DATA HANDBOOK

Electrolytic Capacitors

BOOK PA01 1994

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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CONTENTS

Electrolytic Capacitors

Type index

Sequence of order numbers

SEQUENCE	SERIES NAME	PAGE
2222 013	RLC	170
2222 021	ASM	350
2222 030–033	AS	376
2222 036	RSP	188
2222 036 92	RB	184
2222 036 93	RBA	186
2222 037	RSM	140
2222 041–043	ASH	400
2222 044	RSH	158
2222 045	RSS	216
2222 046	RSL	270
2222 047	RMS	202
2222 048	RML	256
2222 049	ASC	334
2222 050/052	PED–PW	570
2222 051/053	PEC–PW	591
2222 056/057	PSM–SI	518
2222 058/059	PLL–SI	538
2222 065	ALC	416
2222 085	CS	85
2222 097	RLP 7	130
2222 114/115	PED–ST	624
2222 116	RLL	228
2222 117	ASD	324
2222 118	AHT	474
2222 119	AHT–DIN	496
2222 122	SAL–RP	696
2222 123	SAL–A	716
2222 128	SAL–RPM	660
2222 129	SAL–RDC	682
2222 132/133	ALL–DIN	454
2222 134	RLP 5	120
2222 135	RLI	242
2222 136	RVI	284
2222 137 92	AB	427
2222 137 93	ABA	429
2222 138	AML	432
2222 139	CLL	100
2222 154/155	PEC–ST	644
2222 162/163	PLL–PW	610
2222 164	RSX	298
2222 165	RHT	310
2222 166/167	PSM–4TSI	557
2222 168/169	PLL–4TSI	564
2222 172	CLP	99
2222 196	DLC	744

Sequence of series names

SEQUENCE	ORDER Nos	PAGE
AB	2222137 92	427
ABA	2222 137 93	429
AHT	2222 118	474
AHT–DIN	2222 119	496
ALC	2222 065	416
ALL–DIN	2222 132/133	454
AML	2222 138	432
AS	2222 030–033	376
ASC	2222 049	334
ASD	2222 117	324
ASH	2222 041–043	400
ASM	2222 021	350
CLL	2222 139	100
CLP	2222 172	99
CS	2222 085	85
DLC	2222 196	744
PEC–PW	2222 051/053	591
PEC–ST	2222 154/155	644
PED–PW	2222 050/052	570
PED–ST	2222 114/115	624
PLL–PW	2222 162/163	610
PLL–SI	2222 058/059	538
PLL–4TSI	2222 168/169	564
PSM–SI	2222 056/057	518
PSM–4TSI	2222 166/167	557
RB	2222 036 92	184
RBA	2222 036 93	186
RHT	2222 165	310
RLC	2222 013	170
RLI	2222 135	242
RLL	2222 116	228
RLP 5	2222 134	120
RLP 7	2222 097	130
RML	2222 048	256
RMS	2222 047	202
RSH	2222 044	158
RSL	2222 046	270
RSM	2222 037	140
RSP	2222 036	188
RSS	2222 045	216
RSX	2222 164	298
RVI	2222 136	284
SAL–A	2222 123	716
SAL–RDC	2222 129	682
SAL–RP	2222 122	696
SAL–RPM	2222 128	660

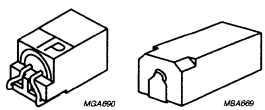
Technical sequence in databook

	SEQUENCE	ORDER Nos	PAGE
SMD	CS	2222 085	85
	CLP	2222 172	99
	CLL	2222 139	100
RADIAL	RLP 5	2222 134	120
	RLP 7	2222 097	130
	RSM	2222 037	140
	RSH	2222 044	158
	RLC	2222 013	170
	RB	2222 036 92	184
	RBA	2222 036 93	186
	RSP	2222 036	188
	RMS	2222 047	202
	RSS	2222 045	216
	RLL	2222 116	228
	RLI	2222 135	242
	RML	2222 048	256
	RSL	2222 046	270
	RVI	2222 136	284
	RSX	2222 164	298
	RHT	2222 165	310
AXIAL	ASD	2222 117	324
	ASC	2222 049	334
	ASM	2222 021	350
	AS	2222 030–033	376
	ASH	2222 041–043	400
	ALC	2222 065	416
	AB	2222 137 92	427
	ABA	2222 137	429
	AML	2222 138	432
	ALL–DIN	2222 132/133	454
	AHT	2222 118	474
	AHT–DIN	2222 119	496
POWER	PSM–SI	2222 056/057	518
	PLL–SI	2222 058/059	538
	PSM–4TSI	2222 166/167	557
	PLL–4TSI	2222 168/169	564
	PED–PW	2222 050/052	570
	PEC–PW	2222 051/053	591
	PLL–PW	2222 162/163	610
	PED–ST	2222 114/115	624
	PEC–ST	2222 154/155	644
SAL	SAL–RPM	2222 128	660
	SAL–RDC	2222 129	682
	SAL–RP	2222 122	696
	SAL–A	2222 123	716
STORAGE	DLC	2222 196	744

SELECTION MATRIX

Electrolytic Capacitors — Selection matrix

SMD ELECTROLYTIC CAPACITORS ('CHIPS')

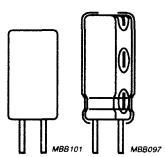


NON-SOLID ALUMINIUM

STANDARD	INDUSTRIAL	PROFESSIONAL
CS085 1500 hours 85 °C page 85	**CLP172** 1000 hours 105 °C page 99	**CLL139** 2000 hours 105 °C page 106

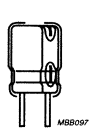
MBC592 - 1

RADIAL NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS



STANDARD & MINIATURE	SEMI-PROFESSIONAL	LONG-LIFE	EXTRA LONG-LIFE or HIGH TEMP.
1500-3000 hours 85 °C	750-1500 hours 105 °C	1500-4000 hours 105 °C	1500 hours / 125 °C ≥ 4000 hours / 105 °C
RLC 013 low leakage page 170	page 184 **RB 036 92** bipolar **RBA 036 93** bipolar audio page 186		**RHT 165** 125 °C page 310
RSH 044 HV page 158	page 188 **RSP 036** **RSS 045** maintenance page 216	**RSL 046** page 270	**RSX 164** 105 °C maintenance page 298
		RLI 135 low Z page 242	**RVI 136** 105 °C very low Z page 284
RSM 037 page 140	page 188 **RSP 036** **RMS 047** page 202	page 228 **RLL 116** **RML 048** page 256	
page 130 **RLP7 097** H: 7 mm **RLP5 134** H: 5 mm page 120			

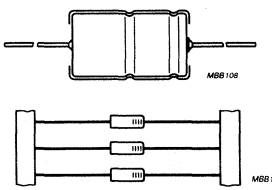
smaller dimension → higher CU per volume



MBB745 - 1

Electrolytic Capacitors — Selection matrix

AXIAL NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS

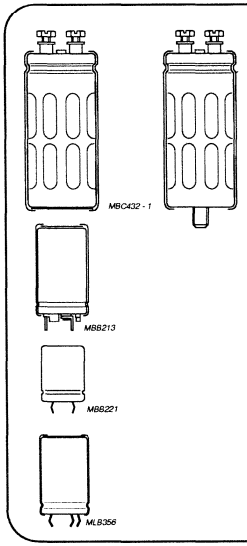


dimension (smaller) → CU per volume (higher)

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 2-5000 hours / 105 °C	4000 hours 125 °C
ALC 065 *low leakage* *page 416*	*page 427* **AB 137 92** *bipolar* **ABA 137** *bipolar audio* *page 429*		
	page 376 **AS 030-033** **ASH 041** *page 400*	*page 454* **ALL-DIN 132-133** **ASH 042-043** *page 400*	**AHT-DIN 119** *page 496*
page 376 **AS 030** Ø D = 3.3 mm **ASD 117** *page 324*	**ASM 021** *page 350*	**AML 138** *page 432*	**AHT 118** *page 474*
	ASC 049 *page 334*		

MBB747 - 2

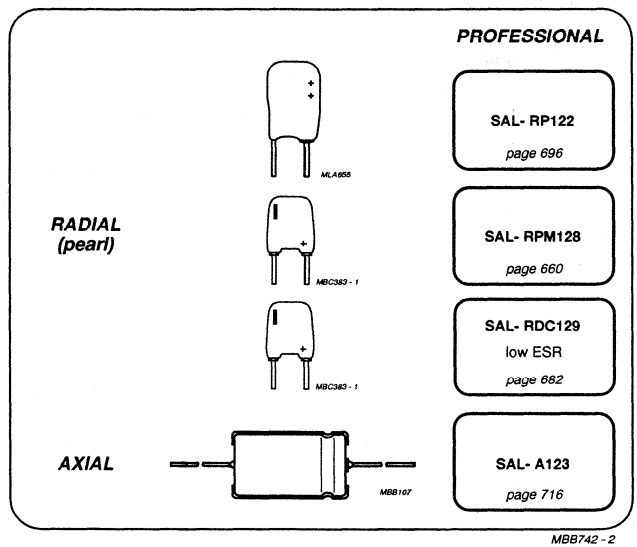
POWER ELECTROLYTIC CAPACITORS



ECONOMY	*EURO-DIN*	*LONG-LIFE*
10 000-12 000 hours 85 °C	15-20 000 hours 85 °C	5-10 000 hours 105 °C
PEC-ST **PEC-STB** **154-155** *page 644*	**PED-ST** **PED-STB** **114-115** *page 624*	
PEC-PW **PEC-SL** **PEC-SLB** **051-053** *page 591*	**PED-PW** **PED-SL** **PED-SLB** **050-052** *page 570*	**PLL-PW** **PLL-SL** **PLL-SLB** **162-163** *page 610*
PSM-SI **056-057** *page 518*		**PLL-SI** **058-059** *page 538*
PSM-4TSI **166-167** *page 557*		**PLL-4TSI** **168-169** *page 564*

MBB746 - 2

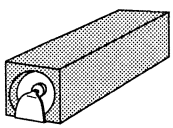
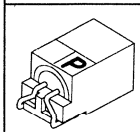
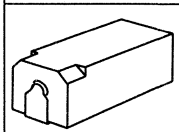
SOLID ALUMINIUM (SAL) ELECTROLYTIC CAPACITORS



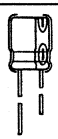
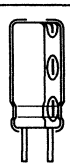
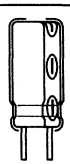
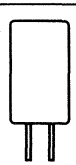
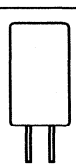
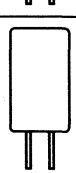
SELECTION GUIDE

Electrolytic Capacitors — Selection guide

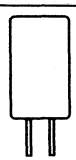
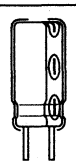
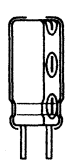
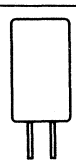
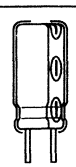
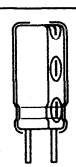
SURFACE MOUNTING DEVICES (SMD)

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	85
 CLP 172	low height industrial	0.22 to 33	6.3 to 50	1000 h/105 °C 100 000 h/40 °C 40/105/56	telecom automotive general industrial low profile equipment	99
 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

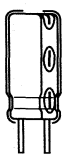
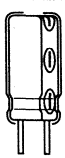
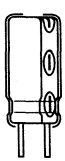
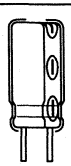
NON-SOLID, RADIAL

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	120
 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	130
 RSM 037	high CU/volume general purpose	0.47 to 10 000	6.3 to 100	2500 h/85 °C 70 000 h/40 °C 40/085/56	consumer automotive general industrial	140
 RSH 044	high voltage long life	1 to 100	160 to 450	3000 h/85 °C 80 000 h/40 °C 40/085/56	consumer, lighting general industrial power supply smoothing	158
Semi-Professional Types						
 RLC 013	low leakage current e-pitch, all-insulated LNZ44-04	0.47 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	170
 RB 036 92	bipolar-general e-pitch, all-insulated high CU/volume	10 to 100	16 to 63	1500 h/105 °C 150 000 h/40 °C 40/105/56	AC, non-fixed polarity automotive telecom audio-video	184
 RBA 036 93	bipolar, audio-frequency low dissipation factor	1.0 to 22	50	1500 h/105 °C 150 000 h/40 °C 40/105/56	audio: speaker crossover network AC applications	186

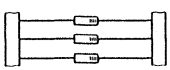
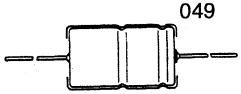
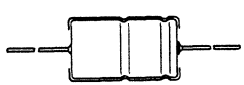
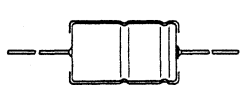
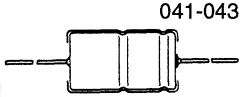
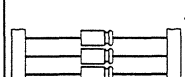
NON-SOLID, RADIAL (continued)

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Semi-Professional Types (continued)						
 RSP 036	high CU/volume long life e-pitch, all insulated LNZ44-04 (COJ)	0.47 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	188
 RMS 047	high CU/volume high temp. 105 °C long life	100 to 10 000	16 to 63	1500 h/105 °C 150 000 h/40 °C 40/105/56	audio-video automotive telecom, EDP SMPS	202
 RSS 045	MAINTENANCE TYPE standard dimensions high temp. 105 °C long life	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	216
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	228
 RLI 135	low impedance high ripple long life	22 to 10 000	6.3 to 100	1500-2500 h/105 °C 150-250 000 h/40 °C 55/105/56	general industrial telecom, EDP SMPS DC-DC converters	242
 RML 048	miniature high CU/volume long life	100 to 10 000	6.3 to 63	3-4000 h/105 °C 200-260 000 h/40 °C 40/105/56	automotive telecom, EDP SMPS stand-by	256

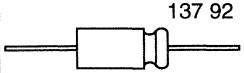
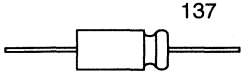
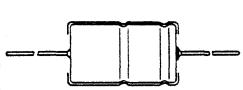
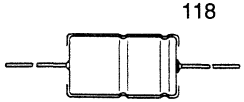
NON-SOLID, RADIAL (continued)

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Long-Life Types (continued)						
 RSL 046	standard dimensions high ripple long life	22 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	270
Extra-Long-Life Types						
 RVI 136	very low impedance extra long life	47 to 6800	10 to 63	4-10 000 h/105 °C 200-500 000 h/40 °C 55/105/56	general industrial telecom, EDP SMPS DC-DC converters	284
 RSX 164	MAINTENANCE TYPE standard dimensions extra long life	47 to 4 700	10 to 63	5-6000 h/105 °C 240-280 000 h/40 °C 40/105/56	telecom, EDP outdoor electronics general industrial SMPS	298
 RHT 165	standard dimensions high temp. 125 °C extra long life	22 to 4 700	10 to 50	1500 h/125 °C 300 000 h/40 °C 40/125/56	automotive outdoor electronics professional telecom military	310

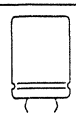
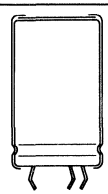
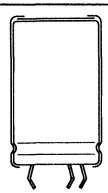
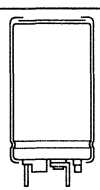
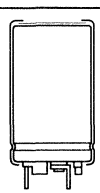
NON-SOLID, AXIAL

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	324
 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	334
 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	350
Semi-Professional Types						
 AS 030-033	standard dimensions general purpose/ long life 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	376
 ASH 041-043	high voltage long life 042-043: CECC 30 301-801, DIN 45910-T123 (without approval)	1.0 to 220	160 to 400	5-15 000 h/85 °C 120-240 000 h/40 °C 40/085/56	consumer, lighting industrial power supply smoothing	400
 ALC 065	low leakage current long life	0.47 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	416

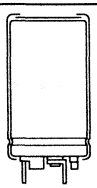
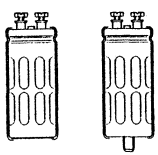
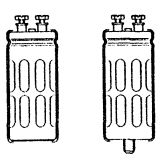
NON-SOLID, AXIAL (continued)

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Semi-Professional Types (continued)						
AB 137 92 	bipolar-general high CU/volume	1.0 to 470	16 to 63	1000 h/105 °C 100 000 h/40 °C 40/085/56	AC, non-fixed polarity automotive telecom general industrial	427
ABA 137 	bipolar- audio-frequency low dissipation factor	2.2 to 22	40 to 100	1500 h/105 °C 150 000 h/40 °C 40/105/56	audio: speaker crossover network simple wiring AC applications	429
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	432
ALL-DIN 132/133 	long life, high reliability high ripple current CECC 30 301-801 CECC 30 301-056 DIN 45910 T.123 UTE C031/C033 (without approval)	1.0 to 4700	10 to 350	10-15 000 h/85 °C 160-240 000 h/40 °C 40/085/56	telecom EDP general industrial power supply lighting	454
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	474
AHT-DIN 119 	high temp. 125 °C high ripple current CECC 30 301-802 CECC 30 301-055 UTE C031/C033	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	496

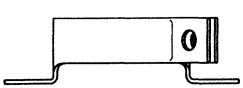
NON-SOLID, POWER

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	12 000 h/85 °C 210 000 h/40 °C 40/085/56	general industrial audio-video power supply smoothing	518
 PLL-SI 058/059	high CU/volume very long life high temp. 105 °C	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	538
4 Terminal snap-in types						
 PSM-4TSI 166/167	high CU/volume 4 snap-in pins keyed polarity high shock and vibration resistant	330 to 68 000	10 to 400	10 000 h/85 °C 175 000 h/40 °C 40/085/56	general industrial power supply smoothing	557
 PLL-4TSI 168/169	high CU/volume 4 snap-in pins keyed polarity high shock and vibration resistant high temp. 105 °C	220 to 47 000	10 to 400	5 000 h/105 °C 125 000 h/40 °C 40/105/56	general industrial power supply smoothing	564
PW-Pin and Solder-Lug Types						
 PED-PW 050/052	high ripple, low ESR CECC 30 301-033 LNZ44-04 DIN 45910-T129	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	570
 PEC-PW 051/053	high CU/volume LNZ44-04 DIN 45910-T129	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	591

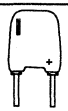
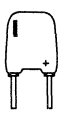
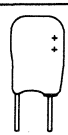
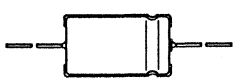
NON-SOLID, POWER (continued)

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (µF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
PW-Pin and Solder-Lug Types (continued)						
 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	610
Screw Terminal/Bolt Types						
 PED-ST 114/115	very long life high ripple low ESR DIN 45910-T128	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	624
 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	644

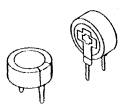
MOUNTING ACCESSORIES

	clamps washers nuts				Power types	653

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	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	660
 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	682
 SAL-RP 122	height 12 mm CECC 30 302 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	696
 SAL-A 123	extremely long life very high reliability CECC 30 302 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	716
SAL-AG 123.8	shock- proof 10 000 g	1 to 2200	4 to 40	20 000 h/125 °C 450 000 h/40 °C 55/125/56	aerospace military	716

ENERGY STORAGE CAPACITORS

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (F)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
 DLC 196	high charge density, ecologically beneficial, maintenance-free	0.047 to 1.0	5.5 to 6.3	1000 h/70 °C or 85 °C 8000 h/40 °C or 23 000 h/40 °C 25/070/21 or 25/085/21	energy storage IC memory backup telecom, EDP audio-video	744

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.

GENERAL INTRODUCTION

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

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:

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

where

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

ε_r = relative dielectric constant (dimensionless)

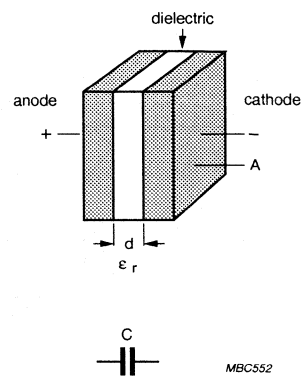
A = surface area (m^2)

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

Energy content of a capacitor:

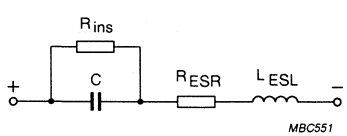
The energy content of a capacitor is given by:

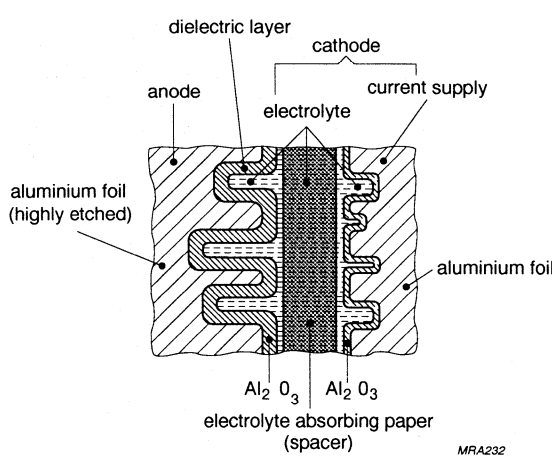
$$W_E = \frac{1}{2} C \cdot U^2$$



NON-POLAR

Fig.1 Equivalent circuit of an ideal capacitor.





POLAR

Anode electrode:

valve effect metal: aluminium

Dielectric:

Al_2O_3

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

non-solid: wet electrolyte, spacer and aluminium foil

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

Fig.2 Equivalent circuit of an electrolytic capacitor.

ELECTRICAL BEHAVIOUR

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

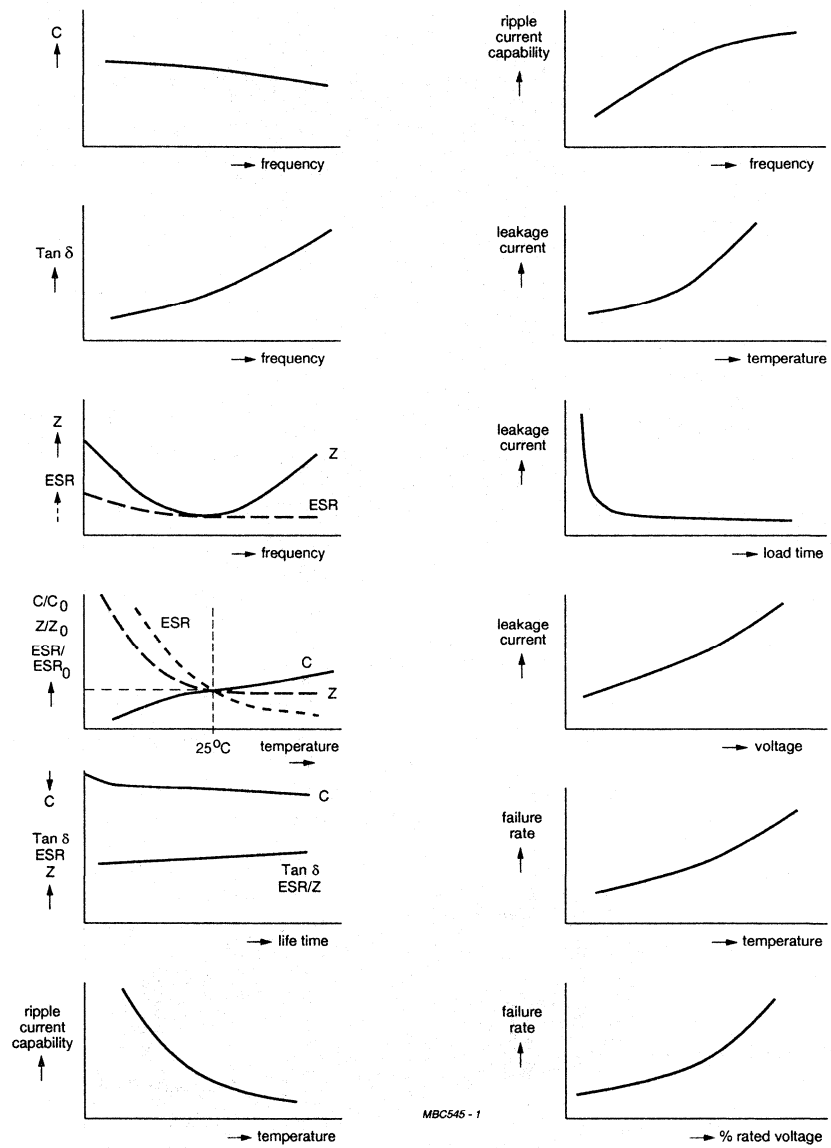


Fig.3 Typical variation of electrical parameters as a function of frequency, ambient temperature, voltage and time.

CONSTRUCTION

Examples

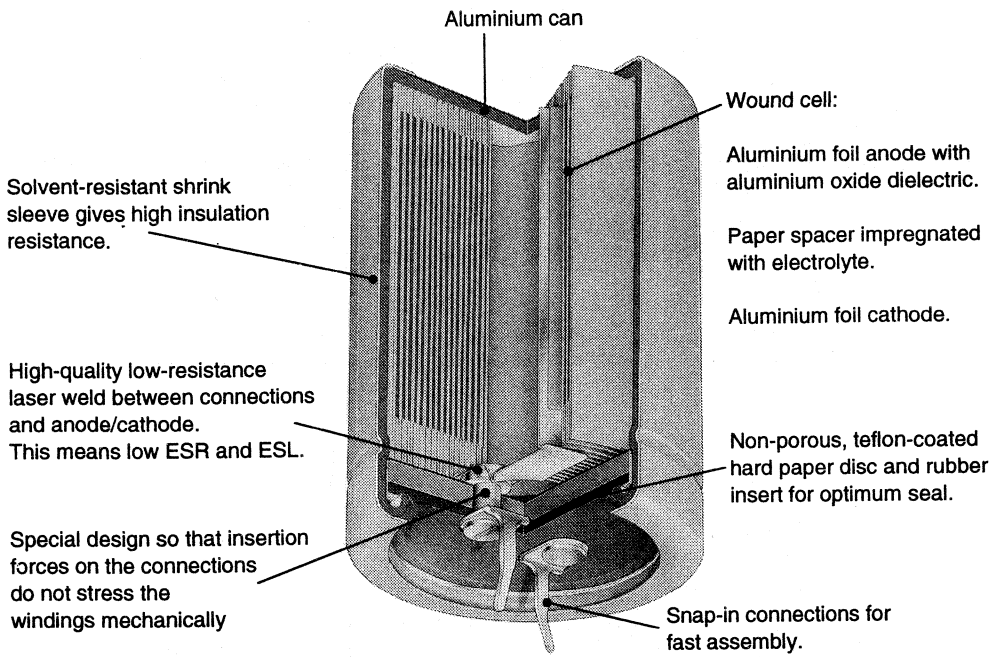


Fig.4 Power non-solid Aluminium, snap-in.

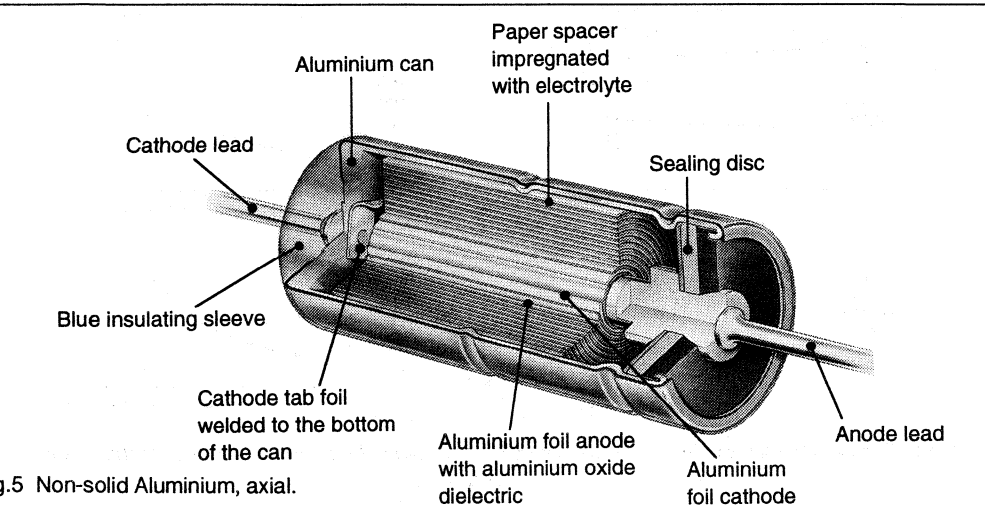


Fig.5 Non-solid Aluminium, axial.

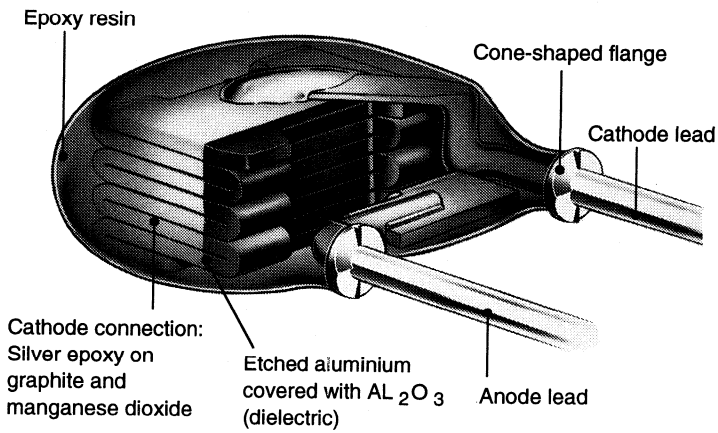


Fig.6 Solid Aluminium (SAL), radial.

DEFINITIONS OF THE ELECTRICAL PARAMETERS

CAPACITANCE

AC capacitance of an electrolytic capacitor

The capacitance of an equivalent circuit, having capacitance, resistance and inductance in series, measured with alternating current of approximately sinusoidal waveform at a specified frequency; refer to Fig. 7.
Standard measuring frequencies for electrolytic capacitors are 100 or 120 Hz.

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.

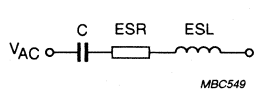


Fig.7 AC equivalent circuit of an electrolytic capacitor.

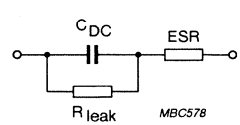


Fig.8 DC equivalent circuit of an electrolytic capacitor.

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 preferably chosen from the E3 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 or fall under 0 V and that the ripple current is 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.

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, inductance and resistance in series measured with alternating current of approximately sinusoidal waveform at a specified frequency; refer to Fig.7.

Equivalent series inductance (ESL)

The ESL of an equivalent circuit having capacitance, resistance and inductance in series measured with alternating current of approximately sinusoidal waveform at a specified frequency; refer to Fig.7.

Dissipation factor, (tangent of loss angle; Tan δ)

The power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of specified frequency:

$$\text{Tan } \delta = \text{ESR} \cdot 2\pi fC \text{ (approximation formula).}$$

Impedance (Z)

The impedance (Z) of an electrolytic capacitor is given by capacitance, ESR and ESL in accordance with the following equation (see Fig.9):

$$Z = \sqrt{ESR^2 + (2\pi f ESL - \frac{1}{2\pi f C})^2}$$

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 (I_{L5}) **after 5 minutes** application of rated voltage at 20 °C, 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 the 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 some 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).

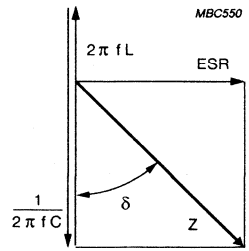


Fig.9 Vector diagram showing the AC parameters of a capacitor.

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.

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).

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_{OP}/I_L	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_{OP}/I_L	<0.5	0.5	0.6	0.8	1	1.5	2.5	4	7	10

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) 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 with a higher rated voltage or higher capacitance, than originally required by the application.

The internal losses and the resultant ripple current capability of electrolytic capacitors are frequency dependent. Therefore, a relevant frequency conversion table ("Multiplier of ripple current as a function of frequency") is stated in the detail specifications.

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.10 for calculating the corresponding RMS value.

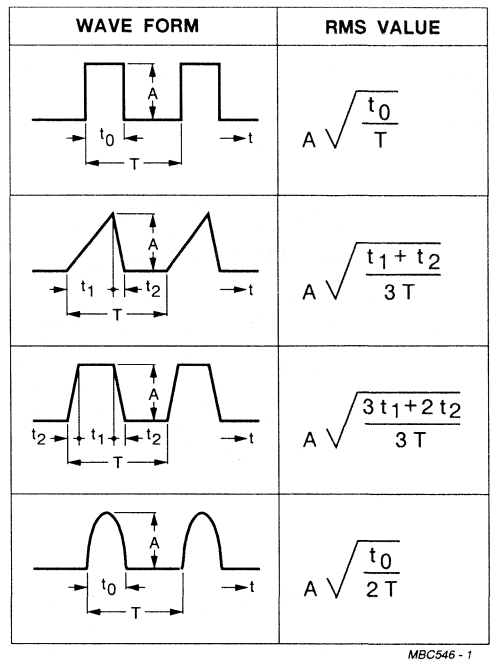


Fig.10 Approximation formulae for RMS values of non-sinusoidal ripple currents.

STORAGE

No pre-condition will be necessary for Philips electrolytic capacitors, when stored under standard atmospheric conditions (IEC 68-1, clause 5.3.1) 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.

To ensure good solderability and quality of taping, for all types and prior to mounting, the storage time shall not exceed 2-3 years. This means for example: 2 years storage time between manufacture and arrival at the customer, plus 1 year in customer storage.

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 sub clause 4.20: unless otherwise specified, 10^6 switching operations (RC = 0.1 s) shall not cause a capacitance change of more than 10%.

Non-frequent charging and discharging, without a series resistor, will not damage the capacitor.

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.

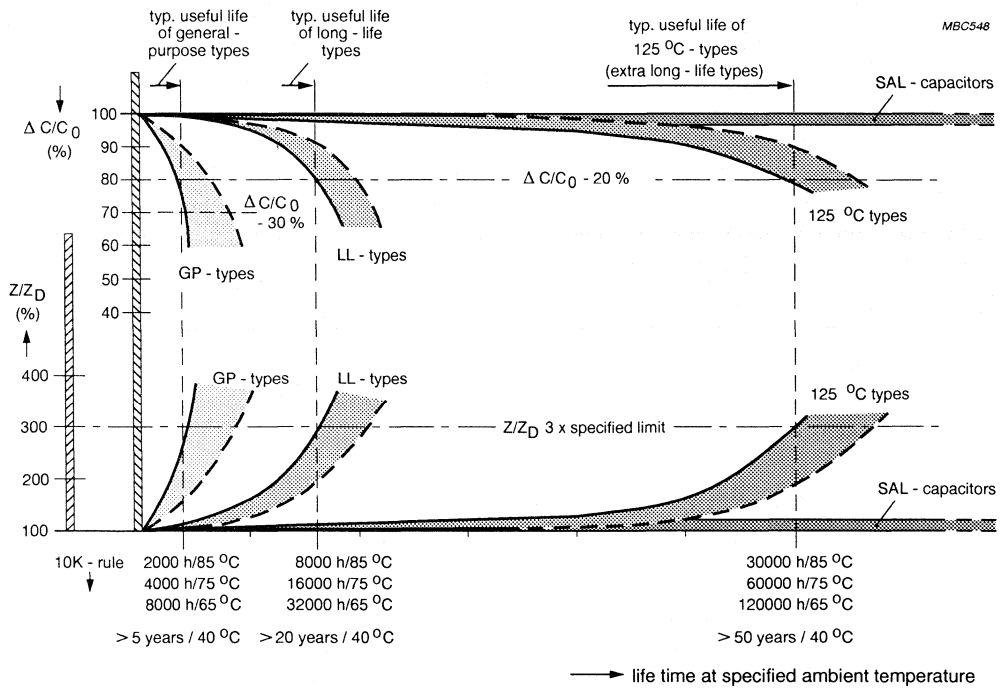
Useful life

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 11 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.

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 "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.



C_0 = initial value of capacitance.

Z_D = specified limit of impedance.

Fig.11 Principal trend of electrical parameters during useful life of different electrolytic capacitors.

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. Ripple currents at other frequencies than specified must be corrected using the frequency conversion tables in the relevant detail specification.

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.

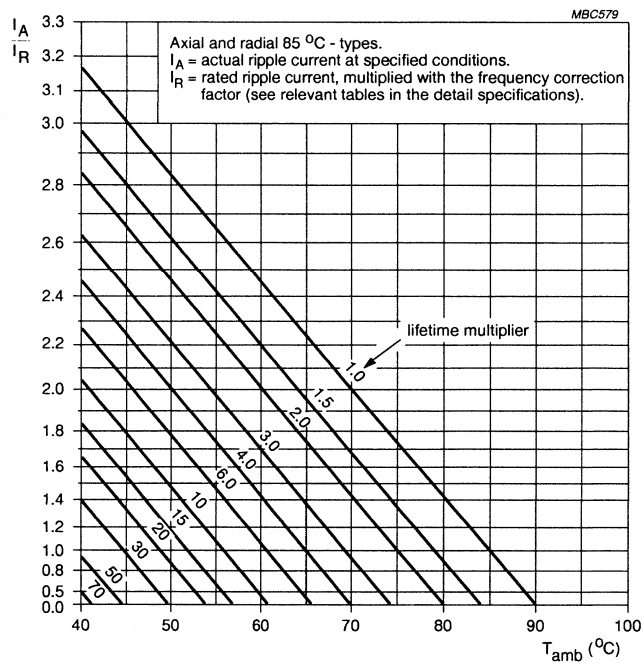


Fig.12 Typical example of a life-time nomogram: useful life as a function of ambient temperature and ripple current load (I_A/I_R); 85 °C types.

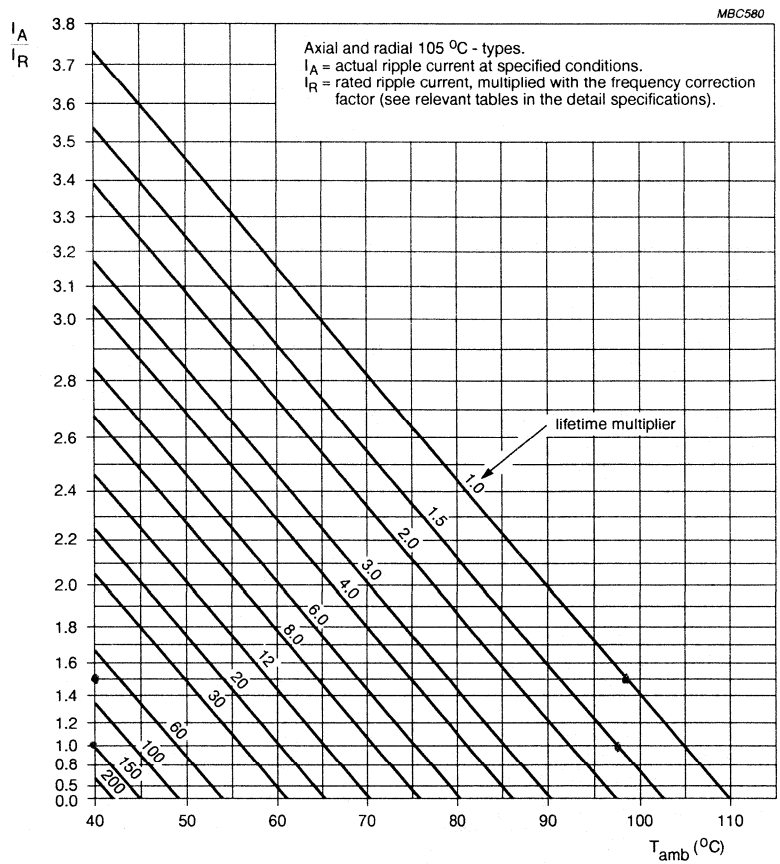


Fig.13 Typical example of a life-time nomogram: useful life as a function of ambient temperature and ripple current load (I_A/I_R); 105 °C types.

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 at 85 °C?

b) for a capacitor with a specified useful life of 2000 hours at 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" (see Fig.12) and for the 105 °C type it is "90" (see Fig.13).

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 20 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 at 75 °C + 9000 hours at 65 °C + 90 000 hours at 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 4):

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 at 10 kHz is 3 times higher than specified for a 16 V - type and the load limit may not be exceeded?

Solution:

The ripple current must first be converted from 10 kHz to 100 Hz by using the conversion table (see typical example, Table 3). This shows that the conversion factor for a 16 V - type is 1.2.

$I_A/I_R = 3$ at 10 kHz and must be divided by 1.2, resulting in $I_A/I_R = 2.5$ at 100 Hz.

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 Typical example of a frequency conversion table (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 V to 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50	0.95	0.85	0.80
100	1.00	1.00	1.00
300	1.07	1.20	1.25
1000	1.12	1.30	1.40
3000	1.15	1.35	1.50
≥10 000	1.20	1.40	1.60

Table 4 Life-time calculation in Example 2

LIFE CONDITIONS	85 °C TYPES (Fig.12)	105 °C TYPES (Fig.13)
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:

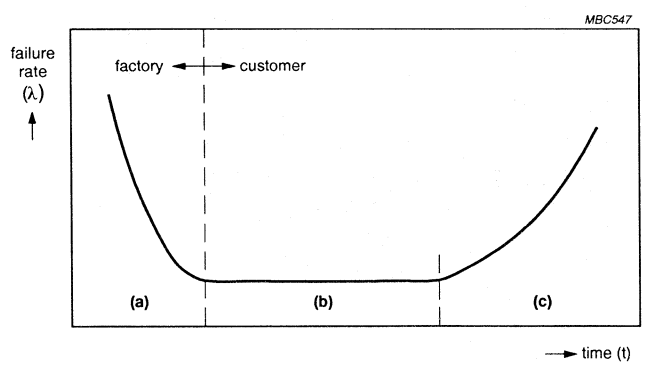
$$\lambda = \frac{\textit{number of failures (statistical upper limit 60\%)}}{\textit{total number of components} \times \textit{duration}}$$

or

$$\lambda = \frac{\textit{failure percentage (\%)}}{100 \times \textit{duration}}$$

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.14):



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

Fig.14 Failure rate (λ) as a function of time ("bathtub" curve).

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.
For other operational conditions, λ has to be converted correspondingly with the aid of Figs 15 and 16, failure rates as a function of stress factors (T and U/U_R) for non-solid and SAL electrolytic capacitors.

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; example given in Table 5.

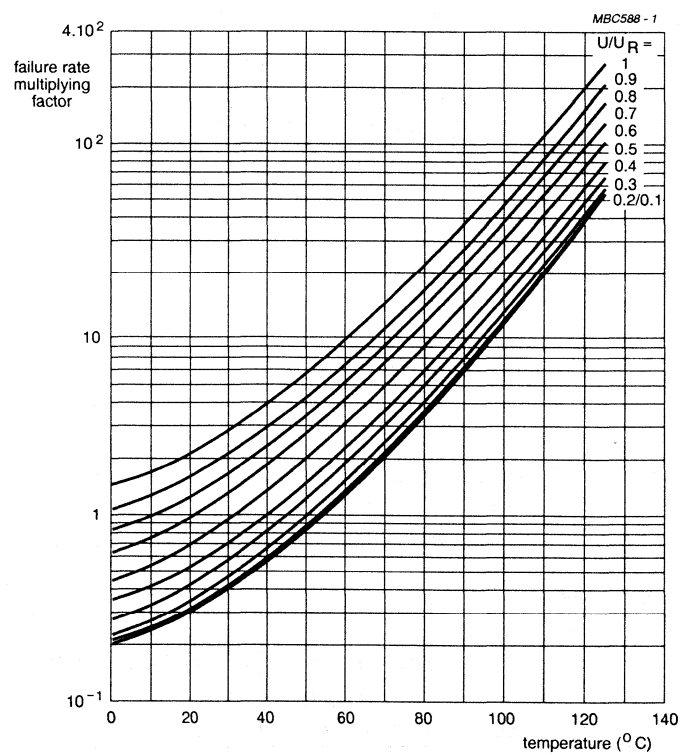


Fig.15 Conversion factors for failure rate (λ) as a function of ambient temperature (T_{amb}) and voltage ratio (U/U_R) for non-solid electrolytic capacitors.

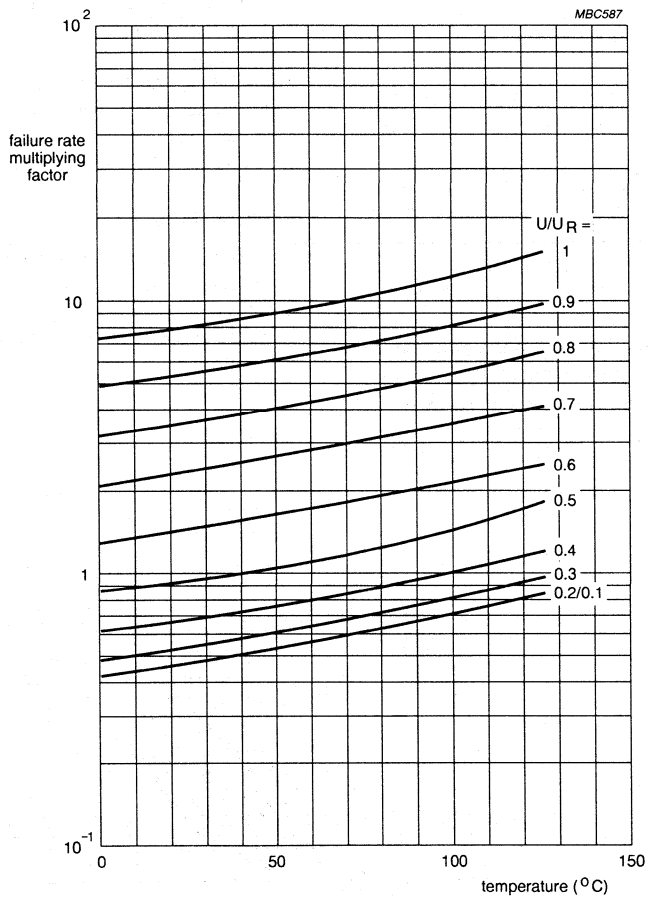


Fig.16 Conversion factors for failure rate (λ) as a function of ambient temperature (T_{amb}) and voltage ratio (U/U_R) for SAL electrolytic capacitors.

Table 5 Example of climatic categories

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)

Table 6 Maximum humidity condition indication for the application class

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

Application class

Although the German standard DIN 40040 has been withdrawn, it is still widely used in industrial specifications for the definition of climatic working conditions. The application class consists of 3 code letters which have the following meanings:

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 6)

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 pressure relief 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 pressure relief in the sealing disc. These types shall be mounted so that no emissions of electrolyte or vapour may reach either the conductors under voltage, or other parts of the printed circuit board. Vertical (pressure relief up) or horizontal mounting position is recommended.

Design rules for "capacitor batteries"

MECHANICAL

Philips power 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.

MARKING

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

Table 7 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 or PH or P
Date code	abbreviation in 2 digits (IEC 62), e.g. 1st digit: X = 1989, A = 1990, B = 1991, C = 1992, D = 1993, E = 1994, F = 1995 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 may also be stamped in the case.
Factory code	indicating the factory of origin
Polarity identification	

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
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 of ≤ 12 000 m.** Minimum air pressure: 8.5 kPa for short periods (in accordance with IEC 384-4, sub clause 4.11.4)	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 on 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

PARAMETER	IMPORTANT INFORMATION – PRODUCT SAFETY	MORE DETAILS
BOARD CLEANING	**No guarantees can be given with regard to solvents based on Halogenated Hydrocarbons or ODC's.** **Warning: such solvents are hazardous to the environment.** Component cleaning using solvents such as demineralized or distilled water, isopropanol, methanol, etanol and propoanol would not normally have any detrimental effects and therefore do not require any special precautions. Aqueous cleaning methods may be used in conjunction with saponification using a neutral detergent like calgonite at 20 g/l. It is recommended that immediate drying of the component in hot air is carried out at approximately 85 °C for at least 5 minutes. For further information regarding the application of solvent temperatures exceeding the temperature mentioned in IEC 68-2-45, contact Philips Components Sales office.	
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 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

Electrolytic Capacitors — Tests and Requirements

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 (note 1)	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; $\Delta C/C \pm 5\%$ with respect to initial measurements
			general-purpose grade and Form MR types: 10 to 55 Hz; 0.75 mm or 10 g (whichever is less); 3 directions; 2 hours per direction	

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Bump (note 1)	4.9	Eb	long-life grade types: 40 g; 2 directions; 4000 bumps total	no visible damage; no leakage of electrolyte; $\Delta C/C \leq 5\%$ 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 (55 °C → 25 °C) of 24 hours; 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 25 ±10 °C; at atmospheric pressure of 8.5 kPa; U_R applied during last minute	no visible damage; no evidence of breakdown or flashover
Damp heat, cyclic	4.11.5	Db	5 cycles (55 °C → 25 °C) of 24 hours each; 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 $\delta \leq 1.2$ x stated limit; $\Delta C/C$ ±10%
External insulation	IEC 384-1/ CECC 30 000 sub clause			
Insulation resistance	4.5		foil method	insulation resistance ≥ 100 MΩ
Voltage proof	4.6		foil method; 1000 V for 1 minute	no breakdown or flashover

Note

1. For vibration and bump testing, the components shall be mounted by their terminations (with mounting accessories where applicable). The capacitors listed below shall also be clamped by their body:
   $\varnothing D_{nom} \geq 12.5$ mm
   $L_{nom} \geq 15$ mm (for radial types)
   $L_{nom} \geq 30$ mm (for axial types).

Non-solid aluminium types (continued)

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
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: $\Delta C/C$ ±10%
				general-purpose grade types: $\Delta C/C$ ±20%
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: $U_R \leq 6.3$ V: $\Delta C/C$ +15/–30%; U_R 10 to 160 V: $\Delta C/C$ ±15%; $U_R \geq 200$ V: $\Delta C/C$ ±10%; tan δ ≤ 1.3 x stated limit; impedance ≤ 2 x stated limit
				general-purpose grade types: $U_R \leq 6.3$ V: $\Delta C/C$ +25/–40%; U_R 10 to 160 V: $\Delta C/C$ ±30%; $U_R \geq 200$ V: $\Delta C/C$ ±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 $U_R \leq 315$ V or 1.1 x U_R for $U_R > 315$ 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; $\Delta C/C$ ±15%
			long-life grade types: at upper category temperature	
			general-purpose grade types: at 25 °C	

NAME OF TEST	IEC 384-4/ CECC 30 300 sub clause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
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	test duration 96 hours at upper category temperature. For longer test duration, refer to the relevant data sheet in this handbook	no visible damage; no leakage of electrolyte; leakage current ≤ 2 x stated limit; tan δ ≤ 1.2 x stated limit; ΔC/C ±10%
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 $U_R \leq 6.3$ V or $U_R > 160$ V; ≤ 5 x value of step 1 for 6.3 V < $U_R \leq$ 16 V; ≤ 4 x value of step 1 for 16 V < $U_R \leq$ 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 $U_R \leq 160$ 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%
Solvent resistance	IEC 384-1/ CECC 30 000 sub clause 4.31	Xa	immersion: 5 ±0.5 minutes with or without ultrasonic at 55 ±0.5 °C Solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected

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; note 1: 10 N for 10 s	no visible damage
Bending		Ub	loading force; note 1: 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; $\Delta C/C$ ±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 tan δ and $Z \leq$ stated limit
Vibration (note 2)	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; $\Delta C/C$ ±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; $\Delta C/C$ ±5% with respect to initial measurement
Bump (note 2)	4.9	Eb	40 g; 2 directions; 4000 bumps total	no visible damage; $\Delta C/C$ ±5% with respect to initial measurement
Shock (note 2)	4.10	Ea	SAL-AG 123: acceleration: 29 400 m/sec^2 or 3000 g; duration of pulse: 0.2 ms; total number of shocks: 18	no visible damage; $\Delta C/C$ ±5% with respect to initial measurement

Notes for solid aluminium types

1. SPECIAL PLIERS MUST BE USED TO DISCHARGE THE CELL BODY AND CONSEQUENTLY KEEP THE BENDING LOCATION UNDER CONTROL.
2. Axial capacitors shall be mounted by clamping both the body and the leads.

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 (55 °C → 25 °C) of 24 hours; 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 (55 °C → 25 °C) of 24 hours each; 95 –100% RH; no voltage applied	
	4.11.7		final measurements after climatic sequence	no visible damage; markings legible; leakage current ≤ stated limit; tan δ and Z ≤ 1.2 x stated limit
				axial types: ΔC/C ±5% with respect to initial measurement radial types: ΔC/C ±10% with respect to initial measurement
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 ≤ stated limit; tanδ and Z ≤ x 1.2 stated limit ΔC/C ±10% of initial measurement
External insulation	IEC 384-1/ CECC 30 000 sub clause			
Insulation resistance	4.5		foil method	insulation resistance ≥ 100 MΩ
Voltage proof	4.6		foil method; 1000 V for 1 minute	no breakdown or flashover

Solid aluminium types (continued).

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 3)	no visible damage; markings legible; leakage current ≤ stated limit; ΔC/C ±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; ΔC/C ±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 3) at 125 °C; 1000 cycles; 30 s on, 330 s off	no visible damage; leakage current ≤ stated limit; tan δ ≤ stated limit
				axial types: ΔC/C ±5% with respect to initial measurement
				radial types: ΔC/C ±10% with respect to initial measurement
Reverse voltage	4.15		0.15 U_R (note 3) in reverse polarity at 125 °C for 125 hours, followed by U_R (note 3) in forward polarity at 125 °C for 125 hours	leakage current ≤ stated limit; ΔC/C ±10% with respect to initial measurement; tan δ and Z ≤ stated limit
Reverse voltage (additional) Radial types			0.30 U_R (note 3) in reverse polarity at 125 °C for 125 hours, followed by U_R (note 3) in forward polarity at 125 °C for 125 hours	leakage current ≤ stated limit; ΔC/C ±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 ≤ stated limit; ΔC/C ±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 ≤ 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 3), tan δ and impedance at 100 Hz	leakage current ≤ 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
Solvent resistance	IEC 384-1/ CECC 30 000 sub clause 4.31	Xa	immersion: 5 ±0.5 minutes with or without ultrasonic at 55 ±0.5 °C Solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected

Additional notes for solid aluminium types

3. 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).
4. For capacitors type SAL-RP 122, 40 V version: <8 x the stated limit.

PACKING – SURFACE MOUNTING DEVICES (SMD)

Electrolytic Capacitors

Packing - Surface Mounting Devices (SMD)

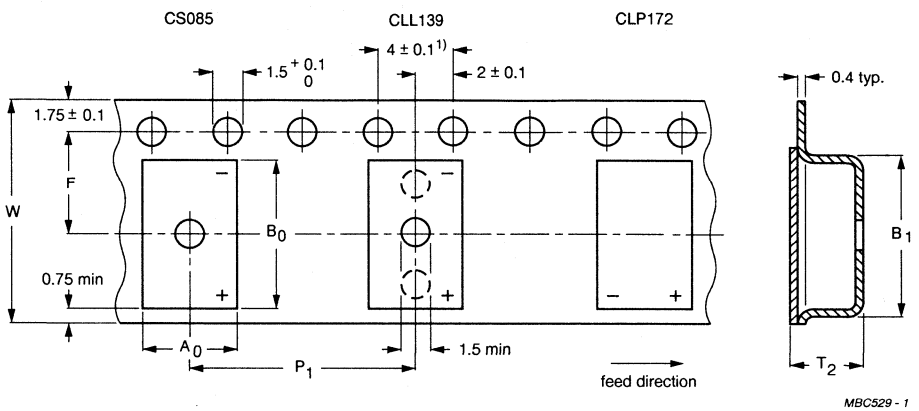
TAPING

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

- **CS 085**
- **CLL 139**
- **CLP 172**

For catalogue numbers, refer to the relevant detail specification.

Philips SMD 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 (CS 085 is also available in magazine packing).



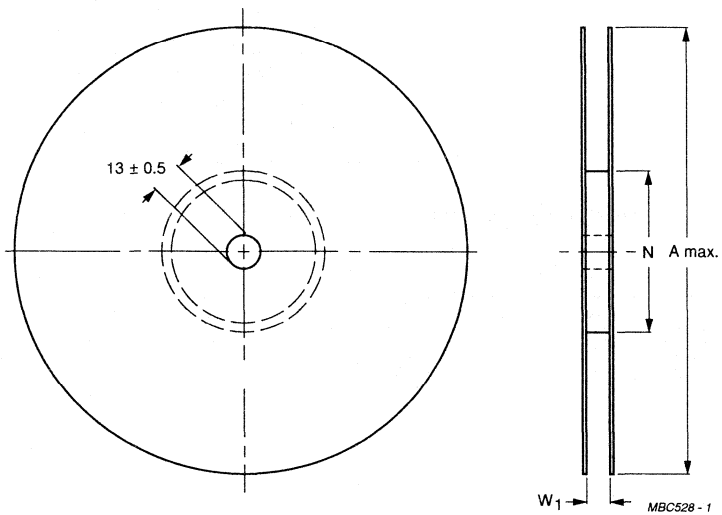
Dimensions in mm.

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

Fig.1 Blister tape.

Table 1 Dimensions of blister tape (in mm)

PARAMETER	SERIES								TOLERANCE
	CS 085		CLL 139		CLP 172				
Case code	1a	1	2	3	63	64	65	85	
Case size:									
L_{nom}	8.8	11.9	14.3	14.3	6.3	6.3	6.3	8.3	–
W_{nom}	3.7	3.7	6.2	7.6	3.5	4.0	4.5	4.5	–
H_{nom}	3.9	3.9	6.9	8.2	3.5	4.0	4.5	4.5	–
W	16	24	24	24	12	12	12	16	±0.3
T_2	4.9	4.9	7.7	9.1	4.2	4.7	5.2	5.2	max.
F	7.5	11.5	11.5	11.5	5.5	5.5	5.5	7.5	±0.1
P_1	8	8	12	12	8	8	8	8	±0.1
A_0	4.1	4.1	6.5	7.9	4.2	4.7	5.2	5.2	±0.2
B_0	9.3	12.5	14.8	14.8	6.8	6.8	6.8	8.8	±0.2
B_1	10	13.2	15.5	15.5	8	8	8	10.5	max.



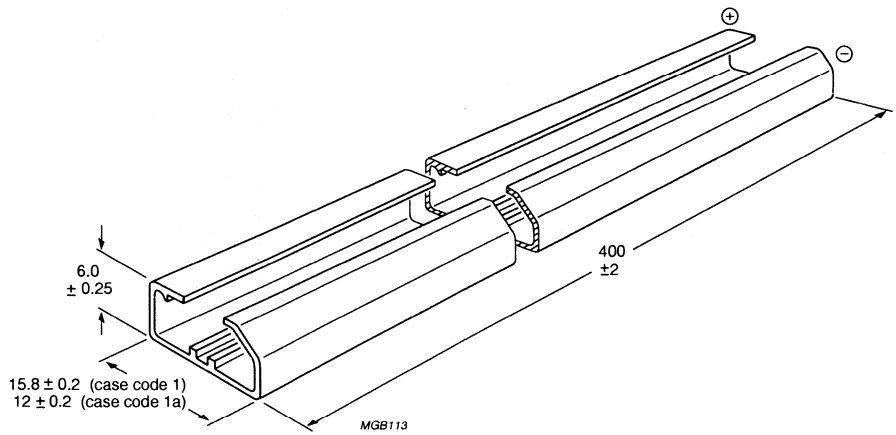
Dimensions in mm.

For other dimensions, see Table 2.

Fig.2 Reel for blister tape.

Table 2 Reel dimensions (in mm)

TAPE WIDTH	A (max.)		N (min.)	W_1
	CS 085 CLL 139	CLP 172		
12	–	382	50	14
16	330	382	50	18
24	330	–	50	26



Material: **PVC**

Dimensions in mm.

Fig.3 Magazine (CS 085 only).

PACKING QUANTITIES

Table 3 Number of capacitors per packing unit

CASE SIZE L_{nom} x W_{nom} x H_{nom} (mm)	CASE CODE	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
14.3 x 6.2 x 6.9	2 (CLL 139)	700	–	–	–
14.3 x 7.6 x 8.2	3 (CLL 139)	700	–	–	–
6.3 x 3.5 x 3.5	63 (CLP 172)	3000	–	–	–
6.3 x 4.0 x 4.0	64 (CLP 172)	2500	–	–	–
6.3 x 4.5 x 4.5	65 (CLP 172)	2500	–	–	–
8.3 x 4.5 x 4.5	85 (CLP 172)	2500	–	–	–

PACKING – RADIAL LEADED DEVICES

Electrolytic Capacitors

Packing - Radial Electrolytic Capacitors

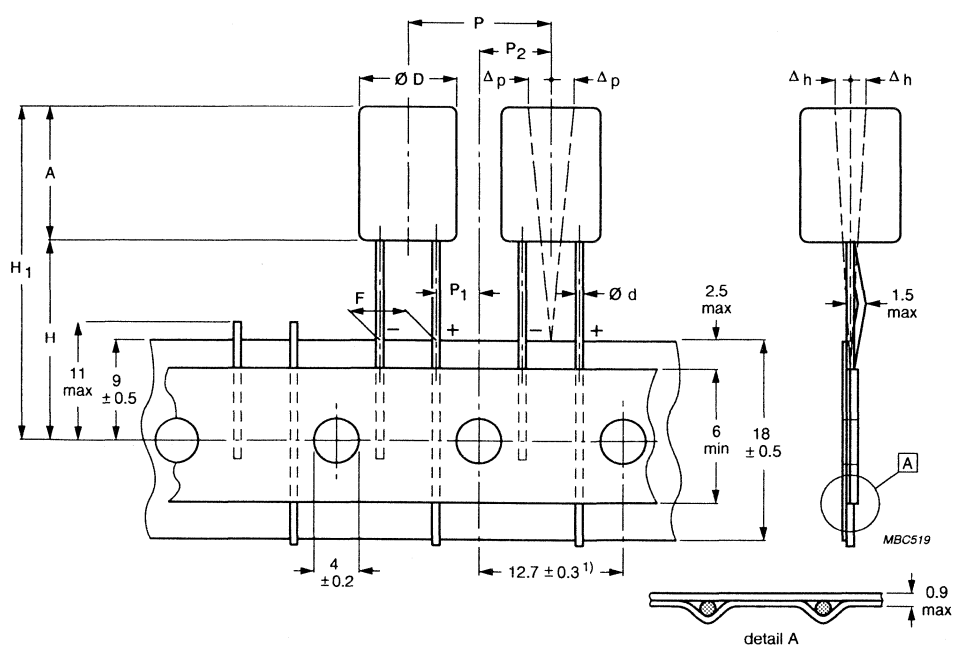
TAPING

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, non-preferred.

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**



Dimensions in mm.

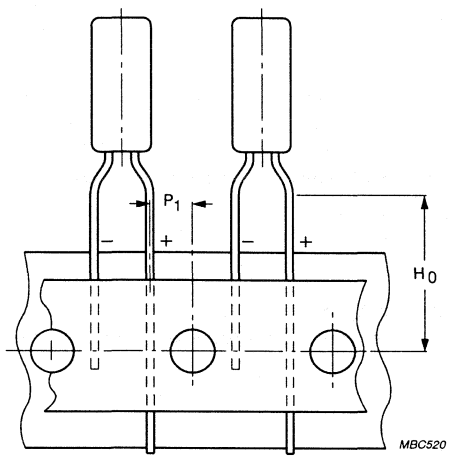
1) Tolerance over any 20 pitches: ±1.0 mm.

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

Form TN+ and **TNA**: 5 x 11 mm; F = 2.5 mm.

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

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



Dimensions in mm.

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

Form TR+ and **TFA**: 5 x 11 mm; F = 5 mm.

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

PARAMETER	Form TN+ and TNA: F = 2.5 mm	Form TR+ and TFA: F = 5 mm		TOLERANCE
Case size ($\varnothing D_{nom}$ x L_{nom})	5 x 11 mm (straight leads) (mm)	5 x 11 mm (formed leads) (mm)	8.2 x 11 mm (straight leads) (mm)	
∅ 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.

Series RLC 013, RSP 036 and RLL 116 (continued)

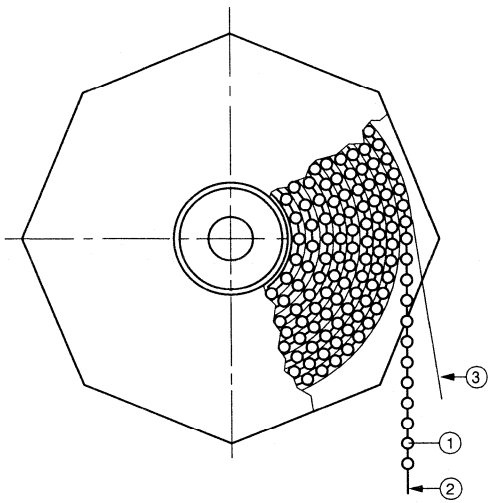
QUANTITIES PER PACKING UNIT

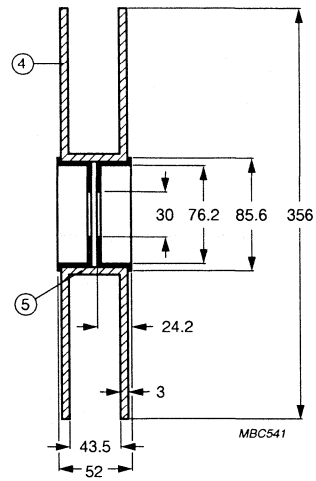
Table 1 Number of capacitors per packing unit

CASE SIZE (∅ D_{nom} x L_{nom}) (mm)	CASE CODE	BULK per box			TAPED per reel		TAPED ammopack; note 1	
		Form CA	Form CB	Form CC	Form TR+	Form TN+	Form TFA	Form TNA
5 x 11	11	1000	1000	1000	1000	1000	2000	2000
8.2 x 11	13	1000	1000	1000	500	500	1000	1000

Note

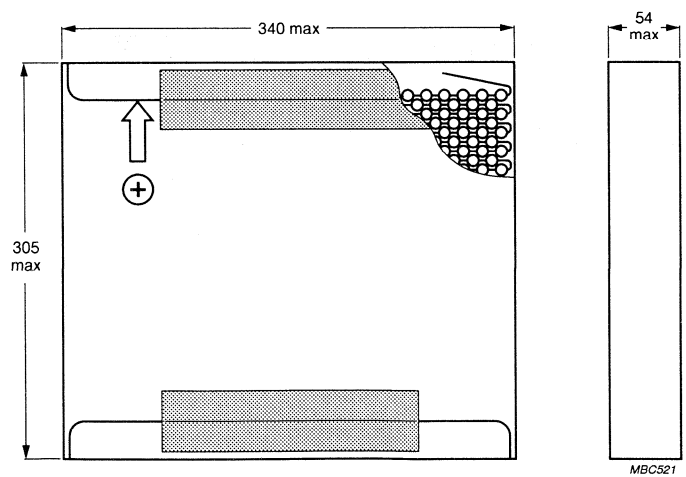
1. Ammopack taping (Form TFA) case size 8.2 x 11 mm: To ensure optimum straightness of the leads and correct position of the capacitors in the folding area of the zig-zag shaped tape, every 25th capacitor is omitted.





Dimensions in mm.
NON-PREFERRED.

Fig.3 Reel, **Form TR+** and **TN+**.



