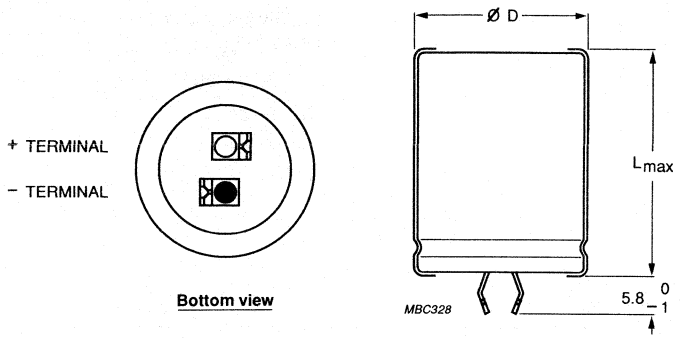
MECHANICAL DATA and PACKING QUANTITIES

Dimensions in mm.



The minus terminal can be marked with a black dot or with an imprinted minus sign.

Fig.2 Snap-in.

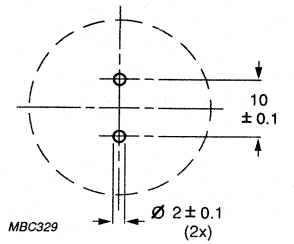


Fig.3 Piercing diagram.

Table 3 Dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE				
22 x 25	2225	23	27	12	100
22 x 30	2230	23	32	16	100
22 x 35	2235	23	37	20	100
22 x 40	2240	23	42	23	100
25 x 30	2530	26.5	32	22	100
25 x 35	2535	26.5	37	24	100
25 x 40	2540	26.5	42	27	100
25 x 45	2545	26.5	47	32	100
25 x 50	2550	26.5	52	38	100
30 x 30	3030	31.5	32	30	100
30 x 35	3035	31.5	37	35	100
30 x 40	3040	31.5	42	40	100
30 x 45	3045	31.5	47	45	100
30 x 50	3050	31.5	52	50	100
35 x 30	3530	36.5	32	40	50
35 x 35	3535	36.5	37	48	50
35 x 40	3540	36.5	42	55	50
35 x 45	3545	36.5	47	63	50
35 x 50	3550	36.5	52	72	50

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 4 and 5 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz
I_R = rated RMS ripple current at 100 Hz, 85 °C
I_{L1} = max. leakage current after 1 minute at U_R
I_{L5} = max. leakage current after 5 minutes at U_R
ESR = max. equivalent series resistance at 100 Hz
Z = max. impedance at 10 kHz.

Ordering Example

Electrolytic capacitors
PSM-SI 056/057
10 000 µF/25 V, ±20%
Case size 25 x 40 mm
Catalogue number:
2222 056 46103.

Table 4 Electrical data and ordering information for 056 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
10	6800	22 x 25	2225	2.04	412	140	76	62	056 54682
	10 000	22 x 30	2230	2.56	608	205	56	45	056 54103
	15 000	25 x 30	2530	3.12	904	304	44	39	056 54153
	15 000	22 x 40	2240	3.39	904	304	41	34	056 44153
	22 000	30 x 30	3030	3.47	1324	444	44	37	056 54223
	22 000	25 x 40	2540	4.12	1324	444	34	28	056 44223
	33 000	30 x 40	3040	4.58	1984	664	32	28	056 54333
	33 000	25 x 50	2550	4.70	1984	664	30	27	056 44333
	47 000	35 x 40	3540	5.10	2824	944	31	26	056 54473
	47 000	30 x 50	3050	5.39	2824	944	28	24	056 44473
	68 000	35 x 50	3550	5.88	4084	1364	28	23	056 54683
16	4700	22 x 25	2225	2.01	455	154	79	62	056 55472
	6800	22 x 30	2230	2.54	657	222	57	45	056 55682
	10 000	25 x 30	2530	3.02	964	324	47	39	056 55103
	10 000	22 x 40	2240	3.28	964	324	44	34	056 45103
	15 000	30 x 30	3030	3.36	1444	484	47	37	056 55153
	15 000	25 x 40	2540	4.00	1444	484	34	28	056 45153
	22 000	30 x 40	3040	4.51	2116	708	33	28	056 55223
	22 000	25 x 50	2550	3.97	2116	708	42	41	056 45223
	33 000	35 x 40	3540	5.02	3172	1060	32	28	056 55333
	33 000	30 x 50	3050	4.75	3172	1060	36	34	056 45333
	47 000	35 x 50	3550	5.34	4516	1508	34	32	056 55473

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

PSM-SI 056/057

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
25	3300	22 x 25	2225	1.88	499	169	89	61	056 56332
	4700	22 x 30	2230	2.37	709	239	65	45	056 56472
	6800	25 x 30	2530	2.81	1024	344	54	41	056 56682
	6800	22 x 40	2240	3.16	1024	344	47	38	056 46682
	10 000	30 x 30	3030	3.25	1504	504	50	38	056 56103
	10 000	25 x 40	2540	3.73	1504	504	39	30	056 46103
	15 000	30 x 40	3040	4.73	2254	754	30	28	056 56153
	15 000	25 x 50	2550	3.92	2254	754	43	39	056 46153
	22 000	35 x 40	3540	4.48	3304	1104	40	28	056 56223
	22 000	30 x 50	3050	4.96	3304	1104	36	23	056 46223
	33 000	35 x 50	3550	4.98	4954	1654	39	33	056 56333
35	2200	22 x 25	2225	1.85	466	158	92	61	056 50222
	3300	22 x 30	2230	2.09	697	235	67	44	056 50332
	4700	25 x 30	2530	2.66	991	333	60	40	056 50472
	4700	22 x 40	2240	3.10	991	333	49	38	056 40472
	6800	30 x 30	3030	3.16	1432	480	53	38	056 50682
	6800	25 x 40	2540	3.44	1432	480	46	30	056 40682
	10 000	30 x 40	3040	4.20	2104	704	38	28	056 50103
	10 000	25 x 50	2550	4.41	2104	704	34	28	056 40103
	15 000	35 x 40	3540	4.32	3154	1054	43	28	056 50153
	15 000	30 x 50	3050	4.75	3154	1054	36	26	056 40153
	22 000	35 x 50	3550	5.33	4624	1544	34	24	056 50223
40	2200	22 x 25	2225	1.85	532	180	92	61	056 57222
	3300	22 x 30	2230	2.09	796	260	67	45	056 57332
	4700	25 x 30	2530	2.28	1132	380	82	70	056 57472
	4700	22 x 40	2240	3.10	1132	380	49	38	056 47472
	6800	30 x 30	3030	3.16	1636	348	53	38	056 57682
	6800	25 x 40	2540	3.06	1636	548	58	50	056 47682
	10 000	30 x 40	3040	4.20	2404	804	38	28	056 57103
	10 000	25 x 50	2550	3.88	2404	804	44	39	056 47103
	15 000	35 x 40	3540	4.05	3604	1204	49	41	056 57153
	15 000	30 x 50	3050	4.45	3604	1204	41	34	056 47153
	22 000	35 x 50	3550	4.86	5284	1764	40	33	056 57223

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

PSM-SI 056/057

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
50	1500	22 x 25	2225	1.36	454	154	170	130	056 51152
	2200	22 x 30	2230	1.75	664	124	120	91	056 51222
	3300	25 x 30	2530	2.17	994	334	90	72	056 51332
	3300	22 x 40	2240	2.42	994	334	80	63	056 41332
	4700	30 x 30	3030	2.65	1414	474	75	63	056 51472
	4700	25 x 40	2540	2.89	1414	474	65	52	056 41472
	6800	30 x 40	3040	3.56	2044	684	53	45	056 51682
	6800	25 x 50	2550	3.75	2044	684	50	43	056 41682
	10 000	35 x 40	3540	4.05	3004	1004	49	42	056 51103
	10 000	30 x 50	3050	4.50	3004	1004	40	35	056 41103
	15 000	35 x 50	3550	4.98	4504	1504	39	33	056 51153
63	1000	22 x 25	2225	1.46	382	130	148	104	056 58102
	1500	22 x 30	2230	1.87	571	193	105	72	056 58152
	2200	25 x 30	2530	2.32	836	281	79	59	056 58222
	2200	22 x 40	2240	2.54	836	281	73	53	056 48222
	3300	30 x 30	3030	2.87	1251	420	64	50	056 58332
	3300	25 x 40	2540	3.14	1251	420	55	44	056 48332
	4700	30 x 40	3040	3.67	1780	596	50	38	056 58472
	4700	25 x 50	2550	3.71	1780	596	48	38	056 48472
	6800	35 x 40	3540	4.33	2574	861	43	38	056 58682
	6800	30 x 50	3050	4.75	2574	861	42	37	056 48682
	10 000	35 x 50	3550	5.26	3784	1264	35	30	056 58103
100	470	22 x 25	2225	0.77	286	98	535	470	056 59471
	680	22 x 30	2230	0.99	412	160	375	328	056 59681
	1000	25 x 30	2530	1.27	604	204	265	235	056 59102
	1000	22 x 40	2240	1.35	604	204	260	225	056 49102
	1500	30 x 30	3030	1.67	904	304	190	170	056 59152
	1500	25 x 40	2540	1.75	904	304	180	160	056 49152
	2200	30 x 40	3040	2.27	1324	444	130	120	056 59222
	2200	25 x 50	2550	2.30	1324	444	125	110	056 49222
	3300	35 x 40	3540	2.84	1984	664	100	95	056 59332
	3300	30 x 50	3050	2.97	1984	664	92	85	056 49332
	4700	35 x 50	3550	3.59	2024	677	75	70	056 59472

Table 5 Electrical data and ordering information for 057 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
200	150	22 x 25	2225	0.77	184	64	950	620	057 52151
	220	22 x 30	2230	1.00	268	92	650	435	057 52221
	270	22 x 35	2235	1.38	328	92	525	380	057 32271
	330	25 x 30	2530	1.36	400	136	430	310	057 52331
	330	22 x 40	2240	1.36	400	136	430	310	057 42331
	390	25 x 35	2535	1.54	472	160	375	280	057 32391
	470	30 x 30	3030	1.80	568	192	310	230	057 52471
	470	25 x 40	2540	1.80	568	192	310	230	057 42471
	560	25 x 45	2545	2.05	676	228	255	220	057 42561
	560	30 x 35	3035	2.05	676	228	255	220	057 62561
	680	30 x 40	3040	2.39	820	276	210	180	057 52681
	680	25 x 50	2550	2.39	820	276	210	180	057 42681
	680	35 x 30	3530	2.33	820	276	210	180	057 62681
	820	30 x 45	3045	2.47	988	332	195	165	057 32821
	820	35 x 35	3535	2.44	988	332	195	165	057 62821
	1000	35 x 40	3540	2.85	1204	404	160	135	057 52102
	1000	30 x 50	3050	2.85	1204	404	160	135	057 42102
	1200	35 x 45	3545	2.98	1444	484	150	130	057 42122
	1500	35 x 50	3550	3.66	1804	604	120	105	057 52152

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

PSM-SI 056/057

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
250	100	22 x 25	2225	0.63	154	54	1440	770	057 53101
	150	22 x 30	2230	0.83	229	79	960	520	057 53151
	180	22 x 35	2235	0.97	274	91	810	450	057 33181
	220	25 x 30	2530	1.10	334	114	660	365	057 53221
	220	22 x 40	2240	1.10	334	114	660	365	057 43221
	270	25 x 35	2535	1.28	409	136	540	325	057 33271
	330	30 x 30	3030	1.49	499	169	440	265	057 53331
	330	25 x 40	2540	1.49	499	169	440	265	057 43331
	390	25 x 45	2545	1.72	590	199	375	225	057 63391
	390	30 x 35	3035	1.74	590	199	375	225	057 33391
	470	30 x 40	3040	1.98	709	239	310	185	057 53471
	470	25 x 50	2550	1.98	709	239	310	185	057 43471
	470	35 x 30	3530	1.95	709	239	310	185	057 63471
	560	30 x 45	3045	2.04	844	284	295	180	057 33561
	560	35 x 35	3535	2.01	844	284	295	180	057 63561
	680	35 x 40	3540	2.60	1024	344	240	145	057 53681
	680	30 x 50	3050	2.60	1024	344	240	145	057 43681
	820	35 x 45	3545	2.70	1234	414	195	128	057 43821
	1000	35 x 50	3550	3.12	1504	504	160	105	057 53102

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

PSM-SI 056/057

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
385	47	22 x 25	2225	0.50	112	40	3000	1400	057 58479
	68	22 x 30	2230	0.63	161	56	2100	1000	057 58689
	100	22 x 35	2235	0.84	235	81	1400	780	057 38101
	100	25 x 30	2530	0.86	235	81	1400	780	057 58101
	100	22 x 40	2240	0.86	235	81	1400	780	057 48101
	120	25 x 35	2535	0.99	281	96	1190	735	057 38121
	150	30 x 30	3030	1.16	350	119	950	520	057 58151
	150	25 x 40	2540	1.16	350	119	950	520	057 48151
	180	25 x 45	2545	1.35	419	143	795	490	057 68181
	220	30 x 35	3035	1.50	512	173	650	400	057 38221
	220	30 x 40	3040	1.57	512	173	650	400	057 58221
	220	25 x 50	2550	1.57	512	173	650	400	057 48221
	270	35 x 30	3530	1.50	627	212	590	340	057 68271
	330	30 x 45	3045	1.75	766	258	480	280	057 38331
	330	35 x 40	3540	2.11	766	258	480	280	057 58331
	330	30 x 50	3050	2.11	766	258	480	280	057 48331
	330	35 x 35	3535	1.73	766	258	480	280	057 68331
	470	35 x 45	3545	2.29	1089	366	340	220	057 48471
	470	35 x 50	3550	2.76	1089	366	340	220	057 58471

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

PSM-SI 056/057

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
400	47	22 x 25	2225	0.50	117	42	3000	1400	057 56479
	68	22 x 30	2230	0.63	167	58	2100	1000	057 56689
	100	22 x 35	2235	0.84	240	84	1400	780	057 36101
	100	25 x 30	2530	0.86	244	84	1400	780	057 56101
	100	22 x 40	2240	0.86	244	84	1400	780	057 46101
	120	25 x 35	2535	0.99	292	100	1190	735	057 36121
	150	30 x 30	3030	1.16	364	124	950	520	057 56151
	150	25 x 40	2540	1.16	364	124	950	520	057 46151
	180	25 x 45	2545	1.35	436	148	795	490	057 66181
	220	30 x 35	3035	1.50	532	180	650	400	057 36221
	220	30 x 40	3040	1.57	532	180	650	400	057 56221
	220	25 x 50	2550	1.57	532	180	650	400	057 46221
	220	35 x 30	3530	1.50	532	180	650	400	057 66221
	270	30 x 45	3045	1.58	652	220	590	340	057 36271
	270	35 x 35	3535	1.56	652	220	590	340	057 66271
	330	35 x 40	3540	2.11	796	268	480	280	057 56331
	330	30 x 50	3050	2.11	796	268	480	280	057 46331
	390	35 x 45	3545	2.08	940	316	410	265	057 46391
	470	35 x 50	3550	2.76	1132	380	340	220	057 56471

Voltage

Surge voltage for short periods
- ≤250 V versions: $U_s = 1.15 \times U_R$
- ≥385 V versions: $U_s = 1.1 \times U_R$

Reverse voltage: $U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R: $I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$

After 5 minutes at U_R: $I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

Equivalent series inductance (ESL)

Typical ESL for all case sizes: 19 nH

Maximum ESL for all case sizes: 25 nH

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

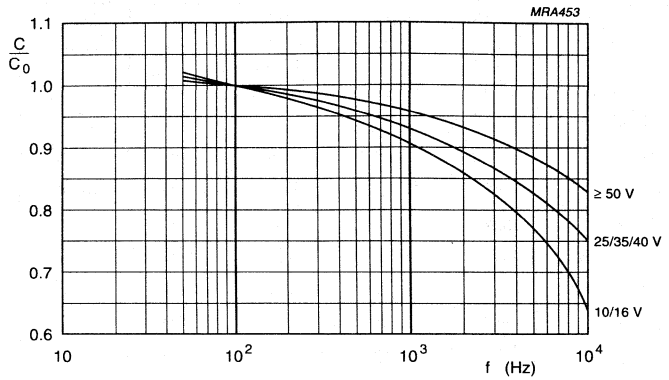
PSM-SI 056/057

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
450	47	22 x 25	2225	0.26	131	45	5600	4400	057 57479
	68	22 x 30	2230	0.33	188	65	3900	3100	057 57689
	82	22 x 35	2235	0.39	225	78	3200	2600	057 37829
	100	25 x 35	2535	0.46	274	94	2600	2100	057 37101
	100	30 x 30	3030	0.48	274	94	2600	2100	057 57101
	100	22 x 40	2240	0.48	274	94	2600	2100	057 47101
	120	25 x 40	2540	0.55	328	112	2100	1700	057 47121
	150	25 x 45	2545	0.66	409	140	1600	1300	057 67151
	150	30 x 40	3040	0.70	409	140	1600	1300	057 57151
	150	25 x 50	2550	0.70	409	140	1600	1300	057 47151
	150	30 x 35	3035	0.66	409	140	1600	1300	057 37151
	180	35 x 30	3530	0.72	490	163	1400	1100	057 67181
	220	30 x 45	3045	0.73	598	202	1100	900	057 37221
	220	35 x 40	3540	0.92	598	202	1100	900	057 57221
	220	30 x 50	3050	0.92	598	202	1100	900	057 47221
	220	35 x 35	3535	0.87	598	202	1100	900	057 67221
	330	35 x 45	3545	1.20	895	301	700	600	057 47331
	330	35 x 50	3550	1.26	895	301	700	600	057 57331

MARKING

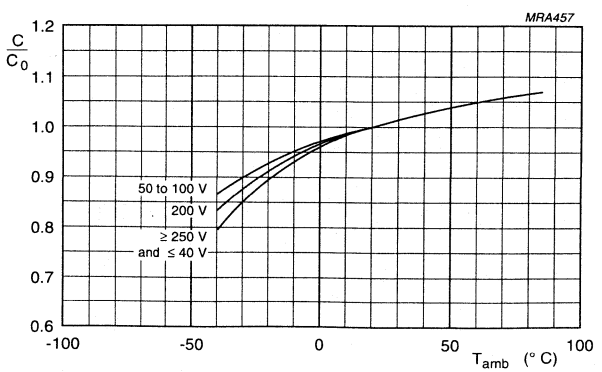
- Rated capacitance
- Tolerance code on rated capacitance (M for ±20%)
- Rated voltage
- Climatic category (in accordance with IEC 68)
- Date code (year and week) in accordance with IEC 62
- Code for factory of origin
- Name of manufacturer
- '–' sign to indicate the negative terminal, visible from the top and side of the capacitor
- Code number (last 8 digits)
- Code for basic specification (in accordance with IEC 384-4-1, CECC 30 301).

Capacitance (C)



C/C_0 = capacitance at 20 °C and 100 Hz.

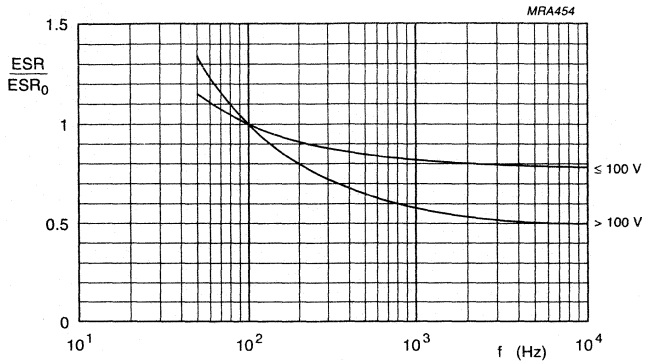
Fig.4 Multiplier of typical capacitance (C/C_0) as a function of frequency.



C/C_0 = capacitance at 20 °C and 100 Hz.

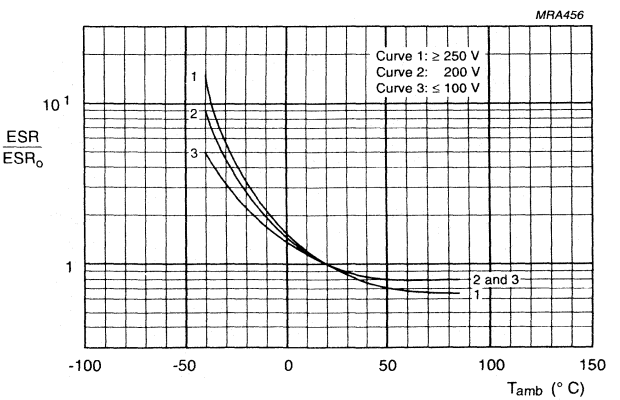
Fig.5 Multiplier of typical capacitance (C/C_0) as a function of ambient temperature.

Equivalent series resistance (ESR)



ESR_0 = typical ESR at 20 °C and 100 Hz.

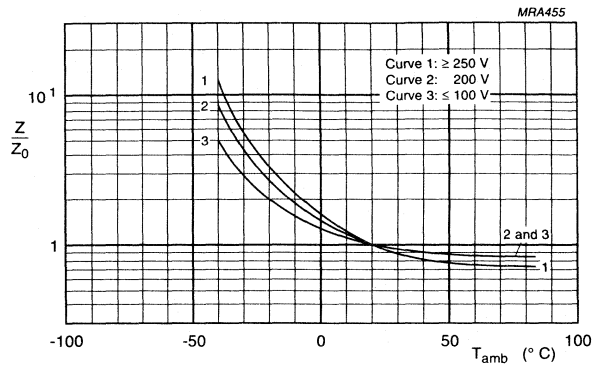
Fig.6 Multiplier of typical ESR (ESR/ESR_0) as a function of frequency.



ESR_0 = typical ESR at 20 °C and 100 Hz.

Fig.7 Multiplier of typical ESR (ESR/ESR_0) as a function of ambient temperature.

Impedance (Z)



Z_0 = typical impedance at 20 °C and 10 kHz.

Fig.8 Multiplier of typical impedance (Z/Z_0) as a function of ambient temperature.

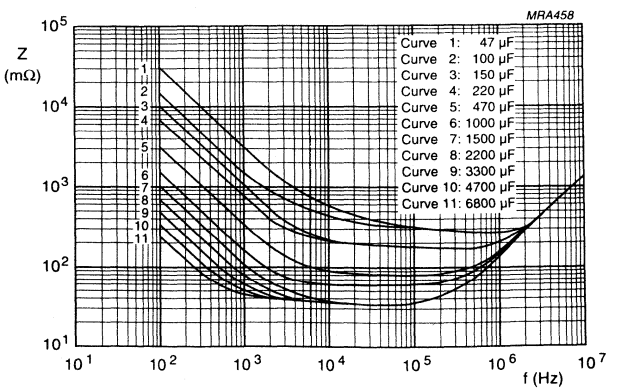


Fig.9 Typical impedance as a function of frequency at +20 °C; case size Ø22 x 25.

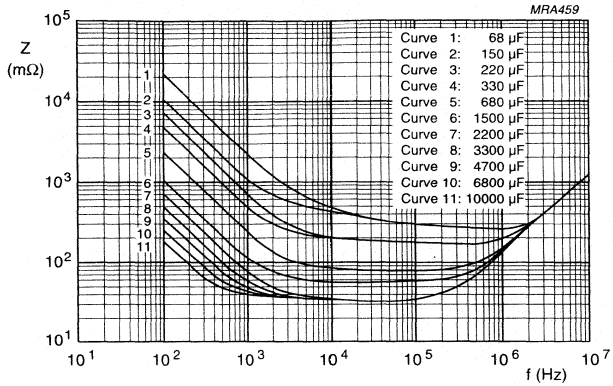


Fig.10 Typical impedance as a function of frequency at +20 °C; case size Ø22 x 30.

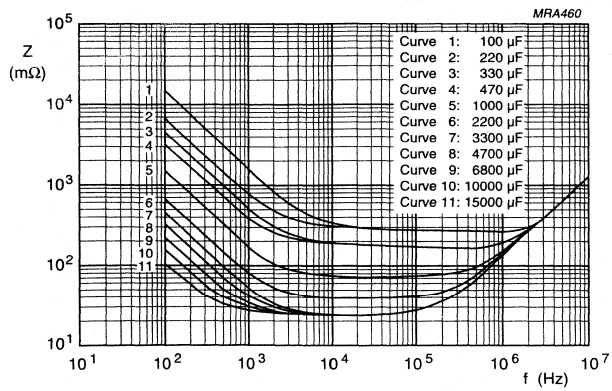


Fig.11 Typical impedance as a function of frequency at +20 °C; case sizes Ø25 x 30 and 22 x 40.

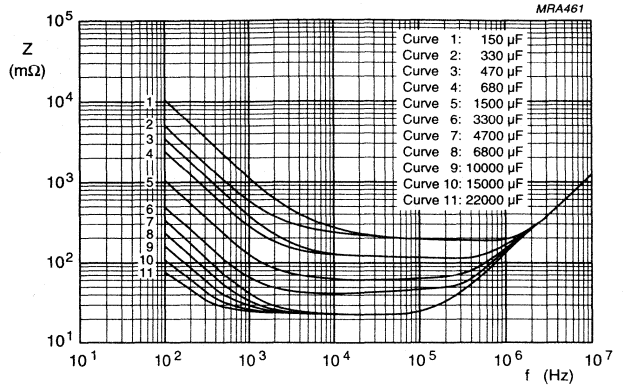


Fig.12 Typical impedance as a function of frequency at +20 °C; case sizes Ø30 x 30 and 25 x 40.

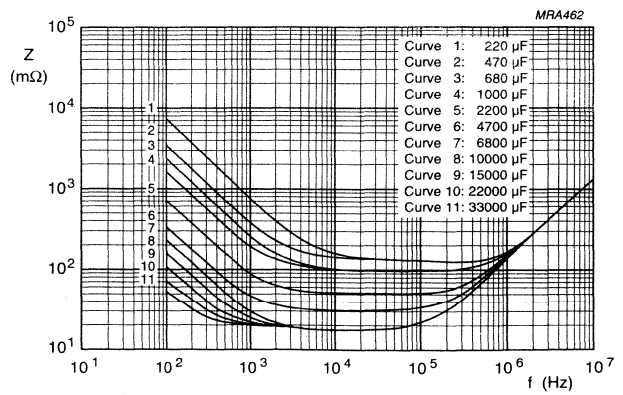


Fig.13 Typical impedance as a function of frequency at +20 °C; case sizes Ø30 x 40 and 25 x 50.

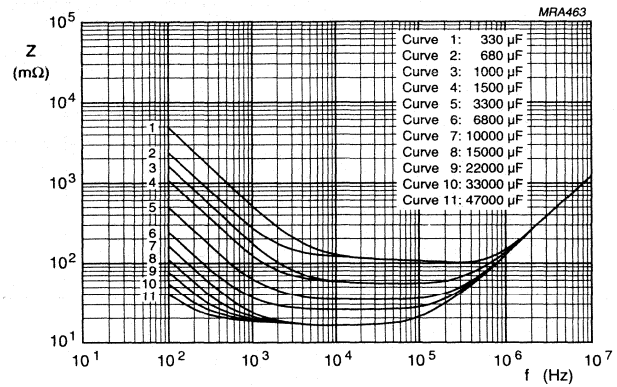


Fig.14 Typical impedance as a function of frequency at +20 °C; case sizes Ø35 x 40 and 30 x 50.

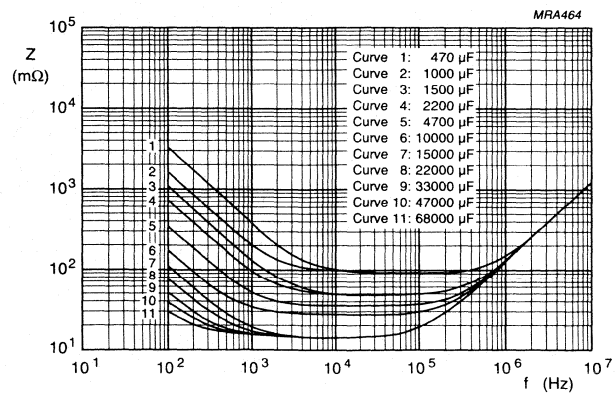
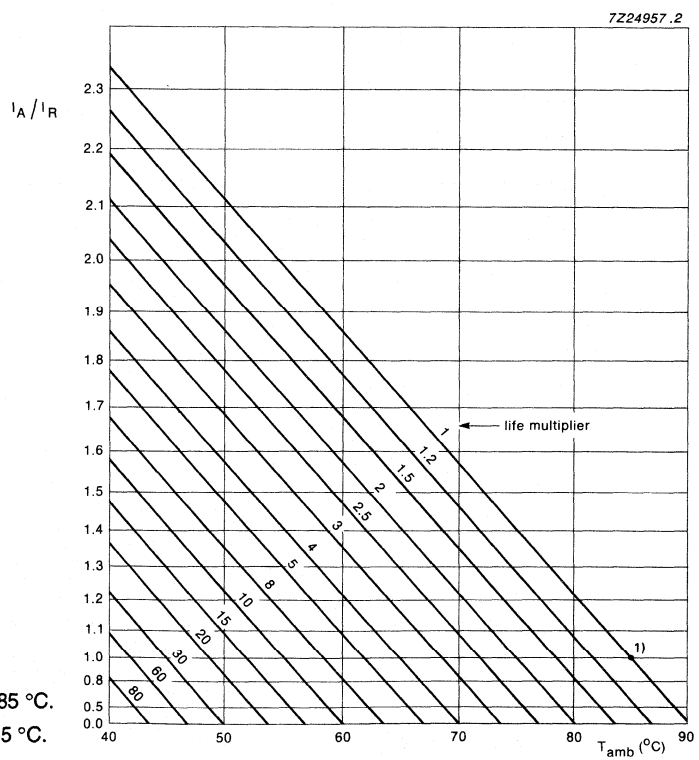


Fig.15 Typical impedance as a function of frequency at +20 °C; case size Ø35 x 50.

RIPPLE CURRENT and USEFUL LIFE

Table 6 Multiplier of ripple current I_R as a function of frequency.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10-35 V	U_R = 40-100 V	U_R > 100 V
50	0.93	0.91	0.86
100	1.00	1.00	1.00
200	1.04	1.05	1.13
400	1.07	1.09	1.21
1000	1.11	1.13	1.29
2000	1.13	1.15	1.32
4000	1.15	1.18	1.35
≥10 000	1.18	1.22	1.40



I_A = actual ripple current at 100 Hz and 85 °C.
I_R = rated ripple current at 100 Hz and 85 °C.

1) Useful life at 85 °C and I_R applied: 10 000 hours.

Fig.16 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 7

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied 5000 hours	$U_R \leq 100$ V: $\Delta C/C \leq 15\%$ $U_R > 100$ V: $\Delta C/C \leq 10\%$ tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 10 000 hours	$\Delta C/C \leq 45\%$ ($U_R \leq 100$ V) $\Delta C/C \leq 30\%$ ($U_R > 100$ V) tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit no visible damage total failure percentage: $U_R \leq 100$ V: ≤1% $U_R > 100$ V: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 group C 5a,4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit $I_{L5} \leq 2$ x spec. limit

Non-solid Al - electrolytic capacitors
Power Economic Snap-In

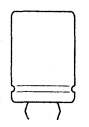
PEC-SI 054/055

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, cylindrical aluminium case, insulated with a blue sleeve
- Safety vent in the bottom of the aluminium case
- Charge and discharge proof
- Long useful life: 12 000 hours/85 °C
- High ripple current capability.

APPLICATIONS

- General purpose and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.



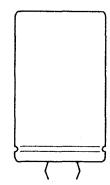


Fig.1 Component outlines.

QUICK REFERENCE DATA

	054	055
Case size ($\varnothing D_{nom}$ x L_{nom} in mm)	22 x 30 to 30 x 50	
Rated capacitance range (E6 series), C_R	47 to 33 000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	10 to 100 V	200 to 400 V
Category temperature range	–40 to +85 °C	
Endurance test at 85 °C	5000 hours	
Useful life at 85 °C	12 000 hours	
Useful life at U_R, 40 °C, 1.4 x I_R applied	200 000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Basic specifications	IEC 384-4-1, CECC 30 301, L.L. grade	
Climatic category IEC 68 DIN 40040	40/085/56 GPF	

Non-solid Al - electrolytic capacitors
Power Economic Snap-In

PEC-SI 054/055

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD x L** in **mm**) for 054/055 series

C_R (µF)	U_R (V)							
	10	**16**	**25**	**40**	**63**	**100**	**200**	**385**
47								22 x 30
68								25 x 30 22 x 40
100							22 x 30	25 x 40 30 x 30
150							25 x 30 22 x 40	30 x 40
220							25 x 40 30 x 30	35 x 40 30 x 50
330							30 x 40	
470						22 x 30	35 x 40 30 x 50	
680						25 x 30 22 x 40		
1000					22 x 30	25 x 40 30 x 30		
1500					25 x 30 22 x 40	30 x 40		
2200				22 x 30	25 x 40 30 x 30	35 x 40 30 x 50		
3300			22 x 30	25 x 30 22 x 40	30 x 40			
4700		22 x 30	25 x 30 22 x 40	25 x 40 30 x 30	35 x 40 30 x 50			
6800	22 x 30	25 x 30 22 x 40	25 x 40 30 x 30	30 x 40				
10 000	25 x 30 22 x 40	25 x 40 30 x 30	30 x 40	35 x 40 30 x 50				
15 000	25 x 40 30 x 30	30 x 40	35 x 40 30 x 50					
22 000	30 x 40	35 x 40 30 x 50						
33 000	35 x 40 30 x 50							

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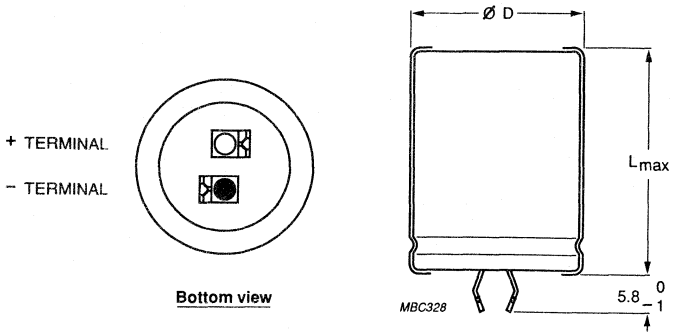
MECHANICAL DATA and PACKING QUANTITIES

Dimensions in mm.



The minus terminal can be marked with a black dot or with an imprinted minus sign.

Fig.2 Snap-In.

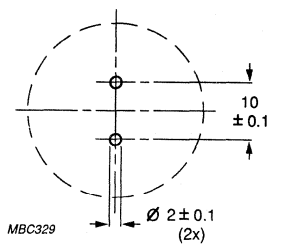


Fig.3 Piercing diagram.

Table 2 Dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE				
22 x 30	2230	23	32	16	100
25 x 30	2530	26.5	32	22	100
22 x 40	2240	23	42	23	100
30 x 30	3030	31.5	32	30	100
25 x 40	2540	26.5	42	27	100
30 x 40	3040	31.5	42	40	100
35 x 40	3540	36.5	42	55	50
30 x 50	3050	31.5	52	50	100

Non-solid Al - electrolytic capacitors
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ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 3 and 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%

C_R = rated capacitance at 100 Hz

I_R = rated RMS ripple current at 100 Hz, 85 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

ESR = max. equivalent series resistance at 100 Hz

Z = max. impedance at 10 kHz.

Ordering Example

Electrolytic capacitors
PEC-SI 054/055
10 000 µF/25 V, ±20%
Case size 30 x 40 mm
Catalogue number:
2222 054 56103.

Table 3 Electrical data and ordering information for 054 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
10	6800	22 x 30	2230	1.98	412	140	89	77	054 54682
	10 000	25 x 30	2530	2.31	604	204	80	75	054 54103
	10 000	22 x 40	2240	2.73	604	204	60	53	054 44103
	15 000	25 x 40	2540	3.18	904	304	54	51	054 54153
	15 000	30 x 30	3030	3.05	904	304	57	55	054 44153
	22 000	30 x 40	3040	4.15	1324	444	39	38	054 54223
	33 000	35 x 40	3540	4.94	1984	664	33	32	054 54333
	33 000	30 x 50	3050	5.29	1984	664	29	30	054 44333
16	4700	22 x 30	2230	1.94	455	154	93	77	054 55472
	6800	25 x 30	2530	2.26	657	222	84	75	054 55682
	6800	22 x 40	2240	2.65	657	222	64	53	054 45682
	10 000	25 x 40	2540	3.15	964	324	55	51	054 55103
	10 000	30 x 30	3030	2.97	964	324	60	55	054 45103
	15 000	30 x 40	3040	4.10	1444	404	40	38	054 55153
	22 000	35 x 40	3540	4.87	2116	708	34	32	054 55223
	22 000	30 x 50	3050	5.20	2116	708	30	30	054 45223
25	3300	22 x 30	2230	1.81	499	169	107	84	054 56332
	4700	25 x 30	2530	2.19	709	239	89	75	054 56472
	4700	22 x 40	2240	2.45	709	239	75	53	054 46472
	6800	25 x 40	2540	2.96	1024	344	62	51	054 56682
	6800	30 x 30	3030	2.88	1024	344	64	55	054 46682
	10 000	30 x 40	3040	3.91	1504	504	44	38	054 56103
	15 000	35 x 40	3540	4.73	2254	754	36	32	054 56153
	15 000	30 x 50	3050	4.89	2254	754	34	30	054 46153

Non-solid Al - electrolytic capacitors
Power Economic Snap-In

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
40	2200	22 x 30	2230	1.64	532	180	129	88	054 57222
	3300	25 x 30	2530	1.95	796	268	112	84	054 57332
	3300	22 x 40	2240	2.28	796	268	86	61	054 47332
	4700	25 x 40	2540	2.70	1132	380	75	57	054 57472
	4700	30 x 30	3030	2.54	1132	380	82	65	054 47472
	6800	30 x 40	3040	3.43	1636	548	57	43	054 57682
	10 000	35 x 40	3540	4.05	2404	804	49	40	054 57103
	10 000	30 x 50	3050	4.40	2404	804	42	34	054 47103
63	1000	22 x 30	2230	1.61	382	130	134	92	054 58102
	1500	25 x 30	2530	1.86	571	193	123	87	054 58152
	1500	22 x 40	2240	2.11	571	193	101	61	054 48152
	2200	25 x 40	2540	2.68	836	281	76	57	054 58222
	2200	30 x 30	3030	2.51	836	281	84	65	054 48222
	3300	30 x 40	3040	3.47	1251	420	56	43	054 58332
	4700	35 x 40	3540	4.01	1781	596	50	40	054 58472
	4700	30 x 50	3050	4.35	1781	596	43	34	054 48472
100	470	22 x 30	2230	1.07	286	98	305	245	054 59471
	680	25 x 30	2530	1.29	412	140	257	215	054 59681
	680	22 x 40	2240	1.46	412	140	211	150	054 49681
	1000	25 x 40	2540	1.76	604	204	175	140	054 59102
	1000	30 x 30	3030	1.74	604	204	175	145	054 49102
	1500	30 x 40	3040	2.40	904	304	117	95	054 59152
	2200	35 x 40	3540	2.93	1324	444	94	75	054 59222
	2200	30 x 50	3050	3.06	1324	444	87	70	054 49222

Voltage

Surge voltage for short periods
- ≤200 V versions: $U_s = 1.15 \times U_R$
- ≥385 V versions: $U_s = 1.1 \times U_R$

Reverse voltage: $U_{rev} \leq 1$ V

Leakage current

- After 1 minute at U_R: $I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
- After 5 minutes at U_R: $I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

Equivalent series inductance (ESL)

- Typical ESL for all case sizes: 19 nH
- Maximum ESL for all case sizes: 25 nH

Non-solid Al - electrolytic capacitors
Power Economic Snap-In

PEC-SI 054/055

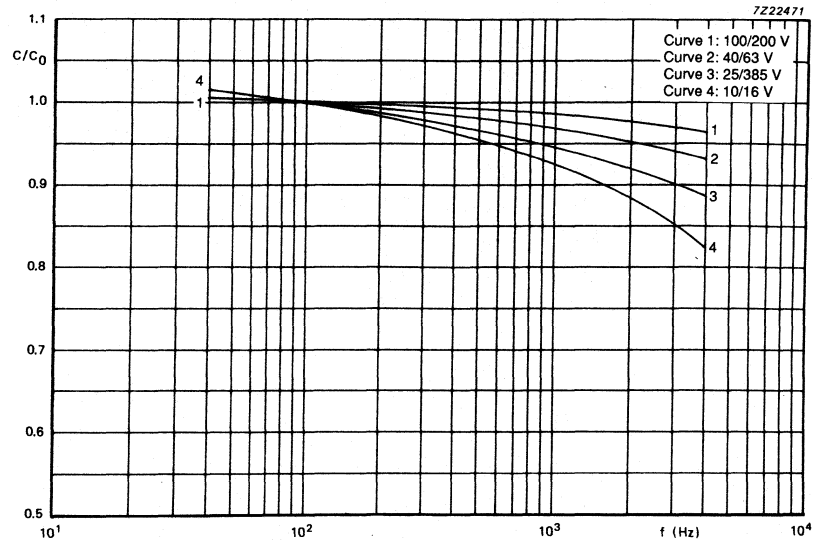
Table 4 Electrical data and ordering information for 055 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
200	100	22 x 30	2230	0.47	124	44	1600	1115	055 52101
	150	25 x 30	2530	0.63	184	64	1070	750	055 52151
	150	22 x 40	2240	0.65	184	64	1070	750	055 42151
	220	25 x 40	2540	0.86	268	92	730	515	055 52221
	220	30 x 30	3030	0.85	268	92	730	515	055 42221
	330	30 x 40	3040	1.17	400	136	490	350	055 52331
	470	35 x 40	3540	1.54	568	192	340	250	055 52471
	470	30 x 50	3050	1.55	568	192	340	250	055 42471
385	47	22 x 30	2230	0.32	113	40	3390	2570	055 58479
	68	25 x 30	2530	0.43	161	56	2340	1780	055 58689
	68	22 x 40	2240	0.44	161	56	2340	1780	055 48689
	100	25 x 40	2540	0.58	235	81	1600	1220	055 58101
	100	30 x 30	3030	0.58	235	81	1600	1220	055 48101
	150	30 x 40	3040	0.79	351	119	1070	815	055 58151
	220	35 x 40	3540	1.05	512	173	730	560	055 58221
	220	30 x 50	3050	1.05	512	173	730	560	055 48221

MARKING

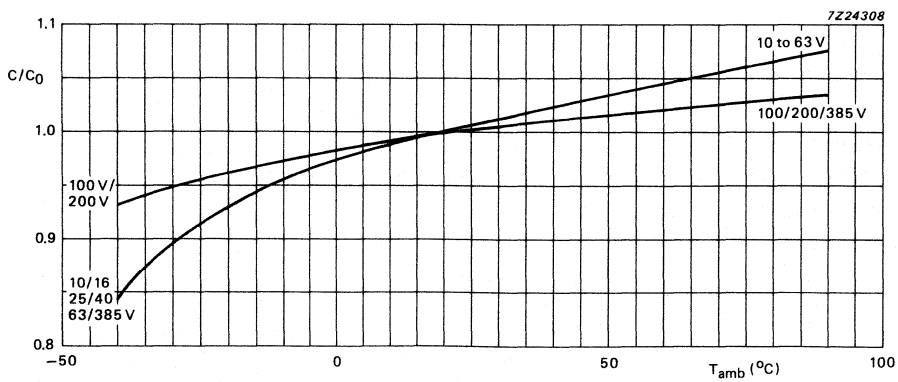
- Rated capacitance
- Tolerance on rated capacitance (M for ±20%)
- Rated voltage
- Climatic category (in accordance with IEC 62)
- Date code (year and week) in accordance with IEC 62
- Code for factory of origin
- Name of manufacturer
- '–' sign to indicate the negative terminal, visible from the top and side of the capacitor
- Code number (last 8 digits)
- Code for basic specification (in accordance with IEC 384-4-1, CECC 30 301).

Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

Fig.4 Multiplier of capacitance (C/C_0) as a function of frequency.

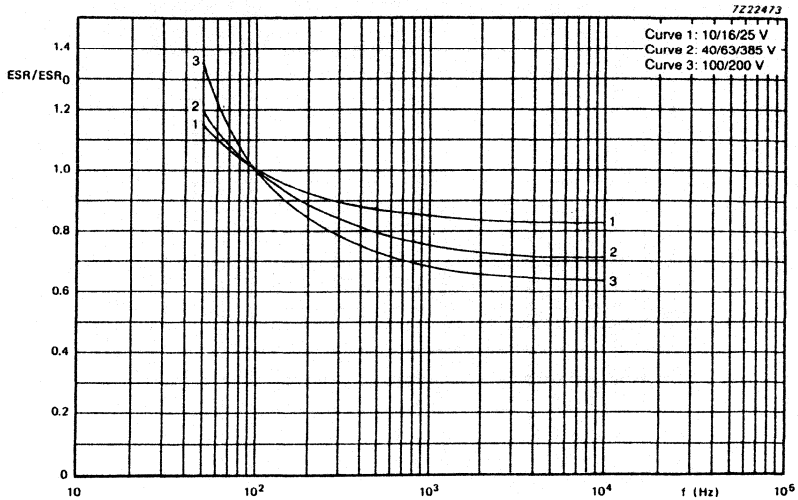


C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature.

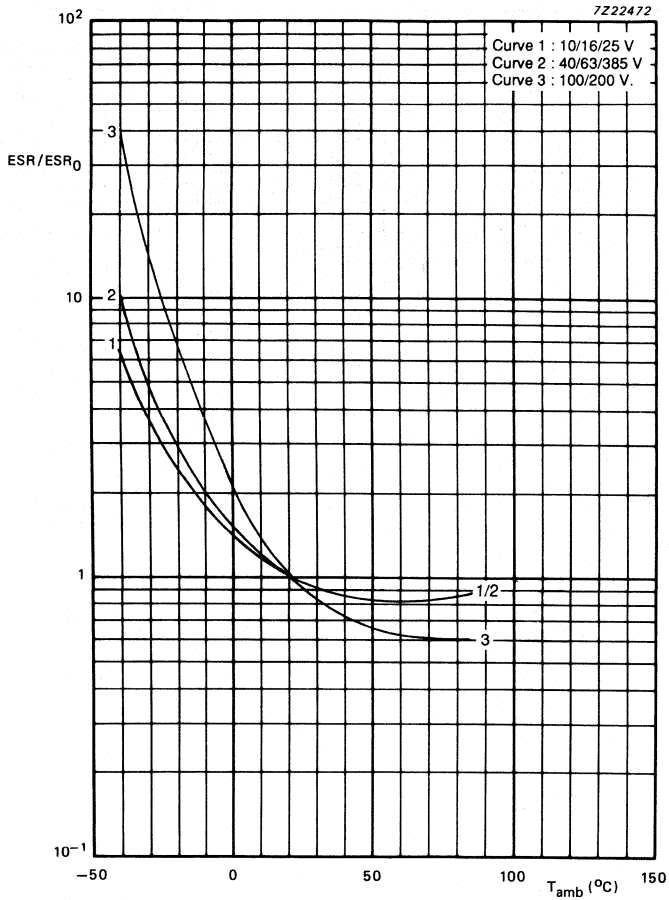
Non-solid Al - electrolytic capacitors
Power Economic Snap-In

Equivalent series resistance (ESR)



ESR_0 = typical ESR at 20 °C, 100 Hz.

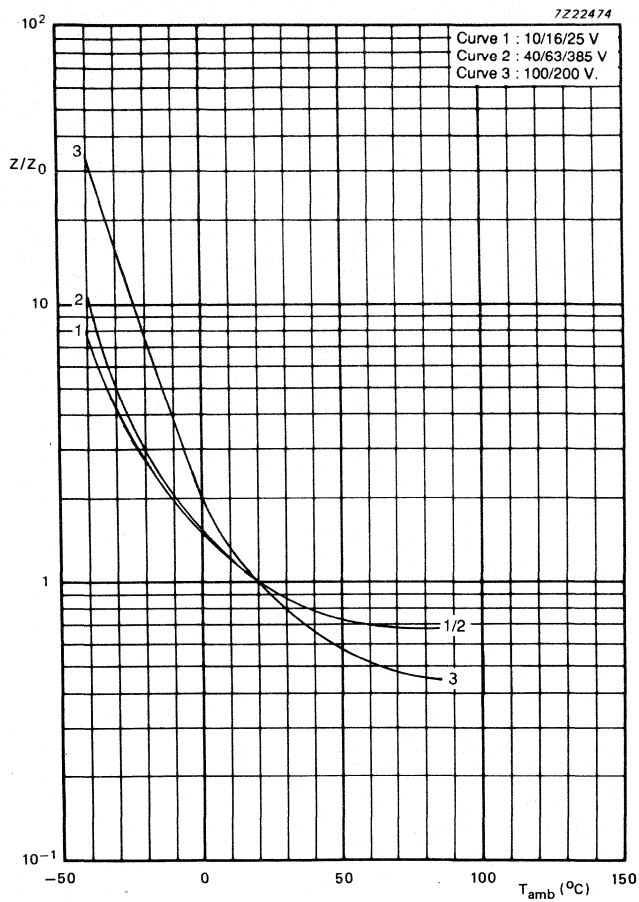
Fig.6 Multiplier of ESR (ESR/ESR_0) as a function of frequency.



ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.7 Typical ESR (ESR/ESR_0) as a function of ambient temperature.

Impedance (Z)



Z_0 = typical impedance at 20 °C, 10 kHz.

Fig.8 Multiplier of impedance (Z/Z_0) as a function of ambient temperature.

Non-solid Al - electrolytic capacitors
Power Economic Snap-In

PEC-SI 054/055

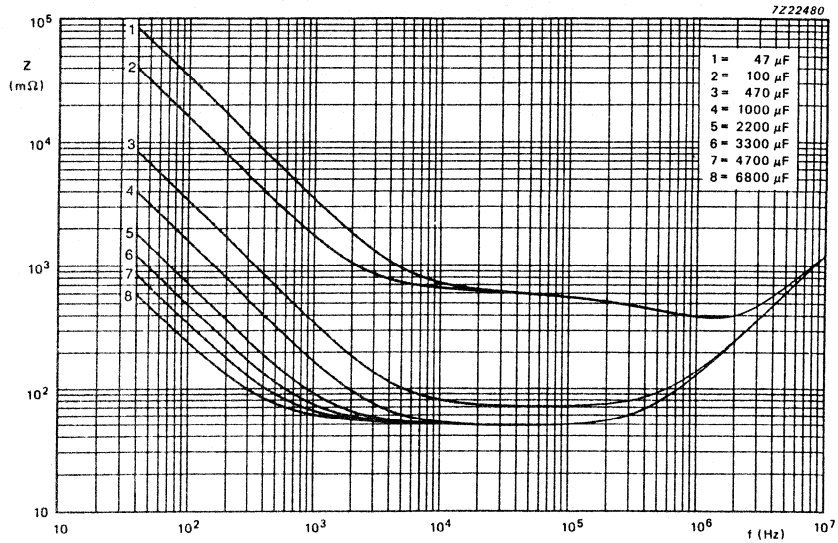


Fig.9 Typical impedance as a function of frequency at 20 °C; case size Ø22 x 30.

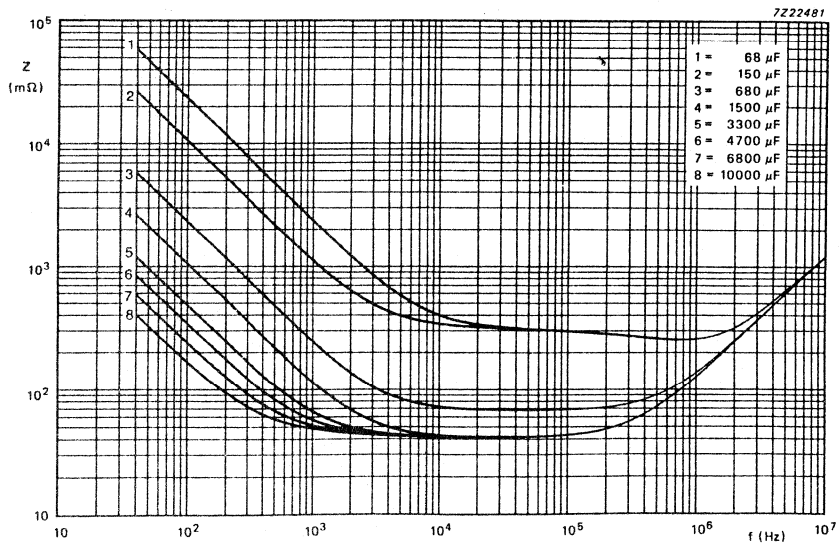


Fig.10 Typical impedance as a function of frequency at 20 °C; case sizes Ø25 x 30 and Ø22 x 40.

Non-solid Al - electrolytic capacitors
Power Economic Snap-In

PEC-SI 054/055

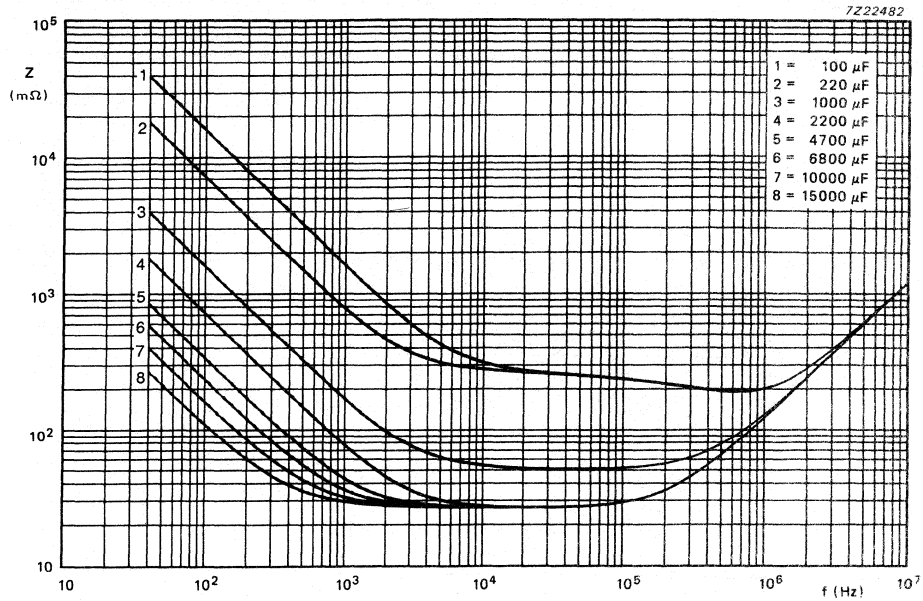


Fig.11 Typical impedance as a function of frequency at 20 °C; case sizes Ø30 x 30 and Ø25 x 40.

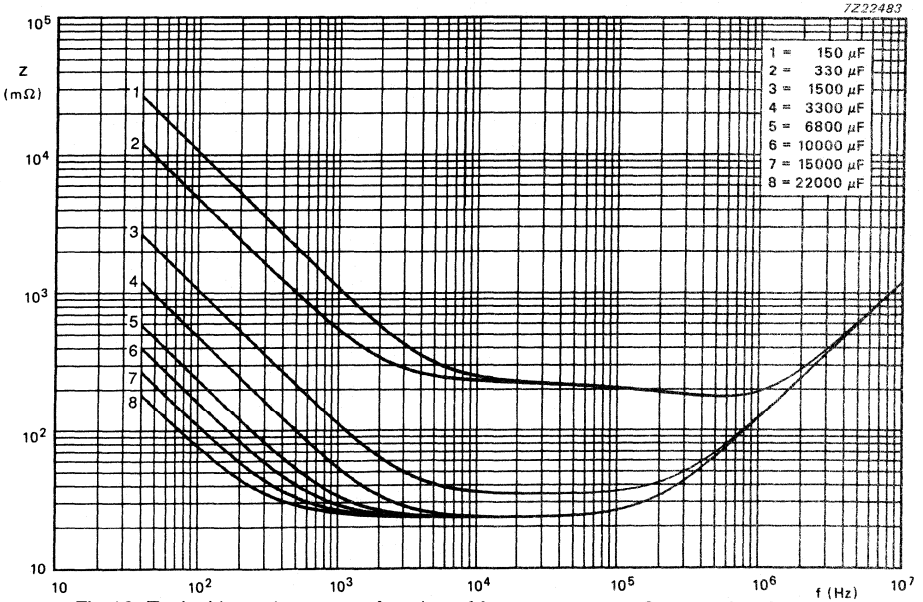


Fig.12 Typical impedance as a function of frequency at 20 °C; case size Ø30 x 40.

Non-solid Al - electrolytic capacitors
Power Economic Snap-In

PEC-SI 054/055

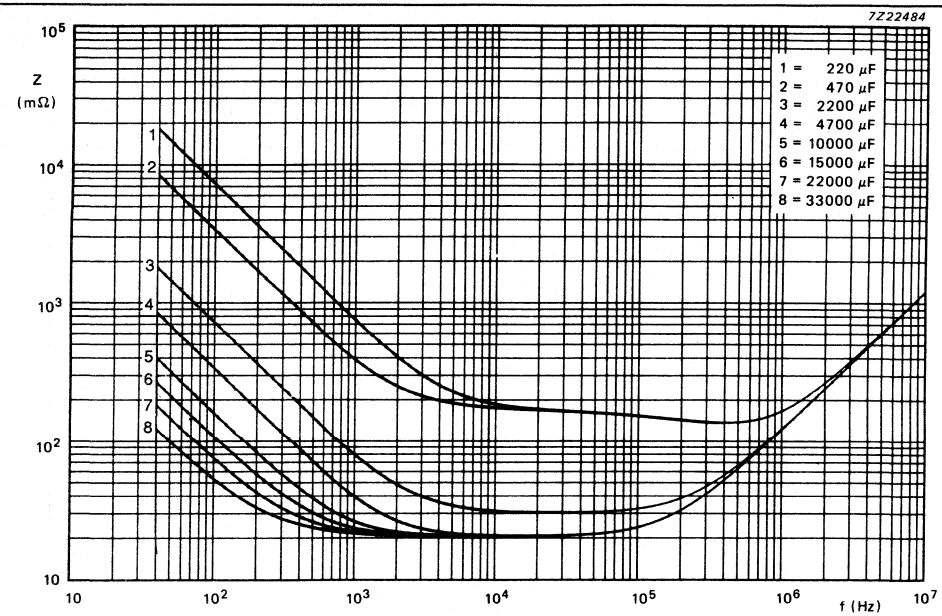
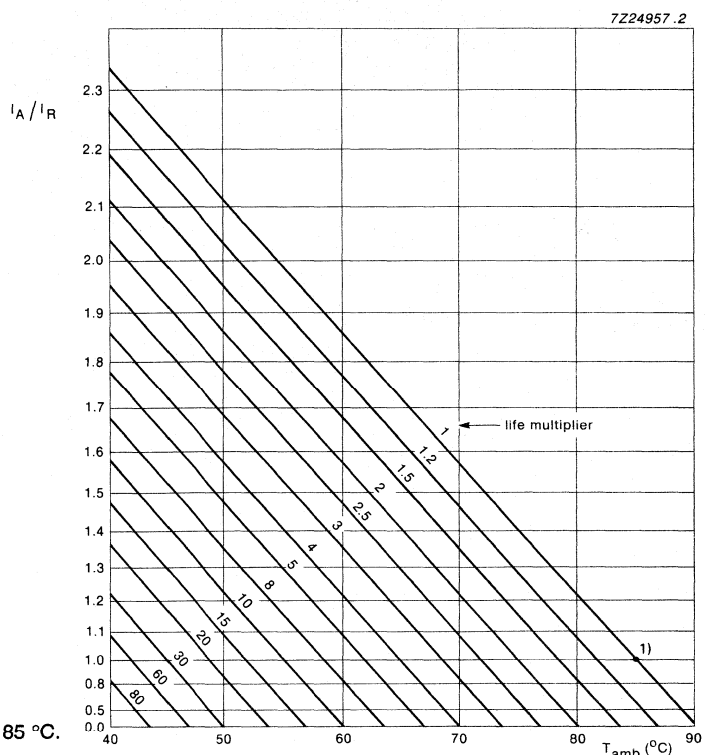


Fig.13 Typical impedance as a function of frequency at 20 °C; case sizes Ø35 x 40 and Ø30 x 50.

RIPPLE CURRENT and USEFUL LIFE

Table 5 Multiplier of ripple current I_R as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.83
100	1.00
200	1.10
400	1.15
1000	1.19
≥2000	1.20



I_A = actual ripple current at 100 Hz and 85 °C.
I_R = rated ripple current at 100 Hz and 85 °C.

1) Useful life at 85 °C and I_R applied:
12 000 hours.

Fig.14 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.

Non-solid Al - electrolytic capacitors
Power Economic Snap-In

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied 5000 hours	U_R ≤100 V: ΔC/C ≤15% U_R >100 V: ΔC/C ≤10% tan δ ≤1.3 x spec. limit Z ≤2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 12 000 hours	ΔC/C ≤45% (U_R ≤100 V) ΔC/C ≤30% (U_R >100 V) tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage: U_R ≤100 V: ≤1% U_R >100 V: ≤3%
Shelf life (storage at high temp).	IEC 384-4-1 CECC 30 301 group C 5a,4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C ≤±10% tan δ ≤1.2 x spec. limit I_{L5} ≤2 x spec. limit

6

Electrolytic Capacitors

Notes

Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

PLL-SI 058/059

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Safety vent in the bottom of the aluminium case
- Charge and discharge proof
- Very long useful life: 10 000 hours/105 °C
- Extended temperature range: 105 °C
- Low ESR, high ripple current capability.

APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering applications
- Standard and switched mode power supplies
- Energy storage in pulse systems.

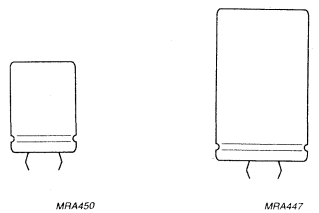


Fig.1 Component outlines.

QUICK REFERENCE DATA

	058	059
Case size ($\varnothing D_{nom}$ x L_{nom} in mm)	22 x 25 to 35 x 50	
Rated capacitance range (E6/E12 series), C_R	33 to 47 000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	10 to 100 V	200 to 400 V
Category temperature range	–40 to +105 °C	
Endurance test at 105 °C	5000 hours	
Useful life at 105 °C	10 000 hours	
Useful life at U_R, 40 °C and 1.9 x I_R applied	250 000 hours	
Shelf life at 0 V, 105 °C	500 hours	
Basic specifications	IEC 384-4, CECC 30 300, LL grade	
Climatic category IEC 68 DIN 40040	40/105/56 GMF	

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Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

PLL-SI 058/059

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD x L in mm**) for 058 series

C_R (µF)	U_R (V)							
	10	**16**	**25**	**35**	**40**	**50**	**63**	**100**
330								22 x 25
470								22 x 30
680							22 x 25	25 x 30 22 x 40
1000						22 x 25	22 x 30	30 x 30 25 x 40
1500				22 x 25	22 x 25	22 x 30	25 x 30 22 x 40	30 x 40 25 x 50
2200			22 x 25	22 x 30	22 x 30	25 x 30 22 x 40	30 x 30 25 x 40	35 x 40 30 x 50
3300		22 x 25	22 x 30	25 x 30 22 x 40	25 x 30 22 x 40	30 x 30 25 x 40	30 x 40 25 x 50	35 x 50
4700	22 x 25	22 x 30	25 x 30 22 x 40	30 x 30 25 x 40	30 x 30 25 x 40	30 x 40 25 x 50	35 x 40 30 x 50	
6800	22 x 30	25 x 30 22 x 40	30 x 30 25 x 40	30 x 40 25 x 50	30 x 40 25 x 50	35 x 40 30 x 50	35 x 50	
10 000	25 x 30 22 x 40	30 x 30 25 x 40	30 x 40 25 x 50	35 x 40 30 x 50	35 x 40 30 x 50	35 x 50		
15 000	30 x 30 25 x 40	30 x 40 25 x 50	35 x 40 30 x 50	35 x 50	35 x 50			
22 000	30 x 40 25 x 50	35 x 40 30 x 50	35 x 50					
33 000	35 x 40 30 x 50	35 x 50						
47 000	35 x 50							

Table 2 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD x L** in **mm**) for 059 series

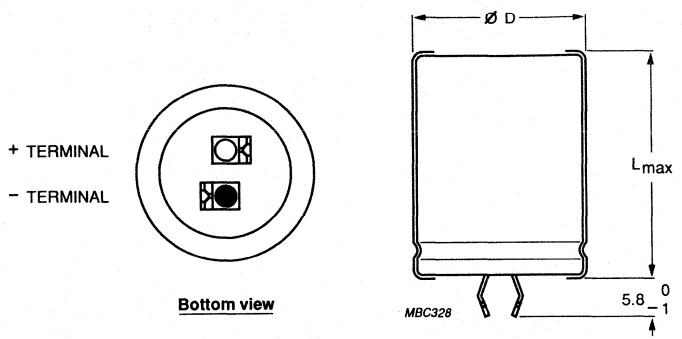
C_R (µF)	U_R (V)			
	200	**250**	**385**	**400**
33			22 x 25	22 x 25
47			22 x 30	22 x 30
68		22 x 25	22 x 35/25 x 30 22 x 40	22 x 35/25 x 30 22 x 40
82			25 x 35	25 x 35
100	22 x 25	22 x 30	30 x 30/25 x 40	30 x 30/25 x 40
120			25 x 45/30 x 35	25 x 45
150	22 x 30	22 x 35/25 x 30 22 x 40	30 x 40/25 x 50 35 x 30	30 x 35/30 x 40 25 x 50/35 x 30
180			30 x 45/35 x 35	30 x 45
220	22 x 35/25 x 30 22 x 40	25 x 35/30 x 30 25 x 40	35 x 40/30 x 50	35 x 40/30 x 50 35 x 35
270	25 x 35	25 x 45	35 x 45	35 x 45
330	30 x 30/25 x 40	30 x 35/30 x 40 25 x 50	35 x 50	35 x 50
390	25 x 45	35 x 30		
470	30 x 35/30 x 40 25 x 50	30 x 45/35 x 40 30 x 50/35 x 35		
560	35 x 30			
680	30 x 45/35 x 40 30 x 50/35 x 35	35 x 50/35 x 45		
820	35 x 45			
1000	35 x 50			

Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

PLL-SI 058/059

MECHANICAL DATA and PACKING QUANTITIES

Dimensions in mm.