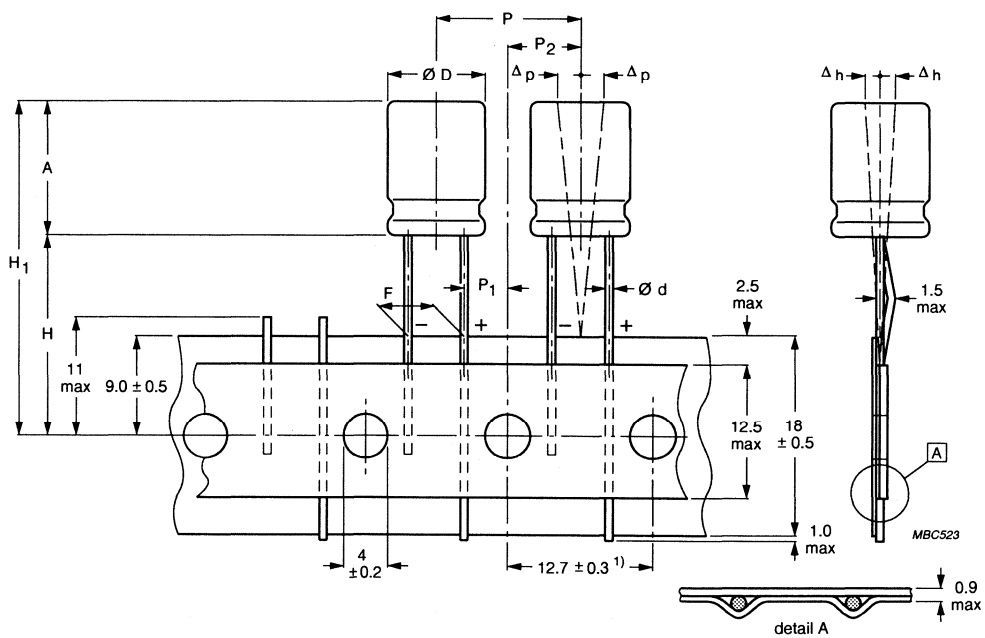
Dimensions in mm.
PREFERRED PACKING.

Fig.4 Ammopack, Form **TFA** and **TNA**.

The information contained within this part is valid for the following series with a case diameter (∅D) of 3 mm to 8 mm:

- **RLP 5-134**
- **RLP 7-097**
- **RSM 037**
- **RSH 044**
- **RLI 135**

For catalogue numbers, refer to the relevant detail specification.



Dimensions in mm.

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

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

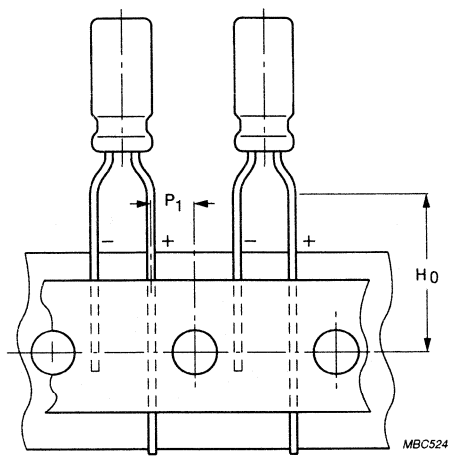
Form TN+ and **TNA**:

5 x 11 mm; F = 2.5 mm (leads slightly bent)

6.3 x 11 mm; F = 2.5 mm

8 x 12 mm; F = 3.5 mm.

Fig.5 Capacitors on tape, straight leads, case sizes 5 x 11, 6.3 x 11 and 8 x 12 mm.



Dimensions in mm.

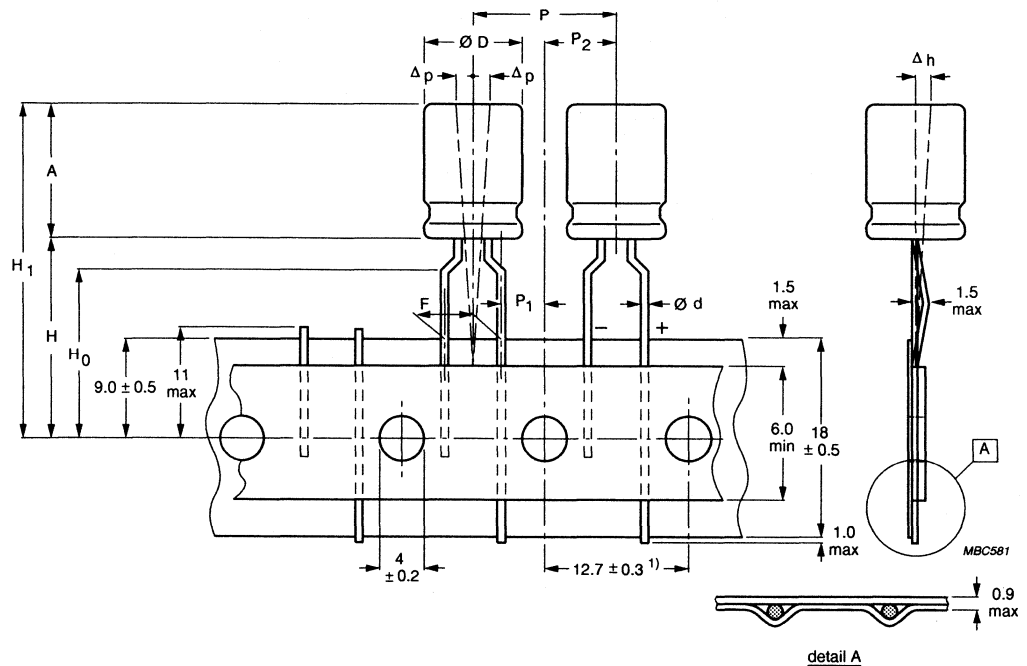
→ direction of tape transport for Form TR+ (positive leading).

Form TR+ and **TFA**: F = 5 mm

Fig.6 Capacitors on tape, formed leads, case sizes 5 x 11, 6.3 x 11 and 8 x 12 mm.

PARAMETER	Case size (∅ D_{nom} x L_{nom}) in mm						TOLERANCE
	Form TN+			Form TR+ and TFA			
	5 x 11 (mm)	6.3 x 11 (mm)	8 x 12 (mm)	5 x 11 (mm)	6.3 x 11 (mm)	8 x 12 (mm)	
∅ 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.

Series RLP 5-134, RLP 7-097, RSM 037, RSH 044 and RLI 135, ∅ = ≤8 mm (continued)



Dimensions in mm.

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

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

Form TR+ and **TFA**

Fig.7 Capacitors on tape, height = 5 to 7 mm.

PARAMETER	Case size (∅ D_{nom} x L_{nom}) in mm									TOLERANCE
	3 x 5 (mm)	3.5 x 5 (mm)	4 x 5 (mm)	5 x 5 (mm)	6.3 x 5 (mm)	4 x 7 (mm)	5 x 7 (mm)	6.3 x 7 (mm)	7 x 7 (mm)	
∅ 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.

QUANTITIES PER PACKING UNIT

Table 2 Number of capacitors per packing unit

CASE SIZE (∅ D_{nom} x L_{nom}) (mm)	CASE CODE	BULK per box			TAPED per reel; note 1		TAPED ammopack	
		Form CA	Form CB	Form CC	Form TR+	Form TN+	Form TFA	Form TNA
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	–	2000	–
5 x 7	72	1000	–	2000	1500	–	2000	–
6.3 x 7	73	1000	–	1000	1000	–	2000	–
7 x 7	74	1000	–	1000	1000	–	1000	–
5 x 11	11	3000	3000	3000	1500	1500	2000	2000
6.3 x 11	12	2000	2000	2000	1000	1000	2000	2000
8 x 12	13	1000	2000	2000	800	800	1000	1000

Note

1. The reel packing box will sometimes have an extra cardboard sheet, in order to avoid an empty space. This cardboard sheet should be removed prior to using the box.

Series RLP 5-134, RLP 7-097, RSM 037, RSH 044 and RLI 135, ∅ = 3 mm to 8 mm (continued)

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

Dimensions in mm.
NON-PREFERRED.

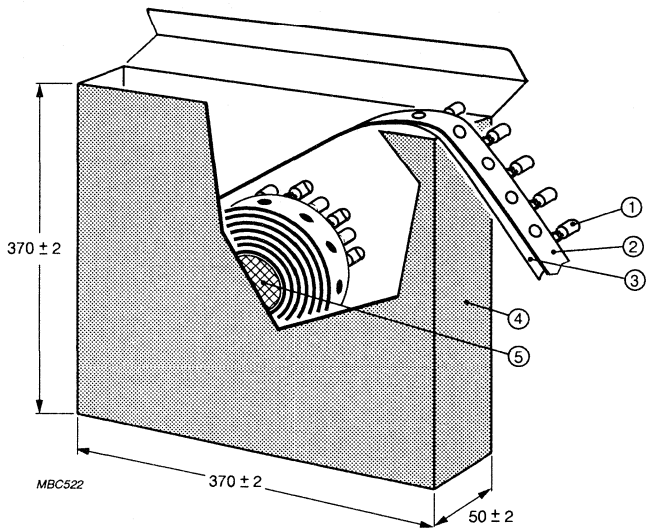
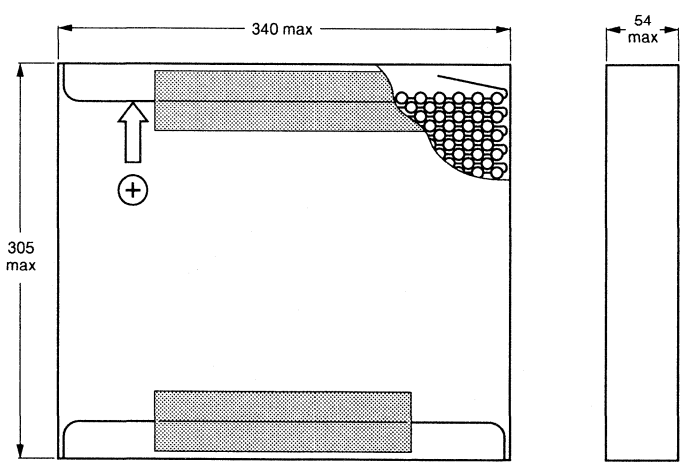


Fig.8 Reel packing box, **Form TR+** and **TN+**.



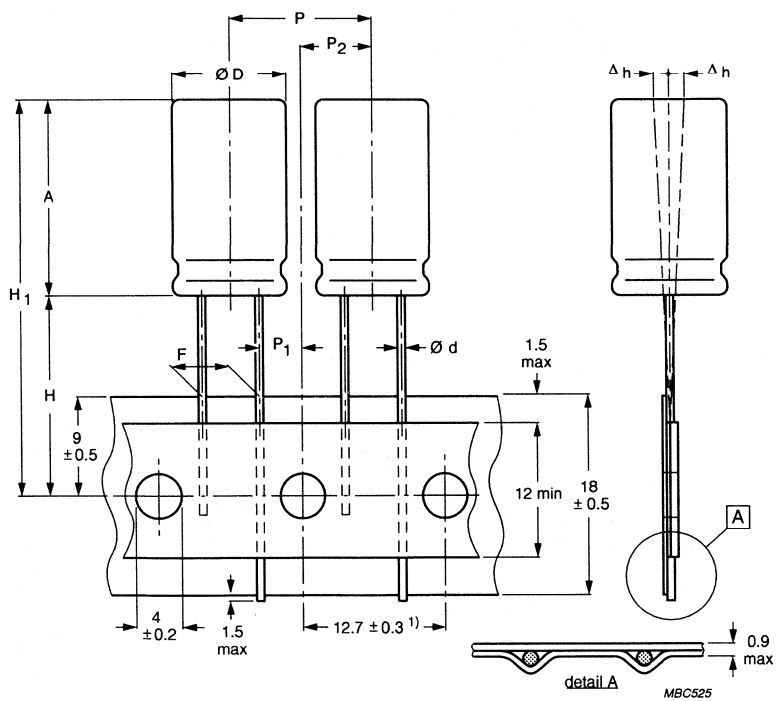
Dimensions in mm.
PREFERRED PACKING.

Fig.9 Ammopack, Form **TFA** and **TNA**.

The information contained in this part is valid for the following series with a case diameter (ØD) of 10 mm to 16 mm:

- **RSM 037**
- **RSH 044**
- **RSS 045**
- **RSL 046**
- **RMS 047**
- **RML 048**
- **RLI 135**
- **RVI 136**
- **RSX 164**
- **RHT 165**

For catalogue numbers, refer to the relevant detail specification.



Dimensions in mm.

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

Fig.10 Capacitors on tape, Ø D = 10 mm.

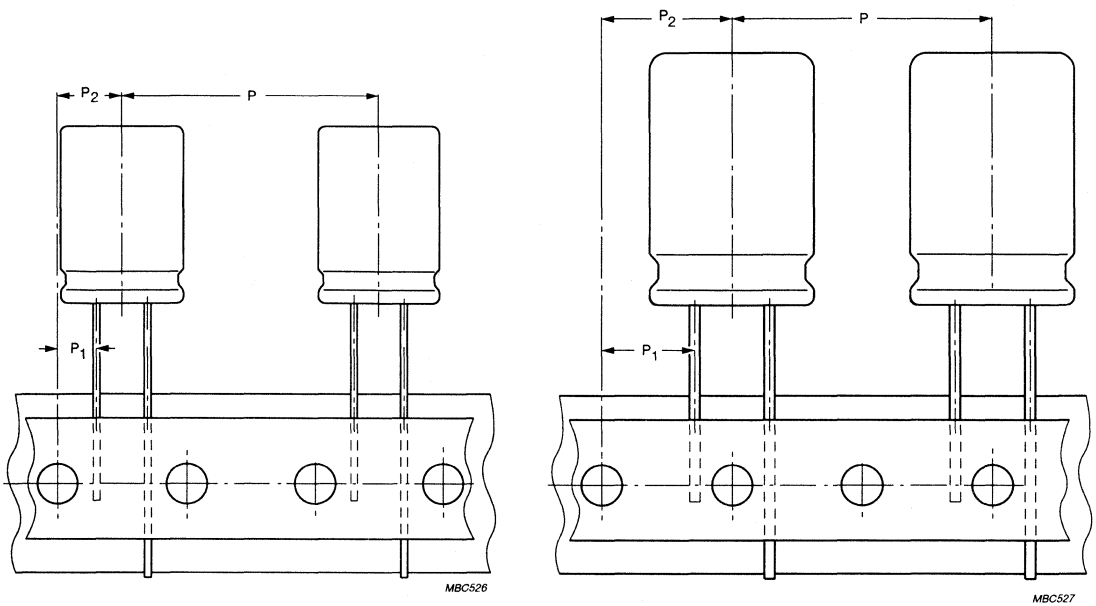


Fig.11 Capacitors on tape, ∅ D = 12.5 and 16 mm.

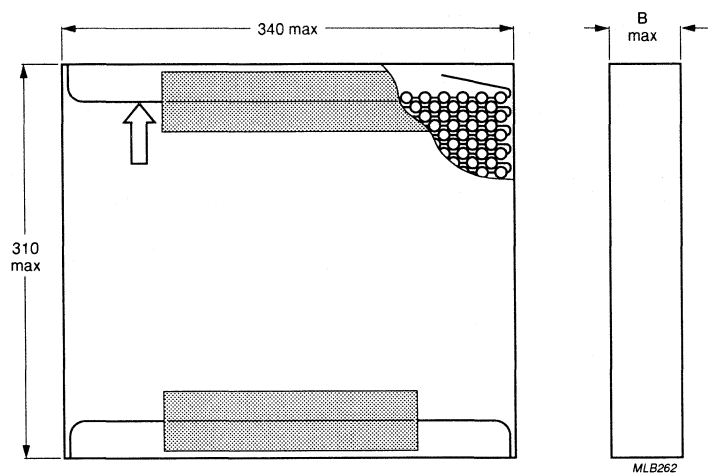
Table 3

PARAMETER	Case size (∅ D_{nom} x L_{nom}) in mm							TOLERANCE
	10 x 12 (mm)	10 x 16 (mm)	10 x 20 (mm)	12.5 x 20 (mm)	12.5 x 25 (mm)	16 x 25 (mm)	16 x 31 (mm)	
∅ 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/−0.2
Δh	0	0	0	0	0	0	0	±3.0
H	18.5	18.5	18.5	18.5	18.5	18.5	18.5	±0.75
H_1	$H_1 = H + A$							
B	54	62	62	62	68	68	75	max.

Series RSM 037, RSH 044, RSS 045, RSL 046, RMS 047, RML 048, RLI 135, RVI 136, RSX 164 and RHT 165 with a case diameter of (∅D) ≥10 mm (continued)

QUANTITIES PER PACKING UNIT

Refer to the relevant detail specification.



For dimension B, refer to Table 3.

Dimensions in mm.

PREFERRED PACKING.

Fig.12 Ammopack, Form TFA.

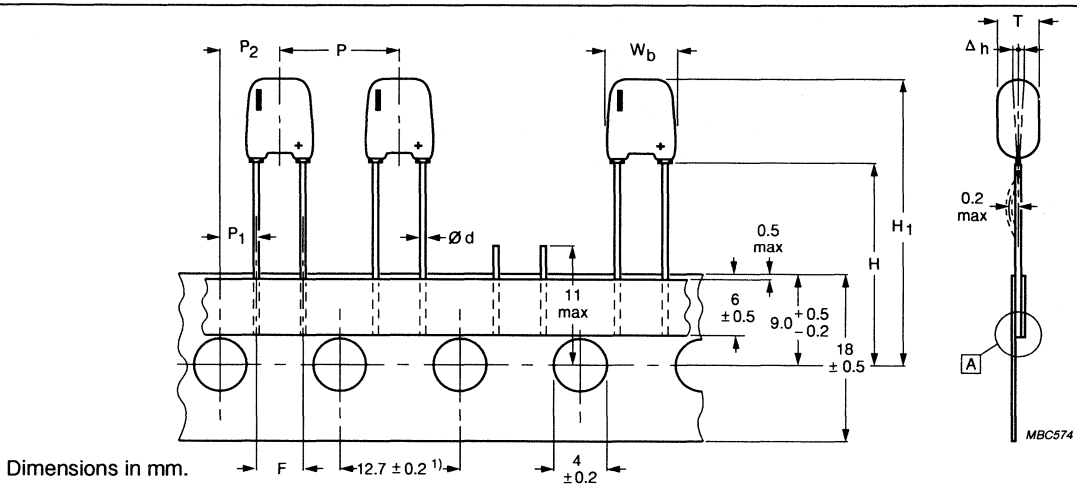
Note

1. Ammopack taping (Form TFA): To ensure optimum straightness of the leads and correct position of the components in the folding area of the zig-zag shaped tape, where necessary, one capacitor is omitted at each folding edge.

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.



Dimensions in mm.

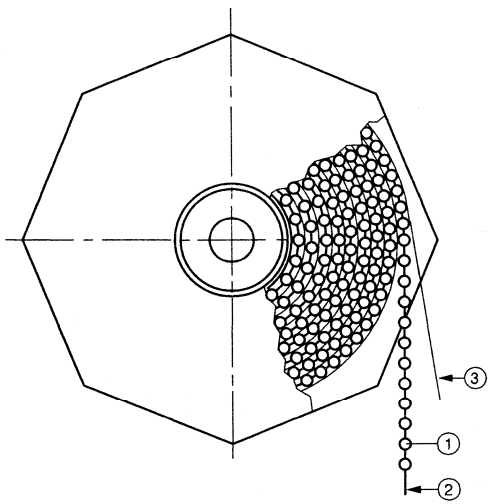
1) Tolerance over any 20 pitches: ±1.0 mm.

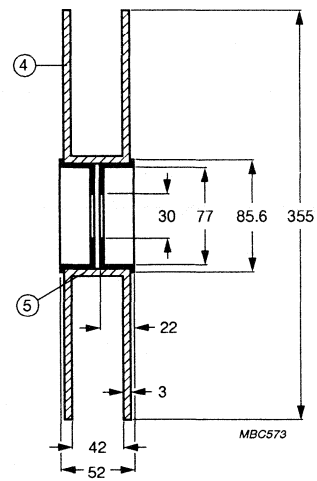
→ direction of tape transport for Form TR+ (positive leading).

Fig.13 Capacitors on tape, max. capacitor height 9.5 or 12.5 mm.

Table 4 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.

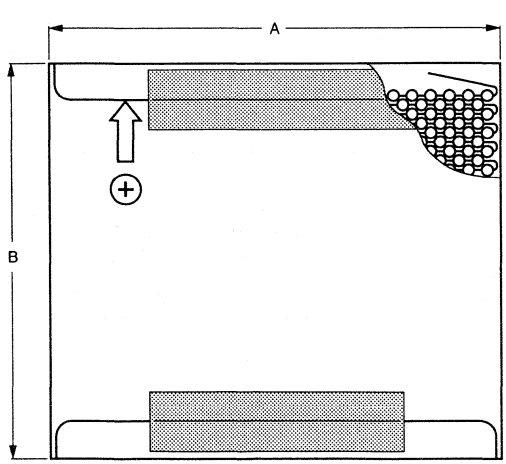


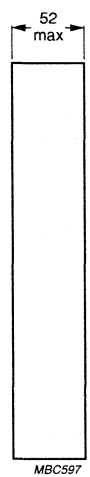


1 = capacitor
2 = tape
3 = paper
4 = flange
5 = cylinder.

Dimensions in mm.

Fig.14 Reel, **Form TR+**.





Dimensions in mm.

PREFERRED PACKING.

Fig.15 Ammopack, **Form TFA**.

Table 5 Ammopack dimensions in mm

PARAMETER	SAL-RP 122	SAL-RPM 128; SAL-RDC 129	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 6 Number of capacitors per packing unit

CASE SIZE H_{max} x W_{max} x T_{max} (m m)	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

PACKING – AXIAL LEADED DEVICES

Electrolytic Capacitors

Packing - Axial Electrolytic Capacitors

TAPING

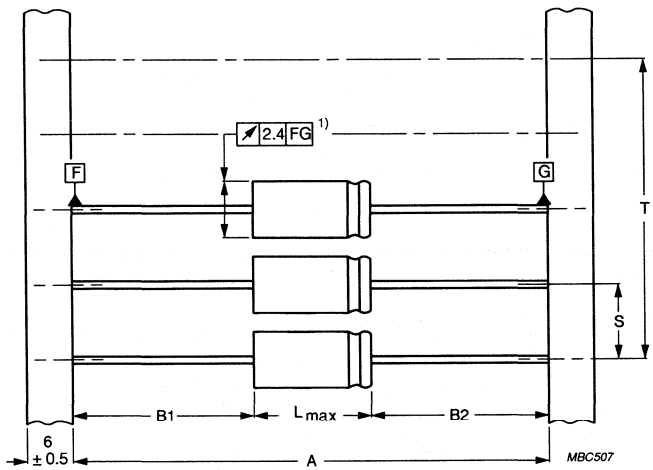
Philips axial, solid and non-solid aluminium electrolytic capacitors in sizes up to Ø15 mm, are available in taped version corresponding to IEC 286-1.

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 Ø D_{nom} x L_{nom} (mm)	CASE CODE	A (mm)	S (mm)	T for number (n)		L_{max} (mm)	C (mm)	D (mm)
				n<50 (mm)	50<n<100 (mm)			
Non-solid types								
3.3 x 8	1a	63.5 ±1.5 [1]	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 [1]	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 [1]	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 [1]	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 [1]	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 [1]	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 [1]	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 [1]	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 [1]	10 ±0.4	10(n-1) ±2	10(n-1) ±4	18.5	88.5	99.5
10 x 18	6	73 ±1.6 [1]	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

Note: [1] = 52 ±1.5 mm on request.



Dimensions in mm.

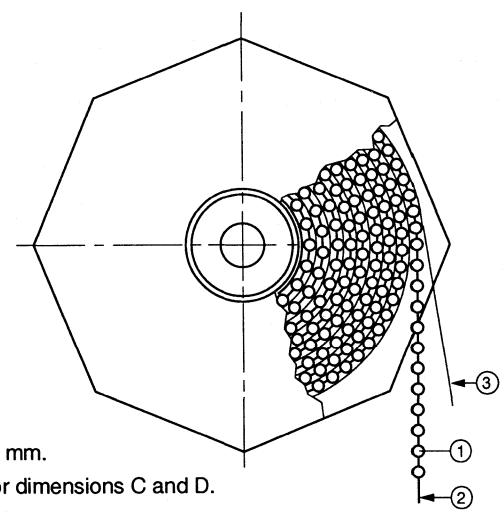
B1 – B2 = max. 1.4 mm.

The negative capacitor terminals are connected to the blue tape.

1) not for case size 15 x 30 mm.

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

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

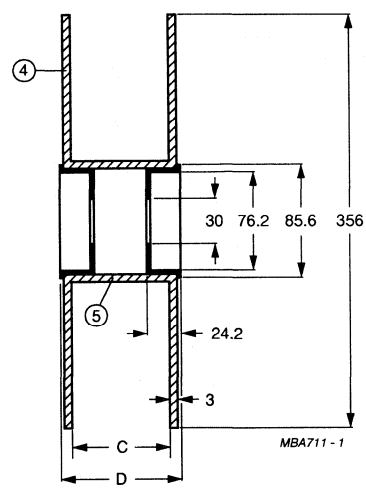
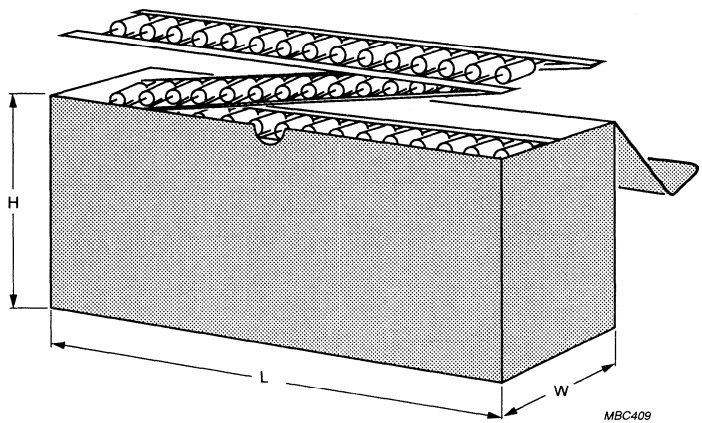


Fig.2 Reel dimensions, case sizes 3.3 x 8 mm to 15 x 30 mm.



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

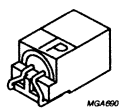
CASE SIZE ∅ D_{nom} x L_{nom} (mm)	CASE CODE	L (mm)	W (mm)	H (mm)
Non-solid types				
3.3 x 8	1a	282	92	64
3.3 x 11	1	282	92	64
4.5 x 10	2	282	92	116
6 x 10	3	415	92	107
6.3 x 12.7	(2)	415	92	107
7.7 x 12.7	(3)	415	92	107
8 x 11	5a	415	92	107
6.5 x 18	4	415	98	127
6.5 x 25	4L	415	98	127
8 x 18	5	415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



NON-SOLID ALUMINIUM

STANDARD	***INDUSTRIAL***	***PROFESSIONAL***
CS085 *1500 hours* 85 °C *page 85*	**CLP172** *1000 hours* 105 °C *page 99*	**CLL139** *2000 hours* 105 °C *page 106*

MBC592 - 1

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.

APPLICATIONS

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

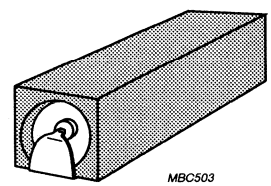


Fig.1 Component outline.

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
Based on sectional specification	IEC 384-18/CECC 32 300
Detail specification	similar to DIN 45910-T126 (without approval), former DIN 41316
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 (**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

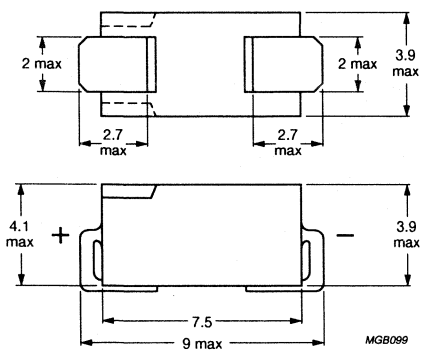

Fig.2 Case size 8.8 x 3.7 x 3.9 mm.

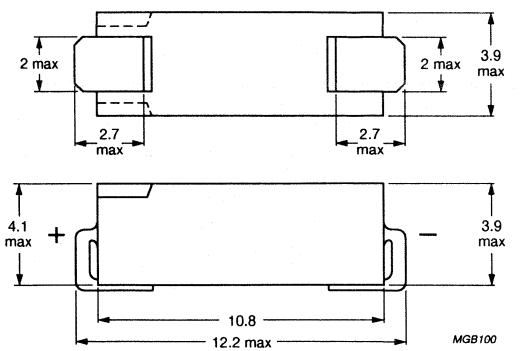

Fig.3 Case size 11.9 x 3.7 x 3.9 mm.

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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.

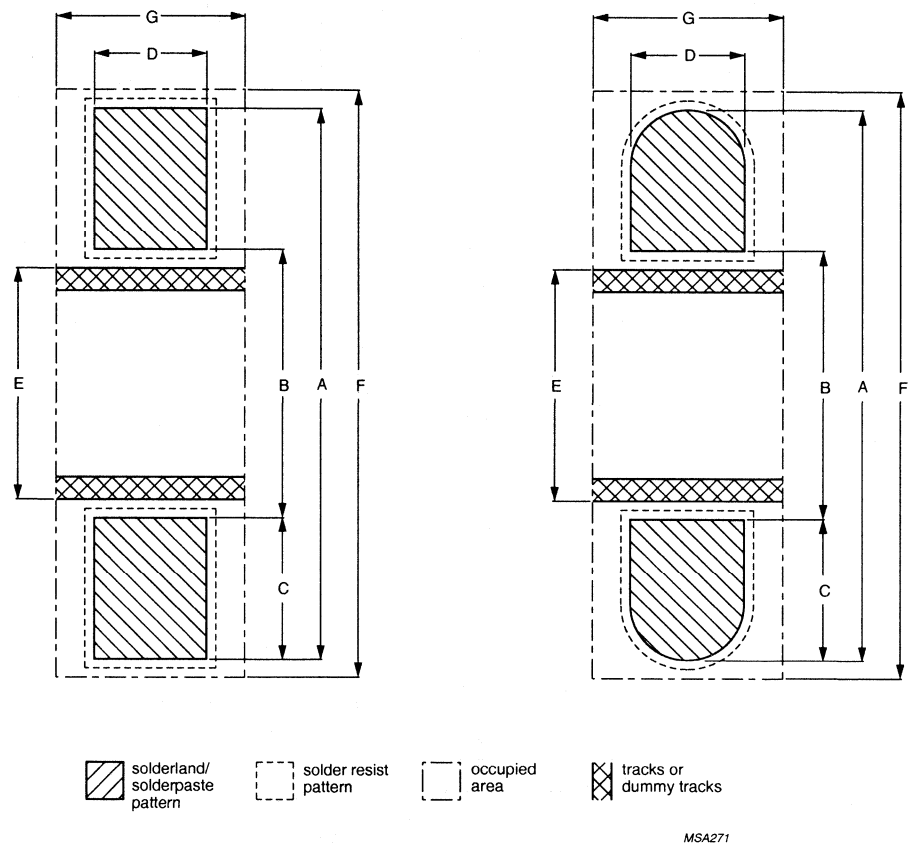
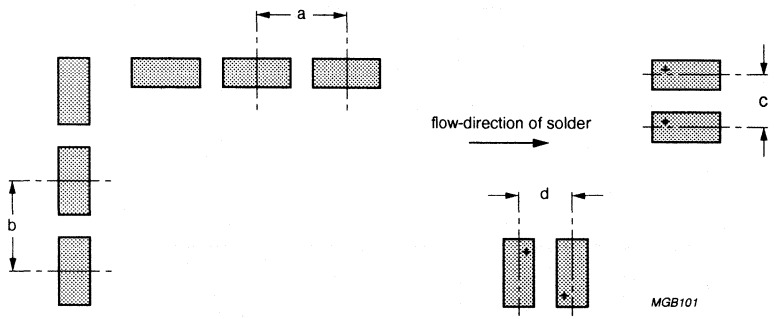


Fig.4 Recommended pad dimensions for reflow and wave soldering.

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

CASE SIZE (mm)	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.

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 4 Minimum distances between capacitors in mm

Case size (mm)	$a_{min.}$	$b_{min.}$	$c_{min.}$	$d_{min.}$
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

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

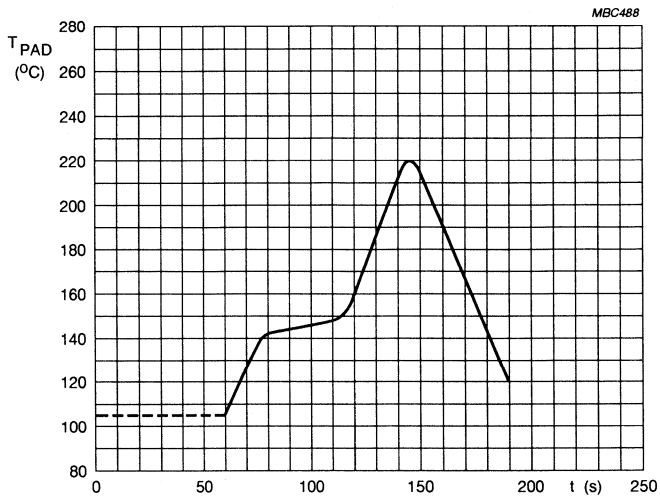


Fig.6 Maximum temperature load during infrared reflow soldering.

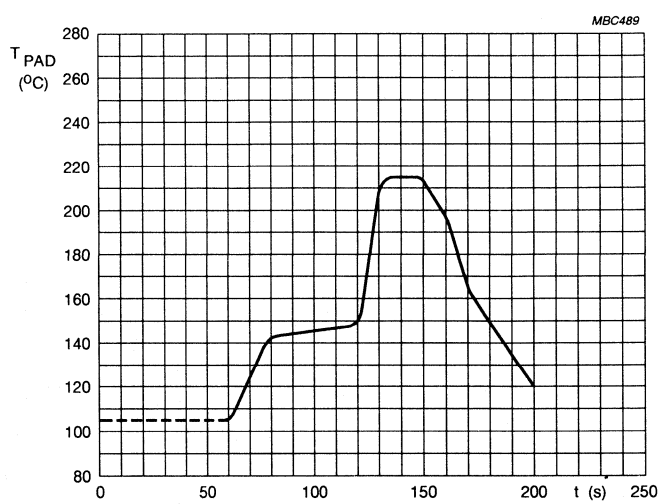


Fig.7 Maximum temperature load during vapour phase reflow soldering.

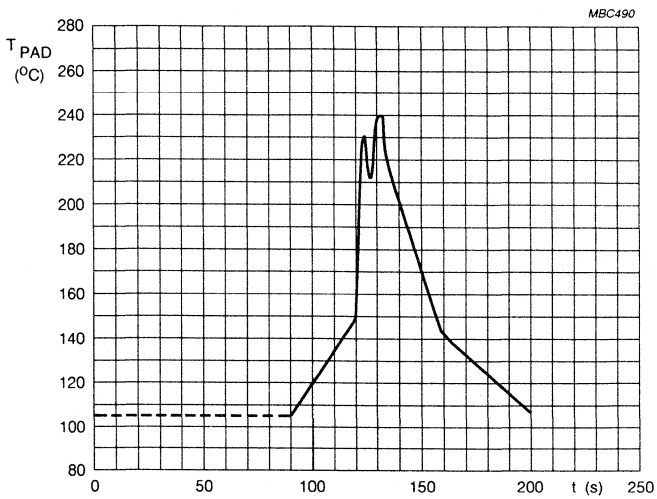


Fig.8 Maximum temperature load during (double-) wave soldering.

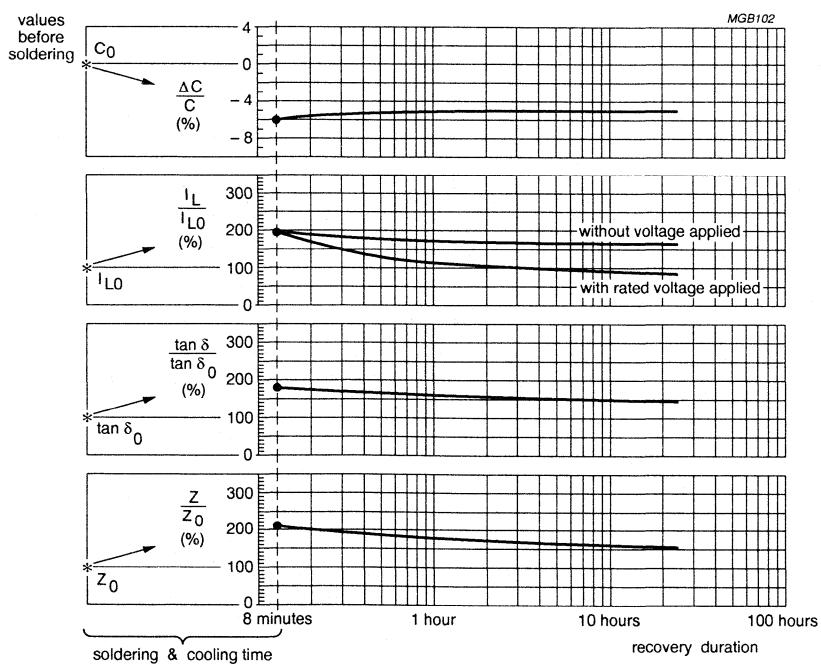


Fig.9 Typical drift of electrical parameters after soldering under maximum conditions, and subsequent recovery.

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.

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

Voltage

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

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor CS 085
10 µF/16 V; −10/+50%
Case size 11.9 x 3.7 x 3.9 mm;
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

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Leakage current

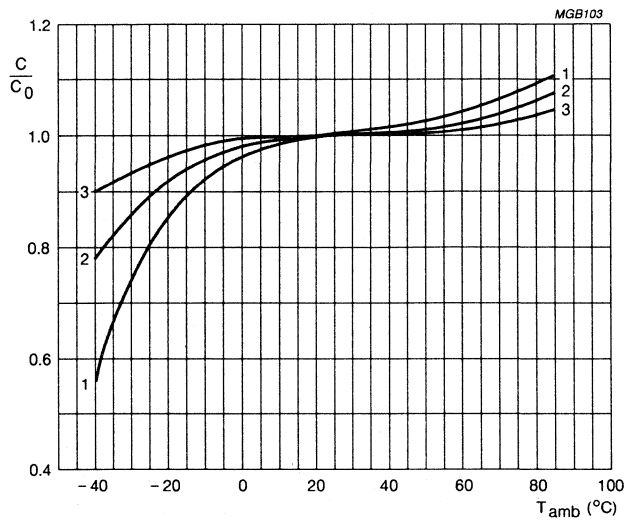
After 1 minute at U_R $I_{L1} \leq 0.02\ C_R \times U_R + 3\ \mu A$

After 5 minutes at U_R $I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$

Equivalent series inductance (ESL)

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

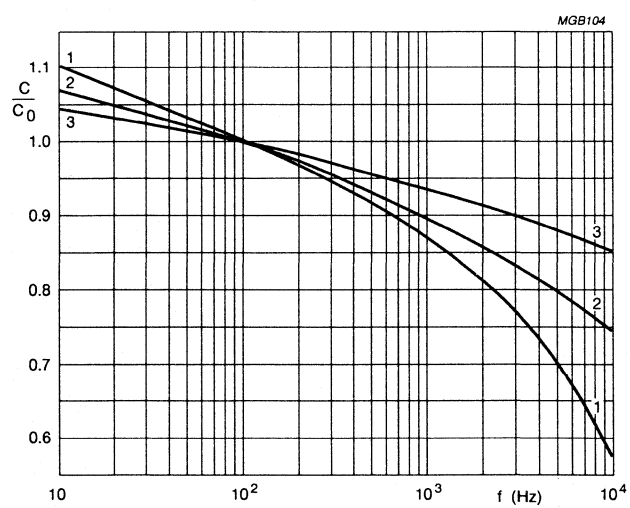
Capacitance (C)



Curve 1: 6.3 V
Curve 2: 25 V
Curve 3: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

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



Curve 1: 6.3 V
Curve 2: 25 V
Curve 3: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.11 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 µF to 3.3 µF
Curve 7: 63 V, 1 µF
Curve 8: 63 V, 0.22 µF to 0.47 µF
Curve 9: 0.1 µF.

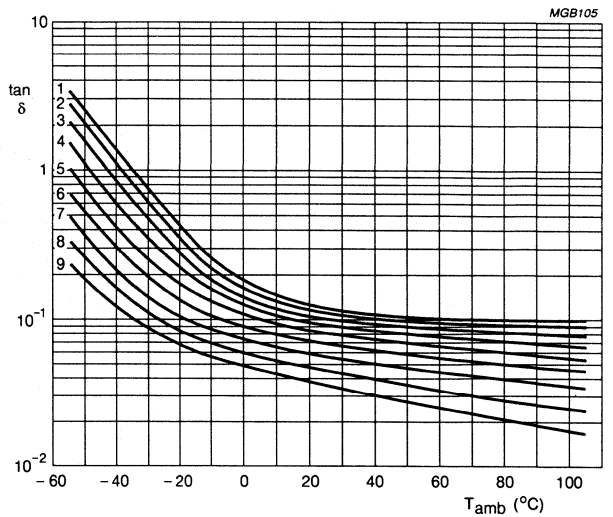


Fig.12 Typical tan δ as a function of ambient temperature at 100 Hz.

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 µF to 3.3 µF
Curve 7: 63 V, 1 µF
Curve 8: 63 V, 0.22 µF to 0.47 µF
Curve 9: 0.1 µF.

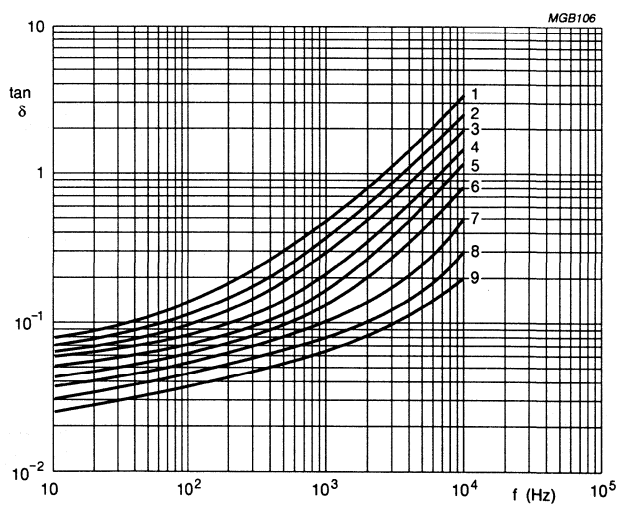
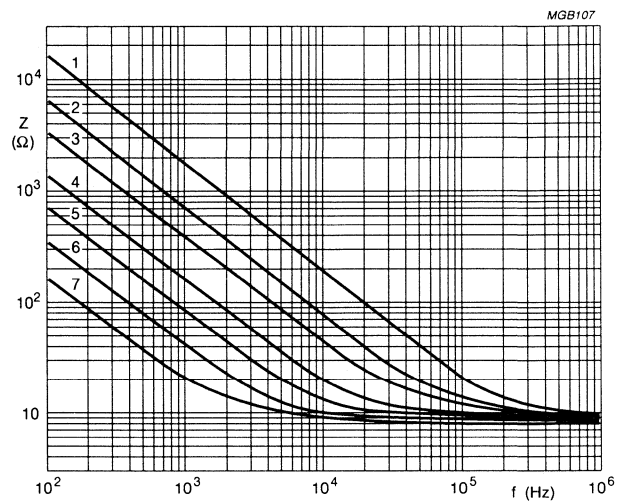


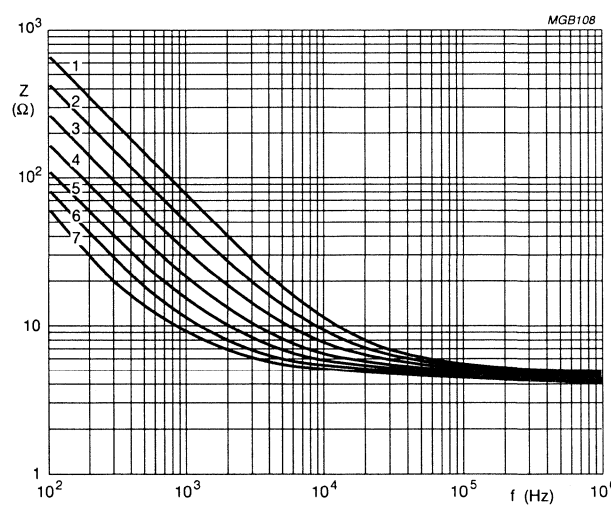
Fig.13 Typical tan δ as a function of frequency at 20 °C.

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



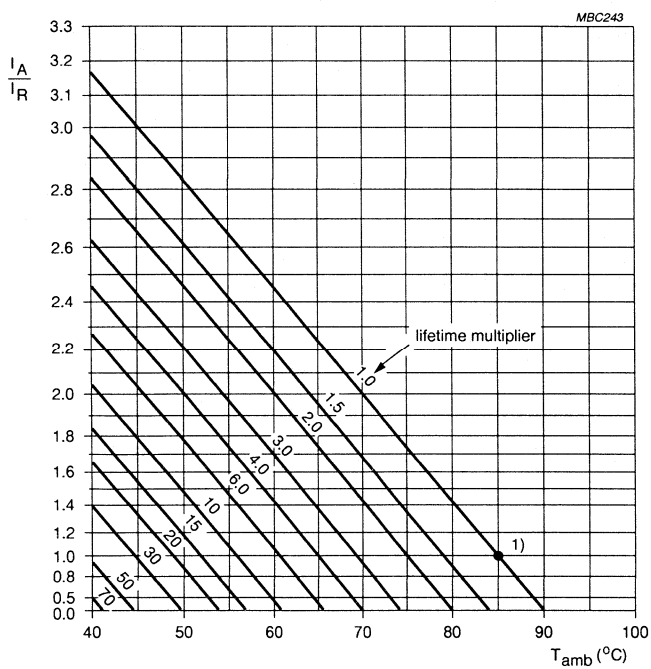
Curve 1: 2.2 µF
Curve 2: 3.3 µF
Curve 3: 4.7 µF
Curve 4: 6.8 µF
Curve 5: 10 µF
Curve 6: 15 µF
Curve 7: 22 µF.

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

RIPPLE CURRENT and USEFUL LIFE

Table 8 Multiplier of ripple current I_R as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 V to 16 V	U_R = 25 V 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).

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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 384-18, sub clause 4.3	shall be performed prior to tests mentioned below. method: reflow or (double-) wave soldering for maximum temperature load refer to chapter, "Mounting"	 $\Delta C/C$ ±10% tan $\delta \leq$ spec. limit $I_{L5} \leq 2$ x spec. limit.
Endurance	IEC 384-18/ CECC 32 300 sub clause 4.15	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 $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 1500 hours	$\Delta C/C$ ±50% 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: ≤3%
Shelf life (storage at high temp.)	IEC 384-18/ CECC 32 300 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 $I_{L5} \leq 2$ x spec. limit

Non-solid Al - electrolytic capacitors SMD (Chip) Low Profile

CLP 172

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid, self healing
- SMD-version, for reflow soldering
- Miniaturized, high CV per unit volume, low height
- Charge and discharge proof, no peak current limitation
- Compact, rectangular shape
- Supplied in blister tape on reel.

APPLICATIONS

- SMD technology, boards/hybrids with restricted mounting height
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Telecommunications, automotive, general industrial, low-profile and lightweight equipment.

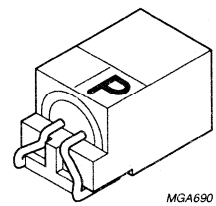


Fig.1 Component outline.

QUICK REFERENCE DATA

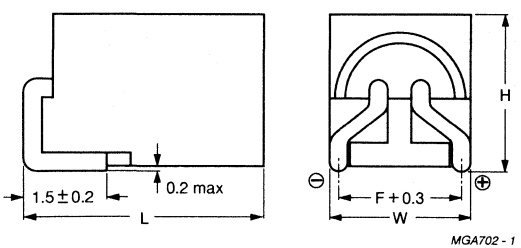
Nominal case sizes (L x W x H in mm)	6.3 x 3.5 x 3.5 to 8.3 x 4.5 x 4.5
Rated capacitance range, C_R	0.22 to 33 µF
Tolerance on C_R	±20%
Rated voltage range, U_R	6.3 to 50 V
Category temperature range	−40 to +105 °C
Useful life at 105 °C	1000 hours
Useful life at 40 °C; 1.3 I_R applied	100 000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-18/CECC 32 300
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259 - with reduced dimensions
Climatic category IEC 68 (DIN 40040)	40/105/56 (GMF)

SM

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

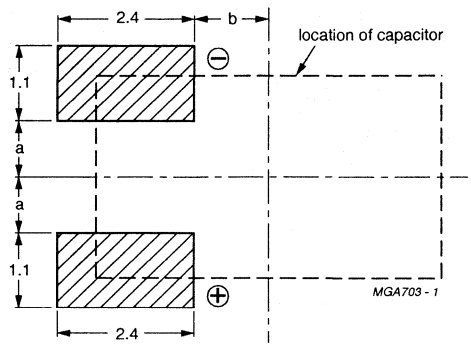
C_R (µF)	U_R (V)					
	6.3	**10**	**16**	**25**	**35**	**50**
0.22						6.3 x 3.5 x 3.5
0.47						6.3 x 3.5 x 3.5
1.0						**6.3 x 3.5 x 3.5**
2.2					**6.3 x 3.5 x 3.5**	**6.3 x 4.0 x 4.0**
3.3				6.3 x 3.5 x 3.5	6.3 x 4.0 x 4.0	6.3 x 4.5 x 4.5
4.7			**6.3 x 3.5 x 3.5**	**6.3 x 4.0 x 4.0**	**6.3 x 4.5 x 4.5**	**8.3 x 4.5 x 4.5**
6.8		6.3 x 3.5 x 3.5	6.3 x 4.0 x 4.0	6.3 x 4.5 x 4.5	8.3 x 4.5 x 4.5	
10	**6.3 x 3.5 x 3.5**		**6.3 x 4.0 x 4.0**	**8.3 x 4.5 x 4.5**		
15	6.3 x 4.0 x 4.0	6.3 x 4.5 x 4.5	8.3 x 4.5 x 4.5			
22	**6.3 x 4.5 x 4.5**	**8.3 x 4.5 x 4.5**				
33	8.3 x 4.5 x 4.5					

MECHANICAL DATA



Dimensions in mm.

Fig.2 Dimensional outline.



Dimensions in mm.

Fig.3 Recommended solder pad dimensions.

Table 2 Dimensions in mm; mass in g

CASE SIZE	CASE CODE	L_{max}	W_{max}	H_{max}	F	a	b	MASS	QUANTITY PER REEL
6.3 x 3.5 x 3.5	63	6.5	3.8	3.7	3.0	1.0	1.2	0.13	3000
6.3 x 4.0 x 4.0	64	6.5	4.3	4.2	3.5	1.3	1.2	0.17	2500
6.3 x 4.5 x 4.5	65	6.5	4.8	4.7	4.0	1.5	1.2	0.20	2500
8.3 x 4.5 x 4.5	85	8.5	4.8	4.7	4.0	1.5	2.2	0.25	2500

PACKING

The capacitors are supplied in blister tape on reel. Tape dimensions are specified in chapter "PACKING".

Packing quantities per reel, are shown in Table 2.

MARKING

- Rated capacitance in μF
  - special capacitance markings:
    R2 = 0.22 μF
    R4 = 0.47 μF
- Rated voltage
- Name of manufacturer (P for PHILIPS)
- "■" sign indicating the cathode terminal.

MOUNTING

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

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

For recommended pad dimensions, refer to Fig.3 and Table 2.

Soldering

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

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

Note:

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

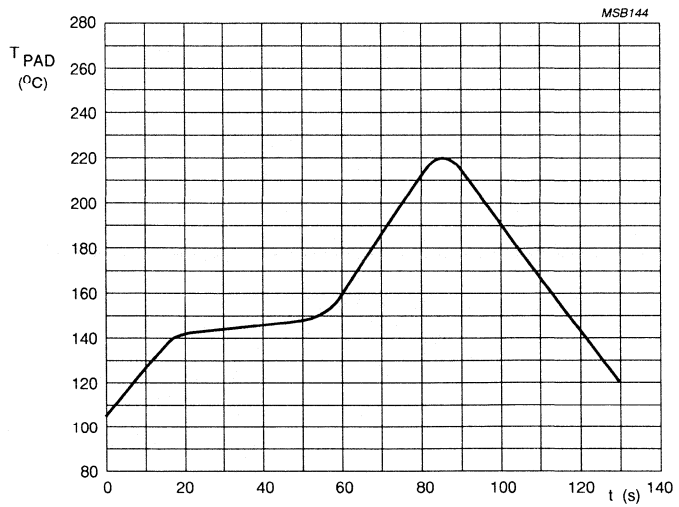


Fig.4 Max. temperature load: Infrared reflow soldering.

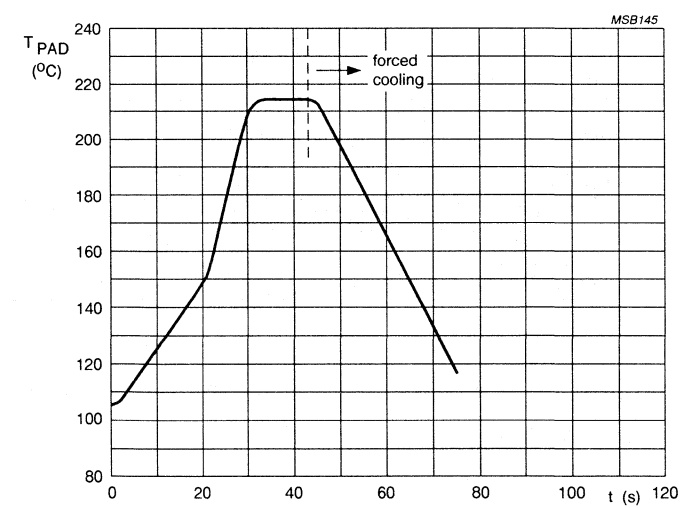


Fig.5 Max. temperature load: Vapour phase reflow soldering.

Non-solid Al - electrolytic capacitors SMD (Chip) Low Profile

CLP 172

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 and 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_{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)

Ordering Example:

Electrolytic Capacitor CLP 172
10 µF/16 V; ±20%
Case size 6.3 x 4.0 x 4.0,
taped on reel
Catalogue number 2222 172 65109

Table 3 Electrical data and ordering information. Preferred types in **bold.**

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE L X W x H (mm)	CASE CODE	I_R 120 Hz 105 °C (mA)	I_{L2} 2 min (µA)	Tan δ 120 Hz	ESR 120 Hz (Ω)	CATALOGUE NUMBER 2222 ... .
6.3	**10**	**6.3 x 3.5 x 3.5**	**63**	11	3	0.32	42	**172 63109**
	15	6.3 x 4.0 x 4.0	64	15	3	0.32	28	172 63159
	22	**6.3 x 4.5 x 4.5**	**65**	20	3	0.30	18	**172 63229**
	33	8.3 x 4.5 x 4.5	85	27	3	0.30	12	172 63339
10	6.8	6.3 x 3.5 x 3.5	63	10	3	0.26	51	172 64688
	15	6.3 x 4.5 x 4.5	65	19	3	0.24	21	172 64159
	22	**8.3 x 4.5 x 4.5**	**85**	25	3	0.24	14	**172 64229**
16	**4.7**	**6.3 x 3.5 x 3.5**	**63**	9	3	0.22	62	**172 65478**
	6.8	6.3 x 4.0 x 4.0	64	12	3	0.22	43	172 65688
	10	**6.3 x 4.0 x 4.0**	**64**	14	3	0.22	29	**172 65109**
	15	8.3 x 4.5 x 4.5	85	23	3	0.20	18	172 65159
25	3.3	6.3 x 3.5 x 3.5	63	8.3	3	0.18	72	172 66338
	4.7	**6.3 x 4.0 x 4.0**	**64**	11	3	0.18	51	**172 66478**
	6.8	6.3 x 4.5 x 4.5	65	16	3	0.16	31	172 66688
	10	**8.3 x 4.5 x 4.5**	**85**	21	3	0.16	21	**172 66109**
35	**2.2**	**6.3 x 3.5 x 3.5**	**63**	7.2	3	0.16	96	**172 60228**
	3.3	6.3 x 4.0 x 4.0	64	9.7	3	0.16	64	172 60338
	4.7	**6.3 x 4.5 x 4.5**	**65**	14	3	0.14	40	**172 60478**
	6.8	8.3 x 4.5 x 4.5	85	18	3	0.14	27	172 60688
50	0.22	6.3 x 3.5 x 3.5	63	2.4	3	0.14	840	172 61227
	0.47	6.3 x 3.5 x 3.5	63	3.5	3	0.14	400	172 61477
	1.0	**6.3 x 3.5 x 3.5**	**63**	5.2	3	0.14	190	**172 61108**
	2.2	**6.3 x 4.0 x 4.0**	**64**	8.4	3	0.14	84	**172 61228**
	3.3	6.3 x 4.5 x 4.5	65	13	3	0.12	48	172 61338
	4.7	**8.3 x 4.5 x 4.5**	**85**	16	3	0.12	34	**172 61478**

Non-solid Al - electrolytic capacitors SMD (Chip) Low Profile

Voltage

Surge voltage for short periods	U_S	$\leq 1.15 \times U_R$
Reverse voltage	U_{rev}	≤ 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)

Impedance (Z)

Table 4 Ratio of impedance at 120 Hz, between –25 °C and 20 °C.

CASE SIZES (mm)	$Z_{-25\ °C} / Z_{20\ °C}$					
	6.3 V	10 V	16 V	25 V	35 V	50 V
6.3 x 3.5 x 3.5 6.3 x 4.0 x 4.0	6	4	3	2	2	2
6.3 x 4.5 x 4.5 8.3 x 4.5 x 4.5	4	3	2	2	2	2

Table 5 Ratio of impedance at 120 Hz, between –40 °C and 20 °C.

CASE SIZES (mm)	$Z_{-40\ °C} / Z_{20\ °C}$					
	6.3 V	10 V	16 V	25 V	35 V	50 V
6.3 x 3.5 x 3.5 6.3 x 4.0 x 4.0	12	9	7	5	4	4
6.3 x 4.5 x 4.5 8.3 x 4.5 x 4.5	10	8	6	4	3	3

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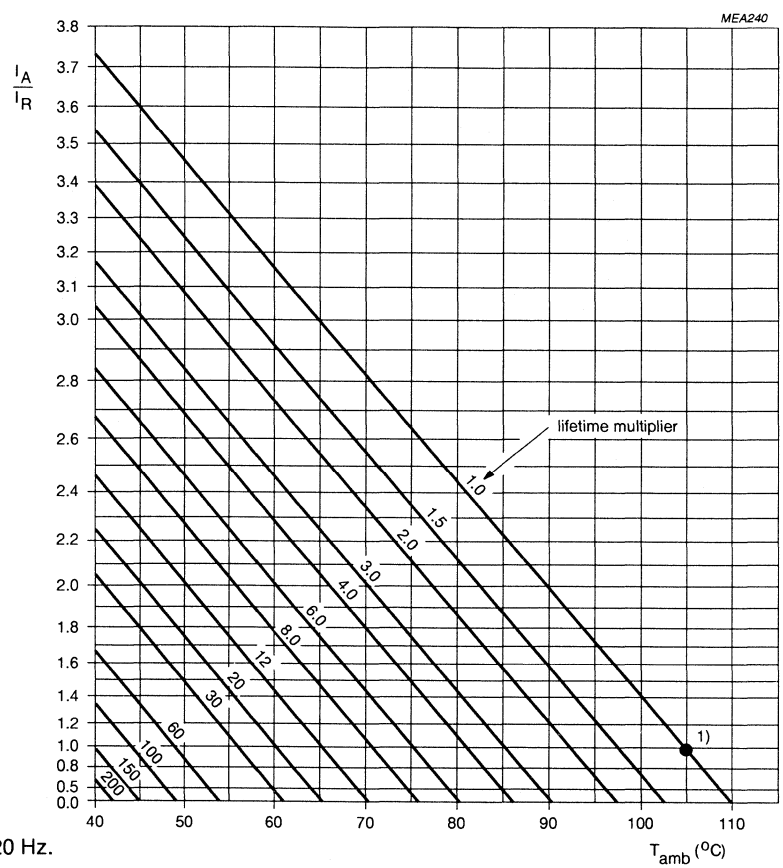
RIPPLE CURRENT and USEFUL LIFE

Table 6 Multiplier of ripple current I_R as a function of frequency

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



I_A = actual ripple current at 120 Hz.

I_R = ripple current at 105 °C, 120 Hz.

Useful life at 105 °C and I_R applied: 1000 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 7

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	Reference		
Mounting	IEC 384-18 sub clause 4.3	to be performed prior to tests mentioned below; reflow soldering for maximum temperature load, refer to chapter, "Mounting"	$\Delta C/C$ ±8% tan $\delta \leq$ spec. limit $I_{L2} \leq 2$ x spec. limit
Useful life	CECC 30 301 amendment 2640, sub clause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; 1000 hours	$\Delta C/C$: case codes 63 and 64: ±25% case codes 65 and 85: ±20% tan $\delta \leq 2$ x spec. limit $I_{L2} \leq$ spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temperature)	IEC 384-18/ CECC 32 300, sub clause 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	$\Delta C/C$: case codes 63 and 64: ±25% case codes 65 and 85: ±15% tan δ: case codes 63 and 64: ≤2 x spec. limit case codes 65 and 85: ≤1.5 x spec. limit $I_{L2} \leq$ spec. limit

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

CLL 139

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid, 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
- Supplied in blister tape on reel.

APPLICATIONS

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

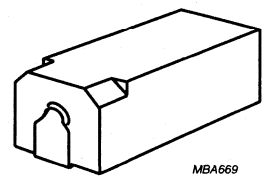

Fig.1 Component outline.

QUICK REFERENCE DATA

Nominal case sizes (L x W x H in mm)	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	–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
Based on sectional specification	IEC 384-18, CECC 32 300
Detail specification	similar to DIN 45910-T126 (without approval), former DIN 41316
Climatic category IEC 68 DIN 40040	 55/105/56 FMF

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							14.3 x 6.2 x 6.9	14.3 x 6.2 x 6.9
0.47	For lower capacitance values see CLP 172 series						14.3 x 6.2 x 6.9	14.3 x 6.2 x 6.9
1							14.3 x 6.2 x 6.9	14.3 x 6.2 x 6.9
1.5							14.3 x 6.2 x 6.9	
2.2							14.3 x 6.2 x 6.9	14.3 x 6.2 x 6.9
3.3							14.3 x 6.2 x 6.9	14.3 x 7.6 x 8.2
4.7							14.3 x 6.2 x 6.9	14.3 x 7.6 x 8.2
6.8						14.3 x 6.2 x 6.9	14.3 x 7.6 x 8.2	
10				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					14.3 x 6.2 x 6.9	14.3 x 7.6 x 8.2		
22			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							

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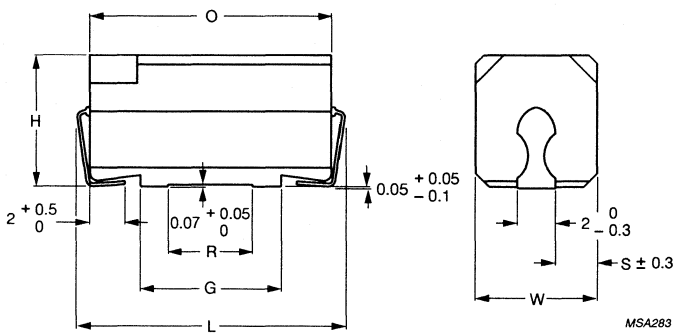
Non-solid Al - electrolytic capacitors SMD (Chip) Long Life

CLL 139

MECHANICAL DATA



Dimensions in mm.

Fig.2 Dimensional outline.

Table 2 Dimensions in mm; mass in g

CASE SIZE (mm)	CASE CODE	$L_{max.}$	$W_{max.}$	$H_{max.}$	$O_{max.}$	S	$G_{max.}$	$R_{min.}$	MASS	PACKING QUANTITIES per reel
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

- 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. The anode is identified by bevelled edges.

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 soldering pad dimensions, refer to Fig.3 and Table 3.

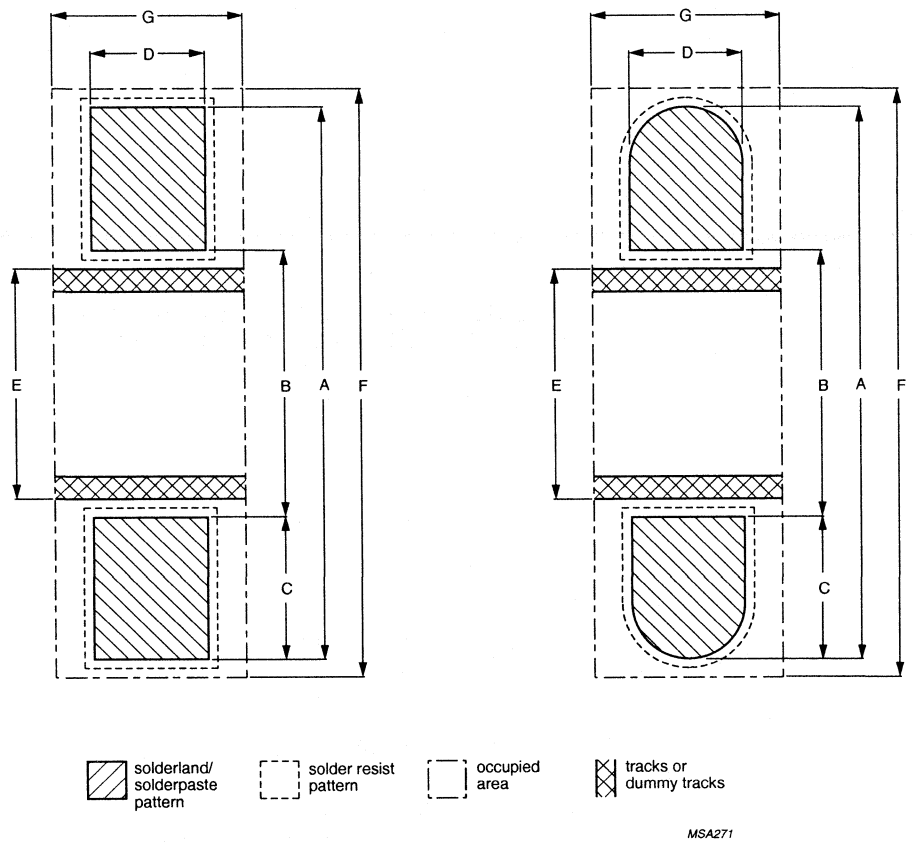


Fig.3 Recommended soldering pad dimensions for reflow and wave soldering.

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

CASE SIZE (mm)	FOR REFLOW SOLDERING							FOR WAVE SOLDERING						
	A	B	C	D	E	F	G	A	B	C	D	E	F	G
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

SM

Soldering

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

For maximum conditions of different soldering methods see Figs 4, 5 and 6.
Any temperature versus time curve may be applied which does not exceed the specified maximum curves.

Maximum temperature load

Table 4 Curing conditions for SMD-glue

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

Note:

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

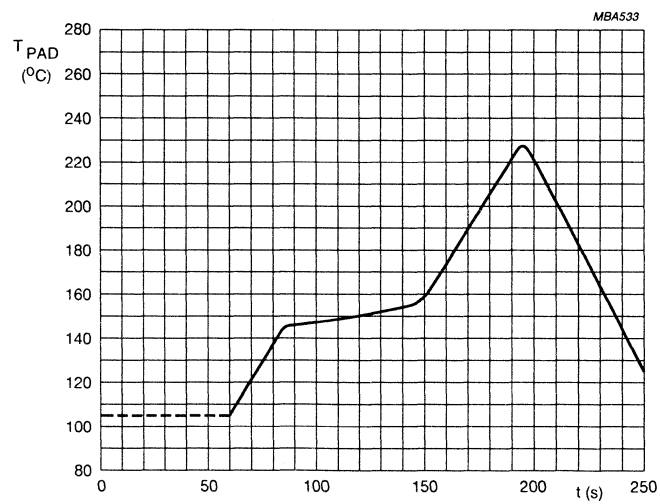


Fig.4 Max. temperature load during infrared reflow soldering.

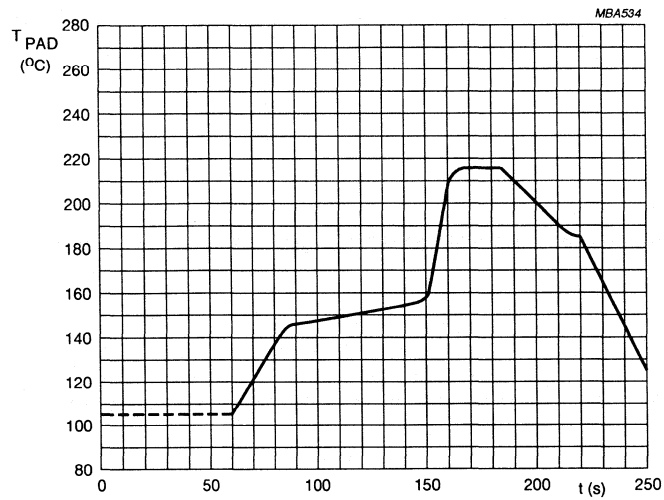


Fig.5 Max. temperature load during vapour phase reflow soldering.

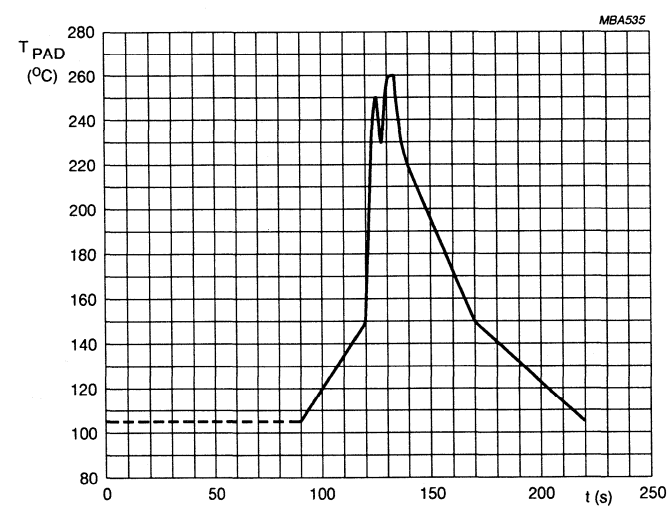


Fig.6 Max. temperature load during (double-) wave soldering.

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

CLL 139

ELECTRICAL DATA and ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 5 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.

Ordering Example

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

Table 5 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	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	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	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	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	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 capacitors 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	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	14.3 x 6.2 x 6.9	2	2.5	4	3.0	0.09	650	160	139 68227
	0.47	14.3 x 6.2 x 6.9	2	5	4	3.1	0.09	300	95	139 68477
	1	14.3 x 6.2 x 6.9	2	11	4	3.1	0.09	140	55	139 68108
	1.5	14.3 x 6.2 x 6.9	2	15	5	3.2	0.09	95	37	139 68158
	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

SM

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 $I_{L1} \leq 0.02\ C_R \times U_R + 3\ \mu A$

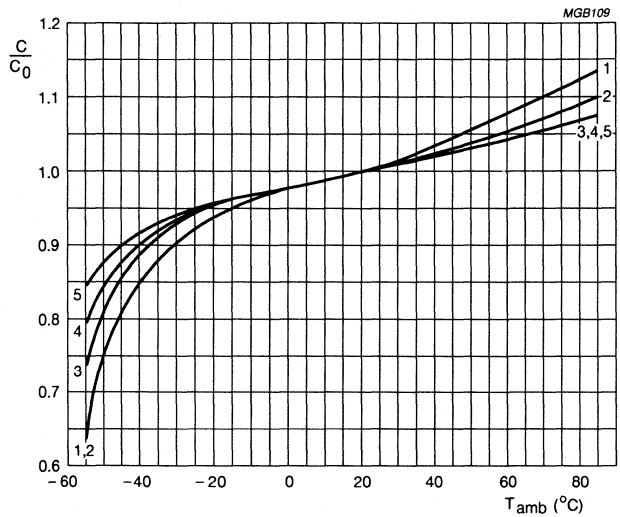
After 5 minutes at U_R $I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$

Equivalent series inductance (ESL)

case size 14.3 x 6.2 x 6.9 mm typ. 18 nH

case size 14.3 x 7.6 x 8.2 mm typ. 28 nH

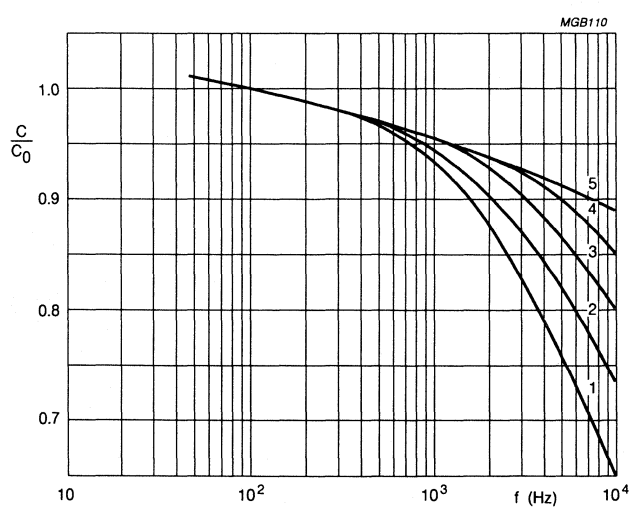
Capacitance (C)



Curve 1: 6.3 V
Curve 2: 10 V
Curve 3: 16 V
Curve 4: 25 V
Curve 5: 40 V to 100 V.

C_0 = capacitance at 20 °C, 100 Hz.

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

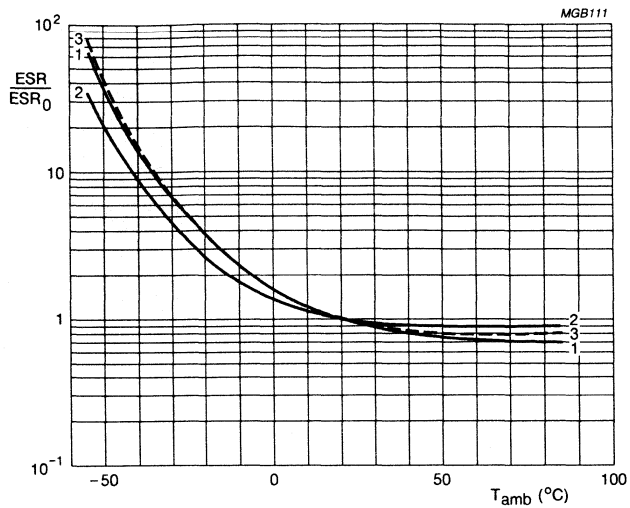


Curve 1: 6.3 V
Curve 2: 10 V
Curve 3: 16 V
Curve 4: 25 V
Curve 5: 40 V to 100 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.8 Multiplier of capacitance (C/C_0) as a function of frequency.

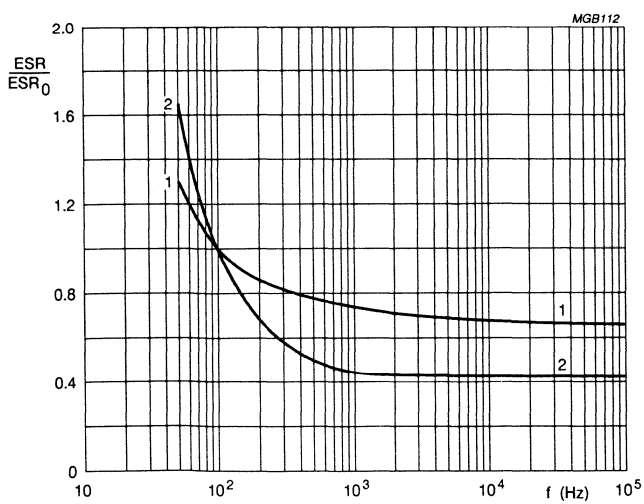
Equivalent series resistance (ESR)



Curve 1: 6.3 V
Curve 2: 40 V to 50 V
Curve 3: 63 V to 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.

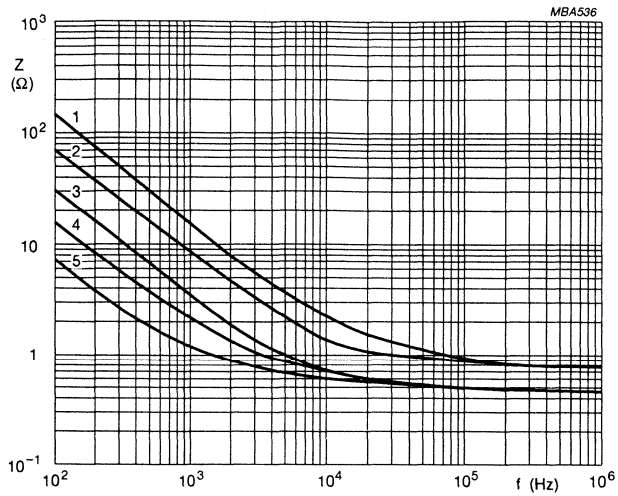


Curve 1: 6.3 V
Curve 2: 40 V to 50 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.10 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

Impedance (Z)



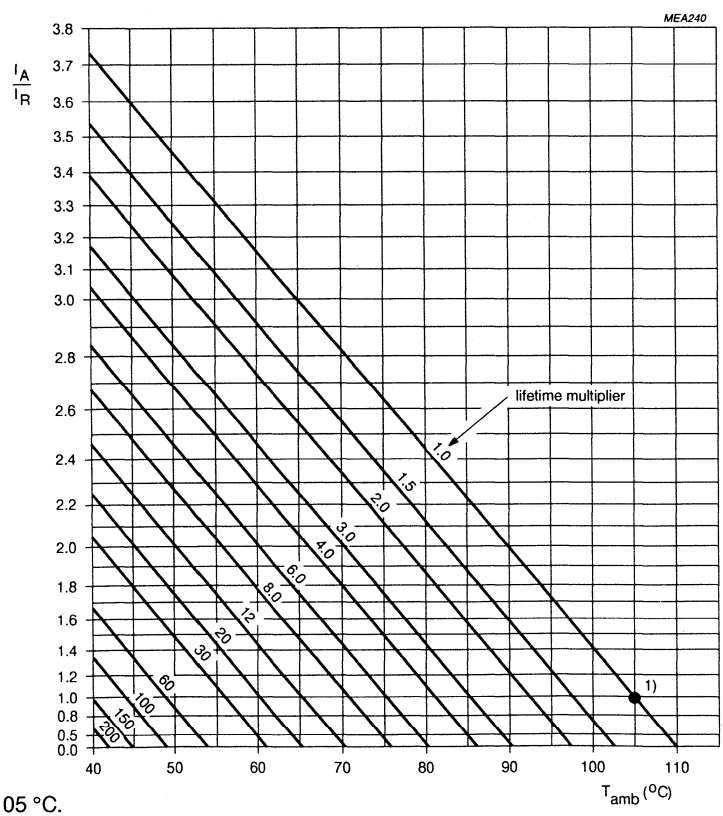
Curve 1: 10 µF, 50 V
Curve 2: 22 µF, 25 V
Curve 3: 47 µF, 25 V
Curve 4: 100 µF, 16 V
Curve 5: 220 µF, 6.3 V.

Fig.11 Typical impedance as a function of frequency at T_{amb} = 20 °C.

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 = 6.3 V to 16 V	U_R = 25 V to 50 V	U_R = 63 V 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, 105 °C.

1) Useful life at 105 °C, U_R 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).

SM

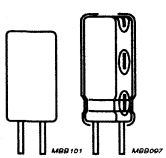
SPECIFIC TESTS and REQUIREMENTS

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

Table 7

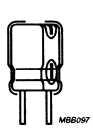
TEST		PROCEDURE (quick reference)	SPECIFIC REQUIREMENTS
Name of test	Reference		
Mounting	IEC-384-18 sub clause 4.3	to be performed prior to tests and method mentioned below: reflow or (double-) wave soldering for max. temperature load, refer to chapter "Mounting"	$\Delta C/C$ ±5% tan $\delta \leq$ spec. limit $I_{L5} \leq$ spec limit
Endurance	IEC 384-18/ CECC 32 300 sub clause 4.15	T_{amb} = 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% 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; 2000 hours	$U_R \leq 6.3$ V: $\Delta C/C$ +45/–50% U_R = 10 to 100 V: $\Delta C/C$ ±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 384-18/ CECC 32 300 sub clause 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	see Endurance (above)

RADIAL NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS



	STANDARD & MINIATURE	*SEMI-PROFESSIONAL*	*LONG-LIFE*	*EXTRA LONG-LIFE or HIGH TEMP.*
	1500-3000 hours	750-1500 hours	1500-4000 hours	1500 hours / 125 °C
	85 °C	105 °C	105 °C	⩾ 4000 hours / 105 °C
	RLC 013 *low leakage* *page 170*	*page 184* **RB 036 92** *bipolar* **RBA 036 93** *bipolar audio* *page 186*		**RHT 165** 125 °C *page 310*
	RSH 044 *HV* *page 158*	*page 188* **RSP 036** **RSS 045** *maintenance* *page 216*	**RSL 046** *page 270*	**RSX 164** 105 °C *maintenance* *page 298*
			RLI 135 *low Z* *page 242*	**RVI 136** 105 °C *very low Z* *page 284*
	RSM 037 *page 140*	*page 188* **RSP 036** **RMS 047** *page 202*	*page 228* **RLL 116** **RML 048** *page 256*	
	page 130 **RLP7 097** *H: 7 mm* **RLP5 134** *H: 5 mm* *page 120*			

smaller dimension → *higher CU per volume*



MBB745 - 1

R

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 vinyl 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.

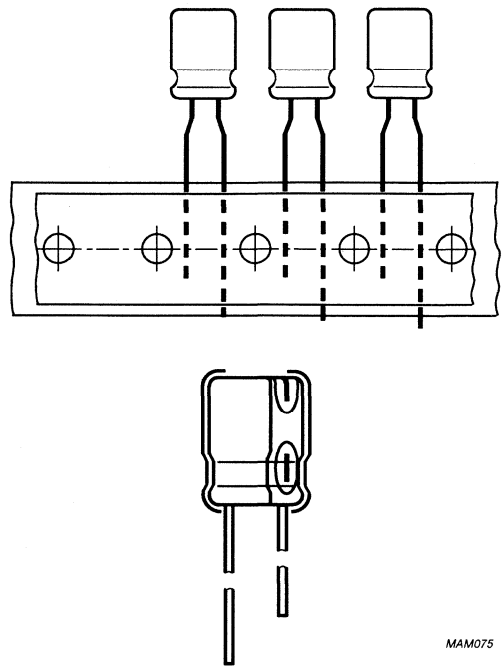


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ 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
Based on sectional specification	IEC 384-4/CECC 30 300, GP grade
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259 - with reduced dimensions
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**). Preferred types in **bold**.

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**
2.2					3 x 5	**3.5 x 5**
3.3				**3 x 5**		4 x 5
4.7			3 x 5	**3.5 x 5**	**4 x 5**	**5 x 5**
6.8				4 x 5	5 x 5	6.3 x 5
10	3 x 5		**3.5 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**			
100	**6.3 x 5**					

R

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

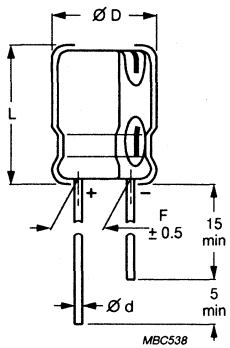
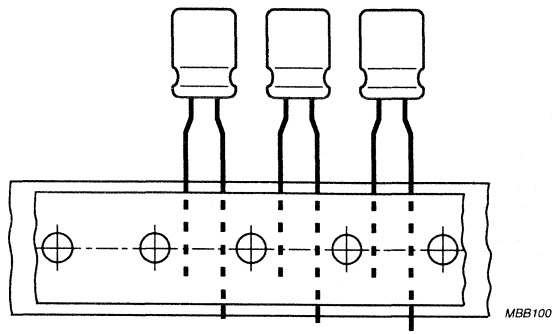


Fig.2 **Form CA**: Long leads.

Table 2 Dimensions in mm

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

Fig.3 Taped with formed leads.

R

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. Preferred types in **bold**.

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
	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	33	5 x 5	35	4	0.20	8.0	7.7	6.0
16	4.7	3 x 5	10	3	0.16	45	22	19
	10	**3.5 x 5**	17	3	0.16	21	18	17
	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
	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
	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
	22	**6.3 x 5**	40	8	0.12	7.2	13	11
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
	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

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. Preferred types in **bold**.

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 (ammopack)
				LONG LEADS	F = 2.5 mm or 5 mm
				Form CA	Form TFA
6.3	10	3 x 5	51	134 53109	134 33109
	22	4 x 5	53	134 53229	134 33229
	47	**5 x 5**	**54**	**134 53479**	**134 33479**
	100	**6.3 x 5**	**55**	**134 53101**	**134 33101**
10	33	5 x 5	54	134 54339	134 34339
16	4.7	3 x 5	51	134 55478	134 35478
	10	**3.5 x 5**	**52**	**134 55109**	**134 35109**
	22	**5 x 5**	**54**	**134 55229**	**134 35229**
	47	**6.3 x 5**	**55**	**134 55479**	**134 35479**
25	**3.3**	**3 x 5**	**51**	**134 56338**	**134 36338**
	4.7	**3.5 x 5**	**52**	**134 56478**	**134 36478**
	6.8	4 x 5	53	134 56688	134 36688
	33	6.3 x 5	55	134 56339	134 36339
35	2.2	3 x 5	51	134 50228	134 30228
	4.7	**4 x 5**	**53**	**134 50478**	**134 30478**
	6.8	5 x 5	54	134 50688	134 30688
	10	**5 x 5**	**54**	**134 50109**	**134 30109**
	22	**6.3 x 5**	**55**	**134 50229**	**134 30229**
50	0.10	3 x 5	51	134 51107	134 31107
	0.22	3 x 5	51	134 51227	134 31227
	0.47	3 x 5	51	134 51477	134 31477
	1.0	**3 x 5**	**51**	**134 51108**	**134 31108**
	2.2	**3.5 x 5**	**52**	**134 51228**	**134 31228**
	3.3	4 x 5	53	134 51338	134 31338
	4.7	**5 x 5**	**54**	**134 51478**	**134 31478**
	6.8	6.3 x 5	55	134 51688	134 31688
	10	6.3 x 5	55	134 51109	134 31109

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

RLP 5 - 134

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

MARKING

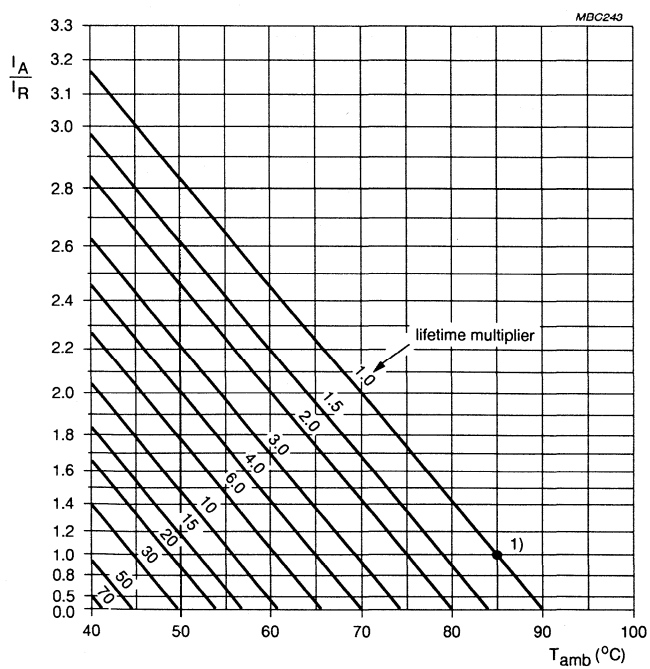
The capacitors are marked (where possible) with the following information:

- 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.4 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/ CECC 30 300 sub clause 4.13	T_{amb} = 85 °C; U_R applied; 1000 hours	$\Delta C/C \pm 20\%$ tan $\delta \leq 2$ 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; 1500 hours	$\Delta C/C \pm 50\%$ 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: ≤3%
Shelf life (storage at high temp).	IEC 384-4/ CECC 30 300 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 $I_{L2} \leq$ spec. limit

NOTES

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 vinyl 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.

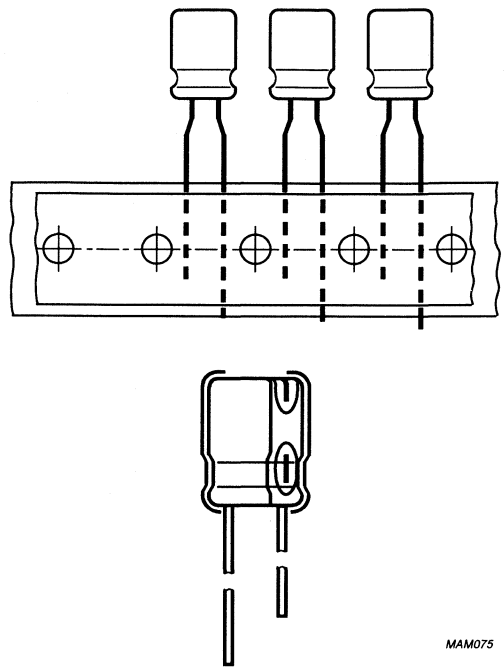


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ 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
Based on sectional specification	IEC 384-4/CECC 30 300, GP grade
Detail specificaton	similar to DIN 45910-T124 (without approval), former DIN 41259 - with reduced dimensions
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

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

RLP 7 - 097

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

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			6.3 x 7	
10			**4 x 7**		**5 x 7**	6.3 x 7	**7 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**			
100		**6.3 x 7**	**7 x 7**				
220	7 x 7						

R

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

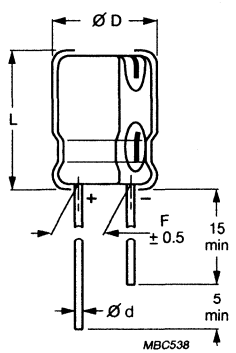
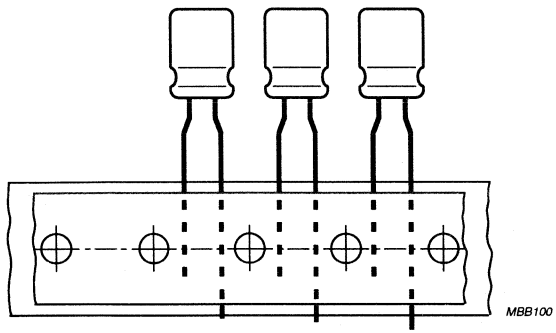


Fig.2 **Form CA**: Long leads.

Table 2 Dimensions in mm

CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	Ø d	ØD_{max}	L_{max}	F ±0.5	PACKING QUANTITIES		
						Form CA	Form TR+	Form TFA
4 x 7	71	0.45	4.5	8	1.5	2000	1800	2000
5 x 7	72	0.45	5.5	8	2	1000	1500	2000
6.3 x 7	73	0.45	6.8	8	2.5	1000	1000	2000
7 x 7	74	0.45	7.5	8	2.5	1000	1000	1000

Tape dimensions are specified in chapter "PACKING".



Form TR+: Taped on reel, positive leading.
Form TFA: Taped in box; (ammopack) PREFERRED.

Fig.3 Taped with formed leads, pitch 5 mm.

R

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. Preferred types in **bold**.

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ 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	33	5 x 7	43	4	0.20	8.0	4	3.7
	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
	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
	10	**5 x 7**	30	4	0.12	16	6.5	5.6
	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. Preferred types in **bold**.

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	TAPED IN BOX (ammopack)
				LONG LEADS	F = 5 mm + leading	F = 5 mm
				Form CA	Form TR+	Form TFA
6.3	22	4 x 7	71	097 53229	097 23229	097 33229
	47	5 x 7	72	097 53479	097 23479	097 33479
	220	7 x 7	74	097 53221	097 23221	097 33221
10	33	5 x 7	72	097 54339	097 24339	097 34339
	100	**6.3 x 7**	**73**	**097 54101**	097 24101	**097 34101**
16	6.8	4 x 7	71	097 55688	097 25688	097 35688
	10	**4 x 7**	**71**	**097 55109**	097 25109	**097 35109**
	22	**5 x 7**	**72**	**097 55229**	097 25229	**097 35229**
	47	**6.3 x 7**	**73**	**097 55479**	097 25479	**097 35479**
	100	**7 x 7**	**74**	**097 55101**	097 25101	**097 35101**
25	33	**6.3 x 7**	**73**	**097 56339**	097 26339	**097 36339**
	47	**7 x 7**	**74**	**097 56479**	097 26479	**097 36479**
35	**4.7**	**4 x 7**	**71**	**097 50478**	097 20478	**097 30478**
	10	**5 x 7**	**72**	**097 50109**	097 20109	**097 30109**
	22	**6.3 x 7**	**73**	**097 50229**	097 20229	**097 30229**
	33	7 x 7	74	097 50339	097 20339	097 30339
50	**3.3**	**4 x 7**	**71**	**097 51338**	097 21338	**097 31338**
	4.7	**5 x 7**	**72**	**097 51478**	097 21478	**097 31478**
	6.8	6.3 x 7	73	097 51688	097 21688	097 31688
	10	6.3 x 7	73	097 51109	097 21109	097 31109
	22	7 x 7	74	097 51229	097 21229	097 31229

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)	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

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)

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

RLP 7 - 097

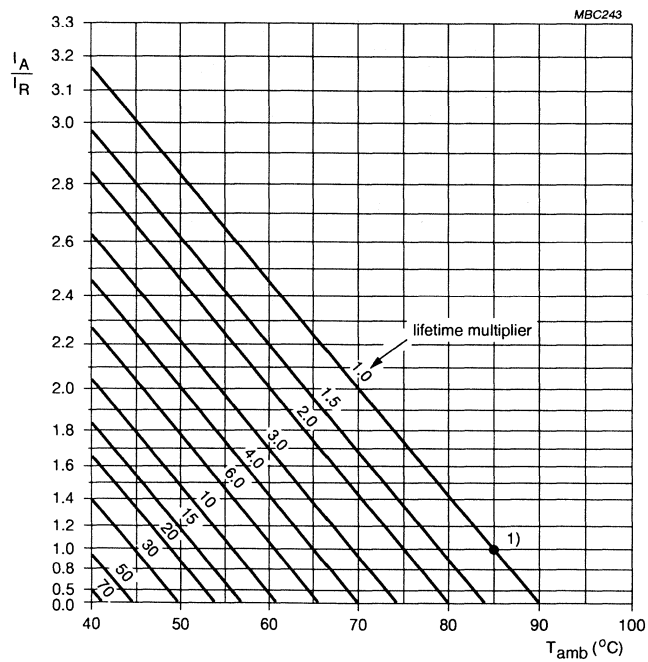
U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING	TAPED ON REEL	TAPED IN BOX (ammopack)
				LONG LEADS	F = 5 mm + leading	F = 5 mm
				Form CA	Form TR+	Form TFA
63	0.10	4 x 7	71	097 58107	097 28107	097 38107
	0.22	4 x 7	71	097 58227	097 28227	097 38227
	0.47	4 x 7	71	097 58477	097 28477	097 38477
	1	**4 x 7**	**71**	**097 58108**	097 28108	**097 38108**
	1.5	4 x 7	71	097 58158	097 28158	097 38158
	2.2	**4 x 7**	**71**	**097 58228**	097 28228	**097 38228**
	3.3	5 x 7	72	097 58338	097 28338	097 38338
	4.7	**6.3 x 7**	**73**	**097 58478**	097 28478	**097 38478**
	10	**7 x 7**	**74**	**097 58109**	097 28109	**097 38109**

F

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.4 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/ CECC 30 300 sub clause 4.13	T_{amb} = 85 °C; U_R applied; 1000 hours	$\Delta C/C \pm 20\%$ tan $\delta \leq 2$ 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; 1500 hours	$\Delta C/C \pm 50\%$ 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: ≤3%
Shelf life (storage at high temp).	IEC 384-4/ CECC 30 300 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 $I_{L2} \leq$ spec. limit

F

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 vinyl sleeve
- Pressure relief for case ØD ≥6.3 mm
- 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.

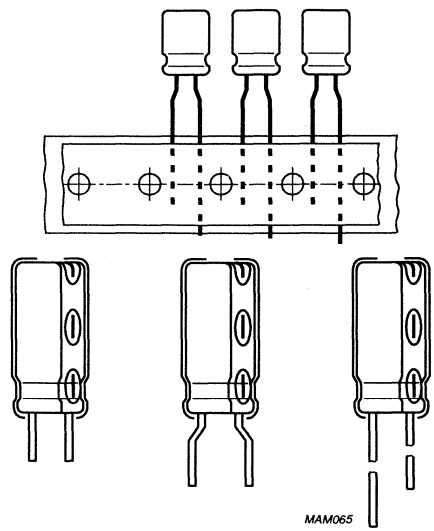


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (Ø D_{nom} x L_{nom})	5 x 11 to 16 x 31 mm
Rated capacitance range, C_R	0.47 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	2000 hours
Useful life at 85 °C	2500 hours
Useful life at 40 °C, 1.4 I_R applied	70 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300, GP grade
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259 - with reduced dimensions
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

Non-solid Al - electrolytic capacitors
Radial Standard Miniature

RSM 037

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (**Ø D x L** in **mm**). Preferred types in **bold**.

C_R (µF)	U_R (V)								
	6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**	**100**
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	
10							**5 x 11**	**5 x 11**	**6.3 x 11**
15								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	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	6.3 x 11			8 x 12	10 x 12	
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	8 x 12	8 x 12		10 x 12		10 x 16	
220		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	10 x 12	10 x 16		10 x 20	12.5 x 20	16 x 25
470		**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 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				
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 31							
10 000	16 x 31								

F

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

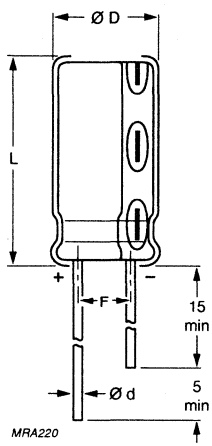


Fig.2 **Form CA**: Long leads.

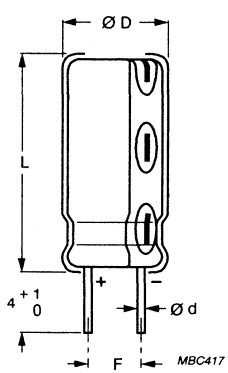


Fig.3 **Form CB**: Cut leads.

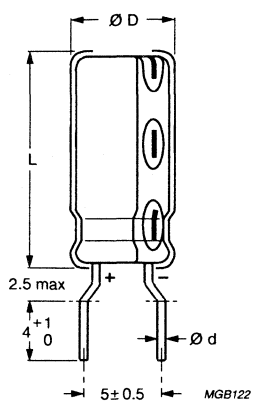


Fig.4 **Form CC**: Cut leads, formed; Ø D = 5, 6.3 and 8 mm only.

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	MASS	PACKING QUANTITIES			
							Form CA	Form CB, CC	Form TR+, TN+	Form TFA
5 x 11	11	0.5	5.5	12.5	2.0	≈0.4	3000	3000	1500	2000
6.3 x 11	12	0.6	6.8	12.5	2.5	≈0.6	2000	2000	1000	2000
8 x 12	13	0.6	8.5	13.0	3.5	≈1.1	1000	2000	800	1000
10 x 12	14	0.6	10.5	13.5	5.0	≈1.6	1000	1000	–	500
10 x 16	15	0.6	10.5	17.5	5.0	≈1.9	1000	1000	–	500
10 x 20	16	0.6	10.5	22.0	5.0	≈2.2	1000	500	–	500
12.5 x 20	17	0.6	13.0	22.0	5.0	≈4.0	1000	2000	–	500
12.5 x 25	18	0.6	13.0	27.0	5.0	≈5.0	500	2000	–	500
16 x 25	19	0.8	16.5	27.0	7.5	≈8.0	500	1000	–	250
16 x 31	20	0.8	16.5	33.5	7.5	≈9.0	200	1000	–	250

Taping dimensions are specified in chapter "PACKING".

Form TR+: Taped on reel, positive leading.
Form TFA : Taped in box (ammopack).

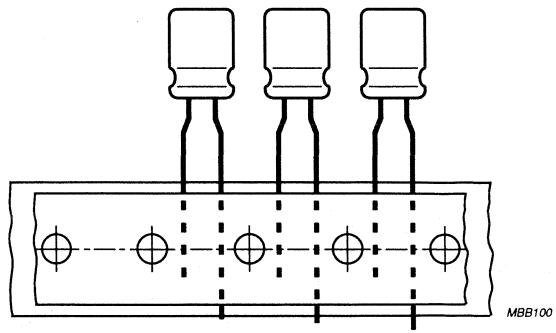
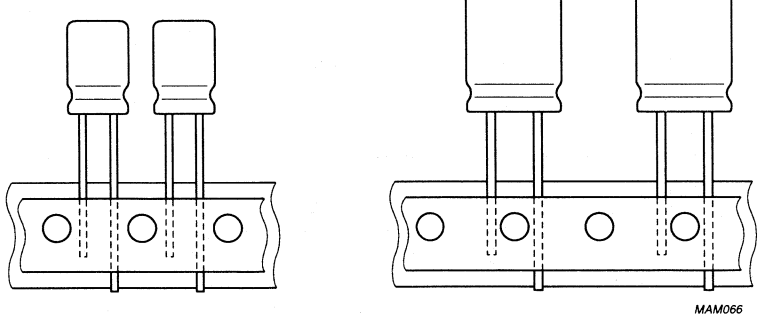


Fig.5 Taped, formed, pitch 5 mm; ØD = 5 to 8 mm.



Form TN+ and TNA:
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 TFA:
ØD 10 and 12.5 mm: F = 5 mm

Form TFA:
ØD 16 mm: F = 7.5 mm

Fig.6 Taped, straight leads.

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. Preferred types in **bold**.

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	330	6.3 x 11	12	280	24	7.2	0.24	1.2	1.8
	1000	10 x 12	14	530	66	16	0.24	0.38	0.6
	1500	10 x 20	16	730	98	22	0.25	0.27	0.4
	2200	12.5 x 20	17	990	140	31	0.26	0.19	0.27
	3300	12.5 x 20	17	1150	210	45	0.28	0.14	0.18
	10 000	16 x 31	20	2250	630	130	0.42	0.07	0.07
10	47	5 x 11	11	100	7.7	3.9	0.20	6.8	9.6
	100	**5 x 11**	**11**	140	13	5	0.20	3.2	4.5
	150	6.3 x 11	12	180	18	6	0.20	2.1	3.0
	220	6.3 x 11	12	250	25	7.4	0.20	1.4	2.0
	470	**8 x 12**	**13**	410	50	12	0.20	0.68	0.96
	1000	**10 x 16**	**15**	630	100	23	0.20	0.32	0.45
	2200	12.5 x 20	17	1050	220	47	0.22	0.16	0.20
	3300	12.5 x 25	18	1350	330	69	0.24	0.12	0.14
	4700	**16 x 25**	**19**	1800	470	97	0.28	0.09	0.10
	6800	16 x 31	20	2200	680	140	0.32	0.07	0.07

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor RSM 037
1000 µF/16 V; ±20%
Case size 10 x 20 mm; Form TFA
Catalogue number: 2222 037 35102.

Table 4 Ordering information. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL		TAPED AMMOPACK	
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED F = 5 mm Form CC	F = 5 mm + leading Form TR+	F = 2.5 mm or 3.5 mm + leading Form TN+	F = 5 mm or 7.5 mm Form TFA	F = 2.5 mm or 3.5 mm Form TNA
6.3	330	037 90021	037 90022	037 90023	037 90024	037 90026	037 90027	037 90028
	1000	037 53102	037 63102	–	–	–	037 33102	–
	1500	037 53152	037 63152	–	–	–	037 33152	–
	2200	037 53222	037 63222	–	–	–	037 33222	–
	3300	037 53332	037 63332	–	–	–	037 33332	–
	10 000	037 53103	037 63103	–	–	–	037 33103	–
10	47	037 54479	037 84479	037 64479	037 24479	037 14479	037 34479	037 74479
	100	**037 54101**	037 84101	037 64101	037 24101	037 14101	**037 34101**	037 74101
	150	037 54151	037 84151	037 64151	037 24151	037 14151	037 34151	037 74151
	220	037 90029	037 90031	037 90032	037 90012	037 90035	037 90036	037 90037
	470	**037 54471**	037 84471	037 64471	037 24471	037 14471	**037 34471**	037 74471
	1000	037 54102	**037 64102**	–	–	–	**037 34102**	–
	2200	037 54222	037 64222	–	–	–	037 34222	–
	3300	037 54332	037 64332	–	–	–	037 34332	–
	4700	037 54472	**037 64472**	–	–	–	**037 34472**	–
	6800	037 54682	037 64682	–	–	–	037 34682	–

F

Non-solid Al - electrolytic capacitors
Radial Standard Miniature

RSM 037

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø 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	90	8.3	4.1	0.16	7.7	9.7
	68	5 x 11	11	130	14	5.2	0.16	3.7	4.7
	100	6.3 x 11	12	180	19	6.2	0.16	2.5	3.2
	150	8 x 12	13	250	27	7.8	0.16	1.7	2.1
	220	8 x 12	13	300	38	10	0.16	1.2	1.5
	330	8 x 12	13	370	56	14	0.16	0.77	0.97
	470	**10 x 12**	**14**	420	78	18	0.16	0.54	0.68
	680	10 x 16	15	520	110	25	0.16	0.37	0.47
	1000	**10 x 20**	**16**	740	160	35	0.16	0.25	0.32
	1500	12.5 x 20	17	900	240	51	0.17	0.18	0.21
	2200	**12.5 x 25**	**18**	1200	360	73	0.18	0.13	0.15
	3300	16 x 25	19	1650	530	109	0.20	0.10	0.10
	4700	16 x 31	20	2100	760	150	0.24	0.08	0.07
25	**47**	**5 x 11**	**11**	120	15	5.4	0.14	4.7	4.7
	68	6.3 x 11	12	130	20	6.4	0.14	3.3	3.2
	100	**6.3 x 11**	**12**	190	28	8	0.14	2.2	2.2
	150	8 x 12	13	230	41	11	0.14	1.5	1.5
	220	**8 x 12**	**13**	320	58	14	0.14	1.0	1.0
	330	10 x 12	14	410	86	20	0.14	0.68	0.67
	470	**10 x 16**	**15**	510	120	26	0.14	0.47	0.47
	1000	**12.5 x 20**	**17**	910	250	53	0.14	0.22	0.22
	1500	12.5 x 25	18	1100	380	78	0.15	0.16	0.15
	2200	**16 x 25**	**19**	1500	550	110	0.16	0.12	0.10
	3300	**16 x 31**	**20**	1900	830	170	0.18	0.09	0.07
35	**22**	**5 x 11**	**11**	87	11	4.5	0.12	8.7	6.8
	33	5 x 11	11	110	15	5.3	0.12	5.8	4.5
	220	**10 x 12**	**14**	330	80	18	0.12	0.87	0.68
	330	10 x 16	15	450	120	26	0.12	0.58	0.45
	470	**10 x 20**	**16**	590	170	36	0.12	0.41	0.32
	680	12.5 x 20	17	830	240	51	0.12	0.28	0.22
	1000	**12.5 x 25**	**18**	1050	350	73	0.12	0.19	0.15
	1500	16 x 25	19	1400	530	110	0.13	0.14	0.10
	2200	**16 x 31**	**20**	1750	770	160	0.14	0.10	0.07

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 AMMOPACK	
		LONG LEADS	CUT LEADS	CUT LEADS FORMED F = 5 mm	F = 5 mm + leading	F = 2.5 mm or 3.5 mm + leading	F = 5 mm or 7.5 mm	F = 2.5 mm or 3.5 mm
		Form CA	Form CB	Form CC	Form TR+	Form TN+	Form TFA	Form TNA
16	33	037 55339	037 85339	037 65339	037 25339	037 15339	037 35339	037 75339
	68	037 55689	037 85689	037 65689	037 25689	037 15689	037 35689	037 75689
	100	037 55101	037 85101	037 65101	037 25101	037 15101	037 35101	037 75101
	150	037 55151	037 85151	037 65151	037 25151	037 15151	037 35151	037 75151
	220	037 55221	037 85221	037 65221	037 25221	037 15221	037 35221	037 75221
	330	037 90038	037 90039	037 90041	037 90042	037 90044	037 90045	037 90046
	470	037 55471	**037 65471**	–	–	–	**037 35471**	–
	680	037 55681	037 65681	–	–	–	037 35681	–
	1000	037 55102	**037 65102**	–	–	–	**037 35102**	–
	1500	037 55152	037 65152	–	–	–	037 35152	–
	2200	037 55222	**037 65222**	–	–	–	**037 35222**	–
	3300	037 55332	037 65332	–	–	–	037 35332	–
	4700	037 55472	037 65472	–	–	–	037 35472	–
25	**47**	**037 56479**	037 86479	037 66479	037 26479	037 16479	**037 36479**	037 76479
	68	037 56689	037 86689	037 66689	037 26689	037 16689	037 36689	037 76689
	100	**037 90047**	037 90048	037 90049	037 90051	037 90053	**037 90054**	037 90055
	150	037 56151	037 86151	037 66151	037 26151	037 16151	037 36151	037 76151
	220	**037 56221**	037 86221	037 66221	037 26221	037 16221	**037 36221**	037 76221
	330	037 56331	037 66331	–	–	–	037 36331	–
	470	037 56471	**037 66471**	–	–	–	**037 36471**	–
	1000	037 56102	**037 66102**	–	–	–	**037 36102**	–
	1500	037 56152	037 66152	–	–	–	037 36152	–
	2200	037 56222	**037 66222**	–	–	–	**037 36222**	–
	3300	037 56332	**037 66332**	–	–	–	**037 36332**	–
35	**22**	**037 50229**	037 80229	037 60229	037 20229	037 10229	**037 30229**	037 70229
	33	037 50339	037 80339	037 60339	037 20339	037 10339	037 30339	037 70339
	220	037 50221	**037 60221**	–	–	–	**037 30221**	–
	330	037 50331	037 60331	–	–	–	037 30331	–
	470	037 50471	**037 60471**	–	–	–	**037 30471**	–
	680	037 50681	037 60681	–	–	–	037 30681	–
	1000	037 50102	**037 60102**	–	–	–	**037 30102**	–
	1500	037 50152	037 60152	–	–	–	037 30152	–
	2200	037 50222	**037 60222**	–	–	–	**037 30222**	–

Non-solid Al - electrolytic capacitors
Radial Standard Miniature

RSM 037

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	22	5 x 11	11	91	12	4.8	0.12	8.7	5.9
	33	6.3 x 11	12	110	16	5.6	0.12	5.8	3.9
	47	6.3 x 11	12	130	22	6.8	0.12	4.1	2.8
	100	8 x 12	13	210	43	11	0.12	1.9	1.3
	150	10 x 12	14	250	63	15	0.12	1.3	0.87
	470	12.5 x 20	17	670	190	41	0.12	0.41	0.28
	680	12.5 x 25	18	850	280	57	0.12	0.28	0.19
	1000	16 x 25	19	1200	400	83	0.12	0.19	0.13
50	**10**	**5 x 11**	**11**	65	8	4	0.10	16	9.5
	22	**5 x 11**	**11**	95	14	5.2	0.10	7.2	4.3
	47	**6.3 x 11**	**12**	150	27	7.7	0.10	3.4	2.0
	68	8 x 12	13	190	37	10	0.10	2.3	1.4
	100	**8 x 12**	**13**	260	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**	740	240	50	0.10	0.34	0.20
	680	12.5 x 25	18	950	340	71	0.10	0.23	0.14
	1000	**16 x 25**	**19**	1350	500	100	0.10	0.16	0.10

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 AMMOPACK	
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED F = 5 mm Form CC	F = 5 mm + leading Form TR+	F = 2.5 mm or 3.5 mm + leading Form TN+	F = 5 mm or 7.5 mm Form TFA	F = 2.5 mm or 3.5 mm Form TNA
40	22	037 57229	037 87229	037 67229	037 27229	037 17229	037 37229	037 77229
	33	037 57339	037 87339	037 67339	037 27339	037 17339	037 37339	037 77339
	47	037 57479	037 87479	037 67479	037 27479	037 17479	037 37479	037 77479
	100	037 57101	037 87101	037 67101	037 27101	037 17101	037 37101	037 77101
	150	037 57151	037 67151	–	–	–	037 37151	–
	470	037 57471	037 67471	–	–	–	037 37471	–
	680	037 57681	037 67681	–	–	–	037 37681	–
	1000	037 57102	037 67102	–	–	–	037 37102	–
50	**10**	**037 51109**	037 81109	037 61109	037 21109	037 11109	**037 31109**	037 71109
	22	**037 90056**	037 90057	037 90058	037 90059	037 90062	**037 90063**	037 90064
	47	**037 90065**	037 90066	037 90067	037 90068	037 90071	**037 90072**	037 90073
	68	037 51689	037 81689	037 61689	037 21689	037 11689	037 31689	037 71689
	100	**037 51101**	037 81101	037 61101	037 21101	037 11101	**037 31101**	037 71101
	220	037 51221	**037 61221**	–	–	–	**037 31221**	–
	330	037 51331	037 61331	–	–	–	037 31331	–
	470	037 51471	**037 61471**	–	–	–	**037 31471**	–
	680	037 51681	037 61681	–	–	–	037 31681	–
	1000	037 51102	**037 61102**	–	–	–	**037 31102**	–

F

Non-solid Al - electrolytic capacitors
Radial Standard Miniature

RSM 037

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	0.47	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**	29	4.4	3.3	0.09	65	36
	3.3	5 x 11	11	35	5.1	3.4	0.09	43	24
	4.7	**5 x 11**	**11**	45	6.0	3.6	0.09	30	17
	6.8	5 x 11	11	51	7.3	3.9	0.09	21	12
	10	**5 x 11**	**11**	70	9.3	4.3	0.09	14	8.0
	15	5 x 11	11	82	12	4.9	0.09	9.5	5.3
	22	**6.3 x 11**	**12**	110	17	5.8	0.09	6.5	3.6
	33	6.3 x 11	12	140	24	7.2	0.09	4.3	2.4
	47	**8 x 12**	**13**	190	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	650	210	45	0.09	0.43	0.24
	470	**12.5 x 25**	**18**	850	300	62	0.09	0.30	0.17
	680	16 x 25	19	1150	430	89	0.09	0.21	0.12
	1000	**16 x 31**	**20**	1550	630	130	0.09	0.14	0.08
100	0.47	5 x 11	11	12	3.5	3.1	0.07	237	130
	1.0	**5 x 11**	**11**	22	4	3.2	0.07	111	60
	2.2	5 x 11	11	33	5.2	3.4	0.07	51	27
	3.3	5 x 11	11	40	6.3	3.7	0.07	34	18
	4.7	5 x 11	11	48	7.7	3.9	0.07	24	13
	10	**6.3 x 11**	**12**	80	13	5	0.07	11	6.0
	15	8 x 12	13	110	18	6	0.07	7.4	4.0
	22	**8 x 12**	**13**	130	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
	100	10 x 20	16	350	100	23	0.07	1.1	0.60
	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

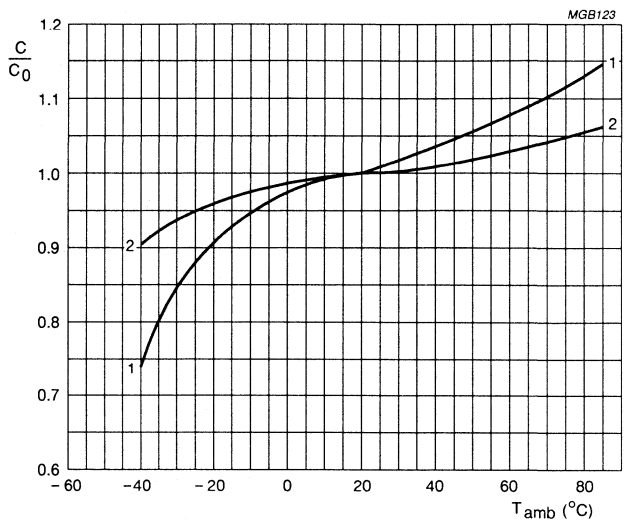
Non-solid Al - electrolytic capacitors
Radial Standard Miniature

RSM 037

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL		TAPED AMMOPACK	
		LONG LEADS	CUT LEADS	CUT LEADS FORMED F = 5 mm	F = 5 mm + leading	F = 2.5 mm or 3.5 mm + leading	F = 5 mm or 7.5 mm	F = 2.5 mm or 3.5 mm
		Form CA	Form CB	Form CC	Form TR+	Form TN+	Form TFA	Form TNA
63	0.47	037 58477	037 88477	037 68477	037 28477	037 18477	037 38477	037 78477
	1.0	**037 58108**	037 88108	037 68108	037 28108	037 18108	**037 38108**	037 78108
	2.2	**037 58228**	037 88228	037 68228	037 28228	037 18228	**037 38228**	037 78228
	3.3	037 58338	037 88338	037 68338	037 28338	037 18338	037 38338	037 78338
	4.7	**037 58478**	037 88478	037 68478	037 28478	037 18478	**037 38478**	037 78478
	6.8	037 58688	037 88688	037 68688	037 28688	037 18688	037 38688	037 78668
	10	**037 58109**	037 88109	037 68109	037 28109	037 18109	**037 38109**	037 78109
	15	037 58159	037 88159	037 68159	037 28159	037 18159	037 38159	037 78159
	22	**037 58229**	037 88229	037 68229	037 28229	037 18229	**037 38229**	037 78229
	33	037 90074	037 90075	037 90076	037 90077	037 90079	037 90081	037 90082
	47	**037 58479**	037 88479	037 68479	037 28479	037 18479	**037 38479**	037 78479
	68	037 58689	037 68689	–	–	–	037 38689	–
	100	037 58101	**037 68101**	–	–	–	**037 38101**	–
	150	037 58151	037 68151	–	–	–	037 38151	–
	220	037 58221	**037 68221**	–	–	–	**037 38221**	–
	330	037 58331	037 68331	–	–	–	037 38331	–
	470	037 58471	**037 68471**	–	–	–	**037 38471**	–
	680	037 58681	037 68681	–	–	–	037 38681	–
	1000	037 58102	**037 68102**	–	–	–	**037 38102**	–
100	0.47	037 59477	037 89477	037 69477	037 29477	037 19477	037 39477	037 79477
	1.0	**037 59108**	037 89108	037 69108	037 29108	037 19108	**037 39108**	037 79108
	2.2	037 59228	037 89228	037 69228	037 29228	037 19228	037 39228	037 79228
	3.3	037 59338	037 89338	037 69338	037 29338	037 19338	037 39338	037 79338
	4.7	037 59478	037 89478	037 69478	037 29478	037 19478	037 39478	037 79478
	10	**037 59109**	037 89109	037 69109	037 29109	037 19109	**037 39109**	037 79109
	15	037 59159	037 89159	037 69159	037 29159	037 19159	037 39159	037 79159
	22	**037 59229**	037 89229	037 69229	037 29229	037 19229	**037 39229**	037 79229
	33	037 59339	037 69339	–	–	–	037 39339	–
	47	037 59479	037 69479	–	–	–	037 39479	–
	100	037 59101	037 69101	–	–	–	037 39101	–
	220	037 59221	037 69221	–	–	–	037 39221	–
	330	037 59331	037 69331	–	–	–	037 39331	–
	470	037 59471	037 69471	–	–	–	037 39471	–

R

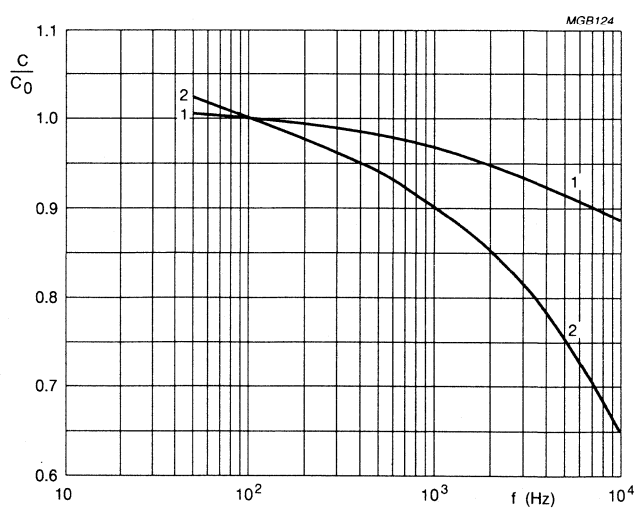
Capacitance (C)



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.

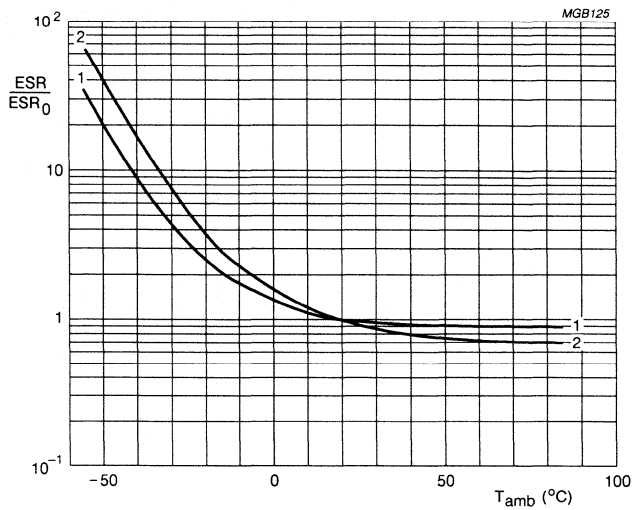


Curve 1: 100 V
Curve 2: 6.3 V.

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)

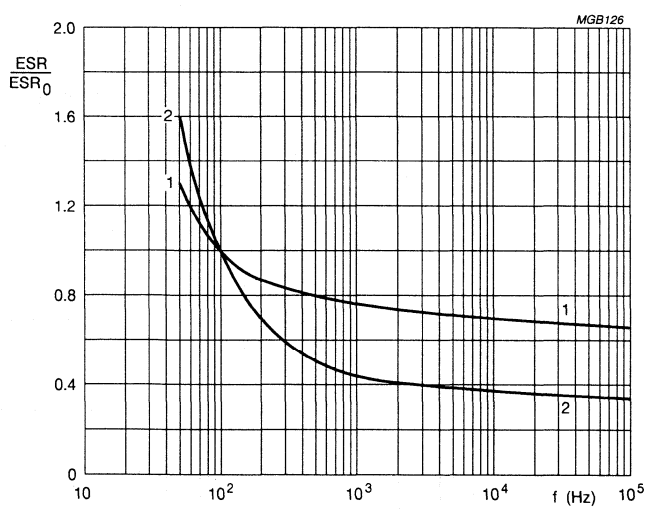


Curve 1: 63 V (≥4.7 µF)
Curve 2: 10 V.

ESR_o = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR_o) as a function of ambient temperature.

R



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.

Impedance (Z)

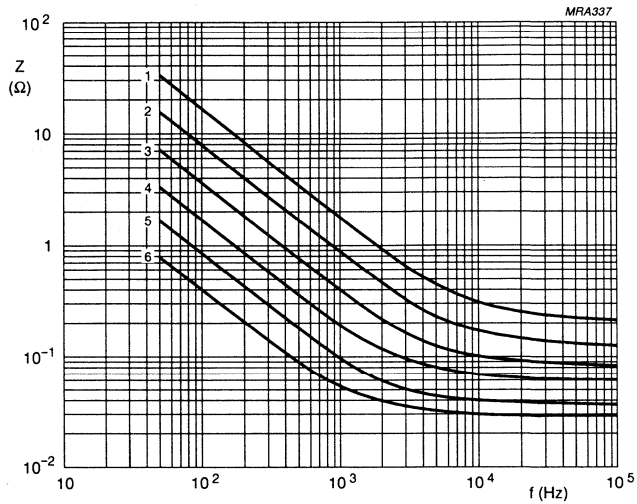


Fig.11 Typical impedance as a function of frequency at T_{amb} = 20 °C.

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	$I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$

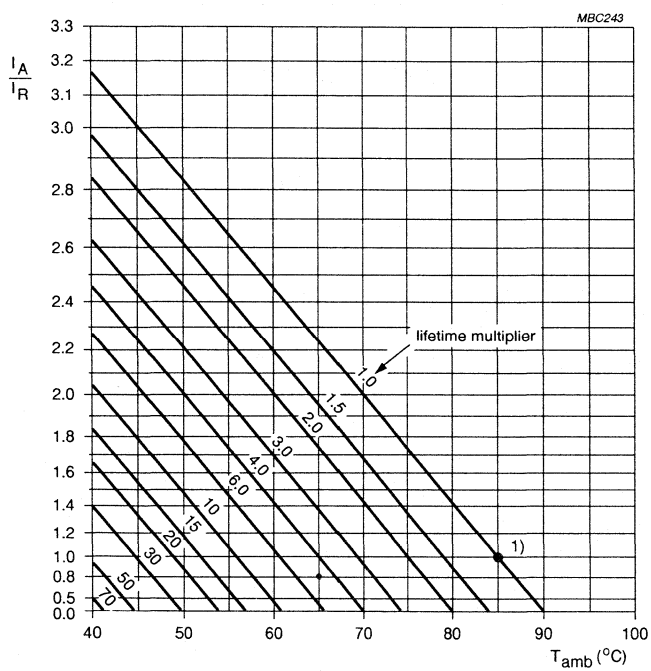
Equivalent series inductance (ESL)

case ∅ D ≤ 8 mm	typ. 13 nH
case ∅ D = 10 mm	typ. 16 nH
case ∅ D ≥ 12.5 mm	typ. 18 nH

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 V to 10 V	U_R = 16 V to 35 V	U_R = 40 V 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: 2500 hours.

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

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.

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/ CECC 30300 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: $\Delta C/C$ ±20% tan $\delta \leq 1.5$ x spec. limit $Z \leq 3$ 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; 2500 hours	$U_R \leq 6.3$ V: $\Delta C/C$ +45/–50% $U_R > 6.3$ V: $\Delta C/C$ ±50% 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: ≤3%
Shelf life (storage at high temp).	IEC 384-4/ CECC 30300 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 $I_{L5} \leq 2$ x spec. limit

NOTES

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 vinyl sleeve
- Pressure relief
- Charge and discharge proof
- Reduced dimensions
- High rated voltage, up to 450 V.

APPLICATIONS

- General purpose, audio-video, lighting, general industrial
- Smoothing, filtering, buffering of high voltages
- Low surface demand on printed circuit board.

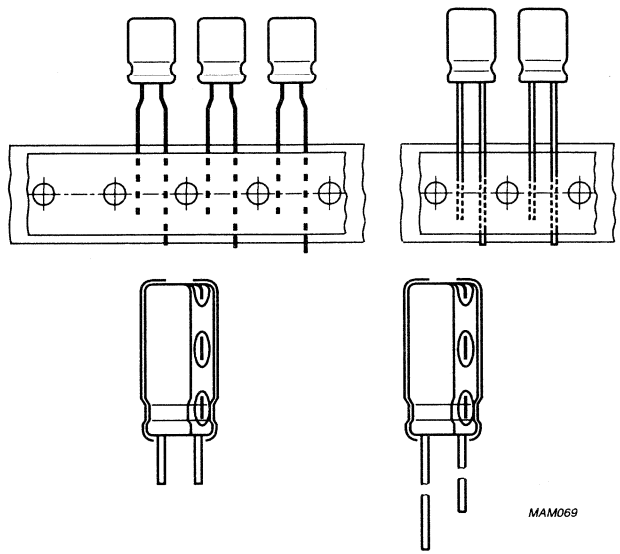


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	6.3 x 11 to 16 x 31
Rated capacitance range, C_R	1.0 to 100 µF
Tolerance on C_R	±20%
Rated voltage range, U_R	160 to 450 V
Category temperature range	≤400 V: −40 to +85 °C; 450 V: −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
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259
Climatic category IEC 68 DIN 40040	 ≤400 V: 40/085/56; 450 V: 25/085/56 ≤400: GPF; 450 V: HPF

Non-solid Al - electrolytic capacitors
Radial Standard, High Voltage

RSH 044

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**	**400**	**450**
1.0			6.3 x 11	8 x 12	8 x 12	10 x 12
2.2			8 x 12	10 x 12	10 x 12	10 x 16
3.3			10 x 12		10 x 16	10 x 20
4.7		10 x 12	10 x 12	10 x 16	10 x 20	12.5 x 20
10	10 x 16	10 x 16	10 x 20	12.5 x 20	12.5 x 20	12.5 x 25
22	10 x 20	10 x 20	12.5 x 25	12.5 x 25	16 x 25	16 x 31
33	12.5 x 20	12.5 x 25	12.5 x 25	16 x 25	16 x 31	
47	12.5 x 25	12.5 x 25	16 x 25	16 x 31		
100	16 x 25	16 x 31				

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	Form CB	Form TFA TNA
6.3 x 11	12	0.6	6.8	12.5	2.5	0.6	2000	2000	2000
8 x 12	13	0.6	8.5	13.0	3.5	1.1	1000	2000	1000
10 x 12	14	0.6	10.5	14.0	5.0	1.6	2000	1500	800
10 x 16	15	0.6	10.5	17.5	5.0	1.9	2000	1500	800
10 x 20	16	0.6	10.5	22.0	5.0	2.2	2000	1500	800
12.5 x 20	17	0.6	13.0	22.0	5.0	4.0	1000	1500	500
12.5 x 25	18	0.6	13.0	27.0	5.0	5.0	1000	1500	500
16 x 25	19	0.8	16.5	27.0	7.5	8.0	500	500	–
16 x 31	20	0.8	16.5	33.5	7.5	9.0	500	500	–

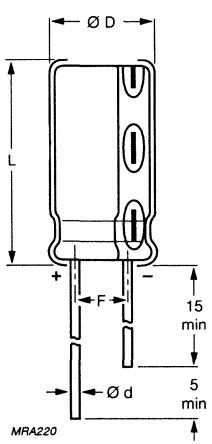


Fig.2 **Form CA**: Long leads.

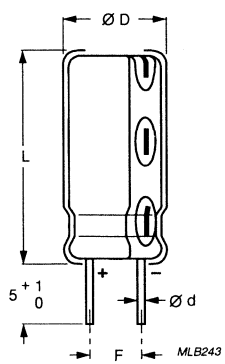
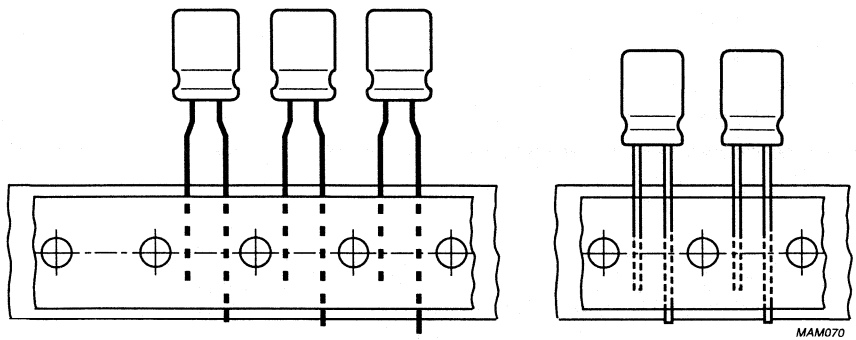


Fig.3 **Form CB**: Cut leads.

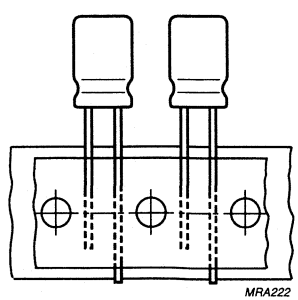
Taping dimensions are specified in chapter "PACKING".



Form TFA : Taped, formed, pitch 5 mm in box (ammopack)

Form TNA : Taped, pitch 2.5 or 3.5 mm respectively in box (ammopack).

Fig.4 Taped, ∅ D = <10 mm only.



Form TFA: ∅D 10 and 12.5 mm, pitch 5mm.

Fig.5 Taped in box (ammopack) ∅D ≥10 mm.

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	83	120	54	0.14	22	12	180
	22	10 x 20	16	140	180	83	0.14	10	5.5	82
	33	12.5 x 20	17	180	230	110	0.14	6.8	3.6	55
	47	12.5 x 25	18	230	300	140	0.14	4.7	2.6	38
	100	16 x 25	19	380	550	270	0.14	2.2	1.8	26
200	4.7	10 x 12	14	51	96	43	0.14	47	26	380
	10	10 x 16	15	85	130	60	0.14	22	12	180
	22	10 x 20	16	140	200	96	0.14	10	5.5	82
	33	12.5 x 25	18	190	270	130	0.14	6.8	3.6	55
	47	12.5 x 25	18	230	350	170	0.14	4.7	2.6	38
	100	16 x 31	20	400	670	330	0.14	2.2	1.5	22
250	1.0	6.3 x 11	12	17	55	23	0.14	220	110	1800
	2.2	8 x 12	13	30	73	32	0.14	100	55	820
	3.3	10 x 12	14	43	90	40	0.14	68	36	550
	4.7	10 x 12	14	51	110	48	0.14	47	26	380
	10	10 x 20	16	95	150	68	0.14	22	12	180
	22	12.5 x 25	18	160	240	110	0.14	10	5.5	82
	33	12.5 x 25	18	190	320	150	0.14	6.8	3.6	55
	47	16 x 25	19	260	420	210	0.14	4.7	2.6	38
350	1.0	8 x 12	13	22	61	26	0.13	210	100	1500
	2.2	10 x 12	14	39	86	38	0.13	94	39	550
	4.7	10 x 16	15	63	120	55	0.13	44	18	260
	10	12.5 x 20	17	120	180	83	0.13	21	8.5	120
	22	12.5 x 25	18	180	300	150	0.13	9.4	3.9	55
	33	16 x 25	19	250	420	200	0.13	6.3	2.6	36
	47	16 x 31	20	320	560	280	0.13	4.4	2.3	31

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor RSH 044
47 µF/250 V; ±20%
Case size 16 x 25 mm; Form CA
Catalogue number: 2222 044 53479.