The minus terminal can be marked with a black dot or with an imprinted minus sign.

Fig.2 Snap-in.

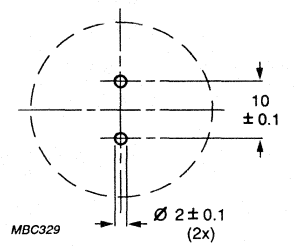


Fig.3 Piercing diagram.

Table 3 Dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE				
22 x 25	2225	23	27	12	100
22 x 30	2230	23	32	16	100
22 x 35	2235	23	37	20	100
22 x 40	2240	23	42	23	100
25 x 30	2530	26.5	32	22	100
25 x 35	2535	26.5	37	24	100
25 x 40	2540	26.5	42	27	100
25 x 45	2545	26.5	47	32	100
25 x 50	2550	26.5	52	38	100
30 x 30	3030	31.5	32	30	100
30 x 35	3035	31.5	37	35	100
30 x 40	3040	31.5	42	40	100
30 x 45	3045	31.5	47	45	100
30 x 50	3050	31.5	52	50	100
35 x 30	3530	36.5	32	40	50
35 x 35	3535	36.5	37	48	50
35 x 40	3540	36.5	42	55	50
35 x 45	3545	36.5	47	63	50
35 x 50	3550	36.5	52	72	50

Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

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ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 4 and 5 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz

I_R = rated RMS ripple current at 100 Hz, 105 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

ESR = max. equivalent series resistance at 100 Hz

Z = max. impedance at 10 kHz.

Ordering Example

Electrolytic capacitors
PLL-SI 058/059
10 000 µF/25 V, ±20%
Case size 30 x 40 mm
Catalogue number:
2222 058 56103.

Table 4 Electrical data and ordering information for 058 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
10	4700	22 x 25	2225	1.95	286	98	82	57	058 54472
	6800	22 x 30	2230	2.44	412	140	61	44	058 54682
	10 000	25 x 30	2530	2.81	604	204	54	42	058 54103
	10 000	22 x 40	2240	3.29	604	204	43	32	058 44103
	15 000	30 x 30	3030	3.53	904	304	42	34	058 54153
	15 000	25 x 40	2540	3.78	904	304	38	30	058 44153
	22 000	30 x 40	3040	4.62	1324	444	31	25	058 54223
	22 000	25 x 50	2550	4.68	1324	444	31	24	058 44223
	33 000	35 x 40	3540	5.15	1984	664	30	24	058 54333
	33 000	30 x 50	3050	5.70	1984	664	24	21	058 44333
	47 000	35 x 50	3550	6.23	2824	944	24	21	058 54473
16	3300	22 x 25	2225	1.90	321	110	86	57	058 55332
	4700	22 x 30	2230	2.36	455	154	65	44	058 55472
	6800	25 x 30	2530	2.75	657	222	56	42	058 55682
	6800	22 x 40	2240	3.18	657	222	46	32	058 45682
	10 000	30 x 30	3030	3.44	964	324	44	34	058 55103
	10 000	25 x 40	2540	3.66	964	324	40	30	058 45103
	15 000	30 x 40	3040	4.55	1444	484	32	25	058 55153
	15 000	25 x 50	2550	4.55	1444	484	32	24	058 45153
	22 000	35 x 40	3540	5.07	2116	708	31	24	058 55223
	22 000	30 x 50	3050	5.67	2116	708	25	21	058 45223
	33 000	35 x 50	3550	6.23	3172	1060	25	21	058 55333

Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

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U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
25	2200	22 x 25	2225	1.76	334	114	100	57	058 56222
	3300	22 x 30	2230	2.23	499	169	73	44	058 56332
	4700	25 x 30	2530	2.60	709	239	62	42	058 56472
	4700	22 x 40	2240	3.00	709	239	52	32	058 46472
	6800	30 x 30	3030	3.26	1024	344	49	34	058 56682
	6800	25 x 40	2540	3.49	1024	344	44	30	058 46682
	10 000	30 x 40	3040	4.37	1504	504	35	25	058 56103
	10 000	25 x 50	2550	4.37	1504	504	35	24	058 46103
	15 000	35 x 40	3540	4.91	2254	754	33	24	058 56153
	15 000	30 x 50	3050	5.43	2254	754	27	21	058 46153
	22 000	35 x 50	3550	6.07	3304	1104	27	21	058 56223
35	1500	22 x 25	2225	1.65	319	109	114	65	058 50152
	2200	22 x 30	2230	2.04	466	158	87	50	058 50222
	3300	25 x 30	2530	2.43	697	235	71	45	058 50332
	3300	22 x 40	2240	2.78	697	235	60	37	058 40332
	4700	30 x 30	3030	2.96	991	333	59	40	058 50472
	4700	25 x 40	2540	3.26	991	333	51	32	058 40472
	6800	30 x 40	3040	3.94	1432	480	42	29	058 50682
	6800	25 x 50	2550	4.10	1432	480	39	26	058 40682
	10 000	35 x 40	3540	4.18	2104	704	46	29	058 50103
	10 000	30 x 50	3050	4.98	2104	704	36	24	058 40103
	15 000	35 x 50	3550	5.21	3154	1054	36	24	058 50153
40	1500	22 x 25	2225	1.65	364	124	114	65	058 57152
	2200	22 x 30	2230	2.04	532	180	87	50	058 57222
	3300	25 x 30	2530	2.43	796	268	71	45	058 57332
	3300	22 x 40	2240	2.78	796	268	60	37	058 47332
	4700	30 x 30	3030	2.96	1132	380	59	40	058 57472
	4700	25 x 40	2540	3.26	1132	380	51	32	058 47472
	6800	30 x 40	3040	3.94	1636	548	42	29	058 57682
	6800	25 x 50	2550	4.10	1636	548	39	26	058 47682
	10 000	35 x 40	3540	4.18	2404	804	46	29	058 57103
	10 000	30 x 50	3050	4.98	2404	804	36	24	058 47103
	15 000	35 x 50	3550	5.21	3604	1204	36	24	058 57153

Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

PLL-SI 058/059

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
50	1000	22 x 25	2225	1.50	304	104	138	69	058 51102
	1500	22 x 30	2230	1.88	454	154	102	54	058 51152
	2200	25 x 30	2530	2.27	664	124	82	47	058 51222
	2200	22 x 40	2240	2.55	664	124	71	38	058 41222
	3300	30 x 30	3030	2.81	994	334	66	41	058 51332
	3300	25 x 40	2540	3.07	994	334	57	33	058 41332
	4700	30 x 40	3040	3.77	1414	474	47	30	058 51472
	4700	25 x 50	2550	3.85	1414	474	43	27	058 41472
	6800	35 x 40	3540	4.01	2044	684	49	30	058 51682
	6800	30 x 50	3050	4.74	2044	684	38	24	058 41682
	10 000	35 x 50	3550	5.04	3004	1004	38	24	058 51103
63	680	22 x 25	2225	1.17	261	90	228	150	058 58681
	1000	22 x 30	2230	1.46	382	130	170	115	058 58102
	1500	25 x 30	2530	1.76	571	193	137	85	058 58152
	1500	22 x 40	2240	2.00	571	193	115	85	058 48152
	2200	30 x 30	3030	2.27	836	281	101	70	058 58222
	2200	25 x 40	2540	2.40	836	281	94	70	058 48222
	3300	30 x 40	3040	3.07	1251	420	70	50	058 58332
	3300	25 x 50	2550	3.07	1251	420	70	50	058 48332
	4700	35 x 40	3540	3.65	1781	596	60	45	058 58472
	4700	30 x 50	3050	3.88	1781	596	53	45	058 48472
	6800	35 x 50	3550	4.58	2574	861	46	35	058 58682
100	330	22 x 25	2225	0.92	202	70	370	250	058 59331
	470	22 x 30	2230	1.14	286	98	280	190	058 59471
	680	25 x 30	2530	1.35	412	140	232	140	058 59681
	680	22 x 40	2240	1.57	412	140	190	140	058 49681
	1000	30 x 30	3030	1.79	604	204	163	115	058 59102
	1000	25 x 40	2540	1.85	604	204	158	115	058 49102
	1500	30 x 40	3040	2.45	904	304	111	85	058 59152
	1500	25 x 50	2550	2.38	904	304	116	85	058 49152
	2200	35 x 40	3540	3.05	1324	444	86	65	058 59222
	2200	30 x 50	3050	3.13	1324	444	82	65	058 49222
	3300	35 x 50	3550	3.84	1984	664	64	50	058 59332

Table 5 Electrical data and ordering information for 059 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
200	100	22 x 25	2225	0.53	124	44	1280	730	059 52101
	150	22 x 30	2230	0.67	184	64	850	540	059 52151
	220	22 x 35	2235	0.86	268	64	610	430	059 32221
	220	25 x 30	2530	0.87	268	92	610	430	059 52221
	220	22 x 40	2240	0.87	268	92	610	430	059 42221
	270	25 x 35	2535	1.01	328	112	535	370	059 32271
	330	30 x 30	3030	1.12	400	136	435	300	059 52331
	330	25 x 40	2540	1.12	400	136	435	300	059 42331
	390	25 x 45	2545	1.33	472	160	405	270	059 62391
	470	30 x 35	3035	1.46	568	192	335	225	059 32471
	470	30 x 40	3040	1.25	568	192	335	225	059 52471
	470	25 x 50	2550	1.25	568	192	335	225	059 42471
	560	35 x 30	3530	1.60	676	228	285	188	059 62561
	680	30 x 45	3045	1.87	820	276	235	155	059 32681
	680	35 x 40	3540	1.91	820	276	235	155	059 52681
	680	30 x 50	3050	1.91	820	276	235	155	059 42681
	680	35 x 35	3535	1.85	820	276	235	155	059 62681
	820	35 x 45	3545	2.18	988	332	195	150	059 42821
	1000	35 x 50	3550	2.45	1204	404	160	125	059 52102

Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

PLL-SI 058/059

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
250	68	22 x 25	2225	0.49	106	38	1640	760	059 53689
	100	22 x 30	2230	0.62	154	54	1110	570	059 53101
	150	22 x 35	2235	0.82	229	79	795	440	059 33151
	150	25 x 30	2530	0.82	229	79	795	440	059 53151
	150	22 x 40	2240	0.82	229	79	795	440	059 43151
	220	25 x 35	2535	1.03	334	114	540	300	059 33221
	220	30 x 30	3030	1.06	334	114	540	300	059 53221
	220	25 x 40	2540	1.06	334	114	540	300	059 43221
	270	25 x 45	2545	1.28	409	139	470	275	059 63271
	330	30 x 35	3035	1.43	499	169	385	225	059 33331
	330	30 x 40	3040	1.40	499	169	385	225	059 53331
	330	25 x 50	2550	1.40	499	169	385	225	059 43331
	390	35 x 30	3530	1.52	589	199	325	190	059 63391
	470	30 x 45	3045	1.79	709	239	270	155	059 33471
	470	35 x 40	3540	1.82	709	239	270	155	059 53471
	470	30 x 50	3050	1.82	709	239	270	155	059 43471
	470	35 x 35	3535	1.79	709	239	270	155	059 63471
	680	35 x 45	3545	2.25	1024	344	190	125	059 43681
	680	35 x 50	3550	2.30	1024	344	190	125	059 53681

Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

PLL-SI 058/059

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
385	33	22 x 25	2225	0.34	80	29	3380	1600	059 58339
	47	22 x 30	2230	0.43	113	40	2370	1200	059 58479
	68	22 x 35	2235	0.57	161	56	1640	800	059 38689
	68	25 x 30	2530	0.56	161	56	1640	800	059 58689
	68	22 x 40	2240	0.56	161	56	1640	800	059 48689
	82	25 x 35	2535	0.67	193	67	1360	680	059 38829
	100	30 x 30	3030	0.75	235	81	1115	560	059 58101
	100	25 x 40	2540	0.75	235	81	1115	560	059 48101
	120	25 x 45	2545	0.90	281	96	935	500	059 68121
	120	30 x 35	3035	0.90	281	96	935	500	059 38121
	150	30 x 40	3040	1.01	351	119	745	400	059 58151
	150	25 x 50	2550	1.01	351	119	745	400	059 48151
	150	35 x 30	3530	1.01	351	119	745	400	059 68151
	180	30 x 45	3045	1.19	419	143	665	340	059 38181
	180	35 x 35	3535	1.19	419	143	665	340	059 68181
	220	35 x 40	3540	1.35	512	173	545	275	059 58221
	220	30 x 50	3050	1.35	512	173	545	275	059 48221
	270	35 x 45	3545	1.57	627	212	445	245	059 48271
	330	35 x 50	3550	1.75	766	258	365	200	059 58331

Voltage

Surge voltage for short periods
- ≤250 V versions: $U_s = 1.15 \times U_R$
- ≥385 V versions: $U_s = 1.1 \times U_R$

Reverse voltage: $U_{rev} \leq 1$ V

Leakage current

- After 1 minute at U_R: $I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
- After 5 minutes at U_R: $I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

Equivalent series inductance (ESL)

- Typical ESL for all case sizes: 19 nH
- Maximum ESL for all case sizes: 25 nH

Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

PLL-SI 058/059

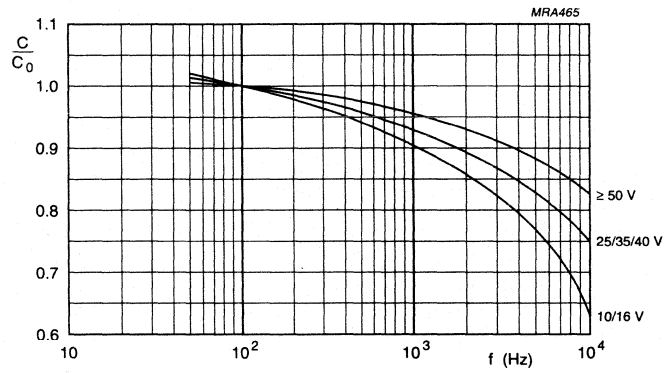
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
400	33	22 x 25	2225	0.23	83	24	6090	4970	059 56339
	47	22 x 30	2230	0.30	117	42	4260	3490	059 56479
	68	22 x 35	2235	0.38	167	58	2950	2420	059 36689
	68	25 x 30	2530	0.41	167	58	2950	2420	059 56689
	68	22 x 40	2240	0.41	167	58	2950	2420	059 46689
	82	25 x 35	2535	0.45	200	70	2460	2020	059 36829
	100	30 x 30	3030	0.55	244	84	2020	1660	059 56101
	100	25 x 40	2540	0.55	244	84	2020	1660	059 46101
	120	25 x 45	2545	0.60	292	100	1690	1390	059 66121
	150	30 x 35	3035	0.68	364	124	1350	1110	059 36151
	150	30 x 40	3040	0.78	364	124	1350	1110	059 56151
	150	25 x 50	2550	0.78	364	124	1350	1110	059 46151
	150	35 x 30	3530	0.68	364	124	1350	1110	059 66151
	180	30 x 45	3045	0.81	436	148	1140	930	059 36181
	220	35 x 40	3540	0.94	532	180	930	760	059 56221
	220	30 x 50	3050	0.94	532	180	930	760	059 46221
	220	35 x 35	3535	0.88	532	180	930	760	059 66221
	270	35 x 45	3545	1.07	652	220	770	630	059 46271
	330	35 x 50	3550	1.25	796	260	620	510	059 56331

Marking

The capacitors are marked (where possible) with the following information:

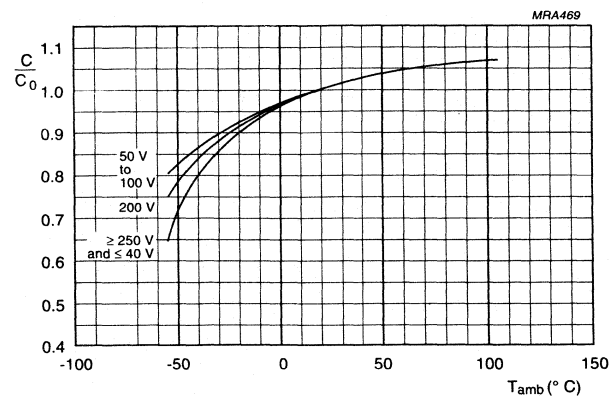
- Rated capacitance
- Tolerance code on rated capacitance (M for ±20%)
- Rated voltage
- Climatic category (in accordance with IEC 68)
- Date code (year and week) in accordance with IEC 62
- Code for factory of origin
- Name of manufacturer
- '–' sign to indicate the negative terminal, visible from the top and side of the capacitor
- Code number (last 8 digits)
- Code for basic specification (in accordance with IEC 384-4-1, CECC 30 301).

Capacitance (C)



C/C_0 = capacitance at 20 °C and 100 Hz.

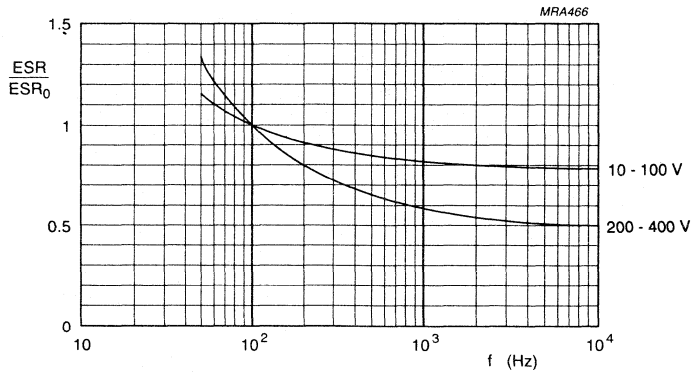
Fig.4 Multiplier of typical capacitance (C/C_0) as a function of frequency.



C/C_0 = capacitance at 20 °C and 100 Hz.

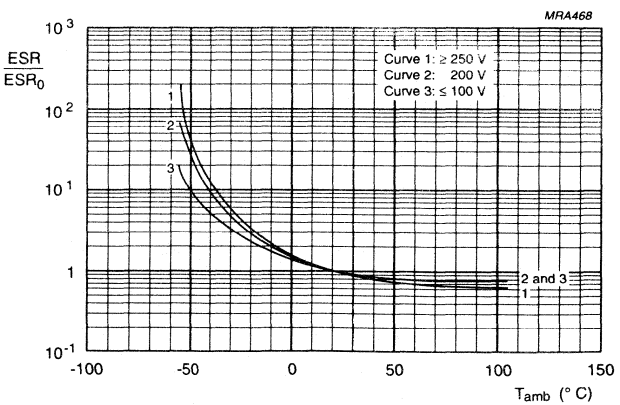
Fig.5 Multiplier of typical capacitance (C/C_0) as a function of ambient temperature.

Equivalent series resistance (ESR)



ESR_0 = typical ESR at 20 °C and 100 Hz.

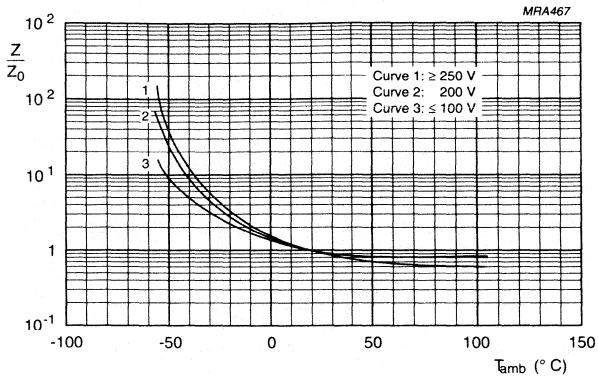
Fig.6 Multiplier of typical ESR (ESR/ESR_0) as a function of frequency.



ESR_0 = typical ESR at 20 °C and 100 Hz.

Fig.7 Multiplier of typical ESR (ESR/ESR_0) as a function of ambient temperature.

Impedance (Z)



Z_0 = typical impedance at 20 °C and 10 kHz.

Fig.8 Multiplier of typical impedance (Z/Z_0) as a function of ambient temperature.

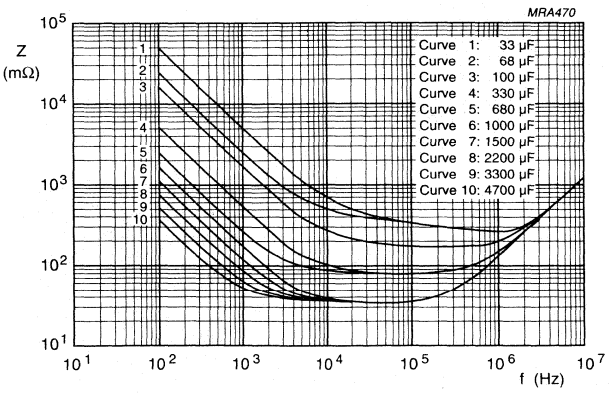


Fig.9 Typical impedance as a function of frequency at +20 °C; case size Ø22 x 25.

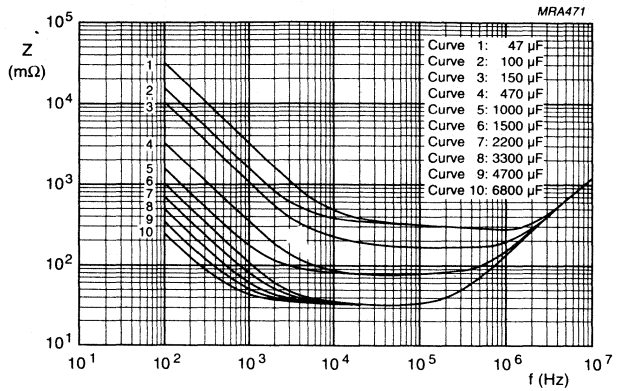


Fig.10 Typical impedance as a function of frequency at +20 °C; case size Ø22 x 30.

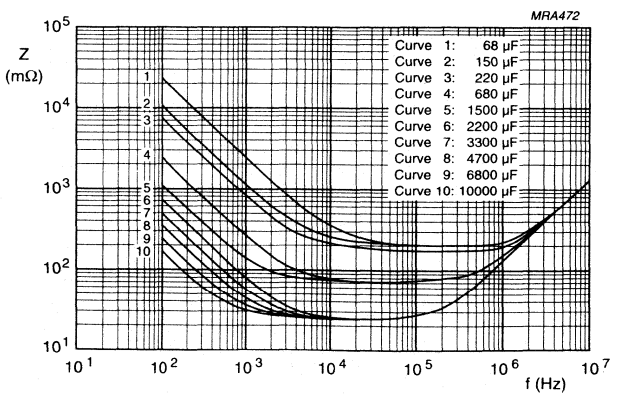


Fig.11 Typical impedance as a function of frequency at +20 °C; case sizes Ø25 x 30 and 22 x 40.

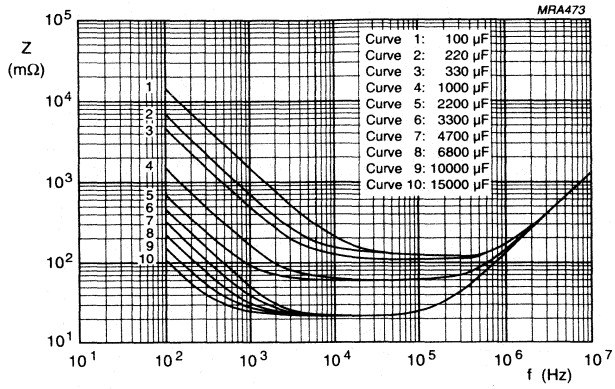


Fig.12 Typical impedance as a function of frequency at +20 °C; case sizes Ø30 x 30 and 25 x 40.

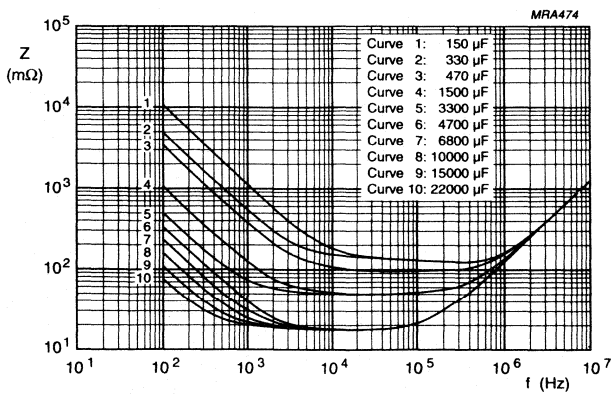


Fig.13 Typical impedance as a function of frequency at +20 °C; case sizes Ø30 x 40 and 25 x 50.

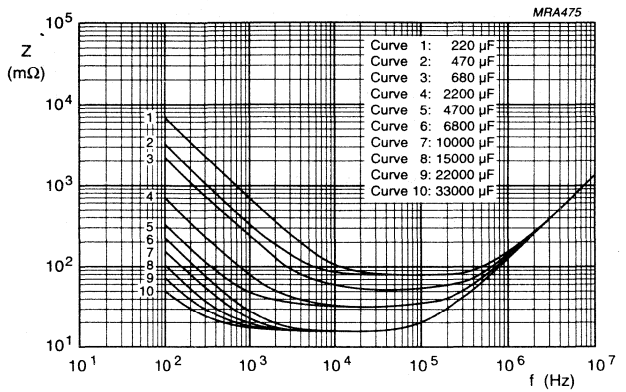


Fig.14 Typical impedance as a function of frequency at +20 °C; case sizes Ø35 x 40 and 30 x 50.

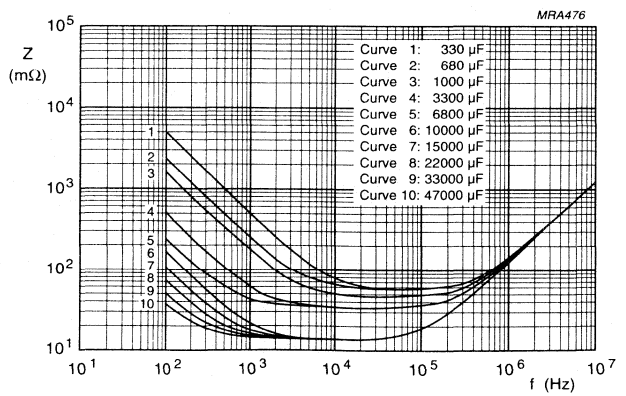
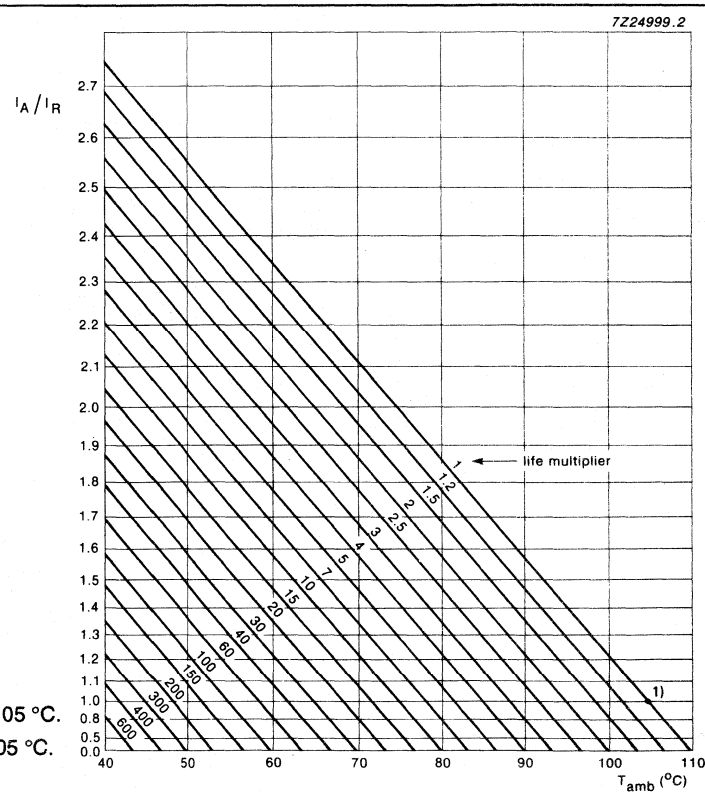


Fig.15 Typical impedance as a function of frequency at +20 °C; case size Ø35 x 50.

RIPPLE CURRENT and USEFUL LIFE

Table 6 Multiplier of ripple current I_R as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10-35 V	U_R = 40-100 V	U_R >100 V
50	0.93	0.91	0.86
100	1.00	1.00	1.00
200	1.04	1.05	1.13
400	1.07	1.09	1.21
1000	1.11	1.13	1.29
2000	1.13	1.15	1.32
4000	1.15	1.18	1.35
≥10 000	1.18	1.22	1.40



I_A = actual ripple current at 100 Hz and 105 °C.
I_R = rated ripple current at 100 Hz and 105 °C.

1) Useful life at 105 °C and I_R applied: 10 000 hours.

Fig.16 Life expectancy (useful life) as a function of ripple current load I_A/I_R and ambient temperature.

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 7

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 105 °C, U_R applied 5000 hours	U_R ≤100 V: ΔC/C ≤15% U_R >100 V: ΔC/C ≤10% tan δ ≤1.3 x spec. limit Z ≤2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 105 °C, U_R and I_R applied 10 000 hours	ΔC/C ≤45% (U_R ≤100 V) ΔC/C ≤30% (U_R >100 V) tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage: U_R ≤100 V: ≤1% U_R >100 V: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 group C 5a,4.17	T_{amb} = 105 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C ≤±10% tan δ ≤1.2 x spec. limit I_{L5} ≤2 x spec. limit

Electrolytic Capacitors

Notes

Non-solid Al - electrolytic capacitors
Power Economic Printed Wiring

PEC-PW 051/053

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types with reduced dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Printed wiring version (PEC-PW) with keyed polarity
- Also available in solder-lug (PEC-SL) and solder-lug-bolt (PEC-SLB) versions
- Safety vent in the bottom of the aluminium case or in the sealing for bolt versions
- Charge and discharge proof
- Long useful life: 12 000 hours/85 °C
- High ripple current capability
- High resistance to shock and vibration achieved by a special internal construction.

APPLICATIONS

- General purpose, industrial and audio/video systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.

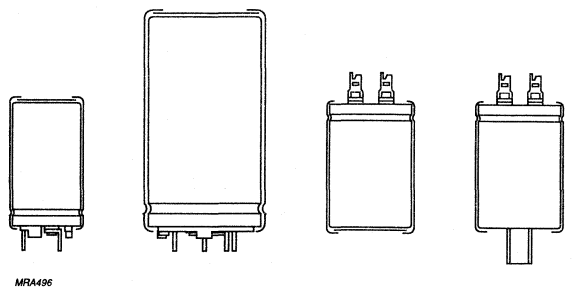


Fig.1 Component outlines.

QUICK REFERENCE DATA

	051	053
Case size ($\varnothing D_{nom}$ x L_{nom} in mm)	25 x 35 to 40 x 105	
Rated capacitance range (E6 series), C_R	68 to 150 000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	10 to 100 V	200 to 400 V
Category temperature range	–40 to +85 °C	
Endurance test at 85 °C	5000 hours	
Useful life at 85 °C	12 000 hours	
Useful life at U_R, 40 °C, 1.4 x I_R applied	200 000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Basic specifications	IEC 384-4, CECC 30 301, LL grade	
Detail specification	similar to DIN 41238	
Climatic category IEC 68 DIN 40040	 40/085/56 GPF	
Approvals	France: liste LNZ 44-04	

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD x L** in **mm**) for 051/053 series

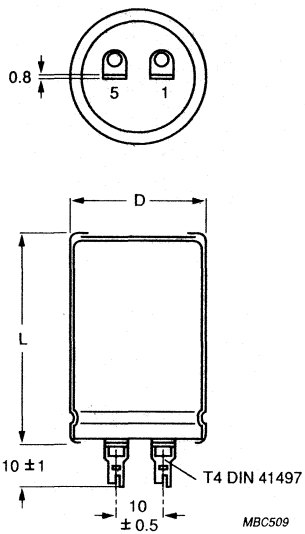
C_R (µF)	U_R (V)								
	10	**16**	**25**	**40**	**63**	**100**	**200**	**385**	**400**
68								25 x 35	25 x 35
100								25 x 45	25 x 45
150							25 x 35	30 x 45	30 x 45
220							25 x 45	35 x 45	35 x 45
330							30 x 45	35 x 55 40 x 45	35 x 55 40 x 45
470							35 x 45	40 x 55	40 x 55
680						25 x 35	35 x 55 40 x 45	40 x 75	40 x 75
1000						25 x 45	40 x 55	40 x 105	40 x 105
1500						30 x 45	40 x 75		
2200					25 x 35	35 x 45	40 x 105		
3300				25 x 35	25 x 45	35 x 55 40 x 45			
4700			25 x 35	25 x 45	30 x 45	40 x 55			
6800		25 x 35	25 x 45	30 x 45	35 x 45	40 x 75			
10 000	25 x 35	25 x 45	30 x 45	35 x 45	35 x 55 40 x 45	40 x 105			
15 000	25 x 45	30 x 45	35 x 45	35 x 55 40 x 45	40 x 75				
22 000	30 x 45	35 x 45	35 x 55 40 x 45	40 x 55	40 x 105				
33 000	35 x 45	35 x 55 40 x 45	40 x 55	40 x 75					
47 000	35 x 55 40 x 45	40 x 55	40 x 75	40 x 105					
68 000	40 x 55	40 x 75	40 x 105						
100 000	40 x 75	40 x 105							
150 000	40 x 105								

Non-solid Al - electrolytic capacitors
Power Economic Printed Wiring

PEC-PW 051/053

MECHANICAL DATA and PACKING QUANTITIES

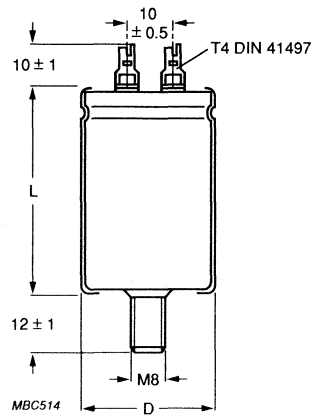
Dimensions in mm.



1 = positive terminal; 5 = negative terminal.

Mounting accessories are specified in the general section.

Fig.2 Solder-lug version (SL).



1 = positive terminal; 5 = negative terminal.

Mounting accessories are specified in the general section.

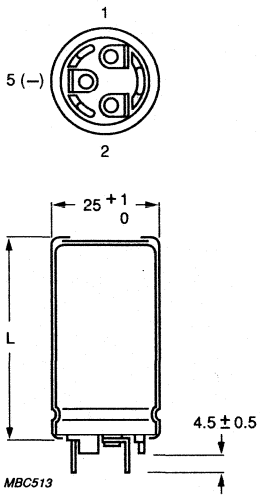
Fig.3 Solder-lug-bolt version (SLB).

Table 2 SL and SLB versions, dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE				
25 x 35	1	26	36.3	24	100
25 x 45	2	26	46.3	28	100
30 x 45	3	31	46.3	38	100
35 x 45	4	36	46.3	51	50
35 x 55	5	36	56.3	66	50
40 x 55	7	41	56.3	82	50
40 x 75	8	41	76.3	110	50
40 x 105	9	41	106.3	176	50

Non-solid Al - electrolytic capacitors
Power Economic Printed Wiring

PEC-PW 051/053



1 = positive terminal; 5 = negative terminal.

Fig.4 Printed wiring pin version, case diameter 25 mm.

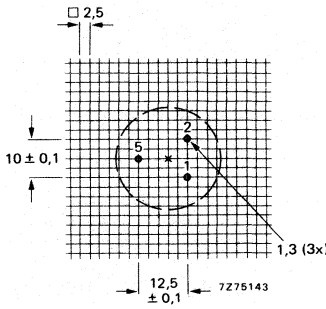
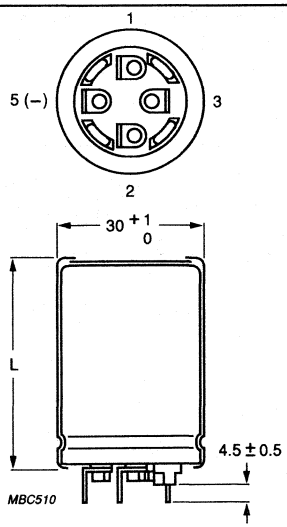


Fig.5 Piercing diagram viewed from component side.



1 = positive terminal; 5 = negative terminal.

Fig.6 Printed wiring pin version, case diameter 30 mm.

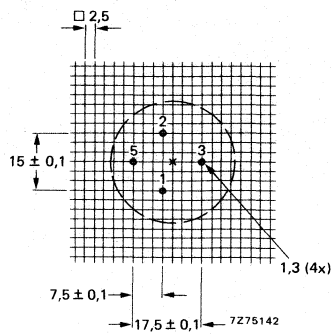
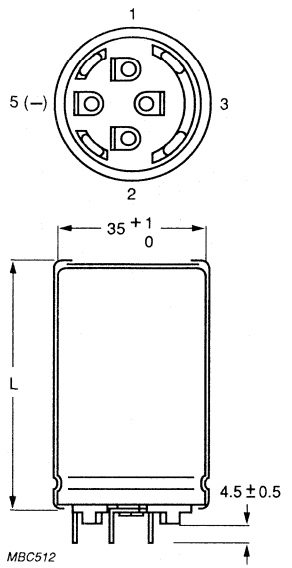


Fig.7 Piercing diagram viewed from component side.

6

Non-solid Al - electrolytic capacitors
Power Economic Printed Wiring

PEC-PW 051/053



1 = positive terminal; 5 = negative terminal.

Fig.8 Printed wiring pin version, case diameter 35 mm.

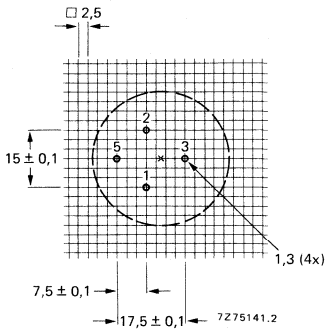


Fig.9 Piercing diagram viewed from component side.

Table 3 PW versions, dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE				
25 x 35	1	26	39.3	24	100
25 x 45	2	26	49.3	28	100
30 x 45	3	31	49.3	38	100
35 x 45	4	36	49.3	51	50
35 x 55	5	36	59.3	66	50
40 x 45	6	41	49.3	78	50
40 x 55	7	41	59.3	82	50
40 x 75	8	41	79.3	110	50
40 x 105	9	41	109.3	176	50

Non-solid Al - electrolytic capacitors
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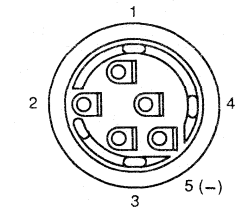
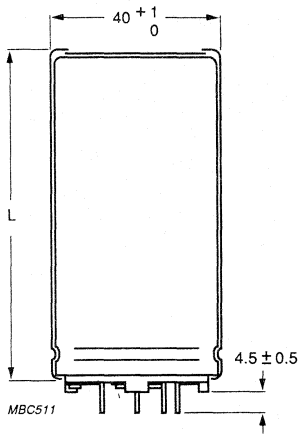




1 = positive terminal; 5 = negative terminal.

Fig.10 Printed wiring pin version, case diameter 40 mm.

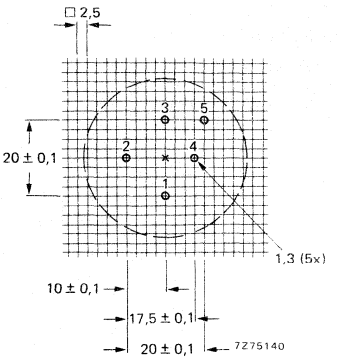


Fig.11 Piercing diagram viewed from component side.

MARKING

- Rated capacitance
- Tolerance on rated capacitance (M for ±20%)
- Rated voltage
- Climatic category (in accordance with IEC 68)
- Date code (year and week) in accordance with IEC 62
- Code for factory of origin
- Name of manufacturer
- Polarity of the terminals and '–' sign to indicate the negative terminal, visible from the top and side of the capacitor
- Code number
- Code for basic specification (in accordance with IEC 384-4-1, CECC 30 301).

Non-solid Al - electrolytic capacitors
Power Economic Printed Wiring

PEC-PW 051/053

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 4 and 5 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz

I_R = rated RMS ripple current at 100 Hz, 85 °C or at 20 kHz, 70 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

ESR = max. equivalent series resistance at 100 Hz

Z = max. impedance at 10 kHz.

Ordering Example

Electrolytic capacitors
PEC-PW 051/053
10 000 µF/25 V, ±20%
Case size 30 x 45 mm;
PW version,
Catalogue number:
2222 051 56103.

Table 4 Electrical data and ordering information for 051 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
10	10 000	25 x 35	1	3.1	5.9	0.60	0.20	51	40	051 54103
	15 000	25 x 45	2	4.1	7.8	0.90	0.30	37	30	051 54153
	22 000	30 x 45	3	5.0	9.5	1.32	0.44	30	25	051 54223
	33 000	35 x 45	4	5.5	10.4	1.98	0.66	28	24	051 54333
	47 000	35 x 55	5	6.8	12.9	2.82	0.94	23	20	051 54473
	47 000	40 x 45	6	5.8	10.4	2.82	0.94	29	22	051 44473
	68 000	40 x 55	7	7.1	13.5	4.08	1.36	24	20	051 54683
	100 000	40 x 75	8	9.2	17.4	6.00	2.00	19	16	051 54104
	150 000	40 x 105	9	12.0	22.7	9.00	3.00	16	14	051 54154
16	6800	25 x 35	1	3.1	5.9	0.65	0.22	53	42	051 55682
	10 000	25 x 45	2	4.0	7.6	0.96	0.32	39	34	051 55103
	15 000	30 x 45	3	5.0	9.5	1.44	0.48	31	27	051 55153
	22 000	35 x 45	4	5.5	10.4	2.12	0.71	29	26	051 55223
	33 000	35 x 55	5	6.7	12.7	3.17	1.06	23	21	051 55333
	33 000	40 x 45	6	5.7	10.8	3.17	1.06	30	24	051 45333
	47 000	40 x 55	7	7.0	13.3	4.52	1.51	24	20	051 55473
	68 000	40 x 75	8	9.2	17.4	6.53	2.18	19	16	051 55683
	100 000	40 x 105	9	12.0	22.7	9.60	3.20	16	14	051 55104
25	4700	25 x 35	1	2.9	5.5	0.71	0.24	60	42	051 56472
	6800	25 x 45	2	3.9	7.4	1.02	0.34	42	34	051 56682
	10 000	30 x 45	3	4.8	9.1	1.50	0.50	34	27	051 56103
	15 000	35 x 45	4	5.3	10.0	2.25	0.75	30	26	051 56153
	22 000	35 x 55	5	6.5	12.3	3.30	1.10	24	21	051 56223
	22 000	40 x 45	6	5.7	10.8	3.30	1.10	31	24	051 46223
	33 000	40 x 55	7	7.0	13.3	4.95	1.65	25	20	051 56333
	47 000	40 x 75	8	9.2	17.4	7.05	2.35	19	16	051 56473
	68 000	40 x 105	9	12.0	22.7	10.20	3.40	16	14	051 56683

Non-solid Al - electrolytic capacitors
Power Economic Printed Wiring

PEC-PW 051/053

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
40	3300	25 x 35	1	2.9	5.5	0.80	0.27	87	63	051 57332
	4700	25 x 45	2	3.8	7.2	1.13	0.38	62	47	051 57472
	6800	30 x 45	3	4.7	8.9	1.64	0.55	49	38	051 57682
	10 000	35 x 45	4	5.2	9.8	2.40	0.80	48	37	051 57103
	15 000	35 x 55	5	6.3	11.9	3.60	1.20	37	28	051 57153
	15 000	40 x 45	6	5.6	10.6	3.60	1.20	50	35	051 47153
	22 000	40 x 55	7	5.8	11.0	5.28	1.76	39	28	051 57223
	33 000	40 x 75	8	7.8	14.8	7.92	2.64	28	21	051 57333
	47 000	40 x 105	9	10.4	19.7	11.28	3.76	22	17	051 57473
63	2200	25 x 35	1	2.5	4.7	0.84	0.28	83	62	051 58222
	3300	25 x 45	2	3.3	6.2	1.25	0.42	58	42	051 58332
	4700	30 x 45	3	4.1	7.8	1.78	0.60	49	38	051 58472
	6800	35 x 45	4	4.5	8.5	2.57	0.86	48	37	051 58682
	10 000	35 x 55	5	5.4	10.2	3.78	1.26	37	28	051 58103
	10 000	40 x 45	6	4.6	8.7	3.78	1.26	52	37	051 48103
	15 000	40 x 75	8	7.5	14.2	5.67	1.89	29	24	051 58153
	22 000	40 x 105	9	10.0	19.0	8.32	2.77	22	19	051 58223
100	680	25 x 35	1	1.74	3.30	0.41	0.14	190	130	051 59681
	1000	25 x 45	2	2.34	4.44	0.60	0.20	130	90	051 59102
	1500	30 x 45	3	2.95	5.59	0.90	0.30	95	67	051 59152
	2200	35 x 45	4	3.69	7.00	1.32	0.44	71	53	051 59222
	3300	35 x 55	5	4.37	8.29	1.98	0.66	55	41	051 59332
	3300	40 x 45	6	4.16	7.89	1.98	0.66	64	48	051 49332
	4700	40 x 55	7	5.21	9.88	2.82	0.94	49	38	051 59472
	6800	40 x 75	8	6.97	13.22	4.08	1.36	35	28	051 59682
	10 000	40 x 105	9	9.50	18.00	6.00	2.00	26	21	051 59103

Note

1. Catalogue number applies to the PW versions; for SL and SLB versions (case size 40 x 45 not available) replace the 8th digit by "1" or "6":
   SL versions: 2222 051/053 1....
   SLB versions: 2222 051/053 6....

Table 5 Electrical data and ordering information for 053 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
200	150	25 x 35	1	0.70	1.33	0.18	0.06	1000	770	053 52151
	220	25 x 45	2	0.94	1.78	0.26	0.09	680	525	053 52221
	330	30 x 45	3	1.27	2.41	0.40	0.14	460	360	053 52331
	470	35 x 45	4	1.66	3.15	0.57	0.19	320	250	053 52471
	680	35 x 55	5	2.19	4.15	0.82	0.28	220	170	053 52681
	680	40 x 45	6	2.17	4.11	0.82	0.28	220	170	053 42681
	1000	40 x 55	7	2.86	5.42	1.20	0.40	150	115	053 52102
	1500	40 x 75	8	3.81	7.22	1.80	0.60	110	85	053 52152
	2200	40 x 105	9	5.20	9.86	2.64	0.88	80	60	053 52222
385	68	25 x 35	1	0.47	0.89	0.16	0.06	2200	1480	053 58689
	100	25 x 45	2	0.64	1.21	0.23	0.08	1500	1020	053 58101
	150	30 x 45	3	0.90	1.71	0.35	0.12	1000	700	053 58151
	220	35 x 45	4	1.15	2.18	0.51	0.17	680	480	053 58221
	330	35 x 55	5	1.53	2.90	0.77	0.26	450	340	053 58331
	330	40 x 45	6	1.52	2.88	0.77	0.26	450	340	053 48331
	470	40 x 55	7	1.96	3.72	1.09	0.36	320	260	053 58471
	680	40 x 75	8	2.70	5.12	1.58	0.53	220	190	053 58681
	1000	40 x 105	9	3.70	7.02	2.31	0.78	180	140	053 58102
400	68	25 x 35	1	0.54	1.02	0.16	0.06	2100	1000	053 56689
	100	25 x 45	2	0.73	1.38	0.24	0.08	1400	780	053 56101
	150	30 x 45	3	0.98	1.86	0.36	0.12	950	520	053 56151
	220	35 x 45	4	1.28	2.43	0.52	0.17	650	400	053 56221
	330	35 x 55	5	1.67	3.17	0.79	0.26	480	280	053 56331
	330	40 x 45	6	1.67	3.17	0.79	0.26	480	280	053 46331
	470	40 x 55	7	2.12	4.02	1.12	0.37	340	220	053 56471
	680	40 x 75	8	2.90	5.50	1.63	0.54	235	155	053 56681
	1000	40 x 105	9	4.05	7.68	2.40	0.80	160	110	053 56102

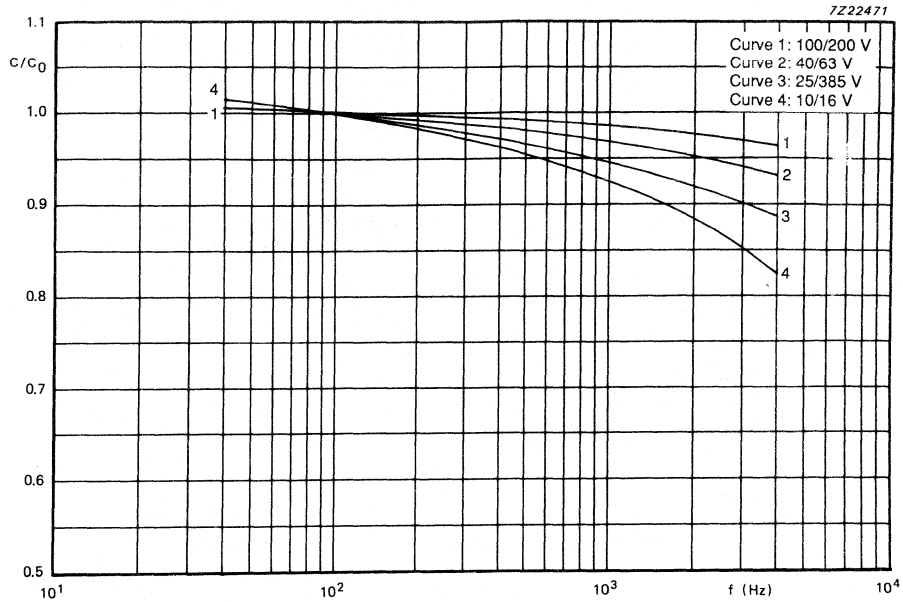
Note

1. Catalogue number applies to the PW versions; for SL and SLB versions (case size 40 x 45 not available) replace the 8th digit by "1" or "6":

   SL versions: 2222 051/053 1....

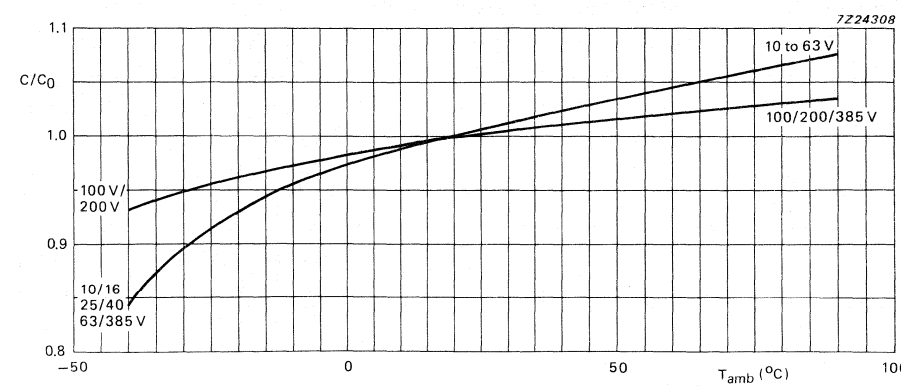
   SLB versions: 2222 051/053 6....

Capacitance (C)



C/C_0 = capacitance at 20 °C and 100 Hz.

Fig.12 Multiplier of typical capacitance (C/C_0) as a function of frequency.



C/C_0 = capacitance at 20 °C and 100 Hz.

Fig.13 Multiplier of typical capacitance (C/C_0) as a function of ambient temperature.

Voltage

Surge voltage for short periods	
≤200 V versions	$U_s = 1.15 \times U_R$
≥385 V versions	$U_s = 1.1 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

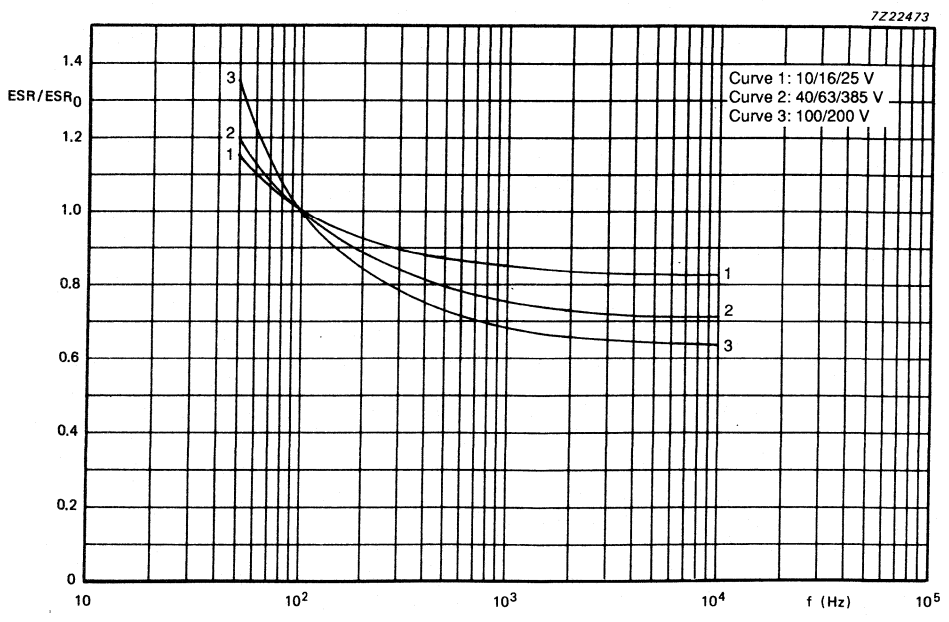
Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

Equivalent series inductance (ESL)

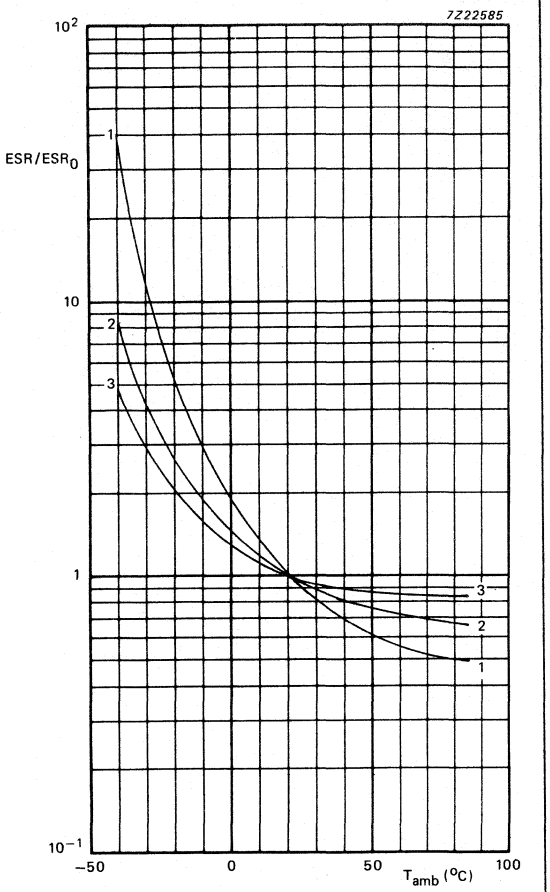
Maximum ESL for case sizes Ø25	25 nH
Maximum ESL for case sizes Ø30 and 35	30 nH
Maximum ESL for case sizes Ø40	35 nH

Equivalent series resistance (ESR)



ESR_0 = typical ESR at 20 °C and 100 Hz.

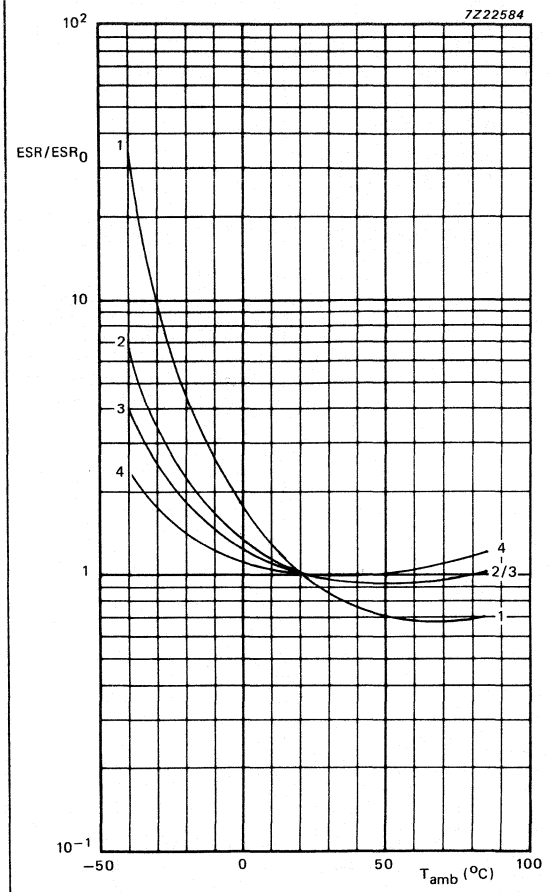
Fig.14 Multiplier of typical ESR (ESR/ESR_0) as a function of frequency.



Curve 1 : 385 V
Curve 2 : 100/200 V
Curve 3 : 10 to 63 V.

ESR_0 = typical ESR at 20 °C and 100 Hz.

Fig.15 Multiplier of typical ESR (ESR/ESR_0) as a function of ambient temperature (case sizes Ø25 x 35, Ø25 x 45, Ø30 x 45 and Ø35 x 45).

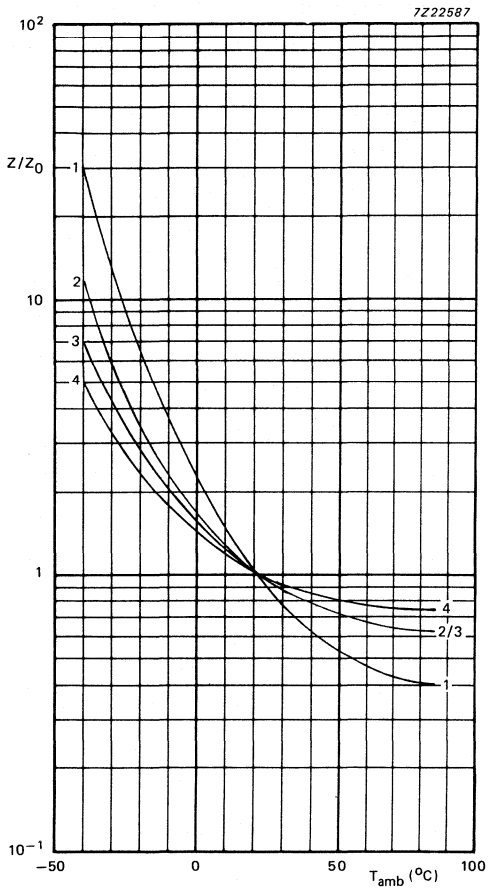


Curve 1 : 385 V
Curve 2 : 200 V
Curve 3 : 100 V
Curve 4 : 10 to 63 V.

ESR_0 = typical ESR at 20 °C and 100 Hz.

Fig.16 Multiplier of typical ESR (ESR/ESR_0) as a function of ambient temperature (case sizes Ø35 x 55, Ø40 x 45, Ø40 x 55, Ø40 x 75 and Ø40 x 105).

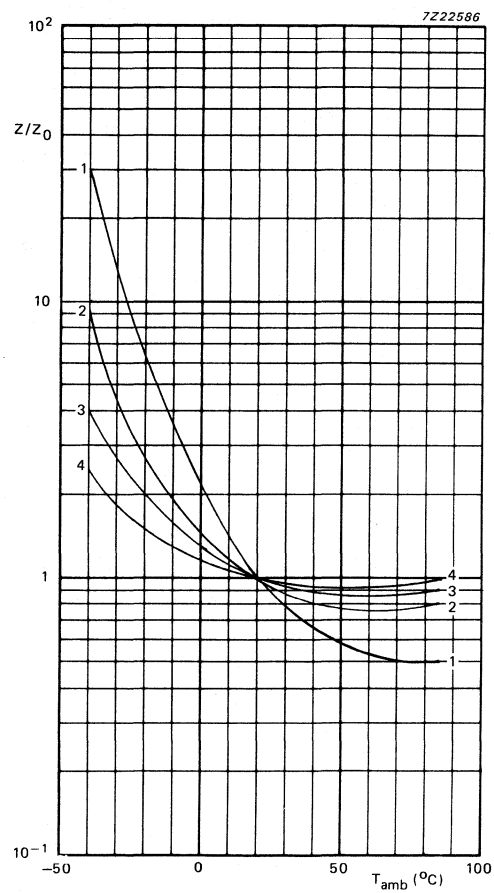
Impedance (Z)



Curve 1 : 385 V
Curve 2 : 200 V
Curve 3 : 100 V
Curve 4 : 10 to 63 V.

Z_0 = typical impedance at 20 °C and 10 kHz.

Fig.17 Multiplier of typical impedance (Z/Z_0) as a function of ambient temperature (case sizes Ø25 x 35, Ø25 x 45, Ø30 x 45 and Ø35 x 45).



Curve 1 : 385 V
Curve 2 : 200 V
Curve 3 : 100 V
Curve 4 : 10 to 63 V.

Z_0 = typical impedance at 20 °C and 10 kHz.

Fig.18 Multiplier of typical impedance (Z/Z_0) as a function of ambient temperature (case sizes Ø35 x 55, Ø40 x 45, Ø40 x 55, Ø40 x 75 and Ø40 x 105).

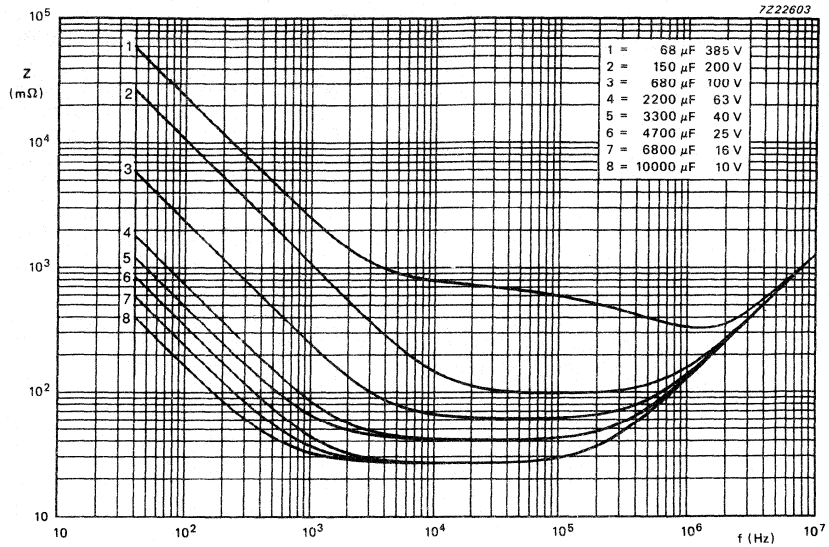


Fig.19 Typical impedance as a function of frequency at +20 °C; case size Ø25 x 35.

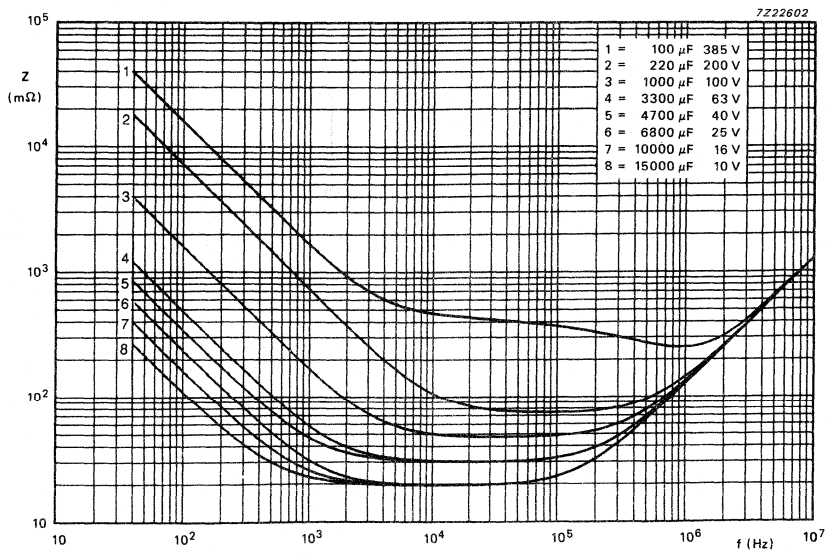


Fig.20 Typical impedance as a function of frequency at +20 °C; case size Ø25 x 45.