Table 4 Ordering information

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222 . . . . . NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	BULK PACKING		TAPED IN BOX (ammopack)	
				LONG LEADS	CUT LEADS	F = 5 mm	F = 2.5 or 3.5 mm
				Form CA	Form CB	Form TFA	Form TNA
160	10	10 x 16	15	044 51109	044 61109	044 31109	–
	22	10 x 20	16	044 51229	044 61229	044 31229	–
	33	12.5 x 20	17	044 51339	044 61339	044 31339	–
	47	12.5 x 25	18	044 90512	044 90513	044 90515	–
	100	16 x 25	19	044 51101	044 61101	–	–
200	4.7	10 x 12	14	044 52478	044 62478	044 32478	–
	10	10 x 16	15	044 52109	044 62109	044 32109	–
	22	10 x 20	16	044 52229	044 62229	044 32229	–
	33	12.5 x 25	18	044 52339	044 62339	044 32339	–
	47	12.5 x 25	18	044 90516	044 90517	044 90519	–
	100	16 x 31	20	044 52101	044 62101	–	–
250	1.0	6.3 x 11	12	044 90501	044 90502	044 90506	044 90507
	2.2	8 x 12	13	044 90015	044 90016	044 90019	044 90529
	3.3	10 x 12	14	044 53338	044 63338	044 33338	–
	4.7	10 x 12	14	044 53478	044 63478	044 33478	–
	10	10 x 20	16	044 53109	044 63109	044 33109	–
	22	12.5 x 25	18	044 53229	044 63229	044 33229	–
	33	12.5 x 25	18	044 90521	044 90522	044 90524	–
	47	16 x 25	19	044 53479	044 63479	–	–
350	1.0	8 x 12	13	044 55108	044 85108	044 35108	044 75108
	2.2	10 x 12	14	044 55228	044 65228	044 35228	–
	4.7	10 x 16	15	044 55478	044 65478	044 35478	–
	10	12.5 x 20	17	044 55109	044 65109	044 35109	–
	22	12.5 x 25	18	044 90525	044 90526	044 90528	–
	33	16 x 25	19	044 55339	044 65339	–	–
	47	16 x 31	20	044 55479	044 65479	–	–

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)
400	1.0	8 x 12	13	22	64	27	0.15	240	85	1200
	2.2	10 x 12	14	39	93	41	0.15	110	39	550
	3.3	10 x 16	15	53	110	50	0.15	72	26	360
	4.7	10 x 20	16	70	130	58	0.15	51	18	260
	10	12.5 x 20	17	110	190	90	0.15	24	8.5	120
	22	16 x 25	19	200	330	160	0.15	11	3.9	55
	33	16 x 31	20	270	470	230	0.15	7.2	3.2	49
450	1.0	10 x 12	14	25	67	29	0.26	410	120	2000
	2.2	10 x 16	15	42	99	45	0.26	190	55	910
	3.3	10 x 20	16	56	110	52	0.26	130	36	700
	4.7	12.5 x 20	17	75	130	62	0.26	88	26	380
	10	12.5 x 25	18	120	210	100	0.26	41	12	260
	22	16 x 31	20	210	370	180	0.26	19	5.5	82

Voltage

Surge voltage for short periods
160 to 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
$CV \leq 1000$ µC $I_{L1} \leq 0.06\ C_R \times U_R + 40$ µA
$CV > 1000$ µC $I_{L1} \leq 0.03\ C_R \times U_R + 70$ µA

After 5 minutes at U_R
$CV \leq 1000$ µC $I_{L5} \leq 0.03\ C_R \times U_R + 15$ µA
$CV > 1000$ µC $I_{L5} \leq 0.015\ C_R \times U_R + 30$ µA

Equivalent series inductance (ESL)

case ∅ D = 6.3 and 8 mm typ. 13 nH
case ∅ D = 10 mm typ. 16 nH
case ∅ D ≥ 12.5 mm typ. 18 nH

Non-solid Al - electrolytic capacitors
Radial Standard, High Voltage

RSH 044

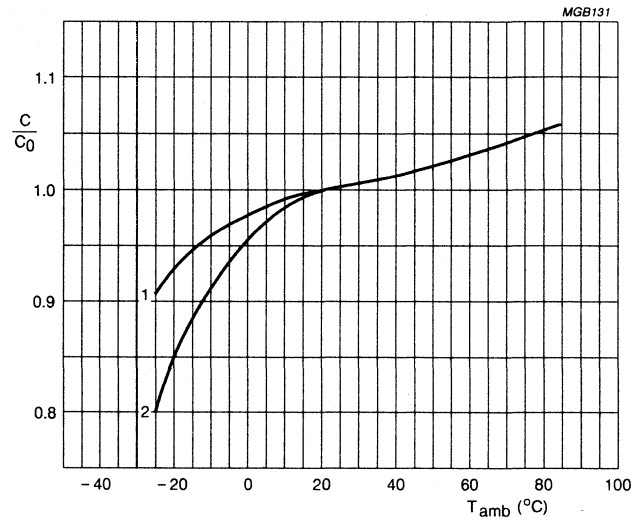
U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222 . . . . . NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	BULK PACKING		TAPED IN BOX (ammopack)	
				LONG LEADS	CUT LEADS	F = 5 mm	F = 2.5 or 3.5 mm
				Form CA	Form CB	Form TFA	Form TNA
400	1.0	8 x 12	13	044 56108	044 86108	044 36108	044 76108
	2.2	10 x 12	14	044 56228	044 66228	044 36228	–
	3.3	10 x 16	15	044 56338	044 66338	044 36338	–
	4.7	10 x 20	16	044 56478	044 66478	044 36478	–
	10	12.5 x 20	17	044 56109	044 66109	044 36109	–
	22	16 x 25	19	044 56229	044 66229	–	–
	33	16 x 31	20	044 56339	044 66339	–	–
450	1.0	10 x 12	14	044 57108	044 67108	044 37108	–
	2.2	10 x 16	15	044 57228	044 67228	044 37228	–
	3.3	10 x 20	16	044 57338	044 67338	044 37338	–
	4.7	12.5 x 20	17	044 57478	044 67478	044 37478	–
	10	12.5 x 25	18	044 57109	044 67109	044 37109	–
	22	16 x 31	20	044 57229	044 67229	–	–

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.

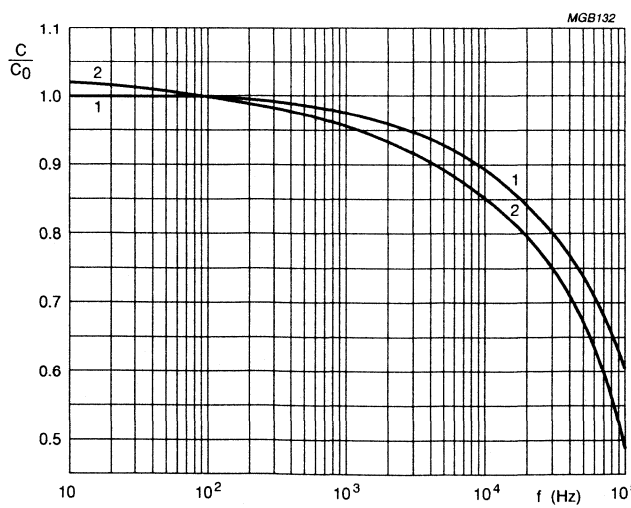
Capacitance (C)



Curve 1: 160 to 250 V
Curve 2: 350 to 450 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.



Curve 1: 160 to 250 V
Curve 2: 350 to 450 V.

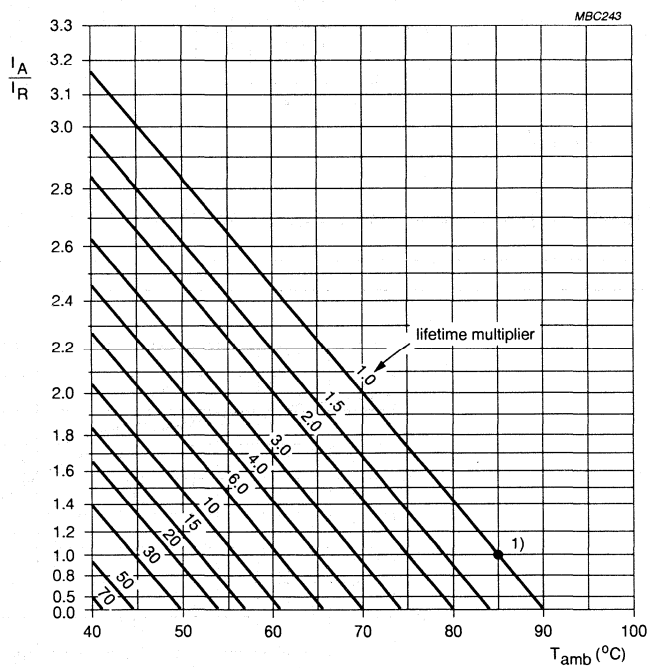
C_0 = capacitance at 20 °C, 100 Hz.

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

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
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.8 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/ CECC 30 300 sub clause 4.13	T_{amb} = 85 °C; U_R applied; 2000 hours	ΔC/C ±20% ≤400 V: tan δ ≤ 2 x spec. limit 450 V: tan δ ≤ 1.5 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	ΔC/C ±50% tan δ ≤ 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/ CECC 30 300 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

NOTES

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.

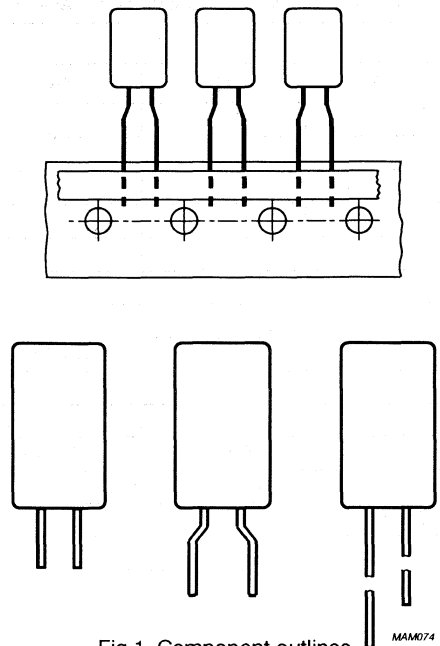


Fig.1 Component outlines.

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	0.47 to 470 µF
Tolerance on C_R	±20%; ±10% available 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
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 45910-T124 (without approval), former 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

RLC 013

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

C_R (µF)	U_R (V)					
	6.3	**10**	**16**	**25**	**35**	**50**
0.47						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**
10				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	
220		**8.2 x 11**				
330	8.2 x 11					
470	8.2 x 11					

R

Non-solid Al - electrolytic capacitors
Radial Low Leakage Current

RLC 013

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

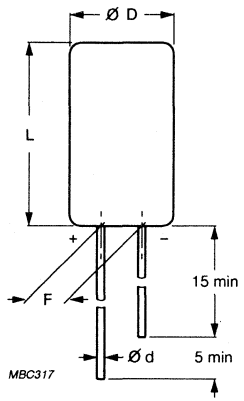


Fig.2 **Form CA**: Long leads.

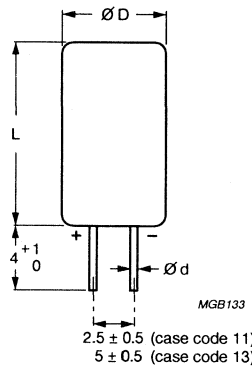


Fig.3 **Form CB**: Cut leads.

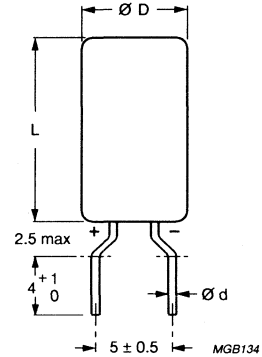
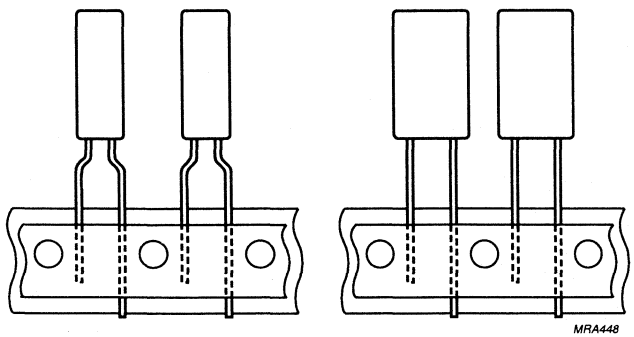


Fig.4 **Form CC**: Cut leads, formed; case size 5 x 11 mm only.

Table 2 Dimensions in mm; mass in g

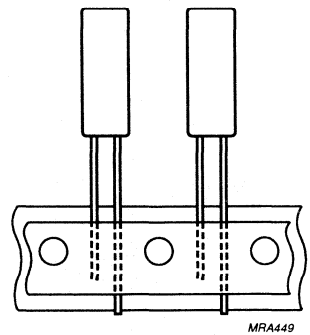
CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	Ø d	ØD_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA CB, CC	Form TR+, TN+	Form TFA, TNA
5 x 11	11	0.5	5.5	12	2.5	0.4	1000	1000	2000
8.2 x 11	13	0.6	8.7	12	5	1.1	1000	500	1000

Tape dimensions are specified in chapter "PACKING".



Form TR+: Taped on reel, positive leading.
Form TFA: Taped in box, (ammopack).

Fig.5 Taped, pitch F = 5 mm; case sizes 5 x 11 and 8.2 x 11 mm.



Form TN+: Taped on reel positive leading.
Form TNA: Taped in box (ammopack).

Fig.6 Taped, pitch F = 2.5 mm; case size 5 x 11 mm 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 (PH)
- Date code in accordance with IEC 62
- Code indicating factory of origin
- Minus-sign on top to identify the negative terminal.

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. Preferred types in **bold**.

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
	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
	47	5 x 11	11	85	1.5	0.13	4.4	2.1	9.5	36
	100	**8.2 x 11**	**13**	150	3.2	0.13	2.1	1.0	5.5	17
25	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
	10	5 x 11	11	50	0.7	0.06	9.5	4.0	17	65
	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

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 Ordering information. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL		TAPED IN BOX	
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 2.5 mm positive leading Form TN+	F = 5 mm Form TFA	F = 2.5 mm Form TNA
6.3	330	013 53331	013 63331	–	013 23331	–	013 33331	–
	470	013 53471	013 63471	–	013 23471	–	013 33471	–
10	47	013 54479	013 84479	013 64479	013 24479	013 14479	013 34479	013 74479
	68	013 54689	013 84689	013 64689	013 24689	013 14689	013 34689	013 74689
	100	013 54101	013 84101	013 64101	013 24101	013 14101	013 34101	013 74101
	220	**013 54221**	013 64221	–	013 24221	–	**013 34221**	–
16	33	013 55339	013 85339	013 65339	013 25339	013 15339	013 35339	013 75339
	47	013 55479	013 85479	013 65479	013 25479	013 15479	013 35479	013 75479
	100	**013 55101**	013 65101	–	013 25101	–	**013 35101**	–
25	1.0	013 56108	013 86108	013 66108	013 26108	013 16108	013 36108	013 76108
	2.2	013 56228	013 86228	013 66228	013 26228	013 16228	013 36228	013 76228
	3.3	013 56338	013 86338	013 66338	013 26338	013 16338	013 36338	013 76338
	4.7	**013 56478**	013 86478	013 66478	013 26478	013 16478	**013 36478**	013 76478
	10	013 56109	013 86109	013 66109	013 26109	013 16109	013 36109	013 76109
	22	**013 56229**	013 86229	013 66229	013 26229	013 16229	**013 36229**	013 76229
	33	013 56339	013 66339	–	013 26339	–	013 36339	–
	47	013 56479	013 66479	–	013 26479	–	013 36479	–
	68	013 56689	013 66689	–	013 26689	–	013 36689	–
35	33	013 50339	013 80339	013 60339	013 20339	013 10339	013 30339	013 70339
	100	013 50101	013 60101	–	013 20101	–	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	0.47	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
	10	**5 x 11**	**11**	55	2.0	0.06	9.5	4.0	17	65
	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

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 V 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

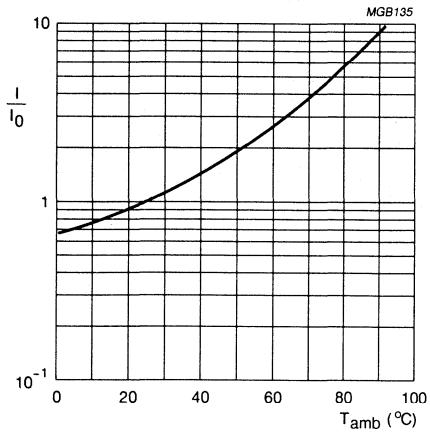
Equivalent series inductance (ESL)

case size 5 x 11 mm	typ. 13 nH
case size 8.2 x 11 mm	typ. 16 nH

Non-solid Al - electrolytic capacitors
Radial Low Leakage Current

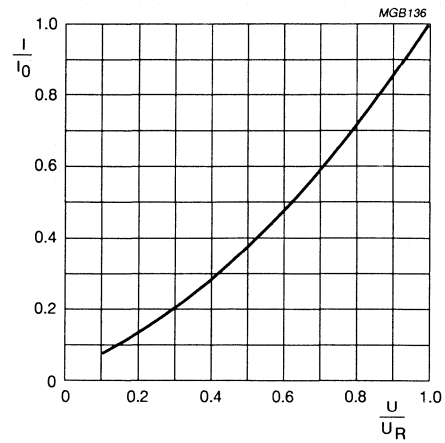
RLC 013

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL		TAPED IN BOX	
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 2.5 mm positive leading Form TN+	F = 5 mm Form TFA	F = 2.5 mm Form TNA
50	0.47	013 51477	013 81477	013 61477	013 21477	013 11477	013 31477	013 71477
	1.0	**013 51108**	013 81108	013 61108	013 21108	013 11108	**013 31108**	013 71108
	2.2	**013 51228**	013 81228	013 61228	013 21228	013 11228	**013 31228**	013 71228
	3.3	013 51338	013 81338	013 61338	013 21338	013 11338	013 31338	013 71338
	4.7	**013 51478**	013 81478	013 61478	013 21478	013 11478	**013 31478**	013 71478
	10	**013 51109**	013 81109	013 61109	013 21109	013 11109	**013 31109**	013 71109
	22	013 51229	013 81229	013 61229	013 21229	013 11229	013 31229	013 71229
	33	013 51339	013 61339	–	013 21339	–	013 31339	–
	47	013 51479	013 61479	–	013 21479	–	013 31479	–
	68	013 51689	013 61689	–	013 21689	–	013 31689	–



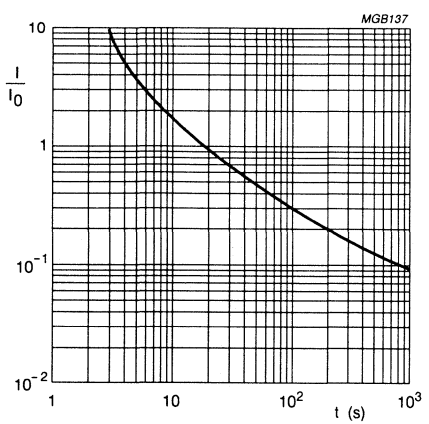
I_o = leakage current during continuous operation at 20 °C and U_R.

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 and 50 V; 0.22 to 2.2 µF
Curve 2: 25 and 50 V; 3.3 to 6.8 µF
Curve 3: 25 and 50 V; 10 to 68 µF
Curve 4: 6.3 V; 10 V; 16 V; 35 V.

C_o = capacitance at 20 °C, 100 Hz.

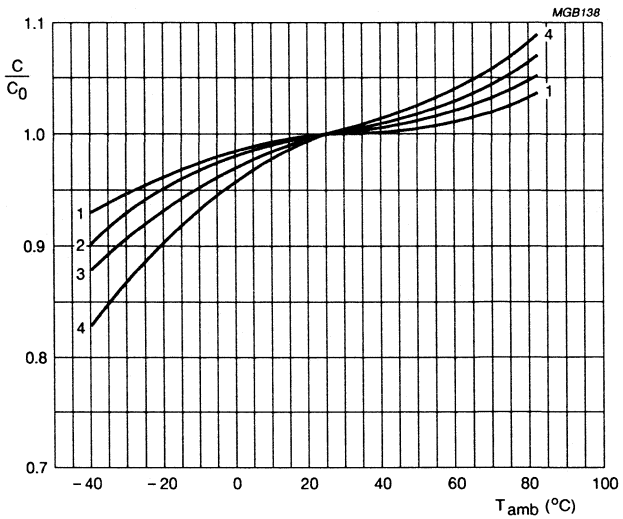


Fig.10 Multiplier of capacitance (C/C_o) as a function of ambient temperature.

Curve 1: 25 and 50 V; 0.22 to 2.2 µF
Curve 2: 25 and 50 V; 3.3 to 6.8 µF
Curve 3: 25 and 50 V; 10 and 15 µF
Curve 4: 25 and 50 V; 22 to 68 µF
Curve 5: 16 and 35 V
Curve 6: 6.3 and 10 V.

C_o = capacitance at 20 °C, 100 Hz.

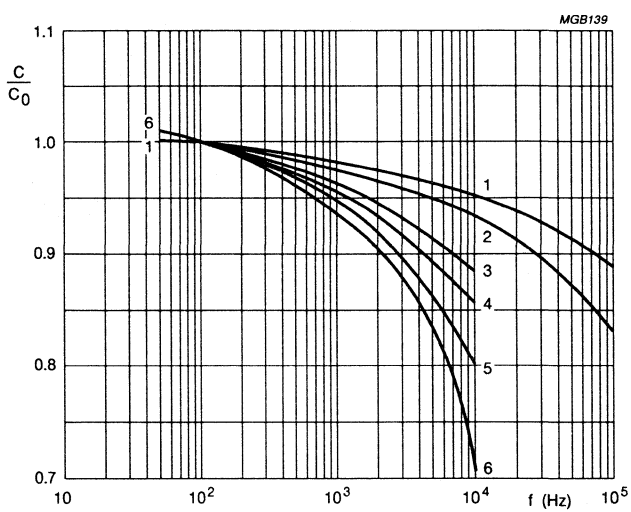
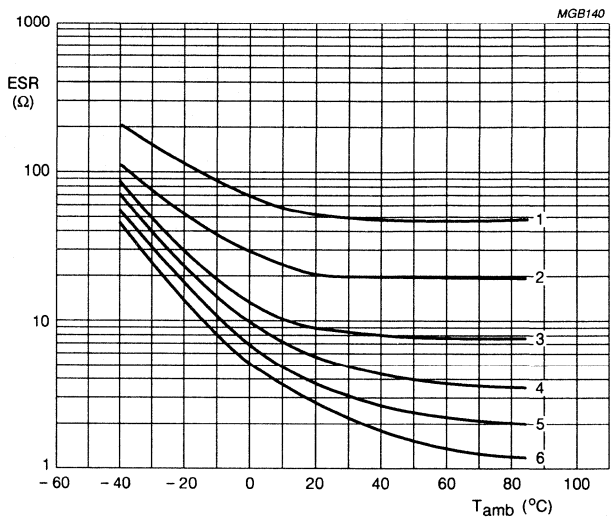


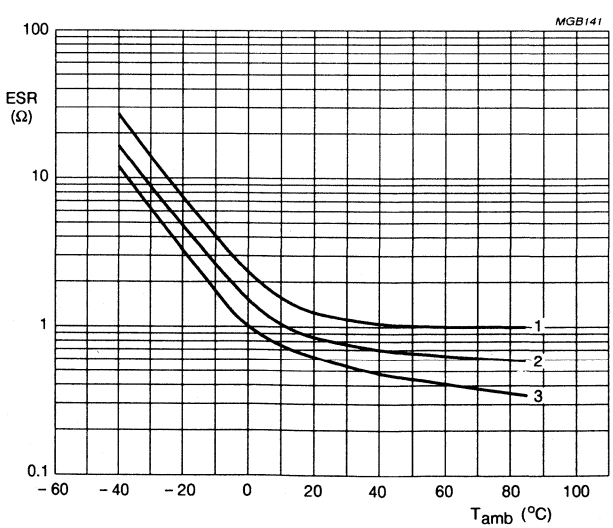
Fig.11 Multiplier of capacitance (C/C_o) as a function of frequency.

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.

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.

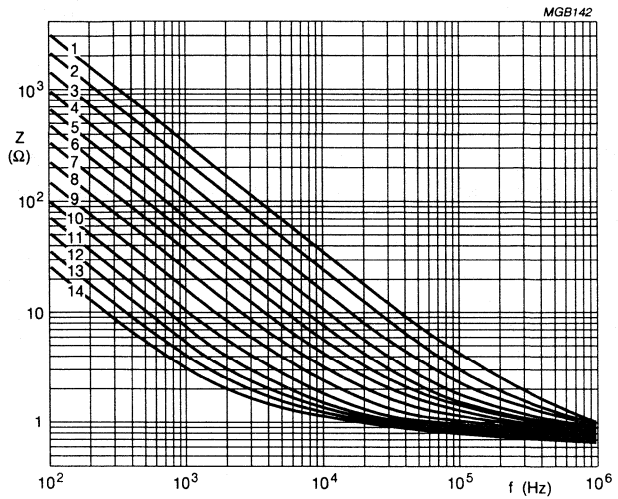


Fig.14 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 5 x 11 mm.

Curve 1: 33 µF
Curve 2: 47 µF
Curve 3: 68 µF
Curve 4: 100 µF
Curve 5: 150 µF
Curve 6: 220 µF.

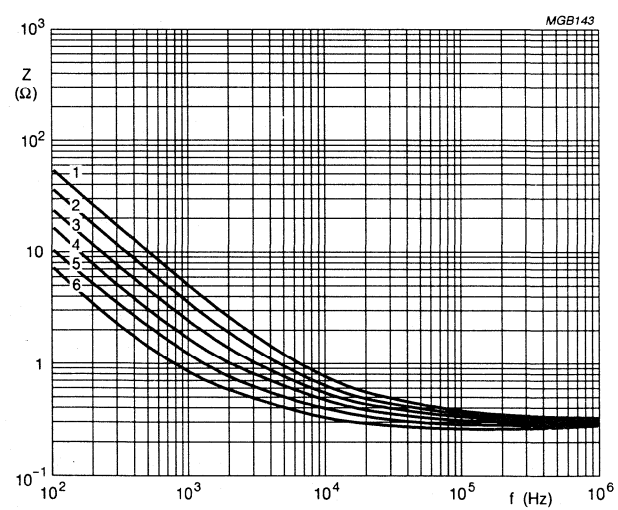
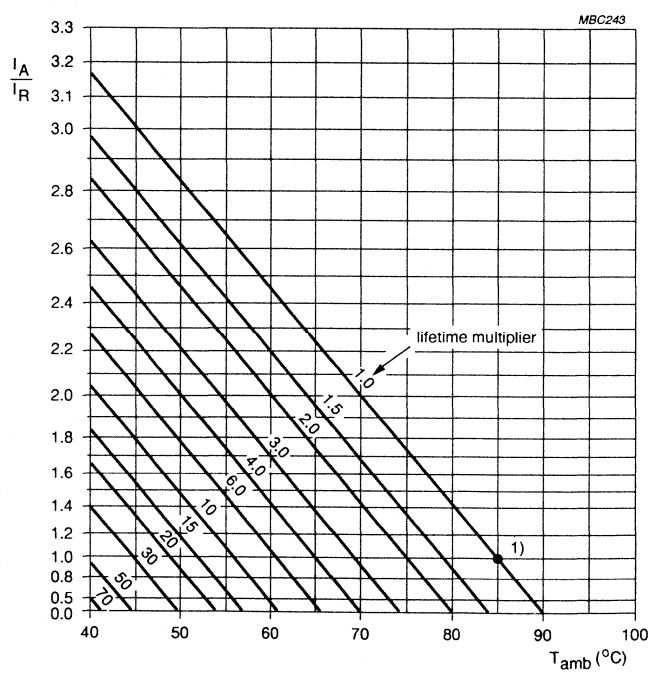


Fig.15 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 8.2 x 11 mm.

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 V; 16 V; 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/ CECC 30 300 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/ CECC 30 300 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

R

Non-solid Al - electrolytic capacitors
Radial Bipolar

RB 036 92

FEATURES

- Non-polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, all-insulated
- AC-capability without DC bias
- Charge and discharge proof
- Long useful life: 1500 hours at 105 °C
- Miniaturized dimensions
- Lead pitch 5 mm.

APPLICATIONS

- Telecommunication, automotive, audio-video and industrial
- For circuits where the polarity is not fixed, or reverse voltages may occur
- Coupling, decoupling, buffering, smoothing and filtering
- Portable and mobile equipment (small size, low mass).

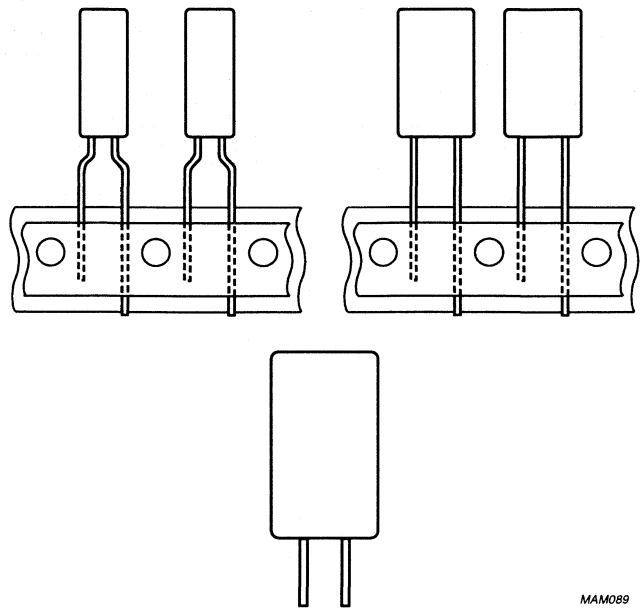


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case size (∅ D_{nom} x L_{nom} in mm)	8.2 x 11 (pitch 5 mm)
Rated capacitance range, C_R	10 to 100 µF
Tolerance on C_R at 100 Hz	±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, 1.4 x I_R applied	150 000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300
Climatic category	40/105/56

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)			
	16	**40**	**50**	**63**
10				8.2 x 11
22				8.2 x 11
33			8.2 x 11	
47		8.2 x 11		
100	8.2 x 11			

Note

Please consult your sales representative for more details.

Non-solid Al - electrolytic capacitors
Radial Bipolar Audio-frequency

RBA 036 93

FEATURES

- Non-polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, all-insulated
- AC-capability without DC bias
- Low dissipation factor, featuring low sound distortion
- Long useful life: 1500 hours at 105 °C
- Miniaturized dimensions
- Lead pitch 5 mm.

APPLICATIONS

- Speaker crossover networks in audio equipment
- For splitting high, middle and low frequencies
- Portable and mobile equipment (small size, low mass).

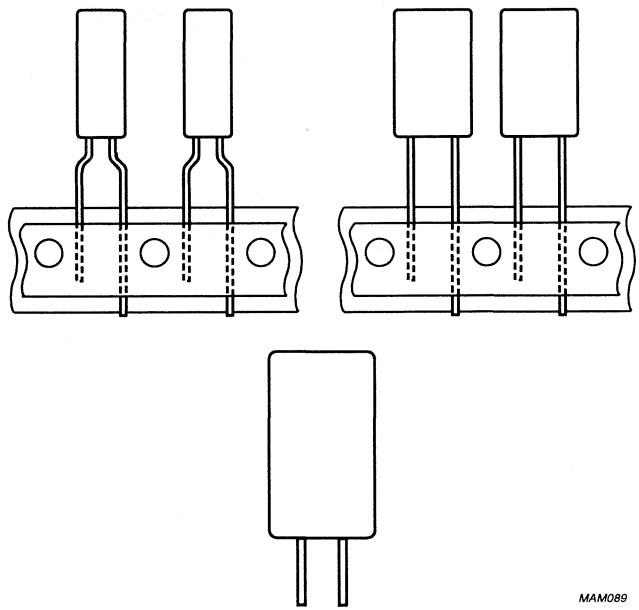


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case size (∅ D_{nom} x L_{nom} in mm)	8.2 x 11 (pitch 5 mm)
Rated capacitance range, C_R (E6 series)	1 to 22 µF
Tolerance on C_R at 1 kHz	±10%
Rated DC voltage, U_R (for standard devices)	50 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, 1.4 x I_R applied	150 000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300
Climatic category IEC 68	40/105/56

Note

Please consult your sales representative for more details.

NOTES

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.

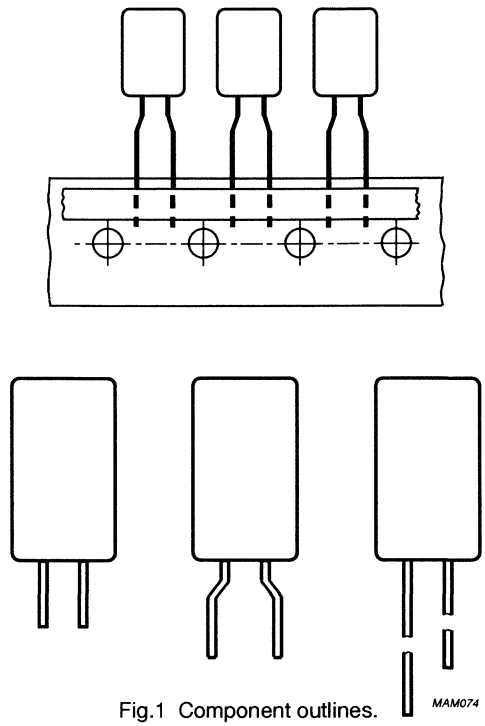


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom})	5 x 11 and 8.2 x 11 mm
Rated capacitance range, C_R	0.47 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
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 45910-T124 (without approval), former 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 types in **bold**.

C_R (µF)	U_R (V)									
	6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**	**100**	**160**
0.47								5 x 11		
1.0								**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		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**								

R

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

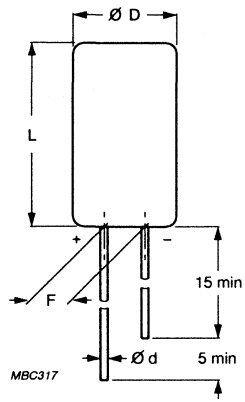


Fig.2 **Form CA**: Long leads.

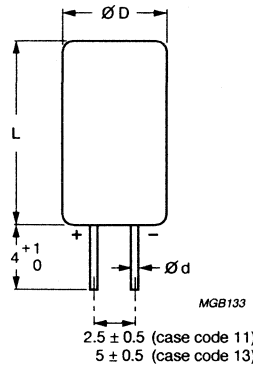


Fig.3 **Form CB**: Cut leads.

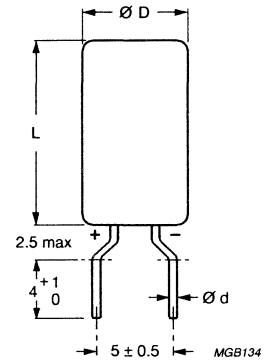
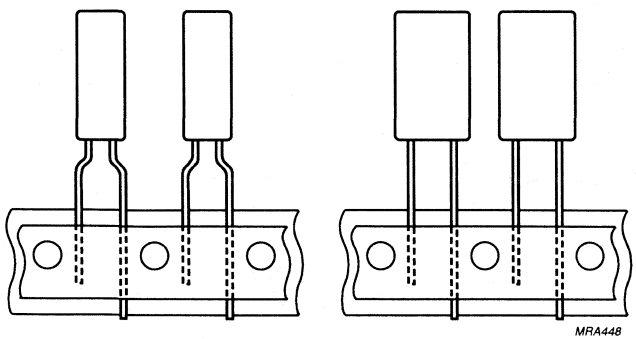


Fig.4 **Form CC**: Cut leads, formed; case size 5 x 11 mm only.

Table 2 Dimensions in mm; mass in g

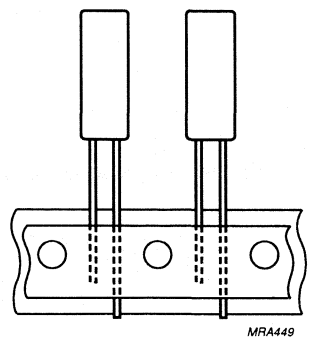
CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	Ø d	ØD_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA CB, CC	Form TR+, TN+	Form TFA, TNA
5 x 11	11	0.5	5.5	12	2.5	0.4	1000	1000	2000
8.2 x 11	13	0.6	8.7	12	5	1.1	1000	500	1000

Tape dimensions are specified in chapter "PACKING".



Form TR+: Taped on reel, positive leading.
Form TFA: Taped in box (ammopack).

Fig.5 Taped, pitch F = 5 mm; case sizes 5 x 11 and 8.2 x 11 mm.



Form TN+: Taped on reel, positive leading.
Form TNA: Taped in box (ammopack).

Fig.6 Taped, pitch F = 2.5 mm; case size 5 x 11 mm only.

R

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 (PH)
- Date code in accordance with IEC 62
- Code indicating factory of origin
- Minus-sign on top 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. Preferred types in **bold**.

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
	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. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL		TAPED IN BOX	
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 2.5 mm positive leading Form TN+	F = 5 mm Form TFA	F = 2.5 mm Form TNA
6.3	100	036 53101	036 83101	036 63101	036 23101	036 13101	036 33101	036 73101
	330	036 53331	036 63331	–	036 23331	–	036 33331	–
10	**47**	**036 54479**	036 84479	036 64479	036 24479	036 14479	**036 34479**	036 74479
	150	036 54151	036 84151	036 64151	036 24151	036 14151	036 34151	036 74151
	220	036 54221	036 64221	–	036 24221	–	036 34221	–
	470	**036 54471**	036 64471	–	036 24471	–	**036 34471**	–
16	33	036 55339	036 85339	036 65339	036 25339	036 15339	036 35339	036 75339
	100	**036 55101**	036 85101	036 65101	036 25101	036 15101	**036 35101**	036 75101
	150	036 55151	036 65151	–	036 25151	–	036 35151	–
	220	**036 55221**	036 65221	–	036 25221	–	**036 35221**	–
	330	**036 55331**	036 65331	–	036 25331	–	**036 35331**	–
25	68	036 56689	036 86689	036 66689	036 26689	036 16689	036 36689	036 76689
	100	**036 56101**	036 66101	–	036 26101	–	**036 36101**	–
	220	**036 56221**	036 66221	–	036 26221	–	**036 36221**	–
35	22	036 90001	036 90002	036 90003	036 90016	036 90164	036 90027	036 90389
	47	**036 90094**	036 90095	036 90096	036 90097	036 90198	**036 90098**	036 90391
	150	036 90099	036 90101	–	036 90102	–	036 90103	–
40	15	036 57159	036 87159	036 67159	036 27159	036 17159	036 37159	036 77159
	68	036 57689	036 67689	–	036 27689	–	036 37689	–
50	10	036 90004	036 90005	036 90006	036 90017	036 90228	036 90028	036 90392
	33	036 90104	036 90105	036 90106	036 90107	036 90321	036 90108	036 90393
	47	036 90011	036 90012	–	036 90019	–	036 90031	–
	100	**036 90109**	036 90111	–	036 90112	–	**036 90113**	–

Non-solid Al - electrolytic capacitors
Radial Semi-Professional

RSP 036

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	0.47	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
	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	0.06	9.5	3.5	15	45
	22	8.2 x 11	13	110	16	5.2	0.06	4.3	1.8	7.3	23
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

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 V 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 V to 100 V $I_{L5} \leq 0.001\ C_R \times U_R + 3\ \mu A$

U_R 160 V $I_{L5} \leq 0.015\ C_R \times U_R + 10\ \mu A$

Equivalent series inductance (ESL)

case size 5 x 11 mm typ. 13 nH

case size 8.2 x 11 mm typ. 16 nH

Non-solid Al - electrolytic capacitors
Radial Semi-Professional

RSP 036

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL		TAPED IN BOX	
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 2.5 mm positive leading Form TN+	F = 5 mm Form TFA	F = 2.5 mm Form TNA
63	0.47	036 58477	036 88477	036 68477	036 28477	036 18477	036 38477	036 78447
	1.0	**036 58108**	036 88108	036 68108	036 28108	036 18108	**036 38108**	036 78108
	2.2	**036 58228**	036 88228	036 68228	036 28228	036 18228	**036 38228**	036 78228
	3.3	036 58338	036 88338	036 68338	036 28338	036 18338	036 38338	036 78338
	4.7	**036 58478**	036 88478	036 68478	036 28478	036 18478	**036 38478**	036 78478
	6.8	036 58688	036 88688	036 68688	036 28688	036 18688	036 38688	035 78688
	10	**036 58109**	036 88109	036 68109	036 28109	036 18109	**036 38109**	036 78109
	10	036 90036	036 90041	–	036 90233	–	036 90181	–
	15	036 58159	036 88159	036 68159	036 28159	036 18159	036 38159	036 78159
	22	**036 58229**	036 88229	036 68229	036 28229	036 18229	**036 38229**	036 78229
	22	036 90117	036 90118	–	036 90138	–	036 90139	–
	33	036 58339	036 68339	–	036 28339	–	036 38339	–
	47	**036 58479**	036 68479	–	036 28479	–	**036 38479**	–
	68	036 58689	036 68689	–	036 28689	–	036 38689	–
100	10	036 59109	036 69109	–	036 29109	–	036 39109	–
	22	036 59229	036 69229	–	036 29229	–	036 39229	–
160	2.2	036 90333	036 90334	–	036 90294	–	036 90336	–
	4.7	036 90337	036 90338	–	036 90302	–	036 90341	–

R

Capacitance (C)

Curve 1: 63 V
Curve 2: 50 V
Curve 3: 35 V; 40 V; 100 V; 160 V
Curve 4: 16 V; 25 V
Curve 5: 6.3 V; 10 V.

C_o = capacitance at 20 °C, 100 Hz.

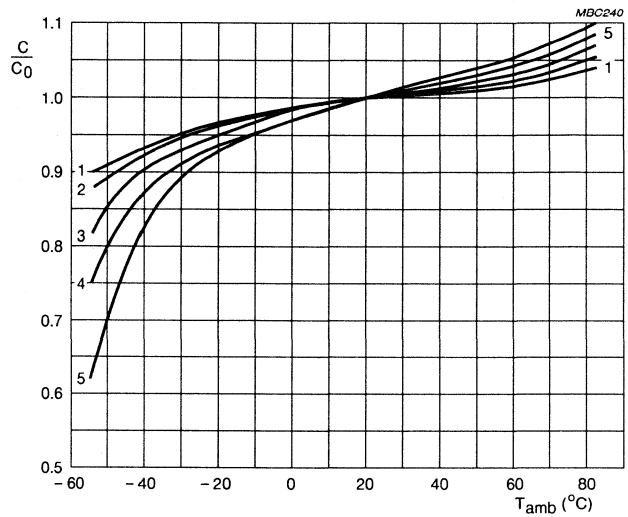


Fig.7 Multiplier of capacitance (C/C_o) as a function of ambient temperature.

Curve 1: 63 V, (≤2.2 µF)
Curve 2: 63 V, (>2.2 µF)
Curve 3: 50 V
Curve 4: 35 V; 40 V; 100 V; 160 V
Curve 5: 25 V
Curve 6: 16 V
Curve 7: 6.3 V; 10 V.

C_o = capacitance at 20 °C, 100 Hz.

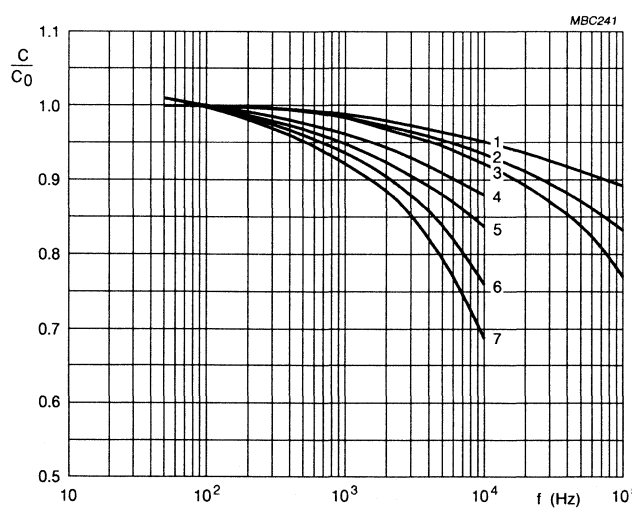
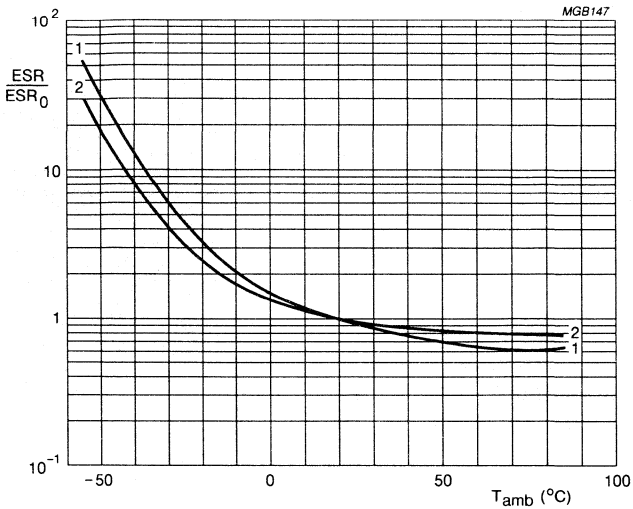


Fig.8 Multiplier of capacitance (C/C_o) as a function of frequency.

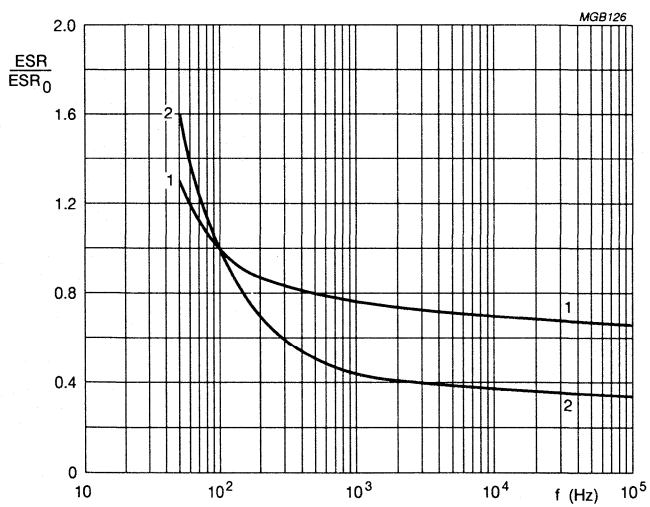
Equivalent series resistance (ESR)



Curve 1: 63 V (≥10 µF)
Curve 2: 6.3 V; 100 V; 160 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



Curve 1: 6.3 V
Curve 2: 63 V, (≥10 µF); 100 V; 160 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.10 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

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.

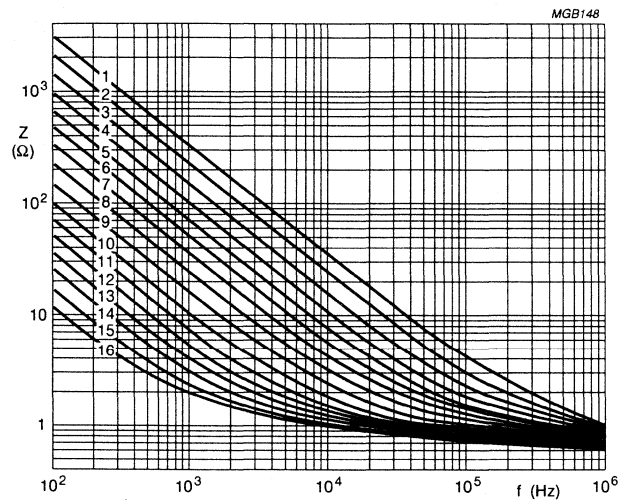


Fig.11 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 5 x 11 mm.

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.

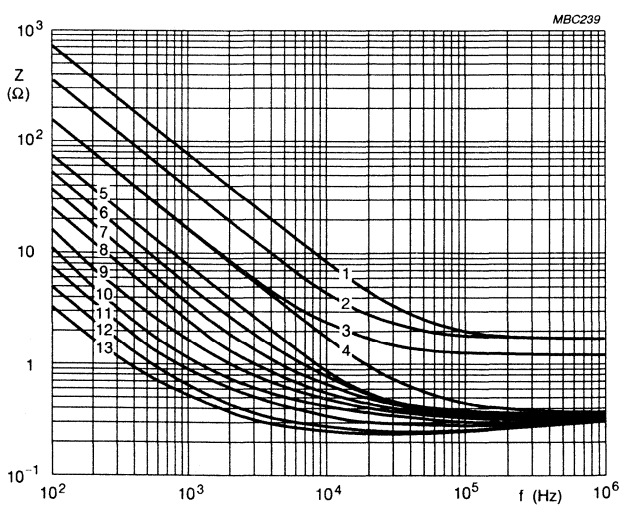
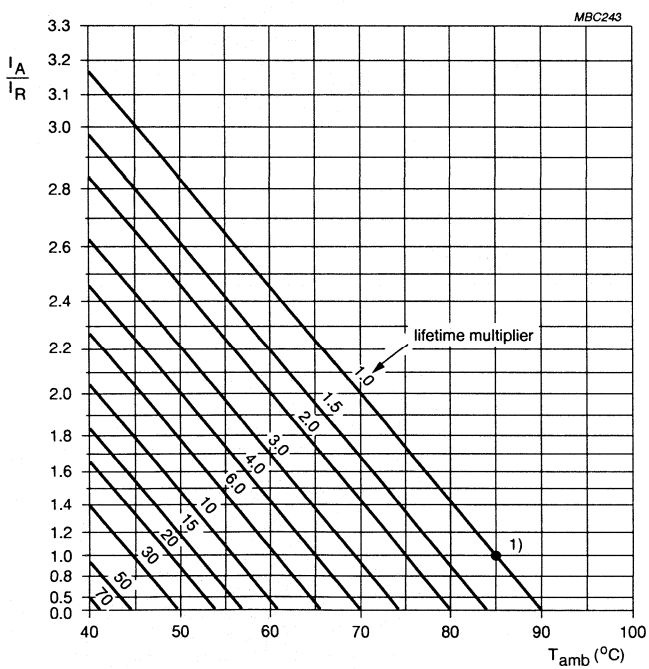


Fig.12 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 8.2 x 11 mm.

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 V to 10 V	U_R = 16 V to 35 V	U_R = 40 V 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/ CECC 30 300 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 $I_{L5} \leq$ 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 $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp).	IEC 384-4/ CECC 30 300 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 $I_{L5} \leq$ spec. limit

NOTES

Non-solid AL - electrolytic capacitors
Radial Miniature Semi-professional

RMS 047

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Long useful life: 1500 hours at 105 °C
- Miniaturized, high CU product per unit volume.

APPLICATIONS

- EDB, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass)
- Low surface demand on printed-circuit board.

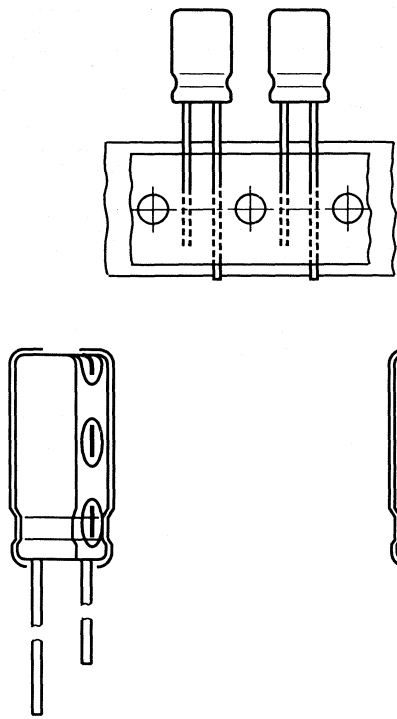


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	10 x 12 to 18 x 40
Rated capacitance range, C_R	100 to 10 000 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	150 000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259 - with reduced dimensions
Climatic category IEC 68 DIN 40040	 40/105/56 GMF

Non-solid AL - electrolytic capacitors
Radial Miniature Semi-professional

RMS 047

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (∅**D x L** in **mm**). Preferred types in **bold**.

C_R (µF)	U_R (V)					
	16	**25**	**35**	**40**	**50**	**63**
100	For lower capacitance values see RSP 036 series					**10 x 12**
220			**10 x 12**		10 x 16	**10 x 20**
330			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**
1000	10 x 20	**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	**16 x 35**	18 x 35	**18 x 40**
3300	16 x 25	16 x 31	18 x 35	**18 x 35**	18 x 40	
4700	16 x 31	18 x 35	18 x 40			
6800	16 x 35	18 x 40				
10 000	18 x 40					

F

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

Tape dimensions are specified in chapter "PACKING".

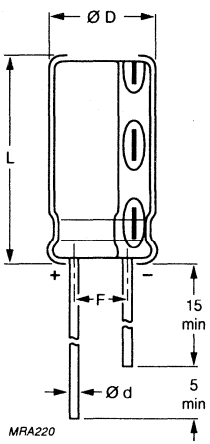


Fig.2 **Form CA**: Long leads. For dimensions, refer to Table 2.

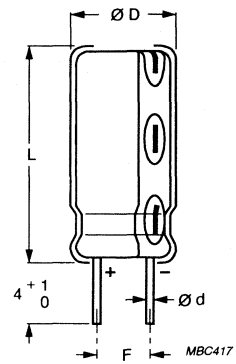


Fig.3 **Form CB**: Cut leads. For dimensions, refer to Table 2.

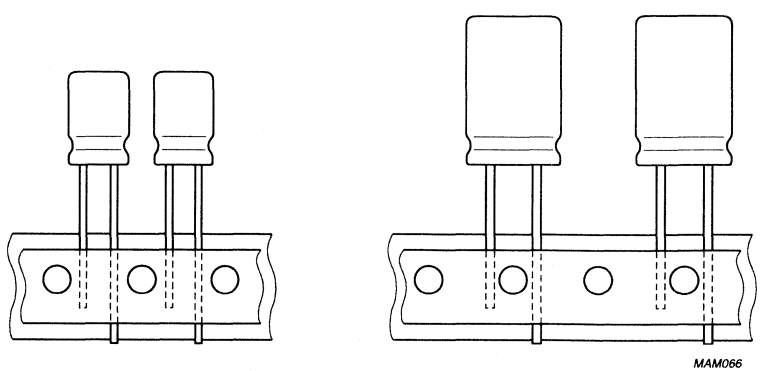


Fig.4 **Form TFA**: case sizes up to Ø16 x 31 mm taped in box (ammopack).

Non-solid AL - electrolytic capacitors
Radial Miniature Semi-professional

RMS 047

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 per box	Form CB per box	Form TFA per box
10 x 12	14	0.6	10.5	13.5	5.0	1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0	1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0	2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0	4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0	5.0	250	250	500
16 x 25	19	0.8	16.5	27.0	7.5	8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5	9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5	11.5	100	100	
18 x 35	22	0.8	18.5	37.5	7.5	14.5	300	1000	
18 x 40	23	0.8	18.5	42.0	7.5	16.0	300	1000	

MARKING

The capacitors are marked with the following information

- Rated capacitance value
- Tolerance on rated capacitance, code letter in accordance with IEC 62 (M for ±20%)
- Rated voltage in V
- Upper category temperature (105 °C)
- Group number (047)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62
- Negative terminal identification.

F

Non-solid AL - electrolytic capacitors
Radial Miniature Semi-professional

RMS 047

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 or 100 kHz.

Table 3 Electrical data. Preferred types in **bold**.

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 (Ω)	Z 100 kHz (Ω)
	470	10 x 12	14	330	78	18	0.16	0.51	0.45	0.33
	1000	10 x 20	16	540	160	35	0.16	0.24	0.21	0.17
	2200	12.5 x 25	18	830	360	73	0.20	0.14	0.12	0.10
	3300	16 x 25	19	1100	530	110	0.22	0.10	0.09	0.08
	4700	16 x 31	20	1300	760	150	0.24	0.08	0.07	0.07
	6800	16 x 35	21	1600	1100	220	0.28	0.06	0.06	0.06
	10 000	18 x 40	23	1800	1600	320	0.36	0.05	0.05	0.05
25	**470**	**10 x 16**	**15**	360	120	27	0.14	0.45	0.38	0.25
	1000	**12.5 x 20**	**17**	630	250	53	0.14	0.21	0.18	0.13
	2200	**16 x 25**	**19**	990	550	110	0.18	0.12	0.09	0.08
	3300	16 x 31	20	1200	830	170	0.20	0.09	0.07	0.07
	4700	18 x 35	22	1500	1200	240	0.22	0.07	0.05	0.05
	6800	18 x 40	23	1700	1700	340	0.26	0.06	0.04	0.04
35	**220**	**10 x 12**	**14**	270	80	18	0.12	0.83	0.57	0.38
	330	10 x 16	15	350	120	26	0.12	0.55	0.38	0.28
	470	10 x 20	16	450	170	36	0.12	0.39	0.27	0.22
	1000	12.5 x 25	18	780	350	73	0.12	0.18	0.13	0.12
	2200	16 x 31	20	1200	770	160	0.16	0.11	0.07	0.07
	3300	18 x 35	22	1500	1200	230	0.18	0.09	0.05	0.05
	4700	18 x 40	23	1800	1600	330	0.20	0.06	0.04	0.04

ORDERING INFORMATION

Ordering Example

Electrolytic capacitors RMS 047
1000 µF/35 V; ±20%
Case size 12.5 x 25 mm; Form TFA
Catalogue number: 2222 047 30102.

Table 4 Ordering information. Preferred types in **bold**.

U_R	C_R 100 Hz	NOMINAL CASE SIZE ∅ D x L	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
(V)	(µF)	(mm)		Form CA	Form CB	Form TFA
16	470	10 x 12	14	047 55471	047 65471	047 35471
	1000	10 x 20	16	047 55102	047 65102	047 35102
	2200	12.5 x 25	18	047 55222	047 65222	047 35222
	3300	16 x 25	19	047 55332	047 65332	047 35332
	4700	16 x 31	20	047 55472	047 65472	047 35472
	6800	16 x 35	21	047 55682	047 65682	–
	10 000	18 x 40	23	047 55103	047 65103	–
25	**470**	**10 x 16**	**15**	047 56471	**047 66471**	**047 36471**
	1000	**12.5 x 20**	**17**	047 56102	**047 66102**	**047 36102**
	2200	**16 x 25**	**19**	047 56222	**047 66222**	**047 36222**
	3300	16 x 31	20	047 56332	047 66332	047 26332
	4700	18 x 35	22	047 56472	047 66472	–
	6800	18 x 40	23	047 56682	047 66682	–
35	**220**	**10 x 12**	**14**	047 50221	**047 60221**	**047 30221**
	330	10 x 16	15	047 50331	047 60331	047 30331
	470	10 x 20	16	047 50471	047 60471	047 30471
	1000	12.5 x 25	18	047 50102	047 60102	047 30102
	2200	16 x 31	20	047 50222	047 60222	047 30222
	3300	18 x 35	22	047 50332	047 60332	–
	4700	18 x 40	23	047 50472	047 60472	–

Non-solid AL - electrolytic capacitors
Radial Miniature Semi-professional

RMS 047

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 (Ω)	Z 100 kHz (Ω)
40	330	10 x 20	16	380	140	29	0.12	0.55	0.33	0.26
	2200	**16 x 35**	**21**	1200	880	180	0.16	0.11	0.06	0.06
	3300	**18 x 35**	**22**	1500	1300	270	0.18	0.08	0.04	0.04
50	220	10 x 16	15	310	110	25	0.10	0.69	0.43	0.03
	470	**12.5 x 20**	**17**	540	240	50	0.10	0.32	0.20	0.17
	1000	**16 x 25**	**19**	940	500	100	0.10	0.15	0.10	0.09
	2200	18 x 35	22	1400	1100	220	0.14	0.10	0.05	0.05
	3300	18 x 40	23	1600	1700	330	0.16	0.07	0.03	0.04
63	**100**	**10 x 12**	**14**	210	66	16	0.09	1.40	0.75	0.65
	220	**10 x 20**	**16**	350	140	31	0.09	0.62	0.34	0.32
	330	12.5 x 20	17	470	210	45	0.09	0.41	0.23	0.22
	470	**12.5 x 25**	**18**	620	300	62	0.09	0.29	0.16	0.16
	1000	16 x 31	20	1100	630	130	0.09	0.14	0.08	0.08
	2200	**18 x 40**	**23**	1500	1400	280	0.13	0.09	0.04	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	$I_{L1} \leq 0.01\ C_R\ U_R + 3$ µA
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R\ U_R + 3$ µA

Equivalent series inductance (ESL)

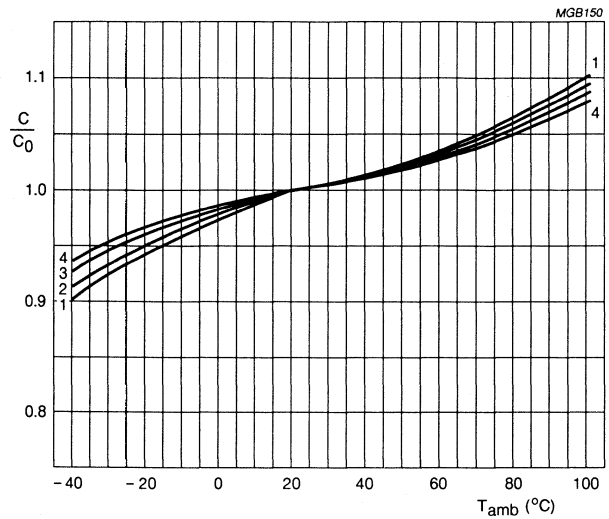
Case diameter 10 mm	typ.16 nH
Case diameter ≥ 12.5 mm	typ. 18 nH

Non-solid AL - electrolytic capacitors
Radial Miniature Semi-professional

RMS 047

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
				Form CA	Form CB	Form TFA
40	330	10 x 20	16	047 57331	047 67331	047 37331
	2200	**16 x 35**	**21**	047 57222	**047 67222**	–
	3300	**18 x 35**	**22**	047 57332	**047 67332**	–
50	220	10 x 16	15	047 51221	047 61221	047 31221
	470	**12.5 x 20**	**17**	047 51471	**047 61471**	**047 31471**
	1000	**16 x 25**	**19**	047 51102	**047 61102**	**047 31102**
	2200	18 x 35	22	047 51222	047 61222	–
	3300	18 x 40	23	047 51332	047 61332	–
63	**100**	**10 x 12**	**14**	047 58101	**047 68101**	**047 38101**
	220	**10 x 20**	**16**	047 58221	**047 68221**	**047 38221**
	330	12.5 x 20	17	047 58331	047 68331	047 38331
	470	**12.5 x 25**	**18**	047 58471	**047 68471**	**047 38471**
	1000	16 x 31	20	047 58102	047 68102	047 38102
	2200	**18 x 40**	**23**	047 58222	**047 68222**	–

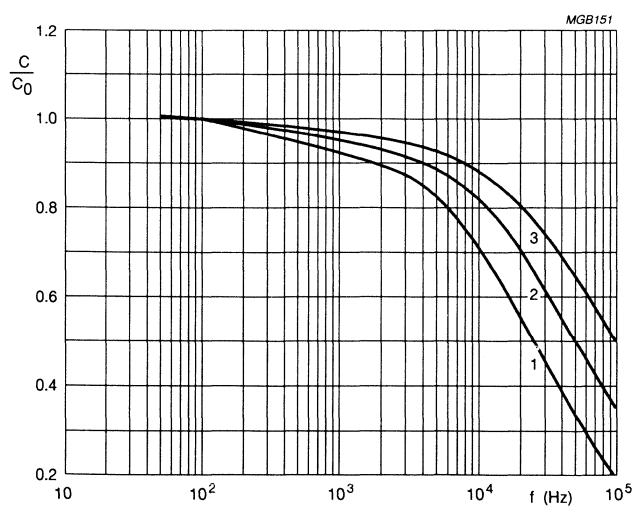
Capacitance (C)



Curve 1: 16 V
Curve 2: 25 V
Curve 3: 35 V
Curve 4: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.

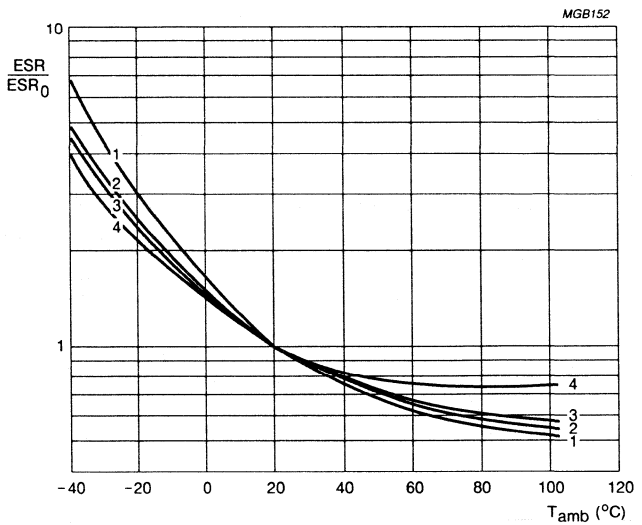


Curve 1: 16 and 25 V
Curve 2: 35 V to 50 V
Curve 3: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Typical multiplier of capacitance (C/C_0) as a function of frequency.

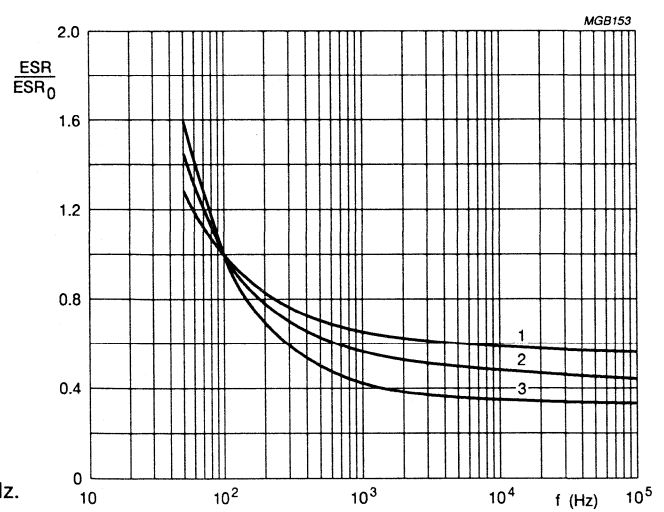
Equivalent series resistance (ESR)



Curve 1: 16 V
Curve 2: 25 V
Curve 3: 35 V
Curve 4: 63 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



Curve 1: 16 and 25 V
Curve 2: 35 and 40 V
Curve 3: 50 and 63 V.