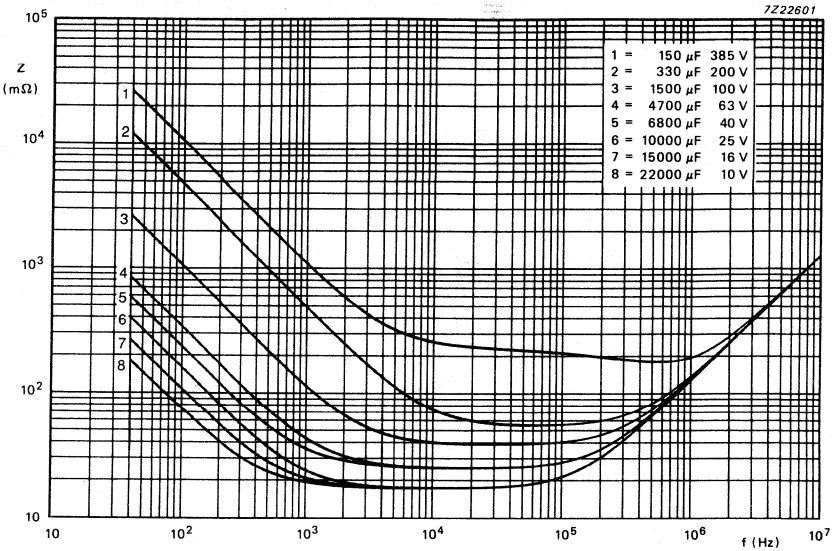


Fig.21 Typical impedance as a function of frequency at +20 °C; case size Ø30 x 45.

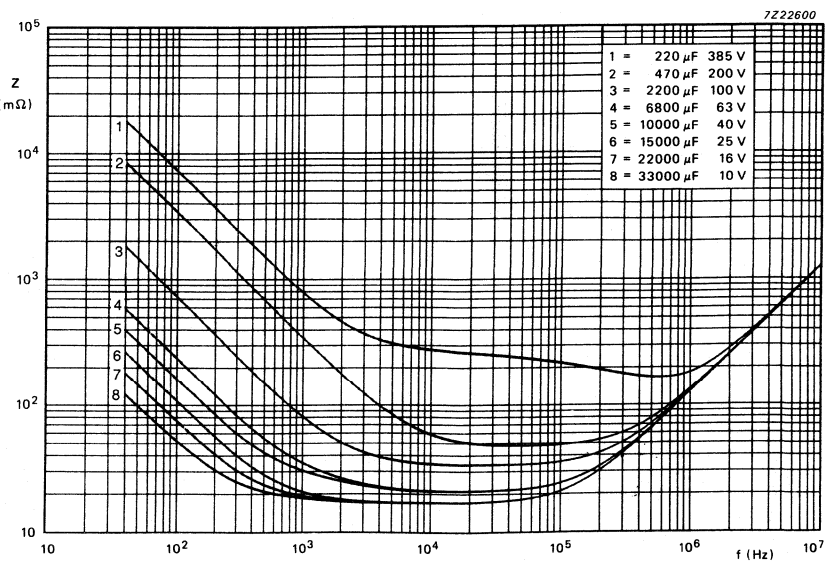


Fig.22 Typical impedance as a function of frequency at +20 °C; case size Ø35 x 45.

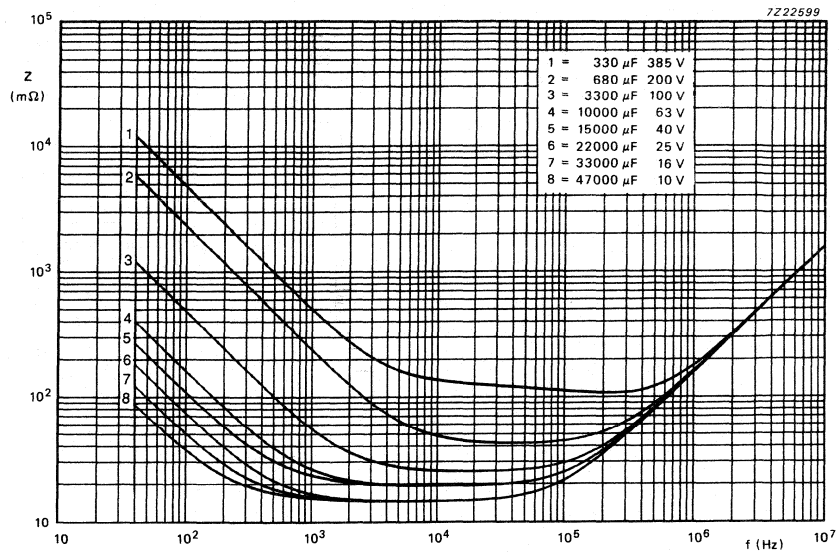


Fig.23 Typical impedance as a function of frequency at +20 °C; case sizes Ø35 x 55 and Ø40 x 45.

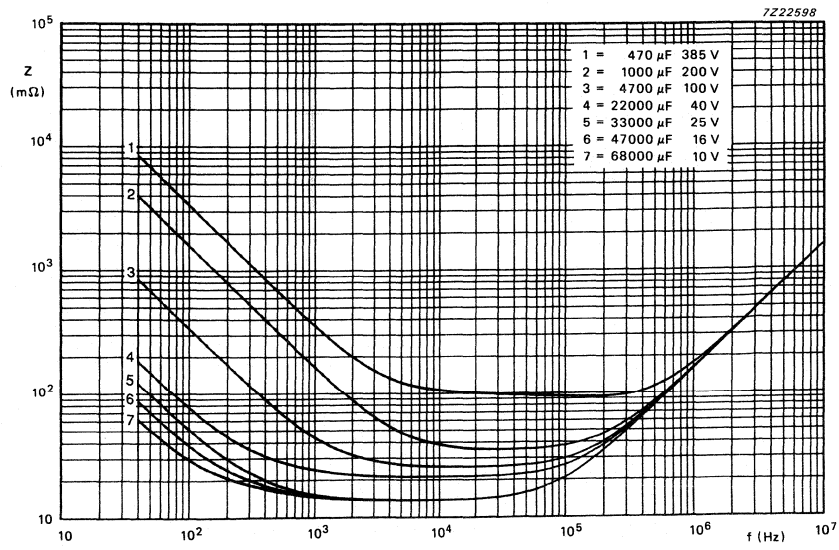


Fig.24 Typical impedance as a function of frequency at +20 °C; case size Ø40 x 55.

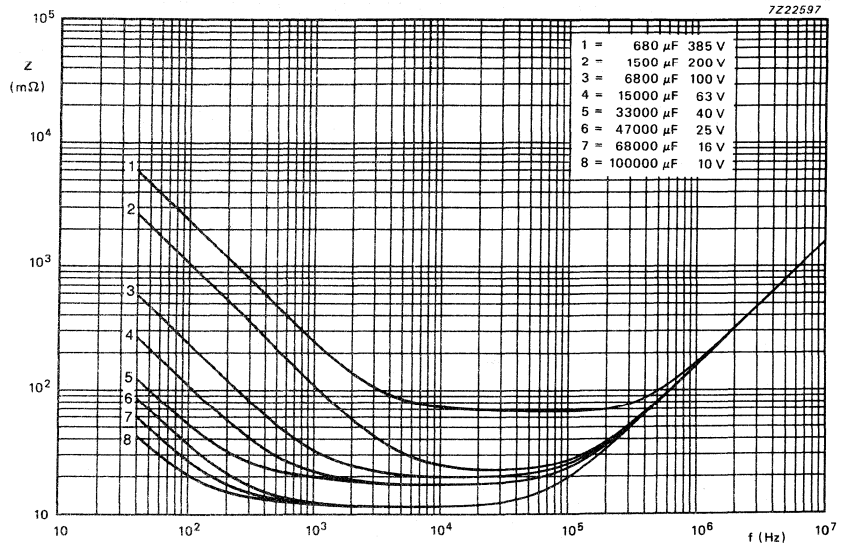


Fig.25 Typical impedance as a function of frequency at +20 °C; case size Ø40 x 75.

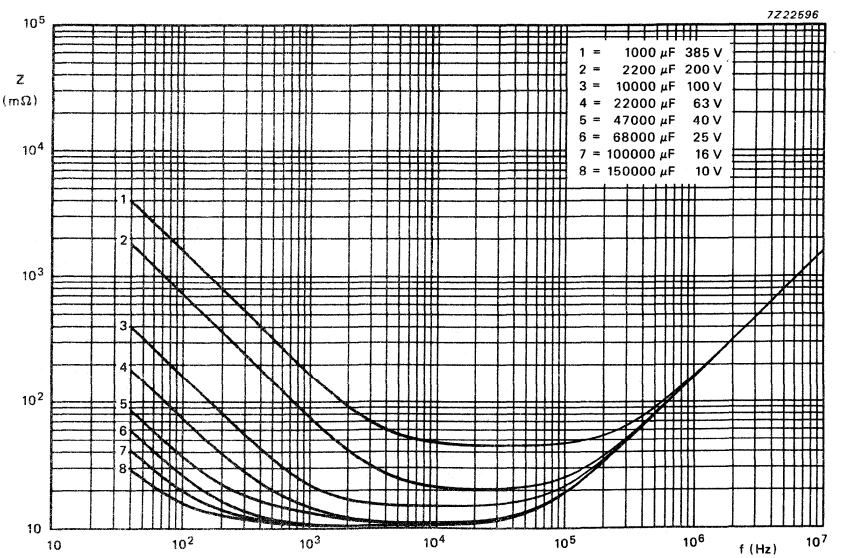
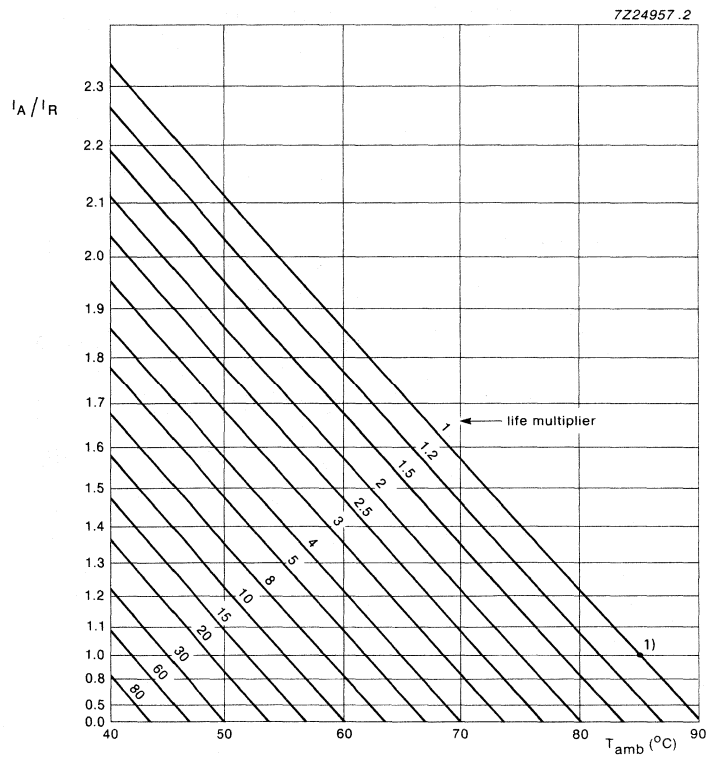


Fig.26 Typical impedance as a function of frequency at +20 °C; case size Ø40 x 105.

RIPPLE CURRENT and USEFUL LIFE

Table 6 Multiplier of ripple current I_R as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.83
100	1.00
200	1.10
400	1.15
1000	1.19
≥2000	1.20



I_A = actual ripple current at 100 Hz and 85 °C.
I_R = rated ripple current at 100 Hz and 85 °C.

1) Useful life at 85 °C and I_R applied: 12 000 hours.

Fig.27 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 7

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied 5000 hours	$U_R \leq 100$ V: $\Delta C/C \leq 15\%$ $U_R > 100$ V: $\Delta C/C \leq 10\%$ tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 15 000 hours	$\Delta C/C \leq 45\%$ ($U_R \leq 100$ V) $\Delta C/C \leq 30\%$ ($U_R > 100$ V) tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage: $U_R \leq 100$ V: ≤1% $U_R > 100$ V: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 group C 5a,4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit I_{L5} ≤2 x spec. limit

Non-solid Al - electrolytic capacitors
Power Eurodin Printed Wiring

PED-PW 050/052

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, cylindrical aluminium case, insulated with a blue sleeve
- Printed wiring versions (PED-PW) with keyed polarity
- Also available in solder-lug (PED-SL) and solder-lug-bolt (PED-SLB) versions
- Safety vent in the bottom of the aluminium case or in the sealing for bolt versions
- Charge and discharge proof
- Very long useful life: 15 000 hours/85 °C
- Low ESR, high ripple current capability
- High resistance to shock and vibration achieved by a special internal construction.

APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.

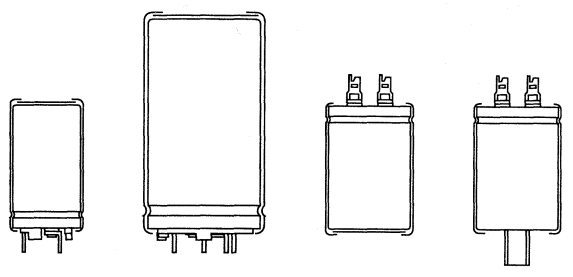


Fig.1 Component outlines.

QUICK REFERENCE DATA

	050	052
Case size ($\varnothing D_{nom}$ x L_{nom} in mm)	25 x 35 to 40 x 105	
Rated capacitance range (E6 series), C_R	47 to 68 000 µF	
Tolerance on C_R	−10 to +30%	
Rated voltage range, U_R	10 to 100 V	250 to 400 V
Category temperature range	−40 to +85 °C	
Endurance test at 85 °C	5000 hours	
Useful life at 85 °C	15 000 hours	
Useful life at U_R, 40 °C and 1.4 x I_R applied	250 000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Basic specifications	IEC 384-4, CECC 30 301, LL grade	
Detail specifications (approved)	DIN 41238 (PW versions)	
Climatic category IEC 68 DIN 40040	 40/085/56 GPF	
Approvals	France: Liste LNZ 4404 CECC 30 301 033 (SL versions) CECC 30 301 805 (PW versions)	

Non-solid Al - electrolytic capacitors
Power Eurodin Printed Wiring

PED-PW 050/052

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD x L in mm**) for 050 series

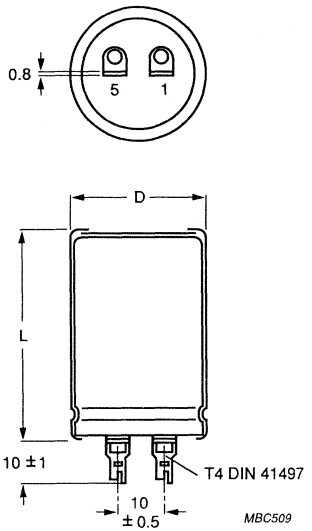
C_R (µF)	U_R (V)					
	10	**16**	**25**	**40**	**63**	**100**
470						25 x 35
680						25 x 45
1000					25 x 35	30 x 45
1500				25 x 35	25 x 45	35 x 45
2200			25 x 35	25 x 45	30 x 45	35 x 55 40 x 45
3300		25 x 35	25 x 45	30 x 45	35 x 45	40 x 55
4700	25 x 35	25 x 45	30 x 45	35 x 45	35 x 55 40 x 45	40 x 75
6800	25 x 45	30 x 45	35 x 45	35 x 55 40 x 45	40 x 55	40 x 105
10 000	30 x 45	35 x 45	35 x 55 40 x 45	40 x 55	40 x 75	
15 000	35 x 45	35 x 55 40 x 45	40 x 55	40 x 75	40 x 105	
22 000	35 x 55 40 x 45	40 x 55	40 x 75	40 x 105		
33 000	40 x 55	40 x 75	40 x 105			
47 000	40 x 75	40 x 105				
68 000	40 x 105					

Table 2 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD x L in mm**) for 052 series

C_R (µF)	U_R (V)		
	250	**385**	**400**
47		25 x 35	25 x 35
68		25 x 45	25 x 45
100	25 x 35	30 x 45	30 x 45
150	25 x 45	35 x 45	35 x 45
220	30 x 45	35 x 55 40 x 45	35 x 55 40 x 45
330	35 x 45	40 x 55	40 x 55
470	35 x 55 40 x 45	40 x 75	40 x 75
680	40 x 55		40 x 105
1000	40 x 75		

MECHANICAL DATA and PACKING QUANTITIES

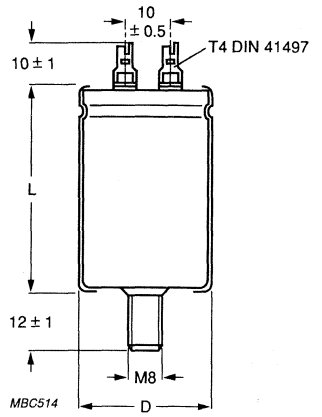
Dimensions in mm.



1 = positive terminal; 5 = negative terminal.

Mounting accessories are specified in the general section.

Fig.2 Solder-lug version (SL).



1 = positive terminal; 5 = negative terminal.

Mounting accessories are specified in the general section.

Fig.3 Solder-lug-bolt version (SLB).

Table 3 SL and SLB versions, dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE				
25 x 35	1	26	36.3	24	100
25 x 45	2	26	46.3	28	100
30 x 45	3	31	46.3	38	100
35 x 45	4	36	46.3	51	50
35 x 55	5	36	56.3	66	50
40 x 55	7	41	56.3	82	50
40 x 75	8	41	76.3	110	50
40 x 105	9	41	106.3	176	50

Non-solid Al - electrolytic capacitors
Power Eurodin Printed Wiring

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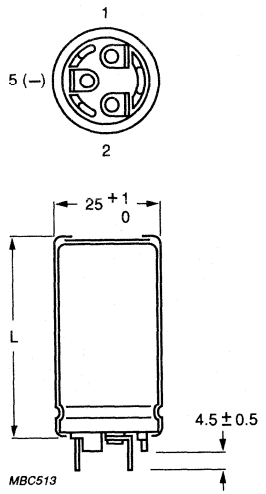


1 = positive terminal; 5 = negative terminal.

Fig.4 Printed wiring pin version, case diameter 25 mm.

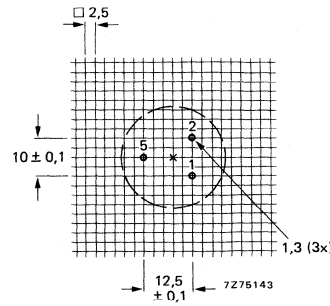
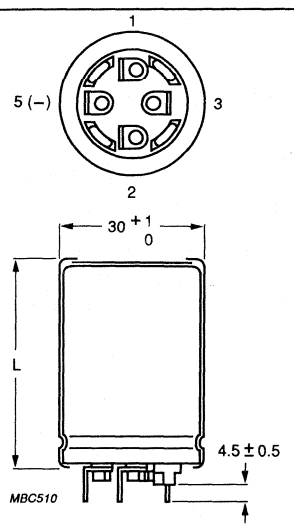


Fig.5 Piercing diagram viewed from component side.



1 = positive terminal; 5 = negative terminal.

Fig.6 Printed wiring pin version, case diameter 30 mm.

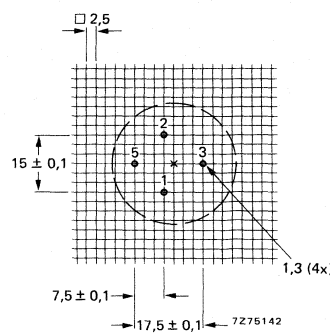
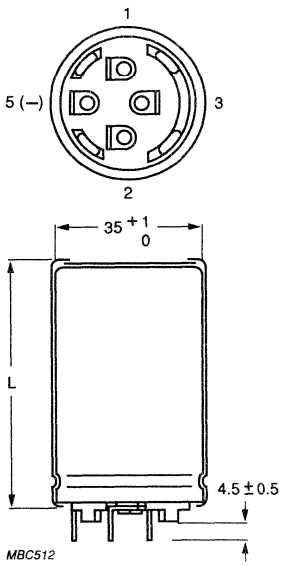


Fig.7 Piercing diagram viewed from component side.

6

Non-solid Al - electrolytic capacitors
Power Eurodin Printed Wiring

PED-PW 050/052



1 = positive terminal; 5 = negative terminal.

Fig.8 Printed wiring pin version, case diameter 35 mm.

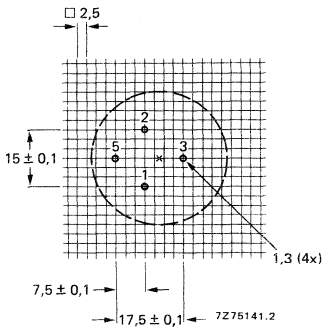


Fig.9 Piercing diagram viewed from component side.

Table 4 PW versions, dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE				
25 x 35	1	26	39.3	24	100
25 x 45	2	26	49.3	28	100
30 x 45	3	31	49.3	38	100
35 x 45	4	36	49.3	51	50
35 x 55	5	36	59.3	66	50
40 x 45	6	41	49.3	78	50
40 x 55	7	41	59.3	82	50
40 x 75	8	41	79.3	110	50
40 x 105	9	41	109.3	176	50

Non-solid Al - electrolytic capacitors
Power Eurodin Printed Wiring

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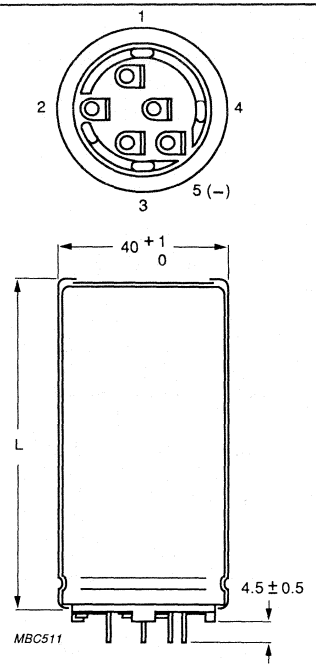


1 = positive terminal; 5 = negative terminal.

Fig.10 Printed wiring pin version, case diameter 40 mm.

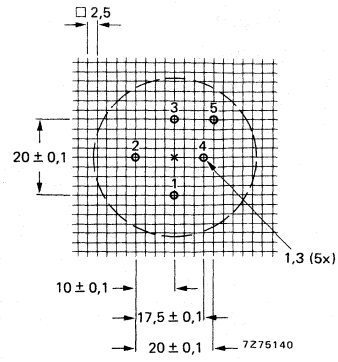


Fig.11 Piercing diagram viewed from component side.

MARKING

- Rated capacitance
- Tolerance on rated capacitance (Q for –10/+30%)
- Rated voltage
- Climatic category (in accordance with IEC 68)
- Date code (year and week) in accordance with IEC 62
- Code for factory of origin
- Name of manufacturer
- Polarity of the terminals and '-' sign to indicate the negative terminal, visible from the top and side of the capacitor
- Code number
- Code for basic specification (in accordance with IEC 384-4-1, CECC 30 301).

Non-solid Al - electrolytic capacitors
Power Eurodin Printed Wiring

PED-PW 050/052

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 5 and 6 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz

I_R = rated RMS ripple current at 100 Hz, 85 °C or at 20 kHz, 70 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

ESR = max. equivalent series resistance at 100 Hz

Z = max. impedance at 10 kHz.

Ordering Example

Electrolytic capacitors
PED-PW 050/052
10 000 µF/25 V, −10/+50%
Case size 35 x 55 mm;
PW version
Catalogue number:
2222 050 56103.

Table 5 Electrical data and ordering information for 050 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
10	4700	25 x 35	1	2.4	4.6	0.28	0.10	74	50	050 54472
	6800	25 x 45	2	3.2	6.1	0.41	0.14	51	37	050 54682
	10 000	30 x 45	3	3.8	7.2	0.60	0.20	39	29	050 54103
	15 000	35 x 45	4	4.1	7.8	0.90	0.30	35	26	050 54153
	22 000	35 x 55	5	5.0	9.5	1.32	0.44	27	21	050 54223
	22 000	40 x 45	6	4.2	8.0	1.32	0.44	36	27	050 44223
	33 000	40 x 55	7	5.0	9.5	1.98	0.66	29	22	050 54333
	47 000	40 x 75	8	6.8	12.9	2.82	0.94	20	17	050 54473
	68 000	40 x 105	9	9.2	17.5	4.08	1.36	15	14	050 54683
16	3300	25 x 35	1	2.4	4.6	0.32	0.11	75	50	050 55332
	4700	25 x 45	2	3.1	5.9	0.45	0.15	52	37	050 55472
	6800	30 x 45	3	3.7	7.0	0.65	0.22	40	30	050 55682
	10 000	35 x 45	4	4.1	7.8	0.96	0.32	36	27	050 55103
	15 000	35 x 55	5	5.0	9.5	1.44	0.48	28	21	050 55153
	15 000	40 x 45	6	4.2	8.0	1.44	0.48	36	27	050 45153
	22 000	40 x 55	7	5.0	9.5	2.12	0.71	29	22	050 55223
	33 000	40 x 75	8	6.7	12.7	3.17	1.06	20	17	050 55333
	47 000	40 x 105	9	9.1	17.3	4.51	1.51	15	14	050 55473
25	2200	25 x 35	1	2.3	4.4	0.33	0.11	78	52	050 56222
	3300	25 x 45	2	3.1	5.9	0.49	0.17	53	38	050 56332
	4700	30 x 45	3	3.7	7.0	0.70	0.24	42	31	050 56472
	6800	35 x 45	4	4.1	7.8	1.02	0.34	37	28	050 56682
	10 000	35 x 55	5	5.0	9.5	1.50	0.50	28	21	050 56103
	10 000	40 x 45	6	4.2	8.0	1.50	0.50	36	27	050 46103
	15 000	40 x 55	7	5.0	9.5	2.25	0.75	29	22	050 56153
	22 000	40 x 75	8	6.8	12.9	3.30	1.10	20	17	050 56223
	33 000	40 x 105	9	9.2	17.5	4.95	1.65	15	14	050 56333

Non-solid Al - electrolytic capacitors
Power Eurodin Printed Wiring

PED-PW 050/052

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
40	1500	25 x 35	1	2.0	3.8	0.36	0.12	112	68	050 57152
	2200	25 x 45	2	2.7	5.1	0.53	0.18	76	51	050 57222
	3300	30 x 45	3	3.3	6.3	0.79	0.27	57	41	050 57332
	4700	35 x 45	4	3.8	7.2	1.13	0.38	48	35	050 57472
	6800	35 x 55	5	4.7	8.9	1.64	0.55	36	27	050 57682
	6800	40 x 45	6	4.1	7.8	1.64	0.55	45	33	050 47682
	10 000	40 x 55	7	4.9	9.3	2.40	0.80	35	27	050 57103
	15 000	40 x 75	8	6.6	12.5	3.60	1.20	25	20	050 57153
	22 000	40 x 105	9	9.0	17.1	5.28	1.76	18	16	050 57223
63	1000	25 x 35	1	1.8	3.4	0.38	0.13	122	74	050 58102
	1500	25 x 45	2	2.5	4.7	0.57	0.19	83	54	050 58152
	2200	30 x 45	3	3.1	5.9	0.83	0.28	57	41	050 58222
	3300	35 x 45	4	3.6	6.8	1.25	0.42	48	35	050 58332
	4700	35 x 55	5	4.4	8.3	1.78	0.60	36	27	050 58472
	4700	40 x 45	6	3.8	7.2	1.78	0.60	45	33	050 48472
	6800	40 x 55	7	4.7	8.9	2.57	0.86	35	27	050 58682
	10 000	40 x 75	8	6.2	11.8	3.78	1.26	25	20	050 58103
	15 000	40 x 105	9	8.5	16.1	5.67	1.89	18	16	050 58153
100	470	25 x 35	1	1.4	2.7	0.28	0.10	247	172	050 59471
	680	25 x 45	2	1.9	3.6	0.41	0.14	170	116	050 59681
	1000	30 x 45	3	2.5	4.7	0.60	0.20	123	88	050 59102
	1500	35 x 45	4	3.1	5.8	0.90	0.30	94	71	050 59152
	2200	35 x 55	5	3.9	7.4	1.32	0.44	69	55	050 59222
	2200	40 x 45	6	3.6	6.8	1.32	0.44	81	65	050 49222
	3300	40 x 55	7	4.6	8.7	1.98	0.66	59	48	050 59332
	4700	40 x 75	8	6.2	11.7	2.82	0.94	42	36	050 59472
	6800	40 x 105	9	8.2	15.5	4.08	1.36	32	28	050 59682

Note

1. Catalogue number applies to the PW versions; for SL and SLB versions (case size 40 x 45 not available) replace the 8th digit by "1" or "6":

   SL versions: 2222 050/052 1....

   SLB versions: 2222 050/052 6....

Table 6 Electrical data and ordering information for 052 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
250	100	25 x 35	1	0.6	1.15	0.15	0.05	1800	1300	052 53101
	150	25 x 45	2	0.8	1.5	0.23	0.08	1100	850	052 53151
	220	30 x 45	3	1.0	1.9	0.33	0.11	750	550	052 53221
	330	35 x 45	4	1.4	2.65	0.49	0.17	500	400	052 53331
	470	35 x 55	5	1.8	3.4	0.70	0.24	360	290	052 53471
	470	40 x 45	6	1.8	3.4	0.70	0.24	420	350	052 43471
	680	40 x 55	7	2.3	4.4	1.02	0.34	250	190	052 53681
	1000	40 x 75	8	3.0	5.7	1.50	0.50	170	140	052 53102
385	47	25 x 35	1	0.4	0.75	0.11	0.04	2800	2200	052 58479
	68	25 x 45	2	0.6	1.15	0.16	0.06	1700	1350	052 58689
	100	30 x 45	3	0.8	1.5	0.23	0.08	1100	850	052 58101
	150	35 x 45	4	1.0	1.9	0.34	0.11	725	525	052 58151
	220	35 x 55	5	1.3	2.45	0.50	0.17	500	350	052 58221
	220	40 x 45	6	1.3	2.45	0.50	0.17	600	420	052 48221
	330	40 x 55	7	1.7	3.2	0.75	0.25	340	230	052 58331
	470	40 x 75	8	2.8	5.3	1.06	0.36	240	160	052 58471
400	47	25 x 35	1	0.51	0.96	0.11	0.04	1830	1140	052 56479
	68	25 x 45	2	0.68	1.29	0.16	0.06	1270	795	052 56689
	100	30 x 45	3	0.92	1.74	0.24	0.08	860	480	052 56101
	150	35 x 45	4	1.24	2.35	0.36	0.12	570	325	052 56151
	220	35 x 55	5	1.60	3.00	0.52	0.17	410	255	052 56221
	220	40 x 45	6	1.60	3.00	0.52	0.17	410	255	052 46221
	330	40 x 55	7	2.09	3.96	0.79	0.26	280	182	052 56331
	470	40 x 75	8	2.82	5.35	1.12	0.37	200	130	052 56471
	680	40 x 105	9	3.93	7.45	1.63	0.54	140	90	052 56681

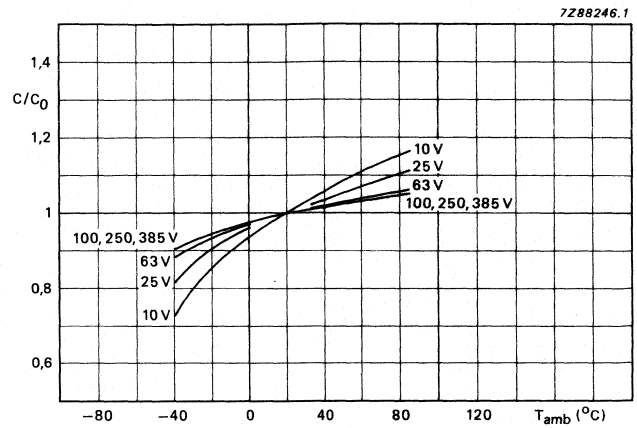
Note

1) Catalogue number applies to the PW versions; for SL and SLB versions (case size 40 x 45 not available) replace the 8th digit by "1" or "6":

SL versions: 2222 050/052 1....

SLB versions: 2222 050/052 6....

Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

Fig.12 Multiplier of capacitance (C/C_0) as a function of ambient temperature.

Voltage

Surge voltage for short periods	
≤250 V versions	$U_s = 1.15 \times U_R$
≥385 V versions	$U_s = 1.1 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

Equivalent series inductance (ESL)

Maximum ESL for case sizes Ø25 mm	25 nH
Maximum ESL for case sizes Ø30 and 35 mm	30 nH
Maximum ESL for case sizes Ø40 mm	35 nH

Equivalent series resistance (ESR)

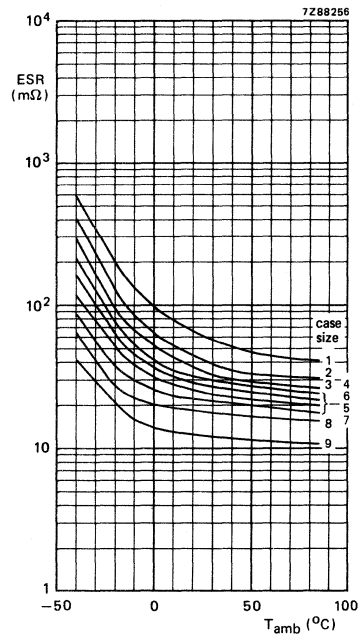


Fig.13 Typical ESR as a function of temperature at 100 Hz and U_R = 10 V.

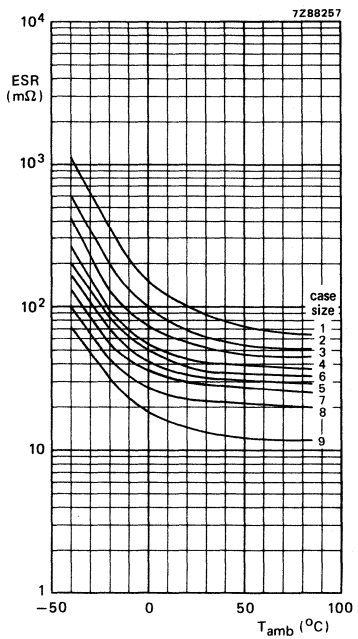


Fig.14 Typical ESR as a function of temperature at 100 Hz and U_R = 63 V.

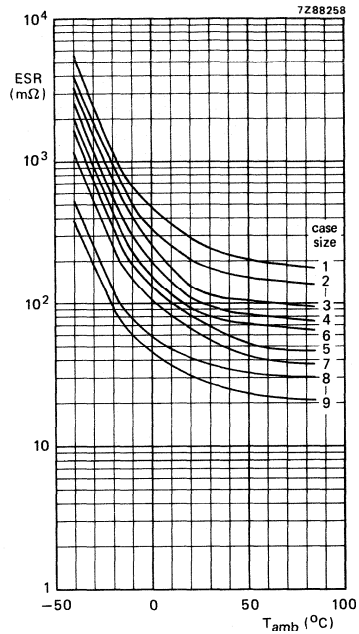


Fig.15 Typical ESR as a function of temperature at 100 Hz and U_R = 100 V.

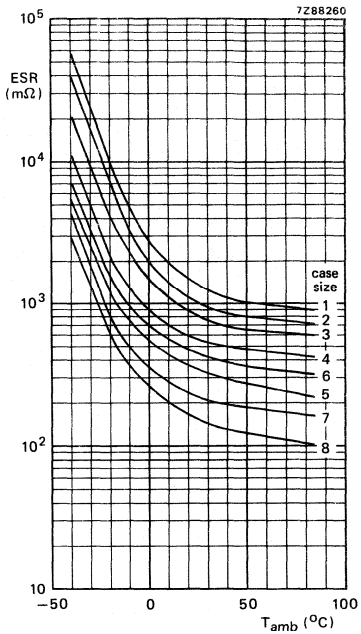


Fig.16 Typical ESR as a function of temperature at 100 Hz and U_R = 385 V.

6

Impedance (Z)

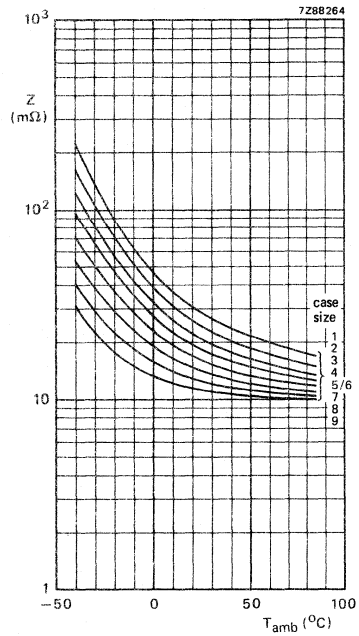


Fig.17 Typical impedance as a function of temperature at 10 kHz and U_R = 10 V.

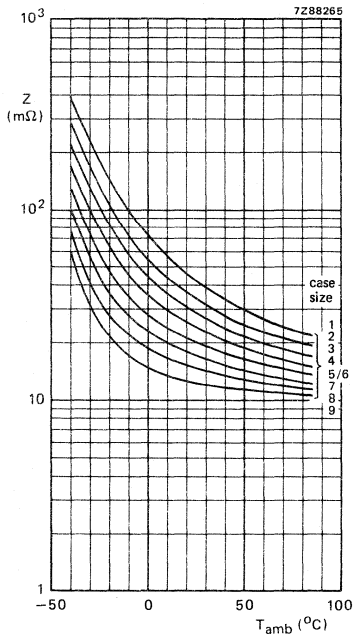


Fig.18 Typical impedance as a function of temperature at 10 kHz and U_R = 63 V.

6

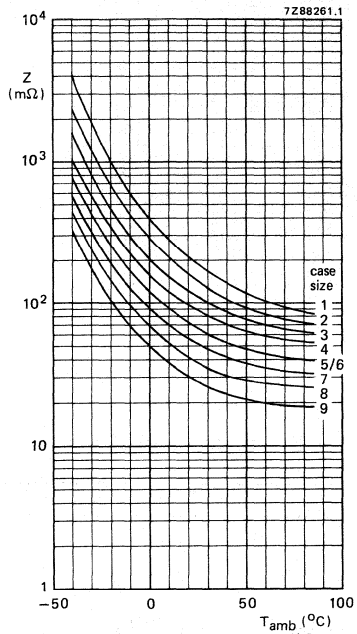


Fig.19 Typical impedance as a function of temperature at 10 kHz and U_R = 100 V.

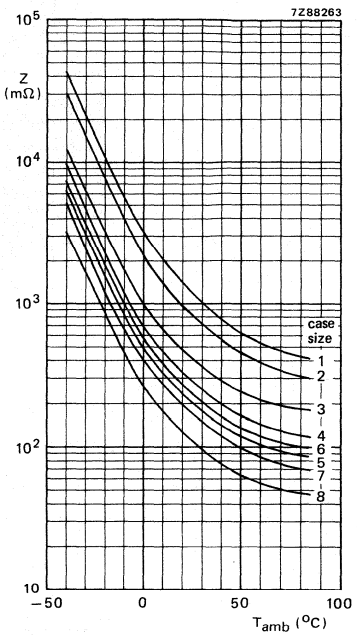
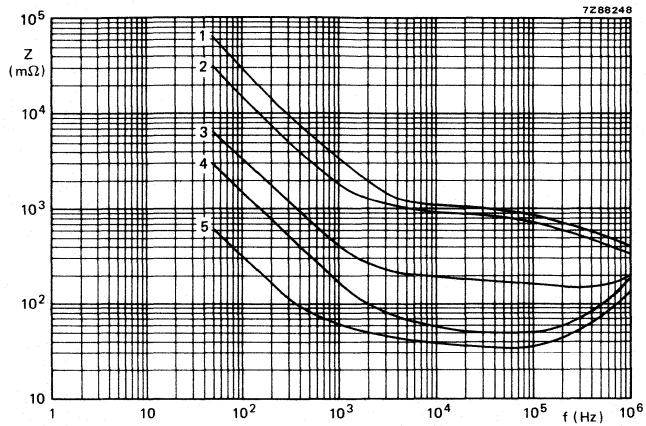
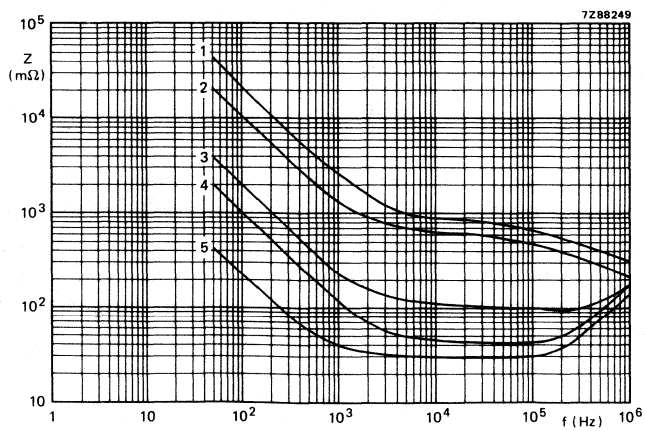


Fig.20 Typical impedance as a function of temperature at 10 kHz and U_R = 385 V.



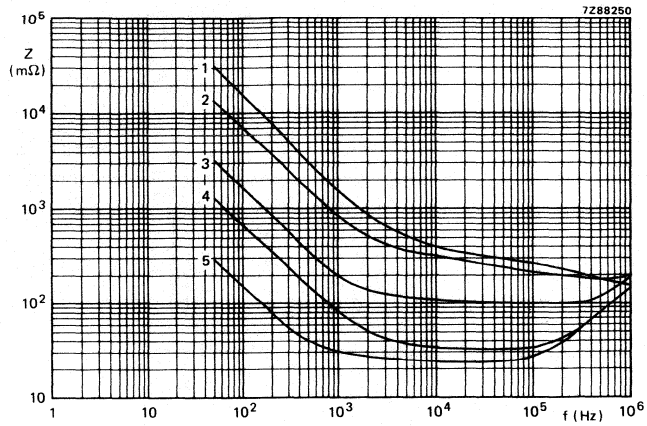
Curve 1 : 47 µF, 385 V
Curve 2 : 100 µF, 250 V
Curve 3 : 470 µF, 100 V
Curve 4 : 1000 µF, 63 V
Curve 5 : 4700 µF, 10 V.

Fig.21 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø25 x 35.



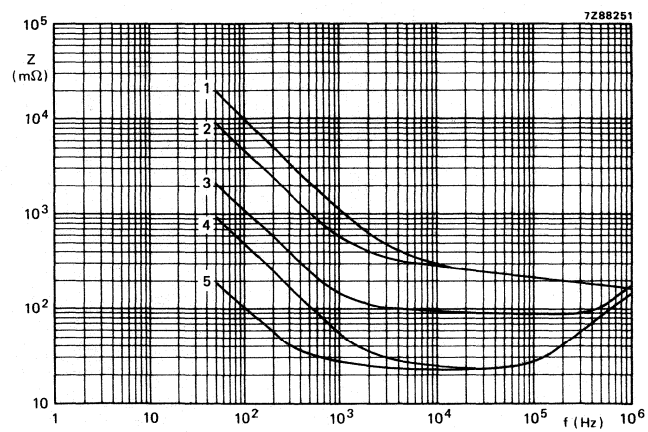
Curve 1 : 68 µF, 385 V
Curve 2 : 150 µF, 250 V
Curve 3 : 680 µF, 100 V
Curve 4 : 1500 µF, 63 V
Curve 5 : 6800 µF, 10 V.

Fig.22 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø25 x 45.



Curve 1 : 100 µF, 385 V
Curve 2 : 220 µF, 250 V
Curve 3 : 1000 µF, 100 V
Curve 4 : 2200 µF, 63 V
Curve 5 : 10 000 µF, 10 V.

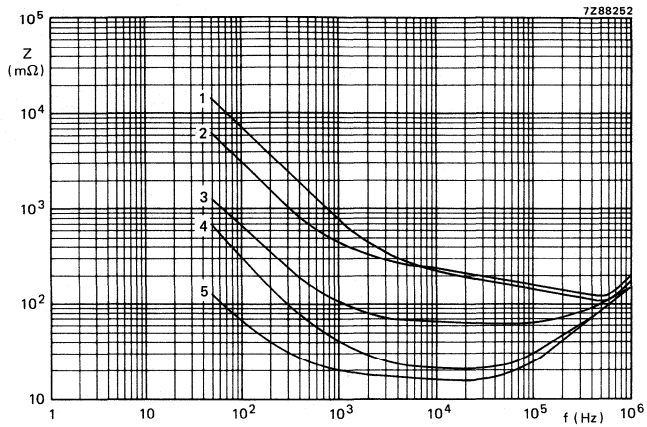
Fig.23 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø30 x 45.



Curve 1 : 150 µF, 385 V
Curve 2 : 330 µF, 250 V
Curve 3 : 1500 µF, 100 V
Curve 4 : 3300 µF, 63 V
Curve 5 : 15 000 µF, 10 V.

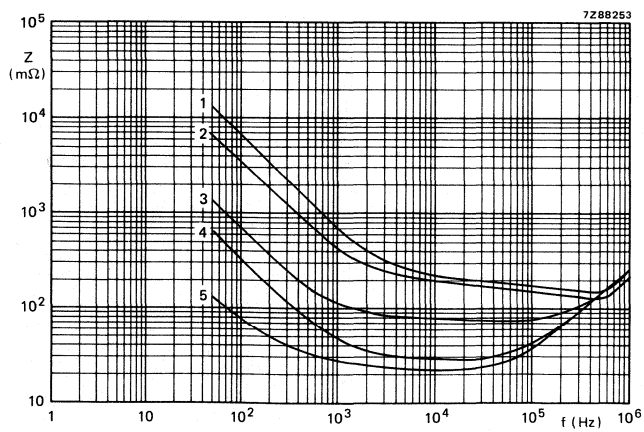
Fig.24 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 45.

6



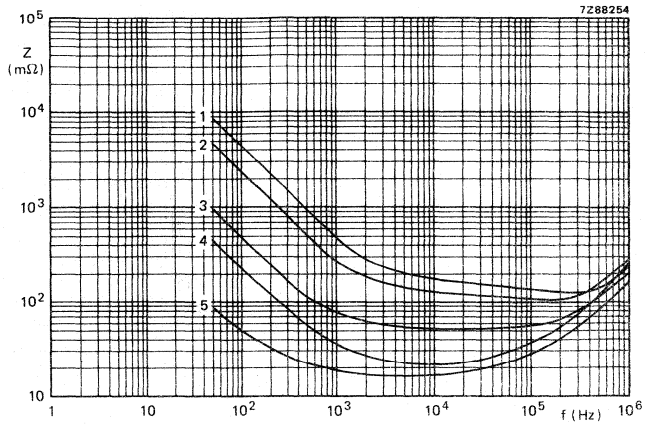
Curve 1 : 220 µF, 385 V
Curve 2 : 470 µF, 250 V
Curve 3 : 2200 µF, 100 V
Curve 4 : 4700 µF, 63 V
Curve 5 : 22 000 µF, 10 V.

Fig.25 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 55.



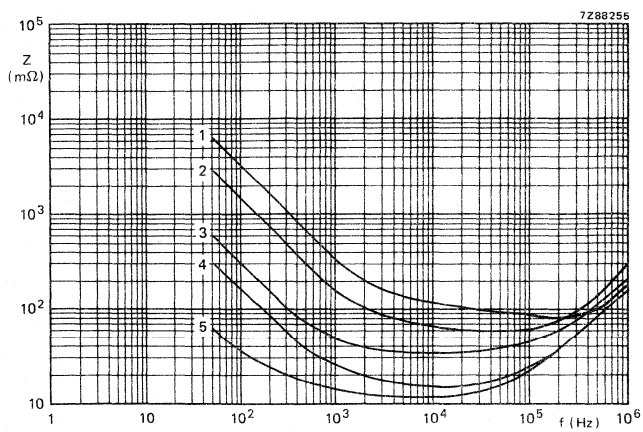
Curve 1 : 220 µF, 385 V
Curve 2 : 470 µF, 250 V
Curve 3 : 2200 µF, 100 V
Curve 4 : 4700 µF, 63 V
Curve 5 : 22 000 µF, 10 V.

Fig.26 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø40 x 45.



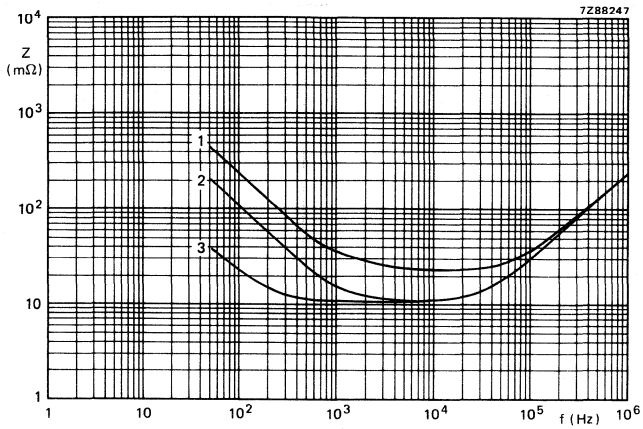
Curve 1 : 330 µF, 385 V
Curve 2 : 680 µF, 250 V
Curve 3 : 3300 µF, 100 V
Curve 4 : 6800 µF, 63 V
Curve 5 : 33 000 µF, 10 V.

Fig.27 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø40 x 55.



Curve 1 : 470 µF, 385 V
Curve 2 : 1000 µF, 250 V
Curve 3 : 4700 µF, 100 V
Curve 4 : 10 000 µF, 63 V
Curve 5 : 47 000 µF, 10 V.

Fig.28 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø40 x 75.



Curve 1 : 6800 µF, 100 V
Curve 2 : 15 000 µF, 63 V
Curve 3 : 68 000 µF, 10 V.

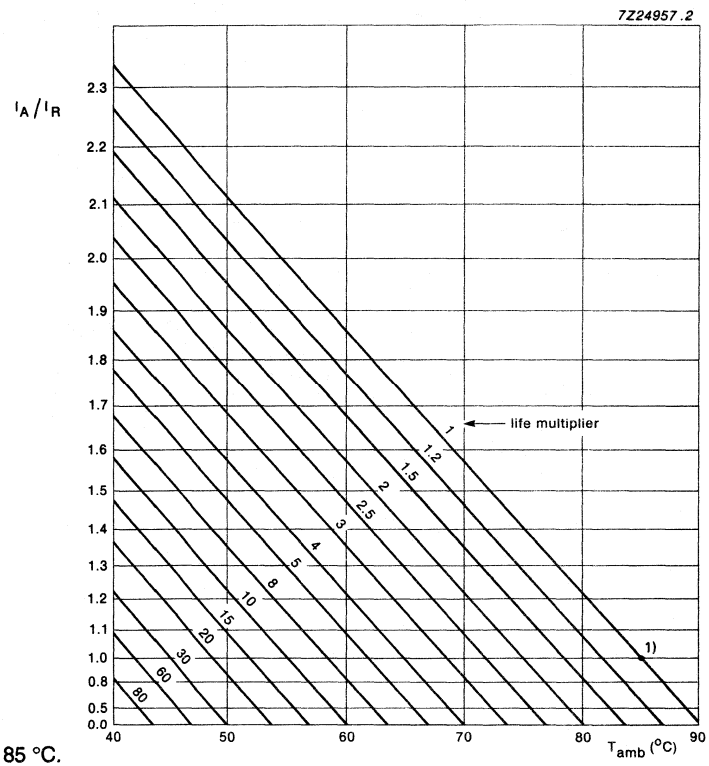
Fig.29 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø40 x 105.

6

RIPPLE CURRENT and USEFUL LIFE

Table 7 Multiplier of ripple current I_R as a function of frequency.

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.83
100	1.00
200	1.10
400	1.15
1000	1.19
≥2000	1.20



I_A = actual ripple current at 100 Hz and 85 °C.
I_R = rated ripple current at 100 Hz and 85 °C.

1) Useful life at 85 °C and I_R applied: 15 000 hours.

Fig.30 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 8

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied 5000 hours	$U_R \leq 100$ V: $\Delta C/C \leq 15\%$ $U_R > 100$ V: $\Delta C/C \leq 10\%$ tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 15 000 hours	$\Delta C/C \leq 45\%$ ($U_R \leq 100$ V) $\Delta C/C \leq 30\%$ ($U_R > 100$ V) tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage: $U_R \leq 100$ V: ≤1% $U_R > 100$ V: ≤3%
Shelf life (storage at high temp).	IEC 384-4-1/ CECC 30 301 group C 5a,4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit $I_{L5} \leq 2$ x spec. limit

Electrolytic Capacitors

Notes

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Printed wiring versions (PLL-PW) with keyed polarity
- Also available in solder-lug (PLL-SL) and solder-lug-bolt (PLL-SLB) versions
- Safety vent in the bottom of the aluminium case, or in the sealing for bolt versions
- Charge and discharge proof
- Very long useful life: 5000 hours/105 °C
- Low ESR, high ripple current capability
- Extended temperature range 105 °C
- High resistance to shock and vibration achieved by a special internal construction.

APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.

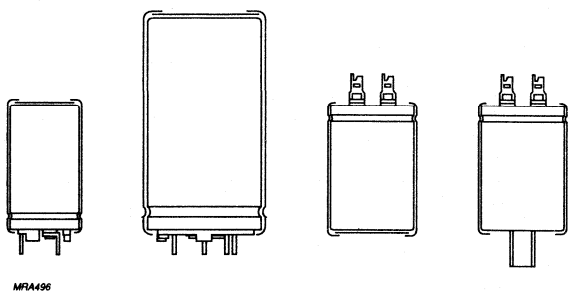


Fig.1 Component outlines.

QUICK REFERENCE DATA

	162	163
Case size ($\varnothing D_{nom}$ x L_{nom} in mm)	25 x 35 to 40 x 105	
Rated capacitance range (E6 series), C_R	68 to 150 000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	10 to 100 V	160 to 400 V
Category temperature range	–40 to +105 °C	
Endurance test at 105 °C	2000 hours	
Useful life at 105 °C	5000 hours	
Useful life at U_R, 40 °C, 1.9 x I_R applied	150 000 hours	
Shelf life at 0 V, 105 °C	500 hours	
Basic specifications	IEC 384-4, CECC 30 301, LL grade	
Detail specification	similar to DIN 41238	
Climatic category IEC 68 DIN 40040	 40/105/56 GMF	

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD x L in mm**) for 162 series

C_R (µF)	U_R (V)							
	10	**16**	**25**	**35**	**40**	**50**	**63**	**100**
470								25 x 35
680								25 x 45
1000							25 x 35	30 x 45
1500						25 x 35	25 x 45	35 x 45
2200					25 x 35	25 x 45	30 x 45	35 x 55 40 x 45
3300				25 x 35	25 x 45	30 x 45	35 x 45	40 x 55
4700			25 x 35	25 x 45	30 x 45	35 x 45	35 x 55 40 x 45	40 x 75
6800		25 x 35	25 x 45	30 x 45	35 x 45	35 x 55 40 x 45	40 x 55	40 x 105
10 000	25 x 35	25 x 45	30 x 45	35 x 45	35 x 55 40 x 45	40 x 55	40 x 75	
15 000	25 x 45	30 x 45	35 x 45	35 x 55 40 x 45	40 x 55	40 x 75	40 x 105	
22 000	30 x 45	35 x 45	35 x 55 40 x 45	40 x 55	40 x 75	40 x 105		
33 000	35 x 45	35 x 55 40 x 45	40 x 55	40 x 75	40 x 105			
47 000	35 x 55 40 x 45	40 x 55	40 x 75	40 x 105				
68 000	40 x 55	40 x 75	40 x 105					
100 000	40 x 75	40 x 105						
150 000	40 x 105							

Table 2 Selection chart for C_R, U_R and relevant nominal case sizes (**∅D x L** in **mm**) for 163 series

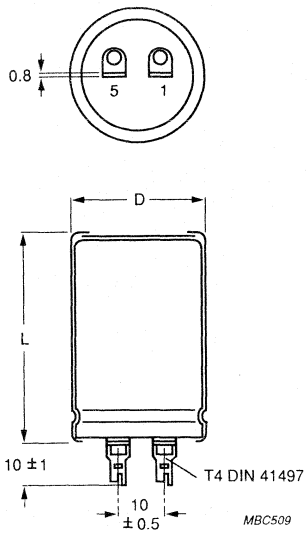
C_R (µF)	U_R (V)				
	160	**200**	**250**	**385**	**400**
68				25 x 35	25 x 35
100			25 x 35	25 x 45	25 x 45
150		25 x 35	25 x 45	30 x 45	30 x 45
220	25 x 35	25 x 45	30 x 45	35 x 45	35 x 45
330	25 x 45	30 x 45	35 x 45	35 x 55 40 x 45	35 x 55 40 x 45
470	30 x 45	35 x 45	35 x 55 40 x 45	40 x 55	40 x 55
680	35 x 45	35 x 55 40 x 45	40 x 55	40 x 75	40 x 75
1000	35 x 55 40 x 45	40 x 55	40 x 75	40 x 105	40 x 105
1500	40 x 55	40 x 75	40 x 105		
2200	40 x 75	40 x 105			
3300	40 x 105				

MARKING

- Rated capacitance
- Tolerance on rated capacitance (M for ±20%)
- Rated voltage
- Climatic category (in accordance with IEC 68)
- Date code (year and week) in accordance with IEC 62
- Code for factory of origin
- Name of manufacturer
- Polarity of the terminals and '–' sign to indicate the negative terminal, visible from the top and side of the capacitor
- Code number
- Code for basic specification (in accordance with IEC 384-4-1,CECC 30 301).

MECHANICAL DATA and PACKING QUANTITIES

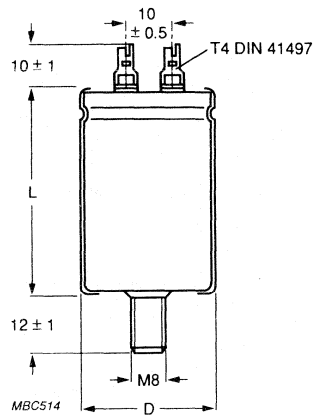
Dimensions in mm.



1 = positive terminal; 5 = negative terminal.

Mounting accessories are specified in the general section.

Fig.2 Solder-lug version (SL).



1 = positive terminal; 5 = negative terminal.

Mounting accessories are specified in the general section.

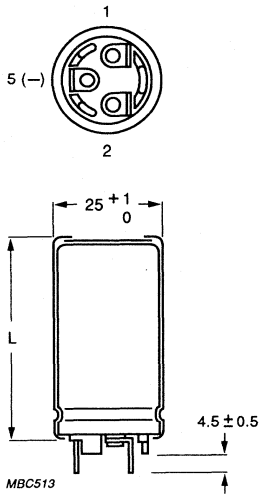
Fig.3 Solder-lug-bolt version (SLB).

Table 3 SL and SLB versions, dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE				
25 x 35	1	26	36.3	24	100
25 x 45	2	26	46.3	28	100
30 x 45	3	31	46.3	38	100
35 x 45	4	36	46.3	51	50
35 x 55	5	36	56.3	66	50
40 x 55	7	41	56.3	82	50
40 x 75	8	41	76.3	110	50
40 x 105	9	41	106.3	176	50

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163



1 = positive terminal; 5 = negative terminal.

Fig.4 Printed wiring pin version, case diameter 25 mm.

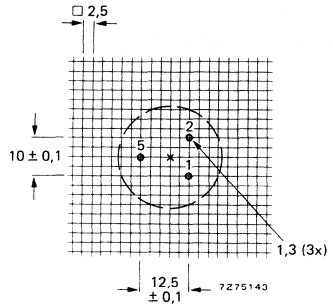
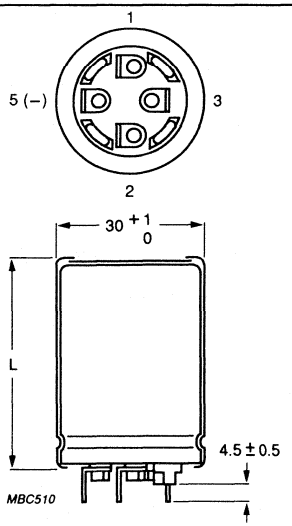


Fig.5 Piercing diagram viewed from component side.



1 = positive terminal; 5 = negative terminal.

Fig.6 Printed wiring pin version, case diameter 30 mm.

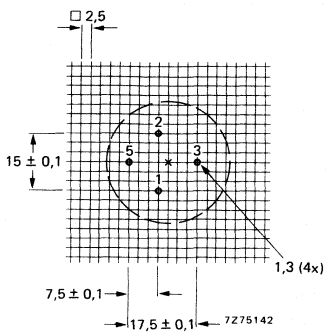
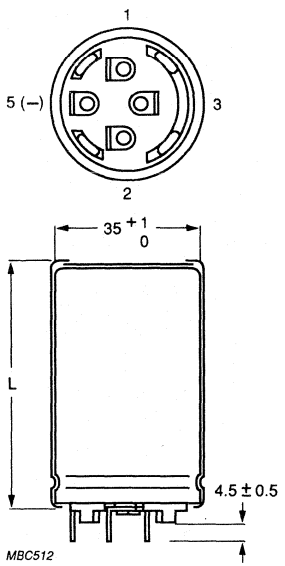


Fig.7 Piercing diagram viewed from component side.

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163



1 = positive terminal; 5 = negative terminal.

Fig.8 Printed wiring pin version, case diameter 35 mm.

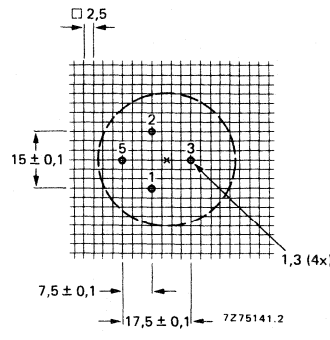
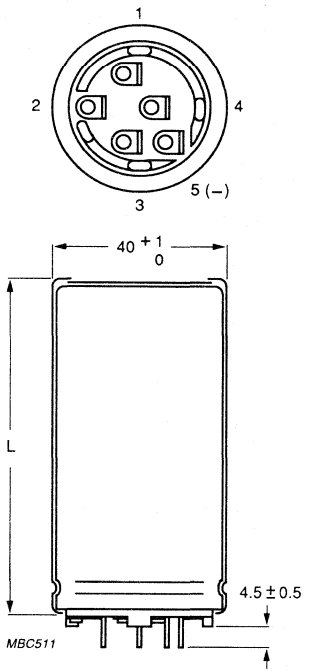


Fig.9 Piercing diagram viewed from component side.

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163



1 = positive terminal; 5 = negative terminal.

Fig.10 Printed wiring pin version, case diameter 40 mm.

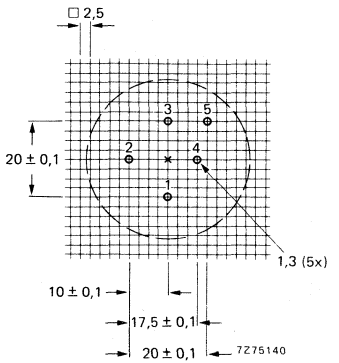


Fig.11 Piercing diagram viewed from component side.

6

Table 4 PW versions, dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE				
25 x 35	1	26	39.3	24	100
25 x 45	2	26	49.3	28	100
30 x 45	3	31	49.3	38	100
35 x 45	4	36	49.3	51	50
35 x 55	5	36	59.3	66	50
40 x 45	6	41	49.3	78	50
40 x 55	7	41	59.3	82	50
40 x 75	8	41	79.3	110	50
40 x 105	9	41	109.3	176	50

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 5 and 6 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz

I_R = rated RMS ripple current at 100 Hz, 105 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

ESR = max. equivalent series resistance at 100 Hz

Z = max. impedance at 10 kHz.

Ordering Example

Electrolytic capacitors
PLL - PW 162/163
10 000 µF/25 V, ±20%
Case size 30 x 45 mm;
PW version
Catalogue number:
2222 162 56103.