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

Fig.8 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

Impedance (Z)

Curve 1: 470 µF, 16 V
Curve 2: 330 µF, 40 V
Curve 3: 1000 µF, 35 V
Curve 4: 1000 µF, 16 V
Curve 5: 3300 µF, 16 V.

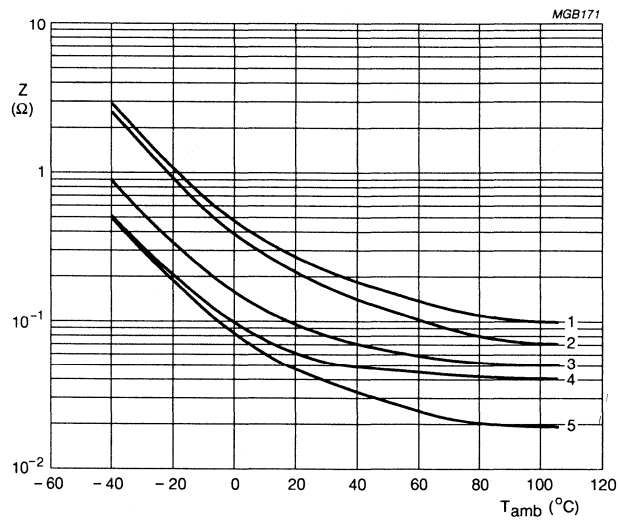


Fig.9 Typical impedance at 10 kHz as a function of ambient temperature.

Curve 1: 100 µF, 63 V
Curve 2: 220 µF, 63 V
Curve 3: 470 µF, 50 V
Curve 4: 1000 µF, 35 V
Curve 5: 2200 µF 25 V
Curve 6: 4700 µF 16 V.

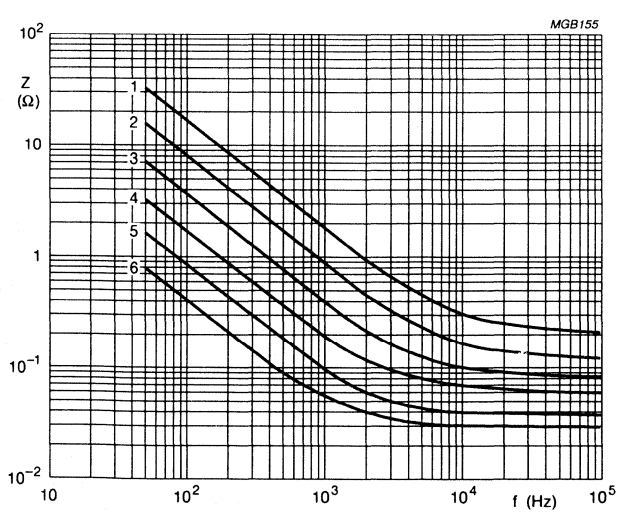
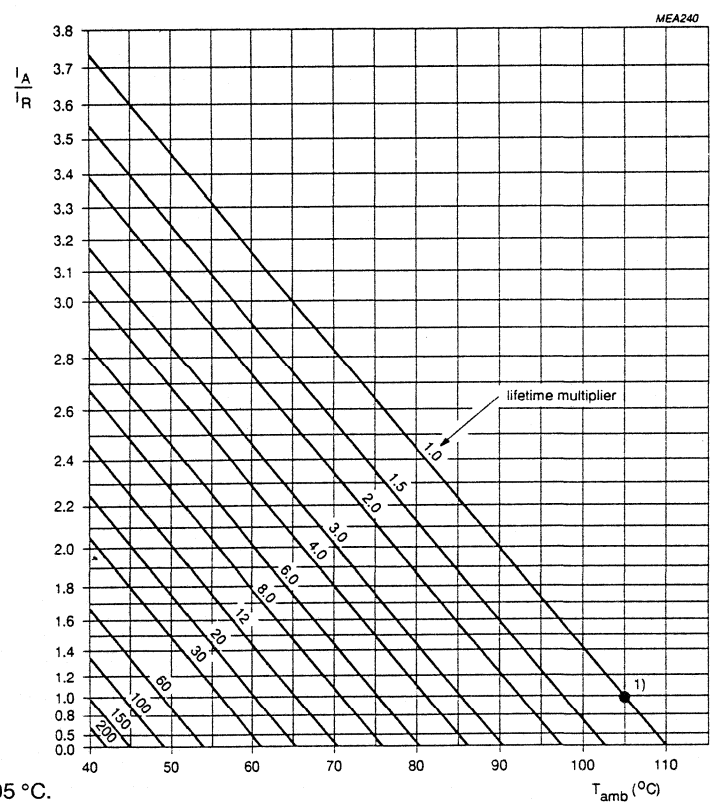


Fig.10 Typical impedance at 20 °C as a function of frequency.

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 = 16 and 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50	0.95	0.85	0.80
100	1.00	1.00	1.00
300	1.07	1.20	1.25
1000	1.12	1.30	1.40
3000	1.15	1.35	1.50
≥10 000	1.20	1.40	1.60



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: 1500 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/ CECC 30 300 sub clause 4.13	T_{amb} = 105 °C; U_R applied; 1000 hours	$\Delta C/C$ ±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	$\Delta C/C$ ±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/ CECC 30 300, 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	$\Delta C/C$ ±15% tan $\delta \leq$ 1.3 x spec. limit $Z \leq$ 2 x spec. limit $I_{L5} \leq$ 2 x spec. limit

NOTES

Non-solid Al - electrolytic capacitors
Radial Standard Semi-professional

RSS 045

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Long useful life: 1500 hours at 105 °C
- High ripple current capability, low impedance.

APPLICATIONS

- EDP, telecommunication, industrial and audio-video
- Smoothing, filtering, buffering in SMPS
- Low surface demand on printed-circuit board.

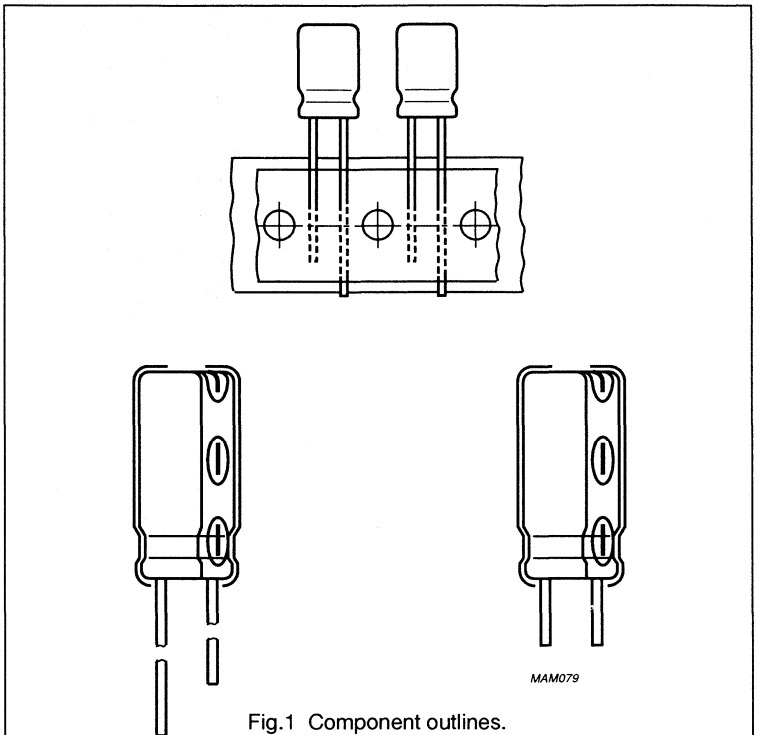


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	10 x 12 to 18 x 35
Rated capacitance range, C_R	47 to 4700 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	150 000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259
Climatic category IEC 68 DIN 40040	 40/105/56 GMF

Non-solid Al - electrolytic capacitors
Radial Standard Semi-professional

RSS 045

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)					
	16	**25**	**35**	**40**	**50**	**63**
47	For lower capacitance values see RSP 036 series					10 x 12
100				10 x 12	10 x 16	10 x 20
220	10 x 12		10 x 16	10 x 20	12.5 x 20	12.5 x 25
330			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					16 x 25	
1000	12.5 x 25		16 x 25		16 x 31	16 x 31
2200	16 x 25	16 x 31		18 x 35		
3300	16 x 31	18 x 35				
4700	18 x 35					

FOR NEW DEVELOPMENTS USE RSL 046 - SERIES.

R

Non-solid Al - electrolytic capacitors
Radial Standard Semi-professional

RSS 045

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

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

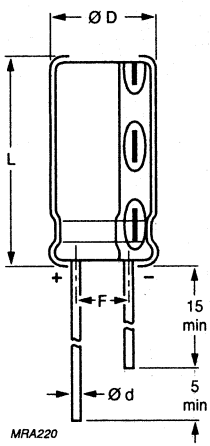


Fig.2 **Form CA**: Long leads. For dimensions refer to Table 2.

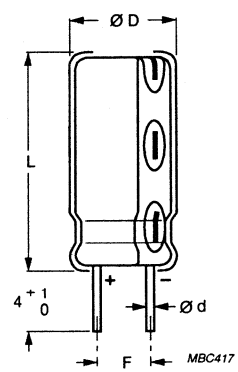


Fig.3 **Form CB**: Cut leads. For dimensions refer to Table 2.

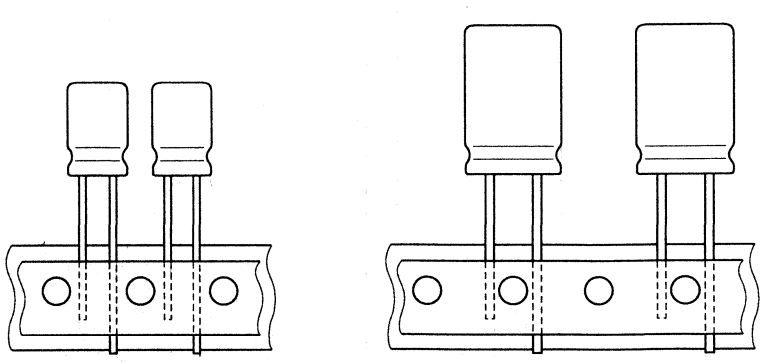


Fig.4 **Form TFA**: case sizes up to Ø16 x 31 mm in box (ammopack).

Non-solid Al - electrolytic capacitors
Radial Standard Semi-professional

RSS 045

Table 2 Dimensions in mm; mass in g

NOMINAL CASE SIZE ∅ D x L	CASE CODE	∅ d	∅ D_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA per box	Form CB per box	Form TFA per box
10 x 12	14	0.6	10.5	13.5	5.0	1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0	1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0	2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0	4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0	5.0	250	250	500
16 x 25	19	0.8	16.5	27.0	7.5	8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5	9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5	11.5	100	100	–
18 x 35	22	0.8	18.5	37.5	7.5	14.5	300	1000	–

MARKING

The capacitors are marked with the following information:

- Rated capacitance value
- Tolerance on rated capacitance, code letter in accordance with IEC 62 (M for ±20%)
- Rated voltage in V
- Upper category temperature (105 °C)
- Group number (045)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62
- Negative terminal identification.

R

Non-solid Al - electrolytic capacitors
Radial Standard Semi-professional

RSS 045

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 or 100 kHz.

Table 3 Electrical data

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 (Ω)	Z 100 kHz (Ω)
16	220	10 x 12	14	230	38	10	0.16	1.00	–	0.59
	470	10 x 20	16	380	78	18	0.16	0.49	–	0.28
	1000	12.5 x 25	18	650	160	35	0.16	0.23	–	0.13
	2200	16 x 25	19	950	360	73	0.20	0.13	0.07	
	3300	16 x 31	20	1200	530	110	0.22	0.10	0.05	–
	4700	18 x 35	22	1500	760	150	0.24	0.07	0.04	–
25	2200	16 x 31	20	1100	550	110	0.18	0.12	0.05	–
	3300	18 x 35	22	1300	830	170	0.20	0.09	0.04	–
35	220	10 x 16	15	290	80	18	0.12	0.78	–	0.39
	330	10 x 20	16	390	120	26	0.12	0.52	–	0.26
	470	12.5 x 20	17	500	170	36	0.12	0.37	–	0.18
	1000	16 x 25	19	880	350	73	0.12	0.17	–	0.09

Non-solid Al - electrolytic capacitors
Radial Standard Semi-professional

RSS 045

ORDERING INFORMATION

Ordering Example

Electrolytic capacitors RSS 045
1000 µF/35 V; ±20%
Case size 16 x 25 mm; Form TFA
Catalogue number: 2222 045 30102.

Table 4 Ordering information

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
				Form CA	Form CB	Form TFA
16	220	10 x 12	14	045 55221	045 65221	045 35221
	470	10 x 20	16	045 55471	045 65471	045 35471
	1000	12.5 x 25	18	045 55102	045 65102	045 35102
	2200	16 x 25	19	045 55222	045 65222	045 35222
	3300	16 x 31	20	045 55332	045 65332	045 35332
	4700	18 x 35	22	045 55472	045 65472	–
25	2200	16 x 31	20	045 56222	045 66222	045 36222
	3300	18 x 35	22	045 56332	045 66332	–
35	220	10 x 16	15	045 50221	045 60221	045 30221
	330	10 x 20	16	045 50331	045 60331	045 30331
	470	12.5 x 20	17	045 50471	045 60471	045 30471
	1000	16 x 25	19	045 50102	045 60102	045 30102

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Non-solid Al - electrolytic capacitors
Radial Standard Semi-professional

RSS 045

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 (Ω)	Z 100 kHz (Ω)
40	100	10 x 12	14	190	43	13	0.12	1.70	–	0.80
	220	10 x 20	16	320	91	21	0.12	0.78	–	0.36
	330	12.5 x 20	17	420	140	29	0.12	0.52	–	0.24
	470	12.5 x 25	18	540	190	41	0.12	0.37	–	0.17
	2200	18 x 35	22	1400	880	180	0.14	0.09	0.04	–
50	100	10 x 16	15	220	53	13	0.10	1.40	–	0.65
	220	12.5 x 20	17	380	110	25	0.10	0.65	–	0.30
	330	12.5 x 25	18	510	170	36	0.10	0.43	–	0.20
	680	16 x 25	19	800	340	71	0.10	0.21	–	0.10
	1000	16 x 31	20	1100	500	100	0.10	0.14	–	0.07
63	47	10 x 12	14	150	33	9	0.08	2.60	–	1.30
	100	10 x 20	16	250	66	16	0.08	1.20	–	0.60
	220	12.5 x 25	18	450	140	31	0.08	0.55	–	0.27
	330	16 x 25	19	600	210	45	0.08	0.37	–	0.18
	470	16 x 25	19	710	300	62	0.08	0.26	–	0.13
	1000	16 x 31	20	1200	630	130	0.08	0.12	–	0.06

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	$I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$

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 Semi-professional

RSS 045

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
				Form CA	Form CB	Form TFA
40	100	10 x 12	14	045 57101	045 67101	045 37101
	220	10 x 20	16	045 57221	045 67221	045 37221
	330	12.5 x 20	17	045 57331	045 67331	045 37331
	470	12.5 x 25	18	045 57471	045 67471	045 37471
	2200	18 x 35	22	045 57222	045 67222	–
50	100	10 x 16	15	045 51101	045 61101	045 31101
	220	12.5 x 20	17	045 51221	045 61221	045 31221
	330	12.5 x 25	18	045 51331	045 61331	045 31331
	680	16 x 25	19	045 51681	045 61681	045 31681
	1000	16 x 31	20	045 51102	045 61102	045 31102
63	47	10 x 12	14	045 58479	045 68479	045 38479
	100	10 x 20	16	045 58101	045 68101	045 38101
	220	12.5 x 25	18	045 58221	045 68221	045 38221
	330	16 x 25	19	045 58331	045 68331	045 38331
	470	16 x 25	19	045 58471	045 68471	045 38471
	1000	16 x 31	20	045 58102	045 68102	–

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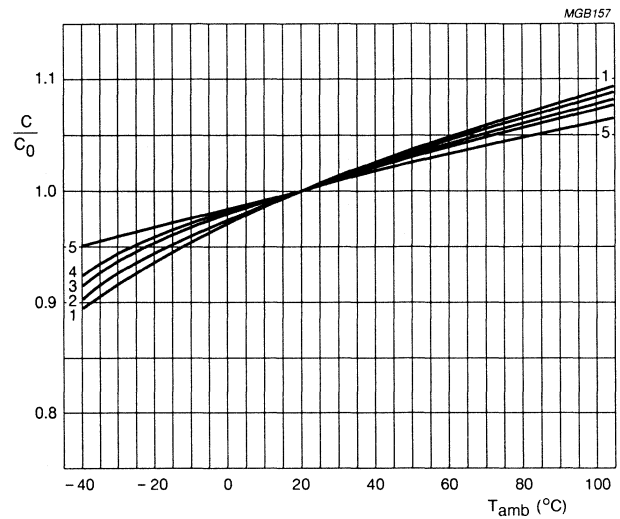
Non-solid Al - electrolytic capacitors
Radial Standard Semi-professional

RSS 045

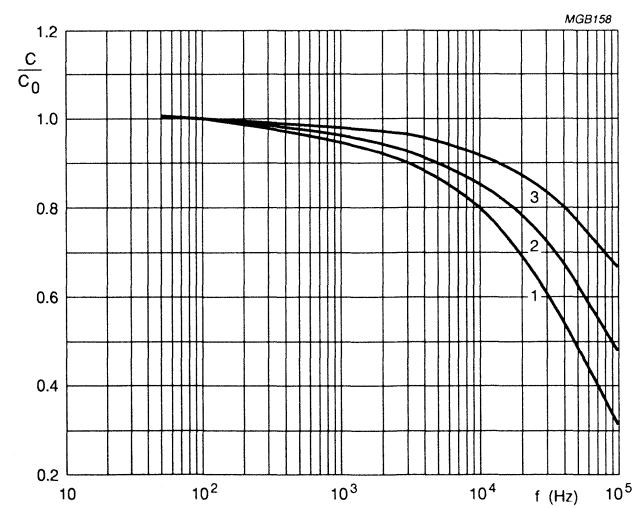
Capacitance (C)



Curve 1: 16 V
Curve 2: 25 V
Curve 3: 35 and 40 V
Curve 4: 50 V
Curve 5: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.



Curve 1: 16 and 25 V
Curve 2: 35 and 40 V
Curve 3: 50 and 63 V.

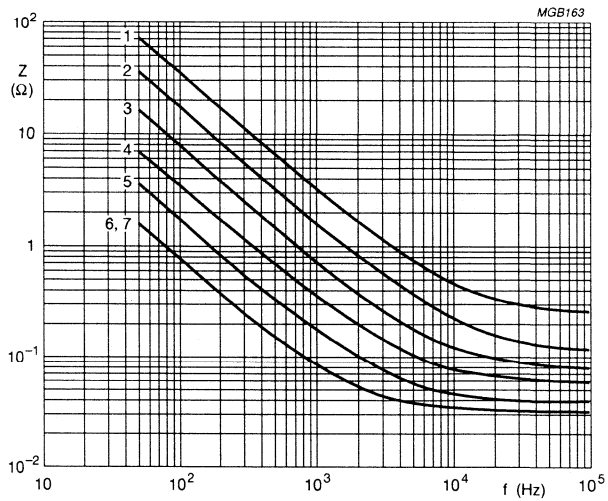
C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Typical multiplier of capacitance (C/C_0) as a function of frequency.

Non-solid Al - electrolytic capacitors
Radial Standard Semi-professional

RSS 045

Impedance (Z)



Curve 1: 47 µF, 63 V
Curve 2: 100 µF, 63 V
Curve 3: 220 µF, 50 V
Curve 4: 470 µF, 40 V
Curve 5: 1000 µF, 35 V
Curve 6: 2200 µF, 16 V
Curve 7: 2200 µF, 25 V.

Fig.7 Typical impedance as a function of frequency at T_{amb} = 20 °C.

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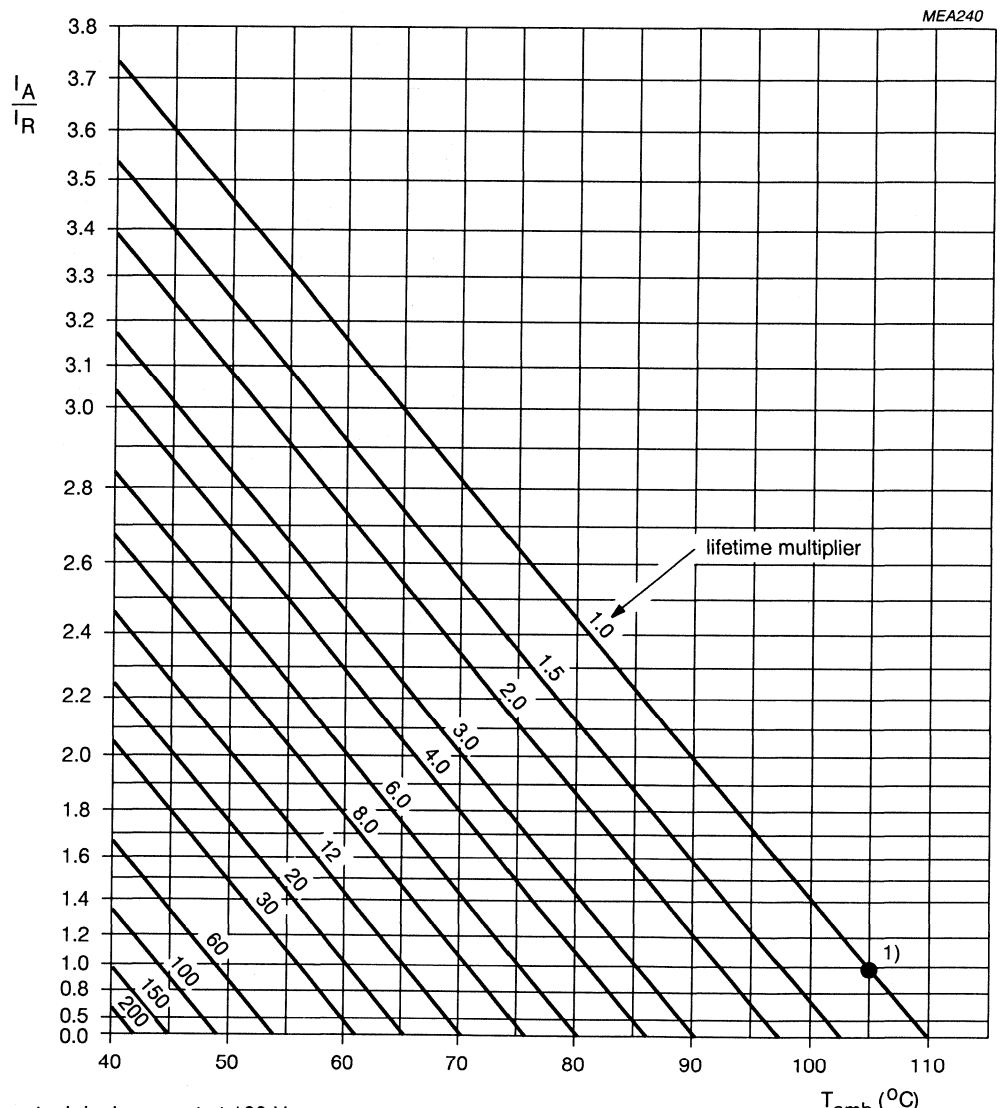
RIPPLE CURRENT and USEFUL LIFE



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: 1500 hours.

Fig.8 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

Non-solid Al - electrolytic capacitors
Radial Standard Semi-professional

RSS 045

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 = 16 and 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50	0.85	0.80	0.75
100	1.00	1.00	1.00
300	1.20	1.25	1.30
1000	1.30	1.40	1.50
3000	1.35	1.50	1.65
≥10000	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 (quick reference)	REQUIREMENTS
Name of test	Reference		
Endurance	IEC 384-4/ CECC 30 300 group C 3, 4.13	T_{amb} = 105 °C; U_R applied; 1000 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} = 105 °C; U_R and I_R applied; 1500 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/ CECC 30 300, 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 ±15% tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ 2 x spec. limit

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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.

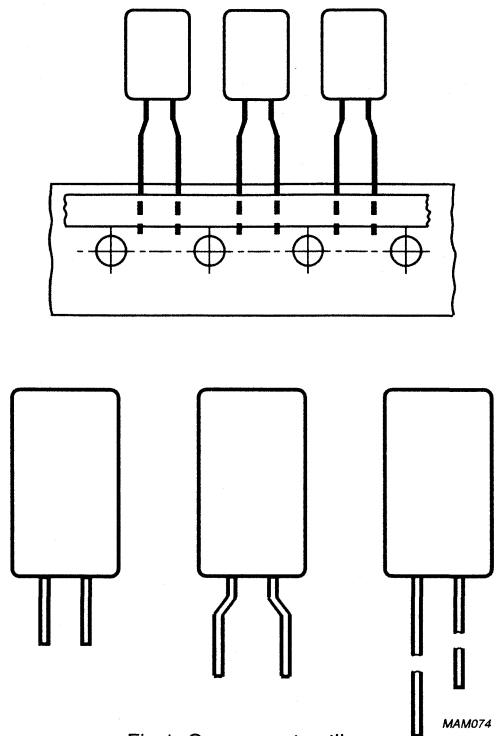

Fig.1 Component outlines.

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
Based on sectional specification	IEC 384-4/CECC 30 300
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259 (with reduced dimensions)
Climatic category IEC 68 DIN 40040	 55/105/56 FMF

Non-solid Al - electrolytic capacitors
Radial Long-Life

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (**Ø D x L** in **mm**). Preferred types in **bold**.

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	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								

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MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

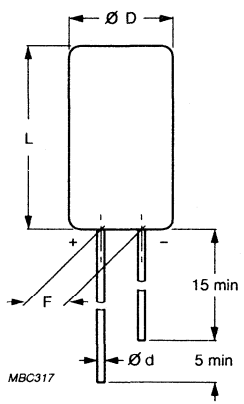


Fig.2 **Form CA**: Long leads.

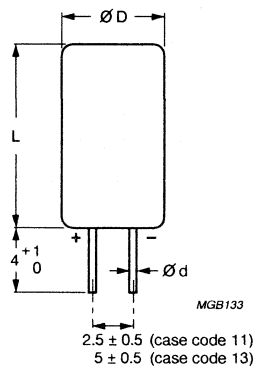


Fig.3 **Form CB**: Cut leads.

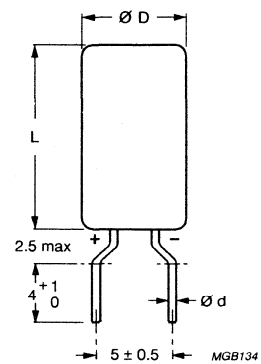
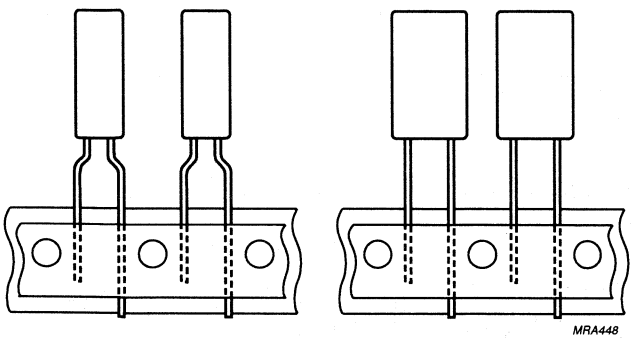


Fig.4 **Form CC**: Cut leads, formed; case size 5 x 11 mm only.

Table 2 Dimensions in mm; mass in g

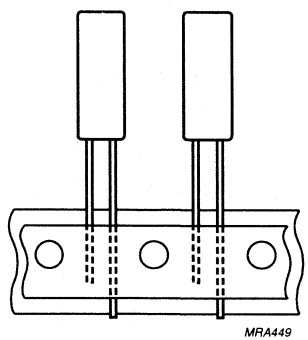
CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	Ø d	ØD_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA CB, CC	Form TR+, TN+	Form TFA, TNA
5 x 11	11	0.5	5.5	12	2.5	0.4	1000	1000	2000
8.2 x 11	13	0.6	8.7	12	5	1.1	1000	500	1000

Tape dimensions are specified in chapter "PACKING".



Form TR+: Taped on reel, positive leading.
Form TFA : Taped in box (ammopack).

Fig.5 Taped, pitch F = 5 mm; case sizes 5 x 11 and 8.2 x 11 mm.



Form TN+: Taped on reel, positive leading
Form TNA: Taped in box (ammopack).

Fig.6 Taped, pitch F = 2.5 mm; case size 5 x 11 mm only.

R

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)
- Name of manufacturer (PH)
- Date code in accordance with IEC 62
- Code indicating factory of origin
- Minus-sign on top to identify the negative terminal.

Non-solid Al - electrolytic capacitors
Radial Long-Life

RLL 116

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. Preferred types in **bold**.

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)
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

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor RLL 116
100 µF/40 V; ±20%
Case size 8.2 x 11 mm; Form TR+
Catalogue number: 2222 116 27101.

Table 4 Ordering information. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL		TAPED IN BOX	
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 2.5 mm positive leading Form TN+	F = 5 mm Form TFA	F = 2.5 mm Form TNA
6.3	150	116 53151	116 83151	116 63151	116 23151	116 13151	116 33151	116 73151
	470	116 53471	116 63471	–	116 23471	–	116 33471	–
10	**100**	**116 54101**	116 84101	116 64101	116 24101	116 14101	**116 34101**	116 74101
	330	116 54331	116 64331	–	116 24331	–	116 34331	–
16	68	116 55689	116 85689	116 65689	116 25689	116 15689	116 35689	116 75689
	220	**116 55221**	116 65221	–	116 25221	–	**116 35221**	–
25	**47**	**116 56479**	116 86479	116 66479	116 26479	116 16479	**116 36479**	116 76479
	150	116 56151	116 66151	–	116 26151	–	116 36151	–
35	33	116 50339	116 80339	116 60339	116 20339	116 10339	116 30339	116 70339
	100	**116 50101**	116 60101	–	116 20101	–	**116 30101**	–
40	33	116 57339	116 87339	116 67339	116 27339	116 17339	116 37339	116 77339
	100	116 57101	116 67101	–	116 27101	–	116 37101	–

Non-solid Al - electrolytic capacitors
Radial Long-Life

RLL 116

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**	120	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	10	8.2 x 11	13	100	7	3.6	0.06	9.5	3.5	15	45
	22	8.2 x 11	13	120	11	4.4	0.06	4.4	1.8	7.3	23
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

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	$I_{L1} \leq 0.006\ C_R \times U_R + 3$ µA
After 5 minutes at U_R	$I_{L5} \leq 0.001\ C_R \times U_R + 3$ µA

Equivalent series inductance (ESL)

case size 5 x 11 mm	typ. 13 nH
case size 8.2 x 11 mm	typ. 16 nH

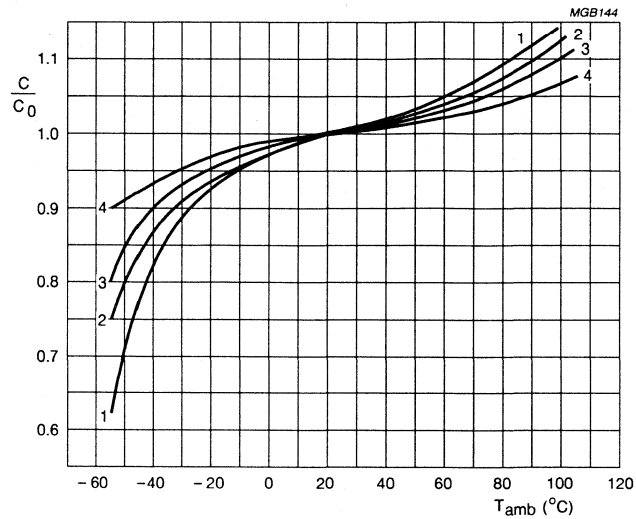
Non-solid Al - electrolytic capacitors
Radial Long-Life

RLL 116

U_R (V)	C_R 100 Hz (µF)	CATALOGUE NUMBER 2222						
		BULK PACKING			TAPED ON REEL		TAPED IN BOX	
		LONG LEADS Form CA	CUT LEADS Form CB	CUT LEADS FORMED Form CC	F = 5 mm positive leading Form TR+	F = 2.5 mm positive leading Form TN+	F = 5 mm Form TFA	F = 2.5 mm Form TNA
50	0.47	116 51477	116 81477	116 61477	116 21477	116 11477	116 31477	116 71477
	1.0	**116 51108**	116 81108	116 61108	116 21108	116 11108	**116 31108**	116 71108
	1.5	116 51158	116 81158	116 61158	116 21158	116 11158	116 31158	116 71158
	2.2	**116 51228**	116 81228	116 61228	116 21228	116 11228	**116 31228**	116 71228
	3.3	116 51338	116 81338	116 61338	116 21338	116 11338	116 31338	116 71338
	4.7	**116 51478**	116 81478	116 61478	116 21478	116 11478	**116 31478**	116 71478
	6.8	116 51688	116 81688	116 61688	116 21688	116 11688	116 31688	116 71688
	10	**116 51109**	116 81109	116 61109	116 21109	116 11109	**116 31109**	116 71109
	10	116 90084	116 90085	–	116 90055	–	116 90036	–
	15	116 51159	116 81159	116 61159	116 21159	116 11159	116 31159	116 71159
	22	**116 51229**	116 81229	116 61229	116 21229	116 11229	**116 31229**	116 71229
	22	**116 90025**	116 90086	–	116 90057	–	**116 90039**	–
	33	116 51339	116 61339	–	116 21339	–	116 31339	–
	47	**116 51479**	116 61479	–	116 21479	–	**116 31479**	–
	68	116 51689	116 61689	–	116 21689	–	116 31689	–
63	10	116 58109	116 68109	–	116 28109	–	116 38109	116 78109
	22	116 58229	116 68229	–	116 28229	–	116 38229	–
100	2.2	116 59228	116 69228	–	116 29228	–	116 39228	–
	4.7	116 59478	116 69478	–	116 29478	–	116 39478	–
	10	116 59109	116 69109	–	116 29109	–	116 39109	–

R

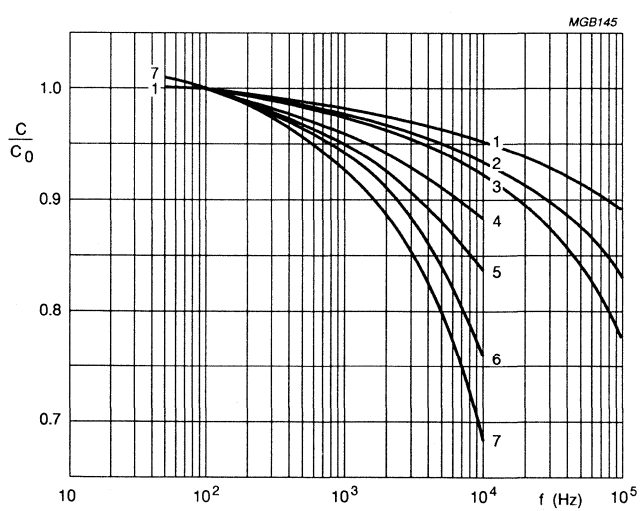
Capacitance (C)



Curve 1: 6.3 V
Curve 2: 10 ; 16 V
Curve 3: 35 V; 40 V; 63 V; 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.

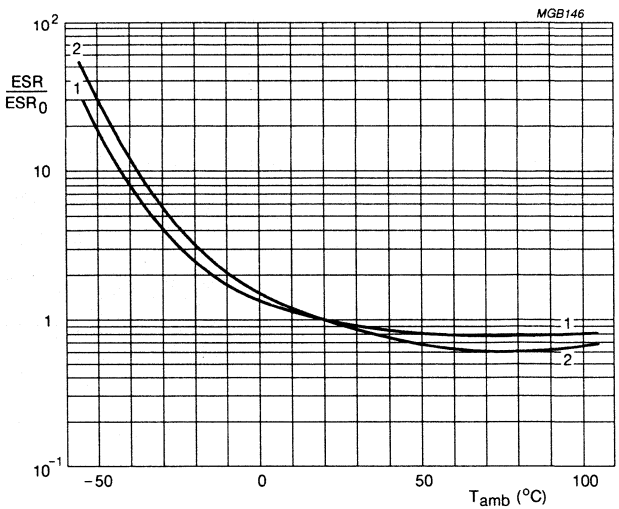


Curve 1: 50 V, (≤2.2 µF)
Curve 2: 50 V, (>2.2 µF)
Curve 3: 50 V, (≥15 µF)
Curve 4: 35 V; 40 V; 63 V; 100 V
Curve 5: 25 V
Curve 6: 16 V
Curve 7: 6.3 V; 10 V.

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)

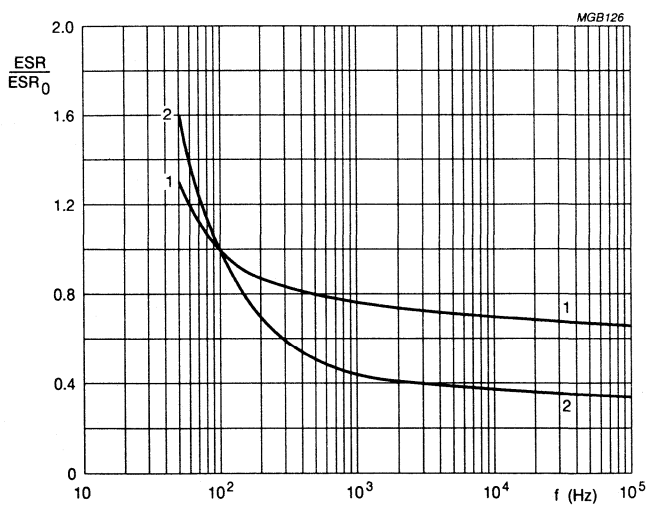


Curve 1: 50 V, (≥10 µF)
Curve 2: 6.3 V; 63 ; 100 V.

ESR_o = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR_o) as a function of ambient temperature.

R



Curve 1: 6.3 V
Curve 2: 50 V, (≥10 µF); 63 V; 100 V.

ESR_o = typical ESR at 20 °C, 100 Hz.

Fig.10 Multiplier of ESR (ESR/ESR_o) as a function of frequency.

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.

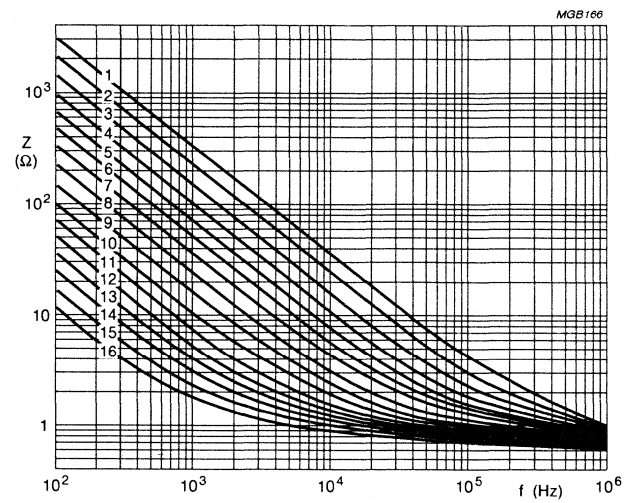


Fig.11 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 5 x 11 mm.

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.

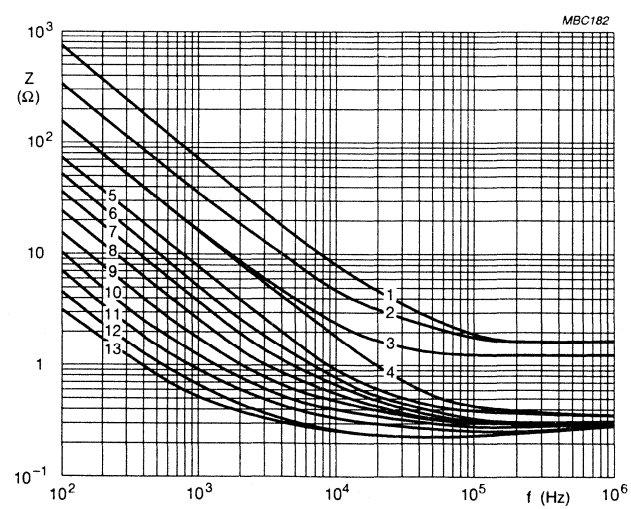
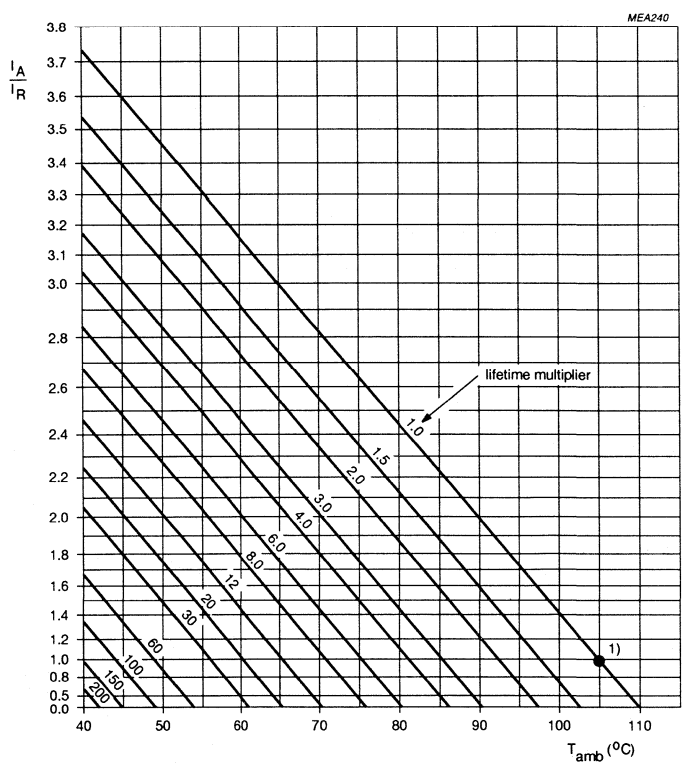


Fig.12 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size 8.2 x 11 mm.

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 V to 10 V	U_R = 16 V to 35 V	U_R = 40 V 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, 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).

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/ CECC 30 300 sub clause 4.13	T_{amb} = 105 °C; U_R applied; 1500 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 $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; 2000 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 $I_{L5} \leq 2$ x spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp).	IEC 384-4/ CECC 30 300 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	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L5} \leq$ spec. limit

NOTES

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 vinyl sleeve
- Charge and discharge proof
- Pressure relief
- Long useful life: 1500 to 2500 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.

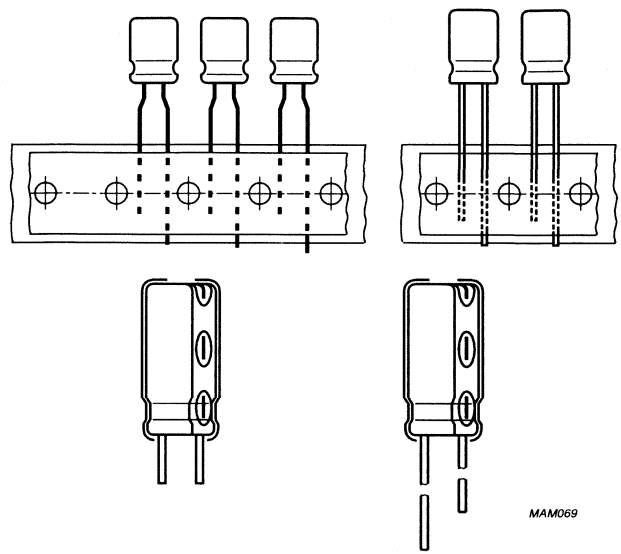


Fig.1 Component outlines.

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	1500 hours	2500 hours
Useful life at 40 °C, 1.3 I_R applied	150 000 hours	250 000 hours
Shelf life at 0 V, 105 °C	1000 hours	1000 hours
Based on sectional specification	IEC 384-4/CECC 30 300	
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259 - with reduced dimensions	
Climatic category IEC 68 DIN 40040	55/105/56 FMF	

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

RLI 135

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (Ø **D x L** in **mm**). Preferred types in **bold**.

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	10 x 25	**12.5 x 20**	16 x 25
330			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**	10 x 30	**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	
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		16 x 30 18 x 25	16 x 35 18 x 30	18 x 40				
6800	16 x 30	16 x 35	18 x 35					
10 000	18 x 30	18 x 40						

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

RLI 135

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

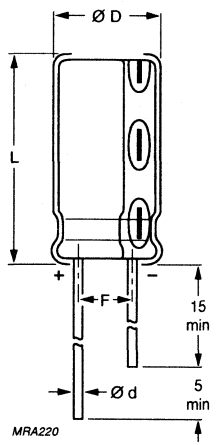


Fig.2 **Form CA**: Long leads.

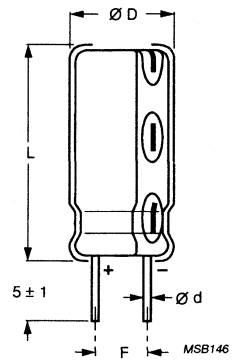


Fig.3 **Form CB**: Cut leads.

Taping dimensions are specified in chapter "PACKING".

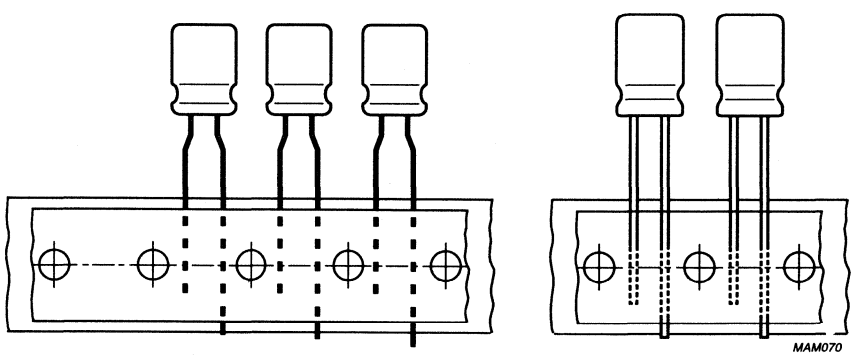


Fig.4 **Form TFA**: Taped in box (ammopack).

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

Table 2 Dimensions in mm, mass in g

CASE SIZE ∅ D_{nom} x L_{nom}	∅ d	∅D_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
						Form CA	Form CB	Form TFA
8 x 12	0.6	8.5	13	3.5	1.1	1000	2000	1000
8 x 15	0.6	8.5	16	3.5	1.3	1000	2000	1000
8 x 20	0.6	8.5	21	3.5	1.5	1000	1000	1000
10 x 12.5	0.6	10.5	13.5	5	1.6	2000	1500	800
10 x 15	0.6	10.5	17.5	5	1.9	2000	1500	800
10 x 20	0.6	10.5	22	5	2.2	2000	1500	800
10 x 25	0.6	10.5	27	5	3.0	1000	1500	800
10 x 30	0.6	10.5	32	5	3.5	1000	750	–
12.5 x 15	0.6	13	17.5	5	2.7	1000	1500	500
12.5 x 20	0.6	13	22	5	4.0	1000	1500	500
12.5 x 25	0.6	13	27	5	5.0	1000	1500	500
12.5 x 30	0.6	13	33.5	5	5.5	1000	750	–
12.5 x 35	0.6	13	37.5	5	6.0	500	750	–
12.5 x 40	0.6	13	42	5	7.5	500	750	–
16 x 20	0.8	16.5	23.5	7.5	6.0	500	500	–
16 x 25	0.8	16.5	27	7.5	8.0	500	500	–
16 x 30	0.8	16.5	33.5	7.5	9.0	500	500	–
16 x 35	0.8	16.5	37.5	7.5	11	500	500	–
16 x 40	0.8	16.5	42	7.5	13	250	500	–
18 x 15	0.8	18.5	17	7.5	6.0	500	500	–
18 x 20	0.8	18.5	23.5	7.5	8.0	500	500	–
18 x 25	0.8	18.5	27.5	7.5	10	500	500	–
18 x 30	0.8	18.5	33.5	7.5	12.5	250	500	–
18 x 35	0.8	18.5	37.5	7.5	14.5	250	500	–
18 x 40	0.8	18.5	42	7.5	16	250	500	–

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. Preferred types in **bold**.

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 100 kHz 20 °C (Ω)	Z 100 kHz −10 °C (Ω)
6.3	470	10 x 12.5	410	510	89	30	0.22	0.62	0.28	0.73
	680	10 x 15	510	640	129	43	0.22	0.43	0.22	0.57
	2200	12.5 x 20	1000	1100	416	140	0.24	0.14	0.089	0.23
	6800	16 x 30	1600	1800	1290	430	0.32	0.062	0.055	0.14
	10 000	18 x 30	1800	2000	1890	630	0.40	0.053	0.047	0.12
10	470	8 x 15	400	500	141	47	0.19	0.54	0.24	0.62
	1000	**12.5 x 15**	780	970	300	100	0.19	0.25	0.12	0.31
	1500	10 x 30	1000	1200	450	150	0.19	0.17	0.093	0.24
	2200	**12.5 x 25**	1200	1300	660	220	0.21	0.13	0.073	0.19
	2200	18 x 15	1200	1300	660	220	0.21	0.13	0.080	0.21
	3300	12.5 x 35	1600	1800	990	330	0.23	0.092	0.052	0.14
	3300	16 x 20	1200	1400	990	330	0.23	0.092	0.075	0.20
	4700	16 x 30	1600	1800	1410	470	0.25	0.071	0.054	0.14
	4700	18 x 25	1700	1800	1410	470	0.25	0.071	0.053	0.14
	6800	16 x 35	1800	2000	2040	680	0.29	0.057	0.046	0.12
	10 000	18 x 40	2200	2500	3000	1000	0.37	0.049	0.037	0.096

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

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. Preferred types in **bold**.

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CATALOGUE NUMBER 2222		
			BULK PACKING		TAPED IN BOX
			LONG LEADS	CUT LEADS	AMMOPACK F = 5 mm
			Form CA	Form CB	Form TFA
6.3	470	10 x 12.5	135 53471	135 63471	135 33471
	680	10 x 15	135 53681	135 63681	135 33681
	2200	12.5 x 20	135 53222	135 63222	135 33222
	6800	16 x 30	135 53682	135 63682	–
	10 000	18 x 30	135 53103	135 63103	–
10	470	8 x 15	135 54471	135 84471	135 34471
	1000	**12.5 x 15**	135 54102	**135 64102**	**135 34102**
	1500	10 x 30	135 54152	135 64152	–
	2200	**12.5 x 25**	135 54222	**135 64222**	**135 34222**
	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	–
	10 000	18 x 40	135 54103	135 64103	–

R

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 100 kHz 20 °C (Ω)	Z 100 kHz −10 °C (Ω)
16	220	8 x 12	220	400	106	35	0.16	0.96	0.33	0.86
	330	8 x 15	350	500	158	53	0.16	0.64	0.23	0.60
	470	8 x 20	520	650	226	75	0.16	0.45	0.18	0.47
	680	10 x 20	690	860	326	110	0.16	0.31	0.14	0.36
	1000	10 x 30	920	1200	480	160	0.16	0.21	0.091	0.24
	1500	12.5 x 25	1200	1300	720	240	0.16	0.14	0.072	0.19
	2200	12.5 x 30	1400	1500	1060	350	0.18	0.11	0.063	0.16
	2200	**16 x 20**	1200	1400	1060	350	0.18	0.11	0.073	0.19
	4700	16 x 35	1800	2000	2260	750	0.22	0.062	0.046	0.12
	4700	18 x 30	1800	2000	2260	750	0.22	0.062	0.046	0.12
	6800	18 x 35	2000	2200	3260	1100	0.26	0.051	0.040	0.10
25	220	8 x 15	350	500	165	55	0.14	0.84	0.23	0.60
	470	**10 x 20**	690	860	353	120	0.14	0.40	0.14	0.36
	1000	**12.5 x 25**	1100	1300	750	250	0.14	0.19	0.071	0.18
	1500	12.5 x 30	1400	1500	1125	380	0.14	0.12	0.062	0.16
	2200	12.5 x 40	1800	2000	1650	550	0.16	0.10	0.044	0.11
	2200	18 x 20	1400	1600	1650	550	0.16	0.10	0.060	0.16
	3300	**16 x 35**	1800	2000	2475	830	0.18	0.072	0.045	0.12
	3300	18 x 30	1800	2000	2475	830	0.18	0.072	0.045	0.12
	4700	18 x 40	2200	2500	3525	1200	0.20	0.056	0.036	0.94
35	100	8 x 12	280	400	105	35	0.12	1.59	0.32	0.83
	220	8 x 20	460	650	231	77	0.12	0.72	0.18	0.47
	330	10 x 20	610	860	347	120	0.12	0.48	0.13	0.34
	470	10 x 30	920	1200	490	160	0.12	0.34	0.089	0.23
	680	12.5 x 25	1100	1300	714	240	0.12	0.23	0.070	0.18
	1000	**12.5 x 30**	1400	1500	1050	350	0.12	0.16	0.061	0.16
	1000	**16 x 20**	1100	1370	1050	350	0.12	0.16	0.071	0.18
	1500	12.5 x 40	1800	2000	1575	530	0.12	0.11	0.043	0.11
	2200	**16 x 35**	1800	2000	2310	770	0.14	0.084	0.044	0.11
	2200	18 x 30	1800	2000	2310	770	0.14	0.084	0.044	0.11
	3300	18 x 40	2200	2500	3465	1200	0.16	0.064	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 IN BOX
			LONG LEADS	CUT LEADS	AMMOPACK F = 5 mm
			Form CA	Form CB	Form TFA
16	220	8 x 12	135 55221	135 85221	135 35221
	330	8 x 15	135 55331	135 85331	135 35331
	470	8 x 20	135 55471	135 85471	135 35471
	680	10 x 20	135 55681	135 65681	135 35681
	1000	10 x 30	135 55102	135 65102	–
	1500	12.5 x 25	135 55152	135 65152	135 35152
	2200	12.5 x 30	135 55222	135 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 36221
	470	**10 x 20**	135 56471	**135 66471**	135 36471
	1000	**12.5 x 25**	135 56102	**135 66102**	135 36102
	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 30101
	220	8 x 20	135 50221	135 80221	135 30221
	330	10 x 20	135 50331	135 60331	135 30331
	470	10 x 30	135 50471	135 60471	–
	680	12.5 x 25	135 50681	135 60681	135 30681
	1000	**12.5 x 30**	135 50102	**135 60102**	–
	1000	**16 x 20**	135 90016	**135 90017**	–
	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	–

R

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 100 kHz 20 °C (Ω)	Z 100 kHz −10 °C (Ω)
50	**100**	**10 x 15**	450	640	150	50	0.10	1.33	0.20	0.52
	220	10 x 25	730	1000	330	110	0.10	0.60	0.11	0.29
	330	12.5 x 20	790	1100	495	170	0.10	0.40	0.081	0.22
	470	**12.5 x 25**	1100	1300	705	240	0.10	0.28	0.068	0.19
	470	18 x 15	1000	1300	705	240	0.10	0.28	0.074	0.19
	1000	**16 x 30**	1500	1800	1500	500	0.10	0.13	0.050	0.13
	1500	16 x 40	2100	2300	2250	750	0.10	0.088	0.035	0.091
	2200	18 x 40	2200	2500	3300	1100	0.12	0.072	0.034	0.091
63	47	8 x 12	220	300	89	30	0.08	2.26	0.56	1.5
	220	**12.5 x 20**	630	890	416	140	0.08	0.48	0.16	0.42
	470	**16 x 25**	1200	1400	888	300	0.08	0.23	0.091	0.25
	680	16 x 30	1400	1800	1285	430	0.08	0.16	0.065	0.18
	1000	16 x 40	1800	2200	1890	630	0.08	0.11	0.049	0.13
100	22	8 x 12	120	310	66	22	0.07	4.22	0.53	1.4
	100	**12.5 x 20**	630	890	300	100	0.07	0.93	0.15	0.40
	220	16 x 25	1000	1400	660	220	0.07	0.42	0.086	0.23
	330	16 x 30	1300	1800	990	330	0.07	0.28	0.062	0.17
	330	18 x 25	1200	1700	990	330	0.07	0.28	0.074	0.20
	470	16 x 40	1800	2200	1410	470	0.07	0.20	0.047	0.13
	680	18 x 40	1900	2400	2040	680	0.07	0.14	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 IN BOX
			LONG LEADS	CUT LEADS	AMMOPACK F = 5 mm
			Form CA	Form CB	Form TFA
50	**100**	**10 x 15**	135 51101	**135 61101**	**135 31101**
	220	10 x 25	135 51221	135 61221	135 31221
	330	12.5 x 20	135 51331	135 61331	135 31331
	470	**12.5 x 25**	135 51471	**135 61471**	**135 31471**
	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 38479
	220	**12.5 x 20**	135 58221	**135 68221**	**135 38221**
	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 39229
	100	**12.5 x 20**	135 59101	**135 69101**	135 39101
	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	–

R

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

RLI 135

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	$I_{L1} \leq 0.03\ C_R U_R$ µA
After 2 minutes at U_R	$I_{L2} \leq 0.01\ C_R U_R$ µA

Capacitance (C)

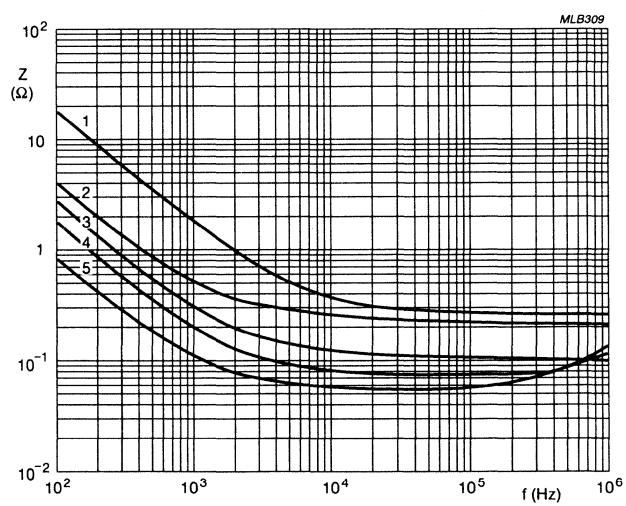
Ratio of capacitance at 120 Hz:

$C_{-55\ °C}/C_{20\ °C} \geq 0.7$ for $U_R = 6.3$ V
$C_{-55\ °C}/C_{20\ °C} \geq 0.8$ for $U_R = 10$ V to 100 V

Impedance (Z)

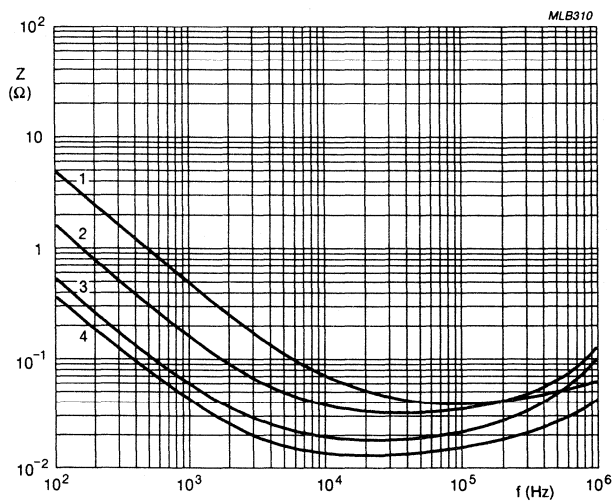
Ratio of impedance at 120 Hz:

$Z_{-55\ °C}/Z_{20\ °C} \leq 3$



Curve 1: 100 µF, 35 V; 8 x 12
Curve 2: 470 µF, 6.3 V; 10 x 12.5
Curve 3: 680 µF, 16 V; 10 x 20
Curve 4: 1000 µF, 25 V; 12.5 x 25
Curve 5: 2200 µF, 16 V; 16 x 20.

Fig.5 Typical impedance as a function of frequency at $T_{amb} = 20$ °C; case sizes 8 x 12 mm to 16 x 20 mm.



Curve 1: 330 µF, 100 V; 18 x 25
Curve 2: 1000 µF, 50 V; 16 x 30
Curve 3: 3300 µF, 35 V; 18 x 40
Curve 4: 4700 µF, 25 V; 18 x 40.

Fig.6 Typical impedance as a function of frequency at T_{amb} = 20 °C; case sizes 16 x 25 mm to 18 x 40 mm.

R

MARKING

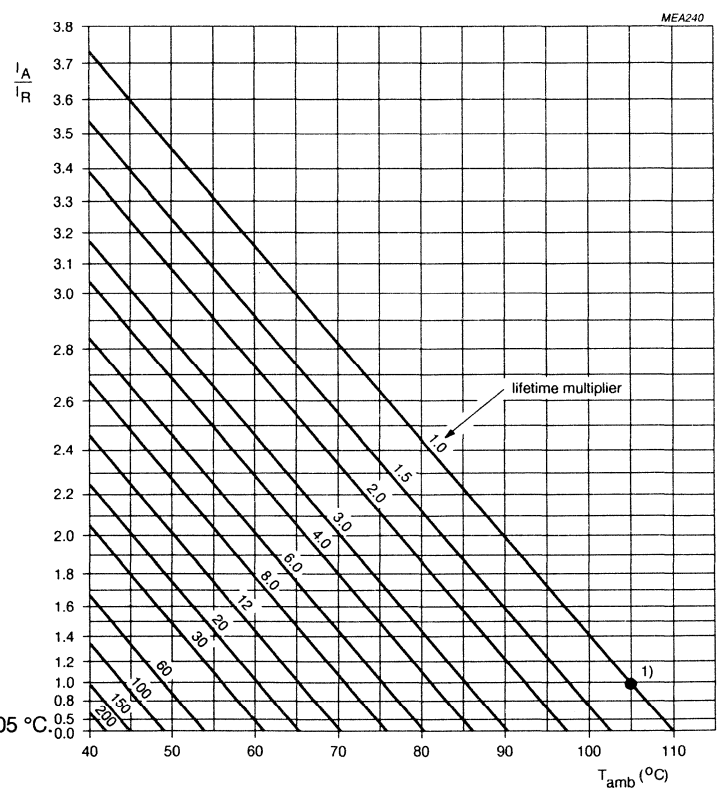
The capacitors are marked (where possible) with the following information:

- 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.

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 µF to 330 µF	470 µF 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
ØD = 8 mm: 1500 hours
ØD = 10 to 18 mm: 2500 hours.

Fig.7 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/ CECC 30 300 sub clause 4.13	T_{amb} = 105 °C; U_R applied; Ø D = 8 mm: 1000 hours ØD = 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; ØD = 8 mm: 1500 hours ØD = 10 to 18 mm: 2500 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/ CECC 30 300, sub clause 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

R

Non-solid Al - electrolytic capacitors
Radial Miniature Long-Life

RML 048

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Miniaturized, high CU product per unit volume
- Very long useful life: 3000 to 4000 hours at 105 °C, high reliability.

APPLICATIONS

- EDP, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Low surface demand on printed-circuit board
- Portable and mobile equipment (small size, low mass).

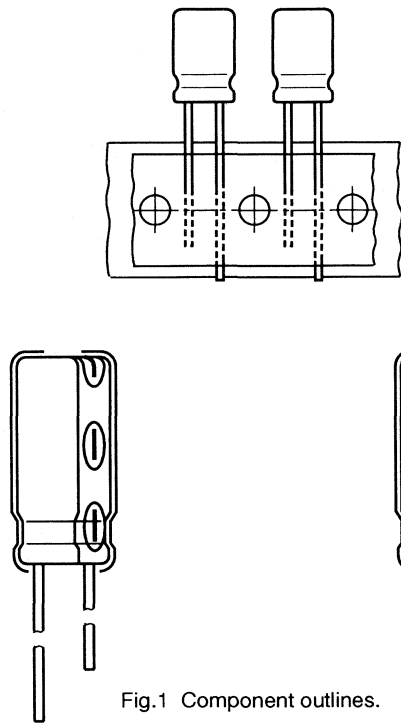


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	10 x 12 to 18 x 40
Rated capacitance range, C_R	100 to 10 000 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 ∅ 10 and 12.5 mm case ∅ 16 and 18 mm	 3000 hours 4000 hours
Useful life at 40 °C, 1.6 I_R applied case ∅ 10 and 12.5 mm case ∅ 16 and 18 mm	 200 000 hours 260 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259 - with reduced dimensions
Climatic category IEC 68 DIN 40040	 40/105/56 GMF

Non-solid Al - electrolytic capacitors
Radial Miniature Long-Life

RML 048

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (⌀ **D x L** in **mm**). Preferred types in **bold**.

C_R (µF)	U_R (V)							
	6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**
100	For lower capacitance values see RLL 116 series							**10 x 12**
220					**10 x 12**		10 x 16	**10 x 20**
330					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**
1000		10 x 16	**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 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					

R

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

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

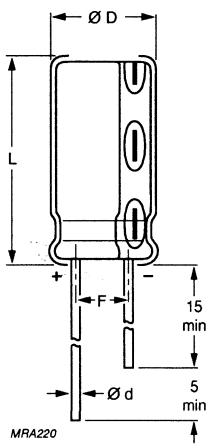


Fig.2 **Form CA**: Long leads. For dimensions, refer to Table 2.

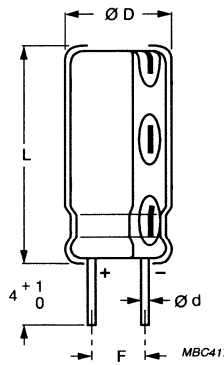


Fig.3 **Form CB**: Cut leads. For dimensions, refer to Table 2.

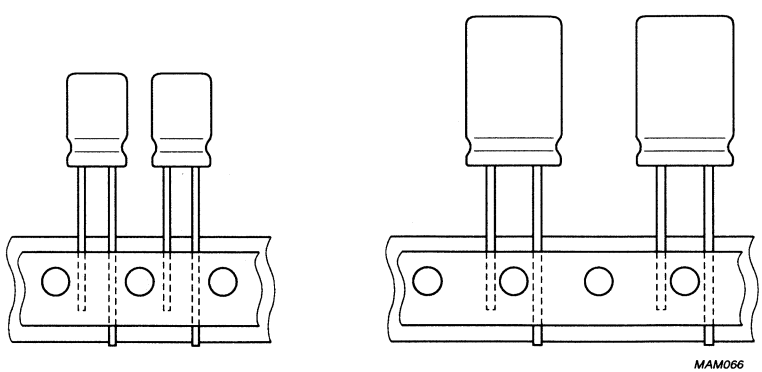


Fig.4 **Form TFA**: case sizes up to Ø16 x 31 taped in box (ammopack).

Non-solid Al - electrolytic capacitors
Radial Miniature Long-Life

RML 048

Table 2 Dimensions in mm; mass in g

NOMINAL CASE SIZE ∅ D x L	CASE CODE	∅ d	∅ D_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA per box	Form CB per box	Form TFA per box
10 x 12	14	0.6	10.5	13.5	5.0	1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0	1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0	2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0	4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0	5.0	250	250	500
16 x 25	19	0.8	16.5	27.0	7.5	8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5	9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5	11.5	100	100	–
18 x 35	22	0.8	18.5	37.5	7.5	14.5	300	1000	–
18 x 40	23	0.8	18.5	42.0	7.5	16.0	300	1000	–

Marking

The capacitors are marked with the following information:

- Rated capacitance value
- Tolerance on rated capacitance, code letter in accordance with IEC 62 (M for ±20%)
- Rated voltage in V
- Upper category temperature (105 °C)
- Group number (048)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62
- Negative terminal identification.

R

Non-solid Al - electrolytic capacitors
Radial Miniature Long-Life

RML 048

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 or 100 kHz.

Table 3 Electrical data. Preferred types in **bold**.

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 (Ω)	Z 100 kHz (Ω)
6.3	6800	16 x 25	19	1200	430	89	0.36	0.08	0.08	0.06
	10000	16 x 35	21	1500	630	130	0.44	0.07	0.06	0.05
10	1000	10 x 16	15	430	100	23	0.20	0.32	0.32	0.23
	2200	12.5 x 20	17	700	220	47	0.24	0.17	0.16	0.12
	3300	12.5 x 25	18	870	330	69	0.26	0.13	0.11	0.09
	4700	16 x 25	19	1100	470	97	0.28	0.10	0.09	0.07
	6800	16 x 31	20	1400	680	140	0.32	0.07	0.07	0.06
	10000	18 x 35	22	1600	1000	200	0.40	0.06	0.06	0.05
16	**470**	**10 x 12**	**14**	330	78	18	0.16	0.49	0.40	0.29
	1000	**10 x 20**	**16**	550	160	35	0.16	0.23	0.19	0.16
	2200	**12.5 x 25**	**18**	870	360	73	0.20	0.13	0.11	0.09
	3300	16 x 25	19	1100	530	110	0.22	0.10	0.09	0.07
	4700	**16 x 31**	**20**	1400	760	150	0.24	0.07	0.07	0.06
	6800	16 x 35	21	1600	1100	220	0.28	0.06	0.06	0.06
	10000	18 x 40	23	1800	1600	320	0.36	0.05	0.05	0.05

Non-solid Al - electrolytic capacitors
Radial Miniature Long-Life

RML 048

ORDERING INFORMATION

Ordering Example

Electrolytic capacitors RML 048
2200 µF/16 V; ±20%
Case size 12.5 x 25 mm; Form TFA
Catalogue number: 2222 048 35222.

Table 4 Ordering information. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
				Form CA	Form CB	Form TFA
6.3	6800	16 x 25	19	048 53682	048 63682	048 33682
	10000	16 x 35	21	048 53103	048 63103	–
10	1000	10 x 16	15	048 54102	048 64102	048 34102
	2200	12.5 x 20	17	048 54222	048 64222	048 34222
	3300	12.5 x 25	18	048 54332	048 64332	048 34332
	4700	16 x 25	19	048 54472	048 64472	048 34472
	6800	16 x 31	20	048 54682	048 64682	048 34682
	10000	18 x 35	22	048 54103	048 64103	–
16	**470**	**10 x 12**	**14**	048 55471	**048 65471**	**048 35471**
	1000	**10 x 20**	**16**	048 55102	**048 65102**	**048 35102**
	2200	**12.5 x 25**	**18**	048 55222	**048 65222**	**048 35222**
	3300	16 x 25	19	048 55332	048 65332	048 35332
	4700	**16 x 31**	**20**	048 55472	**048 65472**	**048 35472**
	6800	16 x 35	21	048 55682	048 65682	–
	10000	18 x 40	23	048 55103	048 65103	–

R

Non-solid Al - electrolytic capacitors
Radial Miniature Long-Life

RML 048

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 (Ω)	Z 100 kHz (Ω)
25	470	10 x 16	15	370	120	27	0.14	0.43	0.34	0.24
	1000	**12.5 x 20**	**17**	640	250	53	0.14	0.20	0.17	0.12
	2200	16 x 25	19	990	550	110	0.18	0.12	0.08	0.07
	3300	**16 x 31**	**20**	1300	830	170	0.20	0.09	0.06	0.06
	4700	18 x 35	22	1500	1200	240	0.22	0.07	0.05	0.05
	6800	18 x 40	23	1800	1700	340	0.26	0.06	0.04	0.04
35	**220**	**10 x 12**	**14**	260	80	18	0.12	0.78	0.48	0.35
	330	10 x 16	15	340	120	26	0.12	0.52	0.33	0.23
	470	**10 x 20**	**16**	430	170	36	0.12	0.37	0.24	0.19
	1000	12.5 x 25	18	760	350	73	0.12	0.17	0.12	0.11
	2200	**16 x 31**	**20**	1200	770	160	0.16	0.10	0.06	0.06
	3300	18 x 35	22	1400	1200	230	0.18	0.08	0.05	0.05
	4700	18 x 40	23	1700	1600	330	0.20	0.06	0.04	0.04
40	330	10 x 20	16	360	140	29	0.12	0.52	0.30	0.24
	2200	16 x 35	21	1200	880	180	0.16	0.10	0.06	0.06
	3300	18 x 35	22	1400	1300	270	0.18	0.08	0.04	0.04
50	220	10 x 16	15	300	110	25	0.10	0.65	0.39	0.27
	470	**12.5 x 20**	**17**	520	240	50	0.10	0.30	0.18	0.16
	1000	**16 x 25**	**19**	920	500	100	0.10	0.14	0.09	0.08
	2200	**18 x 35**	**22**	1300	1100	220	0.14	0.09	0.05	0.05
	3300	18 x 40	23	1600	1700	330	0.16	0.07	0.03	0.04
63	**100**	**10 x 12**	**14**	200	66	16	0.09	1.30	0.65	0.58
	220	**10 x 20**	**16**	340	140	31	0.09	0.59	0.32	0.29
	330	12.5 x 20	17	460	210	45	0.09	0.39	0.22	0.20
	470	**12.5 x 25**	**18**	600	300	62	0.09	0.27	0.15	0.14
	1000	16 x 31	20	1000	630	130	0.09	0.13	0.08	0.08
	2200	18 x 40	23	1400	1400	280	0.13	0.09	0.04	0.05

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	$I_{L1} \leq 0.01\ C_R \times U_R + 3$ µA
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3$ µA

Non-solid Al - electrolytic capacitors
Radial Miniature Long-Life

RML 048

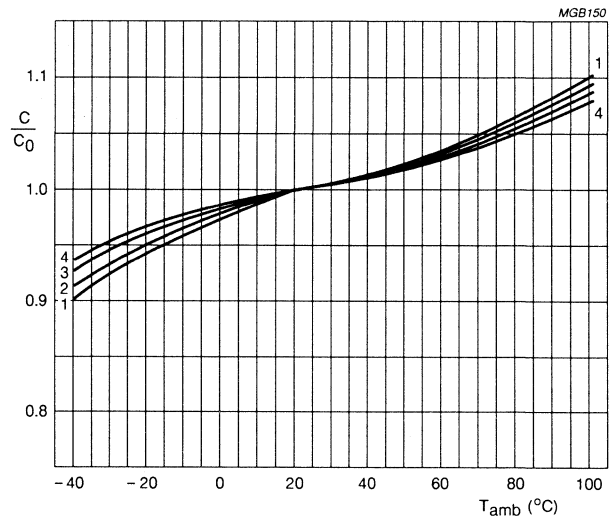
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
				Form CA	Form CB	Form TFA
25	470	10 x 16	15	048 56471	048 66471	048 36471
	1000	**12.5 x 20**	**17**	048 56102	**048 66102**	**048 36102**
	2200	16 x 25	19	048 56222	048 66222	048 36222
	3300	**16 x 31**	**20**	048 56332	**048 66332**	**048 36332**
	4700	18 x 35	22	048 56472	048 66472	–
	6800	18 x 40	23	048 56682	048 66682	–
35	**220**	**10 x 12**	**14**	**048 50221**	**048 60221**	**048 30221**
	330	10 x 16	15	048 50331	048 60331	048 30331
	470	**10 x 20**	**16**	048 50471	**048 60471**	**048 30471**
	1000	12.5 x 25	18	048 50102	048 60102	048 30102
	2200	**16 x 31**	**20**	048 50222	**048 60222**	**048 30222**
	3300	18 x 35	22	048 50332	048 60332	–
	4700	18 x 40	23	048 50472	048 60472	–
40	330	10 x 20	16	048 57331	048 67331	048 37331
	2200	16 x 35	21	048 57222	048 67222	–
	3300	18 x 35	22	048 57332	048 67332	–
50	220	10 x 16	15	048 51221	048 61221	048 31221
	470	**12.5 x 20**	**17**	048 51471	**048 61471**	**048 31471**
	1000	**16 x 25**	**19**	048 51102	**048 61102**	**048 31102**
	2200	**18 x 35**	**22**	048 51222	048 61222	–
	3300	18 x 40	23	048 51332	048 61332	–
63	**100**	**10 x 12**	**14**	048 58101	**048 68101**	**048 38101**
	220	**10 x 20**	**16**	048 58221	**048 68221**	**048 38221**
	330	12.5 x 20	17	048 58331	048 68331	048 38331
	470	**12.5 x 25**	**18**	048 58471	**048 68471**	**048 38471**
	1000	16 x 31	20	048 58102	048 68102	048 38102
	2200	18 x 40	23	048 58222	048 68222	–

R

Equivalent series inductance (ESL)

Case diameter = 10 mm	typ. 16 nH
Case diameter ≥ 12.5 mm	typ. 18 nH

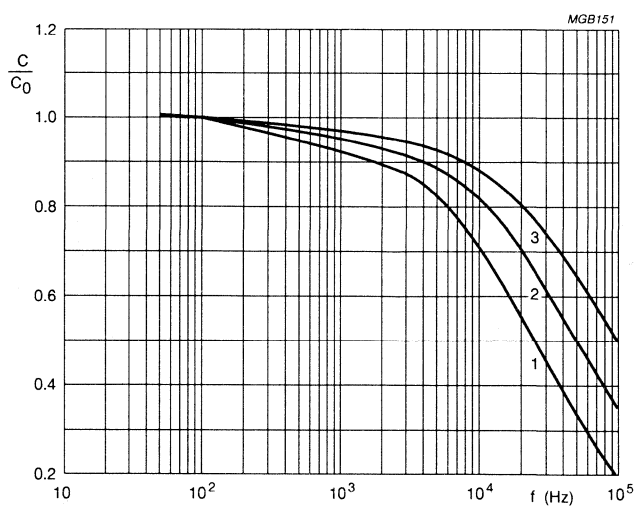
Capacitance (C)



Curve 1: 16 V
Curve 2: 25 V
Curve 3: 35 V
Curve 4: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.



Curve 1: 16 and 25 V
Curve 2: 35 V to 50 V
Curve 3: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Typical 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
Curve 4: 35 V
Curve 5: 40 V
Curve 6: 50 and 63 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

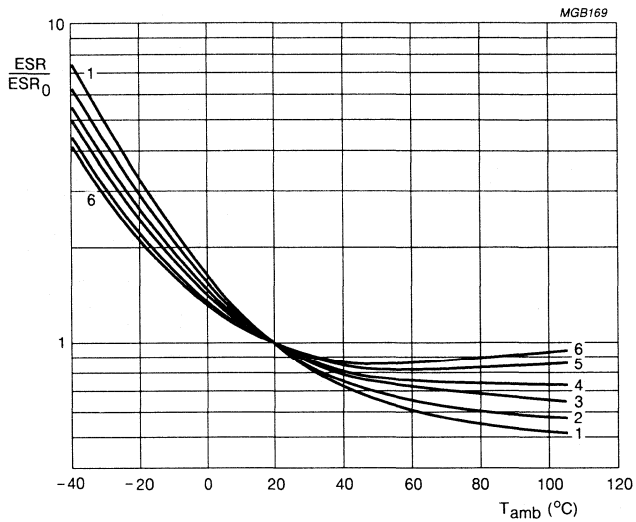


Fig.7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.

Curve 1: 6.3 V
Curve 2: 10 V
Curve 3: 16 V
Curve 4: 25 V
Curve 5: 35 V
Curve 6: 40 V
Curve 7: 50 V
Curve 8: 63 V.

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

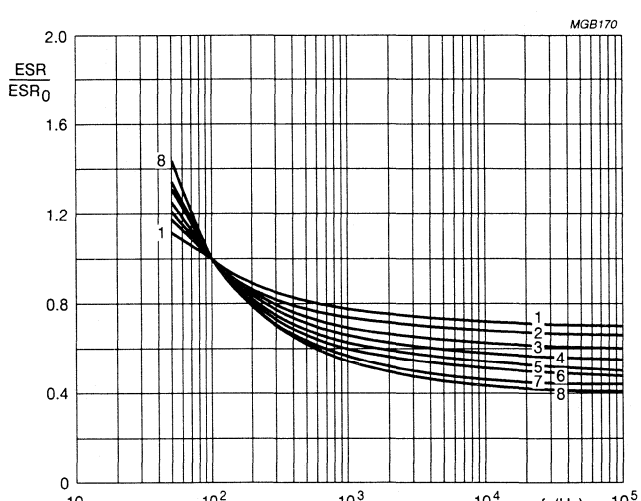
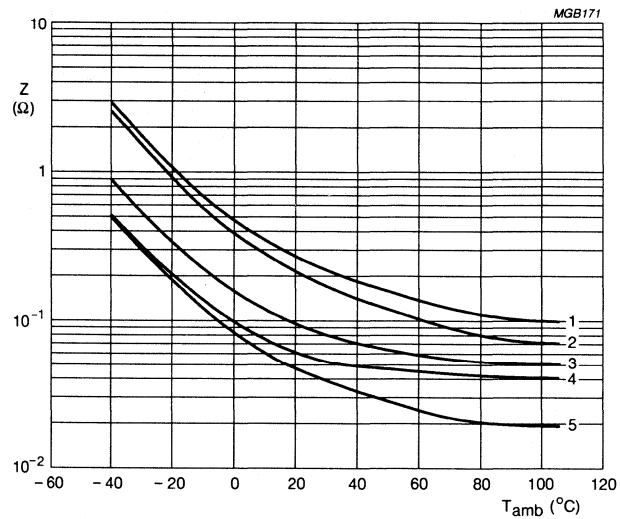


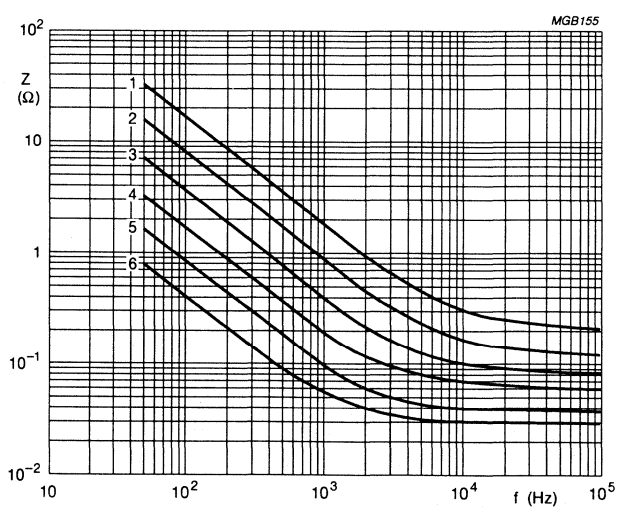
Fig.8 Multiplier of ESR(ESR/ESR_0) as a function of frequency.

Impedance (Z)



Curve 1: 470 µF, 16 V
Curve 2: 330 µF, 40 V
Curve 3: 1000 µF, 35 V
Curve 4: 1000 µF, 16 V
Curve 5: 3300 µF, 16 V.

Fig.9 Typical impedance at 10 kHz as a function of ambient temperature.



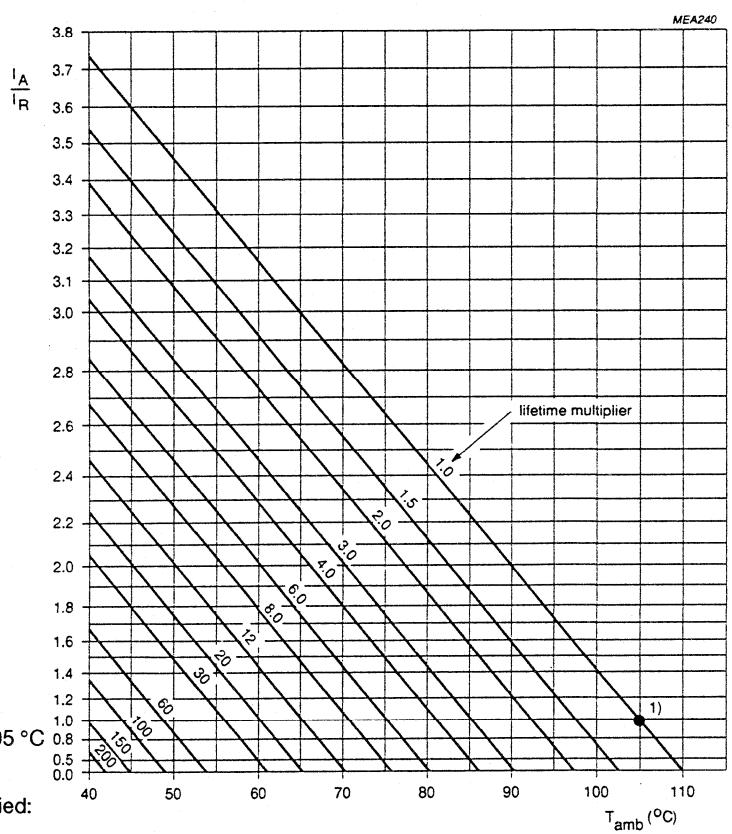
Curve 1: 100 µF, 63 V
Curve 2: 220 µF, 63 V
Curve 3: 470 µF, 50 V
Curve 4: 1000 µF, 35 V
Curve 5: 2200 µF, 25 V
Curve 6: 4700 µF, 16 V.

Fig.10 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 V to 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50	0.95	0.85	0.80
100	1.00	1.00	1.00
300	1.07	1.20	1.25
1000	1.12	1.30	1.40
3000	1.15	1.35	1.50
≥10000	1.20	1.40	1.60



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:
Ø10 and 12.5 mm 3000 hours
Ø16 and 18 mm 4000 hours.

Fig.11 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

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/ CECC 30 300 group C 3, 4.13	T_{amb} = 105 °C; U_R applied; 2000 hours	U_R = 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 $I_{L5} \leq$ 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 ∅10 and 12.5 mm 4000 hours case ∅16 and 18 mm	U_R = 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 $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temp.)	IEC 384-4/ CECC 30 300, 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	U_R = 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 $I_{L5} \leq$ 2 x spec. limit

NOTES

Non-solid Al - electrolytic capacitors
Radial Standard Long-Life

RSL 046

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Very long useful life, 3000/4000 hours at 105 °C, high reliability
- High ripple current capability, low impedance, low ESR.

APPLICATIONS

- Power conversion, EDP, telecommunication, industrial and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Low surface demand on printed-circuit board.

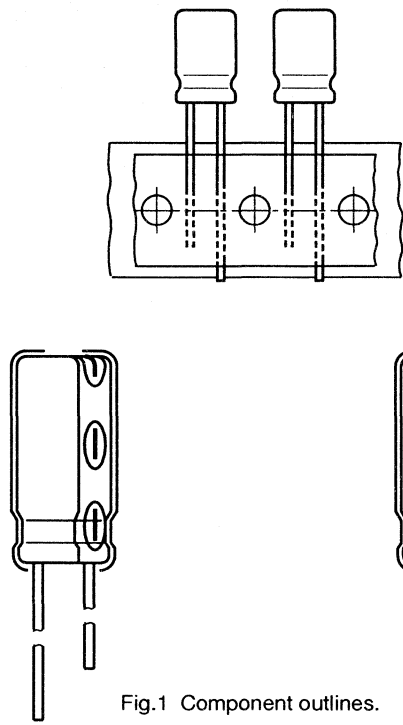


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (Ø D_{nom} x L_{nom} in mm)	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 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	 200 000 hours 260 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259
Climatic category IEC 68 DIN 40040	 40/105/56 GMF

Non-solid Al - electrolytic capacitors
Radial Standard Long-Life

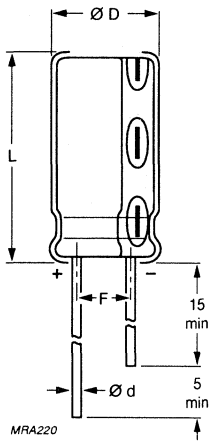
RSL 046

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (**⌀ D x L** in **mm**). Preferred types in **bold**.

C_R (µF)	U_R (V)							
	6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**
22	For lower capacitance values see RLL 116 series							10 x 12
47								10 x 12
100						**10 x 12**	**10 x 16**	**10 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**
1000	10 x 20	12.5 x 20	**12.5 x 25**	12.5 x 25	**16 x 25**		**16 x 31**	18 x 35
2200	12.5 x 25		**16 x 25**	**16 x 31**		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					
10 000	18 x 35	18 x 40						

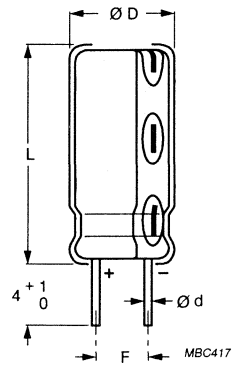
F

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES



Dimensions in mm.

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



Dimensions in mm.

Fig.3 **Form CB**: Cut leads.

Table 2 Dimensions in mm; mass in g

CASE SIZE ∅ D_{nom} x L_{nom} (mm)	CASE CODE	∅ d (mm)	∅D_{max} (mm)	L_{max} (mm)	F ±0.5 (mm)	APPROX. MASS	PACKING QUANTITIES		
							Form CA	Form CB	Form TFA
10 x 12	14	0.6	10.5	13.5	5.0	1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0	1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0	2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0	4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0	5.0	250	250	500
16 x 25	19	0.8	16.5	27.0	7.5	8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5	9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5	11.5	100	100	–
18 x 35	22	0.8	18.5	37.5	7.5	14.5	300	1000	–
18 x 40	23	0.8	18.5	42.0	7.5	16.0	300	1000	–

Taping dimensions are specified in chapter "PACKING".

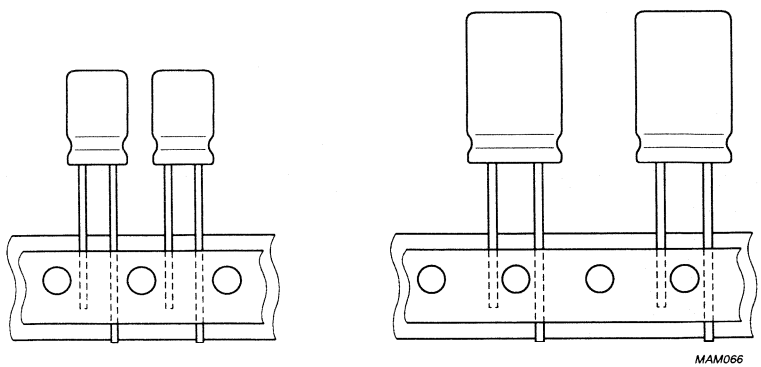


Fig.4 **Form TFA**: case sizes up to 16 x 31 mm. Taped in box (ammopack).

Marking

The capacitors are marked with the following information:

- Rated capacitance in μF
- Tolerance on rated capacitance, code letter in accordance with IEC 62 (M for ±20%)
- Rated voltage in V
- Upper category temperature (105 °C)
- Group number (046)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62
- Negative terminal identification.

Non-solid Al - electrolytic capacitors
Radial Standard Long-Life

RSL 046

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_{RH} = rated RMS ripple current at 100 kHz, 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 3 Electrical data. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 100 Hz 105 °C (mA)	I_{RH} 100 kHz 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	470	10 x 12	14	360	600	33	9	0.19	0.64	0.32	0.28
	1000	10 x 20	16	600	1000	66	16	0.19	0.30	0.15	0.14
	2200	12.5 x 25	18	950	1500	140	31	0.23	0.17	0.08	0.07
	3300	16 x 25	19	1200	1700	210	45	0.25	0.12	0.06	0.06
	4700	16 x 31	20	1400	2000	300	62	0.27	0.09	0.05	0.05
	6800	16 x 35	21	1600	2100	430	89	0.31	0.07	0.05	0.05
	10 000	18 x 35	22	1800	2300	630	130	0.39	0.06	0.04	0.04
10	330	10 x 12	14	370	620	36	10	0.15	0.72	0.38	0.31
	470	10 x 16	15	460	800	50	12	0.15	0.51	0.27	0.22
	1000	12.5 x 20	17	770	1100	100	23	0.15	0.24	0.13	0.12
	4700	16 x 35	21	1600	2300	470	97	0.23	0.08	0.04	0.04
	6800	18 x 35	22	1800	2500	680	140	0.27	0.06	0.03	0.03
	10 000	18 x 40	23	2000	2600	1000	200	0.35	0.06	0.03	0.03
16	220	10 x 12	14	350	620	38	10	0.13	0.94	0.40	0.31
	330	10 x 16	15	430	800	56	14	0.13	0.63	0.30	0.22
	470	10 x 20	16	560	920	78	18	0.13	0.44	0.21	0.18
	1000	**12.5 x 25**	**18**	900	1500	160	35	0.13	0.21	0.10	0.10
	2200	**16 x 25**	**19**	1300	1800	360	73	0.17	0.12	0.06	0.05
	3300	16 x 31	20	1600	2200	530	110	0.19	0.09	0.04	0.04
	4700	18 x 35	22	1800	2500	760	150	0.21	0.07	0.03	0.03
	6800	18 x 40	23	2000	2600	1100	220	0.25	0.06	0.03	0.03
25	1000	12.5 x 25	18	900	1500	250	53	0.11	0.18	0.09	0.08
	2200	**16 x 31**	**20**	1600	2100	550	110	0.15	0.11	0.04	0.04
	3300	18 x 35	22	1900	2500	830	170	0.17	0.08	0.03	0.03
	4700	18 x 40	23	2000	2600	1200	240	0.19	0.06	0.03	0.03

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitors RSL 046
2200 µF/16 V; ±20%
Case size 16 x 25 mm; Form TFA
Catalogue number: 2222 046 35222.

Table 4 Ordering information. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
				LONG LEADS Form CA	CUT LEADS Form CB	IN BOX Ammopack Form TFA
6.3	470	10 x 12	14	046 53471	046 63471	046 33471
	1000	10 x 20	16	046 53102	046 63102	046 33102
	2200	12.5 x 25	18	046 53222	046 63222	046 33222
	3300	16 x 25	19	046 53332	046 63332	046 33332
	4700	16 x 31	20	046 53472	046 63472	046 33472
	6800	16 x 35	21	046 53682	046 63682	–
	10 000	18 x 35	22	046 53103	046 63103	–
10	330	10 x 12	14	046 54331	046 64331	046 34331
	470	10 x 16	15	046 54471	046 64471	046 34471
	1000	12.5 x 20	17	046 54102	046 64102	046 34102
	4700	16 x 35	21	046 54472	046 64472	–
	6800	18 x 35	22	046 54682	046 64682	–
	10 000	18 x 40	23	046 54103	046 64103	–
16	220	10 x 12	14	046 55221	046 65221	046 35221
	330	10 x 16	15	046 55331	046 65331	046 35331
	470	10 x 20	16	046 55471	046 65471	046 35471
	1000	**12.5 x 25**	**18**	046 55102	**046 65102**	**046 35102**
	2200	**16 x 25**	**19**	046 55222	**046 65222**	**046 35222**
	3300	16 x 31	20	046 55332	046 65332	046 35332
	4700	18 x 35	22	046 55472	046 65472	–
	6800	18 x 40	23	046 55682	046 65682	–
25	1000	12.5 x 25	18	046 56102	046 66102	046 36102
	2200	**16 x 31**	**20**	046 56222	**046 66222**	**046 36222**
	3300	18 x 35	22	046 56332	046 66332	–
	4700	18 x 40	23	046 56472	046 66472	–

Non-solid Al - electrolytic capacitors
Radial Standard Long-Life

RSL 046

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 105 °C (mA)	I_{RH} 100 kHz 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)
35	220	10 x 16	15	400	740	80	18	0.10	0.72	0.30	0.23
	330	10 x 20	16	510	880	120	26	0.10	0.48	0.26	0.16
	470	**12.5 x 20**	**17**	650	1000	170	36	0.10	0.34	0.14	0.11
	1000	**16 x 25**	**19**	1200	1600	350	73	0.10	0.16	0.07	0.06
40	**100**	**10 x 12**	**14**	300	560	43	11	0.09	1.43	0.60	0.35
	220	10 x 20	16	450	850	91	21	0.09	0.65	0.27	0.17
	330	12.5 x 20	17	590	1000	140	29	0.09	0.43	0.18	0.13
	470	**12.5 x 25**	**18**	750	1300	190	41	0.09	0.30	0.13	0.08
	2200	18 x 35	22	1900	2500	880	180	0.11	0.08	0.03	0.03
	3300	18 x 40	23	2100	2600	1300	270	0.12	0.06	0.03	0.03
50	**100**	**10 x 16**	**15**	310	610	53	13	0.07	1.11	0.50	0.28
	220	12.5 x 20	17	500	980	110	25	0.07	0.51	0.23	0.13
	330	12.5 x 25	18	680	1200	170	36	0.07	0.34	0.15	0.09
	1000	**16 x 31**	**20**	1400	1800	500	100	0.07	0.11	0.05	0.05
	2200	18 x 40	23	2000	2600	1100	220	0.09	0.07	0.03	0.03
63	22	10 x 12	14	170	310	17	9	0.06	4.3	1.6	0.7
	47	10 x 12	14	230	430	33	9	0.06	2.03	0.96	0.40
	100	**10 x 20**	**16**	360	710	66	16	0.06	0.95	0.45	0.20
	220	12.5 x 25	18	610	1100	140	31	0.06	0.43	0.20	0.11
	330	16 x 25	19	750	1300	210	45	0.06	0.29	0.14	0.08
	470	**16 x 25**	**19**	950	1600	300	62	0.06	0.20	0.10	0.06
	1000	18 x 35	22	1500	2100	630	130	0.06	0.10	0.04	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	$I_{L1} \leq 0.01\ C_R \times U_R + 3$ µA
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3$ µA

Equivalent series inductance (ESL)

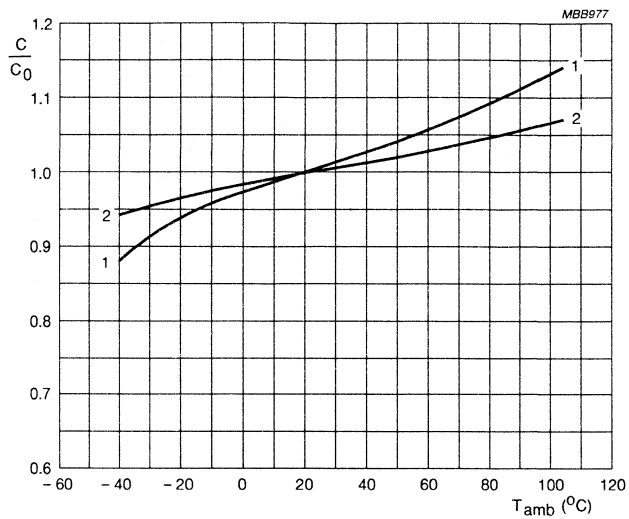
Case Ø = 10 mm	typ. 16 nH
Case Ø ≥ 12.5 mm	typ. 18 nH

Non-solid Al - electrolytic capacitors
Radial Standard Long-Life

RSL 046

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
				LONG LEADS Form CA	CUT LEADS Form CB	IN BOX Ammopack Form TFA
35	220	10 x 16	15	046 50221	046 60221	046 30221
	330	10 x 20	16	046 50331	046 60331	046 30331
	470	**12.5 x 20**	**17**	046 50471	**046 60471**	**046 30471**
	1000	**16 x 25**	**19**	046 50102	**046 60102**	**046 30102**
40	**100**	**10 x 12**	**14**	046 57101	**046 67101**	**046 37101**
	220	10 x 20	16	046 57221	046 67221	046 37221
	330	12.5 x 20	17	046 57331	046 67331	046 37331
	470	**12.5 x 25**	**18**	046 57471	**046 67471**	**046 37471**
	2200	18 x 35	22	046 57222	046 67222	–
	3300	18 x 40	23	046 57332	046 67332	–
50	**100**	**10 x 16**	**15**	046 51101	**046 61101**	**046 31101**
	220	12.5 x 20	17	046 51221	046 61221	046 31221
	330	12.5 x 25	18	046 51331	046 61331	046 31331
	1000	**16 x 31**	**20**	046 51102	**046 61102**	**046 31102**
	2200	18 x 40	23	046 51222	046 61222	–
63	22	10 x 12	14	046 58229	046 68229	046 38229
	47	10 x 12	14	046 58479	046 68479	046 38479
	100	**10 x 20**	**16**	046 58101	**046 68101**	**046 38101**
	220	12.5 x 25	18	046 58221	046 68221	046 38221
	330	16 x 25	19	046 58331	046 68331	046 38331
	470	**16 x 25**	**19**	046 58471	**046 68471**	**046 38471**
	1000	18 x 35	22	046 58102	046 68102	–

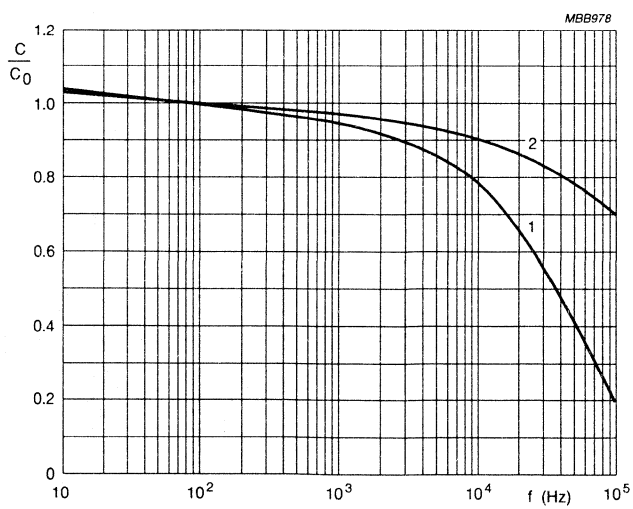
Capacitance (C)



Curve 1: 6.3 V
Curve 2: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.

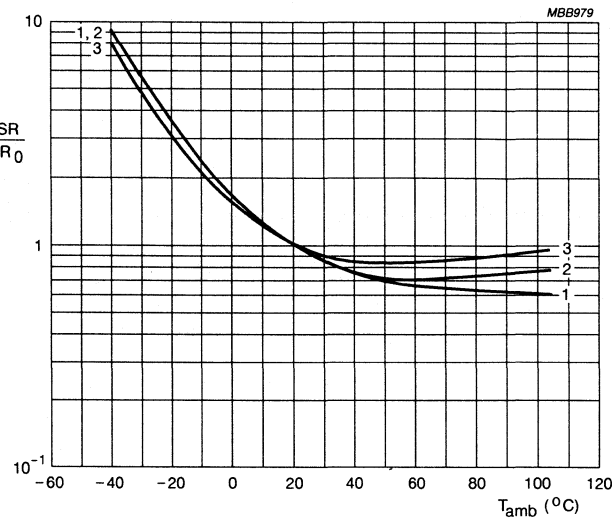


Curve 1: 6.3 V
Curve 2: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Typical multiplier of capacitance (C/C_0) as a function of frequency.

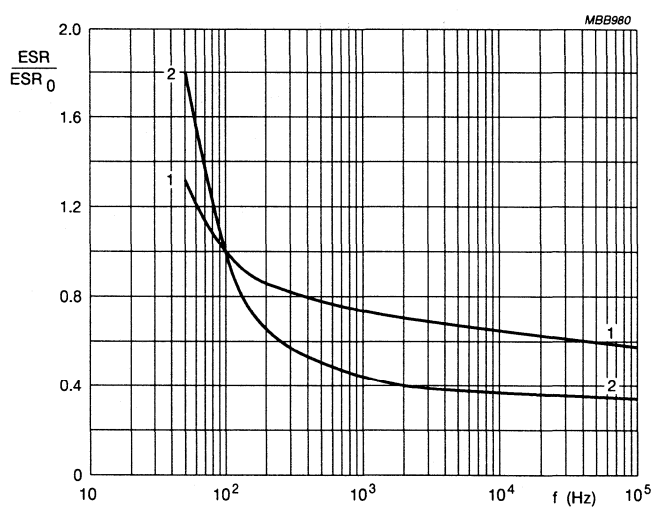
Equivalent series resistance (ESR)



Curve 1: 6.3 V; case ∅10 and 12.5 mm
Curve 2: 6.3 V; case ∅16 and 18 mm
Curve 3: 63 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.

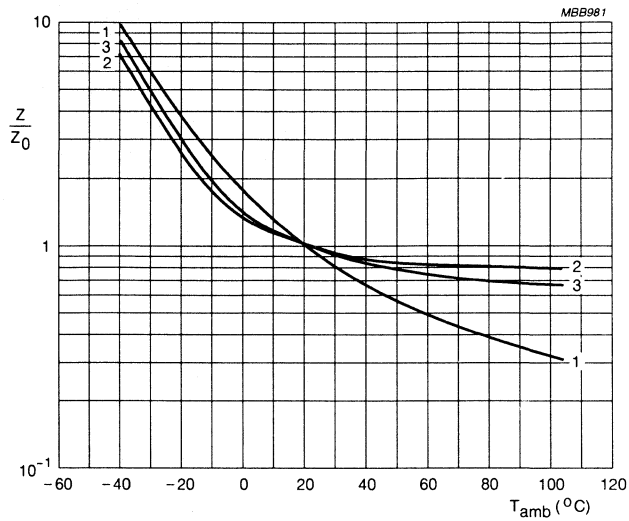


Curve 1: 6.3 V
Curve 2: 63 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.8 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

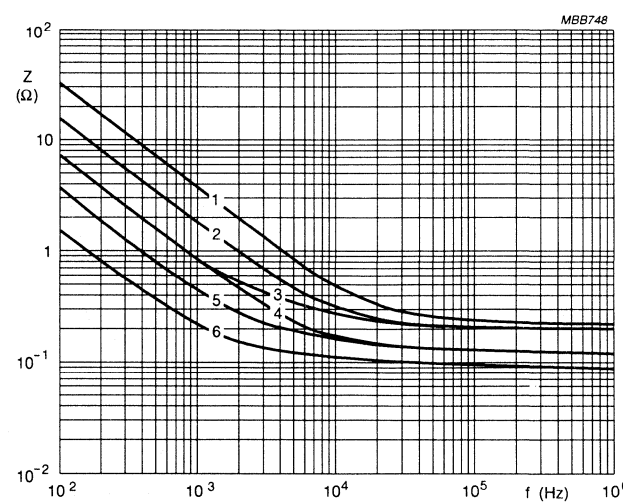
Impedance (Z)



Curve 1: 6.3 V; case ∅10 and 12.5 mm
Curve 2: 6.3 V; case ∅16 and 18 mm.
Curve 3: 63 V.

Z_0 = typical impedance at 20 °C, 10 kHz.

Fig.9 Multiplier of Impedance (Z/Z_0) as a function of ambient temperature.



Curve 1: 47 µF, 63 V; 10 x 12
Curve 2: 100 µ,F 40 V; 10 x 12
Curve 3: 220 µF, 16 V; 10 x 12
Curve 4: 220 µF, 40 V; 10 x 20
Curve 5: 470 µF, 16 V; 10 x 20
Curve 6: 1000 µF, 6.3 V; 10 x 20.

Fig.10 Typical impedance at 20 °C as a function of frequency. Case ∅ = 10 mm.

Curve 1: 220 µF, 50 V; 12.5 x 20
Curve 2: 330 µF, 50 V; 12.5 x 25
Curve 3: 470 µF, 40 V; 12.5 x 25
Curve 4: 1000 µF, 35 V; 16 x 25
Curve 5: 1000 µF, 50 V; 16 x 31
Curve 6: 1000 µF, 63 V; 18 x 35
Curve 7: 4700 µF, 16 V; 18 x 35.

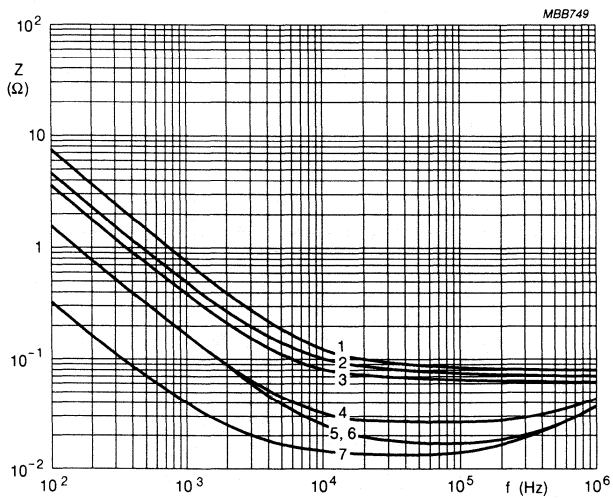
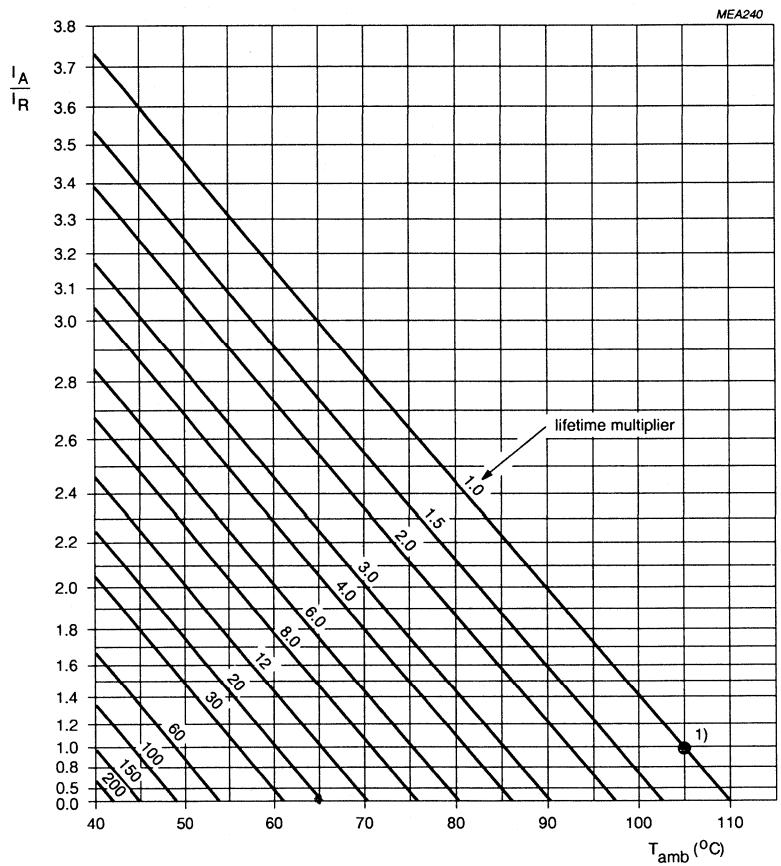


Fig.11 Typical impedance at 20 °C as a function of frequency. Case ∅ = 12.5 mm to 18 mm.

R

RIPPLE CURRENT and USEFUL LIFE



I_A = actual ripple current at 100 Hz or 100 kHz

I_R = rated ripple current at 100 Hz or 100 kHz, 105 °C

1) Useful life at 105 °C and I_R applied:
Ø10 and 12.5 mm; 3000 hours
Ø16 and 18 mm; 4000 hours.

Fig.12 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 as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 V to 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50	0.82	0.80	0.75
100	1.00	1.00	1.00
300	1.12	1.25	1.30
1000	1.20	1.40	1.50
3000	1.25	1.50	1.65
≥10 000	1.30	1.60	1.80

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/ CECC 30 300 4.13	T_{amb} = 105 °C; U_R applied; 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; 3000 hours, case ∅10 and 12.5 mm 4000 hours, case ∅16 and 18 mm	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/ CECC 30 300, 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	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} ≤ 2 x spec. limit

F

Non-solid Al - electrolytic capacitors Radial, Very Low Impedance

RVI 136

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case with safety vent, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Very long useful life, 4000 to 10 000 hours at 105 °C, very high reliability
- Very low impedance or ESR respectively, which is significantly lower than the RLI 135 series
- Excellent ripple current capability.

APPLICATIONS

- Power supplies (SMPS, DC/DC converters) for general industrial, EDP, audio-video and telecommunications
- Smoothing, filtering, buffering.

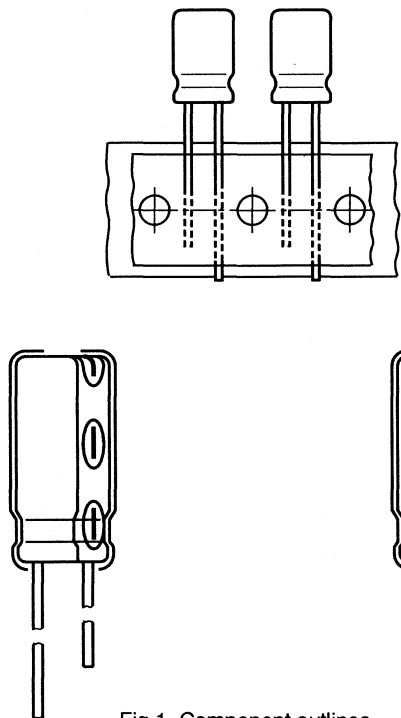


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes ($\varnothing D_{nom}$ x L_{nom} in mm)	10 x 12 to 16 x 35
Rated capacitance range, C_R	47 to 6800 µF
Tolerance on C_R	±20%
Rated voltage range, C_R	10 to 63 V
Category temperature range	–55 to +105 °C
Endurance test at 105 °C	3000 to 5000 hours (dependent on case size)
Useful life at 105 °C	4000 to 10 000 hours (dependent on case size)
Useful life at 40 °C, 1.8 I_R applied	200 000 to 500 000 hours (dependent on case size)
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259 - with reduced dimensions
Climatic category IEC 68 (DIN 40040)	55/105/56 (FMF)

Non-solid Al - electrolytic capacitors
Radial, Very Low Impedance

RVI 136

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (Ø D x L in mm). Preferred types in **bold**.

C_R (µF)	U_R (V)					
	10	**16**	**25**	**35**	**50**	**63**
47						**10 x 12**
56						10 x 12
68						10 x 16
82					10 x 12	
100					10 x 12 [1]	**10 x 16**
120				10 x 12	10 x 16	10 x 20 12.5 x 16
150				10 x 12 [1]	10 x 20 [1]	10 x 25
180			10 x 12		10 x 20 12.5 x 16	10 x 30
220			10 x 12 [1]	**10 x 16**	10 x 25	**12.5 x 20**
270		10 x 12				12.5 x 25
330		10 x 12 [1]	10 x 16	10 x 20 12.5 x 16	10 x 30 12.5 x 20	16 x 20
390	10 x 12			10 x 25		12.5 x 30
470	10 x 12 [1]	**10 x 16**	**10 x 20** 12.5 x 16	12.5 x 20 [1]	**12.5 x 25**	**16 x 25**
560			10 x 25	10 x 30 12.5 x 20	12.5 x 30	
680	10 x 16	10 x 20 12.5 x 16		12.5 x 25	16 x 20	16 x 31
820		10 x 25	10 x 30 12.5 x 20		16 x 25	16 x 35
1000	**10 x 20** 12.5 x 16	12.5 x 20 [1]	**12.5 x 25**	12.5 x 30 16 x 20	**16 x 31**	
1200	10 x 25	10 x 30 12.5 x 20		16 x 25	16 x 35	
1500	10 x 30 12.5 x 20 [1]	12.5 x 25	12.5 x 30 16 x 20	16 x 25 [1]		
1800	12.5 x 20		16 x 25	16 x 31		
2200	**12.5 x 25**	12.5 x 30 16 x 20	16 x 31 [1]	**16 x 35**		
2700	12.5 x 30	16 x 25	16 x 31			
3300	16 x 20	16 x 25 [1]	**16 x 35**			
3900	16 x 25	16 x 31				
4700	16 x 31 [1]	**16 x 35**				
5600	16 x 31					
6800	16 x 35					

Note [1] = under consideration.

MSB183

R

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

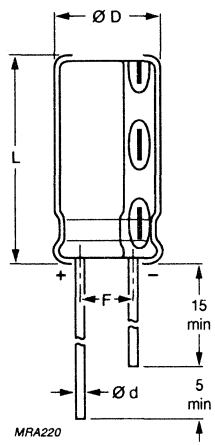


Fig.2 **Form CA**: Long Leads.

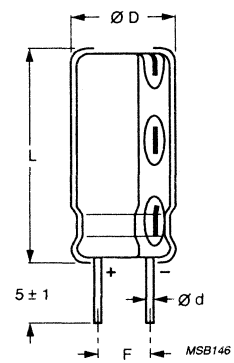


Fig.3 **Form CB**: Cut leads.

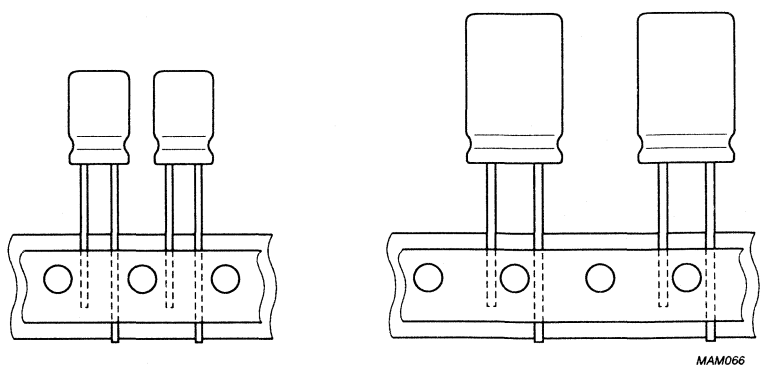


Fig.4 **Form TFA**: Taped in box (ammopack) **PREFERRED**.

Non-solid Al - electrolytic capacitors Radial, Very Low Impedance

RVI 136

Table 2 Dimensions in mm

CASE SIZE $\varnothing D_{nom}$ x L_{nom} (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	APPROX. MASS (g)	PACKING QUANTITIES		
							Form CA	Form CB	Form TFA
10 x 12	14	0.6	10.5	13.5	5.0 ±0.5	1.6	2000	1500	500
10 x 16	15	0.6	10.5	17.5	5.0 ±0.5	1.9	2000	1500	800
10 x 20	16	0.6	10.5	22.0	5.0 ±0.5	2.2	2000	1500	800
10 x 25	16L	0.6	10.5	27.0	5.0 ±0.5	3.0	1000	1500	800
10 x 30	16LL	0.6	10.5	32.0	5.0 ±0.5	3.5	1000	750	–
12.5 x 16	17a	0.6	13.0	17.5	5.0 ±0.5	2.7	1000	1500	500
12.5 x 20	17	0.6	13.0	22.0	5.0 ±0.5	4.0	1000	1500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ±0.5	5.0	1000	1500	500
12.5 x 30	18L	0.6	13.0	33.5	5.0 ±0.5	5.5	1000	750	–
16 x 20	19a	0.8	16.5	23.5	7.5 ±0.5	6.0	500	500	–
16 x 25	19	0.8	16.5	27.0	7.5 ±0.5	8.0	500	500	–
16 x 31	20	0.8	16.5	33.5	7.5 ±0.5	9.0	500	500	–
16 x 35	21	0.8	16.5	37.5	7.5 ±0.5	11.0	500	500	–

MARKING

The capacitors are marked with the following information:

- Rated capacitance in µF
- Tolerance on rated capacitance, code letter in accordance with IEC 62 (M for ±20%)
- Rated voltage in V
- Upper category temperature (105 °C)
- Group number (136)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62
- Negative terminal identification.

R

Non-solid Al - electrolytic capacitors Radial, Very Low Impedance

RVI 136

ELECTRICAL DATA

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

C_R = rated capacitance at 100 Hz, tolerance ±20%

I_R = rated RMS ripple current at 100 kHz, 105°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 100 kHz and 20 or −10 °C

Table 3 Electrical data. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L2} 2 min (µA)	Tan δ 100 Hz	ESR 100 Hz (mΩ)	Z 100 kHz 20 °C (mΩ)	Z 100 kHz −10 °C (mΩ)
10	390	10 x 12	630	39	0.19	780	120	240
	470	10 x 12 [1]	630	47	0.19	640	120	240
	680	10 x 16	830	68	0.19	450	84	170
	1000	**10 x 20**	1000	100	0.19	300	62	130
	1000	12.5 x 16	940	100	0.19	300	76	160
	1200	10 x 25	1300	120	0.19	250	52	110
	1500	10 x 30	1400	150	0.19	200	44	88
	1500	12.5 x 20 [1]	1300	150	0.19	200	46	92
	1800	12.5 x 20	1340	180	0.19	170	46	92
	2200	**12.5 x 25**	1700	220	0.21	150	34	68
	2700	12.5 x 30 [1]	2000	270	0.21	120	30	60
	3300	16 x 20	1600	330	0.23	110	38	76
	3900	16 x 25	2100	390	0.23	94	28	56
	4700	16 x 31 [1]	2400	470	0.25	85	25	50
	5600	16 x 31	2400	560	0.27	77	25	50
	6800	16 x 35	2600	680	0.29	68	22	44
16	270	10 x 12	630	43	0.16	940	120	240
	330	10 x 12 [1]	630	53	0.16	770	120	240
	470	**10 x 16**	830	75	0.16	540	84	170
	680	10 x 20	1000	110	0.16	380	62	130
	680	12.5 x 16	940	110	0.16	380	76	160
	820	10 x 25	1300	130	0.16	310	52	110
	1000	12.5 x 20 [1]	1300	160	0.16	260	48	96
	1200	10 x 30	1400	190	0.16	210	44	88
	1200	12.5 x 20	1300	190	0.16	210	46	92
	1500	12.5 x 25	1700	240	0.16	170	34	68

Non-solid Al - electrolytic capacitors
Radial, Very Low Impedance

RVI 136

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor RVI 136
1000 µF/25 V; ±20%
Case size 12.5 x 25 mm; Form TFA
Catalogue number: 2222 136 36102.

Table 4 Ordering information. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK LONG LEADS Form CA	BULK CUT LEADS Form CB	TAPED AMMOPACK Form TFA
10	390	10 x 12	14	136 54391	136 64391	136 34391
	470	10 x 12 [1]	14			
	680	10 x 16	15	136 54681	136 64681	136 34681
	1000	**10 x 20**	**16**	136 54102	**136 64102**	**136 34102**
	1000	12.5 x 16	17a	136 94105	136 94106	136 94103
	1200	10 x 25	16L	136 54122	136 64122	136 34122
	1500	10 x 30	16LL	136 94155	136 94156	–
	1500	12.5 x 20 [1]	17			
	1800	12.5 x 20	17	136 54182	136 64182	136 34182
	2200	**12.5 x 25**	**18**	136 54222	**136 64222**	**136 34222**
	2700	12.5 x 30	18L	136 54272	136 64272	–
	3300	16 x 20	19a	136 54332	136 64332	–
	3900	16 x 25	19	136 54392	136 64392	–
	4700	16 x 31 [1]	20			
	5600	16 x 31	20	136 54562	136 64562	–
	6800	16 x 35	21	136 54682	136 64682	–
16	270	10 x 12	14	136 55271	136 65271	136 35271
	330	10 x 12 [1]	14			
	470	**10 x 16**	**15**	136 55471	**136 65471**	**136 35471**
	680	10 x 20	16	136 55681	136 65681	136 35681
	680	12.5 x 16	17a	136 95685	136 95686	136 95683
	820	10 x 25	16L	136 55821	136 65821	136 35821
	1000	12.5 x 20 [1]	17			
	1200	10 x 30	16LL	136 95125	136 95126	–
	1200	12.5 x 20	17	136 55122	136 65122	136 35122
	1500	12.5 x 25	18	136 55152	136 65152	136 35152

R

Non-solid Al - electrolytic capacitors
Radial, Very Low Impedance

RVI 136

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L2} 2 min (µA)	Tan δ 100 Hz	ESR 100 Hz (mΩ)	Z 100 kHz 20 °C (mΩ)	Z 100 kHz −10 °C (mΩ)
16	2200	12.5 x 30	2000	350	0.18	130	30	60
	2200	16 x 20	1600	350	0.18	130	38	76
	2700	16 x 25	2100	430	0.18	110	28	56
	3300	16 x 25 [1]	2100	530	0.20	97	28	56
	3900	16 x 31	2400	620	0.20	82	25	50
	4700	**16 x 35**	2600	750	0.22	75	22	44
25	180	10 x 12	630	45	0.14	1200	120	240
	220	10 x 12 [1]	630	55	0.14	1000	120	240
	330	10 x 16	830	83	0.14	680	84	170
	470	**10 x 20**	1000	120	0.14	470	62	130
	470	12.5 x 16	940	120	0.14	470	76	160
	560	10 x 25	1300	140	0.14	400	52	110
	820	10 x 30	1400	210	0.14	270	44	88
	820	12.5 x 20	1300	210	0.14	270	46	92
	1000	**12.5 x 25**	1700	250	0.14	220	34	68
	1500	12.5 x 30	2000	380	0.14	150	30	60
	1500	16 x 20	1700	380	0.14	150	38	76
	1800	16 x 25	2100	450	0.14	120	28	56
	2200	16 x 31 [1]	2400	550	0.16	120	25	50
	2700	16 x 31	2400	680	0.16	94	25	50
	3300	**16 x 35**	2600	830	0.18	87	22	44
35	120	10 x 12	630	42	0.12	1600	120	240
	150	10 x 12 [1]	630	53	0.12	1300	120	240
	220	**10 x 16**	830	77	0.12	870	84	170
	330	10 x 20	1000	120	0.12	580	62	130
	330	12.5 x 16	940	120	0.12	580	76	160
	390	10 x 25	1300	140	0.12	490	52	110
	470	12.5 x 20 [1]	1300	170	0.12	410	48	96
	560	10 x 30	1400	200	0.12	340	44	88
	560	12.5 x 20	1300	200	0.12	340	46	92
	680	12.5 x 25	1700	240	0.12	280	34	68
	1000	12.5 x 30	2000	350	0.12	190	30	60
	1000	16 x 20	1700	350	0.12	190	38	76
	1200	16 x 25	2100	420	0.12	160	28	56
	1500	16 x 25 [1]	2100	530	0.12	130	28	56
	1800	16 x 31	2400	630	0.12	110	25	50
	2200	**16 x 35**	2600	770	0.14	100	22	44

Non-solid Al - electrolytic capacitors
Radial, Very Low Impedance

RVI 136

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK LONG LEADS Form CA	BULK CUT LEADS Form CB	TAPED AMMOPACK Form TFA
16	2200	12.5 x 30	18L	136 95225	136 95226	–
	2200	16 x 20	19a	136 55222	136 65222	–
	2700	16 x 25	19	136 55272	136 65272	–
	3300	16 x 25 [1]	19			
	3900	16 x 31	20	136 55392	136 65392	–
	4700	**16 x 35**	**21**	136 55472	**136 65472**	–
25	180	10 x 12	14	136 56181	136 66181	136 36181
	220	10 x 12 [1]	14			
	330	10 x 16	15	136 56331	136 66331	136 36331
	470	**10 x 20**	**16**	136 56471	**136 66471**	**136 36471**
	470	12.5 x 16	17a	136 96475	136 96476	136 96473
	560	10 x 25	16L	136 56561	136 66561	136 36561
	820	10 x 30	16LL	136 96825	136 96826	–
	820	12.5 x 20	17	136 56821	136 66821	136 36821
	1000	**12.5 x 25**	**18**	136 56102	**136 66102**	**136 36102**
	1500	12.5 x 30	18L	136 96155	136 96156	–
	1500	16 x 20	19a	136 56152	136 66152	–
	1800	16 x 25	19	136 56182	136 66182	–
	2200	16 x 31 [1]	20			
	2700	16 x 31	20	136 56272	136 66272	–
	3300	**16 x 35**	**21**	136 56332	**136 66332**	–
35	120	10 x 12	14	136 50121	136 60121	136 30121
	150	10 x 12 [1]	14			
	220	**10 x 16**	**15**	136 50221	**136 60221**	**136 30221**
	330	10 x 20	16	136 50331	136 60331	136 30331
	330	12.5 x 16	17a	136 90335	136 90336	136 90333
	390	10 x 25	16L	136 50391	136 60391	136 30391
	470	12.5 x 20 [1]	17			
	560	10 x 30	16LL	136 90565	136 90566	–
	560	12.5 x 20	17	136 50561	136 60561	136 30561
	680	12.5 x 25	18	136 50681	136 60681	136 30681
	1000	12.5 x 30	18L	136 90105	136 90106	–
	1000	16 x 20	19a	136 50102	136 60102	–
	1200	16 x 25	19	136 50122	136 60122	–
	1500	16 x 25 [1]	19			
	1800	16 x 31	20	136 50182	136 60182	–
	2200	**16 x 35**	**21**	136 50222	**136 60222**	–

Non-solid Al - electrolytic capacitors
Radial, Very Low Impedance

RVI 136

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L2} 2 min (µA)	Tan δ 100 Hz	ESR 100 Hz (mΩ)	Z 100 kHz 20 °C (mΩ)	Z 100 kHz −10 °C (mΩ)
50	82	10 x 12	480	41	0.10	1900	200	400
	100	10 x 12 [1]	480	50	0.10	1600	200	400
	120	10 x 16	760	60	0.10	1300	100	200
	150	10 x 20 [1]	850	75	0.10	1100	90	180
	180	10 x 20	950	90	0.10	880	75	150
	180	12.5 x 16	780	90	0.10	880	110	120
	220	10 x 25	1200	110	0.10	720	63	130
	330	10 x 30	1300	170	0.10	480	54	110
	330	12.5 x 20	1200	170	0.10	480	59	120
	470	**12.5 x 25**	1500	240	0.10	340	44	88
	560	12.5 x 30	1700	280	0.10	280	39	78
	680	16 x 20	1400	340	0.10	230	50	100
	820	16 x 25	1900	410	0.10	190	34	68
	1000	**16 x 31**	2200	500	0.10	160	30	60
	1200	16 x 35	2300	600	0.10	130	27	54
63	**47**	**10 x 12**	380	30	0.10	3400	300	750
	56	10 x 12	420	35	0.10	2800	270	680
	68	10 x 16	520	43	0.10	2300	210	530
	100	**10 x 16**	580	63	0.10	1600	190	480
	120	10 x 20	650	76	0.10	1300	160	400
	120	12.5 x 16	610	76	0.10	1300	180	450
	150	10 x 25	780	95	0.10	1100	130	330
	180	10 x 30	960	110	0.10	880	100	250
	220	**12.5 x 20**	870	140	0.10	720	110	280
	270	12.5 x 25	1200	170	0.10	590	74	190
	330	16 x 20	1100	210	0.10	480	85	220
	390	12.5 x 30	1300	250	0.10	410	68	170
	470	**16 x 25**	1500	300	0.10	340	55	140
	680	16 x 31	1700	430	0.10	230	46	120
	820	16 x 35	1900	520	0.10	190	40	100

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

Non-solid Al - electrolytic capacitors
Radial, Very Low Impedance

RVI 136

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK LONG LEADS Form CA	BULK CUT LEADS Form CB	TAPED AMMOPACK Form TFA
50	82	10 x 12	14	136 51829	136 61829	136 31829
	100	10 x 12 [1]	14			
	120	10 x 16	15	136 51121	136 61121	136 31121
	150	10 x 20 [1]	16			
	180	10 x 20	16	136 51181	136 61181	136 31181
	180	12.5 x 16	17a	136 91185	136 91186	136 91183
	220	10 x 25	16L	136 51221	136 61221	136 31221
	330	10 x 30	16LL	136 91335	136 91336	–
	330	12.5 x 20	17	136 51331	136 61331	136 31331
	470	**12.5 x 25**	**18**	136 51471	**136 61471**	**136 31471**
	560	12.5 x 30	18L	136 51561	136 61561	–
	680	16 x 20	19a	136 51681	136 61681	–
	820	16 x 25	19	136 51821	136 61821	–
	1000	**16 x 31**	**20**	136 51102	**136 61102**	–
	1200	16 x 35	21	136 51122	136 61122	–
63	**47**	**10 x 12**	**14**	136 58479	**136 68479**	**136 38479**
	56	10 x 12	14	136 58569	136 68569	136 38569
	68	10 x 16	15	136 58689	136 68689	136 38689
	100	**10 x 16**	**15**	136 58101	**136 68101**	**136 38101**
	120	10 x 20	16	136 58121	136 68121	136 38121
	120	12.5 x 16	17a	136 98125	136 98126	136 98123
	150	10 x 25	16L	136 58151	136 68151	136 38151
	180	10 x 30	16LL	136 58181	136 68181	–
	220	**12.5 x 20**	**17**	136 58221	**136 68221**	**136 38221**
	270	12.5 x 25	18	136 58271	136 68271	136 38271
	330	16 x 20	19a	136 58331	136 68331	–
	390	12.5 x 30	18L	136 58391	136 68391	–
	470	**16 x 25**	**19**	136 58471	**136 68471**	–
	680	16 x 31	20	136 58681	136 68681	–
	820	16 x 35	21	136 58821	136 68821	–

R

Note

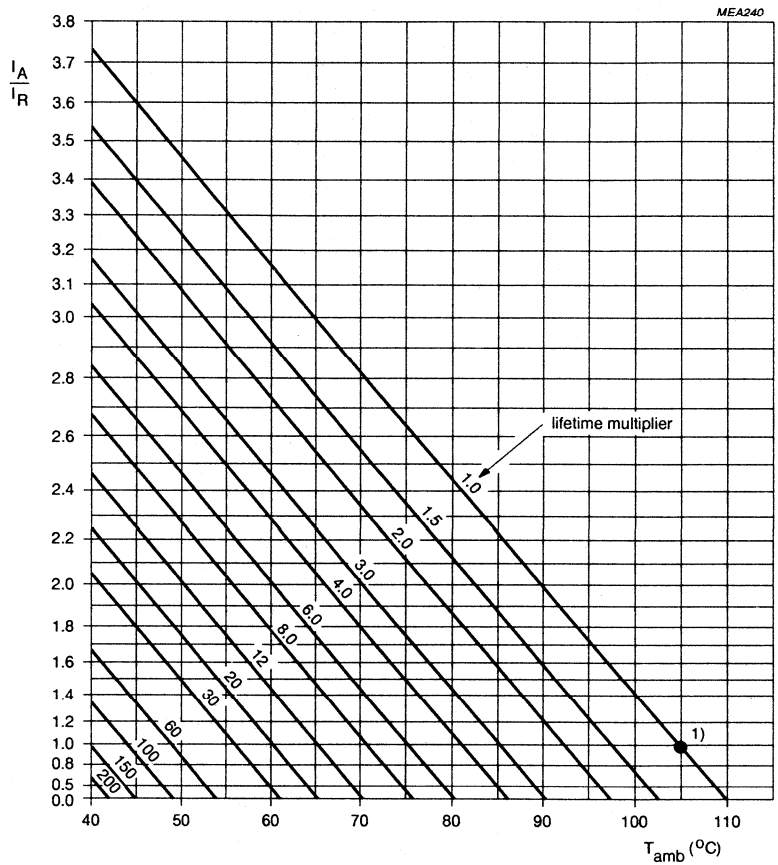
[1] = under consideration.