Table 5 Electrical data and ordering information for 162 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
10	10 000	25 x 35	1	3.17	0.60	0.20	48	37	162 54103
	15 000	25 x 45	2	4.21	0.90	0.30	34	27	162 54153
	22 000	30 x 45	3	5.05	1.32	0.44	29	23	162 54223
	33 000	35 x 45	4	5.63	1.98	0.66	27	22	162 54333
	47 000	35 x 55	5	6.19	2.82	0.94	26	21	162 54473
	47 000	40 x 45	6	6.19	2.82	0.94	26	21	162 44473
	68 000	40 x 55	7	7.64	4.08	1.36	21	18	162 54683
	100 000	40 x 75	8	10.0	6.00	2.00	16	15	162 54104
	150 000	40 x 105	9	12.9	9.00	3.00	13	12	162 54154
16	6800	25 x 35	1	3.11	0.65	0.22	50	37	162 55682
	10 000	25 x 45	2	4.09	0.96	0.32	36	27	162 55103
	15 000	30 x 45	3	4.97	1.44	0.48	30	23	162 55153
	22 000	35 x 45	4	5.53	2.12	0.71	29	22	162 55223
	33 000	35 x 55	5	6.08	3.17	1.06	28	21	162 55333
	33 000	40 x 45	6	6.08	3.17	1.06	28	21	162 45333
	47 000	40 x 55	7	7.46	4.52	1.51	22	18	162 55473
	68 000	40 x 75	8	9.70	6.53	2.18	17	15	162 55683
	100 000	40 x 105	9	12.90	9.60	3.20	13	12	162 55104
25	4700	25 x 35	1	2.94	0.71	0.24	56	37	162 56472
	6800	25 x 45	2	3.93	1.02	0.34	39	27	162 56682
	10 000	30 x 45	3	4.81	1.50	0.50	32	23	162 56103
	15 000	35 x 45	4	5.43	2.25	0.75	30	22	162 56153
	22 000	35 x 55	5	5.98	3.30	1.10	29	21	162 56223
	22 000	40 x 45	6	5.98	3.30	1.10	29	21	162 46223
	33 000	40 x 55	7	7.30	4.95	1.65	23	18	162 56333
	47 000	40 x 75	8	9.43	7.05	2.35	18	15	162 56473
	68 000	40 x 105	9	12.44	10.20	3.40	14	12	162 56683

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
35	3300	25 x 35	1	2.61	0.69	0.24	71	42	162 50332
	4700	25 x 45	2	3.44	0.99	0.33	51	31	162 50472
	6800	30 x 45	3	4.20	1.43	0.48	42	28	162 50682
	10 000	35 x 45	4	4.65	2.10	0.70	41	27	162 50103
	15 000	35 x 55	5	5.09	3.15	1.09	40	26	162 50153
	15 000	40 x 45	6	5.09	3.15	1.09	40	26	162 40153
	22 000	40 x 55	7	6.18	4.62	1.54	32	22	162 50223
	33 000	40 x 75	8	8.34	6.93	2.31	23	17	162 50333
	47 000	40 x 105	9	10.97	9.87	3.29	18	14	162 50473
40	2200	25 x 35	1	2.36	0.53	0.18	87	54	162 57222
	3300	25 x 45	2	3.17	0.79	0.27	60	38	162 57332
	4700	30 x 45	3	3.93	1.13	0.38	48	33	162 57472
	6800	35 x 45	4	4.59	1.63	0.55	42	31	162 57682
	10 000	35 x 55	5	5.03	2.40	0.80	41	29	162 57103
	10 000	40 x 45	6	5.03	2.40	0.80	41	29	162 47103
	15 000	40 x 55	7	6.09	3.60	1.20	33	24	162 57153
	22 000	40 x 75	8	8.34	5.28	1.76	23	18	162 57223
	33 000	40 x 105	9	10.97	7.92	2.64	18	15	162 57333
50	1500	25 x 35	1	2.14	0.45	0.15	106	60	162 51152
	2200	25 x 45	2	2.86	0.66	0.22	74	42	162 51222
	3300	30 x 45	3	3.64	0.99	0.33	56	34	162 51332
	4700	35 x 45	4	4.34	1.41	0.47	47	31	162 51472
	6800	35 x 55	5	4.91	2.04	0.68	43	29	162 51682
	6800	40 x 45	6	4.91	2.04	0.68	43	29	162 41682
	10 000	40 x 55	7	6.00	3.00	1.00	34	34	162 51103
	15 000	40 x 75	8	8.17	4.50	1.50	24	18	162 51153
	22 000	40 x 105	9	10.97	6.60	2.20	18	15	162 51223
63	1000	25 x 35	1	1.55	0.38	0.13	202	155	162 58102
	1500	25 x 45	2	2.10	0.57	0.19	137	109	162 58152
	2200	30 x 45	3	2.72	0.83	0.28	100	79	162 58222
	3300	35 x 45	4	3.44	1.25	0.42	75	61	162 58332
	4700	35 x 55	5	4.09	1.78	0.60	62	53	162 58472
	4700	40 x 45	6	4.09	1.78	0.60	62	53	162 48472
	6800	40 x 55	7	5.10	2.57	0.86	47	40	162 58682
	10 000	40 x 75	8	6.86	3.78	1.26	34	29	162 58103
	15 000	40 x 105	9	9.31	5.67	1.89	25	21	162 58153

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
100	470	25 x 35	1	1.42	0.28	0.10	240	155	162 59471
	680	25 x 45	2	1.90	0.41	0.14	167	109	162 59681
	1000	30 x 45	3	2.48	0.60	0.20	120	79	162 59102
	1500	35 x 45	4	3.17	0.90	0.30	88	61	162 59152
	2200	35 x 55	5	3.79	1.32	0.44	72	53	162 59222
	2200	40 x 45	6	3.79	1.32	0.44	72	53	162 49222
	3300	40 x 55	7	4.81	1.98	0.66	53	40	162 59332
	4700	40 x 75	8	6.49	2.82	0.94	38	29	162 59472
	6800	40 x 105	9	8.80	4.08	1.36	28	21	162 59682

Note

1. Catalogue number applies to the PW versions; for SL and SLB versions (case size 40 x 45 not available) replace the 8th digit by "1" or "6":

   SL versions: 2222 162/163 1....

   SLB versions: 2222 162/163 6....

Table 6 Electrical data and ordering information for 163 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
160	220	25 x 35	1	0.83	0.21	0.07	710	540	163 51221
	330	25 x 45	2	1.12	0.32	0.10	477	360	163 51331
	470	30 x 45	3	1.47	0.45	0.15	345	265	163 51471
	680	35 x 45	4	1.88	0.65	0.22	250	195	163 51681
	1000	35 x 55	5	2.35	0.96	0.32	188	152	163 51102
	1000	40 x 45	6	2.35	0.96	0.32	188	152	163 41102
	1500	40 x 55	7	3.05	1.44	0.48	132	109	163 51152
	2200	40 x 75	8	4.17	2.11	0.70	92	75	163 51222
	3300	40 x 105	9	5.86	3.17	1.06	63	53	163 51332
200	150	25 x 35	1	0.72	0.18	0.06	950	710	163 52151
	220	25 x 45	2	0.96	0.26	0.09	650	485	163 52221
	330	30 x 45	3	1.29	0.40	0.14	442	330	163 52331
	470	35 x 45	4	1.66	0.57	0.19	321	240	163 52471
	680	35 x 55	5	2.09	0.82	0.28	237	185	163 52681
	680	40 x 45	6	2.09	0.82	0.28	237	185	163 42681
	1000	40 x 55	7	2.71	1.20	0.40	167	133	163 52102
	1500	40 x 75	8	3.75	1.80	0.60	114	90	163 52152
	2200	40 x 105	9	5.24	2.64	0.88	79	62	163 52222
250	100	25 x 35	1	0.67	0.15	0.05	1060	710	163 53101
	150	25 x 45	2	0.92	0.22	0.08	710	485	163 53151
	220	30 x 45	3	1.28	0.33	0.11	492	330	163 53221
	330	35 x 45	4	1.65	0.49	0.17	325	240	163 53331
	470	35 x 55	5	2.01	0.70	0.24	256	185	163 53471
	470	40 x 45	6	2.01	0.70	0.24	256	185	163 43471
	680	40 x 55	7	2.59	1.02	0.34	182	133	163 53681
	1000	40 x 75	8	3.58	1.50	0.50	125	90	163 53102
	1500	40 x 105	9	5.05	2.25	0.75	85	62	163 53152
385	68	25 x 35	1	0.61	0.16	0.06	1650	1260	163 58689
	100	25 x 45	2	0.82	0.23	0.08	1120	855	163 58101
	150	30 x 45	3	1.10	0.35	0.12	755	580	163 58151
	220	35 x 45	4	1.44	0.51	0.17	525	405	163 58221
	330	35 x 55	5	1.84	0.77	0.26	360	280	163 58331
	330	40 x 45	6	1.84	0.77	0.26	360	280	163 48331
	470	40 x 55	7	2.37	1.09	0.36	260	205	163 58471
	680	40 x 75	8	3.24	1.58	0.53	180	140	163 58681
	1000	40 x 105	9	4.54	2.31	0.78	125	100	163 58102

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
400	68	25 x 35	1	0.39	0.16	0.06	3200	2660	163 56689
	100	25 x 45	2	0.53	0.24	0.08	2180	1810	163 56101
	150	30 x 45	3	0.72	0.36	0.12	1460	1210	163 56151
	220	35 x 45	4	0.94	0.52	0.17	1010	830	163 56221
	330	35 x 55	5	1.24	0.79	0.26	680	570	163 56331
	330	40 x 45	6	1.24	0.79	0.26	680	570	163 46331
	470	40 x 55	7	1.59	1.12	0.37	485	407	163 56471
	680	40 x 75	8	2.18	1.63	0.54	336	282	163 56681
	1000	40 x 105	9	3.07	2.40	0.80	230	193	163 56102

Note

1. Catalogue number applies to the PW versions; for SL and SLB versions (case size 40 x 45 not available) replace the 8th digit by "1" or "6":
   SL versions: 2222 162/163 1....
   SLB versions: 2222 162/163 6....

Equivalent series inductance (ESL)

Maximum ESL for case sizes Ø25	25 nH
Maximum ESL for case sizes Ø30 and 35	30 nH
Maximum ESL for case sizes Ø40	35 nH

Voltage

Surge voltage for short periods	
≤200 V versions	$U_s = 1.15 \times U_R$
≥385 V versions	$U_s = 1.1 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

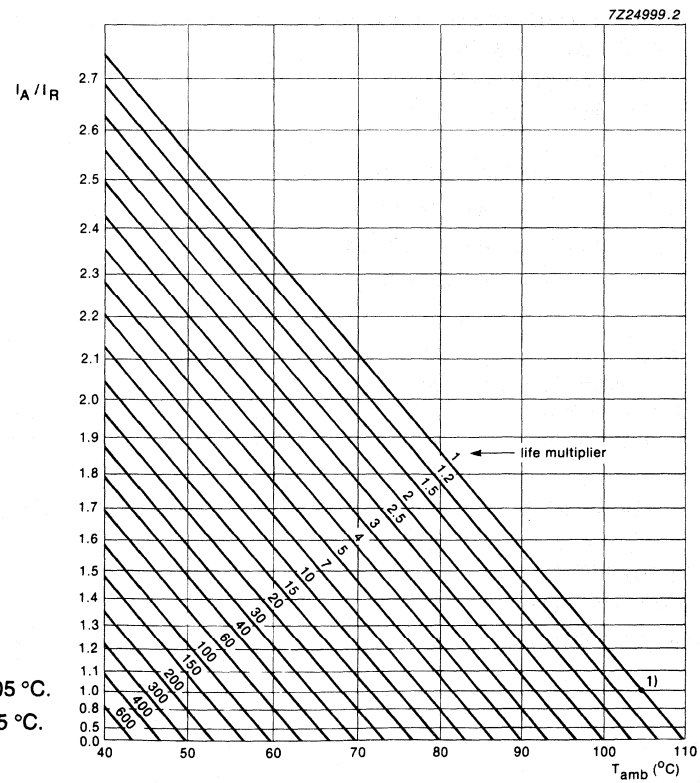
Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

RIPPLE CURRENT and USEFUL LIFE

Table 7 Multiplier of ripple current I_R as a function of frequency.

FREQUENCY (Hz)	I_R MULITPLIER		
	U_R = 10-35 V	U_R = 40-100 V	U_R = 160- 400 V
50	0.93	0.91	0.86
100	1.00	1.00	1.00
200	1.04	1.05	1.13
400	1.07	1.09	1.21
1000	1.11	1.13	1.29
2000	1.13	1.15	1.32
4000	1.15	1.18	1.35
≥10 000	1.18	1.22	1.40



I_A = actual ripple current at 100 Hz and 105 °C.
I_R = rated ripple current at 100 Hz and 105 °C.

1) Useful life at 105 °C I_R applied: 5000 hours.

Fig.12 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 8

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 105 °C, U_R applied 2000 hours	$U_R \leq 100$ V: $\Delta C/C \leq 15\%$ $U_R > 100$ V: $\Delta C/C \leq 10\%$ tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 5000 hours	$\Delta C/C \leq 45\%$ ($U_R \leq 100$ V) $\Delta C/C \leq 30\%$ ($U_R > 100$ V) tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage: $U_R \leq 100$ V: ≤1% $U_R > 100$ V: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 group C 5a,4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit $I_{L5} \leq 2$ x spec. limit

Non-solid Al - electrolytic capacitors
Power Economic Screw Terminals

PEC-ST 154/155

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Also available in bolt version (PEC-STB)
- Safety vent in the sealing
- Charge and discharge proof
- Long useful life: 12 000 hours/85 °C
- High ripple current capability
- High resistance to shock and vibration achieved by longitudinal rills and special internal construction.

APPLICATIONS

- General purpose, computer and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.

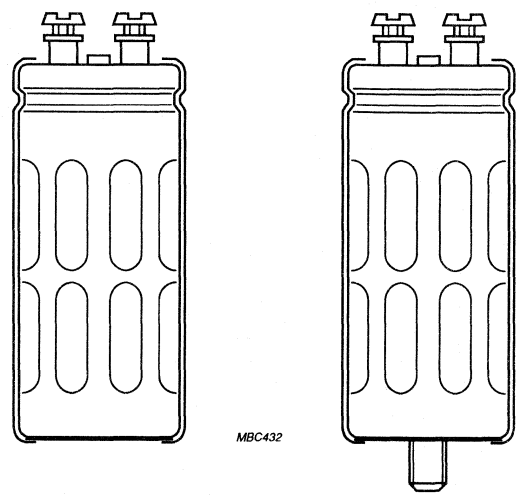


Fig.1 Component outlines.

QUICK REFERENCE DATA

	154	155
Case size ($\varnothing D_{nom}$ x L_{nom} in mm)	35 x 60 to 75 x 105	
Rated capacitance range (E6 series), C_R	220 to 470 000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	10 to 100 V	160 to 400 V
Category temperature range	–40 to +85 °C	
Endurance test at 85 °C	5000 hours	
Useful life at 85 °C	12 000 hours	
Useful life at U_R, 40 °C, 1.4 x I_R applied	200 000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Basic specifications	IEC 384-4-1, CECC 30 301, LL grade	
Climatic category IEC 68 DIN 40040	40/085/56 GPF	

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**∅D x L** in **mm**) for 154 series

C_R (μF)	U_R (V)					
	10	**16**	**25**	**40**	**63**	**100**
3300						35 x 60
4700						35 x 80
6800					35 x 60	35 x 105
10 000					35 x 80	50 x 80
15 000				35 x 60	35 x 105	50 x 105
22 000			35 x 60	35 x 80	50 x 80	65 x 105
33 000		35 x 60	35 x 80	50 x 80	50 x 105	75 x 105
47 000	35 x 60	35 x 80	35 x 105	50 x 80	65 x 105	
68 000	35 x 80	35 x 105	50 x 80	50 x 105	75 x 105	
100 000	35 x 105	50 x 80	50 x 105	65 x 105		
150 000	50 x 80	50 x 105	65 x 105	75 x 105		
220 000	50 x 105	65 x 105	75 x 105			
330 000	65 x 105	75 x 105				
470 000	75 x 105					

Table 2 Selection chart for C_R, U_R and relevant nominal case sizes (**∅D x L** in **mm**) for 155 series

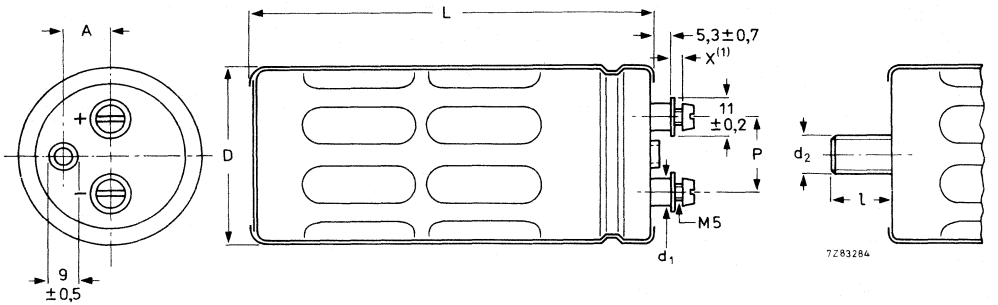
C_R (μF)	U_R (V)					
	160	**200**	**250**	**350**	**385**	**400**
220					35 x 60	35 x 60
330				35 x 60	35 x 80	35 x 80
470			35 x 60	35 x 80	35 x 80	35 x 80
680		35 x 60	35 x 80	35 x 105	35 x 105	35 x 105
1000	35 x 60	35 x 80	35 x 105	50 x 80	50 x 80	50 x 80
1500	35 x 80	35 x 105	50 x 80	50 x 105	50 x 105	50 x 105
2200	35 x 105	50 x 80	50 x 105	65 x 105	65 x 105	65 x 105
3300	50 x 80	50 x 105	65 x 105	65 x 105	75 x 105	75 x 105
4700	50 x 105	65 x 105	65 x 105			
6800	65 x 105	65 x 105	75 x 105			
10 000	65 x 105	75 x 105				

Non-solid Al - electrolytic capacitors
Power Economic Screw Terminals

PEC-ST 154/155

MECHANICAL DATA and PACKING QUANTITIES

Dimensions in mm.



Maximum permissible torque which may be applied to the termination screws at various heights (dimension x in drawing):

4 Nm for x = 3

3 Nm for x = 6.

For mounting accessories see data handbook PA01, Electrolytic Capacitors.

The capacitors are delivered with screws and washers.

Fig.2 Screw terminal/screw terminal bolt.

Table 3 Dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	P (tol. ±0.1)	A	d_1 (tol. ±0.2)	d_2 x l	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE								
35 x 60	10	36.5	63	13.0	8.4	8	M8 x 12	55	25
35 x 80	11	36.5	83	13.0	8.4	8	M8 x 12	80	25
35 x 105	12a	36.5	108	13.0	8.4	8	M8 x 12	110	25
50 x 80	14	51.5	83	22.0	14.3	8	M12 x 16	160	25
50 x 105	15a	51.5	108	22.0	14.3	8	M12 x 16	210	25
65 x 105	16a	66.5	108	28.5	19.0	9.6	M12 x 16	370	10
75 x 105	17	76.5	108	32.0	21.0	9.6	M12 x 16	535	10

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 4 and 5 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz

I_R = rated RMS ripple current at 100 Hz, 85 °C and 20 kHz, 70 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

ESR = typical equivalent series resistance at 100 Hz

Z = impedance at 20 kHz.

Ordering Example

Electrolytic capacitors, PEC-ST 154/155

10 000 µF/63 V, ±20%

Case size 35 x 80 mm, ST version

Catalogue number: 2222 154 18103.

Table 4 Electrical data and ordering information for 154 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Typ. Z 20 kHz (mΩ)	Max. Z 20 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
10	47 000	35 x 60	8.4	15.9	2.82	0.94	11	11	16.5	154 14473
	68 000	35 x 80	8.7	16.5	4.08	1.36	14	9	13.5	154 14683
	100 000	35 x 105	10.7	20.3	6.00	2.00	10.5	8	12	154 14104
	150 000	50 x 80	13.2	25.0	9.00	3.00	8	8	12	154 14154
	220 000	50 x 105	16.5	31.4	13.20	4.40	6.5	7	10.5	154 14224
	330 000	65 x 105	20.8	39.5	19.80	6.60	5.5	7	10.5	154 14334
	470 000	75 x 105	22.6	42.9	28.20	9.40	5.5	7	10.5	154 14474
16	33 000	35 x 60	8.4	15.9	3.17	1.06	11	10	15	154 15333
	47 000	35 x 80	8.7	16.5	4.51	1.51	14	9	13.5	154 15473
	68 000	35 x 105	12.2	23.2	6.53	2.18	8	8	12	154 15683
	100 000	50 x 80	13.2	25.0	9.60	3.20	8	8	12	154 15104
	150 000	50 x 105	14.9	28.3	14.40	4.80	8	7	10.5	154 15154
	220 000	65 x 105	20.8	39.5	21.10	7.04	5.5	7	10.5	154 15224
	330 000	75 x 105	22.6	42.9	31.70	10.60	5.5	7	10.5	154 15334
25	22 000	35 x 60	8.1	15.4	3.30	1.10	12	10	15	154 16223
	33 000	35 x 80	9.6	18.2	4.95	1.65	10	9	13.5	154 16333
	47 000	35 x 105	12.2	23.2	7.05	2.35	8	8	12	154 16473
	68 000	50 x 80	13.2	25.0	10.20	3.40	8	8	12	154 16683
	100 000	50 x 105	15.9	30.2	15.00	5.00	7	8	12	154 16104
	150 000	65 x 105	19.7	37.4	22.50	7.50	7	8	12	154 16154
	220 000	75 x 105	22.6	42.9	33.00	11.00	5.5	7	10.5	154 16224

Non-solid Al - electrolytic capacitors
Power Economic Screw Terminals

PEC-ST 154/155

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Typ. Z 20 kHz (mΩ)	Max. Z 20 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
40	15 000	35 x 60	7.7	14.6	3.60	1.20	13	10	15	154 17153
	22 000	35 x 80	9.8	18.6	5.28	1.76	11	9	13.5	154 17223
	33 000	50 x 80	11.8	22.4	7.92	2.64	10	9	13.5	154 17333
	47 000	50 x 80	11.8	22.4	11.30	3.76	10	9	13.5	154 17473
	68 000	50 x 105	14.1	26.8	16.30	5.44	9	8	12	154 17683
	100 000	65 x 105	17.3	32.9	24.00	8.00	9	8	12	154 17104
	150 000	75 x 105	20.8	39.5	36.00	12.00	6.5	7	10.5	154 17154
63	6800	35 x 60	6.6	12.5	2.57	0.86	17	13	19	154 18682
	10 000	35 x 80	8.6	16.3	3.78	1.26	12.5	10	15	154 18103
	15 000	35 x 105	10.9	20.7	5.67	1.89	10	9	13.5	154 18163
	22 000	50 x 80	11.8	22.4	8.32	2.77	10	9	13.5	154 18223
	33 000	50 x 105	14.1	26.8	12.50	4.16	9	8	12	154 18333
	47 000	65 x 105	17.3	32.9	17.80	5.92	9	8	12	154 18473
	68 000	75 x 105	17.7	33.6	25.70	8.57	9	8	12	154 18683
100	3300	35 x 60	3.1	5.9	1.98	0.66	90	70	110	154 19332
	4700	35 x 80	4.9	9.4	2.82	0.94	60	60	90	154 19472
	6800	35 x 105	5.8	11.0	4.08	1.36	40	40	60	154 19682
	10 000	50 x 80	6.4	12.1	6.00	2.00	38	38	55	154 19103
	15 000	50 x 105	8.6	16.3	9.00	3.00	27	28	40	154 19153
	22 000	65 x 105	12.2	23.2	13.20	4.40	20	18	28	154 19223
	33 000	75 x 105	14	26.6	19.80	6.60	18	17	26	154 19333

Note

1. Catalogue number applies to the ST version; for STB version replace 8th digit by "5" (2222 154/155 5....).

Table 5 Electrical data and ordering information for 155 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Typ. Z 20 kHz (mΩ)	Max. Z 20 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
160	1000	35 x 60	2.5	4.7	0.96	0.32	140	110	165	155 11102
	1500	35 x 80	3.5	6.7	1.44	0.48	95	74	112	155 11152
	2200	35 x 105	4.8	9.1	2.11	0.70	65	52	79	155 11222
	3300	50 x 80	5.4	10.3	3.17	1.06	60	49	74	155 11332
	4700	50 x 105	7.1	13.5	4.51	1.51	40	35	53	155 11472
	6800	65 x 105	10.9	20.7	6.53	2.18	25	20	31	155 11682
	10 000	65 x 105	11.7	22.2	9.60	3.20	22	20	31	155 11103
200	680	35 x 60	2.3	4.4	0.82	0.28	160	117	176	155 12681
	1000	35 x 80	3.3	6.3	1.20	0.40	105	80	120	155 12102
	1500	35 x 105	4.6	8.7	1.80	0.60	70	52	80	155 12152
	2200	50 x 80	5.2	9.9	2.64	0.88	65	51	77	155 12222
	3300	50 x 105	7.0	13.3	3.96	1.32	45	36	55	155 12332
	4700	65 x 105	10.9	20.7	5.64	1.88	25	20	31	155 12472
	6800	65 x 105	11.7	22.2	8.16	2.72	22	20	31	155 12682
	10 000	75 x 105	12.6	23.9	12.00	4.00	22	20	31	155 12103
250	470	35 x 60	1.6	3.0	0.70	0.24	360	300	450	155 13471
	680	35 x 80	2.2	4.2	1.02	0.34	250	216	325	155 13681
	1000	35 x 105	2.9	5.5	1.50	0.50	175	140	210	155 13102
	1500	50 x 80	3.9	7.4	2.25	0.75	115	100	150	155 13152
	2200	50 x 105	5.3	10.1	3.30	1.10	80	70	105	155 13222
	3300	65 x 105	7.7	14.6	4.95	1.65	50	43	65	155 13332
	4700	65 x 105	8.2	15.6	7.05	2.35	44	40	60	155 13472
	6800	75 x 105	10	19	10.20	3.40	35	33	50	155 13682
350	330	35 x 60	1.5	2.9	0.69	0.23	370	313	470	155 15331
	470	35 x 80	2.1	4.0	0.99	0.33	260	223	335	155 15471
	680	35 x 105	2.9	5.5	1.43	0.48	180	146	220	155 15681
	1000	50 x 80	3.7	7.0	2.10	0.70	125	113	170	155 15102
	1500	50 x 105	4.3	8.2	3.15	1.05	120	106	160	155 15152
	2200	65 x 105	6.5	12.6	4.62	1.54	70	63	95	155 15222
	3300	65 x 105	7.1	13.5	6.93	2.31	60	63	95	155 15332

Non-solid Al - electrolytic capacitors
Power Economic Screw Terminals

PEC-ST 154/155

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Typ. Z 20 kHz (mΩ)	Max. Z 20 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
385	220	35 x 60	1.4	2.7	0.51	0.17	455	356	535	155 18221
	330	35 x 80	2	3.8	0.76	0.25	305	236	355	155 18331
	470	35 x 80	2.1	4.0	1.08	0.36	240	255	380	155 18471
	680	35 x 105	2.8	5.3	1.57	0.52	170	170	265	155 18681
	1000	50 x 80	3.7	7.0	2.31	0.77	125	103	170	155 18102
	1500	50 x 105	4.2	8.0	3.46	1.15	125	116	175	155 18152
	2200	65 x 105	6.3	12.0	5.08	1.69	75	66	100	155 18222
	3300	75 x 105	8	15.2	7.62	2.54	55	50	75	155 18332
400	220	35 x 60	1.19	2.26	0.53	0.18	500	335	500	155 16221
	330	35 x 80	1.70	3.22	0.79	0.27	335	225	340	155 16331
	470	35 x 80	1.90	3.60	1.13	0.38	270	190	285	155 16471
	680	35 x 105	2.60	4.93	1.63	0.54	185	150	230	155 16681
	1000	50 x 80	3.41	6.47	2.40	0.80	125	90	140	155 16102
	1500	50 x 105	4.67	8.85	3.60	1.20	85	60	95	155 16152
	2200	65 x 105	6.54	12.40	5.28	1.76	58	40	60	155 16222
	3300	75 x 105	7.64	14.49	7.92	2.64	50	35	55	155 16332

Note

1. Catalogue number applies to the ST version; for STB version replace 8th digit by "5" (2222 154/155 5....).

Marking

- Rated capacitance
- Tolerance code on rated capacitance (M for ±20%)
- Rated voltage
- Climatic category (in accordance with IEC 68)
- Date code (year and week) in accordance with IEC 62
- Code for factory of origin
- Name of manufacturer
- Code number
- Code for basic specification (in accordance with IEC 384-4-1, CECC 30 301)
- Maximum RMS ripple current at 70 °C and 20 kHz.

Non-solid Al - electrolytic capacitors
Power Economic Screw Terminals

PEC-ST 154/155

Voltage

Surge voltage for short periods	
≤250 V versions	$U_s = 1.15 \times U_R$
≥350 V versions	$U_s = 1.1 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

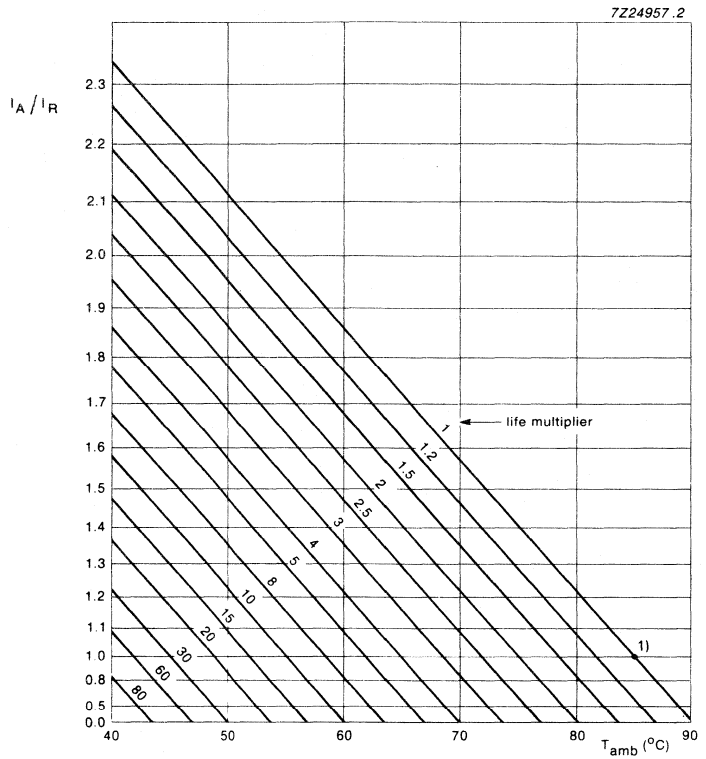
Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

Equivalent series inductance (ESL)

Typical ESL for case sizes Ø35	18 nH
Typical ESL for case sizes Ø50	25 nH
Typical ESL for case size Ø65	27 nH
Typical ESL for case size Ø75	29 nH

RIPPLE CURRENT and USEFUL LIFE



I_A = actual ripple current at 100 Hz and 85 °C.
I_R = rated ripple current at 100 Hz and 85 °C.
With an absolute maximum of 50 A.

1) Useful life at 85 °C and I_R applied: 12 000 hours.

Fig.3 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.

Table 6 Multiplier of ripple current I_R as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.83
100	1.00
200	1.10
400	1.15
1000	1.19
≥2000	1.20

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

Table 7

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	Reference		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied 5000 hours	U_R ≤100 V: ΔC/C ≤15% U_R >100 V: ΔC/C ≤10% tan δ ≤1.3 x spec. limit Z ≤2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 12 000 hours	ΔC/C ≤45% (U_R ≤100 V) ΔC/C ≤30% (U_R >100 V) tan δ ≤3 x spec. limit Z ≤3 x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage: U_R ≤100 V: ≤1% U_R >100 V: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 group C 5a,4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C ≤±10% tan δ ≤1.2 x spec. limit I_{L5} ≤2 x spec. limit

6

Non-solid Al - electrolytic capacitors
Power Eurodin Screw Terminals

PED-ST 114/115

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, cylindrical aluminium case, insulated with a blue sleeve
- Also available in bolt version (PED-STB)
- Safety vent in the sealing
- Charge and discharge proof
- Extremely low ESR and ESL allowing very high ripple current load, achieved by a special construction with multiple internal anode and cathode connections
- Very long useful life: 20 000 hours/85 °C
- High resistance to shock and vibration achieved by longitudinal rills and special internal construction.

APPLICATIONS

- Computer, telecommunications and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.

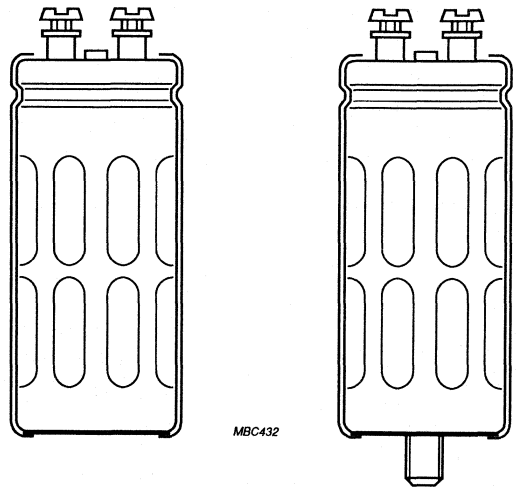


Fig.1 Component outline.

QUICK REFERENCE DATA

	114	115
Case size ($\varnothing D_{nom}$ x L_{nom} in mm)	35 x 60 to 75 x 105	
Rated capacitance range (E6 series), C_R	150 to 220 000 µF	
Tolerance on C_R	−10 to +30%	
Rated voltage range, U_R	10 to 100 V	250 to 400 V
Category temperature range	−40 to +85 °C	
Endurance test at 85 °C	8000 hours	
Useful life at 85 °C	20 000 hours	
Useful life at U_R, 40 °C, 1.4 x I_R applied	350 000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Basic specifications	IEC 384-4-1, CECC 30 301, LL grade	
Detail specification (approved)	DIN 41248	
Climatic category IEC 68 DIN 40040 NF C93-001	 40/085/56 GPF 554	

6

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**∅D x L** in **mm**) for 114 series

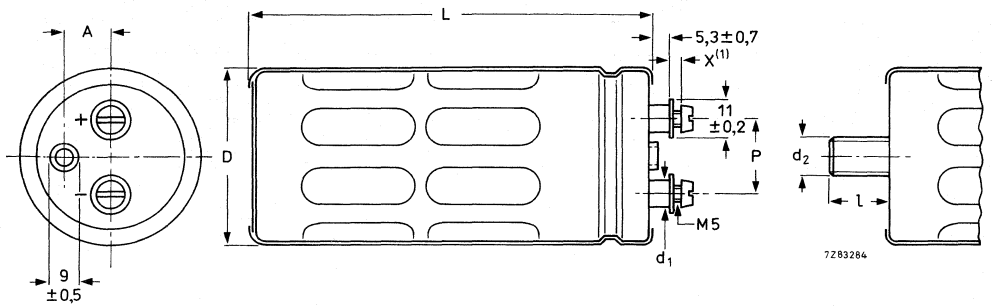
C_R (µF)	U_R (V)					
	10	**16**	**25**	**40**	**63**	**100**
1000						35 x 60
1500						35 x 60
2200					35 x 60	35 x 80
3300				35 x 60	35 x 60	35 x 105
4700			35 x 60	35 x 60	35 x 80	50 x 80
6800			35 x 60	35 x 80	35 x 105	50 x 105
10 000		35 x 60	35 x 80	35 x 105	50 x 80	65 x 105
15 000	35 x 60	35 x 80	35 x 105	50 x 80	50 x 105	65 x 105
22 000	35 x 80	35 x 105	50 x 80	50 x 105	65 x 105	75 x 105
33 000	35 x 105	50 x 80	50 x 105	65 x 105	65 x 105	
47 000	50 x 80	50 x 105	65 x 105	65 x 105	75 x 105	
68 000	50 x 105	65 x 105	65 x 105	75 x 105		
100 000	65 x 105	65 x 105	75 x 105			
150 000	65 x 105	75 x 105				
220 000	75 x 105					

Table 2 Selection chart for C_R, U_R and relevant nominal case sizes (**∅D x L** in **mm**) for 115 series

C_R (µF)	U_R (V)			
	250	**350**	**385**	**400**
150			35 x 60	35 x 60
220			35 x 80	35 x 80
330	35 x 60		35 x 105	35 x 105
470	35 x 80		50 x 80	50 x 80
680	35 x 105	50 x 80	50 x 105	50 x 105
1000	50 x 80	50 x 105	65 x 105	65 x 105
1500	50 x 105		65 x 105	65 x 105
2200	65 x 105		75 x 105	75 x 105
3300	65 x 105	75 x 105		
4700	75 x 105			

MECHANICAL DATA

Dimensions in mm.



Maximum permissible torque which may be applied to the termination screws at various heights (dimension x in drawing):

4 Nm for x = 3

3 Nm for x = 6.

The capacitors are delivered with screws and washers.

Mounting accessories are specified in the general section.

Fig.2 Screw terminal/screw terminal bolt.

Table 3 Dimensions in mm; mass in g

CASE		∅D_{max}	L_{max}	P (tol. ±0.1)	A	d_1 (tol. ±0.2)	d_2 x l	APPROX. MASS	PACKING QUANTITIES (units per box)
SIZE ∅D_{nom} x L_{nom}	CODE								
35 x 60	10	36.5	63	13.0	8.4	8	M8 x 12	55	25
35 x 80	11	36.5	83	13.0	8.4	8	M8 x 12	80	25
35 x 105	12a	36.5	108	13.0	8.4	8	M8 x 12	110	25
50 x 80	14	51.5	83	22.0	14.3	8	M12 x 16	160	25
50 x 105	15a	51.5	108	22.0	14.3	8	M12 x 16	210	25
65 x 105	16a	66.5	108	28.5	19.0	9.6	M12 x 16	370	10
75 x 105	17	76.5	108	32.0	21.0	9.6	M12 x 16	535	10

Non-solid Al - electrolytic capacitors
Power Eurodin Screw Terminals

PED-ST 114/115

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 4 and 5 apply at T_{amb} = 20 °C, P= 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz (tolerance –10 to +30%)

I_R = rated RMS ripple current at 100 Hz, 85 °C and 20 kHz, 70 °C

I_{L1} = max. leakage current after 1 minute at U_R

I_{L5} = max. leakage current after 5 minutes at U_R

ESR = typical equivalent series resistance at 100 Hz

Z = impedance at 20 kHz.

Ordering Example

Electrolytic capacitors
PED-ST 114/115

10 000 µF/25 V, –10/+30%

Case size 35 x 80 mm;
ST version

Catalogue number:
2222 114 16103.

Table 4 Electrical data for 114 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Typ. Z 20 kHz (mΩ)	Max. Z 20 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
10	15 000	35 x 60	6	11.4	0.90	0.30	20	13	20	114 14153
	22 000	35 x 80	7.5	14.2	1.32	0.43	14	9.5	14	114 14223
	33 000	35 x 105	10	19	1.98	0.66	10	7.5	10	114 14333
	47 000	50 x 80	14	26.5	2.82	0.94	7.5	5.0	9.5	114 14473
	68 000	50 x 105	18	34	4.08	1.36	5.5	4.0	8.0	114 14683
	100 000	65 x 105	30	50	6.00	2.00	3.5	3.0	5.0	114 14104
	150 000	65 x 105	30	50	9.00	3.00	3.0	3.0	5.0	114 14154
	220 000	75 x 105	37	50	13.20	4.40	2.0	2.5	4.0	114 14224
16	10 000	35 x 60	6	11.4	0.96	0.32	22	13	20	114 15103
	15 000	35 x 80	7.5	14.2	1.44	0.40	15	9.5	14	114 15153
	22 000	35 x 105	10	19	2.12	0.71	11	7.0	10	114 15223
	33 000	50 x 80	13	24.6	3.17	1.06	7.5	5.0	9.5	114 15333
	47 000	50 x 105	18	34	4.52	1.51	5.5	4.0	8.0	114 15473
	68 000	65 x 105	28	50	6.53	2.18	3.5	3.0	5.0	114 15683
	100 000	65 x 105	28	50	9.60	3.20	3.0	3.0	5.0	114 15104
	150 000	75 x 105	37	50	14.40	4.80	2.0	2.5	4.0	114 15154
25	4700	35 x 60	5.2	10	0.71	0.24	30	15	23	114 16472
	6800	35 x 60	5.2	10	1.02	0.34	25	14	21	114 16682
	10 000	35 x 80	6.7	12.7	1.50	0.50	18	10	15	114 16103
	15 000	35 x 105	9.7	18.4	2.25	0.75	12	7.5	11	114 16153
	22 000	50 x 80	12.5	23.7	3.30	1.10	8.5	5.5	9.5	114 16223
	33 000	50 x 105	18	34	4.95	1.65	6.0	4.0	8.0	114 16333
	47 000	65 x 105	27	50	7.05	2.35	4.0	3.0	5.0	114 16473
	68 000	65 x 105	27	50	10.20	3.40	3.5	3.0	5.0	114 16683
	100 000	75 x 105	37	50	15.00	5.0	2.5	2.5	4.0	114 16104

Non-solid Al - electrolytic capacitors
Power Eurodin Screw Terminals

PED-ST 114/115

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Typ. Z 20 kHz (mΩ)	Max. Z 20 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
40	3300	35 x 60	4.5	8.5	0.80	0.27	37	21	32	114 17332
	4700	35 x 60	4.5	8.5	1.13	0.38	35	22	33	114 17472
	6800	35 x 80	6	11.4	1.64	0.55	25	15	23	114 17682
	10 000	35 x 105	7.5	14.2	2.40	0.80	17	11	17	114 17103
	15 000	50 x 80	10	19	3.60	1.20	11	7.5	13	114 17153
	22 000	50 x 105	15	28.5	5.28	1.76	8.0	5.5	10.5	114 17223
	33 000	65 x 105	21	40	7.92	2.64	5.0	3.5	6.0	114 17333
	47 000	65 x 105	22	42	11.28	3.76	4.5	3.5	6.0	114 17473
	68 000	75 x 105	30	50	16.32	5.44	3.0	3.0	4.5	114 17683
63	2200	35 x 60	3.7	7	0.84	0.28	39	22	33	114 18222
	3300	35 x 60	3.7	7	1.25	0.42	32	20	30	114 18332
	4700	35 x 80	5.2	10	1.78	0.66	23	14	21	114 18472
	6800	35 x 105	7.5	14.2	2.57	0.86	17	10	15	114 18682
	10 000	50 x 80	9.5	18	3.78	1.26	12	7.5	14	114 18103
	15 000	50 x 105	13.5	25.6	5.67	1.89	8.5	5.5	10.5	114 18153
	22 000	65 x 105	21	40	8.32	2.77	5.0	3.5	6.0	114 18223
	33 000	65 x 105	22	42	12.48	4.16	4.5	3.5	6.0	114 18333
	47 000	75 x 105	30	50	17.77	5.92	3.0	3.0	4.5	114 18473
100	1000	35 x 60	3.0	5.7	0.60	0.20	85	45	67	114 19102
	1500	35 x 60	3.3	6.3	0.90	0.30	65	40	60	114 19152
	2200	35 x 80	4.6	8.7	1.32	0.41	45	28	42	114 19222
	3300	35 x 105	6.5	12.3	1.98	0.66	30	19	28	114 19332
	4700	50 x 80	7.4	14.0	2.82	0.94	27	17	25	114 19472
	6800	50 x 105	9.9	18.8	4.08	1.36	19	12	18	114 19682
	10 000	65 x 105	15.8	30.0	6.00	2.00	10	6	10	114 19103
	15 000	65 x 105	15.0	28.5	9.00	3.00	11	7	11	114 19153
	22 000	75 x 105	20.5	38.9	13.20	4.40	7	5	8	114 19223

Note

1. Catalogue number applies to the ST version; for STB version replace 8th digit by "5" (2222 114/115 5....).

Table 5 Electrical data for 115 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	I_R 100 Hz 85 °C (A)	I_R 20 kHz 70 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Typ. Z 20 kHz (mΩ)	Max. Z 20 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
250	330	35 x 60	1.8	3.4	0.50	0.17	300	275	500	115 13331
	470	35 x 80	2.5	4.7	0.71	0.24	250	140	375	115 13471
	680	35 x 105	3.5	6.6	1.02	0.34	180	125	300	115 13681
	1000	50 x 80	4.2	8	1.50	0.50	110	60	130	115 13102
	1500	50 x 105	6.3	12	2.25	0.75	60	40	100	115 13152
	2200	65 x 105	8.8	16.7	3.30	1.10	45	30	60	115 13222
	3300	65 x 105	10.5	20	4.95	1.65	30	25	50	115 13332
	4700	75 x 105	14	26.5	7.05	2.35	25	20	40	115 13472
350	680	50 x 80	2.7	5.1	1.47	0.48	140	60	130	115 15681
	1000	50 x 105	4.8	9.1	2.14	0.71	65	50	100	115 15102
	3300	75 x 105	10.0	19.0	6.93	2.31	30	20	45	115 15332
385	150	35 x 60	1.2	2.3	0.34	0.12	425	250	500	115 18151
	220	35 x 80	1.6	3	0.50	0.17	275	200	380	115 18221
	330	35 x 105	2.2	4.2	0.75	0.25	175	140	300	115 18331
	470	50 x 80	2.7	5.1	1.06	0.36	110	75	130	115 18471
	680	50 x 105	4.8	9.1	1.53	0.51	90	60	130	115 18681
	1000	65 x 105	7	13.3	2.25	0.75	70	45	60	115 18102
	1500	65 x 105	7	13.3	3.38	1.13	45	30	50	115 18152
	2200	75 x 105	9	17	4.95	1.65	35	20	45	115 18222
400	150	35 x 60	1.1	2.0	0.36	1.12	630	370	565	115 16151
	220	35 x 80	1.5	2.9	0.53	0.18	430	260	310	115 16221
	330	35 x 105	2.1	4.0	0.79	0.26	285	170	260	115 16331
	470	50 x 80	2.7	5.1	1.13	0.38	200	100	150	115 16471
	680	50 x 105	3.6	6.9	1.63	0.54	140	79	105	115 16681
	1000	65 x 105	5.1	9.7	2.40	0.80	95	50	77	115 16102
	1500	65 x 105	5.7	10.6	3.60	1.20	80	45	67	115 16152
	2200	75 x 105	7.3	13.8	5.28	1.76	40	40	60	115 16222

Note

1. Catalogue number applies to the ST version; for STB version replace 8th digit by "5" (2222 114/115 5....).

Voltage

Surge voltage for short periods	
≤250 V versions	$U_s = 1.15 \times U_R$
≥350 V versions	$U_s = 1.1 \times U_R$
Reverse voltage	U_{rev} ≤1 V

Leakage current

After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

Equivalent series inductance (ESL)

Typical ESL for case sizes Ø35	13 nH
Typical ESL for case sizes Ø50	16 nH
Typical ESL for case size Ø65	19 nH
Typical ESL for case size Ø75	20 nH

Marking

- Rated capacitance
- Tolerance code on rated capacitance (M for ±20%)
- Rated voltage
- Climatic category (in accordance with IEC 68)
- Date code (year and week) in accordance with IEC 62
- Code for factory of origin
- Name of manufacturer
- Code number
- Code for basic specification (in accordance with IEC 384-4-1, CECC 30 301)
- Maximum RMS ripple current at 70 °C and 20 kHz.

Equivalent series resistance (ESR)

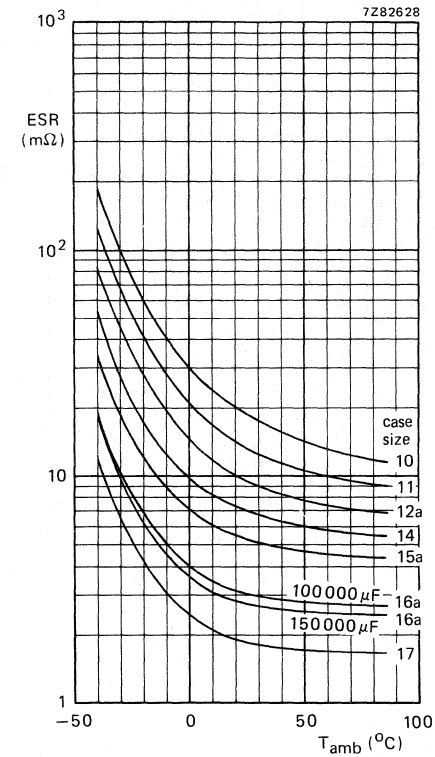


Fig.3 Typical ESR as a function of temperature at 100 Hz and U_R = 10 V.

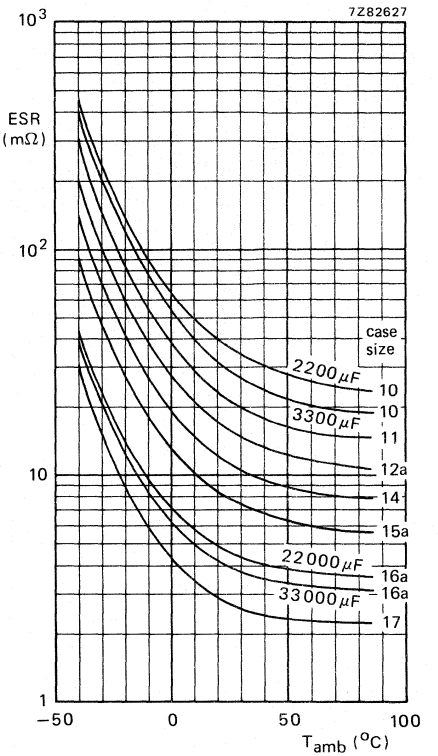


Fig.4 Typical ESR as a function of temperature at 100 Hz and U_R = 63 V.

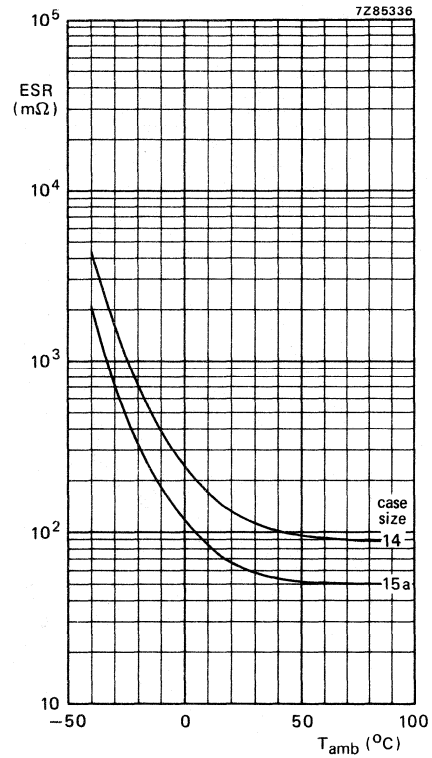


Fig.5 Typical ESR as a function of temperature at 100 Hz and U_R = 250 V.

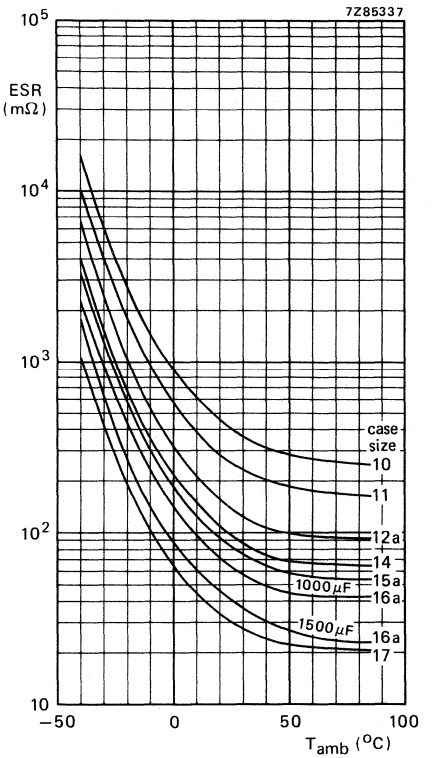


Fig.6 Typical ESR as a function of temperature at 100 Hz and U_R = 385 V.

Impedance (Z)

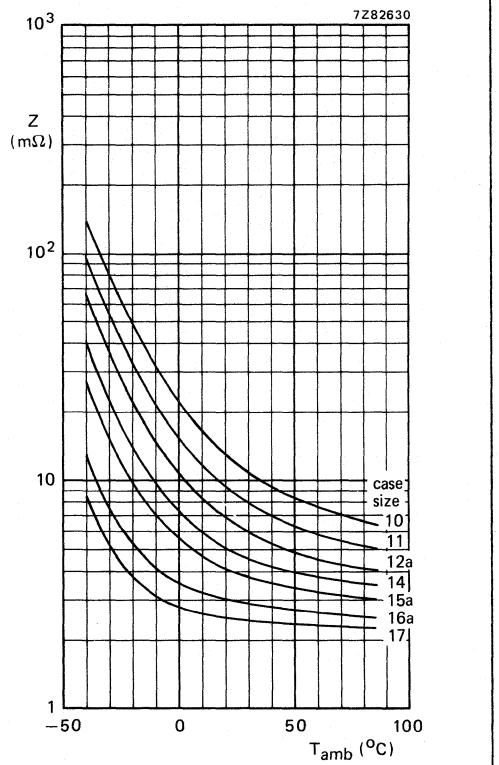


Fig.7 Typical impedance as a function of temperature at 20 kHz and U_R = 10 V.

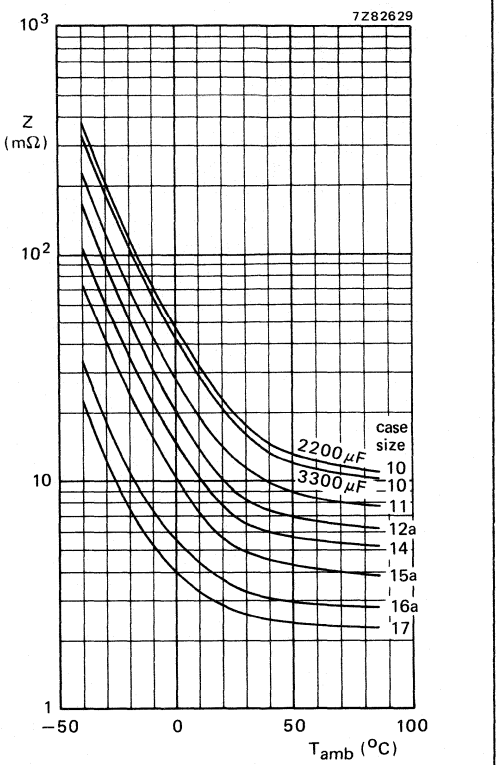


Fig.8 Typical impedance as a function of temperature at 20 kHz and U_R = 63 V.

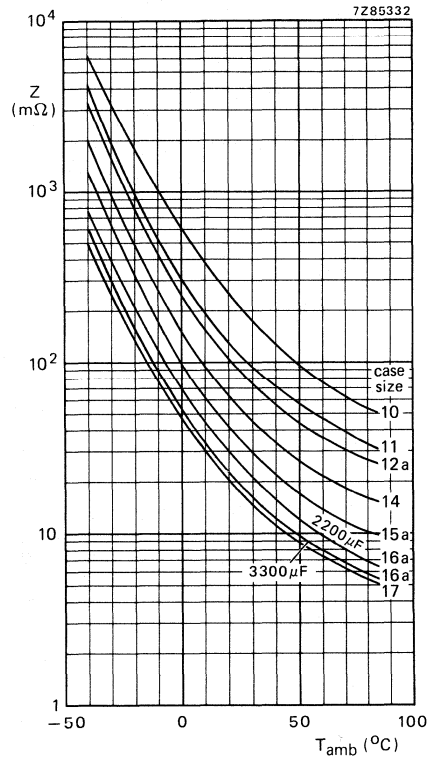


Fig.9 Typical impedance as a function of temperature at 20 kHz and U_R = 250 V.

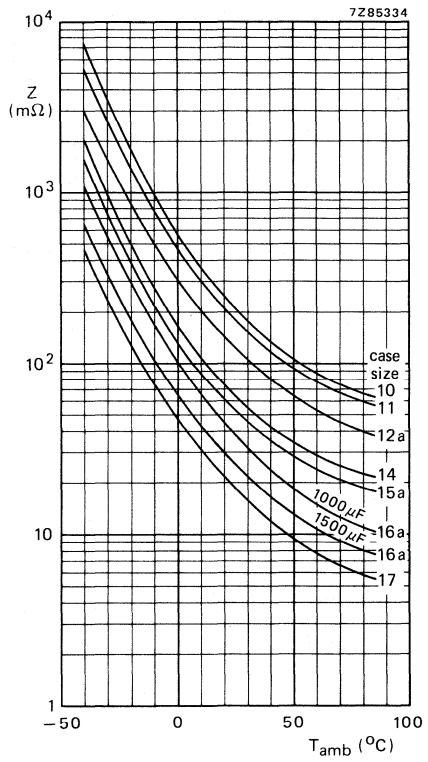
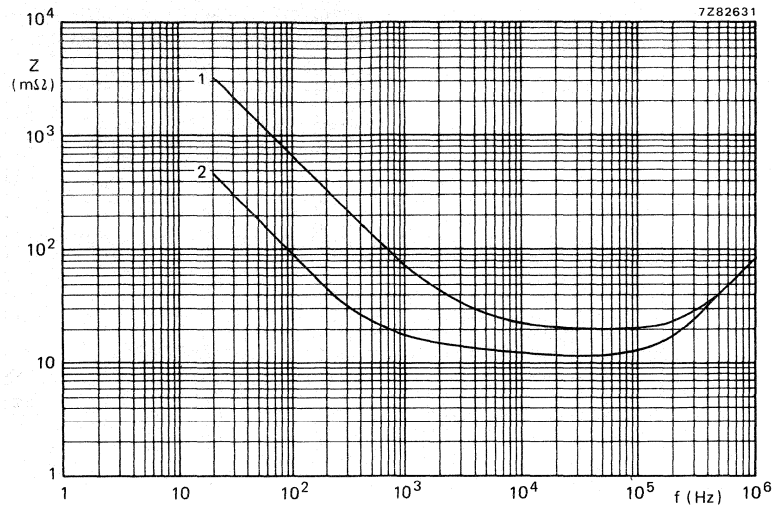
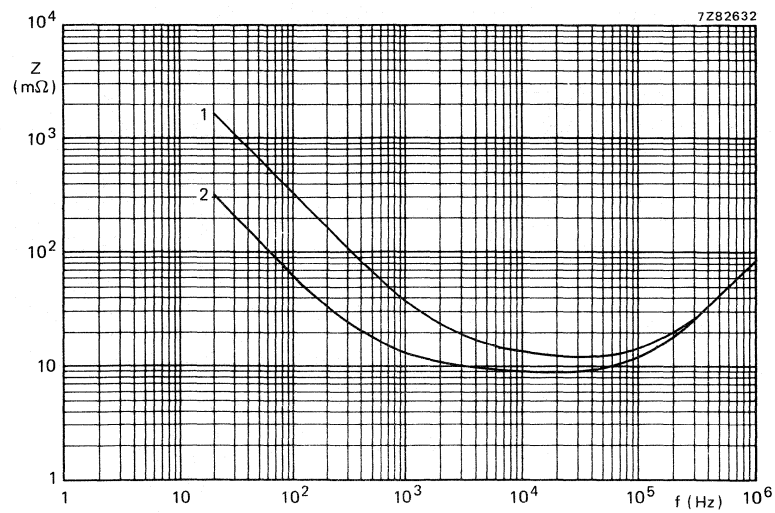


Fig.10 Typical impedance as a function of temperature at 20 kHz and U_R = 385 V.



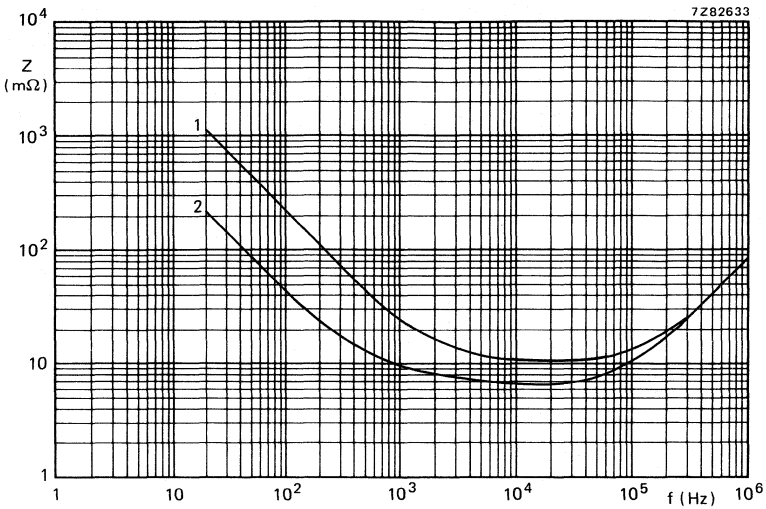
Curve 1 : 2200 µF, 63 V
Curve 2 : 15 000 µF, 10 V.

Fig.11 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 60.



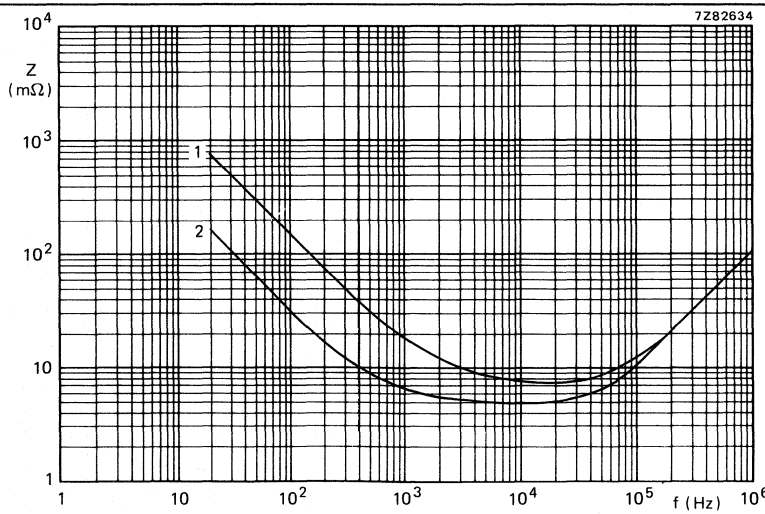
Curve 1 : 4700 µF, 63 V
Curve 2 : 22 000 µF, 10 V.

Fig.12 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 80.



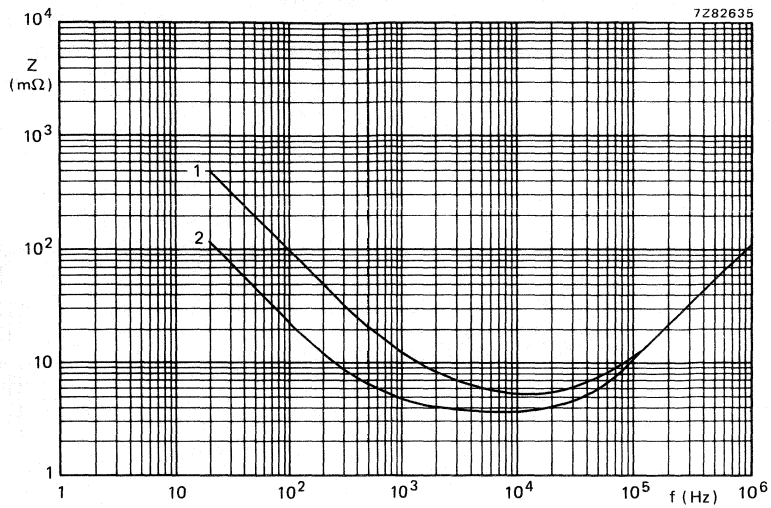
Curve 1 : 6800 µF, 63 V
Curve 2 : 33 000 µF, 10 V.

Fig.13 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 105.



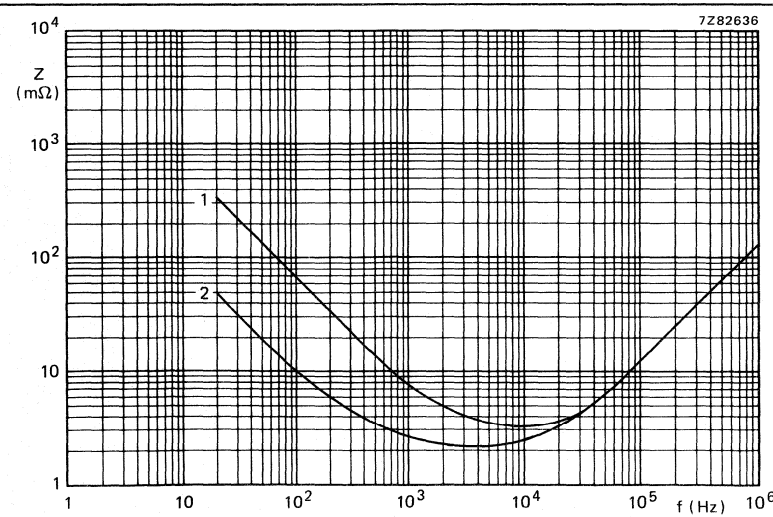
Curve 1 : 10 000 µF, 63 V
Curve 2 : 47 000 µF, 10 V.

Fig.14 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø50 x 80.



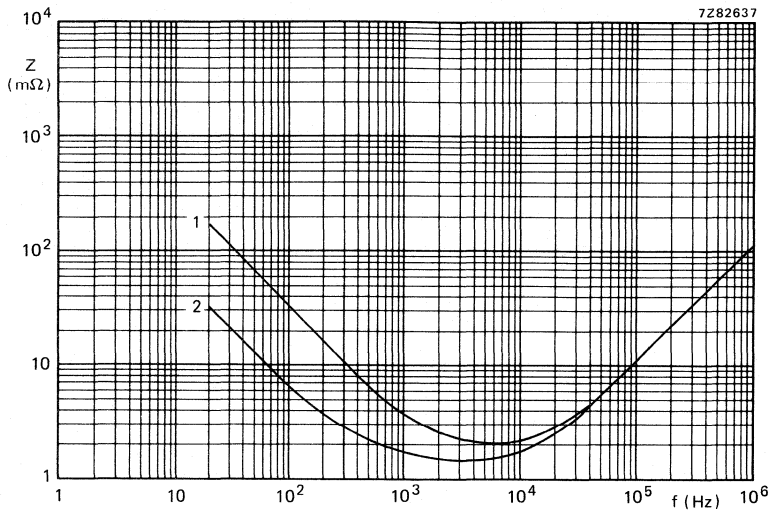
Curve 1 : 15 000 µF, 63 V
Curve 2 : 68 000 µF, 10 V.

Fig.15 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø50 x 105.



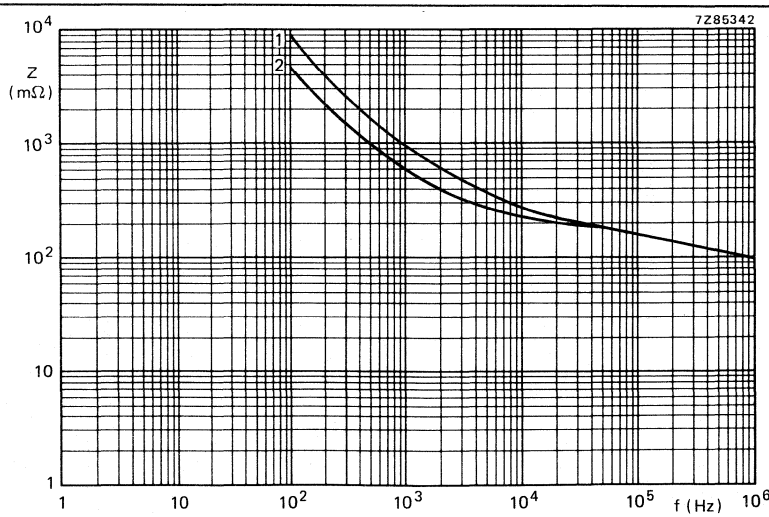
Curve 1 : 22 000 µF, 63 V
Curve 2 : 150 000 µF, 10 V.

Fig.16 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø65 x 105.



Curve 1 : 47 000 µF, 63 V
Curve 2 : 220 000 µF, 10 V.

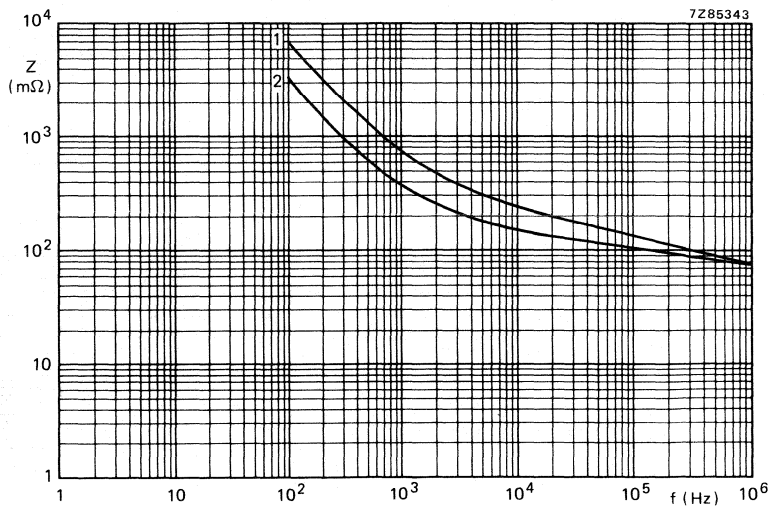
Fig.17 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø75 x 105.



Curve 1 : 150 µF, 385 V
Curve 2 : 330 µF, 250 V.

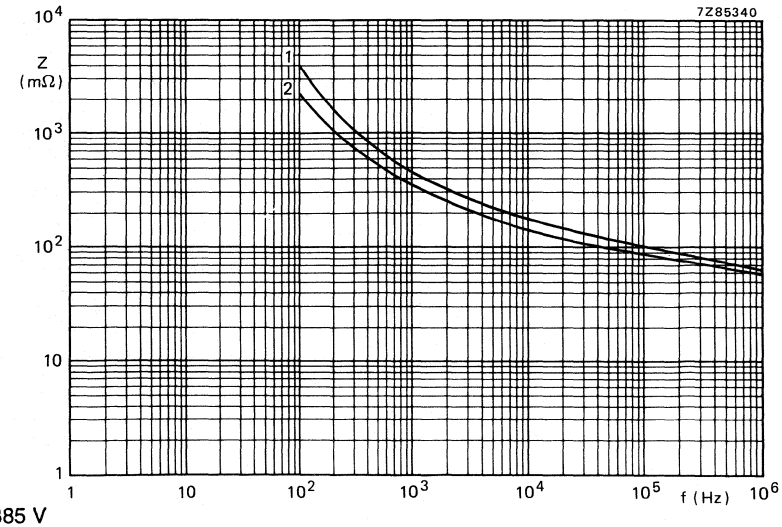
Fig.18 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 60.

6



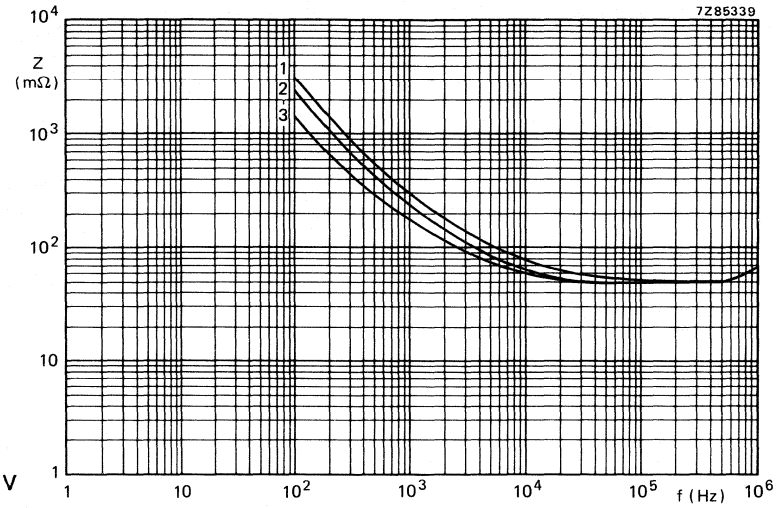
Curve 1 : 220 µF, 385 V
Curve 2 : 470 µF, 250 V.

Fig.19 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 80.



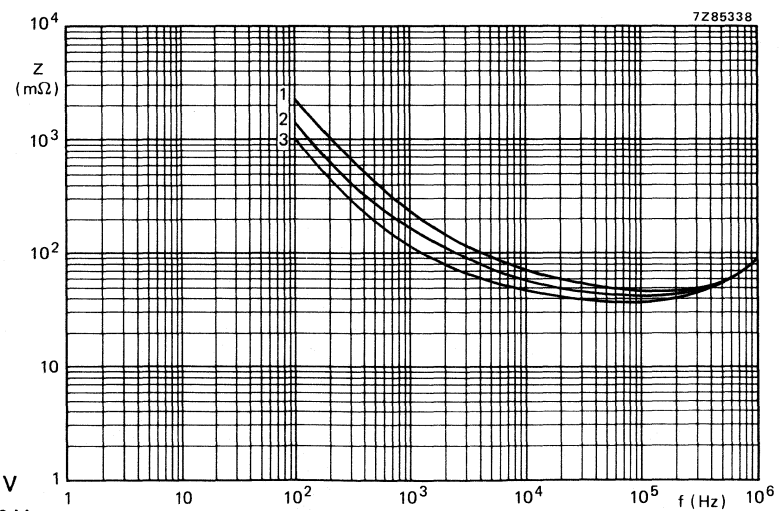
Curve 1 : 330 µF, 385 V
Curve 2 : 680 µF, 250 V.

Fig.20 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 105.



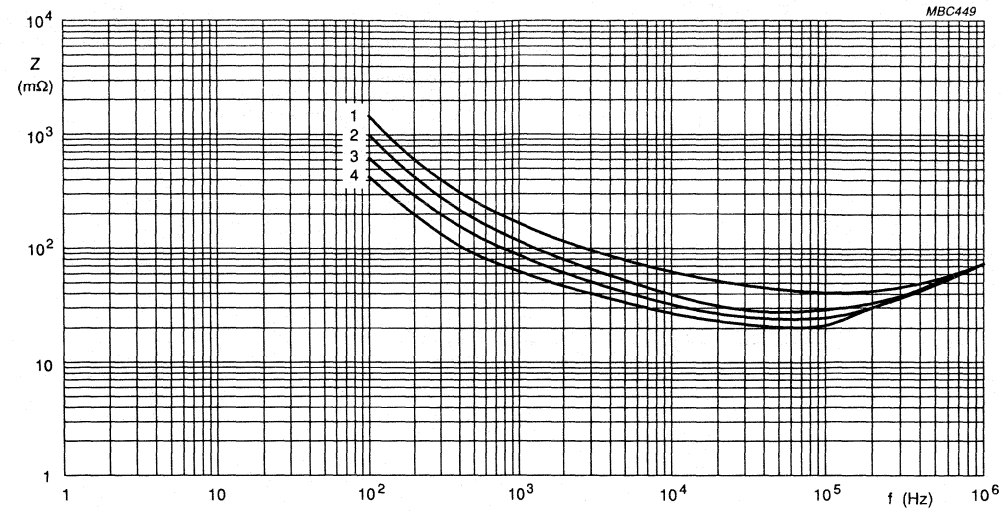
Curve 1 : 470 µF, 385 V
Curve 2 : 1000 µF,250 V
Curve 3 : 680 µF, 350 V.

Fig.21 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø50 x 80.



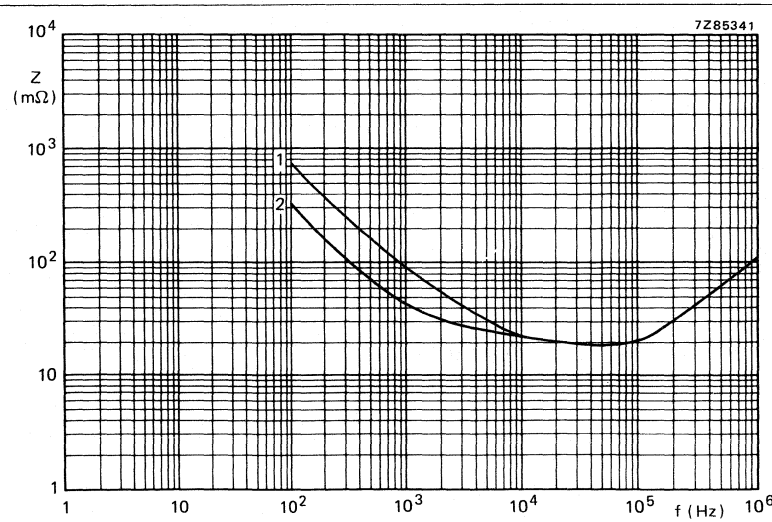
Curve 1 : 680 µF, 385 V
Curve 2 : 1000 µF, 350 V
Curve 3 : 1500 µF, 250 V.

Fig.22 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø50 x 105.



Curve 1 : 1000 µF, 385 V
Curve 2 : 1500 µF, 385 V
Curve 3 : 2200 µF, 250 V
Curve 4 : 3300 µF, 250 V.

Fig.23 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø65 x 105.



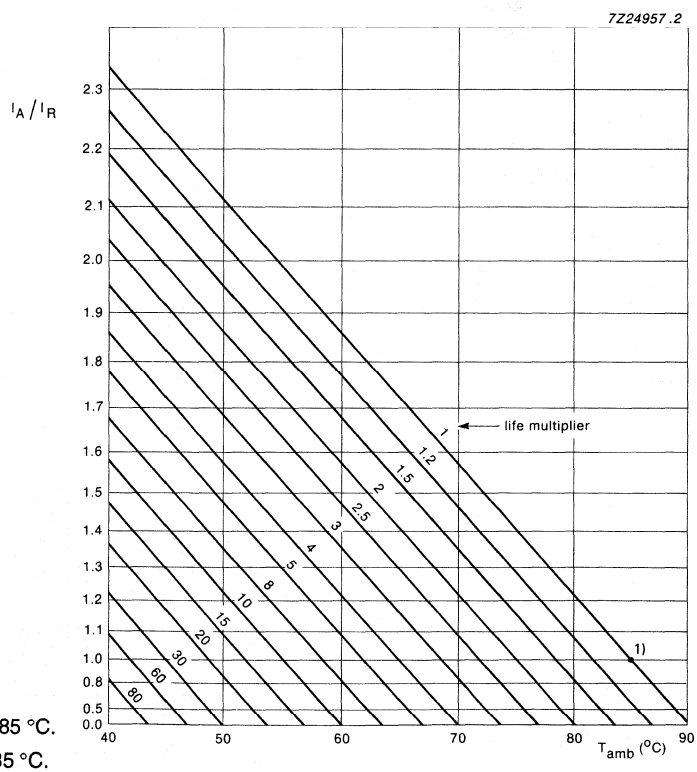
Curve 1 : 2200 µF, 385 V
Curve 2 : 4700 µF, 250 V.

Fig.24 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø75 x 105.

RIPPLE CURRENT and USEFUL LIFE

Table 6 Multiplier of ripple current I_R as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.83
100	1.00
200	1.10
400	1.15
1000	1.19
≥2000	1.20



I_A = actual ripple current at 100 Hz and 85 °C.
I_R = rated ripple current at 100 Hz and 85 °C.
With an absolute maximum of 50 A.

1) Useful life at 85 °C and I_R applied: 20 000 hours.

Fig.25 Life expectancy (useful life) as a function of ripple current load (I_A/I_R) and ambient temperature.

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements",

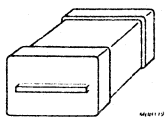
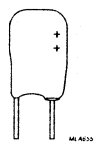
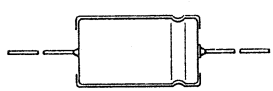
Table 7

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-1/ CECC 30 301 group C3, 4.13	T_{amb} = 85 °C, U_R applied 5000 hours	$U_R \leq 100$ V: $\Delta C/C \leq 15\%$ $U_R > 100$ V: $\Delta C/C \leq 10\%$ tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C, U_R and I_R applied 20 000 hours	$\Delta C/C \leq 45\%$ ($U_R \leq 100$ V) $\Delta C/C \leq 30\%$ ($U_R > 100$ V) tan $\delta \leq 3$ x spec. limit $Z \leq 3$ x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage: $U_R \leq 100$ V: ≤1% $U_R > 100$ V: ≤3%
Shelf life (storage at high temp.)	IEC 384-4-1/ CECC 30 301 group C 5a,4.17	T_{amb} = 85 °C, no voltage applied 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit $I_{L5} \leq 2$ x spec. limit

Electrolytic Capacitors

Notes

SOLID ALUMINIUM (SAL) ELECTROLYTIC CAPACITORS

		INDUSTRIAL	PROFESSIONAL
SMD		SAL- CPL127 *Page 120*	
RADIAL (pearl)			SAL- RP122 *Page 784* SAL- RPM128 *Page 750* SAL- RDC129 low ESR *Page 770*
AXIAL			SAL- A123 *Page 802*

Solid Al - electrolytic capacitors
Solid Al, Radial Pearl Miniature

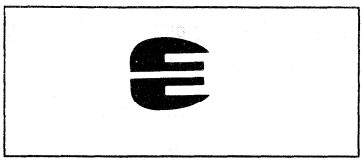
SAL-RPM 128

FEATURES

- Polarized aluminium electrolytic capacitors, solid electrolyte MnO_2
- Radial leads, max. height 9.5 mm, resin dipped, orange coloured
- Extremely long useful life, 20 000 hours/125 °C
- Extended usable temperature range up to 175 °C
- Excellent low temperature, impedance and ESR behaviour
- Charge and discharge proof, application with 0 Ω resistance allowed
- Reverse DC voltage up to 0.3 x U_R allowed
- AC voltage up to 0.8 x U_R allowed
- Advanced technology to achieve high reliability and high stability.

APPLICATIONS

- EDP, telecommunication, general industrial, automotive and audio-video
- Smoothing, filtering and buffering
- For small power supplies, DC/DC converters.



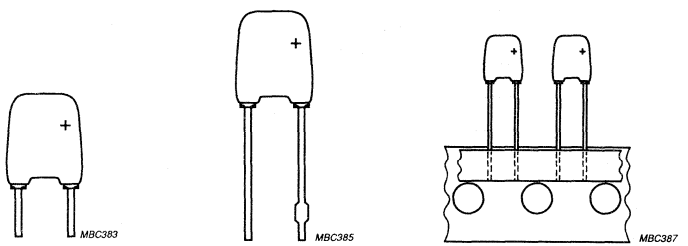


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (H_{max} x W_{max} x T_{max} in mm)	9.5 x 7 x 3 to 9.5 x 8 x 6
Rated capacitance range (E6 series), C_R	0.1 to 68 µF
Tolerance on C_R	±20%, ±10% to special order
Rated voltage range, U_R	6.3 to 40 V
Category temperature range for U_R = 6.3 to 25 V for U_R = 35 and 40 V for U_C = 35 and 40 V	 –55 to +125 °C –55 to +85 °C –55 to +125 °C
Endurance test at 125 °C	10 000 hours
Useful life at 125 °C	20 000 hours
Useful life at 175 °C	2000 hours
Useful life at 40 °C, I_R applied	>300 000 hours
Shelf life at 0 V, 125 °C	500 hours
Basic specifications	IEC 384-4/CECC 30 300
Climatic category IEC 68 DIN 40040 NF C20-600	 55/125/56 FKD 434
Approval	CECC 30 302 - 005

Solid Al - electrolytic capacitors
Solid Al, Radial Pearl Miniature

SAL-RPM 128

Table 1 Selection chart for C_R, U_R, U_C and relevant maximum case sizes **(H x W x T in mm)** for 128 series

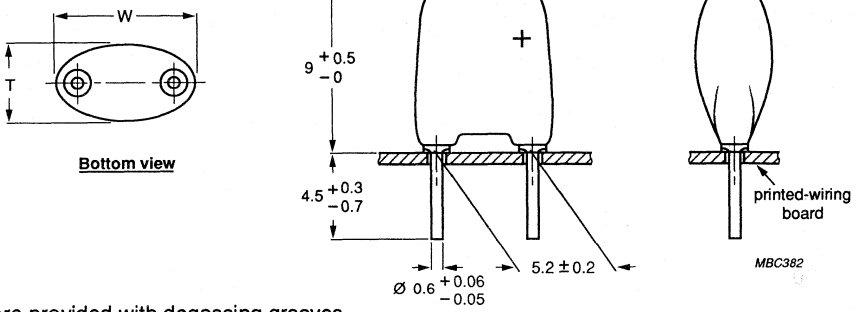
C_R (µF)	U_R (V)					
	6.3	10	16	25	35	40
	U_C (V)					
	6.3	10	16	25	25	25
0.1						9.5 x 7 x 3
0.15						9.5 x 7 x 3
0.22						9.5 x 7 x 3.5
0.33					9.5 x 7 x 3.5	9.5 x 7 x 4
0.47					9.5 x 7 x 4	9.5 x 7 x 5
0.68				9.5 x 7 x 3.5	9.5 x 7 x 4	9.5 x 7 x 5
1				9.5 x 7 x 3.5	9.5 x 7 x 5	9.5 x 8 x 5
1.5				9.5 x 7 x 3.5	9.5 x 8 x 5	9.5 x 8 x 6
2.2			9.5 x 7 x 3.5	9.5 x 7 x 4	9.5 x 8 x 6	9.5 x 8 x 6 [1]
3.3			9.5 x 7 x 3.5	9.5 x 7 x 5	9.5 x 8 x 6 [1]	
4.7		9.5 x 7 x 3.5	9.5 x 7 x 4	9.5 x 8 x 5		
6.8		9.5 x 7 x 3.5	9.5 x 7 x 4	9.5 x 8 x 6		
10	9.5 x 7 x 3.5	9.5 x 7 x 4	9.5 x 7 x 5	9.5 x 8 x 6 [1]		
15		9.5 x 7 x 4	9.5 x 8 x 5			
22	9.5 x 7 x 4	9.5 x 7 x 5	9.5 x 8 x 6 [1]			
33	9.5 x 7 x 5	9.5 x 8 x 5				
47	9.5 x 8 x 5	9.5 x 8 x 6				
68	9.5 x 8 x 6					

Note

[1] Non CECC types.

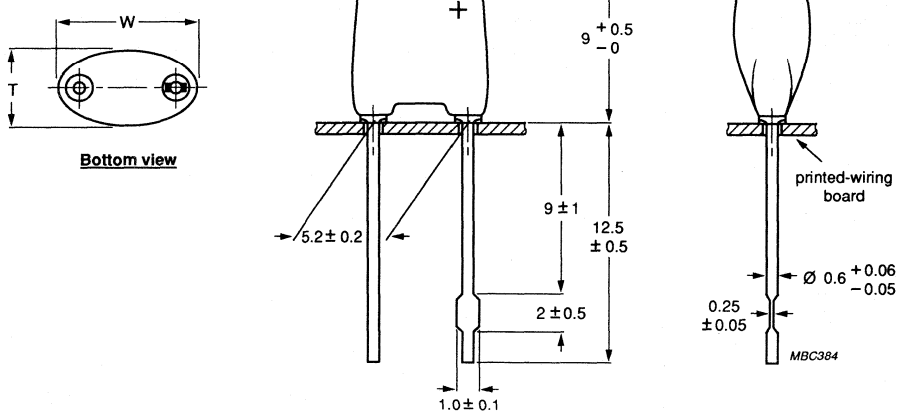
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.



Flanges are provided with degassing grooves.

Fig.2 **Form CB**: Short leads in boxes.



The diameter of the mounting holes in the printed-wiring board is 0.8 ±0.1 mm, except for the hole of the anode lead of Form CA capacitors: 1.3 −0.2 mm.

Flanges are provided with degassing grooves.

Fig.3 **Form CA**: Long leads with keyed polarity, in boxes.

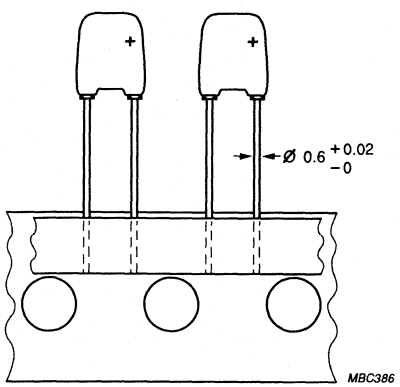
Table 2 Dimensions in mm; mass in g

CASE		APPROX. MASS	PACKING QUANTITIES			
SIZE H_{max} x W_{max} x T_{max}	CODE		FORM CA [1]	FORM CB [1]	FORM TR+	FORM TFA
9.5 x 7 x 3	10	0.22	1000	1000	2000	2000
9.5 x 7 x 3.5	20	0.25	1000	1000	2000	2000
9.5 x 7 x 4	30	0.30	1000	1000	2000	2000
9.5 x 7 x 5	40	0.35	1000	1000	1000	1000
9.5 x 8 x 5	50	0.50	1000	1000	1000	1000
9.5 x 8 x 6	60	0.60	1000	1000	1000	1000

Note

[1] In plastic bags of 200 units each.

Tape dimensions are specified in chapter "PACKING".



Form TR+: Taped on reel, positive leading.
Form TFA: Taped in ammopack.

Fig.4 Taped versions.

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance
- Tolerance code on rated capacitance (M = ±20%, K = ±10%)
- Rated voltage (and category voltage if applicable)
- Date code in accordance with IEC 62
- Name of manufacturer
- '+' signs to identify the anode terminal
- '-' sign to identify the cathode terminal.

Mounting

When bending, cutting or straightening the leads, ensure that the capacitor body is relieved of stress.
Bending after soldering must be avoided.

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 3 and 4 apply at T_{amb} = 20 to 25 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz (tolerance ±20%)
I_R = max. RMS ripple current no necessary DC applied
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = max. equivalent series resistance at 100 Hz
Z = max. impedance at 100 kHz.

Table 3 Electrical data for 128 series

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	I_R 100 Hz 125 °C (mA)	I_R 10 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
6.3	6.3	10	9.5 x 7 x 3.5	9	156	211	2	0.10	20	3.0
		22	9.5 x 7 x 4	20	234	317	4	0.10	9	1.0
		33	9.5 x 7 x 5	30	293	396	5	0.10	6.1	0.7
		47	9.5 x 8 x 5	42	371	502	7	0.10	4.8	0.5
		68	9.5 x 8 x 6	61	449	607	11	0.10	3.0	0.5
10	10	4.7	9.5 x 7 x 3.5	7	117	158	2	0.10	43	3.0
		6.8	9.5 x 7 x 3.5	10	137	185	2	0.10	30	3.0
		10	9.5 x 7 x 4	14	156	211	3	0.10	20	1.5
		15	9.5 x 7 x 4	21	195	264	4	0.10	14	1.0
		22	9.5 x 7 x 5	31	234	317	6	0.10	9	0.7
		33	9.5 x 8 x 5	47	312	422	8	0.10	6.1	0.5
		47	9.5 x 8 x 6	70	312	422	12	0.10	4.3	0.5
16	16	2.2	9.5 x 7 x 3.5	5	98	132	2	0.10	91	5.0
		3.3	9.5 x 7 x 3.5	8	117	158	2	0.10	61	5.0
		4.7	9.5 x 7 x 4	11	137	185	2	0.10	43	2.0
		6.8	9.5 x 7 x 4	16	156	211	3	0.10	30	1.5
		10	9.5 x 7 x 5	23	195	264	4	0.10	20	1.0
		15	9.5 x 8 x 5	34	254	343	6	0.10	14	0.7
		22	9.5 x 8 x 6	50	254	343	9	0.10	9	0.7

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ORDERING INFORMATION

Ordering example

Electrolytic capacitors SAL-RPM
10 µF/16 V, ±20%
Form CB
Catalogue number: 2222 128 55109.

Table 4 Ordering information for 128 series

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	CASE CODE	CATALOGUE NUMBER 2222 . . . . . [1]			
					FORM CB	FORM CA	FORM TR+ on reel	FORM TFA in ammopack
6.3	6.3	10	9.5 x 7 x 3.5	20	128 53109	128 73109	128 23109	128 33109
		22	9.5 x 7 x 4	30	128 53229	128 73229	128 23229	128 33229
		33	9.5 x 7 x 5	40	128 53339	128 73339	128 23339	128 33339
		47	9.5 x 8 x 5	50	128 53479	128 73479	128 23479	128 33479
		68	9.5 x 8 x 6	60	128 53689	128 73689	128 23689	128 33689
10	10	4.7	9.5 x 7 x 3.5	20	128 54478	128 74478	128 24478	128 34478
		6.8	9.5 x 7 x 3.5	20	128 54688	128 74688	128 24688	128 34688
		10	9.5 x 7 x 4	30	128 54109	128 74109	128 24109	128 34109
		15	9.5 x 7 x 4	30	128 54159	128 74159	128 24159	128 34159
		22	9.5 x 7 x 5	40	128 54229	128 74229	128 24229	128 34229
		33	9.5 x 8 x 5	50	128 54339	128 74339	128 24339	128 34339
		47	9.5 x 8 x 6	60	128 54479	128 74479	128 24479	128 34479
16	16	2.2	9.5 x 7 x 3.5	20	128 55228	128 75228	128 25228	128 35228
		3.3	9.5 x 7 x 3.5	20	128 55338	128 75338	128 25338	128 35338
		4.7	9.5 x 7 x 4	30	128 55478	128 75478	128 25478	128 35478
		6.8	9.5 x 7 x 4	30	128 55688	128 75688	128 25688	128 35688
		10	9.5 x 7 x 5	40	128 55109	128 75109	128 25109	128 35109
		15	9.5 x 8 x 5	50	128 55159	128 75159	128 25159	128 35159
		22	9.5 x 8 x 6	60	128 55229	128 75229	128 25229	128 35229

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U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	I_R 100 Hz 125 °C (mA)	I_R 10 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
25	25	0.68	9.5 x 7 x 3.5	2	55	74	2	0.10	295	20
		1	9.5 x 7 x 3.5	4	62	85	2	0.10	200	15
		1.5	9.5 x 7 x 3.5	5	78	106	2	0.10	135	15
		2.2	9.5 x 7 x 4	8	98	132	2	0.10	91	10
		3.3	9.5 x 7 x 5	12	117	158	2	0.10	61	7
		4.7	9.5 x 8 x 5	17	137	185	3	0.10	43	5
		6.8	9.5 x 8 x 6	24	176	238	4	0.10	30	3
		10	9.5 x 8 x 6	35	176	238	6	0.10	20	2
25	35	0.33	9.5 x 7 x 3.5	1	39	53	2	0.10	610	30
		0.47	9.5 x 7 x 4	2	47	63	2	0.10	430	30
		0.68	9.5 x 7 x 4	2	55	74	2	0.10	295	20
		1	9.5 x 7 x 5	4	62	85	2	0.10	200	15
		1.5	9.5 x 8 x 5	5	78	106	2	0.10	135	10
		2.2	9.5 x 8 x 6	8	98	132	2	0.10	91	5
		3.3	9.5 x 8 x 6	12	117	158	3	0.10	61	5
25	40	0.1	9.5 x 7 x 3	0.4	20	26	2	0.10	1990	70
		0.15	9.5 x 7 x 3	0.5	23	32	2	0.10	1330	50
		0.22	9.5 x 7 x 3.5	0.8	31	42	2	0.10	910	30
		0.33	9.5 x 7 x 4	1	39	53	2	0.10	610	30
		0.47	9.5 x 7 x 5	2	47	63	2	0.10	430	20
		0.68	9.5 x 7 x 5	2	55	74	2	0.10	295	15
		1	9.5 x 8 x 5	4	62	85	2	0.10	200	10
		1.5	9.5 x 8 x 6	5	78	106	2	0.10	135	7
		2.2	9.5 x 8 x 6	8	98	132	2	0.10	91	5

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U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	CASE CODE	CATALOGUE NUMBER 2222 . . . . . [1]			
					FORM CB	FORM CA	FORM TR+ on reel	FORM TFA in ammopack
25	25	0.68	9.5 x 7 x 3.5	20	128 56687	128 76687	128 26687	128 36687
		1	9.5 x 7 x 3.5	20	128 56108	128 76108	128 26108	128 36108
		1.5	9.5 x 7 x 3.5	20	128 56158	128 76158	128 26158	128 36158
		2.2	9.5 x 7 x 4	30	128 56228	128 76228	128 26228	128 36228
		3.3	9.5 x 7 x 5	40	128 56338	128 76338	128 26338	128 36338
		4.7	9.5 x 8 x 5	50	128 56478	128 76478	128 26478	128 36478
		6.8	9.5 x 8 x 6	60	128 56688	128 76688	128 26688	128 36688
		10	9.5 x 8 x 6	60	128 56109	128 76109	128 26109	128 36109
25	35	0.33	9.5 x 7 x 3.5	20	128 50337	128 70337	128 20337	128 30337
		0.47	9.5 x 7 x 4	30	128 50477	128 70477	128 20477	128 30477
		0.68	9.5 x 7 x 4	30	128 50687	128 70687	128 20687	128 30687
		1	9.5 x 7 x 5	40	128 50108	128 70108	128 20108	128 30108
		1.5	9.5 x 8 x 5	50	128 50158	128 70158	128 20158	128 30158
		2.2	9.5 x 8 x 6	60	128 50228	128 70228	128 20228	128 30228
		3.3	9.5 x 8 x 6	60	128 50338	128 70338	128 20338	128 30338
25	40	0.1	9.5 x 7 x 3	10	128 57107	128 77107	128 27107	128 37107
		0.15	9.5 x 7 x 3	10	128 57157	128 77157	128 27157	128 37157
		0.22	9.5 x 7 x 3.5	20	128 57227	128 77227	128 27227	128 37227
		0.33	9.5 x 7 x 4	30	128 57337	128 77337	128 27337	128 37337
		0.47	9.5 x 7 x 5	40	128 57477	128 77477	128 27477	128 37477
		0.68	9.5 x 7 x 5	40	128 57687	128 77687	128 27687	128 37687
		1	9.5 x 8 x 5	50	128 57108	128 77108	128 27108	128 37108
		1.5	9.5 x 8 x 6	60	128 57158	128 77158	128 27158	128 37158
		2.2	9.5 x 8 x 6	60	128 57228	128 77228	128 27228	128 37228

Note

[1] The 8th digit of the catalogue number represents the tolerance, as follows:

TOLERANCE	FORM CB	FORM CA	FORM TR+	FORM TFA
±20% : 2222	128 5....	128 7....	128 2....	128 3....
±10% : 2222	128 4....	128 6....	128 1....	to special order

Voltage

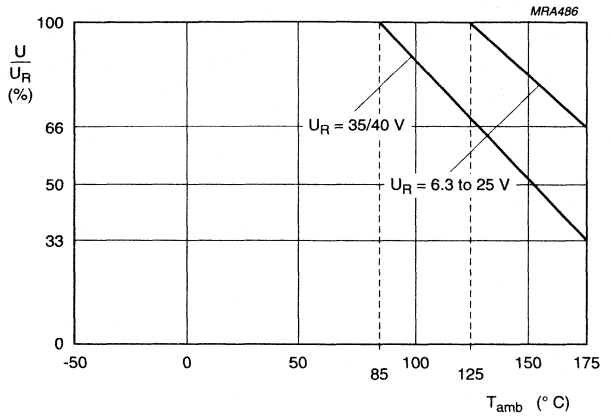


Fig.5 Maximum permissible voltage up to 175 °C.

Surge voltage for short periods	$U_s \leq 1.15 \cdot U_R$	
Reverse voltage	$U_{rev} < 0.3 \cdot U_R$	
Max. peak AC voltage, reverse voltage applied	≤2 V	
Max. peak AC voltage, without reverse voltage applied		
	T_{amb} ≤85 °C	85 °C < T_{amb} ≤125 °C
at f ≤ 0.1 Hz	0.30 x U_R	0.15 x U_R
at 0.1 Hz < f ≤ 1 Hz	0.45 x U_R	0.22 x U_R
at 1 Hz < f ≤ 10 Hz	0.60 x U_R	0.30 x U_R
at 10 Hz < f ≤ 50 Hz	0.65 x U_R	0.32 x U_R
at f > 50 Hz	0.80 x U_R	0.40 x U_R

Ripple current (I_R)

Applying the max. RMS ripple current given in Table 3 will cause a device temperature of 138 °C. The 100 kHz values in Table 3 for other temperatures are to be calculated with the following I_R multipliers:

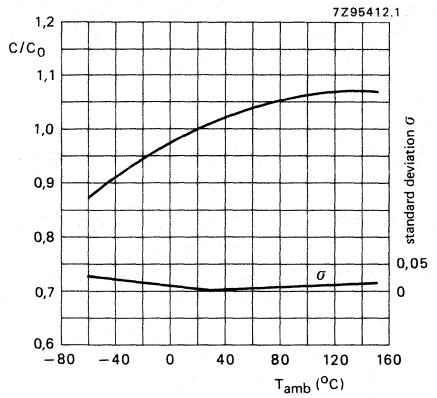
T_{amb}	25 °C	40 °C	65 °C	85 °C	105 °C	125 °C
I_R multiplier	1.1	1.0	0.88	0.75	0.59	0.37

Max. power dissipation

case sizes 9.5 x 7 x 3 to 9.5 x 7 x 5: P_{125} = 88 mW

case size 9.5 x 8 x 5 and 9.5 x 8 x 6: P_{125} = 104 mW.

Capacitance (C)



C_0 = capacitance at 25 °C and 100 Hz.

Fig.6 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.

Typical parameter change after endurance test at T_{amb} = 125 °C.

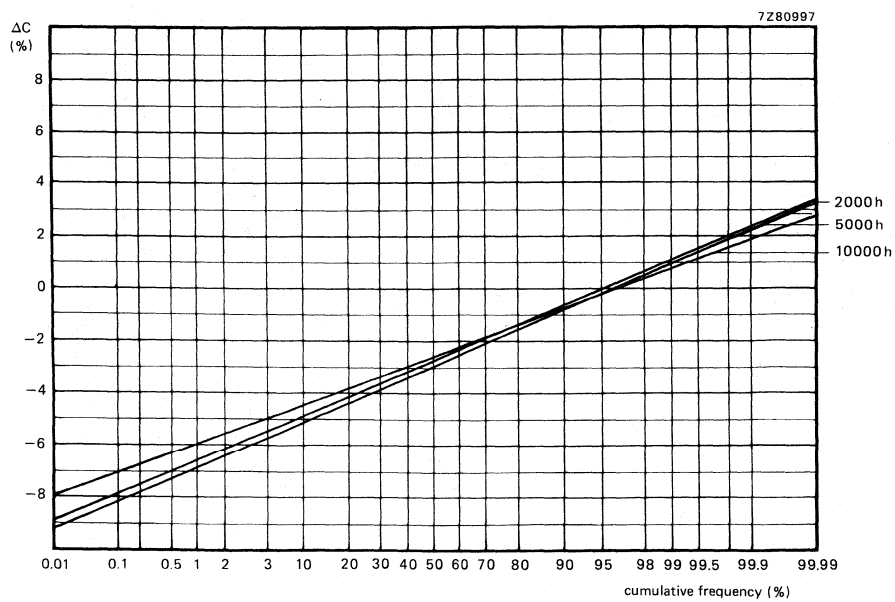
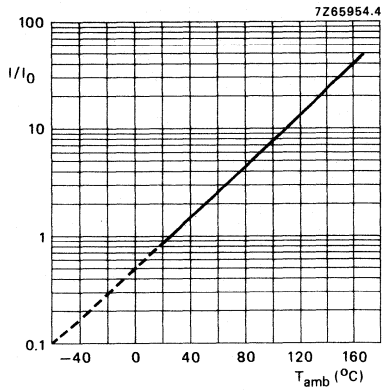


Fig.7 Change of capacitance after endurance test.

Leakage current



I_0 = leakage current during continuous operation at U_R and T_{amb} = 25 °C.

Fig.8 Typical multiplier of leakage current (I/I_0) as a function of ambient temperature.

Maximum leakage current after 5 minutes at U_R and T_{amb} = 25 °C	$I_{L5} \leq 0.025\ C_R \times U_R$ or 2 μA, whichever is greater (see Table 3)

Typical leakage current 15 s at U_R and T_{amb} = 25 °C

6.3V to 16 V versions	approx. 0.2 x value stated in Table 3
25V to 40 V versions	approx. 0.1 x value stated in Table 3

Typical parameter change after endurance test at T_{amb} = 125 °C.

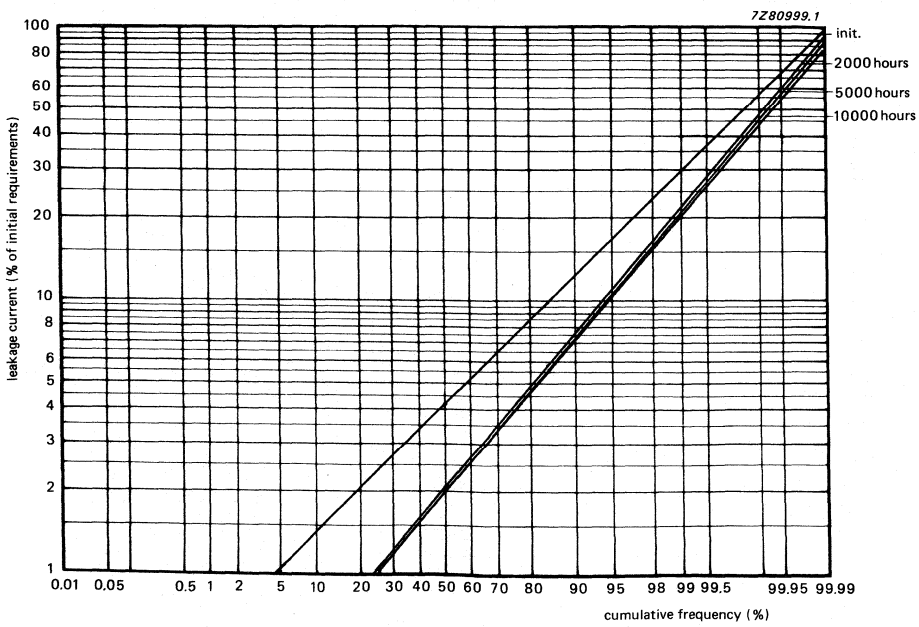
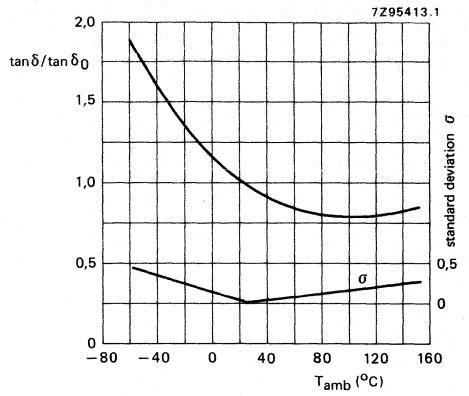


Fig.9 Leakage current after endurance test.

Dissipation factor (tan δ)



$\tan \delta_0$ = dissipation factor at T_{amb} = 25 °C and 100 Hz.

Fig.10 Typical multiplier of dissipation factor ($\tan \delta / \tan \delta_0$) as a function of temperature.

Typical parameter change after endurance test at T_{amb} = 125 °C.

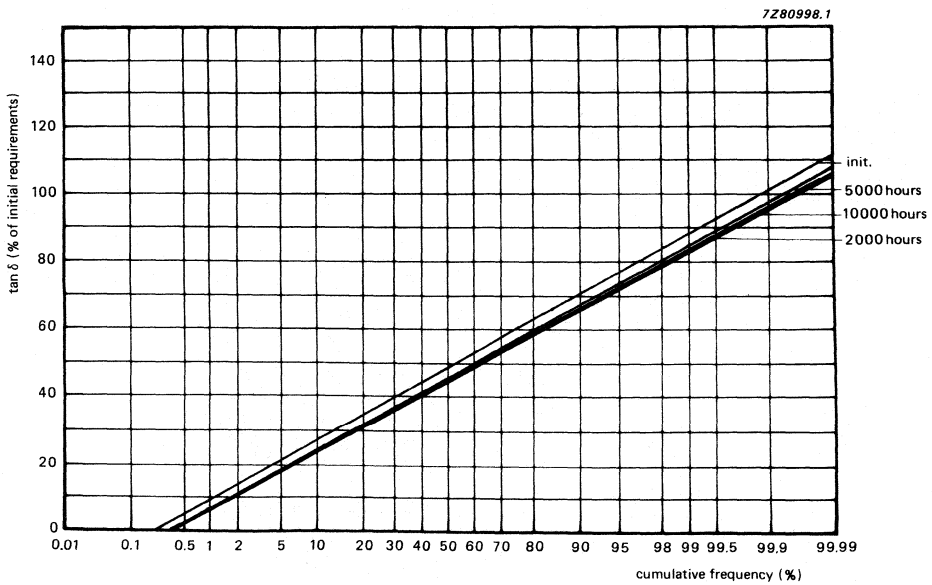
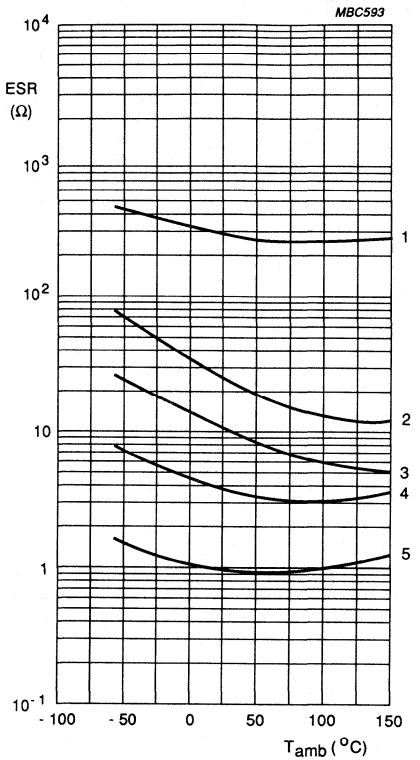


Fig.11 Tan δ after endurance test.

Equivalent series resistance (ESR)



Curve 1 : 0.1 µF, 40 V
Curve 2 : 1.5 µF, 40 V
Curve 3 : 3.3 µF, 25 V
Curve 4 : 10 µF, 6.3 V
Curve 5 : 22 µF, 10 V

Fig.12 Typical ESR as a function of temperature at 100 Hz.

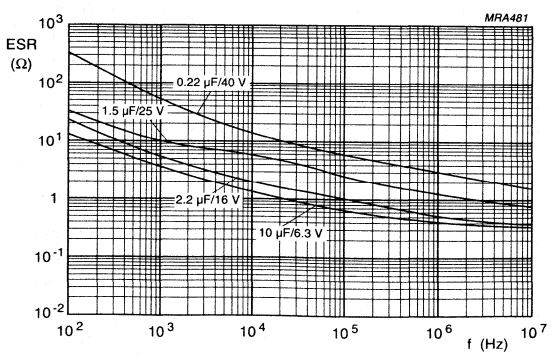


Fig.13 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 7 x 3.5 mm.

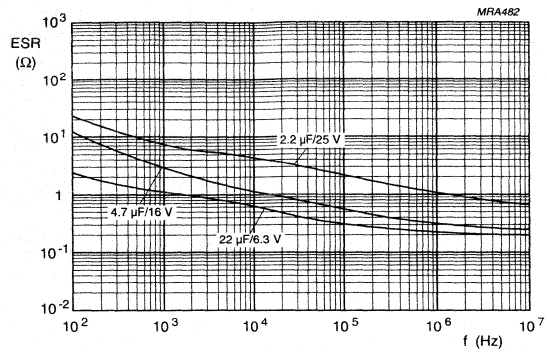


Fig.14 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 7 x 4 mm.

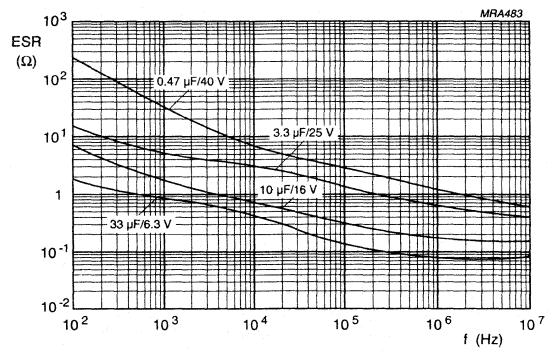


Fig.15 Typical ESR as a function of frequency at T_{amb} = 25 °C; case sizes 9.5 x 7 x 5 mm.

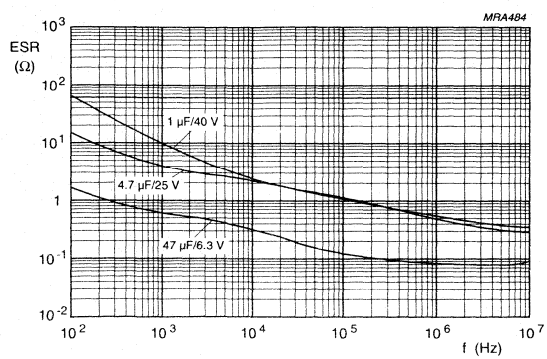


Fig.16 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 8 x 5 mm.

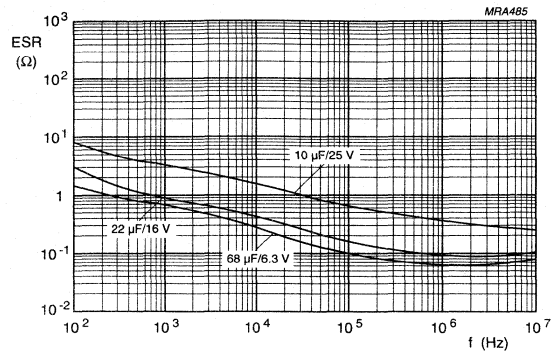
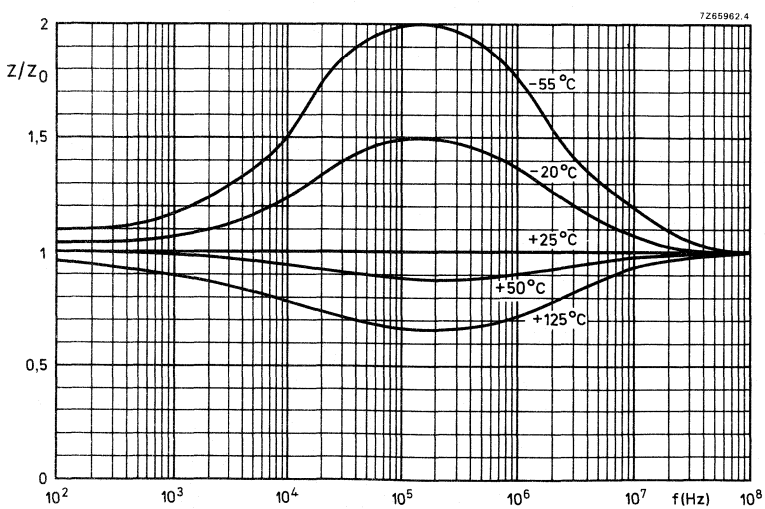


Fig.17 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 8 x 6 mm.

Equivalent series inductance (ESL), f = 10 MHz

Typical ESL for; case sizes 9.5 x 7 x 3 to 9.5 x 7 x 5	9 to 14 nH
Typical ESL for; case sizes 9.5 x 8 x 5 and 9.5 x 8 x 6	11 to 16 nH
Maximum ESL for all; case sizes	20 nH

Impedance (Z)



Z_0 = initial impedance value at T_{amb} = 25 °C.

Fig.18 Typical multiplier of impedance (Z/Z_0) as a function of frequency at different temperatures.

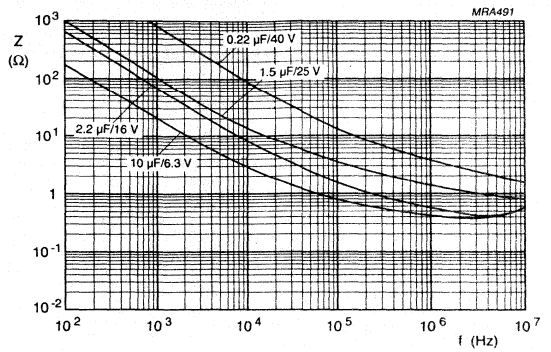


Fig.19 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 7 x 3.5 mm.

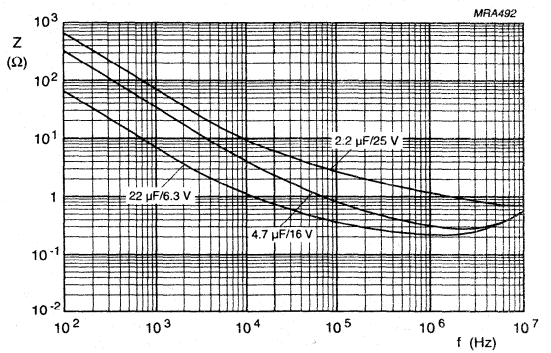


Fig.20 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 7 x 4 mm.

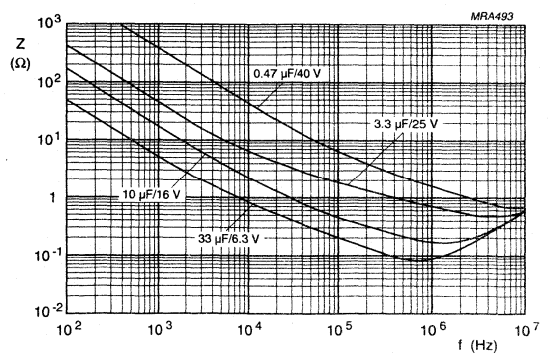


Fig.21 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 7 x 5 mm.

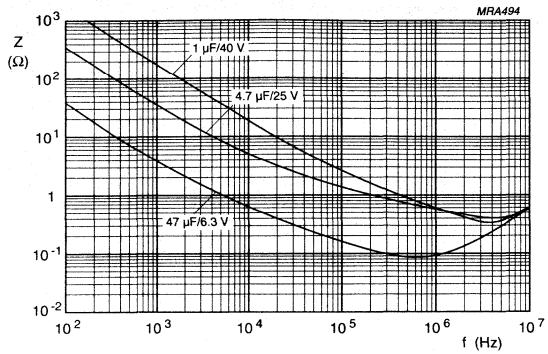


Fig.22 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 8 x 5 mm.

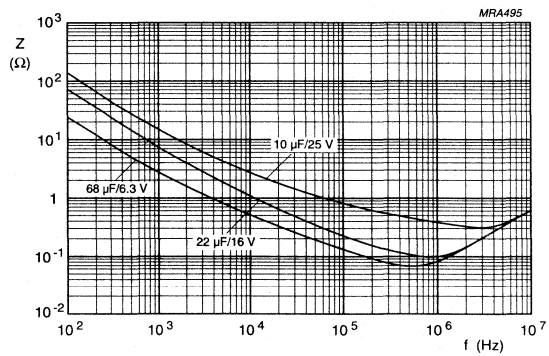


Fig.23 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 8 x 6 mm.

7

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 5

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-2/ CECC 30 302 group C3, 4.13	T_{amb} = 125 °C U_R = 6.3 to 25 V with U_R applied U_R = 35 and 40 V with U_C applied 10 000 hours	$\Delta C/C$ ≤±10% tan δ ≤1.2 x spec. limit Z ≤1.2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 302 amendment 2642 sub clause 1.8.1	T_{amb} = 125 °C, I_R applied and U_R = 6.3 to 25 V with U_R applied U_R = 35 and 40 V with U_C applied 20 000 hours	$\Delta C/C$ ≤15% tan δ ≤1.5 x spec. limit Z ≤1.5 x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage <1%
Shelf life (storage at high temp.)	IEC 384-4-2/ CECC 30 302 group C 5a, 4.17	T_{amb} = 125 °C, no voltage applied 500 hours	$\Delta C/C$ ≤±10% tan δ ≤1.2 x spec. limit I_{L5} ≤1 x spec. limit
Charge and discharge	IEC 384-4-2 sub clause 9.21	10^6 cycles without series resistance 0.5 s to U_R 0.5 s to ground	$\Delta C/C$ ≤5% no short or open circuit no visible damage
Solvent resistance test	IEC 68-2-45, IEC 653 test XA	sequence: - 30 s vapour phase - 5 minutes ultrasonic immersion at ambient temperature - 30 s vapour phase Solvents: - deionized water (50 ±5 °C); - calgonite solution (20 g/l, 70 ±5 °C); - 1.1.1.-trichloro-ethane; - mixtures of 1.1.2.-trichloro-1.2.2.-trifluoro-ethane (fluorocarbon 113) and the following solvents in the respective mass percentage ratios of these solvents to fluorocarbon; * ARKLONE K; 75% w/w F113 and 25% w/w isopropanol * FREON TE; 95.5% w/w F113 and 4.5% w/w ethanol * FREON TMS; 94% w/w F113, 5.7% w/w methanol and 0.3% w/w nitro-methane *ARKLONE F; 95.6% w/w F113, 4.0% w/w ethylalcohol, 0.07% w/w stabilizer and 0.3% w/w special additives * ARKLONE A-M; 94.15% w/w F113, 3.7% w/w ethylalcohol, 2.1% w/w methylacetate and 0.05% w/w stabilizer	visual appearance not affected

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	Reference		
Extended vibration test	IEC 68-2-6 test Fc	10 to 2 000 Hz 1.5 mm or 20 g 1 octave/minute 3 directions 1 sweep per direction no voltage applied	no intermittent contacts; no breakdown; no open circuiting; no mechanical damage; $\Delta C/C$ ≤5% tan δ ≤1.2 x spec. limit Z ≤1.2 x spec. limit I_{L5} ≤1.5 x spec. limit
Shock test	IEC 68-2-27 test Ea	half-sine or saw tooth pulse shape 50 g, 11 ms, 3 successive shocks in each direction of 3 mutually perpendicular axes, no voltage applied	no intermittent contacts; no breakdown; no open circuiting; no mechanical damage; $\Delta C/C$ ≤5% tan δ ≤1.2 x spec. limit Z ≤1.2 x spec. limit I_{L5} ≤1.5 x spec. limit
Passive flammability test	IEC 695-2-2	capacitor mounted to a vertical printed-wiring board, one flame on capacitor body, T_{amb} = 20 to 25 °C, test duration = 20 s.	after removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s; no burning particles must drop from the sample

Notes

1. ARKLONE is a trade mark of I.C.I.
2. FREON is a trade mark of Dupont de Nemours.

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Electrolytic Capacitors

Notes

Solid Al - electrolytic capacitors
Solid Al Radial, DC/DC converters

SAL-RDC 129

FEATURES

- Polarized aluminium electrolytic capacitors, solid electrolyte MnO_2
- Radial leads, max. height 9.5 mm, resin dipped, orange coloured
- Extremely long useful life, 20 000 hours/125 °C
- Extended usable temperature range up to 175 °C
- Very low and time stable ESR values at higher frequencies
- Extremely high ripple current capability
- Excellent low temperature behaviour
- Charge and discharge proof, application with 0 Ω resistance allowed
- Reverse DC voltage up to 0.3 x U_R allowed
- AC voltage up to 0.8 x U_R allowed
- Advanced technology to achieve high reliability and high stability.

APPLICATIONS

- Especially suitable for DC/DC converters
- EDP, telecommunication, general industrial, automotive and audio-video
- Smoothing, filtering and buffering
- Small power supplies and high frequency SMPS.

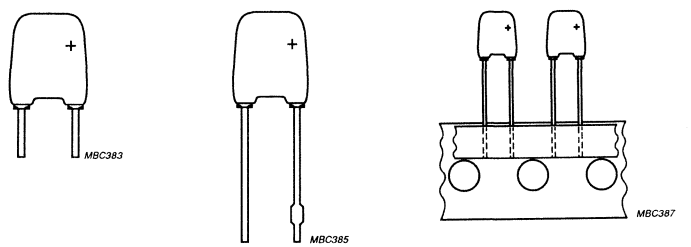

Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (H_{max} x W_{max} x T_{max} in mm)	9.5 x 7 x 3.5 to 9.5 x 8 x 6
Rated capacitance range (E6 series), C_R	0.22 to 68 µF
Tolerance on C_R	±20%, ±10% to special order
Rated voltage range, U_R	6.3 to 40 V
Category temperature range for U_R = 6.3 to 25 V for U_R = 35 to 40 V for U_C = 35 to 40 V	 –55 to +125 °C –55 to +85 °C –55 to +125 °C
Endurance test at 125 °C	10 000 hours
Useful life at 125 °C	20 000 hours
Useful life at 175 °C	2000 hours
Useful life at U_R, 40 °C, I_R applied	>300 000 hours
Shelf life at 0 V, 125 °C	500 hours
Basic specification	IEC 384-4/CECC 30 300
Climatic category IEC 68 DIN 40040 NF C20-600	 55/125/56 FKD 434

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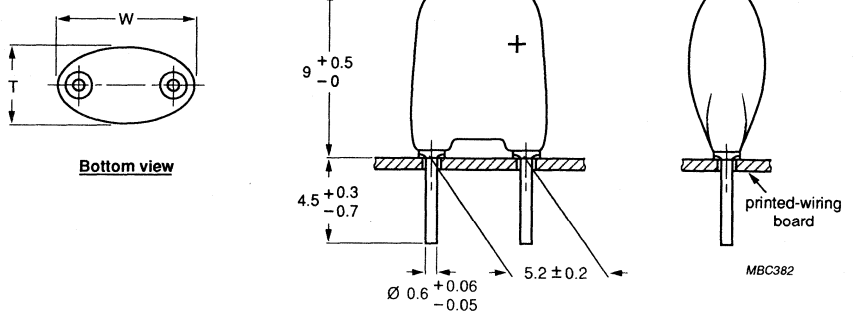
Table 1 Selection chart for C_R, U_R, U_C and relevant maximum case sizes **(H x W x T** in **mm)** for 129 series

C_R (µF)	U_R (V)					
	6.3	**10**	**16**	**25**	**35**	**40**
	U_C (V)					
	6.3	**10**	**16**	**25**	**25**	**25**
0.22						9.5 x 7 x 3.5
0.33					9.5 x 7 x 3.5	9.5 x 7 x 4
0.47					9.5 x 7 x 4	9.5 x 7 x 5
0.68				9.5 x 7 x 3.5	9.5 x 7 x 4	9.5 x 7 x 5
1				9.5 x 7 x 3.5	9.5 x 7 x 5	9.5 x 8 x 5
1.5				9.5 x 7 x 3.5	9.5 x 8 x 5	9.5 x 8 x 6
2.2			9.5 x 7 x 3.5	9.5 x 7 x 4	9.5 x 8 x 6	9.5 x 8 x 6
3.3			9.5 x 7 x 3.5	9.5 x 7 x 5	9.5 x 8 x 6	
4.7		9.5 x 7 x 3.5	9.5 x 7 x 4	9.5 x 8 x 5		
6.8		9.5 x 7 x 3.5	9.5 x 7 x 4	9.5 x 8 x 6		
10	9.5 x 7 x 3.5	9.5 x 7 x 4	9.5 x 7 x 5	9.5 x 8 x 6		
15		9.5 x 7 x 4	9.5 x 8 x 5			
22	9.5 x 7 x 4	9.5 x 7 x 5	9.5 x 8 x 6			
33	9.5 x 7 x 5	9.5 x 8 x 5				
47	9.5 x 8 x 5	9.5 x 8 x 6				
68	9.5 x 8 x 6					

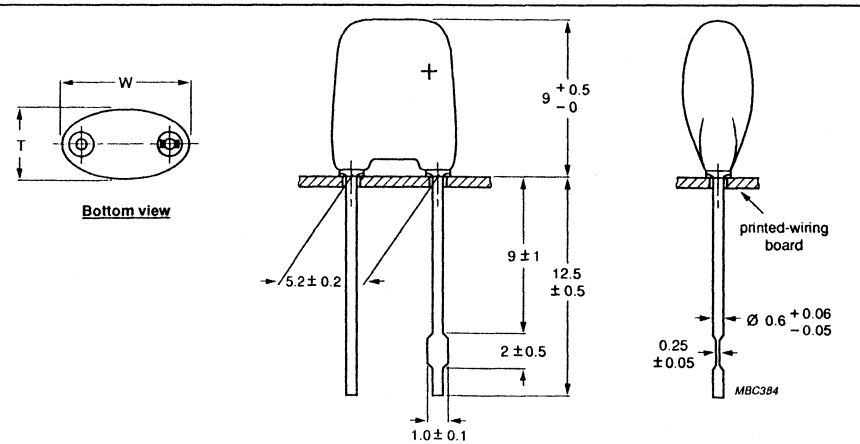
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.



Flanges are provided with degassing grooves.

Fig.2 **Form CB**: Short leads, in boxes.



The diameter of the mounting holes in the printed-wiring board is 0.8 ±0.1 mm, except for the hole of the anode lead of Form CA capacitors: 1.3 −0.2 mm.

Flanges are provided with degassing grooves.

Fig.3 **Form CA**: Long leads with keyed polarity, in boxes.

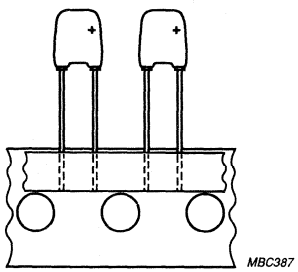
Table 2 Dimensions in mm; mass in g

CASE		APPROX. MASS	PACKING QUANTITIES			
SIZE H_{max} x W_{max} x T_{max}	CODE		FORM CA [1]	FORM CB [1]	FORM TR+	FORM TFA
9.5 x 7 x 3.5	20	0.25	1000	1000	2000	2000
9.5 x 7 x 4	30	0.30	1000	1000	2000	2000
9.5 x 7 x 5	40	0.35	1000	1000	1000	1000
9.5 x 8 x 5	50	0.50	1000	1000	1000	1000
9.5 x 8 x 6	60	0.60	1000	1000	1000	1000

Note

[1] In plastic bags of 200 units each.

Tape dimensions are specified in chapter "PACKING",



Form TR+: Taped on reel, positive leading.
Form TFA: Taped in ammopack.

Fig.4 Taped versions.

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance
- Tolerance code on rated capacitance (M = ±20%, K = ±10%)
- Rated voltage (and category voltage if applicable)
- Date code in accordance with IEC 62
- Name of manufacturer
- '+' signs to identify the anode terminal
- '-' sign to identify the cathode terminal.

Mounting

When bending, cutting or straightening the leads, ensure that the capacitor body is relieved of stress.
Bending after soldering must be avoided.

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 3 and 4 apply at T_{amb} = 20 to 25 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz (tolerance ±20%)

I_R = max. RMS ripple current no necessary DC applied

I_{L5} = max. leakage current after 5 minutes at U_R

ESR = equivalent series resistance at 100 Hz/100 kHz

Z = max. impedance at 100 kHz.

Table 3 Electrical data for 129 series

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	ESR 100 kHz (TYP.) (Ω)	ESR 100 Hz (MAX.) (Ω)	Z 100 kHz (Ω)
6.3	6.3	10	9.5 x 7 x 3.5	780	2	0.80	18	2.0
		22	9.5 x 7 x 4	1370	4	0.30	4.9	0.7
		33	9.5 x 7 x 5	1550	5	0.20	3.3	0.5
		47	9.5 x 8 x 5	2000	7	0.15	2.9	0.3
		68	9.5 x 8 x 6	2100	11	0.13	2.7	0.3
10	10	4.7	9.5 x 7 x 3.5	780	2	1.0	23	2.0
		6.8	9.5 x 7 x 3.5	780	2	0.80	16	2.0
		10	9.5 x 7 x 4	1000	3	0.50	11	1.0
		15	9.5 x 7 x 4	1370	4	0.40	7.2	0.7
		22	9.5 x 7 x 5	1640	6	0.25	4.9	0.5
		33	9.5 x 8 x 5	2000	8	0.15	3.3	0.3
		47	9.5 x 8 x 6	2100	12	0.13	2.3	0.3
16	16	2.2	9.5 x 7 x 3.5	640	2	1.5	49	3.0
		3.3	9.5 x 7 x 3.5	640	2	1.2	33	3.0
		4.7	9.5 x 7 x 4	820	2	0.80	23	2.0
		6.8	9.5 x 7 x 4	910	3	0.60	16	1.5
		10	9.5 x 7 x 5	1190	4	0.45	11	1.0
		15	9.5 x 8 x 5	1370	6	0.30	7.2	0.7
		22	9.5 x 8 x 6	1460	9	0.20	4.9	0.7

ORDERING INFORMATION

Ordering example

Electrolytic capacitors SAL-RDC
10 µF/16 V, ±20%
Form CB
Catalogue number: 2222 129 55109.