Equivalent series inductance (ESL)

Case Ø = 10 mm: typ.16 nH

Case Ø ≥ 12.5 mm: typ.18 nH

RIPPLE CURRENT and USEFUL LIFE



Useful life at 105 °C and I_R applied: see Table 6.

Fig.5 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_{R0}) as a function of frequency; I_{RO} = ripple current at 100 kHz

FREQUENCY (Hz)	I_R MULTIPLIER							
	U_R = 10 V		U_R = 16 and 25 V		U_R = 35 and 50 V		U_R = 63 V	
	∅ ≤12.5 (mm)	∅ ≥16 (mm)	∅ ≤12.5 (mm)	∅ ≥16 (mm)	∅ ≤12.5 (mm)	∅ ≥16 (mm)	∅ ≤12.5 (mm)	∅ ≥16 (mm)
100	0.7	0.83	0.63	0.69	0.5	0.6	0.35	0.5
300	0.8	0.9	0.72	0.79	0.61	0.71	0.51	0.64
1000	0.88	0.95	0.8	0.87	0.72	0.8	0.66	0.74
3000	0.92	0.98	0.88	0.92	0.81	0.88	0.76	0.83
10 000	0.96	0.99	0.92	0.96	0.88	0.93	0.85	0.9
30 000	0.99	1.0	0.98	0.99	0.94	0.96	0.92	0.95
100 000	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 6 Endurance test duration and useful life as a function of case size

CASE SIZE ∅D_{nom} x L_{nom} (mm)	CASE CODE	ENDURANCE TEST at 105 °C (hours)	USEFUL LIFE at 105 °C (hours)
10 x 12	14	3000	4000
10 x 16	15	3000	6000
10 x 20	16	3000	6000
10 x 25	16L	5000	7000
10 x 30	16LL	5000	7000
12.5 x 16	17a	3000	5000
12.5 x 20	17	3000	7000
12.5 x 25	18	5000	8000
12.5 x 30	18L	5000	8000
16 x 20	19a	3000	7000
16 x 25	19	5000	10 000
16 x 31	20	5000	10 000
16 x 35	21	5000	10 000

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/ CECC 30 300 sub clause 4.13	T_{amb} = 105 °C; U_R applied; for test duration see Table 6	$\Delta C/C$ ±20% tan $\delta \leq$ 2 x spec. limit $I_{L2} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640, sub clause 1.8.1	T_{amb} = 105°C; U_R and I_R applied; for duration see Table 6	$\Delta C/C$ ±30% tan $\delta \leq$ 3 x spec. limit $I_{L2} \leq$ spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30 300, sub clause 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	$\Delta C/C$ ±20% tan $\delta \leq$ 2 x spec. limit $I_{L2} \leq$ spec. limit

NOTES

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Extended useful life, 5000 to 6000 hours at 105 °C, high reliability
- High ripple current capability, low impedance.

APPLICATIONS

- Power supplies, EDP, telecommunication and industrial
- Smoothing, filtering, buffering in SMPS
- Low surface demand on printed-circuit board.

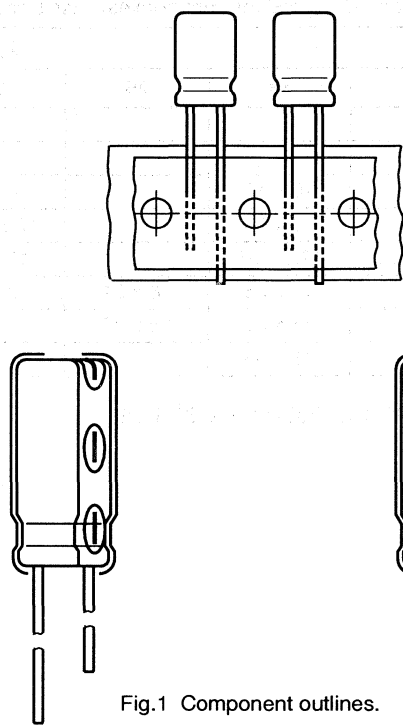


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	10 x 12 to 18 x 35
Rated capacitance range, C_R	47 to 4700 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 ∅ 10 and 12.5 mm case ∅ 16 and 18 mm	 5000 hours 6000 hours
Useful life at 40 °C, 1.8 I_R applied case ∅ 10 and 12.5 mm case ∅ 16 and 18 mm	 240 000 hours 280 000 hours
Shelf life at 0 V, 105 °C	2000 hours
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259
Climatic category IEC 68 DIN 40040	 40/105/56 GMF

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

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**	**35**	**40**	**50**	**63**
47							10 x 12
100					10 x 12	10 x 16	10 x 20
220		10 x 12		10 x 16	10 x 20	12.5 x 20	12.5 x 25
470	10 x 16	10 x 20		12.5 x 20	12.5 x 25		16 x 25
1000	12.5 x 20	12.5 x 25		16 x 25		16 x 31	18 x 35
2200		16 x 25	16 x 31	18 x 35	18 x 35		
3300		16 x 31	18 x 35				
4700	16 x 35	18 x 35					

FOR NEW DEVELOPMENTS USE RVI 136 SERIES

F

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

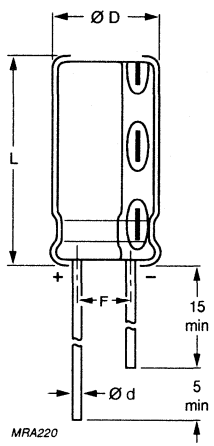


Fig.2 **Form CA**: Long leads.

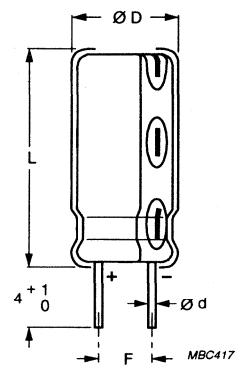


Fig.3 **Form CB**: Cut leads.

Tape dimensions are specified in chapter "PACKING".

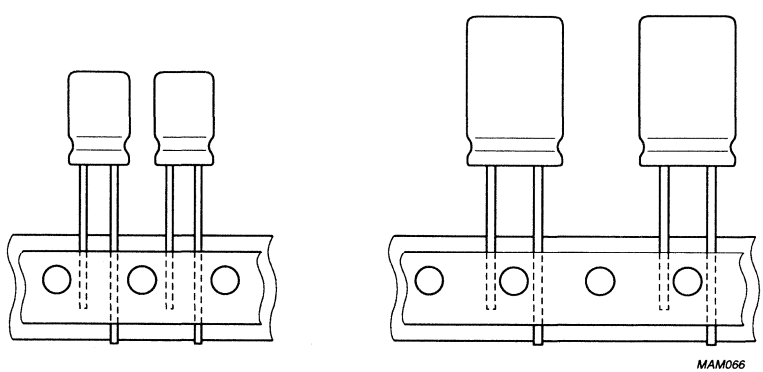


Fig.4 **Form TFA**: case sizes up to ∅16 x 31 mm taped in box (ammopack).

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

Table 2 Dimensions in mm; mass in g

NOMINAL CASE SIZE ∅ D x L	CASE CODE	∅ d	∅ D_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA per box	Form CB per box	Form TFA per box
10 x 12	14	0.6	10.5	13.5	5.0	1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0	1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0	2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0	4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0	5.0	250	250	500
16 x 25	19	0.8	16.5	27.0	7.5	8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5	9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5	11.5	100	100	–
18 x 35	22	0.8	18.5	37.5	7.5	14.5	300	1000	–

Marking

The capacitors are marked with the following information:

- Rated capacitance in μF
- Tolerance on rated capacitance, code letter in accordance with IEC 62 (M for ±20%)
- Rated voltage in V
- Upper category temperature (105 °C)
- Group number (164)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62
- Negative terminal identification.

R

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

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 or 100 kHz.

Table 3 Electrical data

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 (Ω)	Z 100 kHz (Ω)
10	470	10 x 16	15	340	50	12	0.15	0.46	–	0.28
	1000	12.5 x 20	17	590	100	23	0.15	0.21	–	0.13
	4700	16 x 35	21	1400	470	97	0.23	0.07	0.04	–
16	220	10 x 12	14	250	38	10	0.13	0.85	–	0.45
	470	10 x 20	16	420	78	18	0.13	0.40	–	0.21
	1000	12.5 x 25	18	720	160	35	0.13	0.19	–	0.10
	2200	16 x 25	19	1000	360	73	0.17	0.11	0.06	–
	3300	16 x 31	20	1300	530	110	0.19	0.08	0.04	–
	4700	18 x 35	22	1600	760	150	0.21	0.06	0.03	–
25	2200	16 x 31	20	1200	550	110	0.15	0.09	0.05	–
	3300	18 x 35	22	1500	830	170	0.17	0.07	0.03	–
35	220	10 x 16	15	320	80	18	0.10	0.62	–	0.27
	470	12.5 x 20	17	550	170	36	0.10	0.29	–	0.13
	1000	16 x 25	19	940	350	73	0.10	0.14	–	0.06
	2200	18 x 35	22	1500	770	160	0.12	0.07	0.04	–

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

ORDERING INFORMATION

Ordering Example

Electrolytic capacitors RSX 164
1000 µF/16 V; ±20%
Case size 12.5 x 25 mm; Form TFA
Catalogue number: 2222 164 35102.

Table 4 Ordering information

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
				LONG LEADS Form CA	CUT LEADS Form CB	IN BOX Ammopack Form TFA
10	470	10 x 16	15	164 54471	164 64471	164 34471
	1000	12.5 x 20	17	164 54102	164 64102	164 34102
	4700	16 x 35	21	164 54472	164 64472	–
16	220	10 x 12	14	164 55221	164 65221	164 35221
	470	10 x 20	16	164 55471	164 65471	164 35471
	1000	12.5 x 25	18	164 55102	164 65102	164 35102
	2200	16 x 25	19	164 55222	164 65222	164 35222
	4700	18 x 35	22	164 55472	164 65472	–
25	2200	16 x 31	20	164 56222	164 66222	164 36222
	3300	18 x 35	22	164 56332	164 66332	–
35	220	10 x 16	15	164 50221	164 60221	164 30221
	470	12.5 x 20	17	164 50471	164 60471	164 30471
	1000	16 x 25	19	164 50102	164 60102	164 30102
	2200	18 x 35	22	164 50222	164 60222	–

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

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 (Ω)	Z 100 kHz (Ω)
40	100	10 x 12	14	220	43	11	0.09	1.20	–	0.55
	220	10 x 20	16	360	91	21	0.09	0.55	–	0.25
	470	12.5 x 25	18	630	190	41	0.09	0.26	–	0.12
	2200	18 x 35	22	1600	880	180	0.11	0.07	0.04	–
50	100	10 x 16	15	260	53	13	0.07	0.89	–	0.50
	220	12.5 x 20	17	460	110	25	0.07	0.41	–	0.23
	1000	16 x 31	20	1300	500	100	0.07	0.09	–	0.05
63	47	10 x 12	14	200	33	9	0.06	1.60	–	0.85
	100	10 x 20	16	320	66	16	0.06	0.76	–	0.40
	220	12.5 x 25	18	560	140	31	0.06	0.35	–	0.18
	470	16 x 25	19	910	300	62	0.06	0.16	–	0.09
	1000	18 x 35	22	1500	630	130	0.06	0.08	–	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	$I_{L1} \leq 0.01\ C_R \times U_R + 3\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$

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 Extended Long-Life

RSX 164

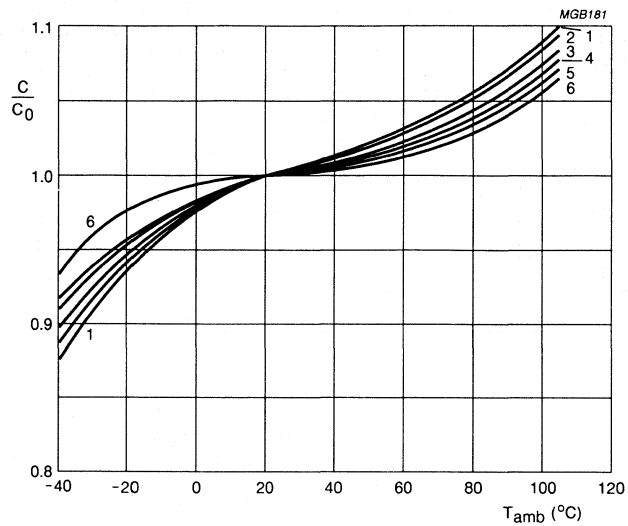
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
				LONG LEADS Form CA	CUT LEADS Form CB	IN BOX Ammopack Form TFA
40	100	10 x 12	14	164 57101	164 67101	164 37101
	220	10 x 20	16	164 57221	164 67221	164 37221
	470	12.5 x 25	18	164 57471	164 67471	164 37471
	2200	18 x 35	22	164 57222	164 67222	–
50	100	10 x 16	15	164 51101	164 61101	164 31101
	220	12.5 x 20	17	164 51221	164 61221	164 31221
	1000	16 x 31	20	164 51102	164 61102	164 31102
63	47	10 x 12	14	164 58479	164 68479	164 38479
	100	10 x 20	16	164 58101	164 68101	164 38101
	220	12.5 x 25	18	164 58221	164 68221	164 38221
	470	16 x 25	19	164 58471	164 68471	164 38471
	1000	18 x 35	22	164 58102	164 68102	–

F

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

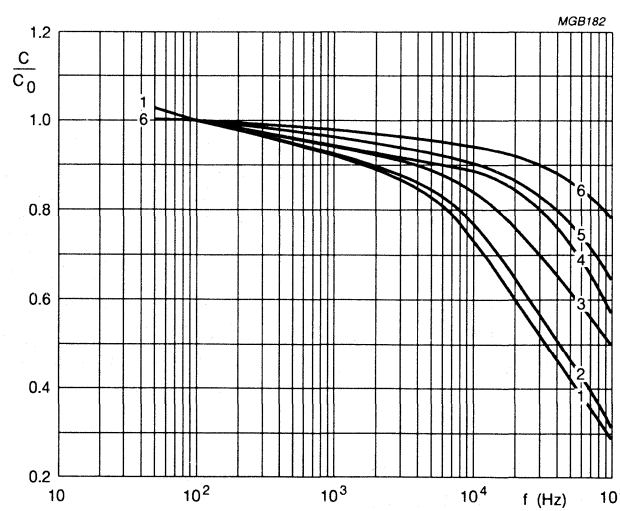
Capacitance (C)



Curve 1: 10 V
Curve 2: 16 V
Curve 3: 35 V
Curve 4: 40 V
Curve 5: 50 V
Curve 6: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.



Curve 1: 10 V
Curve 2: 16 V
Curve 3: 35 V
Curve 4: 40 V
Curve 5: 50 V
Curve 6: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Typical multiplier of capacitance (C/C_0) as a function of frequency.

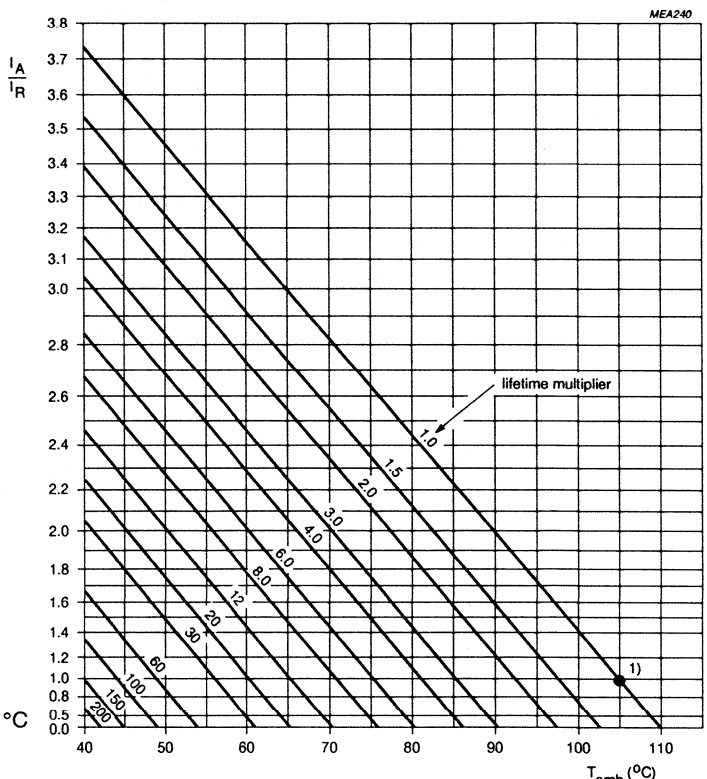
Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

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 = 10 V to 25 V	U_R = 35 and 40 V	U_R = 50 and 63 V
50	0.85	0.80	0.75
100	1.00	1.00	1.00
300	1.20	1.25	1.30
1000	1.30	1.40	1.50
3000	1.35	1.50	1.65
≥10000	1.40	1.60	1.80



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:
Ø10 and 12.5 mm 5000 hours
Ø16 and 18 mm 6000 hours.

Fig.7 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

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/ CECC 30 300 sub clause 4.13	T_{amb} = 105 °C; U_R applied; 3000 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} = 105 °C; U_R and I_R applied; 5000 hours, case ∅10 and 12.5 mm 6000 hours, case ∅16 and 18 mm	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/ CECC 30 300 sub clause 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	ΔC/C ±15% tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ 2 x spec. limit

Non-solid Al - electrolytic capacitors
Radial Standard Extended Long-Life

RSX 164

NOTES

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case with pressure relief, insulated with a blue sleeve
- Charge and discharge proof
- Very long useful life: 1500 hours at 125 °C, high stability, high reliability
- Extended temperature range up to 125 °C
- High ripple current capability.

APPLICATIONS

- EDP, telecommunication, industrial, automotive and military
- Smoothing, filtering, buffering in SMPS
- High ambient temperature environments
- Low surface demand on printed-circuit board.

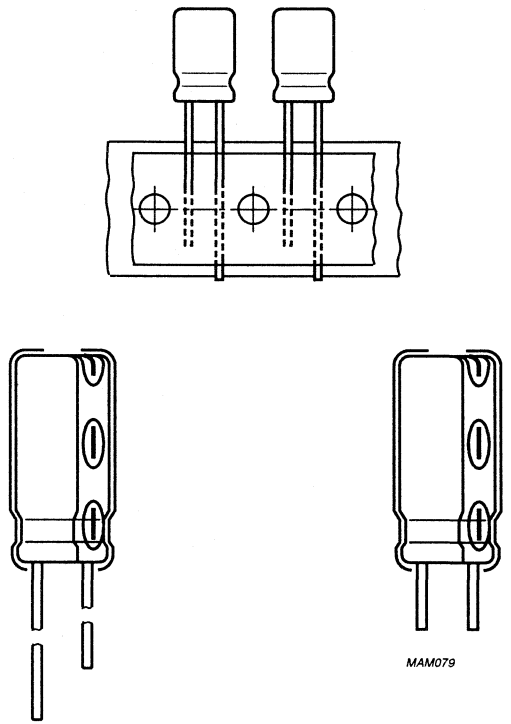


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (Ø D_{nom} x L_{nom} in mm)	10 x 12 to 18 x 40 (18 x 35)
Rated capacitance range, C_R	22 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	300 000 hours
Shelf life at 0 V, 125 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 45910-T124 (without approval), former DIN 41259
Climatic category IEC 68 DIN 40040	 40/125/56 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 (∅**D x L** in **mm**). Preferred types in **bold**.

C_R (µF)	U_R (V)					
	10	**16**	**25**	**35**	**40**	**50**
22						10 x 12
47					10 x 12	10 x 16
100			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**	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
1000		12.5 x 25	16 x 31		**16 x 35**	18 x 40 (35)
1500	16 x 25	16 x 31	16 x 35	18 x 35		
2200	16 x 31	**16 x 35**	18 x 40 (35)			
3300	16 x 35	18 x 40 (35)				
4700	18 x 40 (35)					

F

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

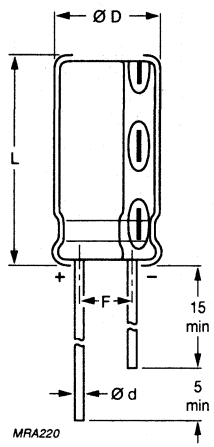


Fig.2 **Form CA**: Long leads.

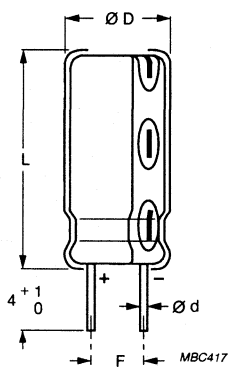


Fig.3 **Form CB**: Cut leads.

Table 2 Dimensions in mm; mass in g

NOMINAL CASE SIZE Ø D x L	CASE CODE	Ø d	Ø D_{max}	L_{max}	F ±0.5	APPROX. MASS	PACKING QUANTITIES		
							Form CA per box	Form CB per box	Form TFA per box
10 x 12	14	0.6	10.5	13.5	5.0	1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0	1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0	2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0	4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0	5.0	250	250	500
16 x 25	19	0.8	16.5	27.0	7.5	8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5	9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5	11.5	100	100	–
18 x 35	22	0.8	18.5	37.5	7.5	14.5	300	1000	–
18 x 40	23	0.8	18.5	42.0	7.5	16.0	300	1000	–

Tape dimensions are specified in chapter "PACKING".

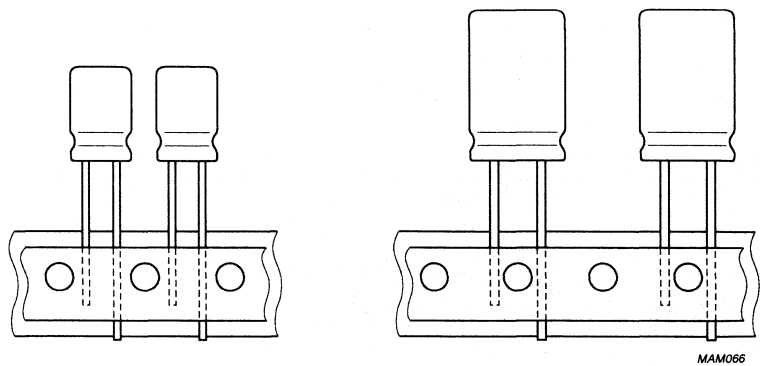


Fig.4 **Form TFA**: case sizes up to ∅16 x 31 mm taped in box (ammopack).

MARKING

The capacitors are marked with the following information:

- Rated capacitance value
- Tolerance on rated capacitance, code letter in accordance with IEC 62 (M for ±20%)
- Rated voltage in V
- Upper category temperature (125 °C)
- Group number (165)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62
- Negative terminal identification.

R

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

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, 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 3 Electrical data. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 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)	Z 100 kHz (Ω)
10	220	10 x 12	14	200	25	7	0.20	1.30	–	0.55
	330	10 x 16	15	260	36	10	0.20	0.87	–	0.36
	470	**10 x 20**	**16**	340	50	12	0.20	0.61	–	0.26
	1500	16 x 25	19	750	150	33	0.22	0.21	0.10	–
	2200	16 x 31	20	930	220	47	0.24	0.16	0.07	–
	3300	16 x 35	21	1200	330	69	0.26	0.11	0.05	–
	4700	18 x 40 (35)	23 (22)	1400	470	97	0.28	0.09	0.04	–
16	220	10 x 16	15	240	38	10	0.16	1.00	–	0.43
	330	10 x 20	16	320	56	14	0.16	0.69	–	0.29
	470	12.5 x 20	17	410	78	18	0.16	0.49	–	0.20
	1000	12.5 x 25	18	650	160	35	0.16	0.23	–	0.10
	1500	16 x 31	20	910	240	51	0.18	0.17	0.07	–
	2200	**16 x 35**	**21**	1100	360	73	0.20	0.13	0.05	–
	3300	18 x 40 (35)	23 (22)	1400	530	110	0.22	0.10	0.04	–
25	100	10 x 12	14	170	28	8	0.14	2.00	–	0.70
	220	**10 x 20**	**16**	280	58	14	0.14	0.91	–	0.32
	330	12.5 x 20	17	370	90	20	0.14	0.61	–	0.21
	470	**12.5 x 25**	**18**	480	120	27	0.14	0.43	–	0.15
	1000	16 x 31	20	830	250	53	0.14	0.20	–	0.07
	1500	16 x 35	21	1000	380	78	0.16	0.15	0.06	–
	2200	18 x 40 (35)	23 (22)	1200	550	110	0.18	0.12	0.04	–

Non-solid Al - electrolytic capacitors
Radial High Temperature

ORDERING INFORMATION

Ordering Example

Electrolytic capacitors RHT 165
220 µF/25 V; ±20%
Case size 10 x 20 mm; Form TFA
Catalogue number: 2222 165 36221.

Table 4 Ordering information. Preferred types in **bold**.

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
				Form CA	Form CB	Form TFA
10	220	10 x 12	14	165 54221	165 64221	165 34221
	330	10 x 16	15	165 54331	165 64331	165 34331
	470	**10 x 20**	**16**	165 54471	**165 64471**	**165 34471**
	1500	16 x 25	19	165 54152	165 64152	165 34152
	2200	16 x 31	20	165 54222	165 64222	165 34222
	3300	16 x 35	21	165 54332	165 64332	–
	4700	18 x 40 (35)	23 (22)	165 54472	165 64472	–
16	220	10 x 16	15	165 55221	165 65221	165 35221
	330	10 x 20	16	165 55331	165 65331	165 35331
	470	12.5 x 20	17	165 55471	165 65471	165 35471
	1000	12.5 x 25	18	165 55102	165 65102	165 35102
	1500	16 x 31	20	165 55152	165 65152	165 35152
	2200	**16 x 35**	**21**	165 55222	**165 65222**	–
	3300	18 x 40 (35)	23 (22)	165 55332	165 65332	–
25	100	10 x 12	14	165 56101	165 66101	165 36101
	220	**10 x 20**	**16**	165 56221	**165 66221**	**165 36221**
	330	12.5 x 20	17	165 56331	165 66331	165 36331
	470	**12.5 x 25**	**18**	165 56471	**165 66471**	**165 36471**
	1000	16 x 31	20	165 56102	165 66102	165 36102
	1500	16 x 35	21	165 56152	165 66152	–
	2200	18 x 40 (35)	23 (22)	165 56222	165 66222	–

R

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅ D x L (mm)	CASE CODE	I_R 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)	Z 100 kHz (Ω)
35	**100**	**10 x 16**	**15**	200	38	10	0.12	1.70	–	0.65
	330	12.5 x 25	18	460	120	26	0.12	0.52	–	0.20
	470	16 x 25	19	600	170	36	0.12	0.37	–	0.14
	1500	18 x 35	22	1200	530	110	0.13	0.12	0.05	–
40	47	10 x 12	14	130	22	7	0.12	3.70	–	1.30
	100	10 x 20	16	210	43	11	0.12	1.70	–	0.60
	220	**12.5 x 20**	**17**	340	91	21	0.12	0.78	–	0.27
	330	16 x 25	19	510	140	29	0.12	0.52	–	0.18
	470	**16 x 31**	**20**	650	190	41	0.12	0.37	–	0.13
	1000	**16 x 35**	**21**	1000	400	83	0.12	0.17	–	0.06
50	22	10 x 12	14	100	14	5	0.10	6.50	–	2.3
	47	10 x 16	15	150	27	8	0.10	3.00	–	1.10
	100	**12.5 x 20**	17	260	53	13	0.10	1.40	–	0.50
	220	16 x 25	19	450	110	25	0.10	0.65	–	0.23
	330	16 x 31	20	600	170	36	0.10	0.43	–	0.15
	470	16 x 35	21	760	240	50	0.10	0.30	–	0.11
	1000	18 x 40 (35)	23 (22)	1200	500	100	0.10	0.14	–	0.05

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	$I_{L1} \leq 0.01\ C_R \times U_R + 3$ µA
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3$ µA

Equivalent series inductance (ESL)

Case diameter = 10 mm	typ. 16 nH
Case diameter ≥ 12.5 mm	typ. 18 nH

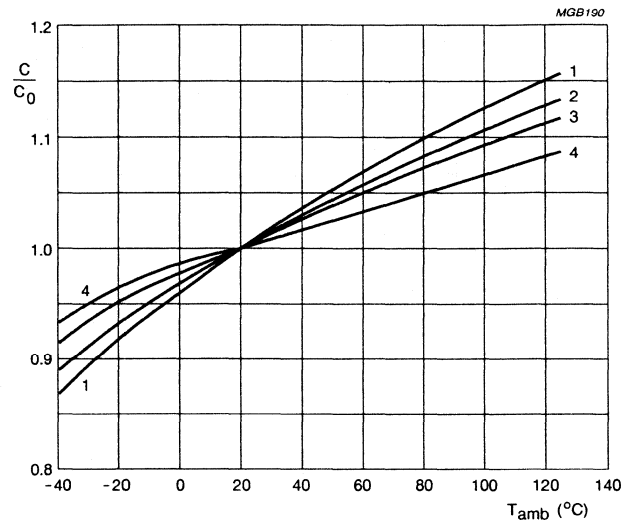
Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

U_R	C_R 100 Hz	NOMINAL CASE SIZE ∅ D x L	CASE CODE	CATALOGUE NUMBER 2222		
				BULK PACKING		TAPED
(V)	(µF)	(mm)		Form CA	Form CB	Form TFA
35	**100**	**10 x 16**	**15**	165 50101	**165 60101**	**165 30101**
	330	12.5 x 25	18	165 50331	165 60331	165 30331
	470	16 x 25	19	165 50471	165 60471	165 30471
	1500	18 x 35	22	165 50152	165 60152	–
40	47	10 x 12	14	165 57479	165 67479	165 37479
	100	10 x 20	16	165 57101	165 67101	165 37101
	220	**12.5 x 20**	**17**	165 57221	**165 67221**	**165 37221**
	330	16 x 25	19	165 57331	165 67331	165 37331
	470	**16 x 31**	**20**	165 57471	**165 67471**	**165 37471**
	1000	**16 x 35**	**21**	165 57102	**165 67102**	–
50	22	10 x 12	14	165 51229	165 61229	165 31229
	47	10 x 16	15	165 51479	165 61479	165 31479
	100	**12.5 x 20**	**17**	165 51101	**165 61101**	**165 31101**
	220	16 x 25	19	165 51221	165 61221	165 31221
	330	16 x 31	20	165 51331	165 61331	165 31331
	470	16 x 35	21	165 51471	165 61471	–
	1000	18 x 40 (35)	23 (22)	165 51102	165 61102	–

R

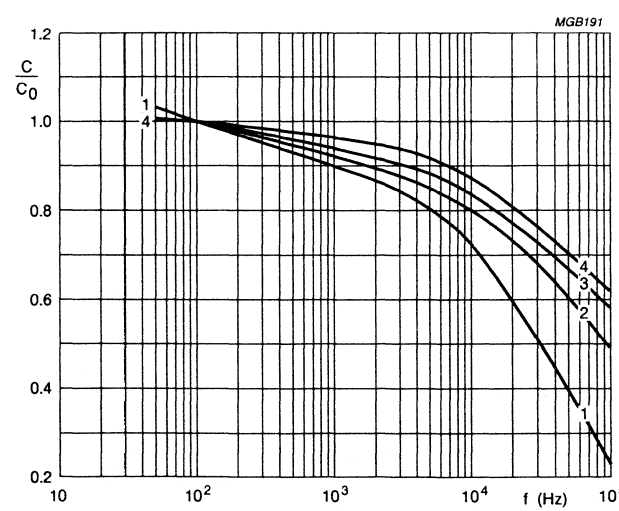
Capacitance (C)



Curve 1: 10 V
Curve 2: 16 and 25 V
Curve 3: 35 and 40 V
Curve 4: 50 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Typical multiplier of capacitance (C/C_0) as a function of ambient temperature.



Curve 1: 10 V; 16 V; 25 V
Curve 2: 35 V
Curve 3: 40 and 50 V
Curve 4: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Typical multiplier of capacitance (C/C_0) as a function of frequency.

Equivalent series resistance (ESR)

Curve 1: 10 V
Curve 2: 16 V
Curve 3: 25 V
Curve 4: 35 V
Curve 5: 40 V
Curve 6: 50 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

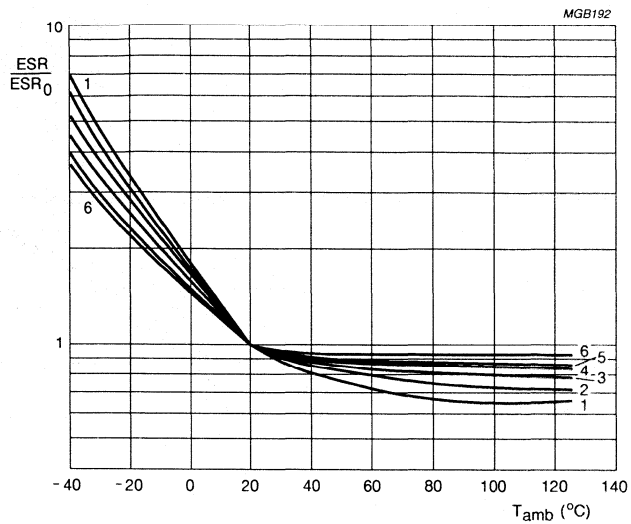


Fig.7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.

R

Curve 1: 10 V
Curve 2: 16 V
Curve 3: 25 V
Curve 4: 35 V
Curve 5: 40 V
Curve 6: 50 V.

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

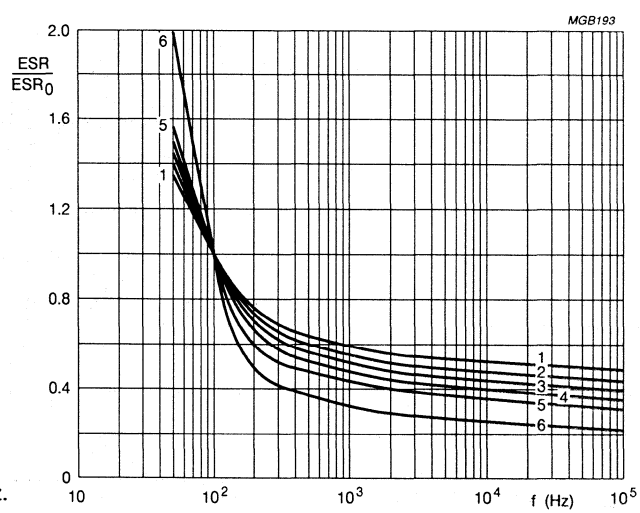
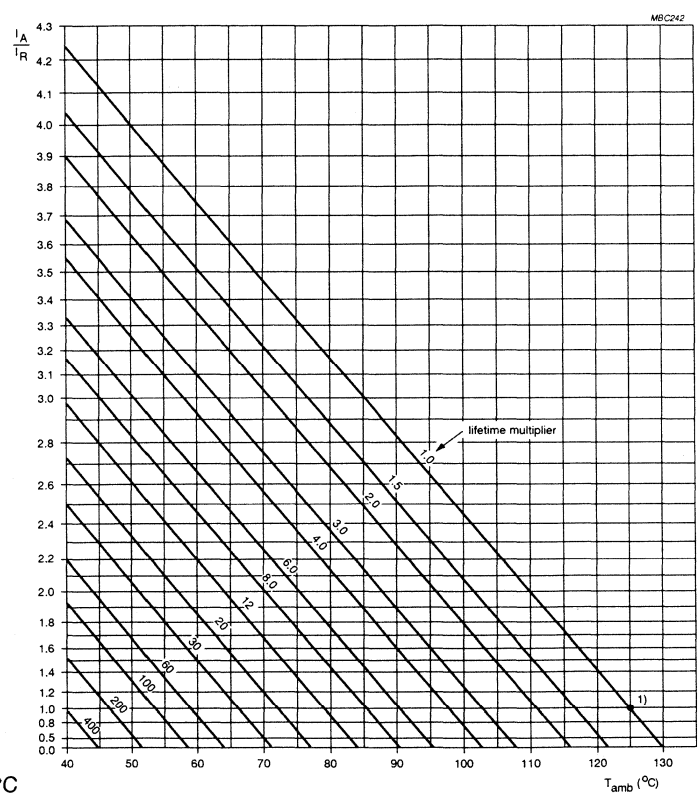


Fig.8 Multiplier of ESR(ESR/ESR_0) as a function of frequency.

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 = 10 V to 25 V	U_R = 35 and 40 V	U_R = 50 V
50	0.85	0.80	0.75
100	1.00	1.00	1.00
300	1.20	1.25	1.30
1000	1.30	1.40	1.50
3000	1.35	1.50	1.65
≥10000	1.40	1.60	1.80



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: 1500 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

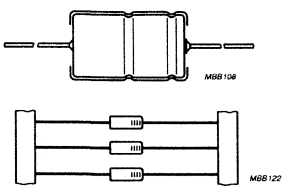
General tests and requirements are specified in chapter "Tests and Requirements".

Table 6

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
Endurance	IEC 384-4/ CECC 30 300 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 ammendment 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/ CECC 30 300, 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	$\Delta C/C \leq \pm 15\%$ tan $\delta \leq 1.3$ x spec. limit $Z \leq 2$ x spec. limit $I_{L5} \leq 2$ x spec. limit

R

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	2-5000 hours / 105 °C	125 °C
ALC 065 *low leakage* *page 416*	*page 427* **AB 137 92** *bipolar* **ABA 137** *bipolar audio* *page 429*		
	page 376 **AS 030-033** **ASH 041** *page 400*	*page 454* **ALL-DIN 132-133** **ASH 042-043** *page 400*	**AHT-DIN 119** *page 496*
page 376 **AS 030** Ø D = 3.3 mm **ASD 117** *page 324*	**ASM 021** *page 350*	**AML 138** *page 432*	**AHT 118** *page 474*
	ASC 049 *page 334*		

MBB747 - 2

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.

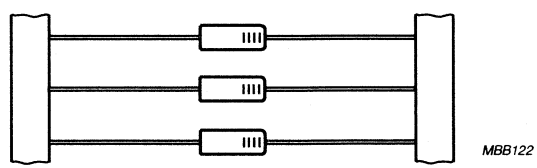


Fig.1 Component outlines.

APPLICATIONS

- General purpose, low profile and lightweight equipment
- Smoothing, filtering, buffering, decoupling, timing
- Boards with restricted mounting height.

QUICK REFERENCE DATA

Case sizes (Ø 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
Based on sectional specification	IEC 384-4/CECC 30 300, GP grade
Detail specification	similar to DIN 45910-T126 (without approval), former DIN 41316 - with reduced dimensions
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

Non-solid Al - electrolytic capacitors Axial, Smallest Diameter

ASD 117

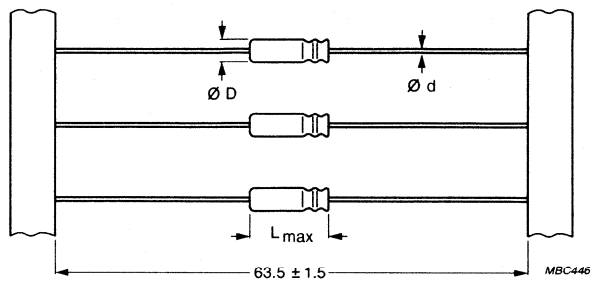
Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**)

C_R (µF)	U_R (V)					
	6.3	**10**	**16**	**25**	**40**	**63**
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					

A

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 mm, 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 BA and BR				APPROX. MASS	PACKING QUANTITIES	
		∅d	∅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

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.

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 mm; 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

A

Voltage

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

Leakage current

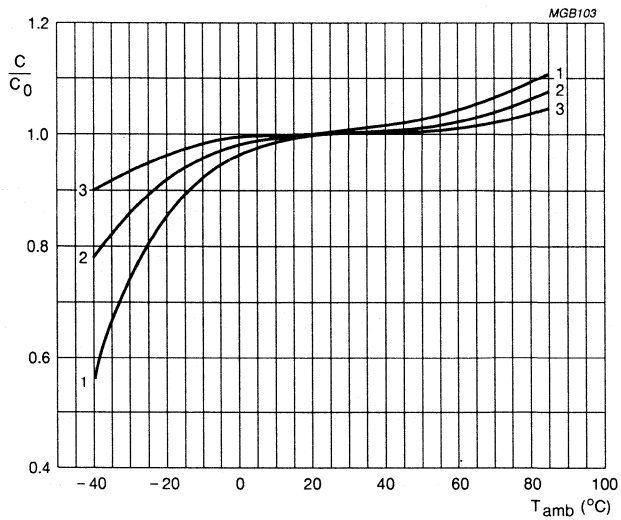
After 1 minute at U_R	$I_{L1} \leq 0.02\ C_R \times U_R + 3\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$

Equivalent series inductance (ESL)

Table 4 Equivalent series inductance, typical values

CASE SIZE (∅D x L) (mm)	TYP. ESL (nH)
3.3 x 8	13
3.3 x 11	15

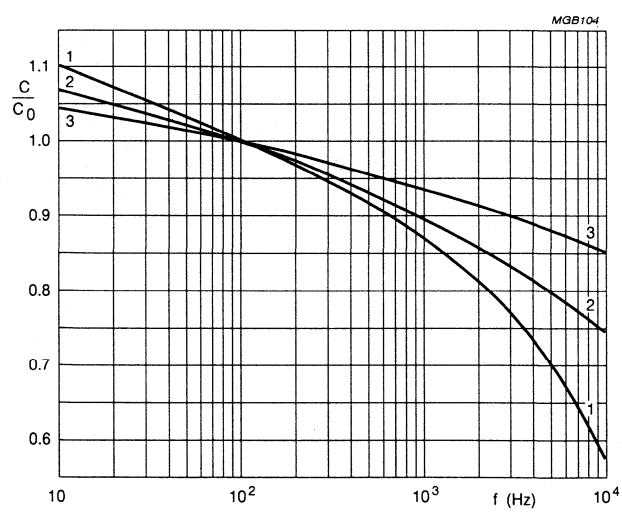
Capacitance (C)



Curve 1: 6.3 V
Curve 2: 25 V
Curve 3: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.3 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



Curve 1: 6.3 V
Curve 2: 25 V
Curve 3: 63 V.

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 µF to 3.3 µF
Curve 7: 63 V, 1 µF
Curve 8: 63 V, 0.22 µF to 0.47 µF
Curve 9: 0.1 µF.

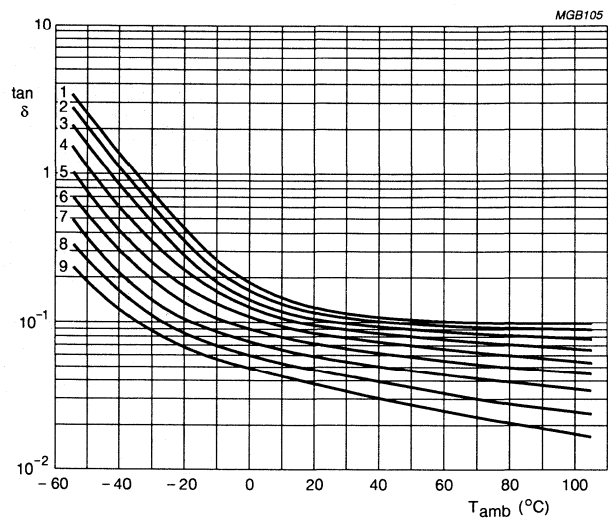


Fig.5 Typical tan δ as a function of ambient temperature at 100 Hz.

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 µF to 3.3 µF
Curve 7: 63 V, 1 µF
Curve 8: 63 V, 0.22 µF to 0.47 µF
Curve 9: 0.1 µF.

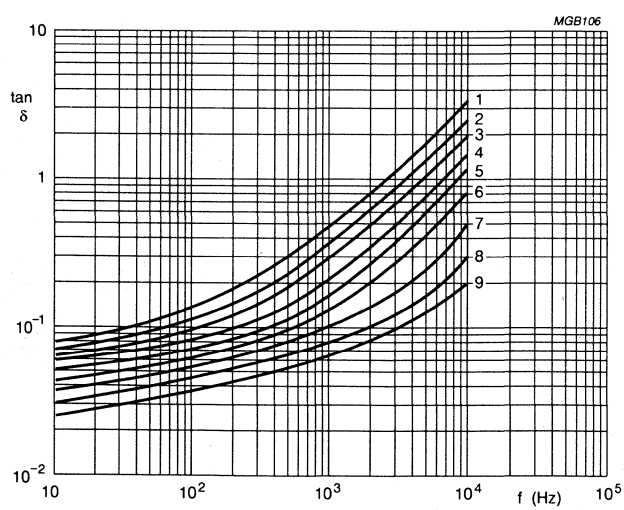


Fig.6 Typical tan δ as a function of frequency at 20 °C.

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.

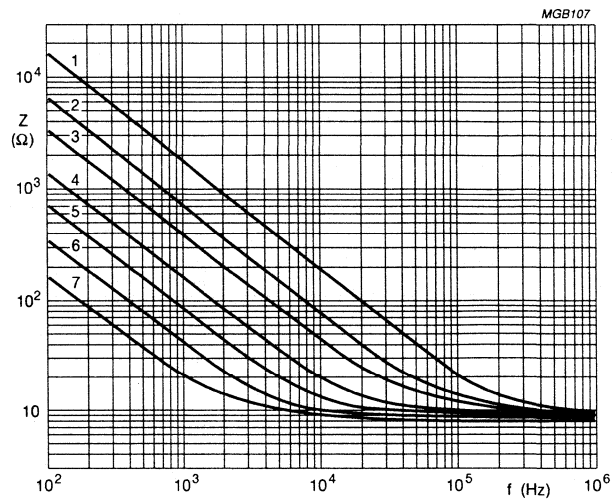


Fig.7 Typical impedance as a function of frequency at 20 °C; case size 3.3 x 8 mm.

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.

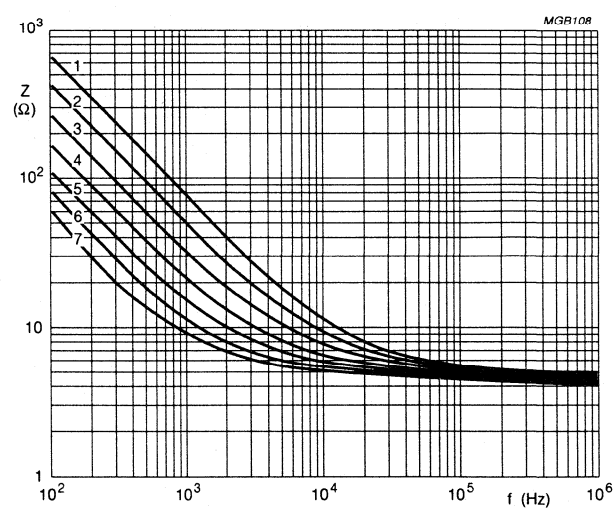


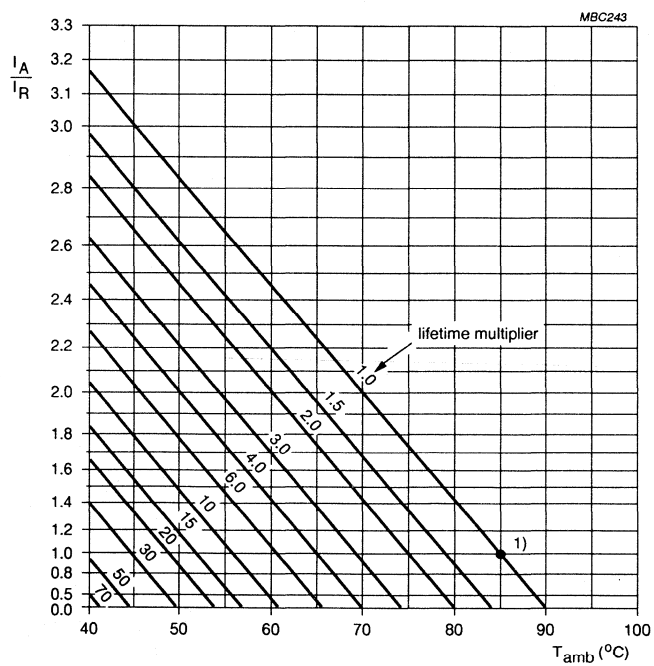
Fig.8 Typical impedance as a function of frequency at 20 °C; case size 3.3 x 11 mm.

A

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 to 16 V	U_R = 25 V 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/ CECC 30 300 sub clause 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/ CECC 30 300 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

A

Non-solid Al - electrolytic capacitors
Axial Super Compact

ASC 049

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case with pressure relief, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Taped version up to case size 15 x 30 mm 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.

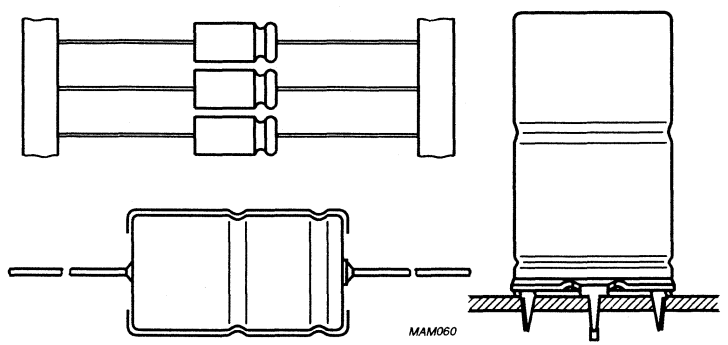


Fig.1 Component outlines.

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
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 45910-T126 (without approval), former DIN 41316 - with reduced dimensions
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

Non-solid Al - electrolytic capacitors
Axial Super Compact

ASC 049

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 *	15 x 30
1500		10 x 30	12.5 x 30	15 x 30	15 x 30 *	18 x 30
2200	10 x 30	12.5 x 30	12.5 x 30 *	15 x 30 *	18 x 30	18 x 40
3300	12.5 x 30	12.5 x 30	15 x 30	18 x 30 *	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					

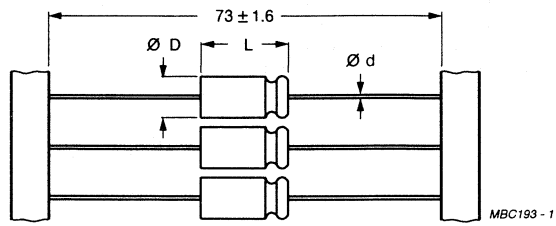
Note

* = Available to special order.

A

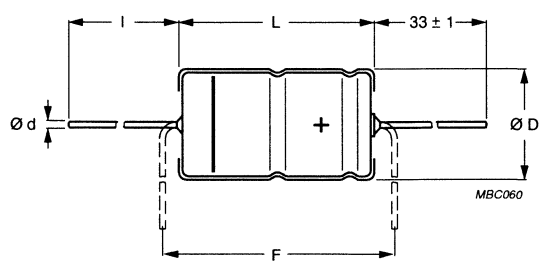
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

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



Form BR: Taped on reel.

Fig.2 Case sizes 10 x 30 mm to 15 x 30 mm.



Form AA: Axial in box.
For case sizes 18 x 40 and 21 x 40 mm, the stated L may be exceeded by 0.7 mm.

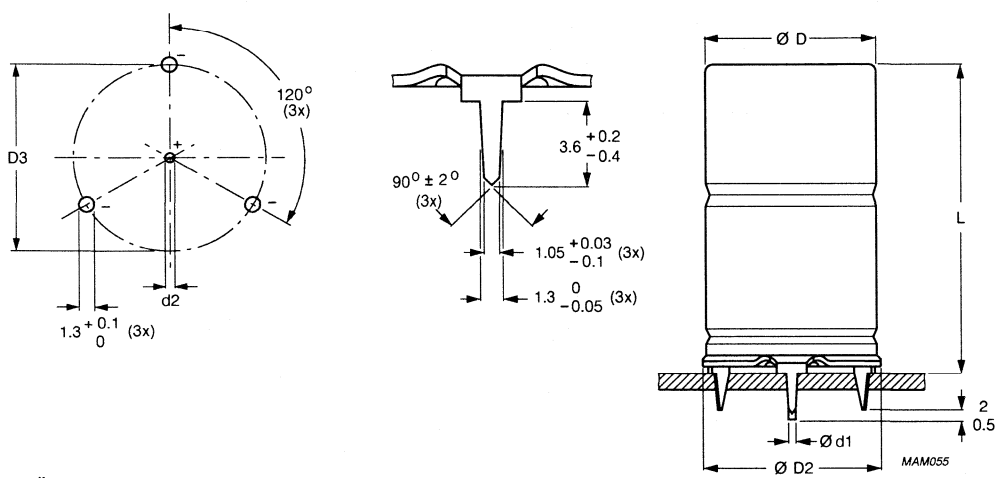
Fig.3 Case sizes 10 x 30 mm to 21 x 40 mm.

Non-solid Al - electrolytic capacitors
Axial Super Compact

ASC 049

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 mm to 21 x 40 mm, 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 Super Compact

ASC 049

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 (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 (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

Note

* = Available to special order.

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

Note

* = Available to special order.

Non-solid Al - electrolytic capacitors
Axial Super Compact

ASC 049

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 *	15 x 30	920	532	180	0.22	175	119
	3300 *	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 *	12.5 x 30	600	304	104	0.23	390	325
	1500 *	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

* = Available to special order.

Non-solid Al - electrolytic capacitors
Axial Super Compact

ASC 049

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 *	15 x 30	02	049 17222	049 27222	049 47222
	3300 *	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 *	12.5 x 30	01	049 11102	049 21102	–
	1500 *	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

* = Available to special order.

Voltage

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

Leakage current

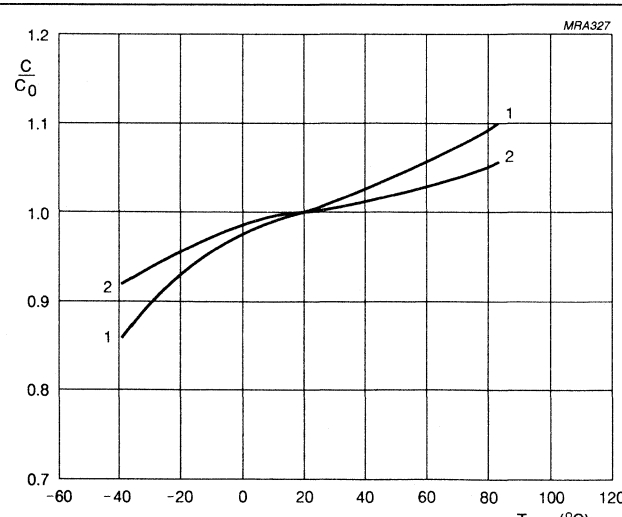
After 1 minute at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

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

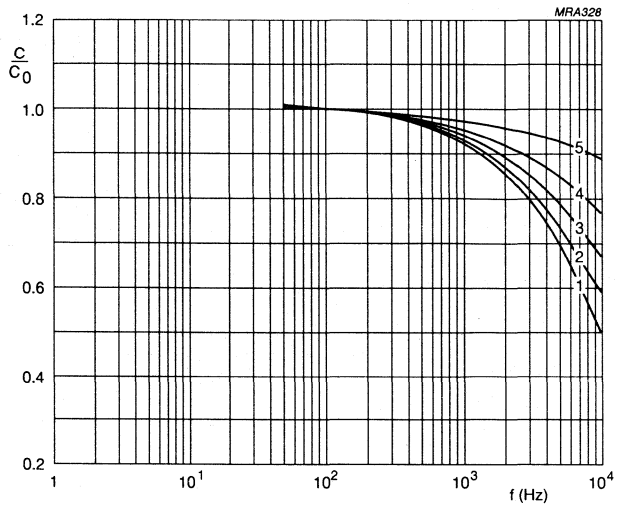
Capacitance (C)



Curve 1: 10 V
Curve 2: 63 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature.

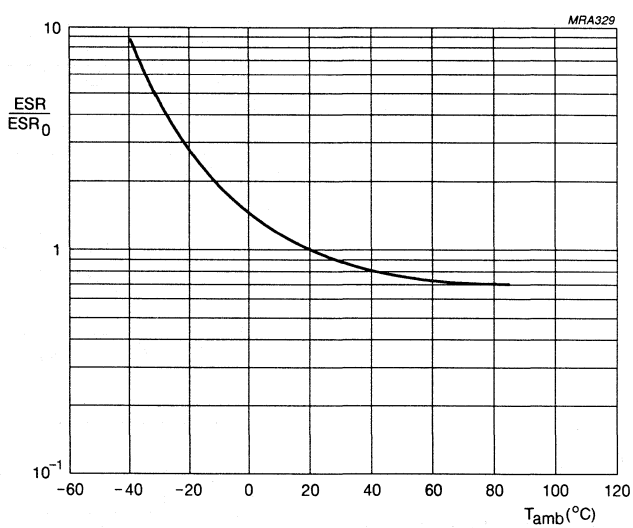


Curve 1: 10 V
Curve 2: 16 V
Curve 3: 25 V
Curve 4: 40 V
Curve 5: 50 and 63 V.

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.

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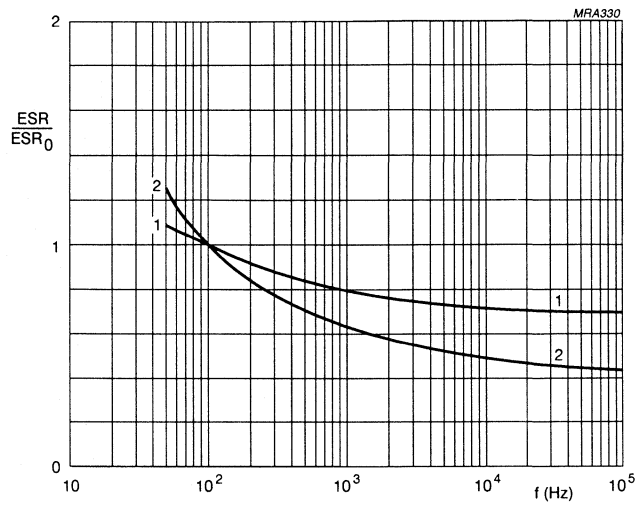
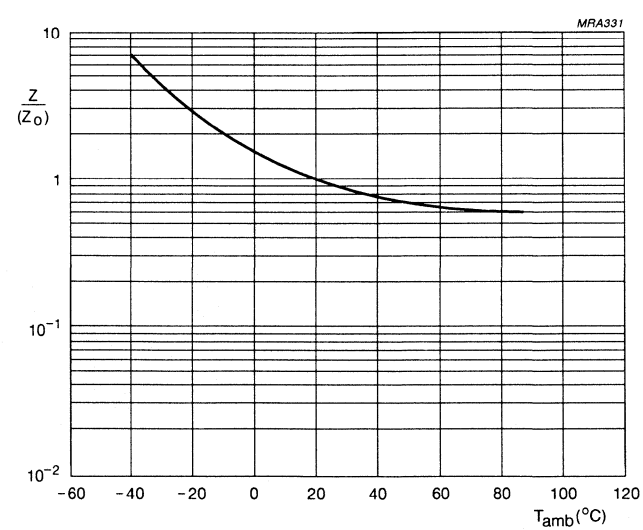


Curve 1: 10 V
Curve 2: 63 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

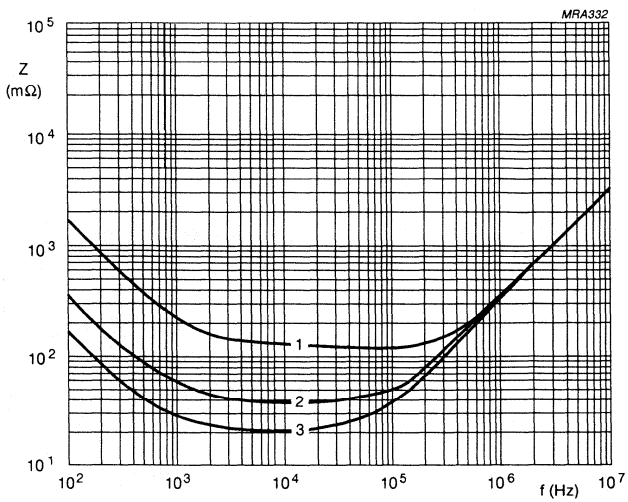
Fig.8 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

Impedance (Z)



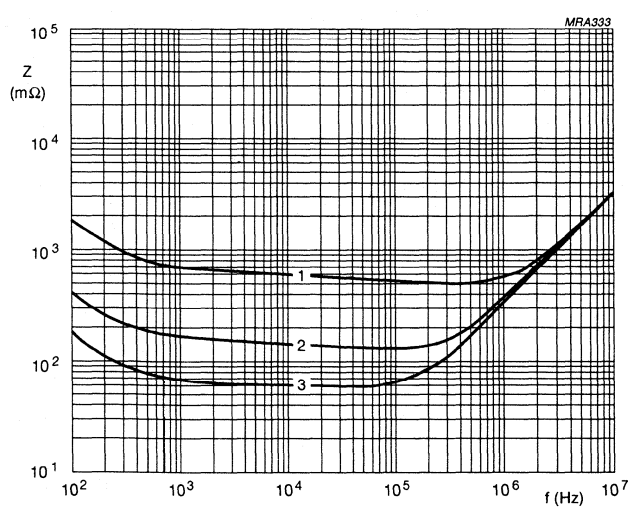
Z_0 = impedance at 20 °C, 10 kHz.

Fig.9 Multiplier of impedance (Z/Z_0) as a function of ambient temperature.



Curve 1: 1000 µF, 25 V
Curve 2: 4700 µF, 25 V
Curve 3: 10 000 µF, 25 V.

Fig.10 Typical impedance as a function of frequency at 20 °C.



Curve 1: 1000 µF, 25 V
Curve 2: 4700 µF, 25 V
Curve 3: 10 000 µF, 25 V.

Fig.11 Typical impedance as a function of frequency at –25 °C.

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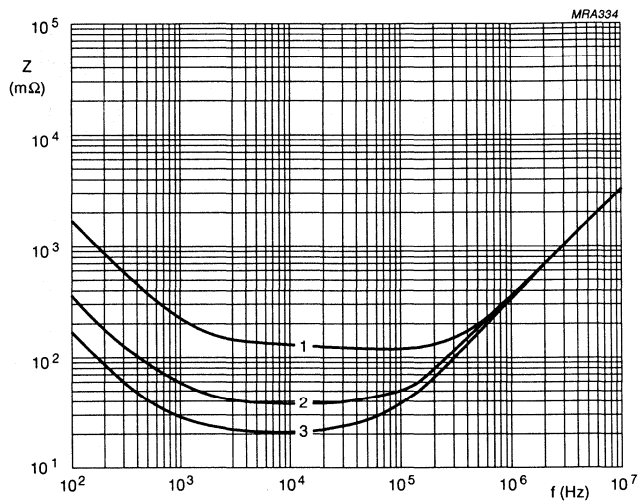


Curve 1: 1000 µF, 25 V
Curve 2: 4700 µF, 25 V
Curve 3: 10 000 µF, 25 V.

Fig.12 Typical impedance as a function of frequency at –40 °C.

MARKING

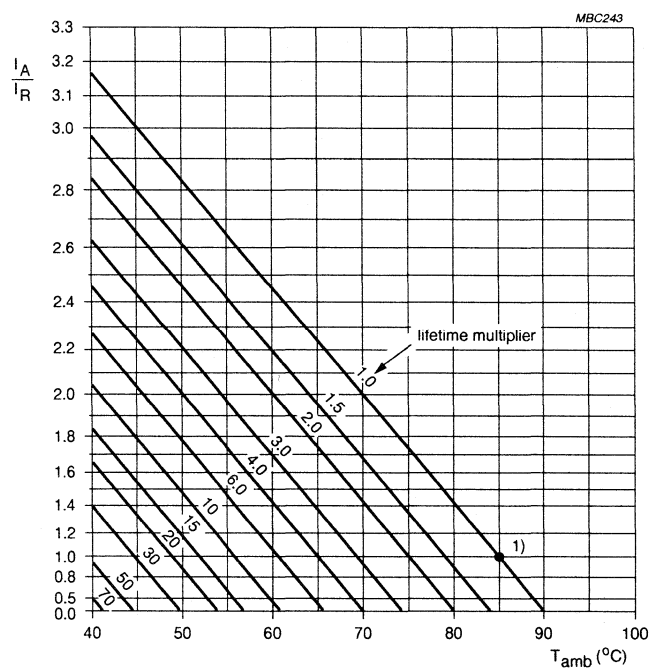
The capacitors are marked (where possible) with the following information:

- 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.

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).

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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

NOTES

Non-solid Al - electrolytic capacitors
Axial Standard Miniature

ASM 021

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 mm to 21 x 40 mm with pressure relief
- Charge and discharge proof
- Taped versions up to case size 15 x 30 mm available for automatic insertion
- Miniaturized, high CU-product per unit volume.

APPLICATIONS

- General purpose, industrial, automotive, audio-video
- Coupling, decoupling, smoothing, filtering, buffering and timing
- Portable and mobile equipment (small size, low mass)
- Low mounting height boards, vibration and shock resistant.

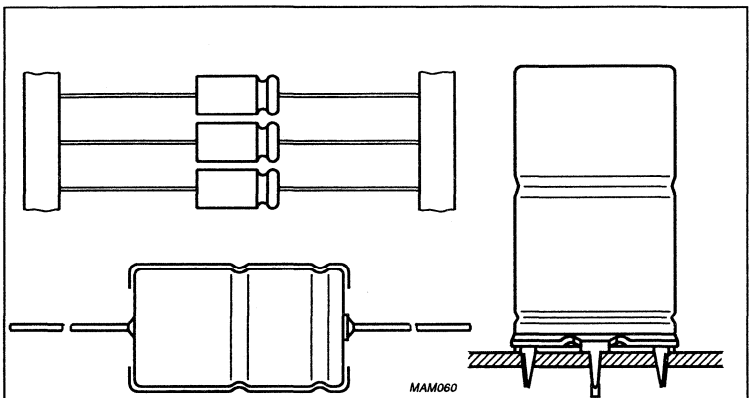

Fig.1 Component outlines.

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
Based on sectional specification 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 specification	similar to DIN 45910-T126 (without approval), former 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 (Ø **D x L** in **mm**). Preferred types in **bold**.

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					

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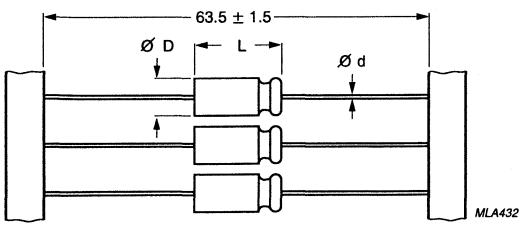
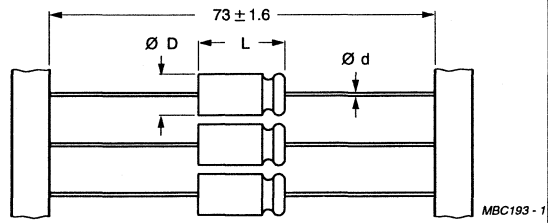
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

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 mm to 8 x 11 mm.



Form BR: Taped on reel,
case sizes 6.5 x 18 mm to 15 x 30 mm.
Form BA: Taped in box (ammopack),
case sizes 6.5 x 18 mm to 10 x 25 mm.