Table 4 Ordering information for 129 series

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	CASE CODE	CATALOGUE NUMBER 2222 . . . . . [1]			
					FORM CB	FORM CA	FORM TR+ on reel	FORM TFA in ammopack
6.3	6.3	10	9.5 x 7 x 3.5	20	129 53109	129 73109	129 23109	129 33109
		22	9.5 x 7 x 4	30	129 53229	129 73229	129 23229	129 33229
		33	9.5 x 7 x 5	40	129 53339	129 73339	129 23339	129 33339
		47	9.5 x 8 x 5	50	129 53479	129 73479	129 23479	129 33479
		68	9.5 x 8 x 6	60	129 53689	129 73689	129 23689	129 33689
10	10	4.7	9.5 x 7 x 3.5	20	129 54478	129 74478	129 24478	129 34478
		6.8	9.5 x 7 x 3.5	20	129 54688	129 74688	129 24688	129 34688
		10	9.5 x 7 x 4	30	129 54109	129 74109	129 24109	129 34109
		15	9.5 x 7 x 4	30	129 54159	129 74159	129 24159	129 34159
		22	9.5 x 7 x 5	40	129 54229	129 74229	129 24229	129 34229
		33	9.5 x 8 x 5	50	129 54339	129 74339	129 24339	129 34339
		47	9.5 x 8 x 6	60	129 54479	129 74479	129 24479	129 34479
16	16	2.2	9.5 x 7 x 3.5	20	129 55228	129 75228	129 25228	129 35228
		3.3	9.5 x 7 x 3.5	20	129 55338	129 75338	129 25338	129 35338
		4.7	9.5 x 7 x 4	30	129 55478	129 75478	129 25478	129 35478
		6.8	9.5 x 7 x 4	30	129 55688	129 75688	129 25688	129 35688
		10	9.5 x 7 x 5	40	129 55109	129 75109	129 25109	129 35109
		15	9.5 x 8 x 5	50	129 55159	129 75159	129 25159	129 35159
		22	9.5 x 8 x 6	60	129 55229	129 75229	129 25229	129 35229

Solid Al - electrolytic capacitors
Solid Al Radial, DC/DC converters

SAL-RDC 129

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	ESR 100 kHz (TYP.) (Ω)	ESR 100 Hz (MAX.) (Ω)	Z 100 kHz (Ω)
25	25	0.68	9.5 x 7 x 3.5	280	2	6.0	160	15
		1	9.5 x 7 x 3.5	320	2	4.5	110	10
		1.5	9.5 x 7 x 3.5	370	2	3.5	73	10
		2.2	9.5 x 7 x 4	410	2	2.5	49	7.0
		3.3	9.5 x 7 x 5	500	2	1.9	33	5.0
		4.7	9.5 x 8 x 5	640	3	1.1	23	3.0
		6.8	9.5 x 8 x 6	820	4	0.90	16	2.0
		10	9.5 x 8 x 6	910	6	0.80	11	1.5
25	35	0.33	9.5 x 7 x 3.5	280	2	8.0	330	20
		0.47	9.5 x 7 x 4	300	2	5.0	230	20
		0.68	9.5 x 7 x 4	320	2	4.0	160	15
		1	9.5 x 7 x 5	390	2	2.5	110	10
		1.5	9.5 x 8 x 5	450	2	2.0	73	7.0
		2.2	9.5 x 8 x 6	640	2	1.5	49	3.0
		3.3	9.5 x 8 x 6	680	3	1.5	33	3.0
25	40	0.22	9.5 x 7 x 3.5	250	2	10	495	20
		0.33	9.5 x 7 x 4	280	2	8.0	330	20
		0.47	9.5 x 7 x 5	300	2	5.0	230	15
		0.68	9.5 x 7 x 5	370	2	4.0	160	10
		1	9.5 x 8 x 5	450	2	2.5	110	7.0
		1.5	9.5 x 8 x 6	550	2	2.0	73	5.0
		2.2	9.5 x 8 x 6	640	2	1.5	49	3.0

Solid Al - electrolytic capacitors
Solid Al Radial, DC/DC converters

SAL-RDC 129

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	CASE CODE	CATALOGUE NUMBER 2222 . . . . . [1]			
					FORM CB	FORM CA	FORM TR+ on reel	FORM TFA in ammopack
25	25	0.68	9.5 x 7 x 3.5	20	129 56687	129 76687	129 26687	129 36687
		1	9.5 x 7 x 3.5	20	129 56108	129 76108	129 26108	129 36108
		1.5	9.5 x 7 x 3.5	20	129 56158	129 76158	129 26158	129 36158
		2.2	9.5 x 7 x 4	30	129 56228	129 76228	129 26228	129 36228
		3.3	9.5 x 7 x 5	40	129 56338	129 76338	129 26338	129 36338
		4.7	9.5 x 8 x 5	50	129 56478	129 76478	129 26478	129 36478
		6.8	9.5 x 8 x 6	60	129 56688	129 76688	129 26688	129 36688
		10	9.5 x 8 x 6	60	129 56109	129 76109	129 26109	129 36109
25	35	0.33	9.5 x 7 x 3.5	20	129 50337	129 70337	129 20337	129 30337
		0.47	9.5 x 7 x 4	30	129 50477	129 70477	129 20477	129 30477
		0.68	9.5 x 7 x 4	30	129 50687	129 70687	129 20687	129 30687
		1	9.5 x 7 x 5	40	129 50108	129 70108	129 20108	129 30108
		1.5	9.5 x 8 x 5	50	129 50158	129 70158	129 20158	129 30158
		2.2	9.5 x 8 x 6	60	129 50228	129 70228	129 20228	129 30228
		3.3	9.5 x 8 x 6	60	129 50338	129 70338	129 20338	129 30338
25	40	0.22	9.5 x 7 x 3.5	20	129 57227	129 77227	129 27227	129 37227
		0.33	9.5 x 7 x 4	30	129 57337	129 77337	129 27337	129 37337
		0.47	9.5 x 7 x 5	40	129 57477	129 77477	129 27477	129 37477
		0.68	9.5 x 7 x 5	40	129 57687	129 77687	129 27687	129 37687
		1	9.5 x 8 x 5	50	129 57108	129 77108	129 27108	129 37108
		1.5	9.5 x 8 x 6	60	129 57158	129 77158	129 27158	129 37158
		2.2	9.5 x 8 x 6	60	129 57228	129 77228	129 27228	129 37228

Note

[1] The 8th digit of the catalogue number represents the tolerance, as follows:

TOLERANCE	FORM CB	FORM CA	FORM TR+	FORM TFA
±20% : 2222	129 5....	129 7....	129 2....	129 3....
±10% : 2222	129 4....	129 6....	129 1....	to special order

Voltage

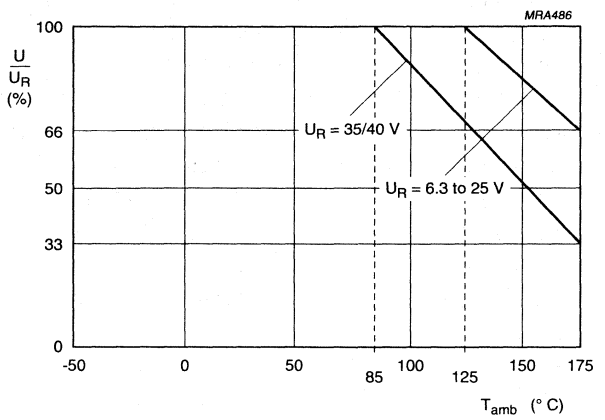


Fig.5 Maximum permissible voltage up to 175 °C.

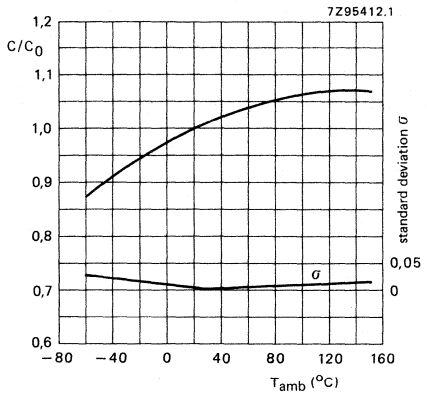
Surge voltage for short periods	$U_s \leq 1.15 \bullet U_R$	
Reverse voltage	$U_{rev} < 0.3 \bullet U_R$	
Max. peak AC voltage, reverse voltage applied	≤2 V	
Max. peak AC voltage, without reverse voltage applied		
	$T_{amb} \leq 85$ °C	85 °C $< T_{amb} \leq 125$ °C
at f ≤ 0.1 Hz	0.30 x U_R	0.15 x U_R
at 0.1 Hz < f ≤ 1 Hz	0.45 x U_R	0.22 x U_R
at 1 Hz < f ≤ 10 Hz	0.60 x U_R	0.30 x U_R
at 10 Hz < f ≤ 50 Hz	0.65 x U_R	0.32 x U_R
at f > 50 Hz	0.80 x U_R	0.40 x U_R

Ripple current (I_R)

Applying the max. RMS ripple current given in Table 3 will cause a device temperature of 138 °C. The 100 kHz values in Table 3 for other temperatures are to be calculated with the following I_R multipliers:

T_{amb}	25 °C	40 °C	65 °C	85 °C	105 °C	125 °C
I_R multiplier	1.1	1.0	0.88	0.75	0.59	0.37

Capacitance (C)



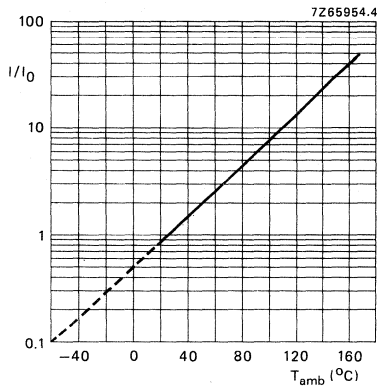
C_0 = capacitance at 25 °C and 100 Hz.

Fig.6 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.

Typical parameter change after endurance test at T_{amb} = 125 °C

Fig.7 Change of capacitance after endurance test.

Leakage current



I_0 = leakage current during continuous operation at U_R and T_{amb} = 25 °C.

Fig.8 Typical multiplier of leakage current (I/I_0) as a function of ambient temperature.

Maximum leakage current after 5 minutes at U_R and T_{amb} = 25 °C	$I_{L5} \leq 0.025\ C_R \times U_R$ or 2 µA, whichever is greater (see Table 3)

Typical leakage current 15 s at U_R and T_{amb} = 25 °C

6.3V to 16 V versions	approx. 0.2 x value stated in Table 3
25V to 40 V versions	approx. 0.1 x value stated in Table 3

Typical parameter change after endurance test at T_{amb} = 125 °C

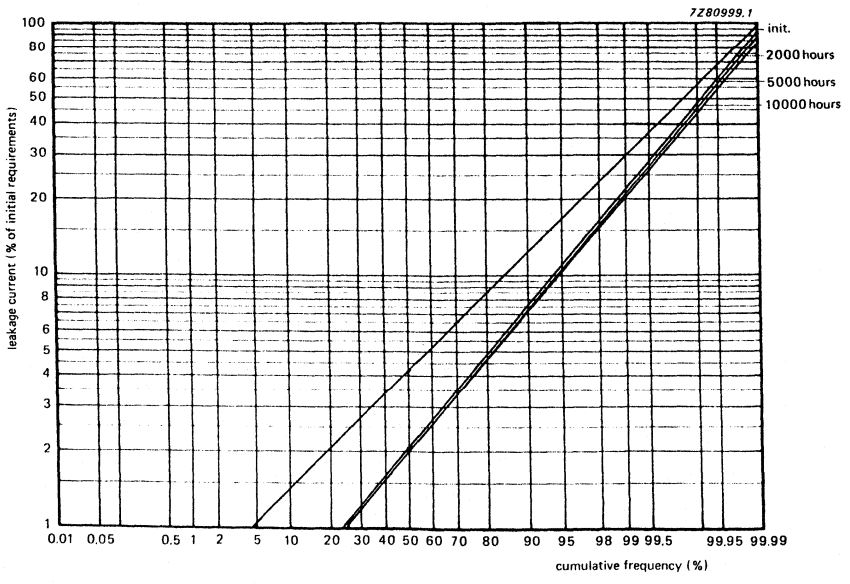
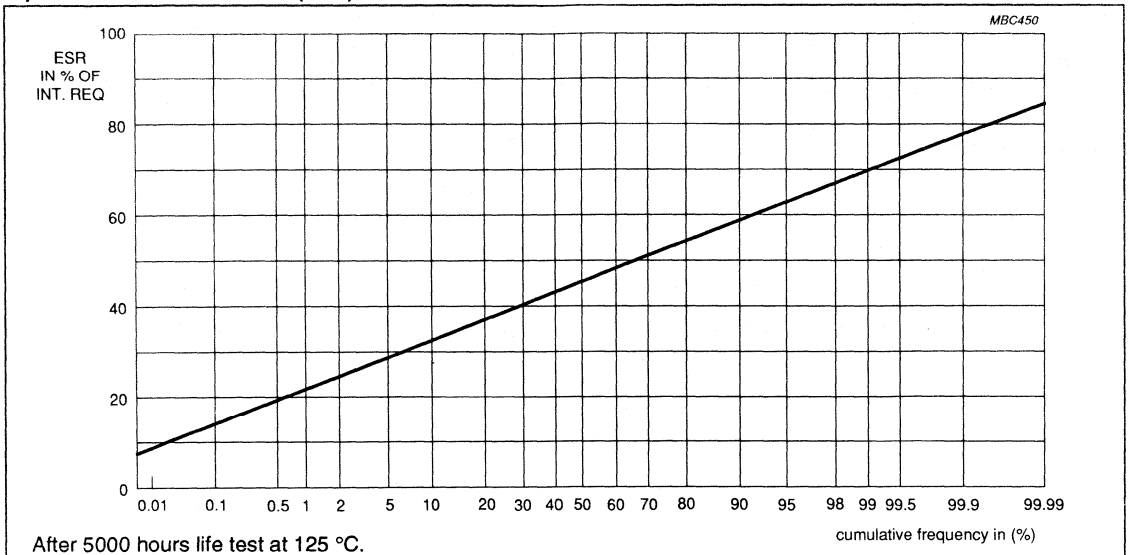


Fig.9 Leakage current after endurance test.

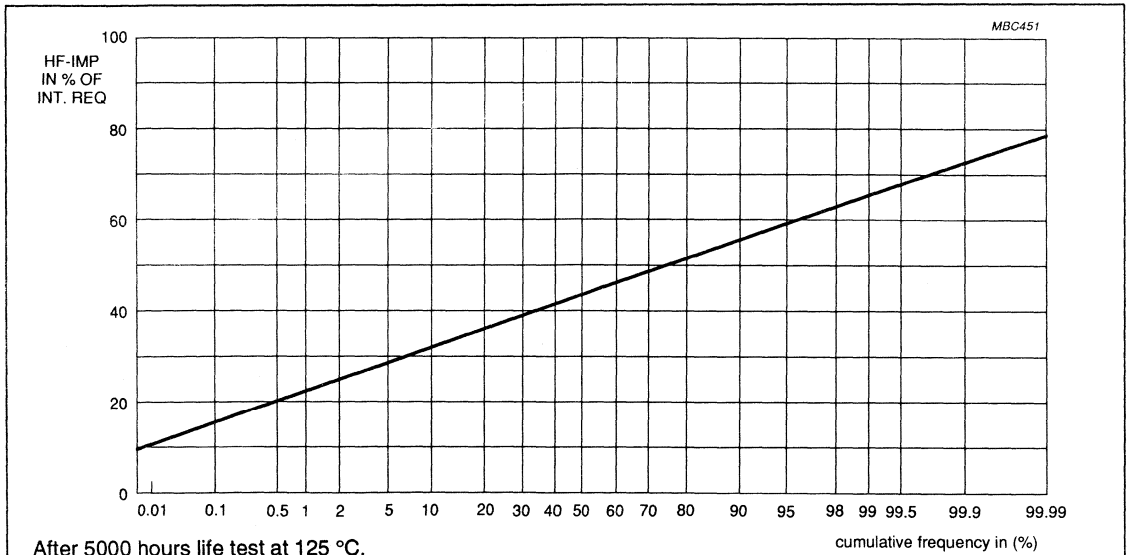
Equivalent series resistance (ESR)



After 5000 hours life test at 125 °C.

Fig.10 ESR distribution after life test.

Impedance (Z)



After 5000 hours life test at 125 °C.

Fig.11 HF-Impedance distribution after life test.

Equivalent series inductance (ESL), f = 10 MHz

Typical ESL for case sizes 9.5 x 7 x 3.5 to 9.5 x 7 x 5	9 to 14 nH
Typical ESL for case sizes 9.5 x 8 x 5 and 9.5 x 8 x 6	11 to 16 nH
Maximum ESL for all case sizes	20 nH

Max. power dissipation

case sizes 9.5 x 7 x 3.5 to 9.5 x 7 x 5: P_{125} = 88 mW
case size 9.5 x 8 x 5 and 9.5 x 8 x 6: P_{125} = 104 mW

SPECIFIC TESTS and REQUIREMENTS (under consideration)

General tests and requirements are specified in chapter "Tests and Requirements", data handbook PA01 Electrolytic Capacitors.

Electrolytic Capacitors

Notes

Solid Al - electrolytic capacitors
Solid Al, Radial Pearl

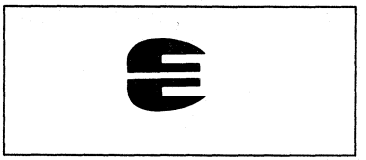
SAL-RP 122

FEATURES

- Polarized aluminium electrolytic capacitors, solid electrolyte MnO_2
- Radial leads, max. height 12.5 mm, resin dipped, orange coloured
- Extremely long useful life, 20 000 hours/125 °C
- Extended usable temperature range up to 175 °C
- Excellent low temperature, impedance and ESR behaviour
- Charge and discharge proof, application with 0 Ω resistance allowed
- Reverse DC voltage up to 0.3 x U_R allowed
- AC voltage up to 0.8 x U_R allowed
- Advanced technology to achieve high reliability and high stability.

APPLICATIONS

- EDP, telecommunication, general industrial, automotive and audio-video
- Smoothing, filtering and buffering
- For small power supplies, DC/DC converters.



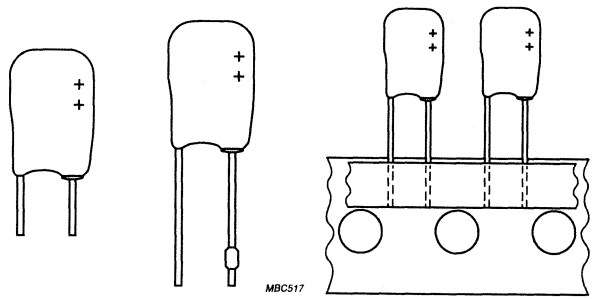


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (H_{max} x W_{max} x T_{max} in mm)	12.5 x 8 x 3.5 to 12.5 x 8 x 6
Rated capacitance range (E6 series), C_R	0.33 to 68 µF
Tolerance on C_R	±20%, ±10% to special order
Rated voltage range, U_R	6.3 to 40 V
Category temperature range for U_R = 6.3 to 25 V for U_R = 35 to 40 V for U_C = 35 to 40 V	 –55 to +125 °C –55 to +85 °C –55 to +125 °C
Endurance test at 125 °C	10 000 hours
Useful life at 125 °C	20 000 hours
Useful life at 175 °C	2000 hours
Useful life at U_R, 40 °C, I_R applied	>300 000 hours
Shelf life at 0 V, 125 °C	500 hours
Basic specification	IEC 384-4/CECC 30 300
Climatic category IEC 68 DIN 40040 NF C20-600	 55/125/56 FKD 434
Approvals	CECC 30 302-002 Liste LNZ 44-04 COS-B Gam-t-1

Table 1 Selection chart for C_R, U_R, U_C and relevant maximum case sizes **(H x W x T** in **mm)** for 122 series

C_R (µF)	U_R (V)					
	6.3	10	16	25	35	40
	U_C (V)					
	6.3	10	16	25	25	25
0.33						12.5 x 8 x 3.5
0.47						12.5 x 8 x 4.5
0.68				12.5 x 8 x 3.5		12.5 x 8 x 4.5
1.0				12.5 x 8 x 3.5	12.5 x 8 x 4.5 [1]	12.5 x 8 x 5
1.5				12.5 x 8 x 3.5		12.5 x 8 x 6
2.2			12.5 x 8 x 3.5	12.5 x 8 x 4.5		12.5 x 8 x 6 [1]
3.3			12.5 x 8 x 3.5	12.5 x 8 x 4.5	12.5 x 8 x 6 [1]	
4.7		12.5 x 8 x 3.5	12.5 x 8 x 4.5	12.5 x 8 x 5		
6.8		12.5 x 8 x 3.5	12.5 x 8 x 4.5	12.5 x 8 x 6		
10	12.5 x 8 x 3.5	12.5 x 8 x 4.5	12.5 x 8 x 5	12.5 x 8 x 6 [1]		
15	12.5 x 8 x 4.5	12.5 x 8 x 4.5	12.5 x 8 x 6			
22	12.5 x 8 x 4.5	12.5 x 8 x 5				
33	12.5 x 8 x 5	12.5 x 8 x 6				
47	12.5 x 8 x 6					
68	12.5 x 8 x 6					

Note

[1] Non CECC-types.

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

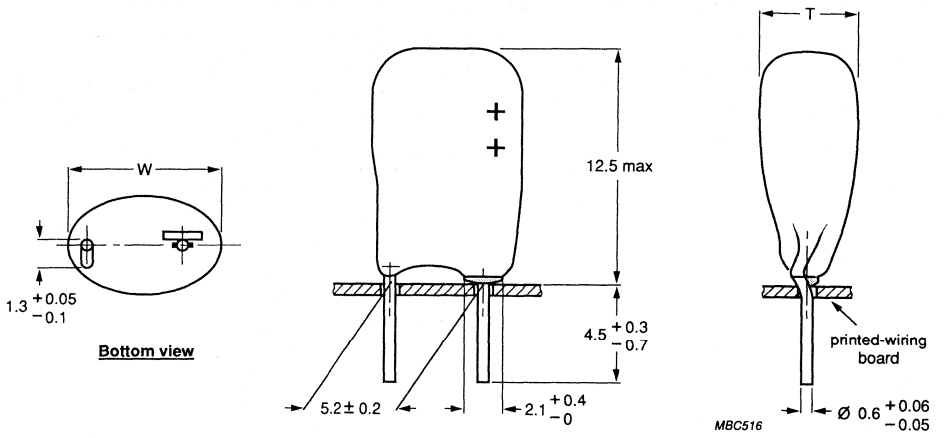
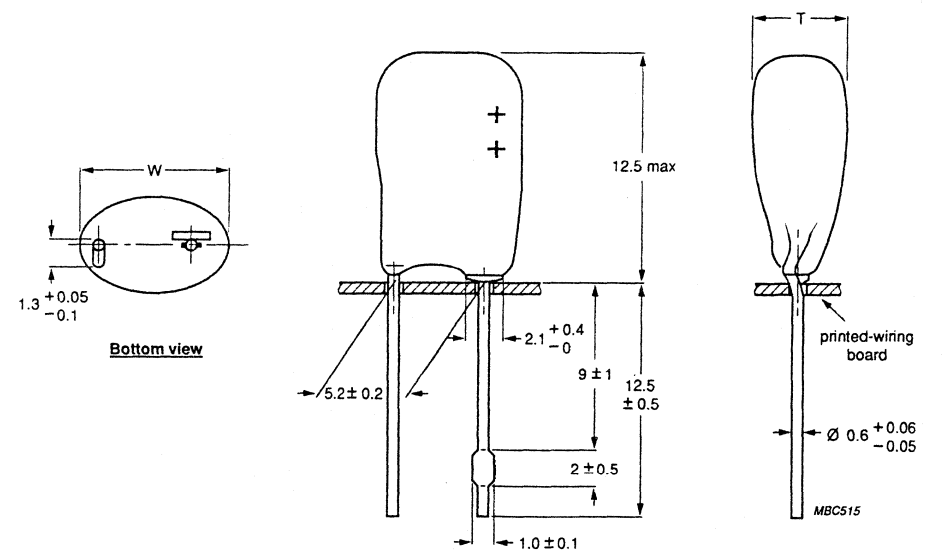


Fig.2 **Form CB**: Short leads, in boxes.



The diameter of the mounting holes in the printed-wiring board is 0.8 ±0.1 mm, except for the hole of the anode lead of Form CA capacitors: 1.3 −0.2 mm.

Fig.3 **Form CA**: Long leads with keyed polarity, in boxes.

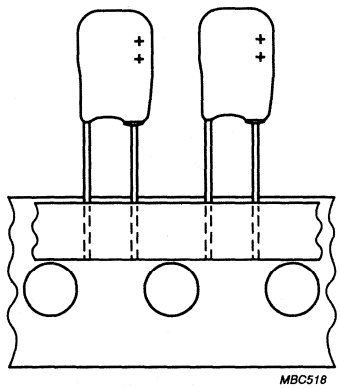
Table 2 Dimensions in mm; mass in g

CASE		APPROX. MASS	PACKING QUANTITIES			
SIZE H_{max} x W_{max} x T_{max}	CODE		FORM CA [1]	FORM CB [1]	FORM TR+	FORM TFA
12.5 x 8 x 3.5	1	0.35	1000	1000	2000	2000
12.5 x 8 x 4.5	2	0.38	1000	1000	2000	2000
12.5 x 8 x 5	3	0.45	1000	1000	1000	1000
12.5 x 8 x 6	4	0.58	800	1000	1000	1000

Note

[1] In plastic bags of 200 units each.

Tape dimensions are specified in chapter "PACKING".



Form TR+: Taped on reel, positive leading.
Form TFA: Taped in ammopack.

Fig.4 Taped versions.

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance
- Tolerance code on rated capacitance (M = ±20%, K = ±10%)
- Rated voltage (and category voltage if applicable)
- Date code in accordance with IEC 62
- Name of manufacturer
- '+' signs to identify the anode terminal.

Mounting

When bending, cutting or straightening the leads, ensure that the capacitor body is relieved of stress.
Bending after soldering must be avoided.

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 3 and 4 apply at T_{amb} = 20 to 25 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz (tolerance ±20%)
I_R = max. RMS ripple current, no necessary DC voltage applied
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = max. equivalent series resistance at 100 Hz
Z = max. impedance at 100 kHz.

Table 3 Electrical data for 122 series

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	I_R 100 Hz 125 °C (mA)	I_R 10 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
6.3	6.3	10	12.5 x 8 x 3.5	9	156	211	3	0.15	30	5
		15	12.5 x 8 x 4.5	13	195	264	5	0.15	20	3
		22	12.5 x 8 x 4.5	20	234	317	7	0.15	14	1.3
		33	12.5 x 8 x 5	30	293	396	11	0.15	9	0.9
		47	12.5 x 8 x 6	42	371	502	15	0.15	6.4	0.7
		68	12.5 x 8 x 6	61	449	607	22	0.15	4.4	0.5
10	10	4.7	12.5 x 8 x 3.5	7	117	158	3	0.15	64	7
		6.8	12.5 x 8 x 3.5	10	137	185	4	0.15	44	5
		10	12.5 x 8 x 4.5	14	156	211	5	0.15	30	1.5
		15	12.5 x 8 x 4.5	21	195	264	8	0.15	20	1
		22	12.5 x 8 x 5	31	234	317	11	0.15	14	0.7
		33	12.5 x 8 x 6	47	312	422	17	0.15	9	0.5
16	16	2.2	12.5 x 8 x 3.5	5	98	132	2	0.10	91	10
		3.3	12.5 x 8 x 3.5	8	117	158	3	0.10	61	7
		4.7	12.5 x 8 x 4.5	11	137	185	4	0.10	43	2
		6.8	12.5 x 8 x 4.5	16	156	211	6	0.10	29.5	1.5
		10	12.5 x 8 x 5	23	195	264	8	0.10	20	1
		15	12.5 x 8 x 6	34	254	343	12	0.10	13.5	0.7

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ORDERING INFORMATION

Ordering example

Electrolytic capacitors SAL-RP
10 µF/16 V, ±20%
Form CB
Catalogue number: 2222 122 55109.

Table 4 Ordering information for 122 series

U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	CASE CODE	CATALOGUE NUMBER 2222 . . . . . [1]			
					FORM CB	FORM CA	FORM TR+ on reel	FORM TFA in ammopack
6.3	6.3	10	12.5 x 8 x 3.5	1	122 53109	122 73109	122 23109	122 33109
		15	12.5 x 8 x 4.5	2	122 53159	122 73159	122 23159	122 33159
		22	12.5 x 8 x 4.5	2	122 53229	122 73229	122 23229	122 33229
		33	12.5 x 8 x 5	3	122 53339	122 73339	122 23339	122 33339
		47	12.5 x 8 x 6	4	122 53479	122 73479	122 23479	122 33479
		68	12.5 x 8 x 6	4	122 53689	122 73689	122 23689	122 33689
10	10	4.7	12.5 x 8 x 3.5	1	122 54478	122 74478	122 24478	122 34478
		6.8	12.5 x 8 x 3.5	1	122 54688	122 74688	122 24688	122 34688
		10	12.5 x 8 x 4.5	2	122 54109	122 74109	122 24109	122 34109
		15	12.5 x 8 x 4.5	2	122 54159	122 74159	122 24159	122 34159
		22	12.5 x 8 x 5	3	122 54229	122 74229	122 24229	122 34229
		33	12.5 x 8 x 6	4	122 54339	122 74339	122 24339	122 34339
16	16	2.2	12.5 x 8 x 3.5	1	122 55228	122 75228	122 25228	122 35228
		3.3	12.5 x 8 x 3.5	1	122 55338	122 75338	122 25338	122 35338
		4.7	12.5 x 8 x 4.5	2	122 55478	122 75478	122 25478	122 35478
		6.8	12.5 x 8 x 4.5	2	122 55688	122 75688	122 25688	122 35688
		10	12.5 x 8 x 5	3	122 55109	122 75109	122 25109	122 35109
		15	12.5 x 8 x 6	4	122 55159	122 75159	122 25159	122 35159

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U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	I_R 100 Hz 125 °C (mA)	I_R 10 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
25	25	0.68	12.5 x 8 x 3.5	2	55	74	2	0.10	295	30
		1	12.5 x 8 x 3.5	4	62	85	2	0.10	200	20
		1.5	12.5 x 8 x 3.5	5	78	106	2	0.10	135	15
		2.2	12.5 x 8 x 4.5	8	98	132	3	0.10	91	10
		3.3	12.5 x 8 x 4.5	12	117	158	4	0.10	61	7
		4.7	12.5 x 8 x 5	17	137	185	6	0.10	43	5
		6.8	12.5 x 8 x 6	24	176	238	9	0.10	29.5	3
		10	12.5 x 8 x 6	35	200	238	13	0.15	20	2
25	35	1.0	12.5 x 8 x 4.5	3	62	85	2	0.10	200	15
		3.3	12.5 x 8 x 6	12	117	132	6	0.10	61	5
25	40	0.33	12.5 x 8 x 3.5	1	39	53	2	0.10	610	30
		0.47	12.5 x 8 x 4.5	2	47	63	2	0.10	430	20
		0.68	12.5 x 8 x 4.5	2	55	74	2	0.10	295	15
		1.0	12.5 x 8 x 5	4	62	85	2	0.10	200	10
		1.5	12.5 x 8 x 6	5	78	106	3	0.10	135	7
		2.2	12.5 x 8 x 6	8	98	132	5	0.10	91	5

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U_C (V)	U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE H x W x T (mm)	CASE CODE	CATALOGUE NUMBER 2222 . . . . . [1]			
					FORM CB	FORM CA	FORM TR+ on reel	FORM TFA in ammopack
25	25	0.68	12.5 x 8 x 3.5	1	122 56687	122 76687	122 26687	122 36687
		1.0	12.5 x 8 x 3.5	1	122 56108	122 76108	122 26108	122 36108
		1.5	12.5 x 8 x 3.5	1	122 56158	122 76158	122 26158	122 36158
		2.2	12.5 x 8 x 4.5	2	122 56228	122 76228	122 26228	122 36228
		3.3	12.5 x 8 x 4.5	2	122 56338	122 76338	122 26338	122 36338
		4.7	12.5 x 8 x 5	3	122 56478	122 76478	122 26478	122 36478
		6.8	12.5 x 8 x 6	4	122 56688	122 76688	122 26688	122 36688
		10	12.5 x 8 x 6	4	122 56109	122 76109	122 26109	122 36109
25	35	1.0	12.5 x 8 x 4.5	2	122 50108	122 70108	122 20108	122 30108
		3.3	12.5 x 8 x 6	4	122 50338	122 70338	122 20338	122 30338
25	40	0.33	12.5 x 8 x 3.5	1	122 57337	122 77337	122 27337	122 37337
		0.47	12.5 x 8 x 4.5	2	122 57477	122 77477	122 27477	122 37477
		0.68	12.5 x 8 x 4.5	2	122 57687	122 77687	122 27687	122 37687
		1.0	12.5 x 8 x 5	3	122 57108	122 77108	122 27108	122 37108
		1.5	12.5 x 8 x 6	4	122 57158	122 77158	122 27158	122 37158
		2.2	12.5 x 8 x 6	4	122 57228	122 77228	122 27228	122 37228

Note

[1] The 8th digit of the catalogue number represents the tolerance, as follows:

TOLERANCE	FORM CB	FORM CA	FORM TR+	FORM TFA
±20% : 2222	122 5....	122 7....	122 2....	122 3....
±10% : 2222	122 4....	122 6....	122 1....	to special order

Voltage

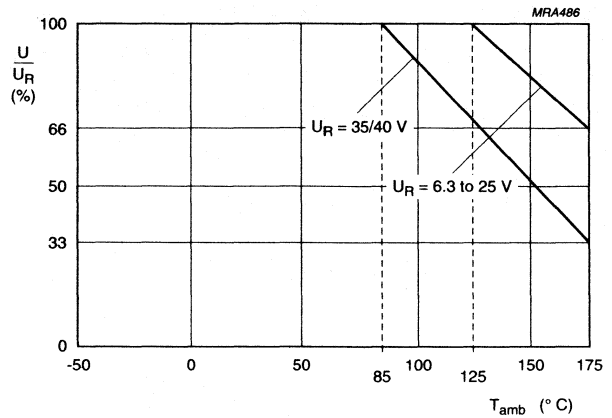


Fig.5 Maximum permissible voltage up to 175 °C.

Surge voltage for short periods	$U_s \leq 1.15 \cdot U_R$	
Reverse voltage	$U_{rev} < 0.3 \cdot U_R$	
Max. peak AC voltage, reverse voltage applied	≤2 V	
Max. peak AC voltage, without reverse voltage applied		
	$T_{amb} \leq 85$ °C	85 °C $< T_{amb} \leq 125$ °C
at f ≤ 0.1 Hz	0.30 x U_R	0.15 x U_R
at 0.1 Hz < f ≤ 1 Hz	0.45 x U_R	0.22 x U_R
at 1 Hz < f ≤ 10 Hz	0.60 x U_R	0.30 x U_R
at 10 Hz < f ≤ 50 Hz	0.65 x U_R	0.32 x U_R
at f > 50 Hz	0.80 x U_R	0.40 x U_R

Ripple current (I_R)

Applying the max. RMS ripple current given in Table 3 will cause a device temperature of 138 °C. The 100 kHz values in Table 3 for other temperatures are to be calculated with the following I_R multipliers:

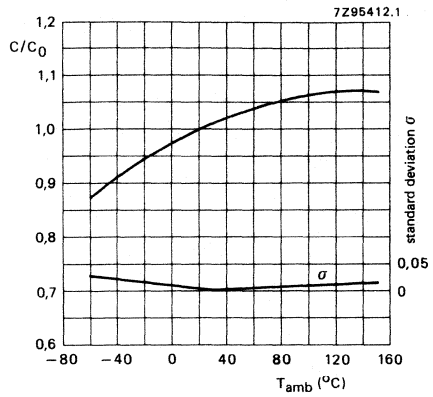
T_{amb}	25 °C	40 °C	65 °C	85 °C	105 °C	125 °C
I_R multiplier	1.1	1.0	0.88	0.75	0.59	0.37

Max. power dissipation

case sizes 12.5 x 8 x 3.5 to 12.5 x 8 x 5: P_{125} = 88 mW

case size 12.5 x 8 x 6: P_{125} = 104 mW.

Capacitance (C)



C_0 = capacitance at 25 °C and 100 Hz.

Fig.6 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.

Typical parameter change after endurance test at T_{amb} = 125 °C.

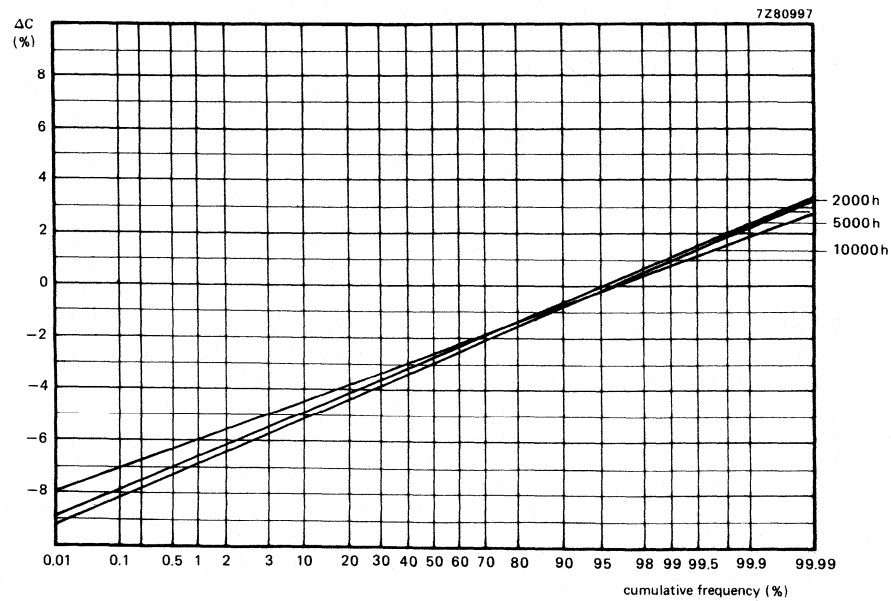
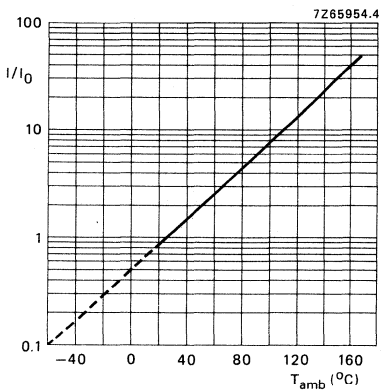


Fig.7 Change of capacitance after endurance test.

Leakage current



I_0 = leakage current during continuous operation at U_R and T_{amb} = 25 °C.

Fig.8 Typical multiplier of leakage current (I/I_0) as a function of ambient temperature.

Maximum leakage current after 5 minutes at U_R and T_{amb} = 25 °C	$I_{L5} \leq 0.05\ C_R \times U_R$ or 2 µA whichever is greater, (see Table 3)
Typical leakage current 15 s at U_R and T_{amb} = 25 °C	
6.3 to 16 V versions	approx. 0.2 x value stated in Table 3
25 to 40 V versions	approx. 0.1 x value stated in Table 3

Typical parameter change after endurance test at T_{amb} = 125 °C.

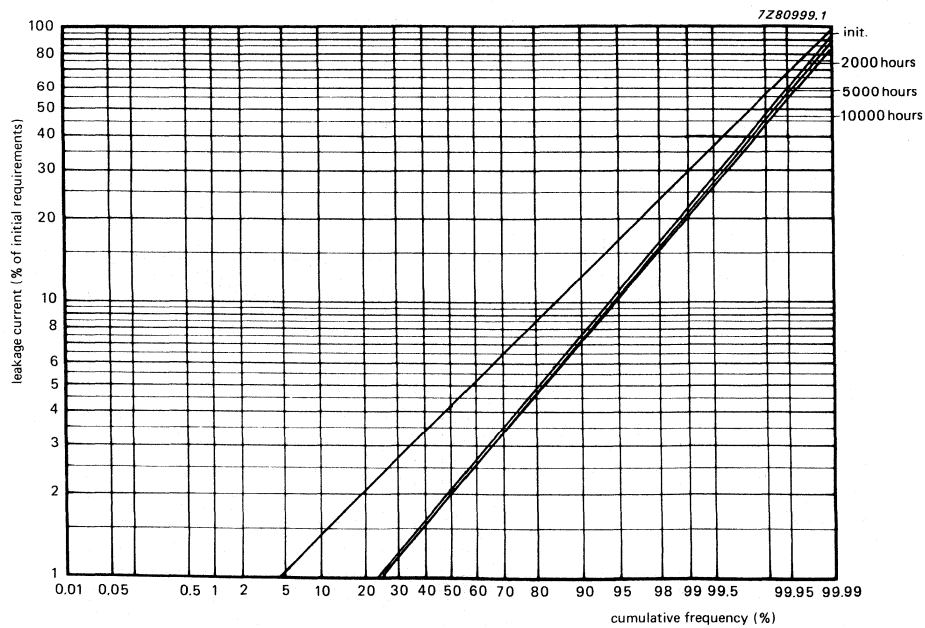
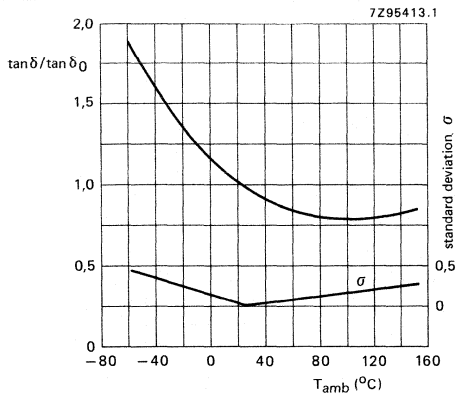


Fig.9 Leakage current after endurance test.

Dissipation factor (tan δ)



$\tan \delta_0$ = dissipation factor at T_{amb} = 25 °C and 100 Hz.

Fig.10 Typical multiplier of dissipation factor ($\tan \delta / \tan \delta_0$) as a function of temperature.

Typical parameter change after endurance test at T_{amb} = 125 °C.

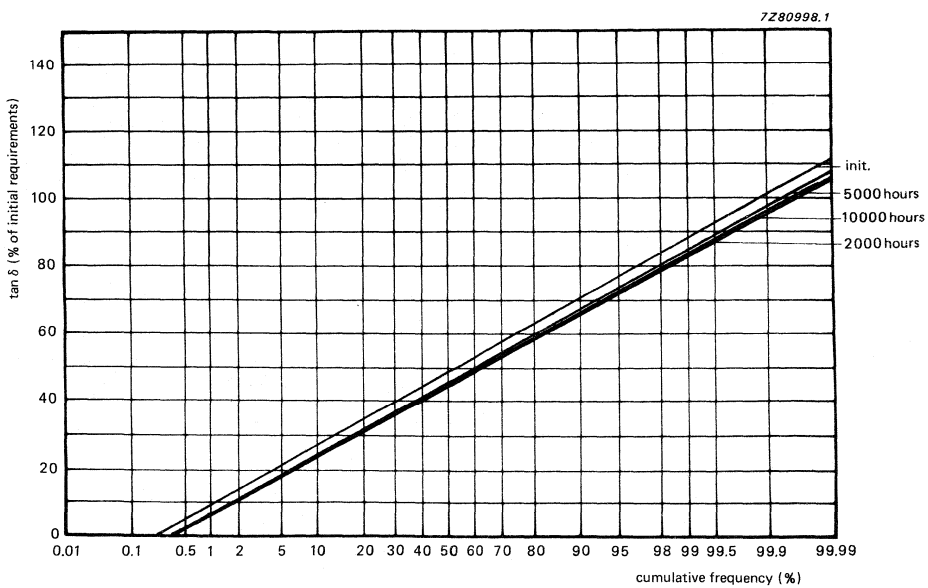
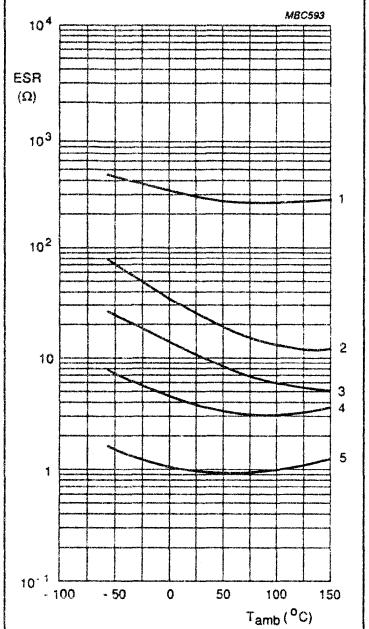


Fig.11 Tan δ after endurance test.

Equivalent series resistance (ESR)



Curve 1 : 0.1 µF, 40 V
Curve 2 : 1.5 µF, 40 V
Curve 3 : 3.3 µF, 25 V
Curve 4 : 10 µF, 6.3 V
Curve 5 : 22 µF, 10 V

Fig.12 Typical ESR as a function of temperature at 100 Hz.

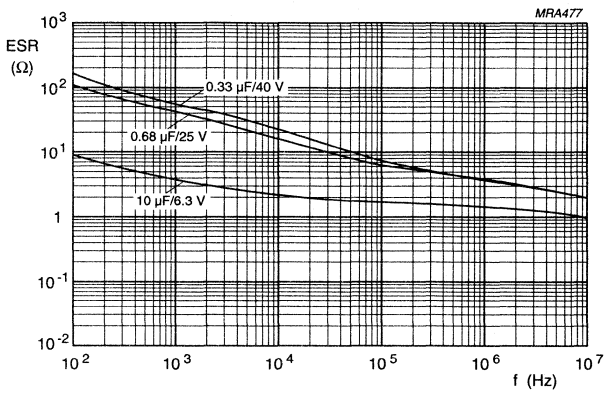


Fig.13 Typical ESR as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 3.5 mm.

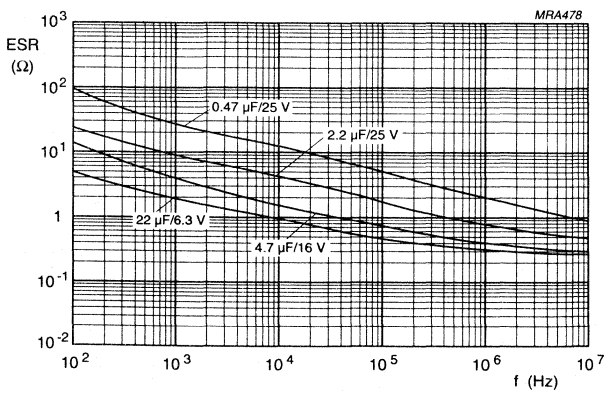


Fig.14 Typical ESR as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 4.5 mm.

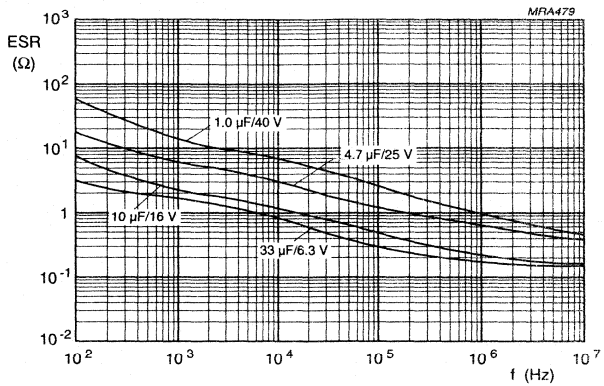


Fig.15 Typical ESR as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 5 mm.

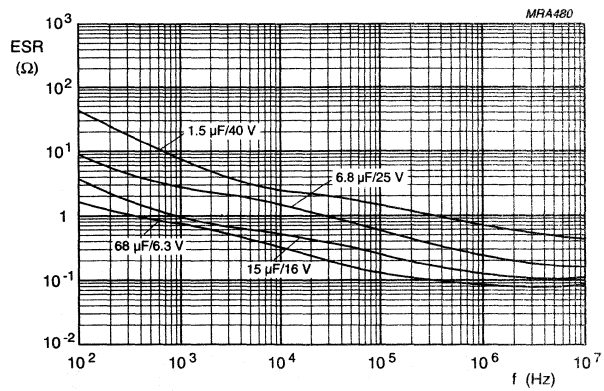
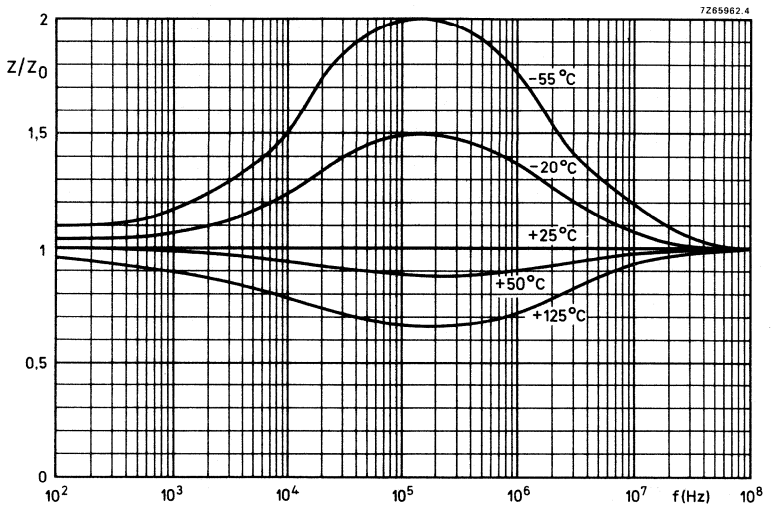


Fig.16 Typical ESR as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 6 mm.

Equivalent series inductance (ESL), f = 10 MHz

Typical ESL for case sizes 12.5 x 8 x 3.5 to 12.5 x 8 x 4.5	9 to 14 nH
Typical ESL for case sizes 12.5 x 8 x 5 and 12.5 x 8 x 6	11 to 16 nH
Maximum ESL for all case sizes	20 nH

Impedance (Z)



Z_0 = initial impedance value at T_{amb} = 25 °C.

Fig.17 Typical multiplier of impedance (Z/Z_0) as a function of frequency at different temperatures.

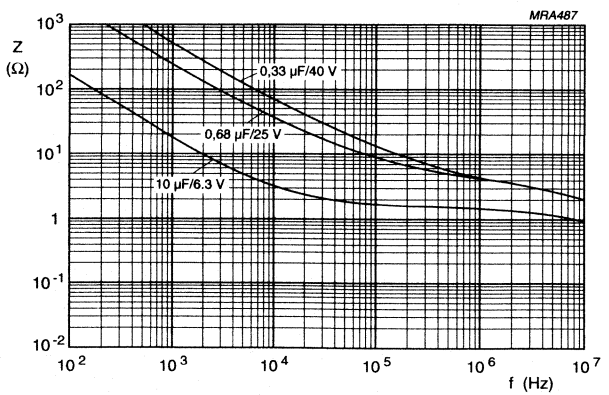


Fig.18 Typical impedance as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 3.5 mm.

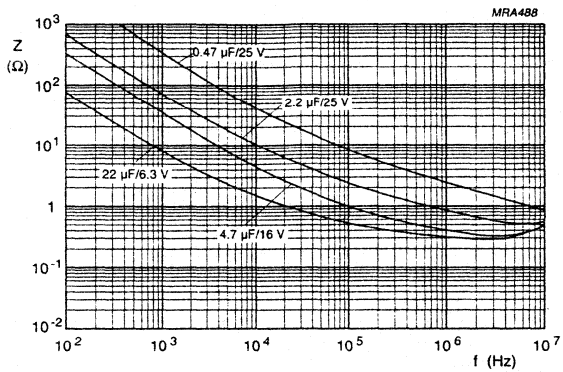


Fig.19 Typical impedance as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 4.5 mm.

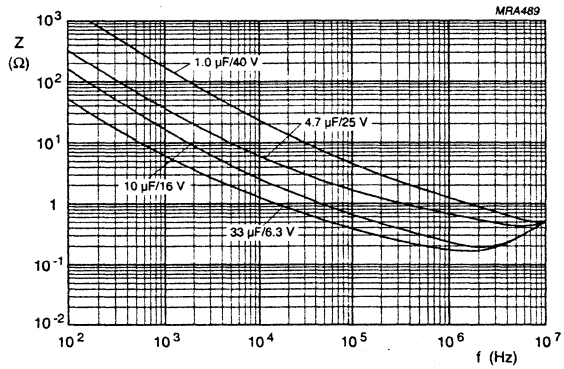


Fig.20 Typical impedance as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 5 mm.

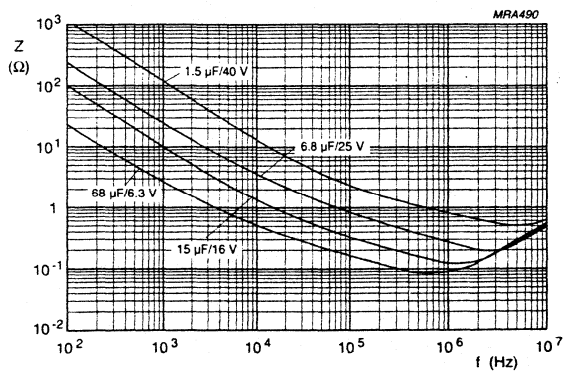


Fig.21 Typical impedance as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 6 mm.

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 5

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	Reference		
Endurance	IEC 384-4-2/ CECC 30 302 group C3, 4.13	T_{amb} = 125 °C U_R = 6.3 to 25 V with U_R applied U_R = 35 and 40 V with U_C applied 10 000 hours	ΔC/C ≤±10% tan δ ≤1.2 x spec. limit Z ≤1.2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 302 amendment 2642 sub clause 1.8.1	T_{amb} = 125 °C, I_R applied and U_R = 6.3 to 25 V with U_R applied U_R = 35 and 40 V with U_C applied 20 000 hours	ΔC/C ≤15% tan δ ≤1.5 x spec. limit Z ≤1.5 x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage <1%
Shelf life (storage at high temp.)	IEC 384-4-2 CECC 30 302 group C 5a, 4.17	T_{amb} = 125 °C, no voltage applied 500 hours	ΔC/C ≤±10% tan δ ≤1.2 x spec. limit I_{L5} ≤1 x spec. limit
Charge and discharge	IEC 384-4-2 sub clause 9.21	10^6 cycles without series resistance 0.5 s to U_R 0.5 s to ground	ΔC/C ≤5% no short or open circuit no visible damage
Solvent resistance test	IEC 68-2-45, IEC 653 test XA	sequence: - 30 s vapour phase - 5 minutes ultrasonic immersion at ambient temperature - 30 s vapour phase Solvents: - deionized water (50 ±5 °C); - calgonite solution (20 g/l, 70 ±5 °C); - 1.1.1.-trichloro-ethane; - mixtures of 1.1.2.-trichloro-1.2.2.-trifluoro-ethane (fluorocarbon 113) and the following solvents in the respective mass percentage ratios of these solvents to fluorocarbon; * ARKLONE K; 75% w/w F113 and 25% w/w isopropanol * FREON TE; 95.5% w/w F113 and 4.5% w/w ethanol * FREON TMS; 94% w/w F113, 5.7% w/w methanol and 0.3% w/w nitro-methane *ARKLONE F; 95.6% w/w F113, 4.0% w/w ethylalcohol, 0.07% w/w stabilizer and 0.3% w/w special additives * ARKLONE A-M; 94.15% w/w F113, 3.7% w/w ethylalcohol, 2.1% w/w methylacetate and 0.05% w/w stabilizer	visual appearance not affected

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	Reference		
Extended vibration test	IEC 68-2-6 test Fc	10 to 2 000 Hz 1.5 mm or 20 g 1 octave/minute 3 directions 1 sweep per direction no voltage applied	no intermittent contacts; no breakdown; no open circuiting; no mechanical damage; $\Delta C/C$ ≤5% tan δ ≤1.2 x spec. limit Z ≤1.2 x spec. limit I_{L5} ≤1.5 x spec. limit
Shock test	IEC 68-2-27 test Ea	half-sine or saw tooth pulse shape 50 g, 11 ms, 3 successive shocks in each direction of 3 mutually perpendicular axes, no voltage applied	no intermittent contacts; no breakdown; no open circuiting; no mechanical damage; $\Delta C/C$ <5% tan δ ≤1.2 x spec. limit Z ≤1.2 x spec. limit I_{L5} ≤1.5 x spec. limit
Passive flammability test	IEC 695-2-2	capacitor mounted to a vertical printed-wiring board, one flame on capacitor body, T_{amb} = 20 to 25 °C, test duration = 20 s.	after removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s; no burning particles must drop from the sample

Notes

1. ARKLONE is a trade mark of I.C.I.
2. FREON is a trade mark of Dupont de Nemours.

Solid Al - electrolytic capacitors
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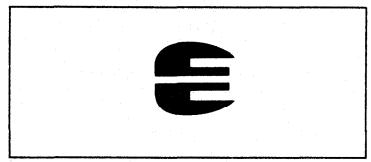
SAL-A 123

FEATURES

- Polarized aluminium electrolytic capacitors, solid electrolyte MnO_2
- Axial leads, aluminium case, ceramic seal, blue insulation sleeve
- SAL-A : standard version
- SAL-AG : epoxy filled shock-proof version up to 10 000 g
- Extremely long useful life 20 000 hours/125 °C
- Extended usable temperature range up to 200 °C
- Excellent low temperature impedance and ESR behaviour
- Charge and discharge proof, application with 0 Ω resistance allowed
- Reverse DC voltage up to 0.3 x U_R allowed
- AC voltage up to 0.8 x U_R allowed
- Advanced technology to achieve high reliability and high stability.

APPLICATIONS

- EDP, telecommunications, general industrial, automotive, military and space
- Smoothing, filtering, buffering, timing
- For power supplies, DC/DC converters.



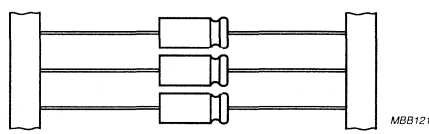


Fig.1 Component outline.

QUICK REFERENCE DATA

Case size ($\varnothing D_{max}$ x L_{max} in mm)	6.7 x 15.3 to 12.9 x 32.0
Rated capacitance range (E6 series), C_R	1.0 to 2200 µF
Tolerance on C_R	±20%, ±10% on request
Rated voltage range, U_R	4 to 40 V
Category temperature range	–55 to +125 °C
Usable temperature range	–80 to +200 °C
Endurance test at 155/125 °C	5 000 hours/8 000 hours
Useful life at U_R, 40 °C, I_R applied	450 000 hours
Shelf life at 0 V, 125 °C	500 hours
Basic specifications	IEC 384-4, CECC 30 300
Climatic category IEC 68 DIN 40040 NF C20-600	 55/125/56 FKD 434
Approvals	CECC 30 302-003 CNET LNZ 44-04 COS-C (PTT) Gam-t-1(MIL)

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Table 1 Selection chart for C_R, U_R and relevant maximum case sizes (**ØD x L in mm**) for 123 series

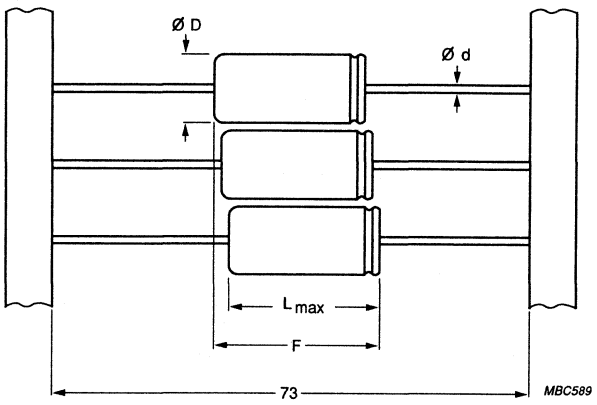
C_R (µF)	U_R (V)							
	4	**6.3**	**10**	**16**	**20**	**25**	**35**	**40** [1]
1.0							6.7 x 15.3	
1.5							6.7 x 15.3	
2.2							6.7 x 15.3	6.7 x 15.3
3.3							6.7 x 15.3	6.7 x 15.3
4.7							6.7 x 15.3	6.7 x 15.3
6.8							6.7 x 15.3	6.7 x 15.3
10				6.7 x 15.3	6.7 x 15.3	6.7 x 15.3	7.6 x 20.4	7.6 x 20.4
15				6.7 x 15.3	6.7 x 15.3	6.7 x 15.3	7.6 x 20.4	7.6 x 20.4
22				6.7 x 15.3		7.6 x 20.4	7.6 x 20.4	9.3 x 23.3
33			6.7 x 15.3	7.6 x 20.4		7.6 x 20.4	9.3 x 23.3	9.3 x 23.3
47		6.7 x 15.3	6.7 x 15.3	7.6 x 20.4	7.6 x 20.4	7.6 x 20.4	9.3 x 23.3	10.3 x 32.0
68	6.7 x 15.3	6.7 x 15.3	7.6 x 20.4	7.6 x 20.4		9.3 x 23.3	10.3 x 32.0	10.3 x 32.0
100	6.7 x 15.3		7.6 x 20.4	9.3 x 23.3	9.3 x 23.3	9.3 x 23.3	12.9 x 32.0	12.9 x 32.0
150		7.6 x 20.4	9.3 x 23.3	9.3 x 23.3	10.3 x 32.0	10.3 x 32.0	12.9 x 32.0	
220	7.6 x 20.4		9.3 x 23.3	10.3 x 32.0	10.3 x 32.0	12.9 x 32.0		
330		9.3 x 23.3	10.3 x 32.0	10.3 x 32.0	12.9 x 32.0	12.9 x 32.0		
470	9.3 x 23.3		10.3 x 32.0	12.9 x 32.0	12.9 x 32.0			
680		10.3 x 32.0	12.9 x 32.0	12.9 x 32.0				
1000	10.3 x 32.0	12.9 x 32.0	12.9 x 32.0					
1500	12.9 x 32.0	12.9 x 32.0						
2200	12.9 x 32.0							

Note

[1] Non CECC-types.

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.
Tape dimensions are specified in chapter "PACKING".



BA: taped in box, (ammopack).

BR: taped on reel.

Fig.2 **Forms**: BA and BR.

Table 2 Dimensions in mm; mass in g

CASE		F_{min}	Ød	APPROX. MASS [1]	PACKING QUANTITIES	
SIZE $ØD_{max}$ x L_{max}	CODE				FORM BA	FORM BR
6.7 x 15.3	1	20.0	0.6	1.05	100	800
7.6 x 20.4	2A	22.5	0.6	1.55	100	800
9.3 x 23.3	4	25.0	0.6	2.6	100	500
10.3 x 32.0	5	35.0	0.8	4.2	100	500
12.3 x 32.0	6	35.0	0.8	7	100	400

Note

[1] Add 10% for SAL-AG epoxy-filled versions.

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MARKING

- Rated capacitance
- Tolerance code on rated capacitance (M = ±20%, K = ±10%, in accordance with IEC 62)
- Rated voltage at corresponding maximum temperature
- Date code in accordance with IEC 62
- Name of manufacturer
- Group number (123)
- Code for factory of origin
- Code for basic specification (in accordance with IEC 384-4)
- '+' signs for the positive terminal
- A band to indentify the negative terminal.

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 to 25 °C, P = 86 to 106 kPa, RH = 45 to 75%.

C_R = rated capacitance at 100 Hz
I_R = max. RMS ripple current no necessary DC voltage applied
I_{L5} = max. leakage current after 5 minutes at U_R
tan δ = max. dissipation factor at 100 Hz
ESR = max. equivalent series resistance at 100 Hz
Z = max. impedance at 100 kHz.

Table 3 Electrical data for 123 series

U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE ØD x L (mm)	I_R 100 Hz 125 °C (mA)	I_R 10 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
4	68	6.7 x 15.3	53	450	650	14	0.25	7.3	1.2
	100	6.7 x 15.3	77	540	790	20	0.25	5.0	1.2
	220	7.6 x 20.4	160	890	1300	44	0.25	2.3	1.0
	470	9.3 x 23.3	300	1470	2140	94	0.25	1.1	0.4
	1000	10.3 x 32.0	630	2450	3570	200	0.25	0.5	0.3
	1500	12.9 x 32.0	950	3330	4840	300	0.25	0.33	0.2
	2200	12.9 x 32.0	1250	4230	6150	440	0.25	0.23	0.2
6.3	47	6.7 x 15.3	58	440	640	15	0.18	7.6	1.2
	68	6.7 x 15.3	83	520	760	21	0.18	5.3	1.2
	150	7.6 x 20.4	160	870	1270	47	0.18	2.4	1.0
	330	9.3 x 23.3	330	1470	2140	104	0.18	1.1	0.4
	680	10.3 x 32.0	680	2340	3410	214	0.18	0.55	0.3
	1000	12.9 x 32.0	940	3180	4640	315	0.18	0.36	0.2
	1500	12.9 x 32.0	1220	4140	6020	473	0.18	0.24	0.2
10	33	6.7 x 15.3	63	360	530	17	0.18	11	1.2
	47	6.7 x 15.3	83	440	640	24	0.18	7.6	1.2
	68	7.6 x 20.4	110	590	850	34	0.18	5.3	1.0
	100	7.6 x 20.4	160	710	1040	50	0.18	3.6	1.0
	150	9.3 x 23.3	240	990	1450	75	0.18	2.4	0.4
	220	9.3 x 23.3	350	1180	1720	110	0.18	1.7	0.4
	330	10.3 x 32.0	490	1650	2410	165	0.18	1.1	0.3
	470	10.3 x 32.0	570	1940	2830	235	0.18	0.8	0.3
	680	12.9 x 32.0	760	2580	3750	340	0.18	0.55	0.2
	1000	12.9 x 32.0	1000	3380	4920	500	0.18	0.36	0.2

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ORDERING INFORMATION

Ordering Example

Electrolytic Capacitors SAL A
10 µF/16 V, ±20%
Case size 6.7 x 15.3; Form BR
Catalogue number: 2222 123 25109

Table 4 Ordering information for 123 series

U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE ØD x L (mm)	CATALOGUE NUMBER 2222 . . . . . [1]			
			SAL-A FORM BA tol. ±20%	SAL-A FORM BR tol. ±20%	SAL-A FORM BA tol. ±10%	SAL-AG FORM BA tol. ±10%, level S
4	68	6.7 x 15.3	123 12689	123 22689	123 42689	123 82689
	100	6.7 x 15.3	123 12101	123 22101	123 42101	123 82101
	220	7.6 x 20.4	123 12221	123 22221	123 42221	123 82221
	470	9.3 x 23.3	123 12471	123 22471	123 42471	123 82471
	1000	10.3 x 32.0	123 12102	123 22102	123 42102	123 82102
	1500	12.9 x 32.0	123 12152	123 22152	123 42152	123 82152
	2200	12.9 x 32.0	123 12222	123 22222	123 42222	123 82222
6.3	47	6.7 x 15.3	123 13479	123 23479	123 43479	123 83479
	68	6.7 x 15.3	123 13689	123 23689	123 43689	123 83689
	150	7.6 x 20.4	123 13151	123 23151	123 43151	123 83151
	330	9.3 x 23.3	123 13331	123 23331	123 43331	123 83331
	680	10.3 x 32.0	123 13681	123 23681	123 43681	123 83681
	1000	12.9 x 32.0	123 13102	123 23102	123 43102	123 83102
	1500	12.9 x 32.0	123 13152	123 23152	123 43152	123 83152
10	33	6.7 x 15.3	123 14339	123 24339	123 44339	123 84339
	47	6.7 x 15.3	123 14479	123 24479	123 44479	123 84479
	68	7.6 x 20.4	123 14689	123 24689	123 44689	123 84689
	100	7.6 x 20.4	123 14101	123 24101	123 44101	123 84101
	150	9.3 x 23.3	123 14151	123 24151	123 44151	123 84151
	220	9.3 x 23.3	123 14221	123 24221	123 44221	123 84221
	330	10.3 x 32.0	123 14331	123 24331	123 44331	123 84331
	470	10.3 x 32.0	123 14471	123 24471	123 44471	123 84471
	680	12.9 x 32.0	123 14681	123 24681	123 44681	123 84681
	1000	12.9 x 32.0	123 14102	123 24102	123 44102	123 84102

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SAL-A 123

U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE ØD x L (mm)	I_R 100 Hz 125 °C (mA)	I_R 10 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
16	10	6.7 x 15.3	31	230	330	16	0.14	28	2.5
	15	6.7 x 15.3	47	280	400	24	0.14	19	2.5
	22	6.7 x 15.3	63	340	490	35	0.14	13	2.5
	33	7.6 x 20.4	89	470	680	55	0.14	8.4	2.0
	47	7.6 x 20.4	120	560	810	75	0.14	5.9	2.0
	68	7.6 x 20.4	180	670	970	110	0.14	4.1	2.0
	100	9.3 x 23.3	260	920	1340	160	0.14	2.8	0.8
	150	9.3 x 23.3	310	1060	1550	240	0.16	2.1	0.8
	220	10.3 x 32.0	420	1420	2060	350	0.16	1.5	0.6
	330	10.3 x 32.0	510	1740	2530	500	0.16	1.0	0.6
	470	12.9 x 32.0	680	2280	3330	750	0.16	0.7	0.4
	680	12.9 x 32.0	850	2870	4170	870	0.16	0.5	0.4
20	10	6.7 x 15.3	39	230	330	20	0.14	28	2.5
	15	6.7 x 15.3	52	280	400	30	0.14	19	2.5
	47	7.6 x 20.4	150	560	810	95	0.14	5.9	2.0
	100	9.3 x 23.3	270	920	1340	200	0.14	2.8	0.8
	150	10.3 x 32.0	350	1200	1740	300	0.16	2.1	0.6
	220	10.3 x 32.0	420	1420	2060	400	0.16	1.5	0.6
	330	12.9 x 32.0	570	1910	2780	660	0.16	1.0	0.4
	470	12.9 x 32.0	720	2420	3530	940	0.16	0.7	0.4
25	10	6.7 x 15.3	43	230	330	25	0.14	28	5
	15	6.7 x 15.3	60	280	400	35	0.14	19	5
	22	7.6 x 20.4	88	370	550	55	0.14	13	2.5
	33	7.6 x 20.4	130	470	680	85	0.14	8.4	2.5
	47	7.6 x 20.4	160	560	810	100	0.14	5.9	2.5
	68	9.3 x 23.3	230	760	1110	170	0.14	4.1	1.0
	100	9.3 x 23.3	250	860	1250	250	0.16	3.2	1.0
	150	10.3 x 32.0	350	1200	1740	400	0.16	2.1	0.8
	220	12.9 x 32.0	460	1560	2270	550	0.16	1.5	0.6
	330	12.9 x 32.0	600	2030	2950	800	0.16	1.0	0.6

Solid Al - electrolytic capacitors
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SAL-A 123

U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE ØD x L (mm)	CATALOGUE NUMBER 2222 . . . . . [1]			
			SAL-A FORM BA tol. ±20%	SAL-A FORM BR tol. ±20%	SAL-A FORM BA tol. ±10%	SAL-AG FORM BA tol. ±10%, level S
16	10	6.7 x 15.3	123 15109	123 25109	123 45109	123 85109
	15	6.7 x 15.3	123 15159	123 25159	123 45159	123 85159
	22	6.7 x 15.3	123 15229	123 25229	123 45229	123 85229
	33	7.6 x 20.4	123 15339	123 25339	123 45339	123 85339
	47	7.6 x 20.4	123 15479	123 25479	123 45479	123 85479
	68	7.6 x 20.4	123 15689	123 25689	123 45689	123 85689
	100	9.3 x 23.3	123 15101	123 25101	123 45101	123 85101
	150	9.3 x 23.3	123 15151	123 25151	123 45151	123 85151
	220	10.3 x 32.0	123 15221	123 25221	123 45221	123 85221
	330	10.3 x 32.0	123 15331	123 25331	123 45331	123 85331
	470	12.9 x 32.0	123 15471	123 25471	123 45471	123 85471
	680	12.9 x 32.0	123 15681	123 25681	123 45681	123 85681
20	10	6.7 x 15.3	123 18109	123 28109	123 48109	123 88109
	15	6.7 x 15.3	123 18159	123 28159	123 48159	123 88159
	47	7.6 x 20.4	123 18479	123 28479	123 48479	123 88479
	100	9.3 x 23.3	123 18101	123 28101	123 48101	123 88101
	150	10.3 x 32.0	123 18151	123 28151	123 48151	123 88151
	220	10.3 x 32.0	123 18221	123 28221	123 48221	123 88221
	330	12.9 x 32.0	123 18331	123 28331	123 48331	123 88331
	470	12.9 x 32.0	123 18471	123 28471	123 48471	123 88471
25	10	6.7 x 15.3	123 16109	123 26109	123 46109	123 86109
	15	6.7 x 15.3	123 16159	123 26159	123 46159	123 86159
	22	7.6 x 20.4	123 16229	123 26229	123 46229	123 86229
	33	7.6 x 20.4	123 16339	123 26339	123 46339	123 86339
	47	7.6 x 20.4	123 16479	123 26479	123 46479	123 86479
	68	9.3 x 23.3	123 16689	123 26689	123 46689	123 86689
	100	9.3 x 23.3	123 16101	123 26101	123 46101	123 86101
	150	10.3 x 32.0	123 16151	123 26151	123 46151	123 86151
	220	12.9 x 32.0	123 16221	123 26221	123 46221	123 86221
	330	12.9 x 32.0	123 16331	123 26331	123 46331	123 86331

Solid Al - electrolytic capacitors
Solid Al, Axial

SAL-A 123

U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE ∅D x L (mm)	I_R 100 Hz 125 °C (mA)	I_R 10 kHz 85 °C (mA)	I_R 100 kHz 40 °C (mA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
35	1.0	6.7 x 15.3	4	55	80	5	0.12	240	16.5
	1.5	6.7 x 15.3	7	68	98	5	0.12	160	11.0
	2.2	6.7 x 15.3	10	82	120	5	0.12	109	7.5
	3.3	6.7 x 15.3	14	100	150	7	0.12	73	7.5
	4.7	6.7 x 15.3	20	120	170	10	0.12	51	7.5
	6.8	6.7 x 15.3	27	140	210	15	0.12	35	7.5
	10	7.6 x 20.4	37	200	280	20	0.12	24	2.5
	15	7.6 x 20.4	53	240	350	30	0.12	16	2.5
	22	7.6 x 20.4	78	290	420	45	0.12	11	2.5
	33	9.3 x 23.3	120	410	590	65	0.12	7.2	1.0
	47	9.3 x 23.3	140	480	700	95	0.12	5.1	1.0
	68	10.3 x 32.0	170	570	820	135	0.16	4.7	0.8
	100	12.9 x 32.0	220	760	1100	200	0.16	3.2	0.6
	150	12.9 x 32.0	290	990	1440	300	0.16	2.1	0.6
40	2.2	6.7 x 15.3	11	82	120	9	0.12	109	7.5
	3.3	6.7 x 15.3	16	100	150	13	0.12	73	7.5
	4.7	6.7 x 15.3	22	120	170	19	0.12	51	7.5
	6.8	6.7 x 15.3	28	140	210	27	0.12	35	7.5
	10	7.6 x 20.4	41	200	280	40	0.12	24	2.5
	15	7.6 x 20.4	61	240	350	60	0.12	16	2.5
	22	9.3 x 23.3	89	330	480	90	0.12	11	1.5
	33	9.3 x 23.3	120	410	590	130	0.12	7.2	1.0
	47	10.3 x 32.0	160	540	790	190	0.12	5.1	1.0
	68	10.3 x 32.0	170	570	820	270	0.16	4.7	0.8
	100	12.9 x 32.0	220	760	1100	400	0.16	3.2	0.6

Solid Al - electrolytic capacitors
Solid Al, Axial

SAL-A 123

U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE ØD x L (mm)	CATALOGUE NUMBER 2222 . . . . . [1]			
			SAL-A FORM BA tol. ±20%	SAL-A FORM BR tol. ±20%	SAL-A FORM BA tol. ±10%	SAL-AG FORM BA tol. ±10%, level S
35	1.0	6.7 x 15.3	123 10108	123 20108	123 40108	123 80108
	1.5	6.7 x 15.3	123 10158	123 20158	123 40158	123 80158
	2.2	6.7 x 15.3	123 10228	123 20228	123 40228	123 80228
	3.3	6.7 x 15.3	123 10338	123 20338	123 40338	123 80338
	4.7	6.7 x 15.3	123 10478	123 20478	123 40478	123 80478
	6.8	6.7 x 15.3	123 10688	123 20688	123 40688	123 80688
	10	7.6 x 20.4	123 10109	123 20109	123 40109	123 80109
	15	7.6 x 20.4	123 10159	123 20159	123 40159	123 80159
	22	7.6 x 20.4	123 10229	123 20229	123 40229	123 80229
	33	9.3 x 23.3	123 10339	123 20339	123 40339	123 80339
	47	9.3 x 23.3	123 10479	123 20479	123 40479	123 80479
	68	10.3 x 32.0	123 10689	123 20689	123 40689	123 80689
	100	12.9 x 32.0	123 10101	123 20101	123 40101	123 80101
	150	12.9 x 32.0	123 10151	123 20151	123 40151	123 80151
40	2.2	6.7 x 15.3	123 17228	123 27228	123 47228	123 87228
	3.3	6.7 x 15.3	123 17338	123 27338	123 47338	123 87338
	4.7	6.7 x 15.3	123 17478	123 27478	123 47478	123 87478
	6.8	6.7 x 15.3	123 17688	123 27688	123 47688	123 87688
	10	7.6 x 20.4	123 17109	123 27109	123 47109	123 87109
	15	7.6 x 20.4	123 17159	123 27159	123 47159	123 87159
	22	9.3 x 23.3	123 17229	123 27229	123 47229	123 87229
	33	9.3 x 23.3	123 17339	123 27339	123 47339	123 87339
	47	10.3 x 32.0	123 17479	123 27479	123 47479	123 87479
	68	10.3 x 32.0	123 17689	123 27689	123 47689	123 87689
	100	12.9 x 32.0	123 17101	123 27101	123 47101	123 87101

Note

[1] The 8th digit of the catalogue number represents the tolerance, as follows:

TOLERANCE	SAL-A		SAL-AG	
	FORM BA	FORM BR	FORM BA	FORM BA, level S
±20% : 2222	123 1....	123 2....	123 6....	–
±10% : 2222	123 4....	123 5....	123 7....	123 8....

7

Voltage

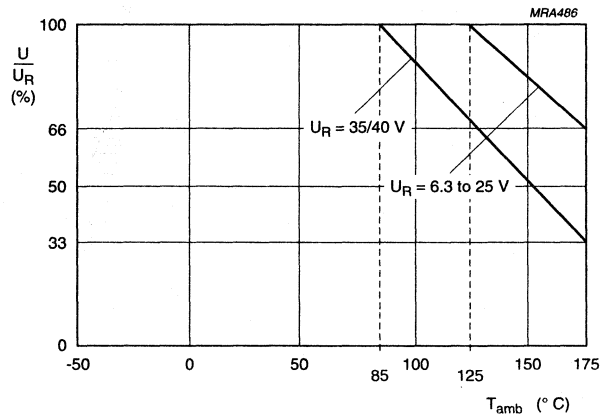


Fig.3 Max. permissible voltage up to 175 °C.

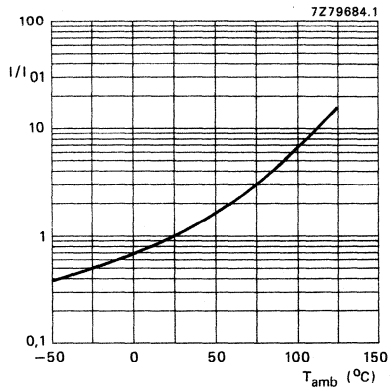
Surge voltage for short periods	$U_s \leq 1.15 \bullet U_R$	
Reverse voltage	$U_{rev} < 0.3 \bullet U_R$	
Max. peak AC voltage, reverse voltage applied	≤2 V	
Max. peak AC voltage, without reverse voltage applied		
	$T_{amb} \leq 85$ °C	85 °C $< T_{amb} \leq 125$ °C
at f ≤ 0.1 Hz	0.30 x U_R	0.15 x U_R
at 0.1 Hz < f ≤ 1 Hz	0.45 x U_R	0.22 x U_R
at 1 Hz < f ≤ 10 Hz	0.60 x U_R	0.30 x U_R
at 10 Hz < f ≤ 50 Hz	0.65 x U_R	0.32 x U_R
at f > 50 Hz	0.80 x U_R	0.40 x U_R

Ripple current (I_R)

Applying the max. RMS ripple current given in Table 3 will cause a device temperature of 138 °C. The 100 kHz values in Table 3 for other temperatures are to be calculated with the following I_R multipliers:

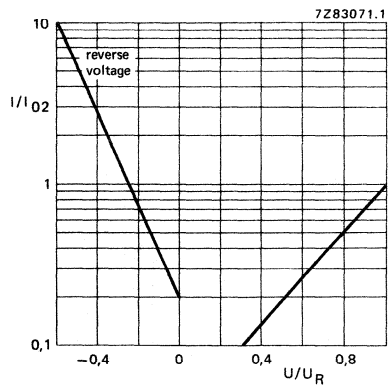
T_{amb}	25 °C	40 °C	65 °C	85 °C	105 °C	125 °C
I_R multiplier	1.1	1.0	0.88	0.75	0.59	0.37

Leakage current



I_{01} = leakage current during continuous operation at U_R and T_{amb} = 25 °C.

Fig.4 Typical multiplier of leakage current (I/I_{01}) as a function of ambient temperature.

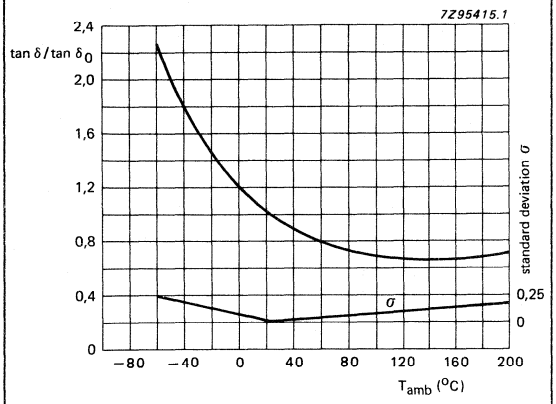


I_{02} = leakage current at U_R at a discrete constant temperature.

Fig.5 Typical multiplier of leakage current (I/I_{02}) as a function of U/U_R.

Maximum leakage current after 5 minutes at U_R and T_{amb} = 25 °C	$I_{L5} \leq 0.05\ C_R \times U_R$ or 2 µA whichever is greater, (see Table 3)
Typical leakage current 15 s at U_R and T_{amb} = 25 °C	
6.3 to 16 V versions	approx. 0.2 x value stated in Table 3
25 to 40 V versions	approx. 0.1 x value stated in Table 3

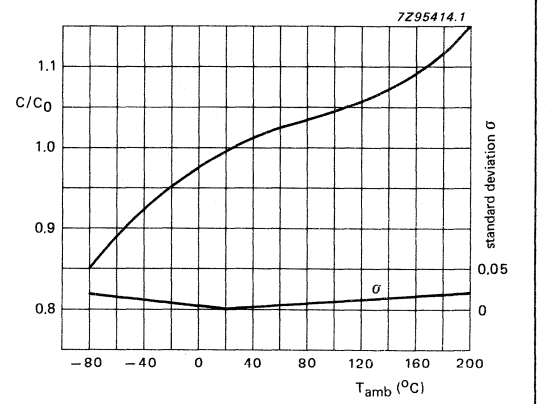
Dissipation factor (tan δ)



$\tan \delta_0$ = dissipation factor at T_{amb} = 25 °C and 100 Hz.

Fig.6 Typical multiplier of dissipation factor ($\tan \delta/\tan \delta_0$) as a function of ambient temperature.

Capacitance (C)



C_0 = capacitance at 25 °C and 100 Hz.

Fig.7 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.

Typical tan δ at 100 Hz and T_{amb} = 25 °C: 0.6 x value stated in Table 3.

Max Power dissipation

CASE SIZE $\varnothing D_{max}$ x L_{max}	$P_{max}(W) = P_{125}$
Ø6.7 x 15.3	0.13
Ø7.6 x 20.4	0.16
Ø9.3 x 23.3	0.21
Ø10.3 x 32.0	0.26
Ø12.9 x 32.0	0.32

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Equivalent series inductance (ESL), f = 10 MHz

CASE SIZE $\varnothing D_{max}$ x L_{max}	PITCH (mm)	MAX. ESL (nH)	TYP. ESL (nH)
Ø6.7 x 15.3	20.3	30	15 to 23
Ø7.6 x 20.4	25.4	30	16 to 24
Ø9.3 x 23.3	27.9	35	20 to 27
Ø10.3 x 32.0	35.6	40	26 to 33
Ø12.9 x 32.0	35.6	55	32 to 49

Equivalent series resistance (ESR)

Typical ESR: see Figs 8 to 17; the standard deviation is 20% of each value.

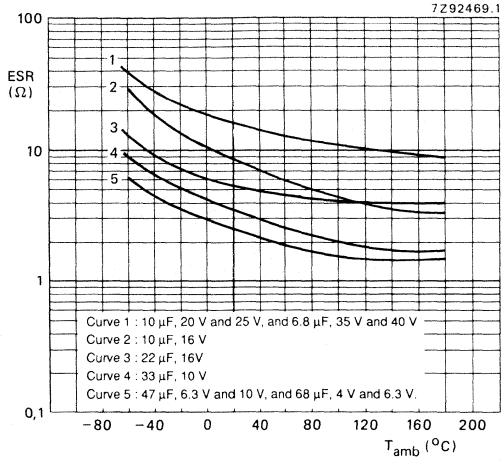


Fig.8 Typical ESR as a function of ambient temperature at 100 Hz, case size Ø6.7 x 15.3.

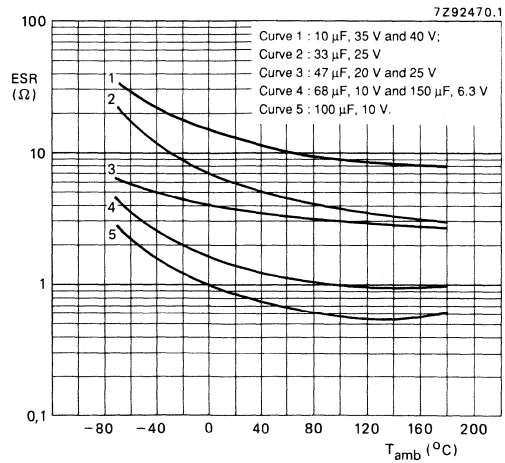


Fig.9 Typical ESR as a function of ambient temperature at 100 Hz, case size Ø7.6 x 20.4.

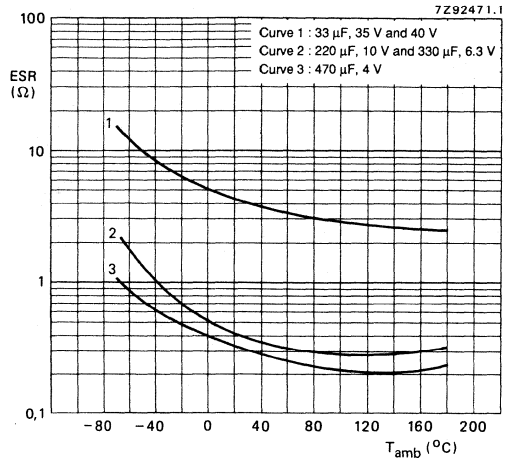


Fig.10 Typical ESR as a function of ambient temperature at 100 Hz, case size Ø9.3 x 23.3.

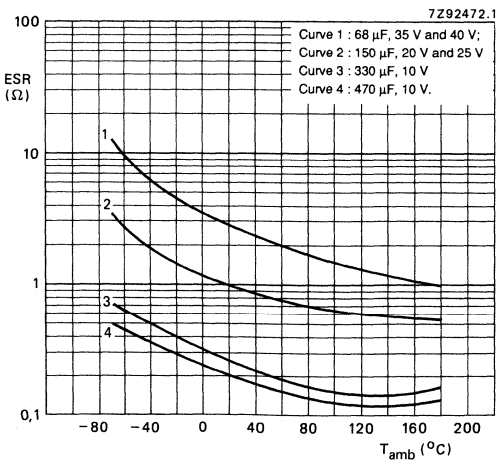


Fig.11 Typical ESR as a function of ambient temperature at 100 Hz, case size Ø10.3 x 32.0.

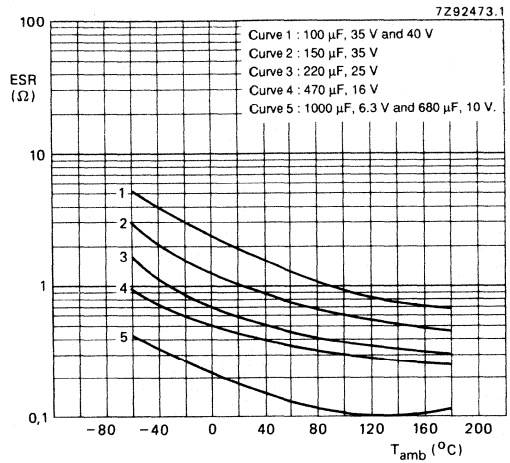


Fig.12 Typical ESR as a function of ambient temperature at 100 Hz, case size Ø12.9 x 32.0.

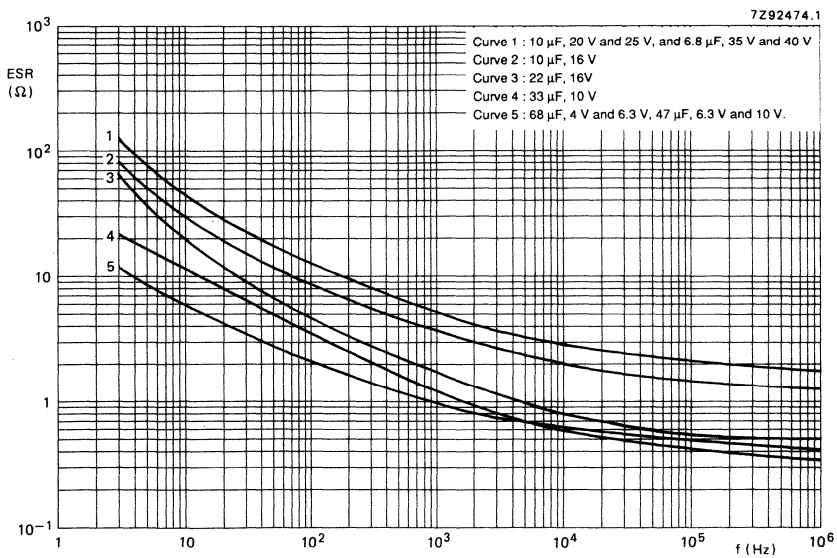


Fig.13 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size Ø6.7 x 15.3.

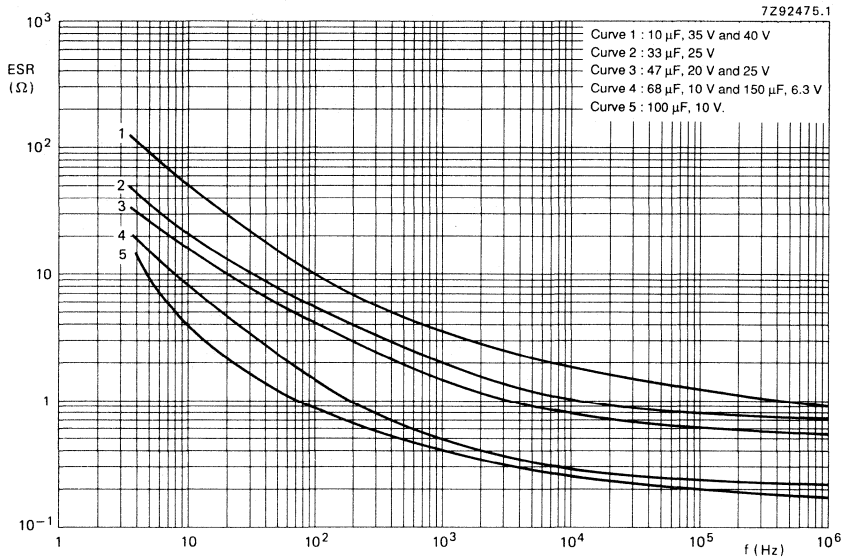


Fig.14 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size Ø7.6 x 20.4.

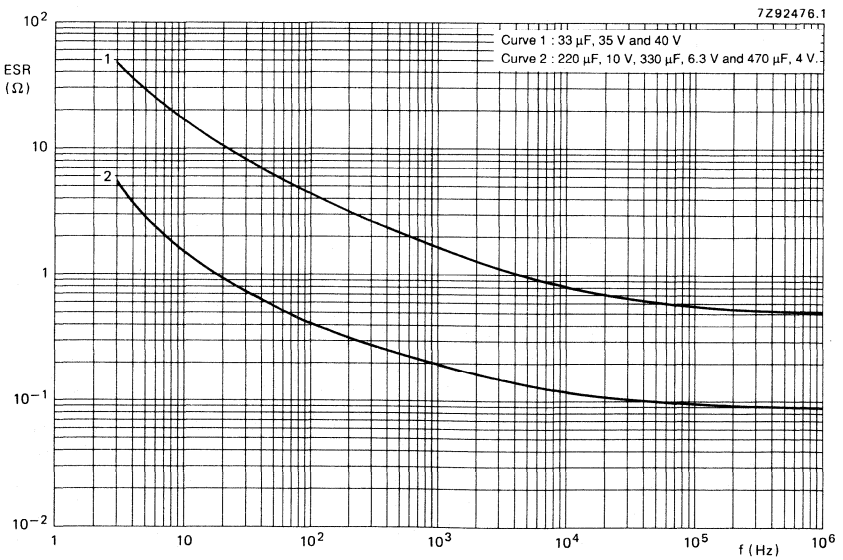


Fig.15 Typical ESR as a function of frequency at T_{amb} = 25 °; case size Ø9.3 x 23.3.

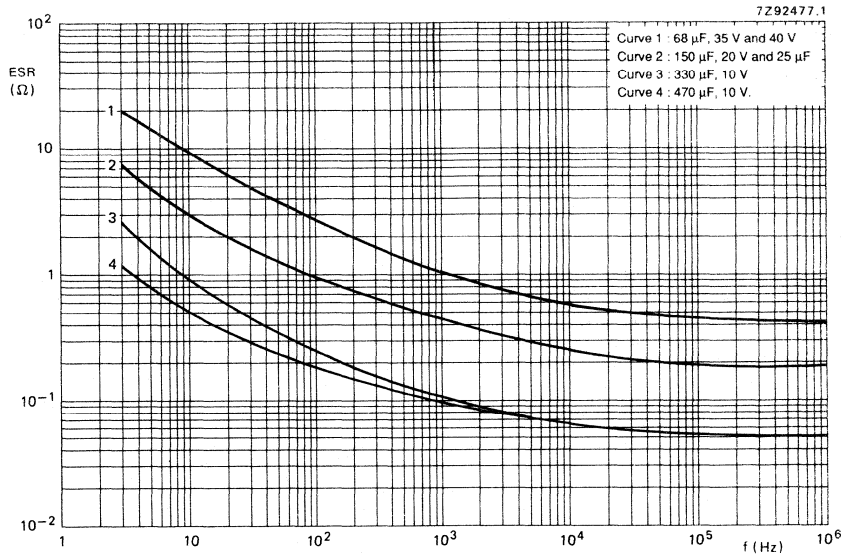


Fig.16 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size Ø10.3 x 32.0.

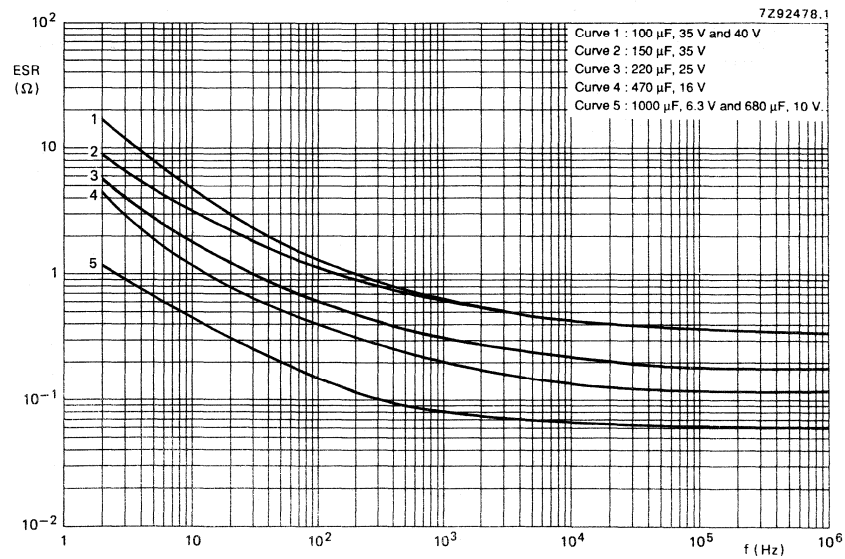
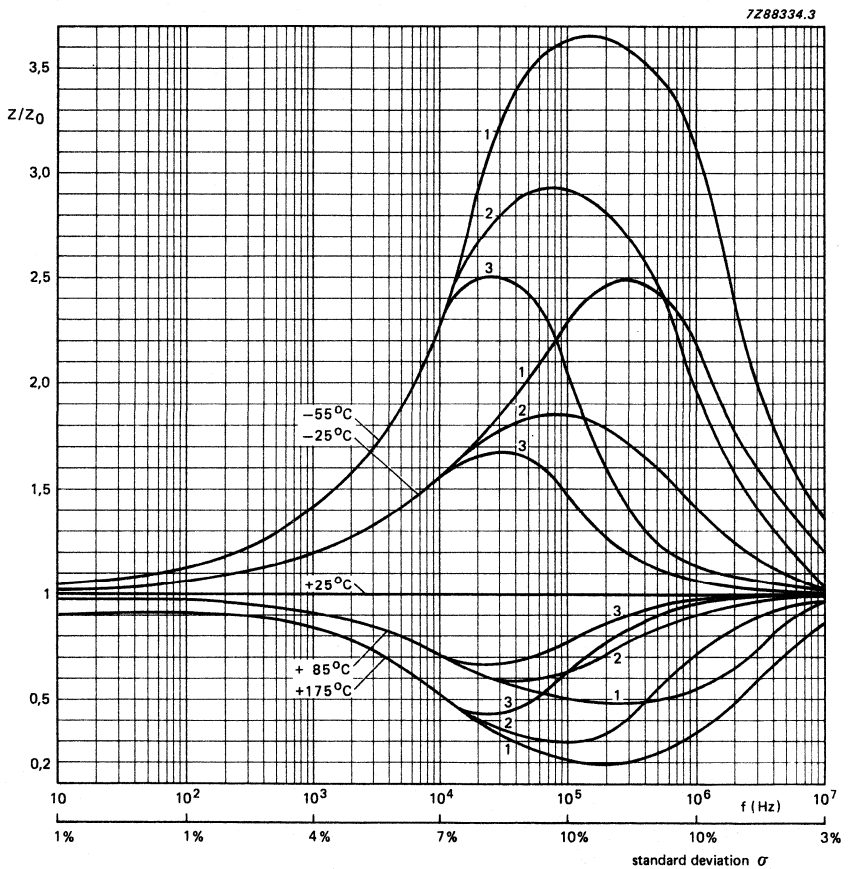


Fig.17 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size Ø12.9 x 32.0.

Impedance (Z)

Typical impedance at 100 kHz and T_{amb} = 25 °C: 0.5 x value stated in Table 3 .



Curve 1 : case sizes Ø6.7 x 15.3 and Ø7.6 x 20.4, 16 V to 40 V
Curve 2 : case size Ø6.7 x 15.3 and Ø7.6 x 20.4, 4 V to 10 V
Curve 3 : case sizes Ø9.3 x 32.0, Ø10.3 x 32.0 and Ø12.9 x 32.0.

Z_0 = initial impedance value at any frequency and T_{amb} = 25 °C.

Fig.18 Typical multiplier of impedance (Z/Z_0) as a function of frequency at different ambient temperatures.

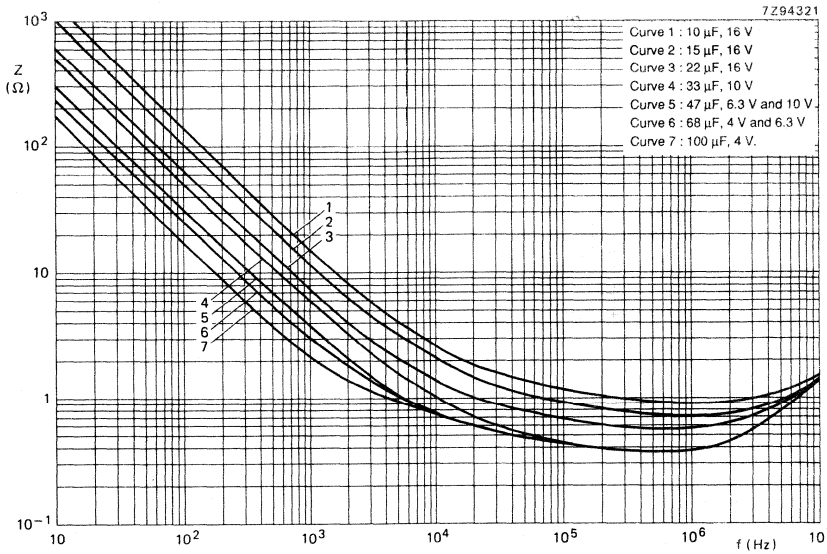


Fig.19 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø6.7 x 15.3, U_R = 4 V to 16 V.

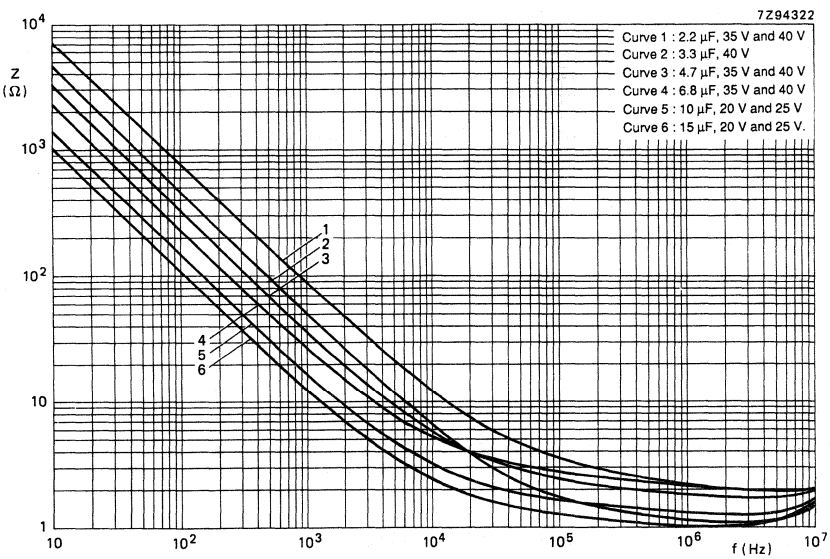


Fig.20 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø6.7 x 15.3, U_R = 20 V to 40 V.

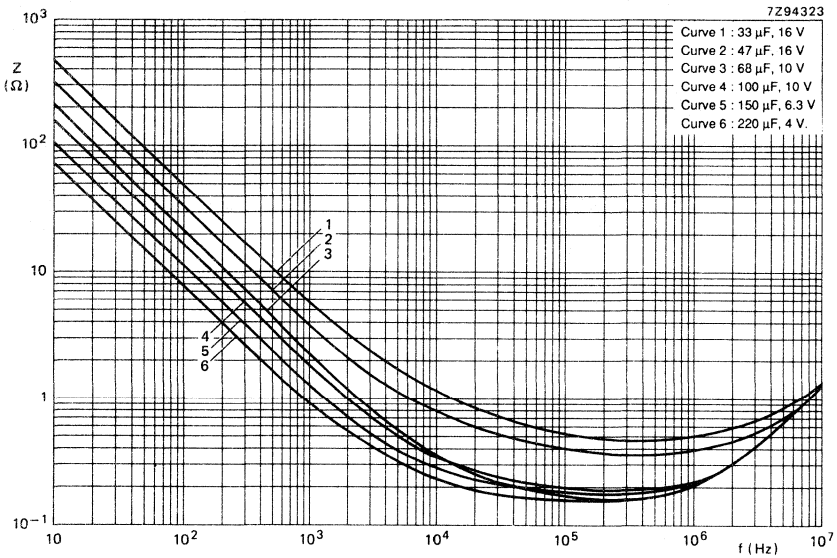


Fig.21 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø7.6 x 20.4, U_R = 4 V to 16 V.

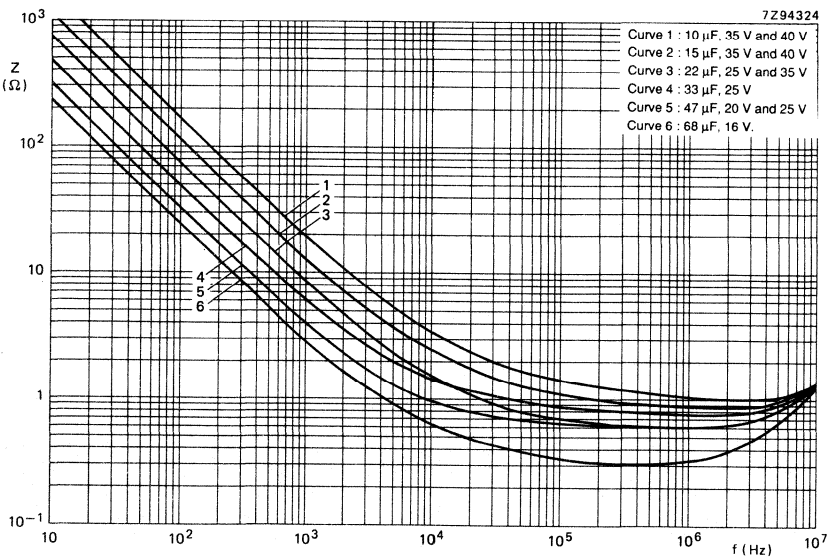


Fig.22 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø7.6 x 20.4, U_R = 16 V to 40 V.

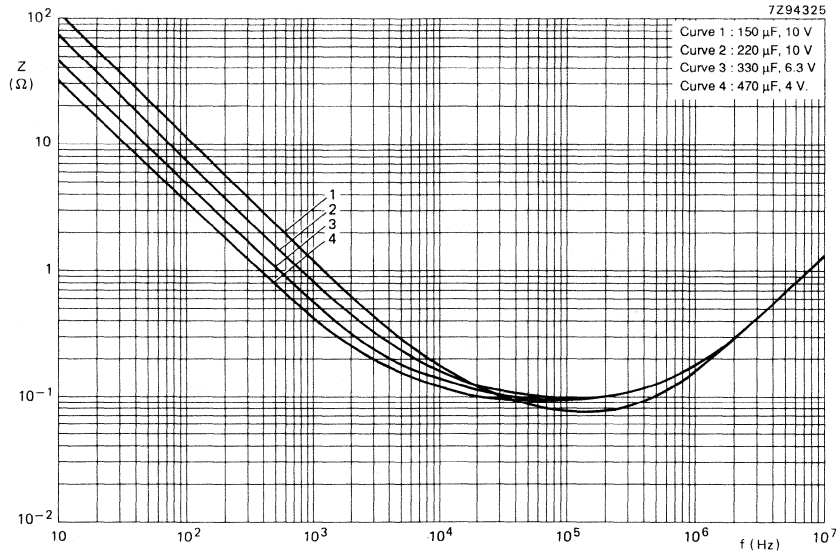


Fig.23 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø9.3 x 23.3, U_R = 4 V to 10 V.

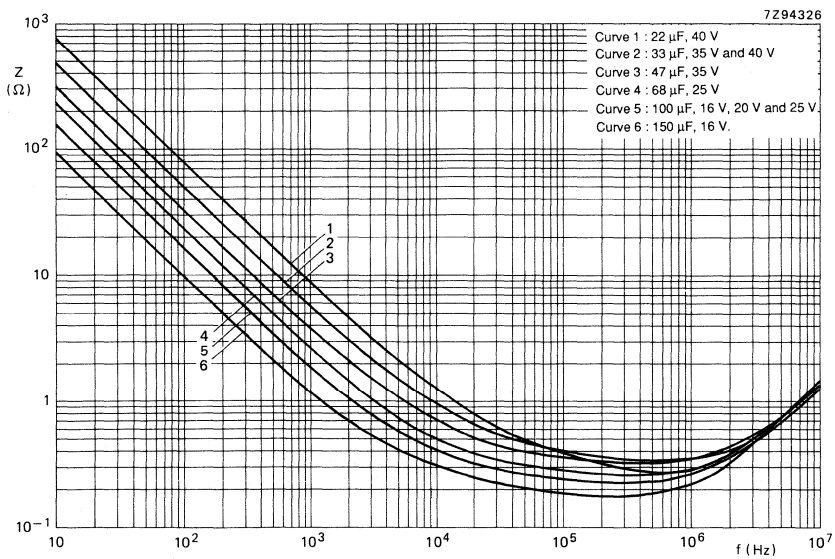


Fig.24 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø9.3 x 23.3, U_R = 16 V to 40 V.

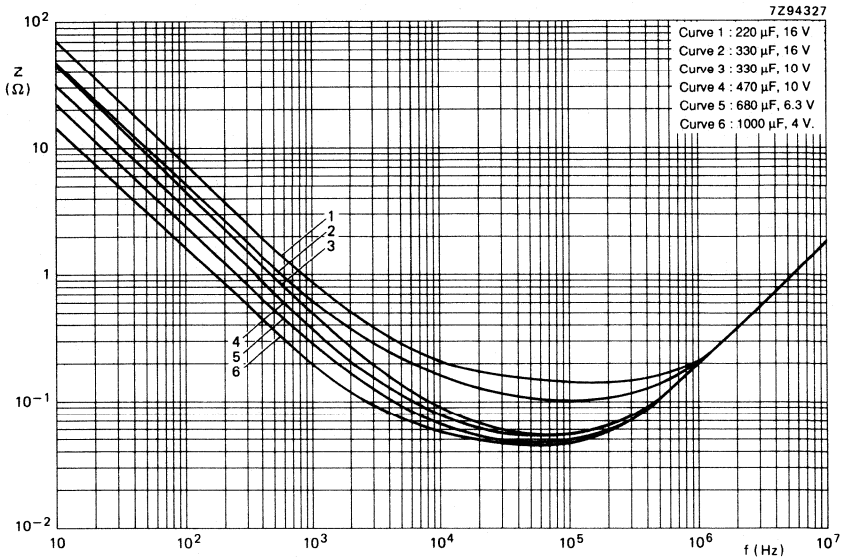


Fig.25 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø10.3 x 32.0, U_R = 4 V to 16 V.

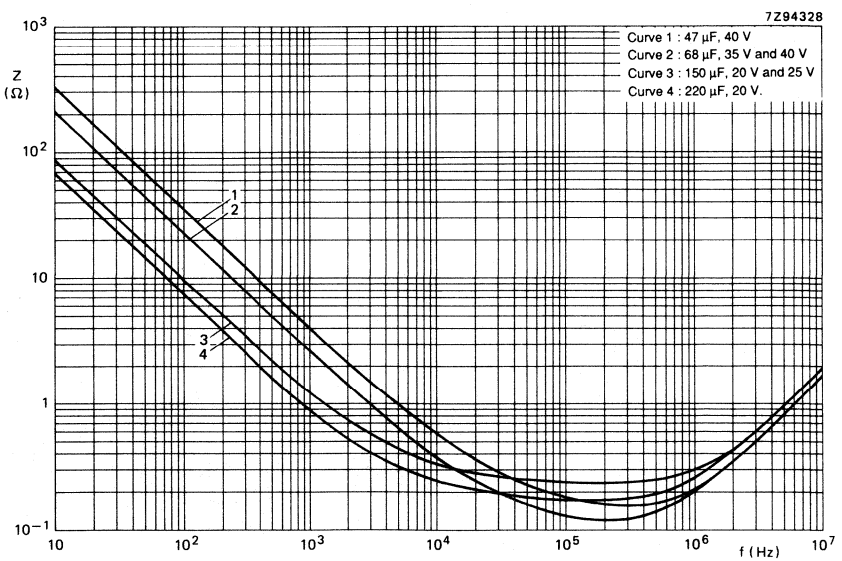


Fig.26 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø10.3 x 32.0, U_R = 20 V to 40 V.

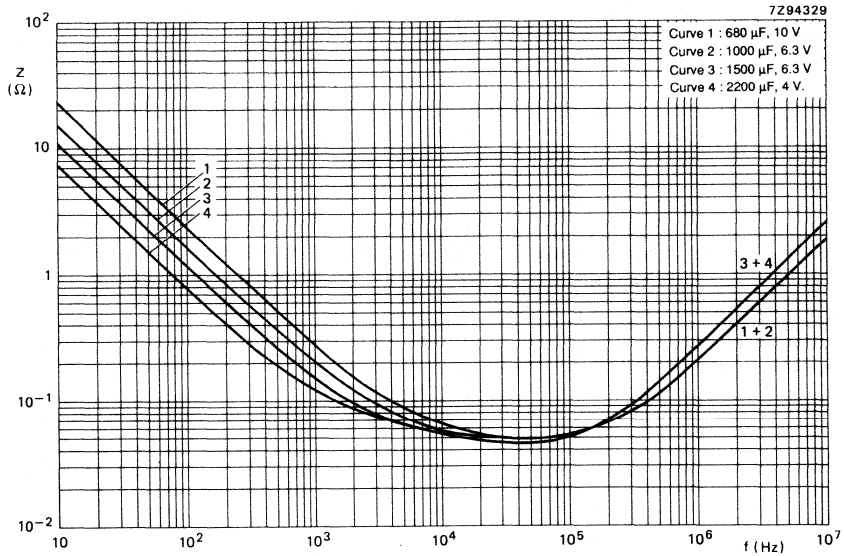


Fig.27 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø12.9 x 32.0, U_R = 4 V to 10 V.

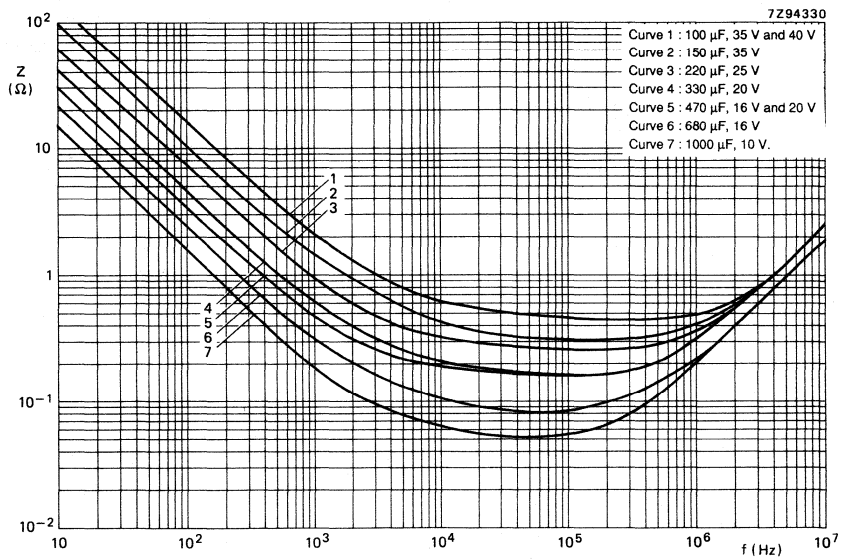


Fig.28 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø12.9 x 32.0, U_R = 10 V to 40 V.

SPECIFIC TESTS and REQUIREMENTS

General tests and requirements are specified in chapter "Tests and Requirements".

Table 5

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4-2/ CECC 30 302 group C3, 4.13	T_{amb} = 125 °C U_R = 6.3 to 25 V with U_R applied U_R = 35 and 40 V with U_C applied 10 000 hours	ΔC/C ≤±10% tan δ ≤1.2 x spec. limit Z ≤1.2 x spec. limit I_{L5} ≤spec. limit
Useful life	CECC 30 302 amendment 2642 sub clause 1.8.1	T_{amb} = 125 °C, I_R applied and U_R = 6.3 to 25 V with U_R applied U_R = 35 and 40 V with U_C applied 20 000 hours	ΔC/C ≤15% tan δ ≤1.5 x spec. limit Z ≤1.5 x spec. limit I_{L5} ≤spec. limit no short or open circuit no visible damage total failure percentage <1%
Shelf life (storage at high temp.)	IEC 384-4-2/ CECC 30 302 group C 5a, 4.17	T_{amb} = 125 °C, no voltage applied 500 hours	ΔC/C ≤±10% tan δ ≤1.2 x spec. limit I_{L5} ≤1 x spec. limit
Charge and discharge	IEC 384-4-2 sub clause 9.21	10^6 cycles without series resistance 0.5 s to U_R 0.5 s to ground	ΔC/C ≤5% no short or open circuit no visible damage
Extended vibration test	IEC 68-2-6 test Fc	10 to 2 000 Hz 1.5 mm or 20 g 1 octave/minute 3 directions 1 sweep per direction no voltage applied	no intermittent contacts; no breakdown; no open circuiting; no mechanical damage; ΔC/C ≤5% tan δ ≤1.2 x spec. limit Z ≤1.2 x spec. limit I_{L5} ≤1.5 x spec. limit
Shock test	IEC 68-2-27 test Ea	half-sine or saw tooth pulse shape 50 g, 11 ms, 3 successive shocks in each direction of 3 mutually perpendicular axes, no voltage applied	no intermittent contacts; no breakdown; no open circuiting; no mechanical damage; ΔC/C <5% tan δ ≤1.2 x spec. limit Z ≤1.2 x spec. limit I_{L5} ≤1.5 x spec. limit
Severe rapid change of temperature		100 cycles of 15 minutes at –40 °C and +125 °C	ΔC/C ≤±10% tan δ ≤1.6 x spec. limit Z ≤1.6 x spec. limit I_{L5} ≤1 x spec.limit

7

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	Reference		
Solvent resistance test	IEC 68-2-45, IEC 653 test XA	sequence: - 30 s vapour phase - 5 minutes ultrasonic immersion at ambient temperature - 30 s vapour phase Solvents: - deionized water (50 ±5 °C); - calgonite solution (20 g/l, 70 ±5 °C); - 1.1.1.-trichloro-ethane; - mixtures of 1.1.2.-trichloro-1.2.2.-trifluoro-ethane (fluorocarbon 113) and the following solvents in the respective mass percentage ratios of these solvents to fluorocarbon; * ARKLONE K; 75% w/w F113 and 25% w/w isopropanol * FREON TE; 95.5% w/w F113 and 4.5% w/w ethanol * FREON TMS; 94% w/w F113, 5.7% w/w methanol and 0.3% w/w nitro-methane *ARKLONE F; 95.6% w/w F113, 4.0% w/w ethylalcohol, 0.07% w/w stabilizer and 0.3% w/w special additives * ARKLONE A-M; 94.15% w/w F113, 3.7% w/w ethylalcohol, 2.1% w/w methylacetate and 0.05% w/w stabilizer	visual appearance not affected
Passive flammability test	IEC 695-2-2	capacitor mounted to a vertical printed-wiring board, one flame on capacitor body, T_{amb} = 20 to 25 °C, test duration = 20 s.	after removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s; no burning particles must drop from the sample

Notes

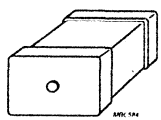
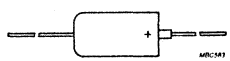
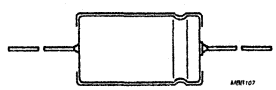
1. ARKLONE is a trade mark of I.C.I.
2. FREON is a trade mark of Dupont de Nemours.

ADDITIONAL TESTS and REQUIREMENTS for Epoxy-filled versions SAL - AG

2222 123 6.... Form BA ±20%
2222 123 7.... Form BA ±10%
2222 123 8.... Form BA ±10%, level S

Severe vibration tests, in accordance with IEC 68-2-6 and MIL STD-202, method 204, letters E, with the following details and additions:		
Method of mounting: severity 1 severity 2 severity 1 and 2	clamping both body and leads. frequency range temp. 10-3000 Hz; 20-25 °C frequency range temp. 50-2000 Hz; 125 °C vibration amplitude: 50 g or 3.5 mm, whichever is less.	
Direction and duration of motion: severity 1 severity 2	 1 octave/minute, 3 directions (mutually perpendicular), 20 sweeps per direction (total 60 sweeps or 18 hours) 1 octave/minute, 2 directions (longitudinal and transversal), 3 sweeps per direction (total 6 sweeps or 1 hour).	
Functioning: severity 1 severity 2	 rated voltage applied no voltage applied	
Requirements:	ΔC/C: tan δ: Z: DC leakage current: general:	≤10% ≤1.2 x stated limit ≤1.4 x stated limit ≤stated limit no intermittent contacts no indication of breakdown no open circuiting no evidence of mechanical damage.
Typical capability: up to 80 g at 10 to 3000 Hz (also at 125 °C).		
Severe shock tests, in accordance with IEC 68-2-27 and MIL STD-202, method 213, letter F, with the following details and additions		
Method of mounting: Pulse shape: severity 1: severity 2: severity 3:	clamping both body and leads. half-sine or sawtooth. 1500 g, 0.5 ms (MIL STD-202, method 213, letter F) 3000 g, 0.2 ms 10 000 g, 0.1 ms.	
Direction and number of shocks: severity 1 and 2: severity 3:	 3 sucessive shocks in each direction of 3 mutually perpendicular axes (total 18 shocks) 1 shock in any direction.	
Functioning:	rated voltage applied.	
Requirements: Typical capability:	see "severe vibration tests" (as above) ≥100 000 g; these shock tests can be preceded by severe vibration tests on the same samples.	

TANTALUM ELECTROLYTIC CAPACITORS

		STANDARD	INDUSTRIAL	PROFESSIONAL
SMD (solid)		49MC195 *Page 138*	*Page 150* 49UC 49XC *Page 158*	*Page 174* 49BC 49SC *Page 166*
RADIAL (solid)		TRM194 *Page 830*		
AXIAL (solid)			40SS (CSR13) *Page 838*	
AXIAL (non-solid)			40AW (CLR79) *Page 846*	

Tantalum Radial Miniature TRM 194

FEATURES

- Polarized tantalum electrolytic capacitors, solid electrolyte MnO_2
- Radial leads, resin dipped, brown coloured
- Long life, high reliability
- High CU product per unit volume
- Low leakage current
- Low dissipation factor

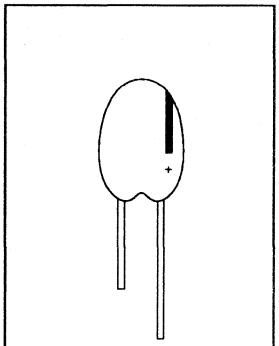


Fig.1 Component outline

APPLICATIONS

- EDP, telecommunication, general industrial, audio-video
- Filtering, buffering, storage and timing
- Portable and mobile equipment (small size)

QUICK REFERENCE DATA

Case size, $\varnothing D_{nom}$ x L_{nom} in mm	4 x 6 to 10.5 x 15
Rated capacitance range, C_R	0.1 to 330 µF
Tolerance on C_R	±20 %, ±10 %
Rated voltage range, U_R	6.3 to 50 V
Category temperature range	–55 to +85 °C
Endurance test at 85 °C	1000 hours
Useful life at 40 °C	100000 hours
Basic specification	IEC 384-15
Detail specification	similar to DIN 44 356
Climatic category IEC 68	55/085/21
Climatic category DIN 40 040	FPE

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (diameter x length in mm)

C_R	U_R (V)					
µF	6.3	10	16	25	35	50
0.10					4 x 6	4.5 x 7
0.15					4 x 6	4.5 x 7
0.22		Natural pitch 2.5 mm			4 x 6	4.5 x 7
0.33					4 x 6	4.5 x 7
0.47			4 x 6		4.5 x 6.5	4.5 x 7
0.68			4 x 6		4.5 x 6.5	5 x 7
1.0			4 x 6	4.5 x 6.5	4.5 x 7	5 x 8
1.5			4.5 x 6.5	4.5 x 7	5 x 7	5.5 x 8
2.2		4.5 x 6.5	4.5 x 7	5 x 7	5 x 7.5	5.5 x 8.5
3.3	4.5 x 6.5	4.5 x 7	5 x 7	5 x 7.5	5 x 8	6 x 9
4.7	4.5 x 7	5 x 7	5 x 7.5	5 x 8	5.5 x 8	6.5 x 11
6.8	5 x 7	5 x 7.5	5 x 8	5.5 x 8	6 x 9	8 x 12
10	5 x 7.5	5 x 8	5.5 x 8	6 x 9	6.5 x 10	
15	5 x 8	5.5 x 8	5.5 x 8.5	6.5 x 10	7.5 x 11	
22	5.5 x 8	5.5 x 8.5	6 x 9	7.5 x 11	8 x 12	
33	5.5 x 8.5	6 x 9	6.5 x 10	8 x 12	9.5 x 14	
47	6 x 9	6.5 x 10	7.5 x 11	9.5 x 14	10.5 x 15	
68	6.5 x 10	7.5 x 11	8 x 12	10.5 x 15		
100	7.5 x 11	8 x 12	9.5 x 14			
150	8 x 12	9.5 x 14	10.5 x 15	Natural pitch 5 mm		
220	9.5 x 14	10.5 x 15				
330	10.5 x 15					

MECHANICAL DATA Dimensions (in mm)

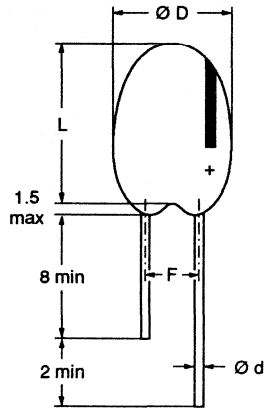


Fig. 2 **Form CA**
long leads, bulk packing;
see Table 2 for dimensions.

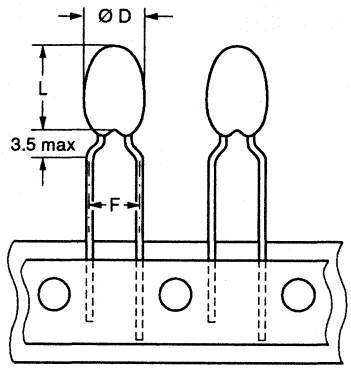


Fig. 3 **Form TA**
taped, pitch 5 mm, Ammopack
for øD = 4 to 7.5 mm

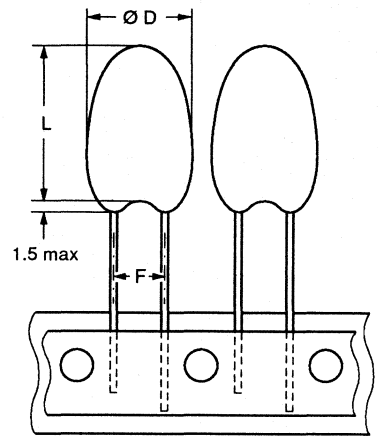


Fig. 4 **Form TA**
taped, pitch 5 mm, Ammopack
for øD = 8.0 to 10.5 mm

See introduction for taping dimensions

Table 2 Dimensions (in mm) and packing quantities

CASE SIZE	CASE CODE	RADIAL				NUMBER
$øD_{nom}$ x L_{nom}		ød	$øD_{max}$	L_{max}	F	Bulk
4 x 6	1	0.5	4	6	2.5	2000
4.5 x 6.5	2	0.5	4.5	6.5	2.5	2000
4.5 x 7	3	0.5	4.5	7	2.5	2000
5 x 7	4	0.5	5	7	2.5	2000
5 x 7.5	5	0.5	5	7.5	2.5	2000
5 x 8	6	0.5	5	8	2.5	2000
5.5 x 8	7	0.5	5.5	8	2.5	2000
5.5 x 8.5	8	0.5	5.5	8.5	2.5	2000
6 x 9	9	0.5	6	9	2.5	2000
6.5 x 10	10	0.5	6.5	10	2.5	2000
7.5 x 11	11	0.5	7.5	11	2.5	2000
8 x 12	12	0.5	8	12	5.0	2000
9.5 x 14	13	0.5	9.5	14	5.0	2000
10.5 x 15	14	0.5	10.5	15	5.0	2000

MARKING

The capacitors are marked with the following information:

- Rated capacitance value
- Rated voltage
- Positive terminal identification

Tantalum Radial Miniature TRM 194

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 apply at an ambient temperature of 20 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75 %.

C_R = rated capacitance at 100 Hz, tolerance ±20 % or ±10 %

I_{L5} = max. leakage current after 5 min. at U_R

tan δ = max. dissipation factor at 100 Hz

Z = max. impedance at 10 kHz

ORDERING EXAMPLE

Tantalum Pearl TRM 194
47 µF/10 V, ±20 %, Form TA
Catalogue number 2222 194 74479

Table 3 Electrical data and ordering information

U_R	C_R	CASE SIZE	I_{L5}	tan δ	Z	CATALOGUE NUMBER 2222	
		$øD_{nom}$ x L_{nom}	5 min.	100 Hz	10 kHz		
(V)	(µF)	(mm)	(µA)		(Ω)	Form CA, ±20 % [1]	Form TA, ±20 % [1]
6.3	3.3	4.5 x 6.5	0.5	0.06	12	194 13338	194 73338
	4.7	4.5 x 7.0	0.5	0.06	11	13478	73478
	6.8	5.0 x 7.0	0.5	0.06	7.7	13688	73688
	10	5.0 x 7.5	0.6	0.06	6.4	13109	73109
	15	5.0 x 8.0	0.9	0.06	4.8	13159	73159
	22	5.5 x 8.0	1.3	0.06	3.2	13229	73229
	33	5.5 x 8.5	2.0	0.06	2.4	13339	73339
	47	6.0 x 9.0	2.9	0.06	2.0	13479	73479
	68	6.5 x 10	4.2	0.06	1.6	13689	73689
	100	7.5 x 11	6.3	0.08	1.2	13101	73101
	150	8.0 x 12	9.4	0.08	0.8	13151	73151
	220	9.5 x 14	13.0	0.08	0.6	13221	73221
	330	10.5 x 15	20.0	0.08	0.6	13331	73331
10	2.2	4.5 x 6.5	0.5	0.06	17	194 14228	194 74228
	3.3	4.5 x 7.0	0.5	0.06	15	14338	74338
	4.7	5.0 x 7.0	0.5	0.06	8.5	14478	74478
	6.8	5.0 x 7.5	0.6	0.06	7.2	14688	74688
	10	5.0 x 8.0	1.0	0.06	6.0	14109	74109
	15	5.5 x 8.0	1.5	0.06	3.6	14159	74159
	22	5.5 x 8.5	2.2	0.06	2.4	14229	74229
	33	6.0 x 9.0	3.3	0.06	2.0	14339	74339
	47	6.5 x 10	4.7	0.06	1.6	14479	74479
	68	7.5 x 11	6.8	0.06	1.4	14689	74689
	100	8.0 x 12	10.0	0.06	0.8	14101	74101
	150	9.5 x 14	15.0	0.06	0.6	14151	74151
	220	10.5 x 15	22.0	0.06	0.6	14221	74221

[1]) The 8. digit of the catalogue number represents the tolerance on C_R.
For a tolerance of ±10 % change this digit as follows:
Form CA, ±10 %, catalogue number 2222 194 **2**....
Form TA, ±10 %, catalogue number 2222 194 **9**....

Table 3 Electrical data and ordering information (continued)

U_R (V)	C_R (µF)	CASE SIZE $øD_{nom}$ x L_{nom} (mm)	I_{L5} 5 min. (µA)	tan δ 100 Hz	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222 ... . Form CA, ±20 % [1]	Form TA, ±20 % [1]
16	0.47	4.0 x 6.0	0.5	0.04	57	194 15477	194 75477
	0.68	4.0 x 6.0	0.5	0.04	43	15687	75687
	1.0	4.0 x 6.0	0.5	0.04	28	15108	75108
	1.5	4.5 x 6.5	0.5	0.06	21	15158	75158
	2.2	4.5 x 7.0	0.5	0.06	16	15228	75228
	3.3	5.0 x 7.0	0.5	0.06	9.4	15338	75338
	4.7	5.0 x 7.5	0.7	0.06	8.1	15478	75478
	6.8	5.0 x 8.0	1.0	0.06	5.1	15688	75688
	10	5.5 x 8.0	1.6	0.06	4.0	15109	75109
	15	5.5 x 8.5	2.4	0.06	2.8	15159	75159
	22	6.0 x 9.0	3.5	0.06	2.0	15229	75229
	33	6.5 x 10	5.2	0.06	1.6	15339	75339
	47	7.5 x 11	7.5	0.06	1.4	15479	75479
	68	8.0 x 12	10.0	0.06	1.0	15689	75689
	100	9.5 x 14	16.0	0.08	0.6	15101	75101
	150	10.5 x 15	24.0	0.08	0.6	15151	75151
25	1.0	4.5 x 6.5	0.5	0.04	33	194 16108	194 76108
	1.5	4.5 x 7.0	0.5	0.06	19	16158	76158
	2.2	5.0 x 7.0	0.5	0.06	12	16228	76228
	3.3	5.0 x 7.5	0.8	0.06	10	16338	76338
	4.7	5.0 x 8.0	1.1	0.06	6.8	16478	76478
	6.8	5.5 x 8.0	1.7	0.06	4.7	16688	76688
	10	6.0 x 9.0	2.5	0.06	3.6	16109	76109
	15	6.5 x 10	3.7	0.06	2.0	16159	76159
	22	7.5 x 11	5.5	0.06	1.6	16229	76229
	33	8.0 x 12	8.2	0.06	1.4	16339	76339
	47	9.5 x 14	11.0	0.06	1.0	16479	76479
	68	10.5 x 15	17.0	0.06	0.8	16689	76689

[1] The 8. digit of the catalogue number represents the tolerance on C_R.
For a tolerance of ±10 % change this digit as follows:
Form CA, ±10 %, catalogue number 2222 194 **2**....
Form TA, ±10 %, catalogue number 2222 194 **9**....

Table 3 Electrical data and ordering information (continued)

U_R (V)	C_R (µF)	CASE SIZE $øD_{nom}$ x L_{nom} (mm)	I_{LS} 5 min. (µA)	tan δ 100 Hz	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222 ... . Form CA, ±20 % [1]	Form TA, ±20 % [1]
35	0.10	4.0 x 6.0	0.5	0.04	266	194 17107	194 77107
	0.15	4.0 x 6.0	0.5	0.04	171	17157	77157
	0.22	4.0 x 6.0	0.5	0.04	124	17227	77227
	0.33	4.0 x 6.0	0.5	0.04	86	17337	77337
	0.47	4.5 x 6.5	0.5	0.04	57	17477	77477
	0.68	4.5 x 6.5	0.5	0.04	43	17687	77687
	1.0	4.5 x 7.0	0.5	0.06	28	17108	77108
	1.5	5.0 x 7.0	0.5	0.06	18	17158	77158
	2.2	5.0 x 7.5	0.7	0.06	12	17228	77228
	3.3	5.0 x 8.0	1.1	0.06	11	17338	77338
	4.7	5.5 x 8.0	1.6	0.06	10	17478	77478
	6.8	6.0 x 9.0	2.3	0.06	9.4	17688	77688
	10	6.5 x 10	3.5	0.06	8.0	17109	77109
	15	7.5 x 11	5.2	0.06	4.8	17159	77159
	22	8.0 x 12	7.7	0.06	4.4	17229	77229
	33	9.5 x 14	11.0	0.06	3.6	17339	77339
	47	10.5 x 15	16.0	0.06	2.4	17479	77479
50	0.10	4.5 x 7.0	0.5	0.04	266	194 19107	194 79107
	0.15	4.5 x 7.0	0.5	0.04	171	19157	79157
	0.22	4.5 x 7.0	0.5	0.04	124	19227	79227
	0.33	4.5 x 7.0	0.5	0.04	86	19337	79337
	0.47	4.5 x 7.0	0.5	0.04	57	19477	79477
	0.68	5.0 x 7.0	0.5	0.04	43	19687	79687
	1.0	5.0 x 8.0	0.5	0.04	28	19108	79108
	1.5	5.5 x 8.0	0.7	0.06	18	19158	79158
	2.2	5.5 x 8.5	1.1	0.06	12	19228	79228
	3.3	6.0 x 9.0	1.6	0.06	11	19338	79338
	4.7	6.5 x 11	2.3	0.06	10	19478	79478
	6.8	8.0 x 12	3.4	0.06	9.4	19688	79688

[1] The 8. digit of the catalogue number represents the tolerance on C_R.
For a tolerance of ±10 % change this digit as follows:
Form CA, ±10 %, catalogue number 2222 194 **2**....
Form TA, ±10 %, catalogue number 2222 194 **9**....

ADDITIONAL ELECTRICAL DATA

Reverse voltage	U_{rev}	≤ 0.5 V
Leakage current after 5 min. at U_R	I_{L5}	≤ 0.01 C_R U_R or 0.5 μA whichever is greater
Dissipation factor	tan δ	≤ 0.04 for C_R = 0.1 to 1 μF
	tan δ	≤ 0.06 for C_R = 1.5 to 68 μF
	tan δ	≤ 0.08 for C_R = 100 to 330 μF
Recommended series resistance		
at U_R, 85 °C	R_s	≥ 3 Ω/V
at 0.5 U_R, 40 °C	R_s	≥ 0.1 Ω/V
Resistance to soldering heat		270 °C, 5 s

SPECIFIC TESTS AND REQUIREMENTS

Table 4

TEST	PROCEDURE	REQUIREMENTS
Stability at low and high temperature	T_{amb} = –55 °C	$\|\Delta C/C\| \leq \pm 12$ % tan δ ≤ (spec. limit + 0.02)
	T_{amb} = +85 °C	$\|\Delta C/C\| \leq \pm 12$ % tan δ ≤ (spec. limit + 0.02)
Endurance	t = (1000 + 48) hours	$\|\Delta C/C\| \leq \pm 10$ % of initial value tan δ ≤ spec. limit $I_{L5} \leq 1.25$ x spec. limit
Humidity	T_{amb} = (40 ± 2) °C RH = 90 to 95 % t = (500 + 24) hours	$\|\Delta C/C\| \leq \pm 15$ % of initial value tan δ ≤ 1.5 x spec. limit $I_{L5} \leq 1.5$ x spec. limit

Electrolytic Capacitors

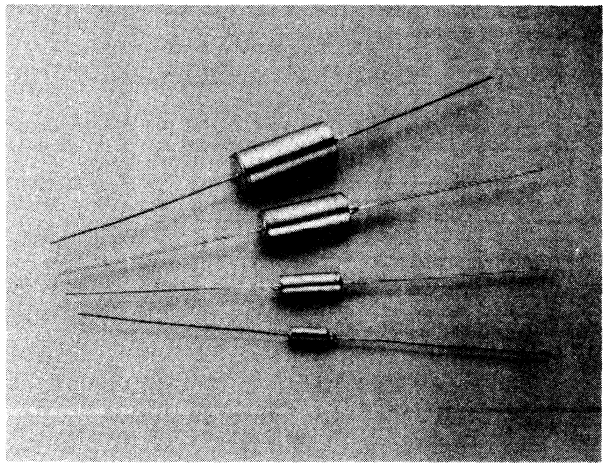
Notes

Tantalum Solid Electrolytic Capacitor
Industrial Type of MIL-C-39003/01, Style CSR 13

40 SS

SERIES 40SS

Solid Electrolyte Tantalum Capacitor



DESCRIPTION

The 40SS type solid tantalum capacitors are products of extensive research and development activities. While their unique design makes the 40SS type capacitors extremely stable over a wide temperature range, their high purity, porous sintered tantalum anode and highly refined tantalum oxide dielectric result in capacitors with low DC leakage currents and low dissipation factor values.

FEATURES

- HERMETIC SEAL
- LOWEST DC LEAKAGE CURRENT
- REDUCED ESR RESULTING IN LOW DISSIPATION FACTOR
- MINIMAL CHANGE IN CAPACITANCE AT TEMPERATURE EXTREMES
- HERMETIC DEVICE

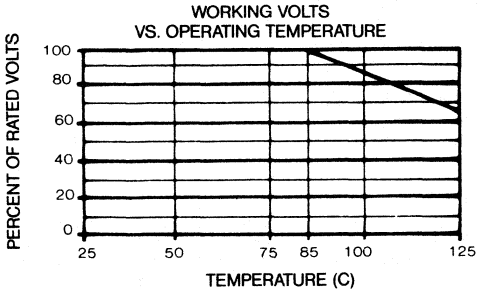
Tantalum Solid Electrolytic Capacitor
Industrial Type of MIL-C-39003/01, Style CSR 13

40 SS

ELECTRICAL CHARACTERISTICS

DC WORKING VOLTAGE

M/C 40SS Type Tantalum Capacitors are available in 8 voltage ratings and may be operated at full rated voltage from 80°C to +85°C. The "S" type may be further operated up to 125°C by derating the DC working voltage in accordance with the following graph and chart:



Rated DC Working Voltage		Rated DC Surge Voltage	
Up to 85°C	125°C	Up to 85°C	125°C
6	4	8	5
10	7	13	9
15	10	20	12
20	13	26	16
35	23	46	28
50	33	65	40
75	50	97	64
100	66	130	86

SURGE VOLTAGE

The surge voltage rating (see table above) of the 40SS Type capacitor is the maximum short duration voltage which may be applied to the capacitor; i.e., "turn on" transients, peak AC voltage, or any other voltage pulses which may be superimposed on the rated DC working voltage.

In no case may the sum of the AC voltage and the applied DC working voltage exceed the rated DC surge voltage.

SURGE VOLTAGE TEST

Appropriate surge voltage shall be applied to the test capacitor(s) through a 1000 ohm series limiting resistor for 30 seconds. The test capacitors shall then be discharged through the 1000 ohm resistor for 5½ minutes. This charge discharge cycle shall be repeated 2000 times.

Following the surge test the following requirements must be met:

A. Capacitance shall not change more than ±5%.
B. Dissipation Factor shall meet initial requirements.
C. DC Leakage Current shall meet initial requirements.

CAPACITANCE RATINGS

The 40SS Type Capacitors are available from .0047 MFD to 330 MFD in an incremental series of nominal values so chosen that the minimum and maximum allowable tolerance of two successive ratings overlap. In the tabulation of standard ratings you will find nominal ratings for ±10% tolerance series.

Intermediate values for a ±5% and ±20% tolerance series are available on special order.

CAPACITANCE MEASUREMENT

40SS Type capacitors are measured on a polarized capacitance bridge. The measurements are made at, or referred to, 120 hz and 25°C conditions. The AC measuring signal shall be limited to 2 volts peak and have a frequency of 120 hz. The bridge shall have a DC polarizing voltage large enough to prevent a reversal of polarity by the AC measuring voltage and at the same time the peak AC measuring voltage and at the same time the peak AC should not exceed the rated DC working voltage of the capacitor.

CAPACITANCE CHANGE WITH TEMPERATURES

One of the most significant characteristics of the "40SS" Type Capacitor Series is the relatively small change in capacitance at temperature extremes compared to other types of electrolytic capacitors.

The change in capacitance from the initial 25°C measured capacitance shall not exceed the following percentages:

TEMPERATURE	MAX. CHANGE IN CAPACITANCE
−55°C	10%
+85°C	8%
+125°C	12%

DISSIPATION FACTOR

DF shall be measured on a polarized bridge, at or referred to 120 cps at 25°C. The maximum DC bias shall be 2.2 VDC for all AC measurements. The magnitude of the AC signal shall be limited to 1.0 VRMS.

The DF so determined shall not exceed:

0.01 uf to 56 uf	6% DF maximum
68 uf to 120 uf	8% DF maximum
150 uf and Up	10% DF maximum

D.C. LEAKAGE CURRENT

When measured at 25°C, rated voltage, and after a 5 minute electrification period, the values in no case need be less than 1 uA or .02uA/ufV, whichever is greater. At 85°C the leakage will not exceed 10 times the 25°C limit and at 125°C will not exceed 12 times the 25°C limit.

LIFE TEST

Capacitors shall be life tested for 2000 hours at 85°C or 125°C with the appropriate DC working voltage applied. After life test when measured at 25°C the dissipation factor shall meet the initial requirement. This leakage current shall not be more than 125% of the original requirements and capacitors shall not have changed more than ±10% from the initial value.

Tantalum Solid Electrolytic Capacitor Industrial Type of MIL-C-39003/01, Style CSR 13

40 SS

PHYSICAL ENVIRONMENTS

The M/C 40SS Type Solid Electrolyte Tantalum Capacitors are capable of meeting the following requirements on environmental test.

In the interest of standardization, these tests follow very closely the testing specified in military specifications on solid tantalums. They do not represent the maximum environment capabilities of the M/C 40SS Type.

For more extreme conditions the M/C Capacitor Engineering Department should be consulted.

LOW FREQUENCY VIBRATION

The capacitors shall be rigidly mounted by suitable case clamps and subjected to a simple harmonic motion having a maximum amplitude of 0.03". The frequency shall be varied uniformly over a frequency range of 10-55 Hz in approximately 1 minute at a uniform rate for a total of 2 hours. Rated DC voltage will be applied to the units during test. During the last ½ hour of test, the test units will be monitored by an instrument capable of detecting intermittent open or short circuits with a duration of .5 milliseconds or greater.

After vibration the capacitors shall meet the initial requirements of dissipation factor and leakage current. The capacitance shall not change more than ±5% from the initial measured value.

HIGH FREQUENCY VIBRATION

The capacitors shall be rigidly mounted by suitable case clamps and subjected to a simple harmonic motion having a maximum amplitude of 0.03" or 15G in 2 mutually perpendicular directions—1 parallel and 1 perpendicular to the cylindrical axis. Capacitors shall withstand vibration from 10 to 10,000 Hz at 15g without internal damage. The frequency shall be varied uniformly over a frequency range (f55-2000 Hz in approximately 20 minutes at a uniform rate for a total of 4 hours. During the last ½ hour of test the test units will be monitored by an instrument capable of detecting intermittent open or short circuits with a duration of .5 milli-seconds or greater. Rated DC voltage will be applied to the units during test.

After vibration the capacitors shall meet the initial requirements of dissipation factor and leakage current. The capacitance shall not change more than ±5% from the initial measured value.

PULL TEST

With the body of the capacitor secured, the leads shall withstand a 3 lb. load applied in any direction for 30 seconds.

BEND TEST

Each capacitor lead shall be capable of withstanding 5 bends. A bend shall be defined as follows:

With the capacitor vertical and a 1 lb. weight attached to the lead, the capacitor body shall be slowly rotated (in approximately 5 seconds) to a horizontal position and then rotated to the vertical position. The 4 succeeding bends shall then be made in the same manner but in alternate directions.

MOISTURE RESISTANCE

M/C 40SS type capacitors shall be tested in accordance with method 106 of MIL Standard 202. The following details and exceptions shall apply:

a. Mounting—The capacitors shall be securely mounted by normal mounting means during the test. This does not apply during measurements.
b. Initial measurements are not applicable.
c. Polarization and loading voltages are not applicable during the test.
d. Final Measurements—With 2-6 hours after the capacitors have been removed from the humidity chamber following the final cycle, the DC leakage, capacitance and dissipation factor shall be measured as specified.
e. Examinations After Test—Following the final measurements the capacitors shall be examined visually for evidence of corrosion, mechanical damage and obliteration of marking.

INSULATING SLEEVES

For insulated capacitors, the insulating sleeves shall be tested as follows for dielectric strength and insulation resistance.

Two wire windings shall be placed around the insulating sleeves ¼" apart. Each winding to consist of 2 close turns of 24AWG bare copper wire.

DIELECTRIC STRENGTH

For dielectric strength a DC test potential of 2000 V shall be applied for 1 minute between the 2 windings. There shall be no breakdown of case insulation.

INSULATION RESISTANCE

For insulation resistance a DC test potential of 100 V shall be applied for 2 minutes. The insulation resistance shall not be less than 100 megohms.

SHELF LIFE TEST

When the capacitors have been exposed to 5000 hours shelf life test at 85°C with no voltage applied capacitance shall not change more than ±4% from the initial measured value. The dissipation factor shall not exceed 150% of the initial requirement and the leakage current shall meet the initial requirement.

SHOCK

The capacitors shall be tested for shock resistance in accordance with MIL Standard 202A methods 205 with the following exceptions.

a. The capacitors shall be rigidly mounted by suitable body clamps.
b. The capacitor shall be subjected to 20 impacts of 50g with an 11 milli-seconds duration. Ten impacts to be applied in the direction of the longitudinal axis, and 10 impacts in a plane normal to the longitudinal axis of the capacitor.
c. Rated DC voltage shall be applied to the capacitors during the shock test.

The test units shall be monitored during test by an instrument capable of detecting intermittent open and short circuits with a duration of .5 milli-seconds or greater.

After test the capacitors shall meet the initial requirements of capacitance, dissipation factor and leakage requirements.

THERMAL SHOCK AND IMMERSION CYCLING

After the capacitors are tested as specified in 8A and 8B, the DC leakage current shall meet the initial requirement. The capacitance change shall not exceed ±5% of the value measured prior to test and the dissipation factor shall meet the initial requirement. When examined visually, at least 90% of all exposed metallic surfaces shall show no evidence of harmful corrosion. When examined internally there shall be no evidence of dye penetration.

THERMAL SHOCK

Capacitors shall be tested in accordance with Method 107 of MIL Standard 202. The following exceptions and details shall apply:

a. Capacitors should be conditioned at a temperature of 25°C for 15 minutes before the first cycle of test one.
b. The B test condition will be followed except that in the third step thereof, the capacitors will be subjected to a test at the highest applicable temperature.
c. Measurements before and after cycling may be omitted.

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IMMERSION CYCLING

After temperature cycling, a capacitor test should be made following Method 104 set down in MIL Standard 202. The following details and exceptions, however, shall apply:

a. A non-corrosive dye, Rhodamine B (tetraethylrhodamine), or its equivalent, shall be added in both baths in addition to steps provided in test condition B.
b. Measurements after final cycle—Measurements of DC leakage, capacitance and dissipation factor shall be made within 30 minutes after the capacitors are removed from the final immersion bath.
c. Examinations after test—The capacitors shall be visually examined for traces of corrosion, mechanical damage, and obliteration of marking. Capacitors shall then be sectioned for evidence of dye penetration.

REDUCED PRESSURE

After the capacitors have been stabilized for 5 minutes in a vacuum of 1.69×10^{1} Torr., rated DC voltage shall be applied for 1 minute. There shall be no voltage flash over nor shall the end seals show evidence of damage by this test. The capacitance, dissipation factor, and leakage current shall meet the initial requirements.

LEAD MATERIAL

Standard construction will include tin lead plated leads for soldering. Plain nickel leads are also available for welding.

MARKING

Capacitors shall be marked with M/C rated capacitance, tolerance, polarity, rated DC working voltage, date code where space permits. Polarity will be marked on one end with a + sign to identify the positive terminal.

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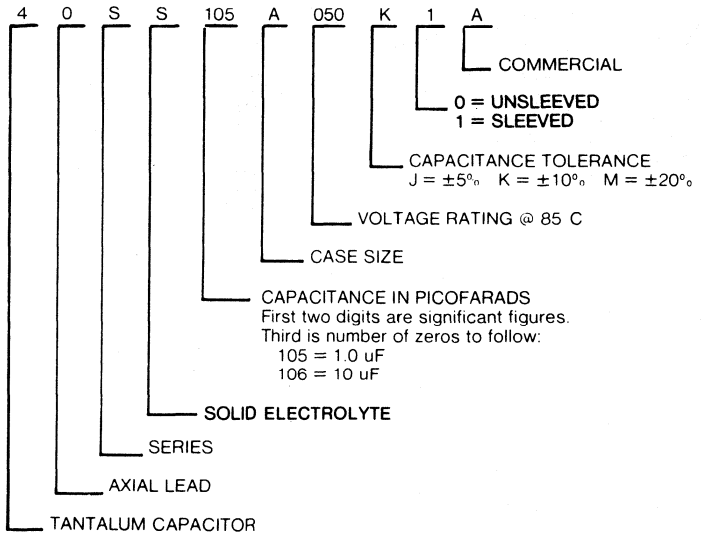
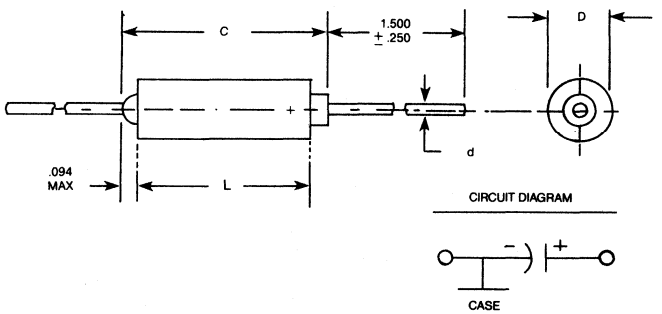
M/C PART NUMBER SYSTEM

EXAMPLE:





DIMENSIONS — INCHES (mm)								
Case Size	Uninsulated		Insulated		C Max.	d Lead Dia. d±002 (0.05)	Lead Length l±.25 (±6.40)	Approx. Weight Grams
	D +.016 (0.41) −.015 (0.38)	L±.031 (.079)	D +.016 (0.41) −.015 (0.38)	L±.031				
A	0.125 (3.18)	0.250 (635)	0.135 (3.43)	0.286 (7.26)	.422 (10.72)	0.020 (0.51)	1.50	0.7
B	0.175 (4.45)	0.438 (11.12)	0.185 (4.70)	0.474 (12.04)	.610 (15.49)	0.020 (0.51)	1.50	1.6
C	0.279 (7.10)	0.650 (16.50)	0.289 (7.34)	0.686 (17.42)	.822 (20.88)	0.025 (0.64)	1.50	4.9
D	0.341 (8.65)	0.750 (19.05)	0.351 (8.92)	0.786 (19.96)	.922 (23.42)	0.025 (0.64)	1.50	8.8

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STANDARD RATINGS

CAPACITANCE +25°C 120Hz	6 WVDC ±10% INSULATED 4V @ 125°C	DCL @ 25°C TYPICAL	10 WVDC ±10% INSULATED 7V @ 125°C	DCL @ 25°C TYPICAL	15 WVDC ±10% INSULATED 10V @ 125°C	DCL @ 25°C TYPICAL	20 WVDC ±10% INSULATED 13V @ 125°C	DCL @ 25°C TYPICAL	MFD
.0047	40SS472A006K1A	0.1	40SS472A010K1A	0.1	40SS472A015K1A	0.1	40SS472A020K1A	0.1	.0047
.0056	40SS562A006K1A	0.1	40SS562A010K1A	0.1	40SS562A015K1A	0.1	40SS562A020K1A	0.1	.0056
.0068	40SS682A006K1A	0.1	40SS682A010K1A	0.1	40SS682A015K1A	0.1	40SS682A020K1A	0.1	.0068
.0082	40SS822A006K1A	0.1	40SS822A010K1A	0.1	40SS822A015K1A	0.1	40SS822A020K1A	0.1	.0082
.01	40SS103A006K1A	0.1	40SS103A010K1A	0.1	40SS103A015K1A	0.1	40SS103A020K1A	0.1	.01
.012	40SS123A006K1A	0.1	40SS123A010K1A	0.1	40SS123A015K1A	0.1	40SS123A020K1A	0.1	.012
.015	40SS153A006K1A	0.1	40SS153A010K1A	0.1	40SS153A015K1A	0.1	40SS153A020K1A	0.1	.015
.018	40SS183A006K1A	0.1	40SS183A010K1A	0.1	40SS183A015K1A	0.1	40SS183A020K1A	0.1	.018
.022	40SS223A006K1A	0.1	40SS223A010K1A	0.1	40SS223A015K1A	0.1	40SS223A020K1A	0.1	.022
.027	40SS273A006K1A	0.1	40SS273A010K1A	0.1	40SS273A015K1A	0.1	40SS273A020K1A	0.1	.027
.033	40SS333A006K1A	0.1	40SS333A010K1A	0.1	40SS333A015K1A	0.1	40SS333A020K1A	0.1	.033
.039	40SS393A006K1A	0.1	40SS393A010K1A	0.1	40SS393A015K1A	0.1	40SS393A020K1A	0.1	.039
.047	40SS473A006K1A	0.1	40SS473A010K1A	0.1	40SS473A015K1A	0.1	40SS473A020K1A	0.1	.047
.056	40SS563A006K1A	0.1	40SS563A010K1A	0.1	40SS563A015K1A	0.1	40SS563A020K1A	0.1	.056
.068	40SS683A006K1A	0.1	40SS683A010K1A	0.1	40SS683A015K1A	0.1	40SS683A020K1A	0.1	.068
.082	40SS823A006K1A	0.1	40SS823A010K1A	0.1	40SS823A015K1A	0.1	40SS823A020K1A	0.1	.082
.1	40SS104A006K1A	0.5	40SS104A010K1A	0.5	40SS104A015K1A	0.5	40SS104A020K1A	0.5	.1
.12	40SS124A006K1A	0.5	40SS124A010K1A	0.5	40SS124A015K1A	0.5	40SS124A020K1A	0.5	.12
.15	40SS154A006K1A	0.5	40SS154A010K1A	0.5	40SS154A015K1A	0.5	40SS154A020K1A	0.5	.15
.18	40SS184A006K1A	0.5	40SS184A010K1A	0.5	40SS184A015K1A	0.5	40SS184A020K1A	0.5	.18
.22	40SS224A006K1A	0.5	40SS224A010K1A	0.5	40SS224A015K1A	0.5	40SS224A020K1A	0.5	.22
.27	40SS274A006K1A	0.5	40SS274A010K1A	0.5	40SS274A015K1A	0.5	40SS274A020K1A	0.5	.27
.33	40SS334A006K1A	0.5	40SS334A010K1A	0.5	40SS334A015K1A	0.5	40SS334A020K1A	0.5	.33
.39	40SS394A006K1A	0.5	40SS394A010K1A	0.5	40SS394A015K1A	0.5	40SS394A020K1A	0.5	.39
.47	40SS474A006K1A	0.5	40SS474A010K1A	0.5	40SS474A015K1A	0.5	40SS474A020K1A	0.5	.47
.56	40SS564A006K1A	0.5	40SS564A010K1A	0.5	40SS564A015K1A	0.5	40SS564A020K1A	0.5	.56
.68	40SS684A006K1A	0.5	40SS684A010K1A	0.5	40SS684A015K1A	0.5	40SS684A020K1A	0.5	.68
.82	40SS824A006K1A	0.5	40SS824A010K1A	0.5	40SS824A015K1A	0.5	40SS824A020K1A	0.5	.82
1.0	40SS105A006K1A	0.5	40SS105A010K1A	0.5	40SS105A015K1A	0.5	40SS105A020K1A	0.5	1.0
1.2	40SS125A006K1A	0.5	40SS125A010K1A	0.5	40SS125A015K1A	0.5	40SS125A020K1A	0.5	1.2
1.5	40SS155A006K1A	0.5	40SS155A010K1A	0.5	40SS155A015K1A	0.5	40SS155A020K1A	0.5	1.5
1.8	40SS185A006K1A	0.5	40SS185A010K1A	0.5	40SS185A015K1A	0.5	40SS185A020K1A	0.5	1.8
2.2	40SS225A006K1A	0.5	40SS225A010K1A	0.5	40SS225A015K1A	0.5	40SS225A020K1A	0.5	2.2
2.7	40SS275A006K1A	0.5	40SS275A010K1A	0.5	40SS275A015K1A	0.5	40SS275B020K1A	0.5	2.7
3.3	40SS335A006K1A	0.5	40SS335A010K1A	0.5	40SS335A015K1A	0.5	40SS335B020K1A	1.0	3.3
3.9	40SS395A006K1A	0.5	40SS395A010K1A	0.5	40SS395B015K1A	0.5	40SS395B020K1A	1.0	3.9
4.7	40SS475A006K1A	0.5	40SS475A010K1A	0.5	40SS475B015K1A	1.0	40SS475B020K1A	1.0	4.7
5.6	40SS565A006K1A	0.5	40SS565B010K1A	0.5	40SS565B015K1A	1.0	40SS565B020K1A	1.0	5.6
6.8	40SS685A006K1A	0.5	40SS685B010K1A	1.0	40SS685B015K1A	1.0	40SS685B020K1A	1.0	6.8
8.2	40SS825A006K1A	0.5	40SS825B010K1A	1.0	40SS825B015K1A	1.0	40SS825B020K1A	1.0	8.2
10	40SS106B006K1A	0.5	40SS106B010K1A	1.0	40SS106B015K1A	1.0	40SS106B020K1A	1.0	10.
12	40SS126B006K1A	0.5	40SS126B010K1A	1.0	40SS126B015K1A	1.0	40SS126B020K1A	2.0	12.
15	40SS156B006K1A	1.0	40SS156B010K1A	1.0	40SS156B015K1A	2.0	40SS156B020K1A	3.0	15.
18	40SS186B006K1A	1.0	40SS186B010K1A	1.0	40SS186B015K1A	2.0	40SS186C020K1A	3.0	18.
22	40SS226B006K1A	1.0	40SS226B010K1A	2.0	40SS226B015K1A	3.0	40SS226C020K1A	3.0	22.
27	40SS276B006K1A	1.0	40SS276B010K1A	2.0	40SS276C015K1A	3.0	40SS276C020K1A	3.0	27.
33	40SS336B006K1A	1.0	40SS336B010K1A	2.0	40SS336C015K1A	3.0	40SS336C020K1A	3.0	33.
39	40SS396B006K1A	1.0	40SS396B010K1A	2.0	40SS396C015K1A	3.0	40SS396C020K1A	3.0	39.
47	40SS476B006K1A	2.0	40SS476C010K1A	3.0	40SS476C015K1A	6.0	40SS476C020K1A	6.0	47.
56	40SS566B006K1A	2.0	40SS566C010K1A	3.0	40SS566C015K1A	6.0	40SS566D020K1A	6.0	56.
68	40SS686C006K1A	3.0	40SS686C010K1A	3.0	40SS686C015K1A	6.0	40SS686D020K1A	6.0	68.
82	40SS826C006K1A	3.0	40SS826C010K1A	3.0	40SS826D015K1A	6.0	40SS826D020K1A	6.0	82.
100	40SS107C006K1A	3.0	40SS107C010K1A	6.0	40SS107D015K1A	6.0	40SS107D020K1A	10.0	100.
120	40SS127C006K1A	3.0	40SS127C010K1A	6.0	40SS127D015K1A	6.0			
150	40SS157C006K1A	6.0	40SS157D010K1A	10.0	40SS157D015K1A	10.0			
180	40SS187C006K1A	6.0	40SS187D010K1A	10.0					
220	40SS227D006K1A	6.0	40SS227D010K1A	10.0					
270	40SS277D006K1A	6.0							
330	40SS337D006K1A	10.0							

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STANDARD RATINGS

CAPACITANCE +25°C 120 Hz	35 WVDC ±10% INSULATED 23V @ 125°C	DCL @25°C TYPICAL	50 WVDC ±10% INSULATED 33V @ 125°C	DCL @25°C TYPICAL	75 WVDC ±10% INSULATED 50V @ 125°C	DCL @25°C TYPICAL	100 WVDC ±10% INSULATED 67V @ 125°C	DCL @25°C TYPICAL	MFD
.0047	40SS472A035K1A	0.1	40SS472A050K1A	0.1	40SS472A075K1A	0.5	40SS472A100K1A	0.5	.0047
.0056	40SS562A035K1A	0.1	40SS562A050K1A	0.1	40SS562A075K1A	0.5	40SS562A100K1A	0.5	.0056
.0068	40SS682A035K1A	0.1	40SS682A050K1A	0.1	40SS682A075K1A	0.5	40SS682A100K1A	0.5	.0068
.0082	40SS822A035K1A	0.1	40SS822A050K1A	0.1	40SS822A075K1A	0.5	40SS822A100K1A	0.5	.0082
.01	40SS103A035K1A	0.1	40SS103A050K1A	0.1	40SS103A075K1A	0.5	40SS103A100K1A	0.5	.01
.012	40SS123A035K1A	0.1	40SS123A050K1A	0.1	40SS123A075K1A	0.5	40SS103A100K1A	0.5	.012
.015	40SS153A035K1A	0.1	40SS153A050K1A	0.1	40SS153A075K1A	0.5	40SS153A100K1A	0.5	.015
.018	40SS183A035K1A	0.1	40SS183A050K1A	0.1	40SS183A075K1A	0.5	40SS183A100K1A	0.5	.108
.022	40SS223A035K1A	0.1	40SS223A050K1A	0.1	40SS223A075K1A	0.5	40SS223A100K1A	0.5	.022
.027	40SS273A035K1A	0.1	40SS273A050K1A	0.1	40SS273A075K1A	0.5	40SS273A100K1A	0.5	.027
.033	40SS333A035K1A	0.1	40SS333A050K1A	0.1	40SS333A075K1A	0.5	40SS333A100K1A	0.5	.033
.039	40SS393A035K1A	0.1	40SS393A050K1A	0.1	40SS393A075K1A	0.5	40SS393A100K1A	0.5	.039
.047	40SS473A035K1A	0.1	40SS473A050K1A	0.1	40SS473A075K1A	0.5	40SS473A100K1A	0.5	.047
.056	40SS563A035K1A	0.1	40SS563A050K1A	0.1	40SS563A075K1A	0.5	40SS563A100K1A	0.5	.056
.068	40SS683A035K1A	0.1	40SS683A050K1A	0.1	40SS683A075K1A	0.5	40SS683A100K1A	0.5	.068
.082	40SS823A035K1A	0.1	40SS823A050K1A	0.1	40SS823A075K1A	0.5	40SS823A100K1A	0.5	.082
.1	40SS104A035K1A	0.5	40SS104A050K1A	0.5	40SS104A075K1A	0.5	40SS104A100K1A	0.5	.1
.12	40SS124A035K1A	0.5	40SS124A050K1A	0.5	40SS124A075K1A	0.5	40SS124A100K1A	0.5	.12
.15	40SS154A035K1A	0.5	40SS154A050K1A	0.5	40SS154A075K1A	0.5	40SS154A100K1A	0.5	.15
.18	40SS184A035K1A	0.5	40SS184A050K1A	0.5	40SS184A075K1A	0.5	40SS184A100K1A	0.5	.18
.22	40SS224A035K1A	0.5	40SS224A050K1A	0.5	40SS224A075K1A	0.5	40SS224A100K1A	0.5	.22
.27	40SS274A035K1A	0.5	40SS274A050K1A	0.5	40SS274A075K1A	0.5	40SS274A100K1A	0.5	.27
.33	40SS334A035K1A	0.5	40SS334A050K1A	0.5	40SS334A075K1A	0.5	40SS334A100K1A	0.5	.33
.39	40SS394A035K1A	0.5	40SS394A050K1A	0.5	40SS394A075K1A	0.5	40SS394A100K1A	0.5	.39
.47	40SS474A035K1A	0.5	40SS474A050K1A	0.5	40SS474A075K1A	0.5	40SS474A100K1A	0.5	.47
.56	40SS564A035K1A	0.5	40SS564A050K1A	0.5	40SS564A075K1A	0.5	40SS564A100K1A	0.5	.56
.68	40SS684A035K1A	0.5	40SS684A050K1A	0.5	40SS684A075K1A	0.5	40SS684B100K1A	0.5	.68
.82	40SS824A035K1A	0.5	40SS824A050K1A	0.5	40SS824B075K1A	0.5	40SS824B100K1A	0.5	.82
1.0	40SS105A035K1A	0.5	40SS105A050K1A	0.5	40SS105B075K1A	0.5	40SS105B100K1A	0.5	1.0
1.2	40SS125B035K1A	0.5	40SS125B050K1A	0.5	40SS125B075K1A	0.5	40SS125B100K1A	0.5	1.2
1.5	40SS155B035K1A	0.5	40SS155B050K1A	0.5	40SS155B075K1A	1.0	40SS155B100K1A	1.0	1.5
1.8	40SS185B035K1A	0.5	40SS185B050K1A	0.5	40SS185B075K1A	1.0	40SS185B100K1A	1.0	1.8
2.2	40SS225B035K1A	1.0	40SS225B050K1A	1.0	40SS225B075K1A	1.5	40SS225B100K1A	1.5	2.2
2.7	40SS275B035K1A	1.0	40SS275B050K1A	1.0	40SS275B075K1A	1.5	40SS275B100K1A	1.5	2.7
3.3	40SS335B035K1A	1.0	40SS335B050K1A	2.0	40SS335B075K1A	2.0			3.3
3.9	40SS395B035K1A	1.0	40SS395B050K1A	2.0	40SS395B075K1A	2.0			3.9
4.7	40SS475B035K1A	1.0	40SS475B050K1A	3.0	40SS475C075K1A	6.0			4.7
5.6	40SS565B035K1A	1.0	40SS565C050K1A	3.0	40SS565C075K1A	6.0			5.6
6.8	40SS685B035K1A	2.0	40SS685C050K1A	3.0	40SS685C075K1A	10.0			6.8
8.2	40SS825C035K1A	3.0	40SS825C050K1A	3.0	40SS825C075K1A	10.0			
10	40SS106C035K1A	3.0	40SS106C050K1A	3.0	40SS106C075K1A	10.0			10.
12	40SS126C035K1A	3.0	40SS126C050K1A	3.0	40SS126D075K1A	10.0			12.
15	40SS156C035K1A	3.0	40SS156C050K1A	6.0	40SS156D075K1A	12.0			15.
18	40SS186C035K1A	3.0	40SS186C050K1A	6.0					
22	40SS226C035K1A	6.0	40SS226D050K1A	6.0					
27	40SS276D035K1A	6.0							
33	40SS336D035K1A	6.0							
39	40SS396D035K1A	6.0							
47	40SS476D035K1A	10.0							

CASE SIZE — The case size in the tabulation above is indicated by the use of the eighth character in the part number.

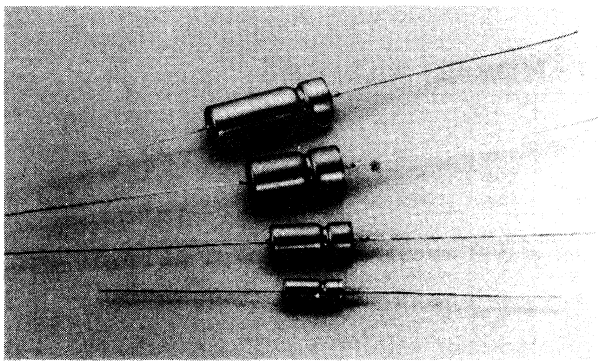
Electrolytic Capacitors

Notes

Tantalum Wet-Slug Capacitor
Industrial Type of MIL-C-39006/22, Style CLR 79

40 AW

−55°C to 125°C 1.7 to 1200 μF
4-125 Volts DC



DESCRIPTION

The 40AW capacitor is an all tantalum cased high reliability porous anode type with a glass to tantalum hermetic seal. This type capacitor is primarily suited for military and aerospace application. This capacitor meets or exceeds all requirements of MIL-C-39006/22.

These capacitors are ideal for such functions as filtering, by-passing, coupling and timing in applications where minimum size and weight conditions must be achieved and reverse voltage up to 3VDC, or high ripple currents, are required.

GLASS-TO-TANTALUM SEAL

The glass-to-tantalum seal is one unique feature of the 40AW Series. This seal differs from other hermetic seals in that it is a tantalum feed-through seal. This construction provides a true glass-to-tantalum seal.

TANTALUM CASE

Use of a tantalum case and tantalum powder cathode permits 3VDC reverse capability without harm; and the sintered powder cathode allows higher vibration and shock levels than comparable silver cased devices.

FEATURES

- **ALL TANTALUM CONSTRUCTION**
- **REVERSE VOLTAGE CAPABILITY OF 3VDC**
- **HIGH RIPPLE CURRENT**
- **LONG LIFE**
- **RATED FOR −55°C TO 125°C OPERATION**
- **EXTENDED RANGE CAPACITANCE AVAILABLE CONSULT FACTORY FOR DETAILS**

Tantalum Wet-Slug Capacitor
Industrial Type of MIL-C-39006/22, Style CLR 79

40 AW

DIMENSIONS

OUTLINE DRAWING

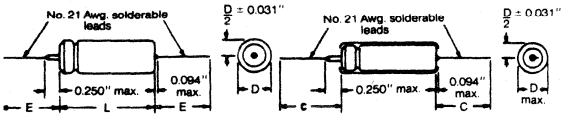


FIG. 1 UNINSULATED

FIG.2 INSULATED

OUTLINE DIMENSIONS

Dimensions — Inches (mm)

Type 40AW	Case Code MIL Equiv.	L* +.031 (.79) −.016 (.41)	D Basic case ±.016 (.41)	D Insulated case max	E ±.250 (6.35)	d ±.002 (.05)
A	T1	.453 (11.51)	.188 (4.78)	.219 (5.56)	1.500 (38.10)	.025 (.64)
B	T2	.641 (16.28)	.281 (7.14)	.312 (7.92)	2.250 (57.15)	.025 (.64)
C	T3	.766 (19.46)	.375 (9.53)	.406 (10.31)	2.250 (57.15)	.025 (.64)
D	T4	1.062 (26.97)	.375 (9.53)	.406 (10.31)	2.250 (57.15)	.025 (.64)

*Length of basic case; sleeving shall lap over the ends of the capacitor body. Non-shrinkable sleeving extends .016 inch minimum, .062 inch maximum beyond each end of the case.

STANDARD RATINGS

µF	Case Code	Catalog Number *	Max. DF at 25°C and 120 Hz %	Max. Impedance at −55°C and 120 Hz (Ω)	Max. D-C Leakage Current at 25°C (µA)	Max. D-C Leakage Current at 85°C & 125°C (µA)	Maximum Capacitance Change in Per Cent at −55°C	Maximum Capacitance Change in Per Cent at +85°C	Maximum Capacitance Change in Per Cent at +125°C	Max. RMS Ripple Current AT 40 KHz (mA)
6 VOLTS D-C AT 85°C, 4 VOLTS D-C AT 125°C										
30	A	40AW306A006KIA	9	100	0.75	1.5	−40	10.5	12	820
68	A	40AW686A006KIA	15	60	0.75	1.5	−40	14	16	960
140	B	40AW147B006KIA	21	40	1.0	2.0	−40	14	16	1200
270	B	40AW277B006KIA	45	25	1.0	2.0	−44	12.5	20	1375
330	C	40AW337C006KIA	36	20	2.0	6.0	−44	14	16	1800
560	C	40AW567C006KIA	55	25	2.0	6.0	−64	17.5	20	1900
1200	D	40AW128D006KIA	90	20	3.0	12.0	−80	25	25	2265
8 VOLTS D-C AT 85°C, 5 VOLTS D-C AT 125°C										
25	A	40AW256A008KIA	7.5	100	0.75	1.5	−40	10.5	12	820
56	A	40AW566A008KIA	14	59	0.75	1.5	−40	14	16	900
120	B	40AW127B008KIA	20	50	1.0	2.0	−44	17.5	20	1220
220	B	40AW227B008KIA	40	30	1.0	2.0	−44	17.5	20	1370
290	C	40AW297C008KIA	40	25	2.0	6.0	−64	17.5	20	1770
430	C	40AW437C008KIA	46	25	2.0	6.0	−64	17.5	20	1825
850	D	40AW857D008KIA	60	22	3.0	12.0	−80	25	25	2330
10 VOLTS D-C AT 85°C, 7 VOLTS D-C AT 125°C										
20	A	40AW206A010KIA	6	120	0.75	1.5	−32	10.5	12	820
47	A	40AW476A010KIA	13	90	0.75	1.5	−36	14	16	855
100	B	40AW107B010KIA	15	60	1.0	2.0	−36	16	16	1200
180	B	40AW187B010KIA	33	40	1.0	2.0	−36	14	16	1365
250	C	40AW257C010KIA	30	30	2.0	6.0	−40	14	16	1720
390	C	40AW397C010KIA	44	25	2.0	6.0	−64	17.5	20	1800
750	D	40AW757D010KIA	50	23	3.0	12.0	−80	25	25	2360
15 VOLTS D-C AT 85°C, 10 VOLTS D-C AT 125°C										
15	A	40AW156A015KIA	5	155	0.75	1.5	−24	10.5	12	780
33	A	40AW336A015KIA	10	90	0.75	1.5	−28	14	16	820
70	B	40AW706B015KIA	13	75	1.0	2.0	−28	14	16	1150
120	B	40AW127B015KIA	25	50	1.0	2.0	−28	17.5	20	1450
170	C	40AW177C015KIA	25	35	2.0	6.0	−32	14	16	1480
270	C	40AW277C015KIA	43	30	2.0	6.0	−56	17.5	20	1740
540	D	40AW547D015KIA	40	23	3.0	12.0	−80	25	25	2300
25 VOLTS D-C AT 85°C, 15 VOLTS D-C AT 125°C										
10	A	40AW106A025KIA	4	220	0.75	1.5	−16	8	9	715
22	A	40AW226A025KIA	7	140	0.75	1.5	−20	10.5	12	825
50	B	40AW506B025KIA	11	70	1.0	2.0	−28	13	15	1130
100	B	40AW107B025KIA	21	50	1.0	2.0	−28	13	15	1435
120	C	40AW127C025KIA	25	38	2.0	6.0	−32	13	15	1450
180	C	40AW187C025KIA	28	32	2.0	6.0	−48	13	15	1525
350	D	40AW357D025KIA	35	24	3.0	12.0	−70	25	25	1970

Tantalum Wet-Slug Capacitor
Industrial Type of MIL-C-39006/22, Style CLR 79

40 AW

μ F	Case Code	Catalog Number *	Max. DF at 25°C and 120 Hz %	Max. Impedance at −55°C and 120 Hz (Ω)	Max. D-C Leakage Current at 25°C (μ A)	Max. D-C Leakage Current at 85°C & 125°C (μ A)	Maximum Capacitance Change in Per Cent at −55°C	Maximum Capacitance Change in Per Cent at +85°C	Maximum Capacitance Change in Per Cent at +125°C	Max. RMS Ripple Current At 40 KHz (mA)
30 VOLTS D-C AT 85°C, 20 VOLTS D-C AT 125°C										
8	A	40AW805A030KIA	4	275	0.75	1.5	−16	8	12	640
15	A	40AW156A030KIA	7	175	0.75	1.5	−20	10.5	12	780
40	B	40AW406B030KIA	12	65	1.0	2.0	−24	10.5	12	1120
68	B	40AW686B030KIA	15	60	1.0	2.0	−24	13	15	1285
100	C	40AW107C030KIA	17	40	2.0	6.0	−28	10.5	12	1450
150	C	40AW157C030KIA	23	35	2.0	6.0	−48	13	15	1525
300	D	40AW307D030KIA	31	25	3.0	12.0	−60	25	25	1950
50 VOLTS D-C AT 85°C, 30 VOLTS D-C AT 125°C										
5	A	40AW505A050KIA	3	400	0.75	2.0	−16	5	6	580
10	A	40AW106A050KIA	5	250	0.75	2.0	−24	8	9	715
25	B	40AW256B050KIA	9	95	1.0	3.0	−20	10.5	12	1005
47	B	40AW476B050KIA	13	70	1.0	3.0	−28	13	15	1155
60	C	40AW606C050KIA	13	45	2.0	7.0	−16	10.5	12	1335
82	C	40AW826C050KIA	15	45	2.0	7.0	−32	13	15	1400
160	D	40AW167D050KIA	17	27	4.0	16.0	−50	25	25	1900
60 VOLTS D-C AT 85°C, 40 VOLTS D-C AT 125°C										
4	A	40AW405A060KIA	2.8	550	0.75	2.0	−16	5	6	525
8.2	A	40AW825A060KIA	4	275	0.75	2.0	−24	8	9	625
20	B	40AW206B060KIA	7	105	1.0	4.0	−16	8	9	930
39	B	40AW396B060KIA	12	90	1.0	4.0	−28	10.5	15	1110
50	C	40AW506C060KIA	11	50	2.0	7.0	−16	10.5	12	1330
68	C	40AW686C060KIA	13	50	2.0	7.0	−32	10.5	15	1365
140	D	40AW147D060KIA	16	28	4.0	16.0	−40	20	20	1850
75 VOLTS D-C at 85°C, 50 VOLTS D-C AT 125°C										
3.5	A	40AW355A075KIA	2.5	650	1.0	2.0	−16	5	6	525
6.8	A	40AW685A075KIA	3.5	300	1.0	2.0	−20	8	9	610
15	B	40AW156B075KIA	6	150	1.0	4.0	−16	8	9	890
33	B	40AW336B075KIA	10	90	1.0	4.0	−24	10.5	15	1000
40	C	40AW406C075KIA	9	60	2.0	8.0	−16	10.5	12	1250
56	C	40AW566C075KIA	11	60	2.0	8.0	−28	10.5	15	1335
110	D	40AW117D075KIA	12	29	4.0	20.0	−35	20	20	1850
100 VOLTS D-C AT 85°C, 65 VOLTS D-C AT 125°C										
2.5	A	40AW255A100KIA	2	950	1.0	2.0	−16	7	8	505
4.7	A	40AW475A100KIA	3	500	1.0	2.0	−16	7	8	565
11	B	40AW116B100KIA	5	200	1.0	4.0	−16	8	8	835
22	B	40AW226B100KIA	8	100	1.0	4.0	−16	8	8	965
30	C	40AW306C100KIA	7.5	80	2.0	8.0	−16	8	8	1240
43	C	40AW436C100KIA	8.5	70	2.0	8.0	−20	8	8	1335
86	D	40AW866D100KIA	10	30	4.0	20.0	−25	15	15	1800
125 VOLTS D-C AT 85°C, 85 VOLTS D-C AT 125°C										
1.7	A	40AW175A125KIA	2	1250	1.0	2.0	−16	7	8	415
3.6	A	40AW365A125KIA	3	600	1.0	2.0	−16	7	8	415
9	B	40AW905B125KIA	5	240	1.0	4.0	−16	7	8	755
14	B	40AW145B125KIA	6	167	1.0	4.0	−16	7	8	860
18	C	40AW186C125KIA	5	129	2.0	8.0	−16	7	8	1130
25	C	40AW256C125KIA	6	93	2.0	8.0	−16	7	8	1200
56	D	40AW566D125KIA	6.5	32	4.0	20.0	−25	15	15	1800

*Catalog numbers listed are for 2=10% capacitance tolerance and are for insulated capacitors.

Tantalum Wet-Slug Capacitor
Industrial Type of MIL-C-39006/22, Style CLR 79

40 AW

PERFORMANCE CHARACTERISTICS

1. Operating Temperature Range. These capacitors are designed to operate over a temperature range of −55°C to +125°C at the appropriate voltage rating given in Para. 17.

2. DC Working Voltage. The dc working voltage is the maximum operating voltage for continuous duty at the rated temperature.

Up to 85°C	125°C
6	4
8	5
10	7
15	10
25	15
30	20
50	30
60	40
75	50
100	65
125	85

3. DC Leakage Current. Measurements shall be made at the applicable rated working voltage at 25°C ±5°C through application of a steady source of power, such as a regulated power supply. A current limiting resistor of 1000 ohms shall be connected in series with each capacitor under test. Rated DC working voltage shall be applied for a maximum period of 5 minutes before making leaking current measurements.

3.1 The maximum leakage current values are as listed in the standard ratings table.

4. Capacitance and Tolerance. The capacitance of all capacitors shall be within the specified tolerance limits of the nominal rating.

4.1 Measurements shall be made by the bridge method at or referred to a frequency of 120 Hz at a temperature of +25°C. The maximum voltage applied to the capacitors during measurements shall be 1 volt rms. Measurement accuracy of the bridge shall be within ±2%.

5. Dissipation Factor. Measurements are made with a polarized capacitance bridge at a frequency of 120 Hz at a temperature of +25°C.

6. Capacitance Change with Temperature. Capacitance change with temperature shall not exceed the limits given in the standard ratings table.

7. Low Temperature Impedance. The impedance of any capacitor at 55°C at 120 Hz shall not exceed the values given in the standard ratings table.

8. Mechanical Shock. Capacitors shall withstand a shock of 100g when tested in accordance with method 213 of MIL-STD-202, test condition I.

8.1 Following the shock test, capacitors shall be examined for evidence of mechanical damage and leakage of electrolyte.

9. High Frequency Vibration. Capacitors shall withstand vibration from 10 to 2000 Hz at 20g without internal damage when tested in accordance with MIL-STD-202, method 204, test condition D. Electrical measurements made while under these conditions shall show no intermittent contacts or open or short circuiting.

9.1 Following the vibration test, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall change not more than 5% from the initial measured value and the DF shall not exceed 115% of initial requirement.

9.2 In addition, there shall be no evidence of mechanical damage, obliteration of marking, or leakage of electrolyte.

10. Pull Test. Leads shall withstand a tensile stress of 3 lbs. for 30 seconds applied axially in accordance with MIL-STD-202, method 211A, test condition A.

11. Lead Bend Test. Leads shall meet the bend test specified in MIL-STD-202, method 211A, test condition C except that the number of bends shall be 4.

12. Surge Voltage. The surge voltage rating is the maximum voltage to which the capacitors shall be subjected under any conditions. This includes transients and peak ripple at the highest line voltage. The surge voltage of these capacitors is 115% of rated dc working voltage.

12.1 The capacitors shall withstand the surge voltage applied through a 1000 ohm ±10% resistor in series with the capacitor and voltage source at the rate of ½ minute on, 4½ minutes off, for 1000 successive test cycles at 85°C.

12.2 Following the surge voltage test, there shall be no intermittent contacts, open or short circuiting, mechanical damage, or leakage of electrolyte.

13. Moisture Resistance. Capacitors shall be subjected to the moisture resistance cycling test specified in MIL-STD-202, method 106.

Tantalum Wet-Slug Capacitor
Industrial Type of MIL-C-39006/22, Style CLR 79

40 AW

PERFORMANCE CHARACTERISTICS

13.1 **Following the moisture resistance test, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall change not more than ±8% from the initial measured value and the DF shall not exceed 115% of initial requirement.**

14. Seal Test. Capacitors shall be tested in accordance with MIL-STD-202, method 112, test condition C, procedure IIIa, 10^{-8} atm cc/sec followed by test condition A.

15. Reverse Voltage Test. Capacitors shall be subjected to a dc potential of 3 volts, applied in the reverse polarity direction, for 125 ±10 hours. The ambient temperature during the test shall be +85°C. Capacitors shall be maintained at +85°C and dc rated voltage shall be applied in the forward direction for an additional period of 125 · 10 hours.

15.1 Following the reverse voltage testing, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall be within the initial value specified and the DF shall not exceed the original requirements.

16. Ripple Life Test at +85°C. Capacitors shall be tested in accordance with MIL-C-39006. a. Operating Conditions. This test shall be run at a frequency of 40 KHz ±2 KHz and at the rms ripple current levels specified in the standard ratings table. b. Applied dc voltage plus the peak a-c voltage shall not exceed the rated voltage of the capacitor.

16.1 When tested as specified above, capacitors shall meet the following requirements: a. The dc leakage current at +25°C and at +85°C shall not exceed the original requirements. b. The capacitance shall not change more than ±10% from the initial measured value. c. The DF shall not exceed the original requirements. d. Visual examination. There shall be no damage, obliteration of marking, or leakage of electrolyte.

17. Life Test. Capacitors are capable of withstanding life test at the following conditions:

Temperature	Hrs.	% Rated Voltage
+85°C	2000	100*
+125°C	2000	100*

*Refer to the standard ratings table.

17.1 After life test and for those tested at +85 and/or +125°C, shall not exceed the initial requirement; the DF shall not exceed the initial requirement; and the capacitance value shall not change more than 10% from the initial measurement.

18. Barometric Pressure (reduced). Capacitors shall be tested in accordance with MIL-STD-202, method 105, test condition E. Rated dc voltage shall be applied for 1 minute ±5 seconds.

18.1 Following Barometric Pressure test, capacitors shall be visually examined for harmful deformation of the case, mechanical damage, obliteration of marking, leakage of electrolyte and indications of flashover and breakdown.

19. Thermal Shock. Capacitors shall be subjected to 300 cycles in accordance with MIL-STD-202, method 107 and MIL-C-39006.

19.1 Following the thermal shock test, dc leakage current shall not exceed 200% of the initial requirement, capacitance shall not have changed more than ±5% from initial measured value and DF shall not exceed 115% of initial specified value.

20. Marking. Capacitors shall be marked with M/C, type number (40AW), rated capacitance and tolerance, rated dc working voltage and the standard EIA date code of manufacture.

21. Polarity. Polarity shall be indicated by plus (+) signs adjacent to the positive terminal.

22. Insulation. When an insulated device is required, the insulating material will be MYLAR.

Tantalum Wet-Slug Capacitor
Industrial Type of MIL-C-39006/22, Style CLR 79

40 AW

RIPPLE CURRENT MULTIPLIERS VS. FREQUENCY, TEMPERATURE & APPLIED PEAK VOLTAGE

Frequency of applied ripple current / Ambient still air	120 Hz Temp °C				800 Hz Temp °C				1 kHz Temp °C				10 kHz Temp °C				40 kHz Temp °C				100 kHz Temp °C			
peak voltage	≤55°	85°	105°	125°	≤55°	85°	105°	125°	≤55°	85°	105°	125°	≤55°	85°	105°	125°	≤55°	85°	105°	125°	≤55°	85°	105°	125°
100%	.60	.39	–	–	.71	.43	–	–	.72	.45	–	–	.88	.55	–	–	1.0	.63	–	–	1.1	.69	–	–
90%	.60	.46	–	–	.71	.55	–	–	.72	.55	–	–	.88	.67	–	–	1.0	.77	–	–	1.1	.85	–	–
80%	.60	.52	.35	–	.71	.62	.42	–	.72	.62	.42	–	.88	.76	.52	–	1.0	.87	.59	–	1.1	.96	.65	–
70%	.60	.58	.44	–	.71	.69	.52	–	.72	.70	.52	–	.88	.85	.64	–	1.0	.97	.73	–	1.1	1.07	.80	–
≤66-2/3%	.60	.60	.46	.27	.71	.71	.55	.32	.72	.72	.55	32	.88	.88	.68	.40	1.0	1.0	.77	.45	1.1	1.1	.85	50

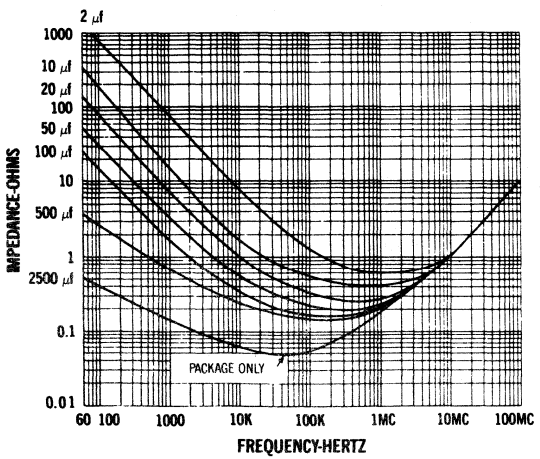
NOTES:
1. At 125°C the rated voltage of the capacitors decreases to 66-2/3% of the 85°C rated voltage.
2. The peak of the applied ac ripple voltage plus the applied dc voltage must not exceed the dc voltage rating of the capacitor either forward or reverse.
3. The ripple current listed in table I represents a rating calculated using a maximum internal temperature rise (△T) of 50°C at 40 kHz at 85°C ambient with a maximum peak rated voltage of 66-2/3% of the 85°C peak voltage rating.
4. The maximum allowable internal temperature rise (△T) decreases linearly to a calculated 10°C rise at 125°C ambient.
5. The internal temperature rise is directly proprotional to the ESR of the capacitor, and ESR increases with decreasing frequency.

TYPICAL CURVES

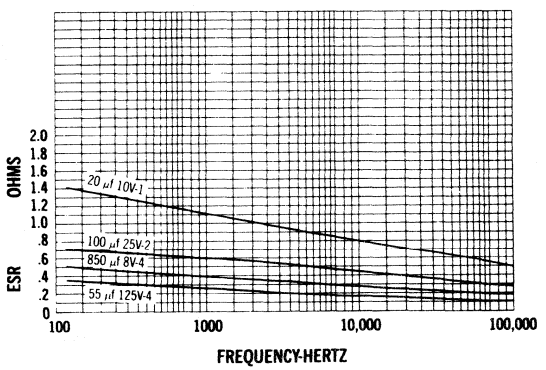
Impedance

1. Impedance in ohms at 25° C may be read directly from Curve 1.
2. To obtain impedance at temperatures other than 25° C, multiply the impedance from Curve 5 by a correction factor from Curve 2, 3, or 4.

IMPEDANCE FOR TANTALUM WET SLUGS AT 25°C NO. 1



TYPICAL ESR VS. FREQUENCY AT 25°C



Tantalum Wet-Slug Capacitor
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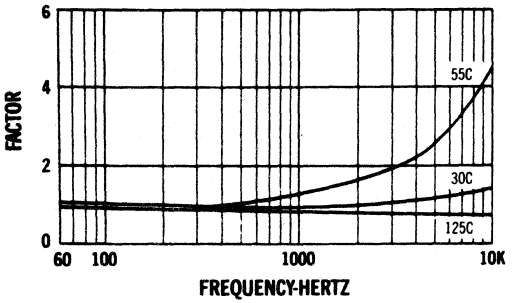
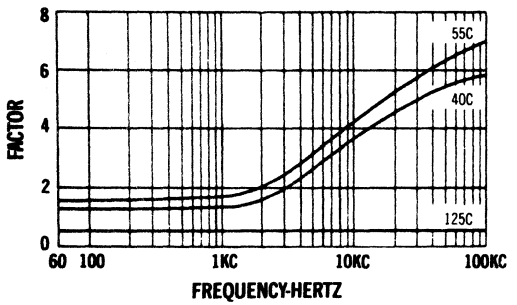
40 AW

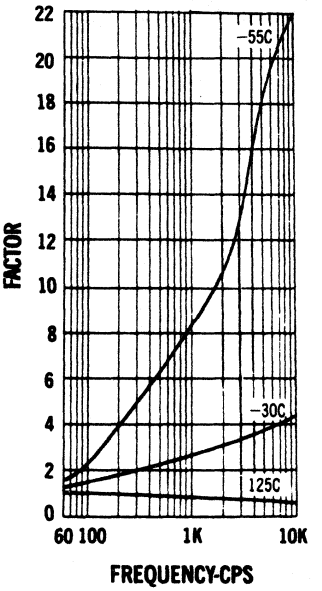
WET SLUG IMPEDANCE CORRECTION FACTORS
UP TO 5 μf
NO. 2



WET SLUG IMPEDANCE CORRECTION FACTORS
FOR CAPACITANCE 5-100 μf
NO. 3

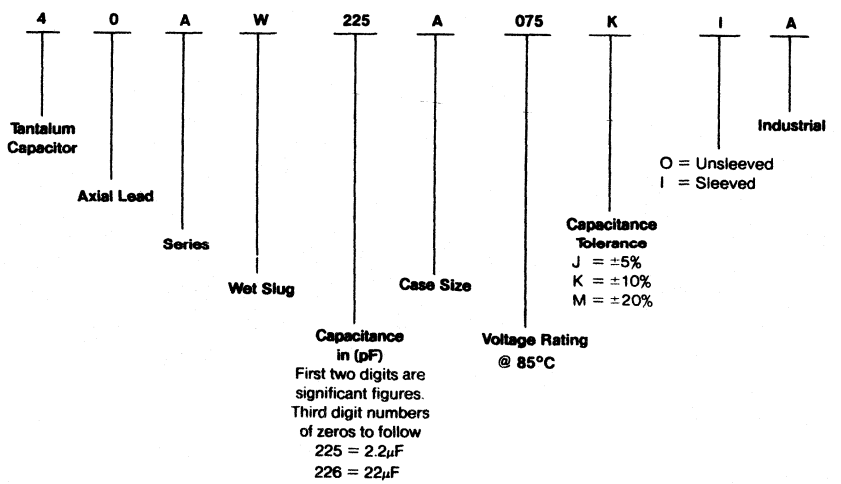


WET SLUG IMPEDANCE CORRECTION FACTORS
FOR CAPACITANCE 100 μf
AND ABOVE INCLUDING PACKAGES
NO. 4



HOW TO SPECIFY

Series 40AW can be specified using the following designation:



DATA HANDBOOK SYSTEM

Data handbook system

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Our data handbook system comprises more than 65 books with subjects including electronic components, subassemblies and magnetic products. The handbooks are classified into seven series:

INTEGRATED CIRCUITS;

DISCRETE SEMICONDUCTORS;

DISPLAY COMPONENTS;

PASSIVE COMPONENTS;

PROFESSIONAL COMPONENTS;

MAGNETIC PRODUCTS;

LIQUID CRYSTAL DISPLAYS.

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IC07 supplement: Additional ACL data	
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Data handbook system

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