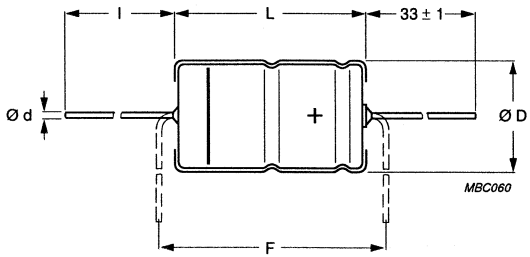
Fig.3 Case sizes 6.5 x 18 mm to 15 x 30 mm.

Table 2 Axial, dimensions in mm; mass in g

CASE SIZE $\varnothing D_{nom} \times L_{nom}$	CASE CODE	AXIAL: Form AA, BA, and BR					APPROX. MASS	PACKING QUANTITIES		
		Ød	l	$\varnothing D_{max}$	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	–	–

Non-solid Al - electrolytic capacitors
Axial Standard Miniature

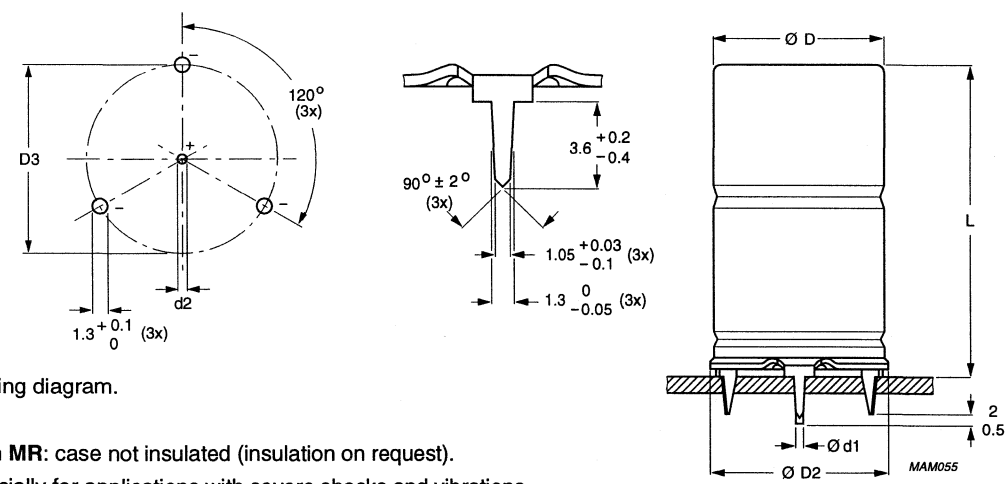
ASM 021



Form AA: Axial in box.

For case sizes 18 x 40 and 21 x 40 mm, the stated L may be exceeded by 0.7 mm.

Fig.4 Case sizes 10 x 30 mm to 21 x 40 mm.



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 mm to 21 x 40 mm, 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	Ø$D2_{max}$	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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Non-solid Al - electrolytic capacitors
Axial Standard Miniature

ASM 021

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

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

A

Non-solid Al - electrolytic capacitors
Axial Standard Miniature

ASM 021

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

Non-solid Al - electrolytic capacitors
Axial Standard Miniature

ASM 021

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

A

Non-solid Al - electrolytic capacitors
Axial Standard Miniature

ASM 021

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
Axial Standard Miniature

ASM 021

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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Non-solid Al - electrolytic capacitors
Axial Standard Miniature

ASM 021

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
Axial Standard Miniature

ASM 021

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	2	–	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

A

Non-solid Al - electrolytic capacitors
Axial Standard Miniature

ASM 021

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

ASM 021

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

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Non-solid Al - electrolytic capacitors
Axial Standard Miniature

ASM 021

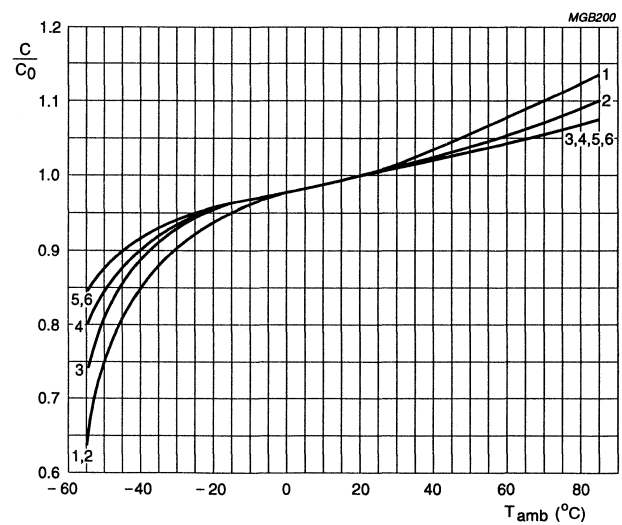
Voltage

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 (6.3 V to 63 V)	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$
U_R (100 V)	$I_{L5} \leq 0.006\ C_R \times U_R + 4\ \mu A$

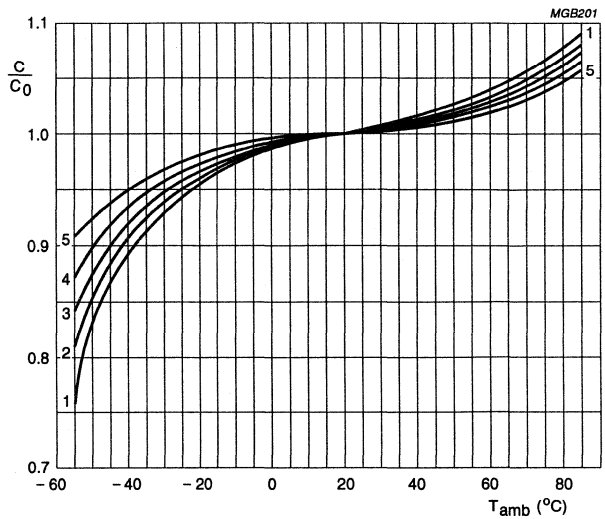
Capacitance (C)



Curve 1: 10 V
Curve 2: 16 V
Curve 3: 25 V
Curve 4: 40 V
Curve 5: 63 V
Curve 6: 100 V.

C_0 = capacitance at 20 °C, 100 Hz.
Case sizes 4.5 x 10 to 10 x 25.

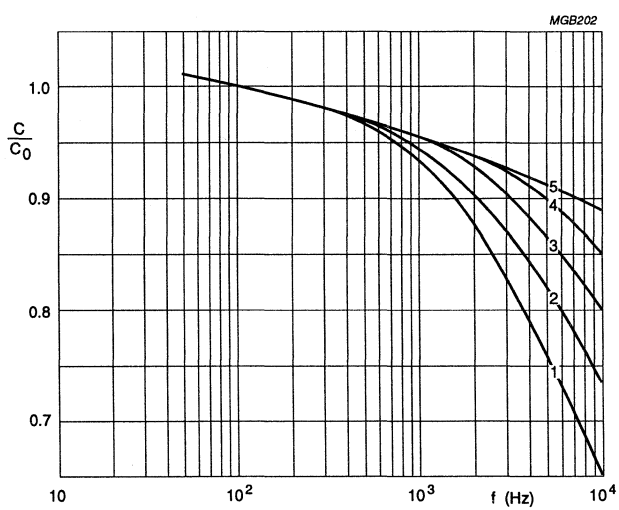
Fig.6 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



Curve 1: 10 V
Curve 2: 16 V
Curve 3: 25 V
Curve 4: 40 V
Curve 5: 63 V.

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.



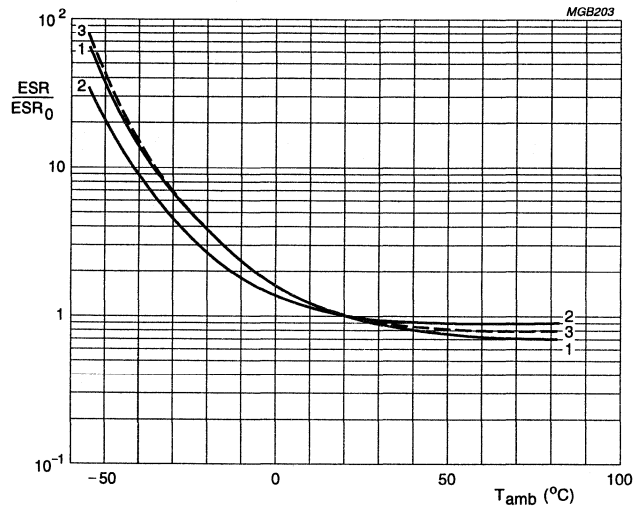
Curve 1: 10 V
Curve 2: 16 V
Curve 3: 25 V
Curve 4: 40 V
Curve 5: 63 V.

C_0 = capacitance at 20 °C; 100 Hz.

Fig.8 Multiplier of capacitance (C/C_0) as a function of frequency.

A

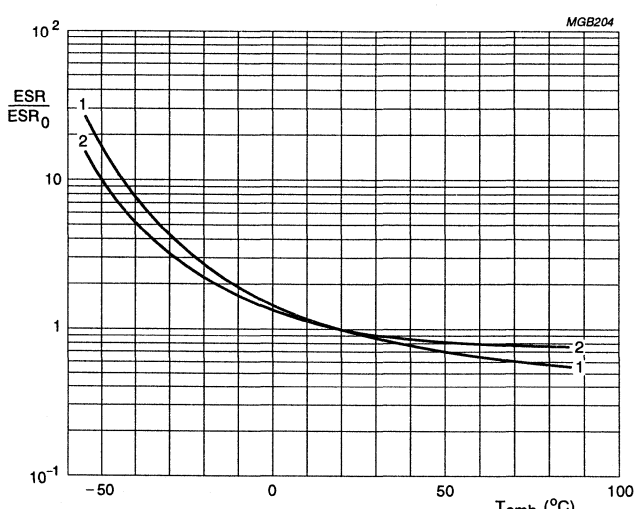
Equivalent series resistance (ESR)



Curve 1: 10 V
Curve 2: 6.3 V (≥4.7 µF)
Curve 3: 100 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.
Case sizes 4.5 x 10 to 10 x 25.

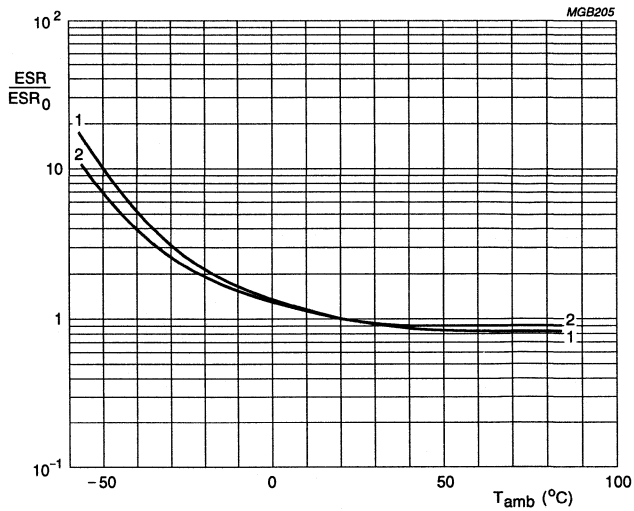
Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



Curve 1: 10 V; 16 V; 25 V
Curve 2: 40 and 63 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.
Case sizes 10 x 30, 12.5 x 30 and 15 x 30.

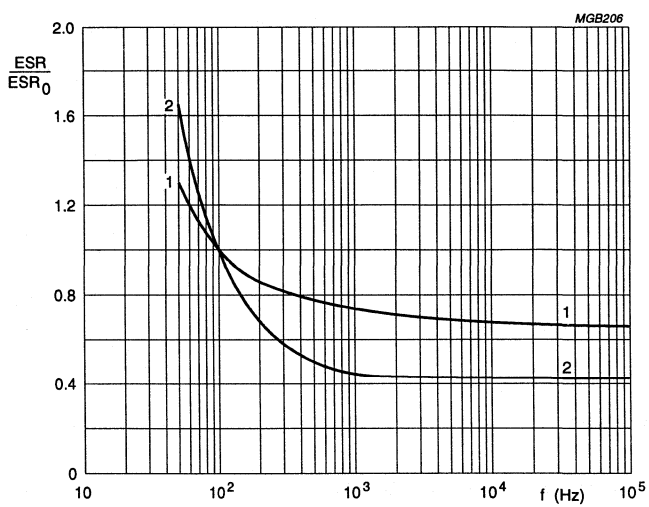
Fig.10 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



Curve 1: 10 V; 16 V; 25 V
Curve 2: 40 and 63 V.

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.



Curve 1: 10 V
Curve 2: 63 V (≥4.7 µF).

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.

Curve 1: 10 V
Curve 2: 16 V
Curve 3: 25 V
Curve 4: 40 and 100 V
Curve 5: 63 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.
Case sizes 10 x 30 to 21 x 40.

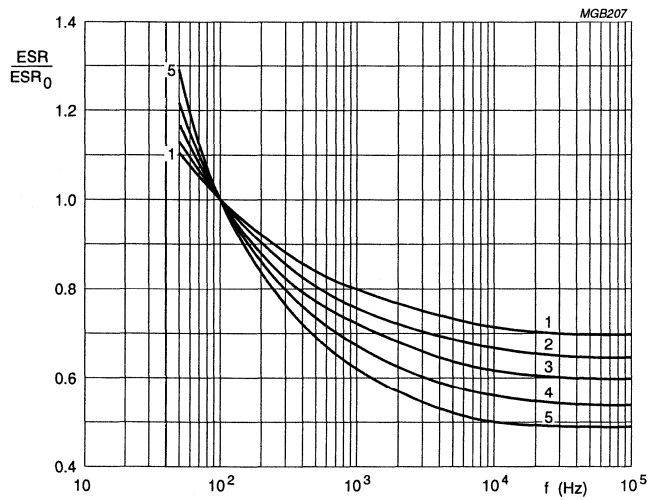


Fig.13 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

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 mm 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: 1 µF, 63 V; 4.5 x 10
Curve 2: 2.2 µF, 63 V; 4.5 x 10
Curve 3: 4.7 µF, 63 V; 4.5 x 10
Curve 4: 10 µF, 63 V; 4.5 x 10
Curve 5: 22 µF, 63 V; 6 x 10
Curve 6: 47 µF, 40 V; 6 x 10
Curve 7: 100 µF, 25 V; 6 x 10
Curve 8: 220 µF, 25 V; 6.5 x 18
Curve 9: 470 µF, 10 V; 6.5 x 18
Curve 10: 1000 µF, 6.3 V; 6.5 x 25.

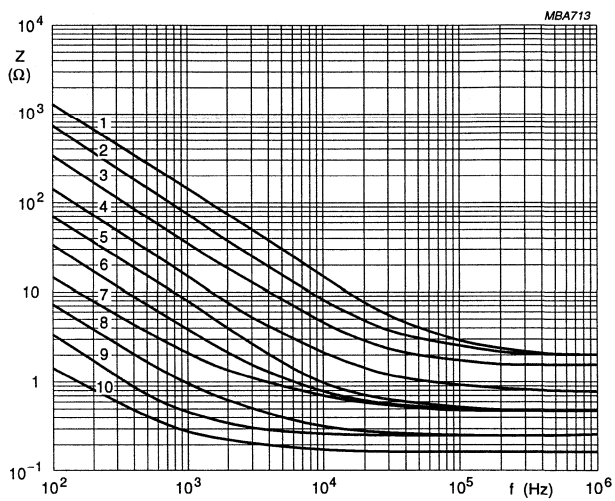


Fig.14 Typical impedance as a function of frequency; case sizes 4.5 x 10 mm to 6.5 x 25 mm.

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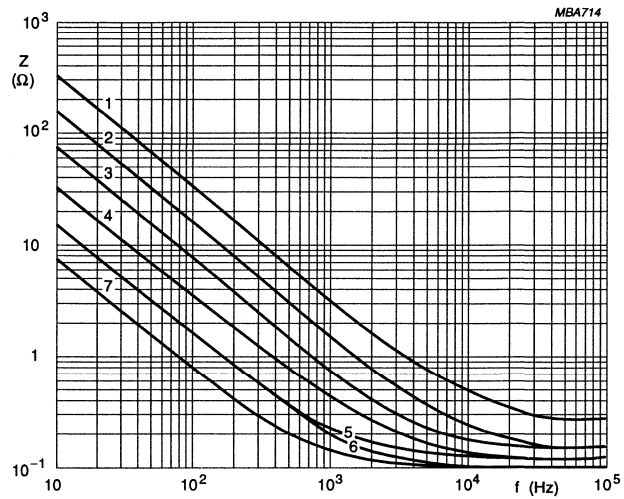
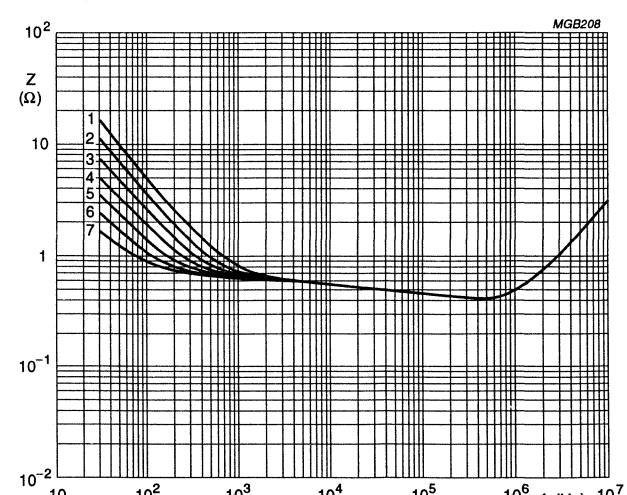


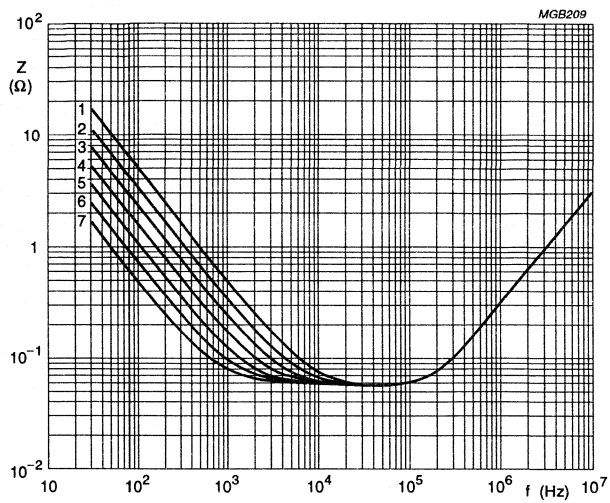
Curve 1: 47 µF, 63 V; 8 x 11
Curve 2: 100 µF, 63 V; 8 x 18
Curve 3: 220 µF, 40 V; 10 x 18
Curve 4: 470 µF, 25 V; 10 x 18
Curve 5: 1000 µF, 10 V; 10 x 18
Curve 6: 1000 µF, 16 V; 10 x 25
Curve 7: 2200 µF, 6.3 V; 10 x 25.

Fig.15 Typical impedance as a function of frequency; case sizes 8 x 11 mm to 10 x 25 mm.



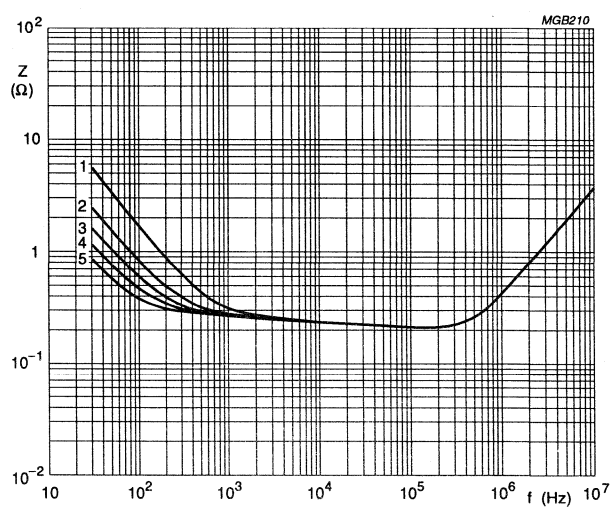
Curve 1: 330 µF, 63 V
Curve 2: 470 µF, 63 V
Curve 3: 680 µF, 40 V
Curve 4: 1000 µF, 25 and 40 V
Curve 5: 1500 µF, 16 and 25 V
Curve 6: 2200 µF, 10 and 16 V
Curve 7: 3300 µF, 10 V.

Fig.16 Typical impedance as a function of frequency at T_{amb} = –40 °C, case size 12.5 x 30 mm.



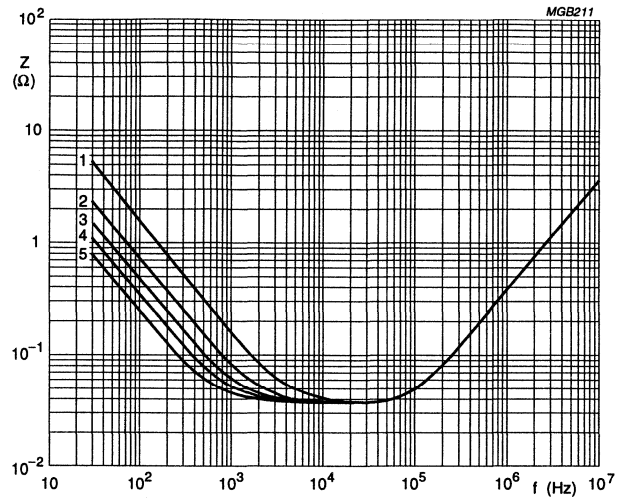
Curve 1: 330 µF, 63 V
Curve 2: 470 µF, 63 V
Curve 3: 680 µF, 40 V
Curve 4: 1000 µF, 25 and 40 V
Curve 5: 1500 µF, 16 and 25 V
Curve 6: 2200 µF, 10 and 16 V
Curve 7: 3300 µF, 10 V.

Fig.17 Typical impedance as a function of frequency at T_{amb} = 20 °C, case size 12.5 x 30 mm.



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 mm.



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 mm.

MARKING

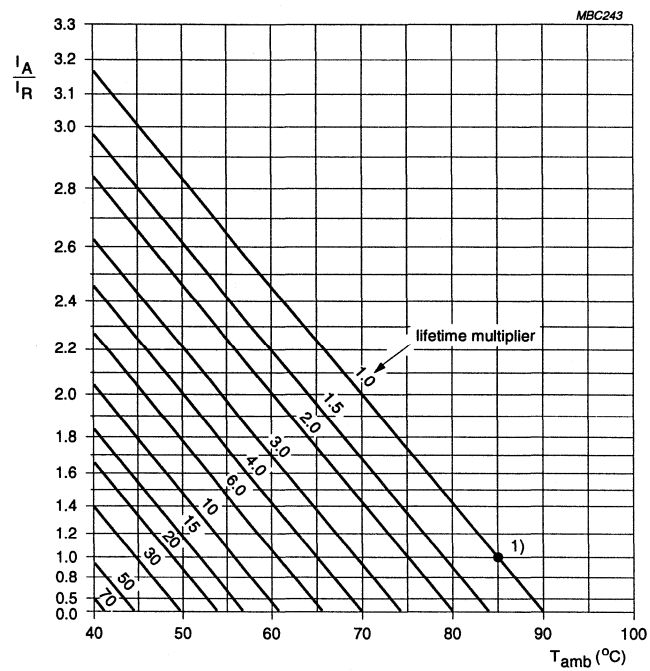
The capacitors are marked (where possible) with the following information:

- 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).

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 V to 16 V	U_R = 25 V to 40 V	U_R = 63 V 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 mm to 10 x 25 mm: 2500 hours
case sizes 10 x 30 mm to 21 x 40 mm: 8000 hours.

Fig.20 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

A

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 mm to 10 x 25 mm U_R = 6.3 to 25 V: 1000 hours U_R = 40 to 100 V: 2000 hours 10 x 30 mm to 21 x 40 mm 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 mm to 10 x 25 mm: 2500 hours 10 x 30 mm to 21 x 40 mm: 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 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

NOTES

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 mm to 21 x 40 mm with pressure relief
- Taped version available for automatic insertion up to case size 15 x 30 mm
- Charge and discharge proof
- Useful life: 3000 to 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.

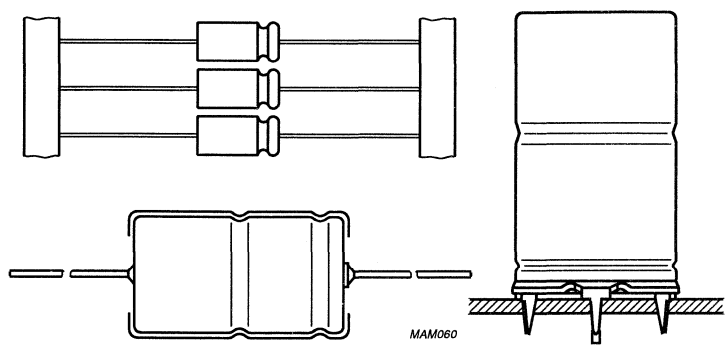


Fig.1 Component outlines.

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		
Based on sectional specification	IEC 384-4/CECC 30 300		
	GP grade	LL grade	l L grade
Detail specification	similar to DIN 45910-T126 (without approval), former DIN 41316		
Climatic category IEC 68 DIN 40040	40/085/56 GPF		
Approvals		LNZ 44-04	

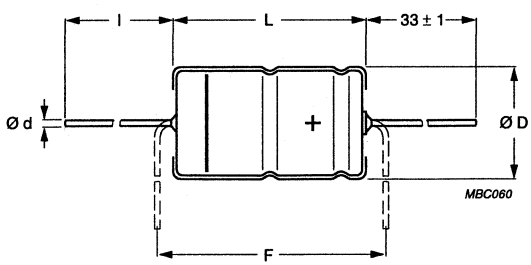
Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**). Preferred types in **bold**.

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						

A

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.



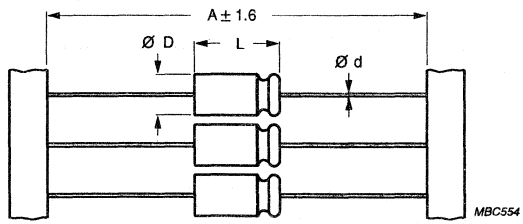
For case sizes 18 x 40 and 21 x 40 mm, the stated L_{max} may be exceeded by 0.7 mm.

Fig.2 Case sizes 10 x 30 mm to 21 x 40 mm **Form AA**: axial; for dimensions see Table 2.

Table 2 Axial, dimensions in mm; mass in g

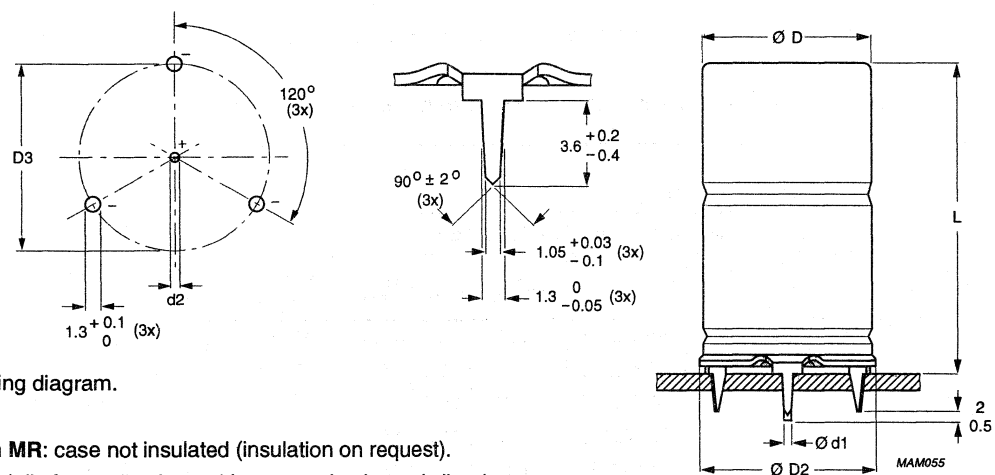
CASE SIZE Ø D_{nom} x L_{nom}	CASE CODE	AXIAL: Form AA, BA, and BR						APPROX. MASS	PACKING QUANTITIES		
		Ød	l	A	ØD_{max}	L_{max}	F_{min}		Form AA	Form BA	Form BR
3.3 x 11	1	0.6	–	63.5 ±1.5	3.5	12	17.5	0.35	–	1000	4000
4.5 x 10	2	0.6	–	63.5 ±1.5	5.0	10.5	15	0.5	–	1000	3000
6 x 10	3	0.6	–	63.5 ±1.5	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	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	–	–

Tape dimensions are specified in chapter "PACKING".



Form BR: Taped on reel, case sizes 3.3 x 11 mm to 15 x 30 mm.
Form BA: Taped in box (ammopack), case sizes 3.3 x 11 mm to 10 x 25 mm.

Fig.3 Case sizes 3.3 x 11 mm to 15 x 30 mm, 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 mm to 21 x 40 mm, 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

A

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

A

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)	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	0.06	
	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
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
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

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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)	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	

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
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

A

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)	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	

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
63	0.33	4.5 x 10	2	–	030 28337	030 38337	–
	0.47	3.3 x 11	1	–	030 90065	030 90098	–
	0.47	4.5 x 10	2	–	030 28477	030 38477	–
	1.0	3.3 x 11	1	–	030 90067	030 90068	–
	1.0	4.5 x 10	2	–	030 28108	030 38108	–
	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

A

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)	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

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 mm: $I_{L1} \leq 0.05\ C_R \times U_R$ or 5 µA, whichever is greater

case sizes 6 x 10 mm to 21 x 40 mm: I_{L1} for CU ≤ 1000 µC: $\leq 0.01\ C_R \times U_R$ or 1 µA, whichever is greater; I_{L1} for CU > 1000 µC: $\leq 0.006\ C_R \times U_R + 4$ µA

After 5 minutes at U_R

6.3 to 63 V: $I_{L5} \leq 0.002\ C_R \times U_R + 5$ 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

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 (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)

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
Curve 7: 100 V.

C_0 = capacitance at 20 °C, 100 Hz.

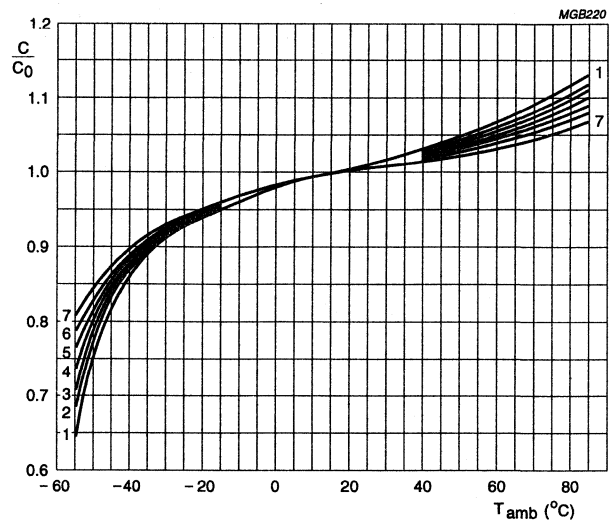


Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 3.3 x 11 mm to 10 x 25 mm.

Curve 1: 6.3 V
Curve 2: 10 V; 16 V
Curve 3: 25 V; 40 V; 63 V
Curve 4: 100 V.

C_0 = capacitance at 20 °C, 100 Hz.

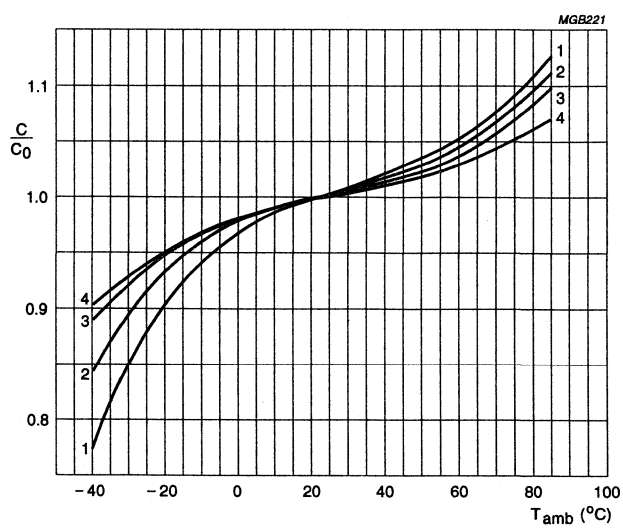
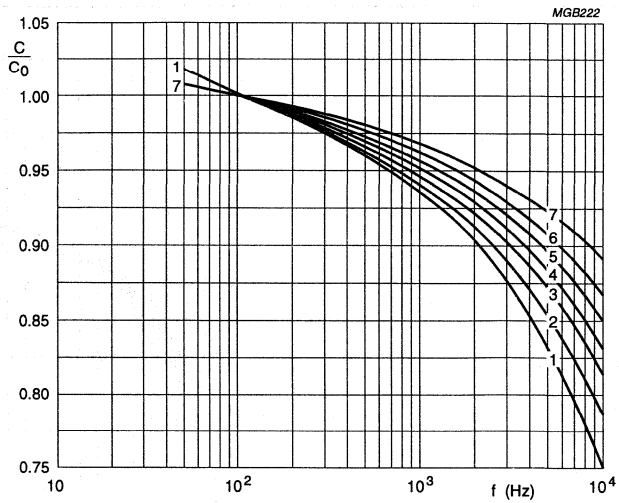


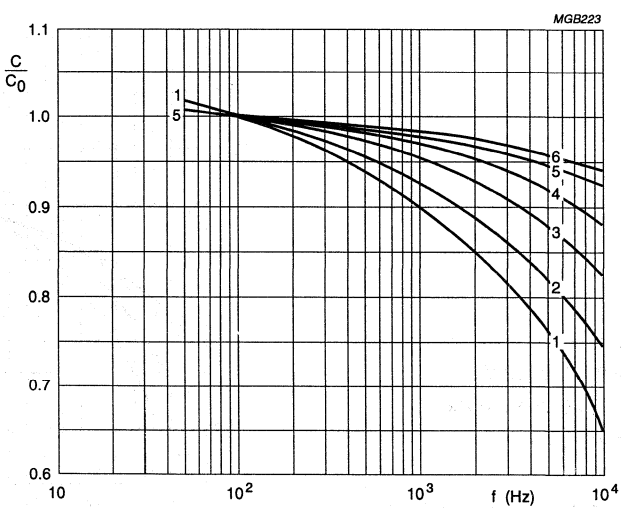
Fig.6 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 10 x 30 mm to 21 x 40 mm.



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
Curve 7: 100 V.

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 mm to 10 x 25 mm.



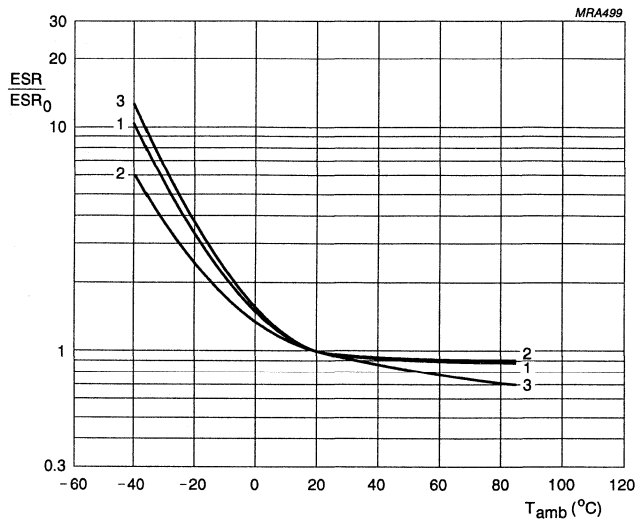
Curve 1: 6.3 V
Curve 2: 10 V
Curve 3: 16 V
Curve 4: 25 V; 100 V
Curve 5: 40 V
Curve 6: 63 V.

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 mm to 21 x 40 mm.

A

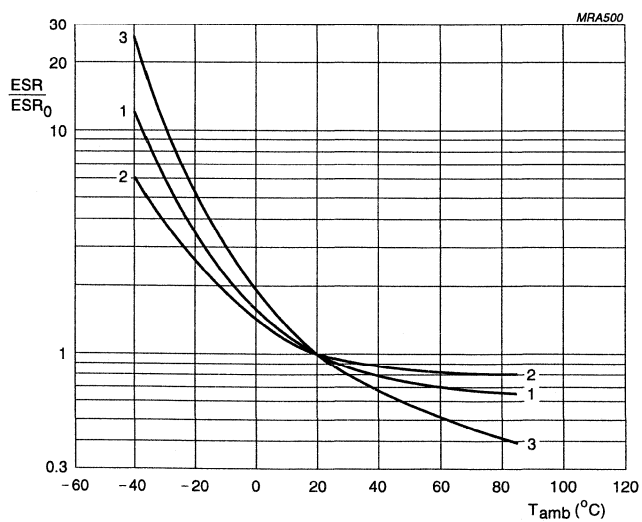
Equivalent series resistance (ESR)



Curve 1: 6.3 V
Curve 2: 63 V
Curve 3: 100 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

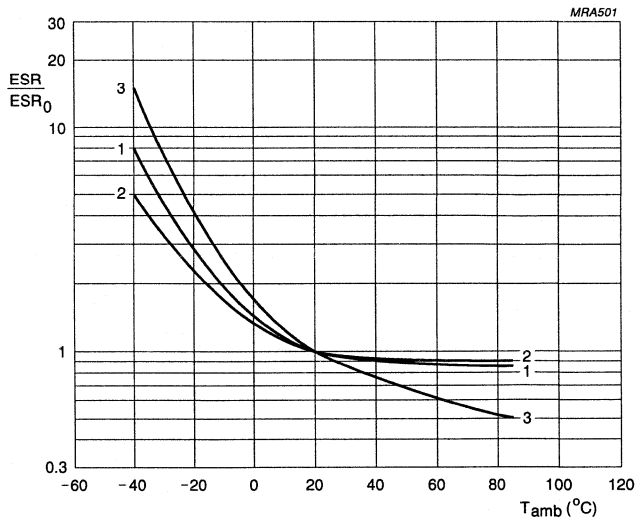
Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 3.3 x 11 mm to 10 x 25 mm.



Curve 1: 6.3 V
Curve 2: 63 V
Curve 3: 100 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

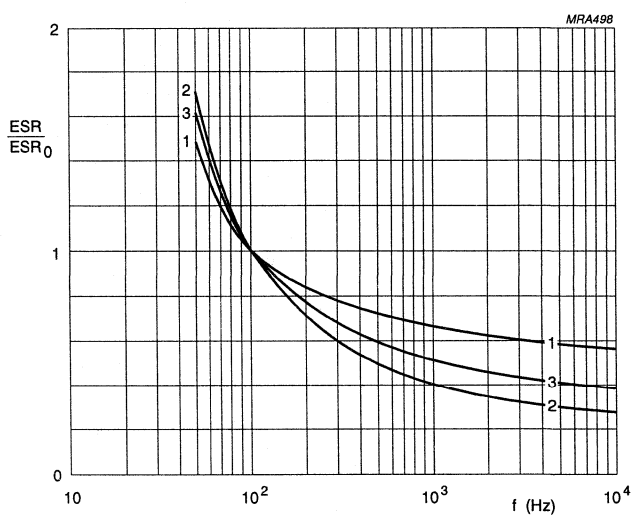
Fig.10 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 10 x 30 mm, 12.5 x 30 and 15 x 30 mm.



Curve 1: 6.3 V
Curve 2: 63 V
Curve 3: 100 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

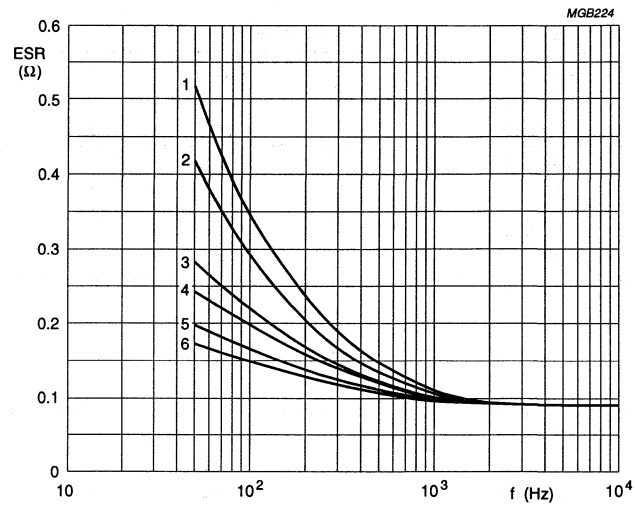
Fig.11 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 18 x 30 mm, 18 x 40 and 21 x 40 mm.



Curve 1: 6.3 V
Curve 2: 63 V
Curve 3: 100 V.

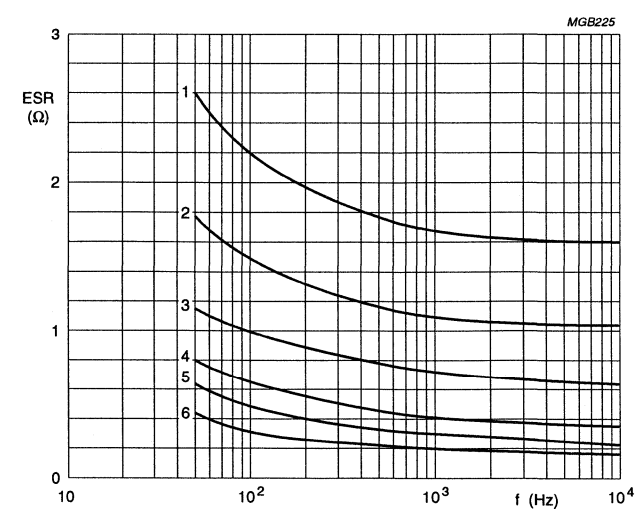
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.12 Multiplier of ESR (ESR/ESR_0) as a function of frequency; case sizes 3.3 x 11 mm to 10 x 25 mm.



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 mm; 6.3 to 63 V types.



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

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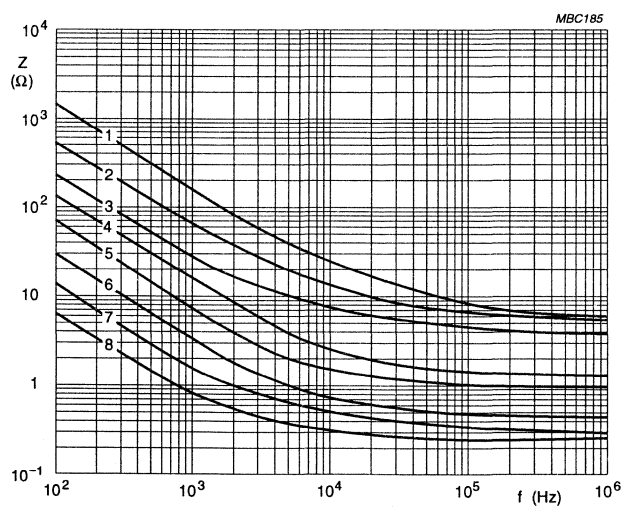
Impedance (Z)

Table 7 Impedance x capacitance values at 10 kHz

T_{amb}	$z = Z \times C_R$ (Ω μF) 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

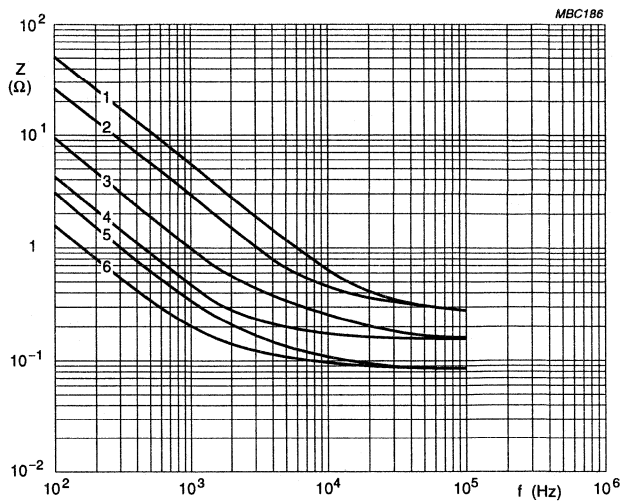
Table 8 Impedance x capacitance values at 1 kHz

T_{amb}	$z = Z \times C_R$ (Ω μF) 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	–



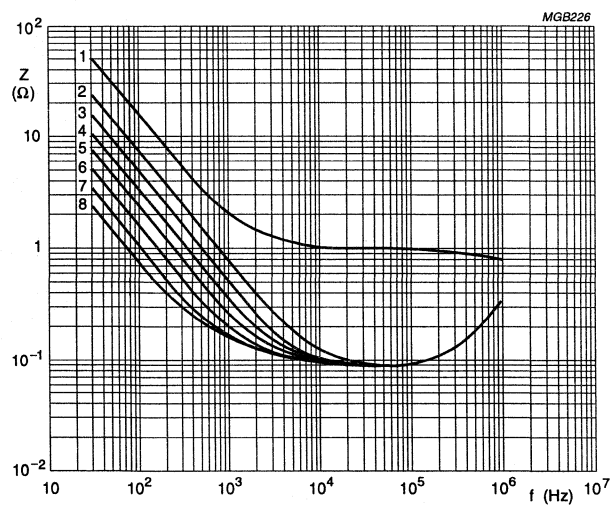
Curve 1: 1 µF, 63 V, case size 3.3 x 11
Curve 2: 2.2 µF, 40 V
Curve 3: 4.7 µF, 16 V
Curve 4: 10 µF, 25 V
Curve 5: 22 µF, 25 V
Curve 6: 47 µF, 25 V
Curve 7: 100 µF, 25 V, case size 6.5 x 18
Curve 8: 220 µF, 10 V, case size 6.5 x 18.

Fig.15 Typical impedance as a function of frequency at 20 °C; case sizes 3.3 x 11 mm to 6.5 x 18 mm.



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 mm to 10 x 25 mm.



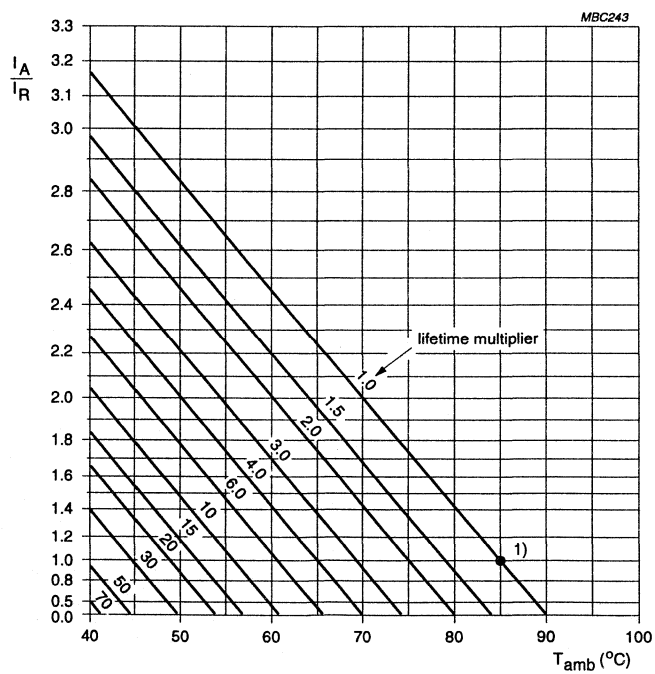
Curve 1: 100 µF, 100 V
Curve 2: 220 µF, 63 V
Curve 3: 330 µF, 40 V
Curve 4: 470 µF, 40 V
Curve 5: 680 µF, 25 V
Curve 6: 1000 µF, 16 V
Curve 7: 1500 µF, 10 V
Curve 8: 2200 µF, 6.3 V.

Fig.17 Typical impedance as a function of frequency at 20 °C; case size 12.5 x 30 mm.

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 V to 10 V	U_R = 16 V to 25 V	U_R = 40 V 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 sizes 3.3 x 11: 1500 hours
case sizes 4.5 x 10 to 10 x 25: 3000 hours
case sizes 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 mm

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 mm to 21 x 40 mm

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

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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 mm to 21 x 40 with pressure relief
- Taped versions up to case size 15 x 30 mm available for automatic insertion
- Charge and discharge proof
- Useful life: 5000 to 15 000 hours at 85 °C
- High rated voltage: up to 400 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.

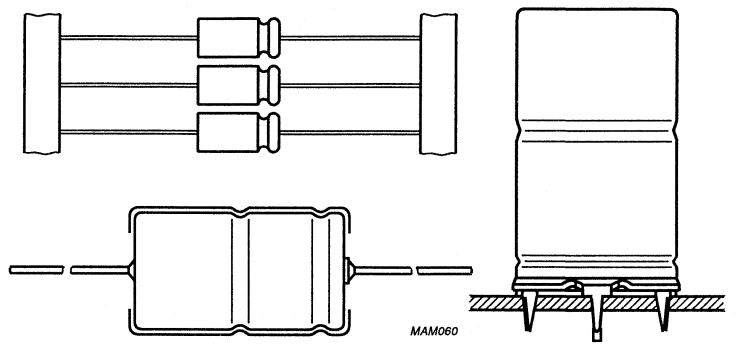

Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (Ø 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 400 V	
Category temperature range	–40 to +85 °C	
Endurance test at 85 °C	2000 hours	8000 hours
Useful life at 85 °C	5000 hours	15 000 hours
Useful life at 40 °C	120 000 hours (1.4 I_R applied)	240 000 hours (1.8 I_R applied)
Shelf life at 0 V, 85 °C	500 hours	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade	
Detail specification	similar to DIN 45910-T126 (without approval), former DIN 41316	similar to DIN 45910-T123 (without approval), former DIN 41257
Climatic category IEC 68 DIN 40040	40/085/56 GPF	

Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

ASH 041-043

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (⌀ **D x L** in **mm**). Preferred types in **bold**.

C_R (µF)	U_R (V)				
	160	**250**	**350**	**385**	**400**
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	8 x 18	10 x 25 10 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
22	10 x 25 10 x 30	12.5 x 30	15 x 30	18 x 30	18 x 30
33	12.5 x 30	15 x 30	18 x 30	18 x 40	18 x 40
47	15 x 30	18 x 30	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
100	18 x 30	21 x 40			
150	18 x 40				
220	21 x 40				

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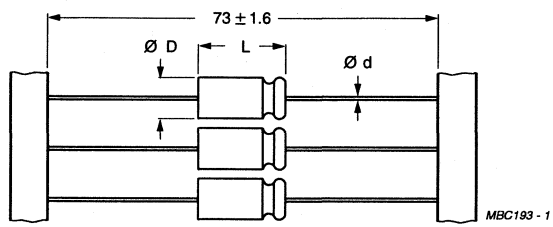
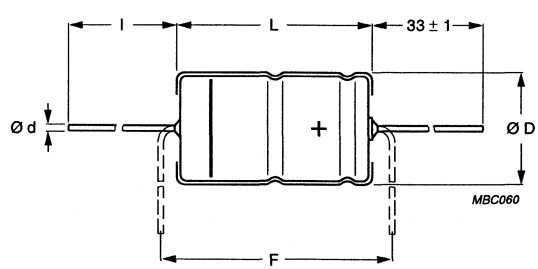
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

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



Form BR: Taped on reel, case sizes 6.5 x 18 mm to 15 x 30 mm.
Form BA: Taped in box (ammopack), case sizes 6.5 x 18 mm to 10 x 25 mm.

Fig.2 Case sizes 6.5 x 18 mm to 15 x 30 mm.



Form AA: Axial in box.
For case sizes 18 x 40 and 21 x 40 mm, the stated L may be exceeded by 0.7 mm.

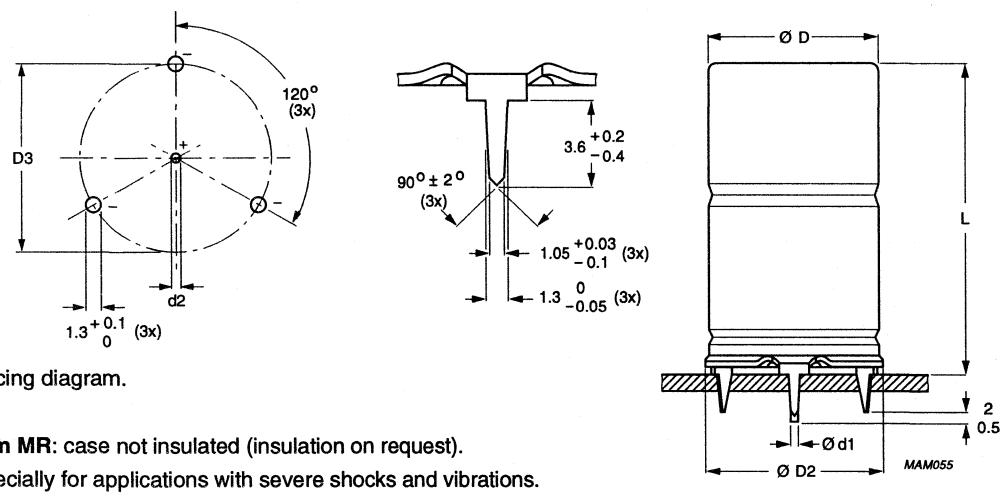
Fig.3 Case sizes 10 x 30 mm to 21 x 40 mm.

Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

ASH 041-043

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
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 mm to 21 x 40 mm, 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

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	120	42	25	0.10	6.8	4.5
	33	12.5 x 30	150	58	36	0.10	4.5	3.1
	47	15 x 30	190	78	49	0.10	3.2	2.1
	68	15 x 30	230	110	69	0.10	2.2	1.4
	100	18 x 30	350	150	100	0.10	1.5	1.0
	150	18 x 40	430	230	150	0.10	1.0	0.7
	220	21 x 40	610	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	15	11
	15	12.5 x 30	100	44	27	0.10	10	7.4
	22	12.5 x 30	130	60	37	0.10	6.8	5.0
	33	15 x 30	160	84	54	0.10	4.5	3.4
	47	18 x 30	220	120	75	0.10	3.2	2.3
	68	18 x 40	290	160	110	0.10	2.2	1.7
	100	21 x 40	390	240	150	0.10	1.5	1.1

Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

ASH 041-043

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

Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

ASH 041-043

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	22	14
	10	12.5 x 30	90	42	25	0.10	15	10
	15	12.5 x 30	100	57	36	0.10	10	6.7
	22	15 x 30	140	79	50	0.10	6.8	4.5
	33	18 x 30	160	110	73	0.10	4.5	3.1
	47	18 x 40	270	160	100	0.10	3.2	2.1
	68	21 x 40	320	220	150	0.10	2.2	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	22	14
	10	12.5 x 30	90	45	27	0.10	15	10
	15	15 x 30	110	62	39	0.10	10	6.0
	22	18 x 30	150	86	55	0.10	6.8	4.1
	33	18 x 40	200	120	80	0.10	4.5	2.7
	47	18 x 40	270	170	110	0.10	3.2	2.1
	68	21 x 40	320	250	160	0.10	2.2	1.4
400	6.8	10 x 30	82	220	110	0.055	11.5	7.3
	10	12.5 x 30	130	240	110	0.055	7.5	4.6
	15	15 x 30	160	250	110	0.055	5.0	3.1
	22	18 x 30	210	280	120	0.055	3.5	2.1
	33	18 x 40	290	320	130	0.055	2.3	1.4
	47	18 x 40	330	370	140	0.055	1.7	1.1
	68	21 x 40	430	440	150	0.055	1.2	0.7

Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

ASH 041-043

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

A

Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

ASH 041-043

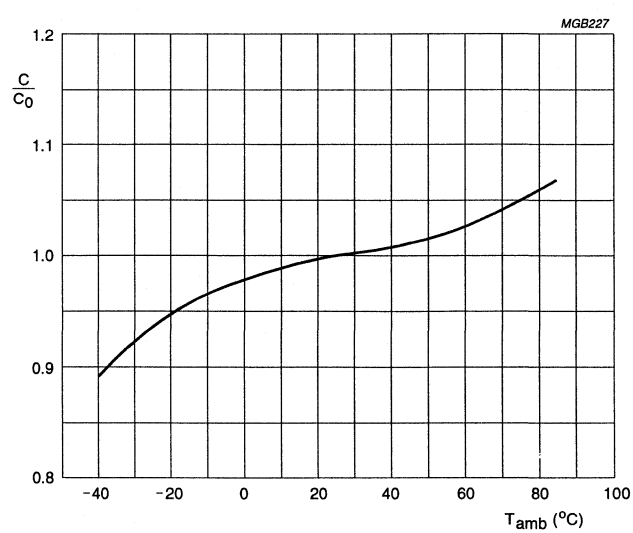
Voltage

Surge voltage for short periods	
160 V and 250 V types	$U_s \leq 1.15 \times U_R$
350 V 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 mm to 10 x 25 mm	for CU $\leq$ 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 mm to 21 x 40 mm	160 V to 385 V: $I_{L1} \leq 0.009\ C_R \times U_R + 10$ µA 400 V: $I_{L1} \leq 0.009\ C_R \times U_R + 200$ µA
After 5 minutes at U_R	
160 V to 385 V	for CU $\leq$ 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 V	$I_{L5} \leq 0.002\ C_R \times U_R + 100$ µA

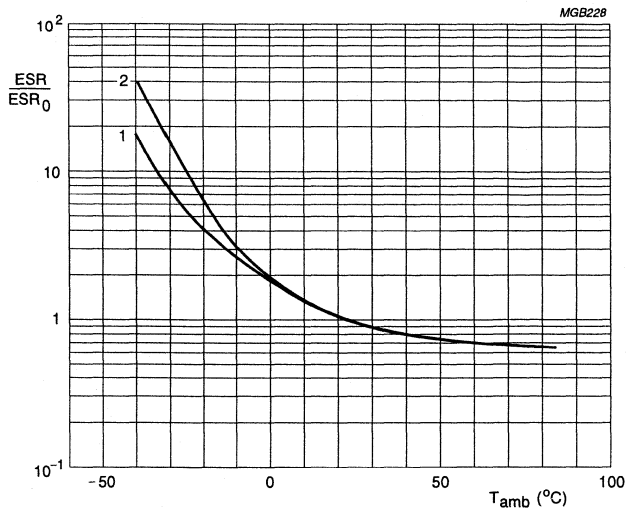
Capacitance (C)



C_0 = capacitance at 20 °C, 100 Hz.

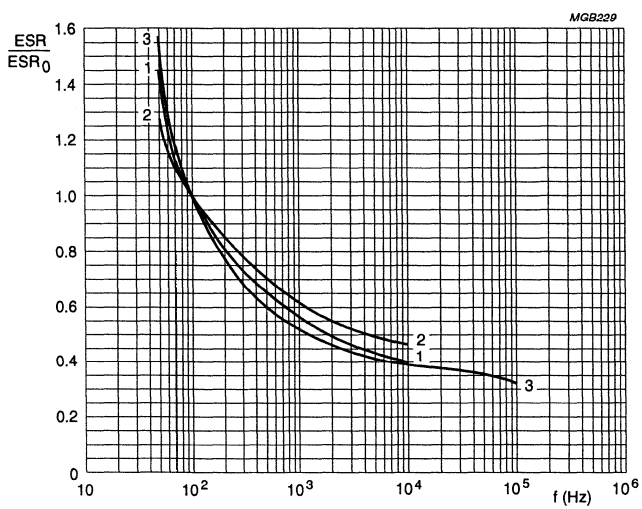
Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature

Equivalent series resistance (ESR)



Curve 1: case codes 00 to 05
(sizes 10 x 30 mm to 21 x 40 mm).
Curve 2: case codes 4 to 7
(sizes 6.5 x 18 mm to 10 x 25 mm).
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.6 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.



Curve 1: case code 00
(size 10 x 30 mm).
Curve 2: case code 05
(size 21 x 40 mm).
Curve 3: case codes 4 to 7
(sizes 6.5 x 18 mm to 10 x 25 mm).
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.7 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

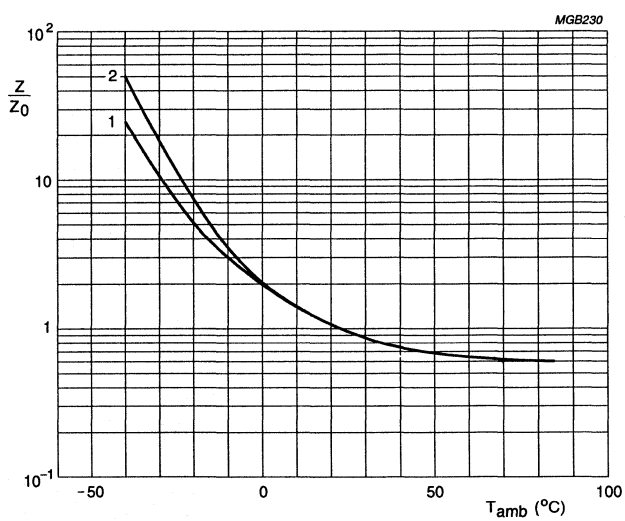
A

Equivalent series inductance (ESL)

Table 6 Equivalent series inductance, typical values

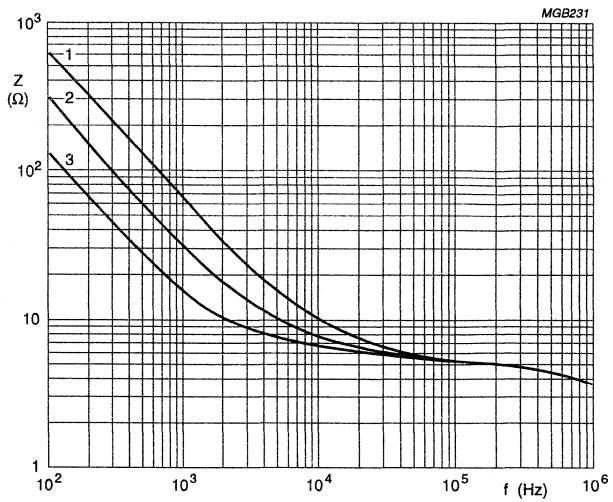
CASE SIZE (∅ x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)		CASE SIZE (∅ x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)
6.5 x 18	15	–		12.5 x 30	46	–
8 x 18	35	–		15 x 30	48	39
10 x 18	69	–		18 x 30	50	39
10 x 25	38	–		18 x 40	54	39
10 x 30	38	–		21 x 40	59	39

Impedance (Z)



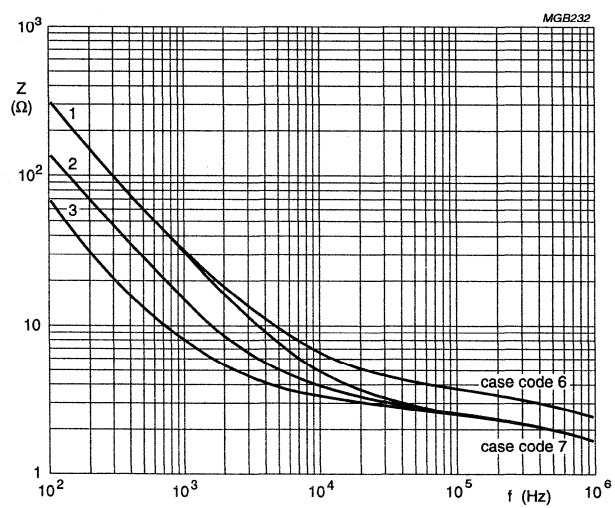
Curve 1: case codes 00 to 05
(sizes 10 x 30 mm to 21 x 40 mm).
Curve 2: case codes 4 to 7
(sizes 6.5 x 18 mm to 10 x 25 mm).
Z_0 = impedance at 20 °C, 10 kHz.

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 mm.



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;
sizes 10 x 18 mm (case code 6) and 10 x 25 mm (case code 7).

A

Curve 1: 10 µF, 350 and 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 and 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 and 385 V; 85 °C
Curve 8: 15 µF, 250 V; 85 °C
Curve 9: 33 µF, 160 V; 85 °C.

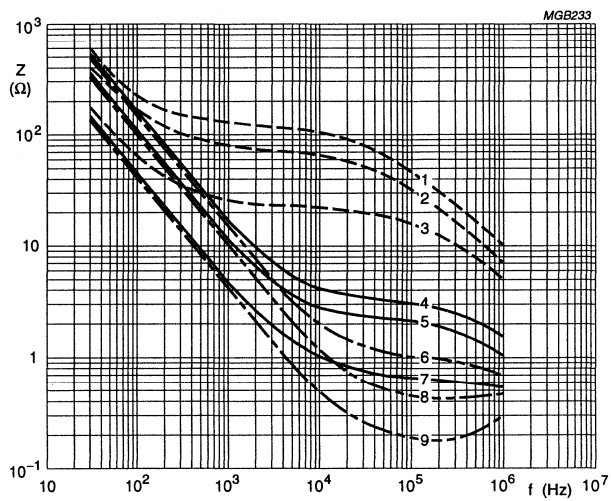


Fig.11 Typical impedance as a function of frequency at different temperatures; case size 12.5 x 30 mm.

MARKING

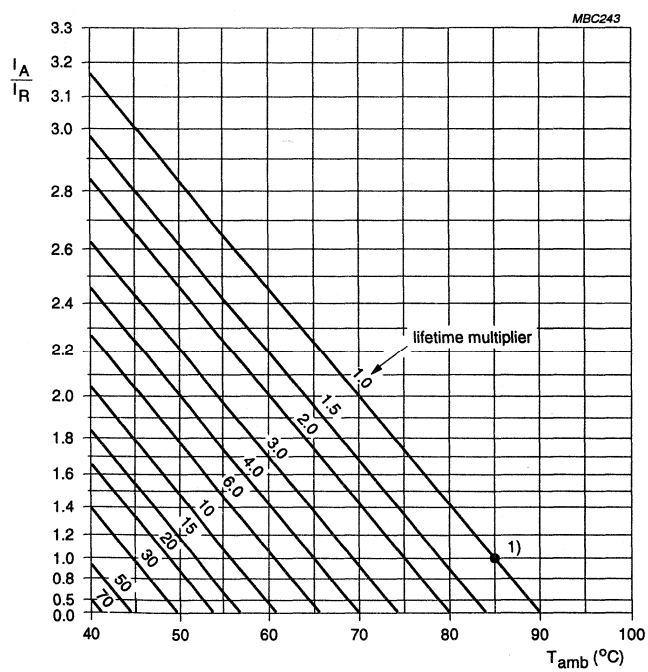
The capacitors are marked (where possible) with the following information:

- 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.

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 mm to 10 x 25 mm: 5000 hours
case sizes 10 x 30 mm to 21 x 40 mm: 15 000 hours.

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

A

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 mm to 10 x 25 mm: 2000 hours 10 x 30 mm to 21 x 40 mm: 8000 hours	U_R 160 V: $\Delta C/C \pm 15\%$ U_R 250 V to 450 V: $\Delta C/C \pm 10\%$ 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; case sizes: 6.5 x 18 mm to 10 x 25 mm: 5000 hours 10 x 30 mm to 21 x 40 mm: 15 000 hours	U_R 160 V: $\Delta C/C \pm 45\%$ U_R 250 V to 450 V: $\Delta C/C \pm 30\%$ 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: ≤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 $I_{L5} \leq 2$ x spec. limit

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.

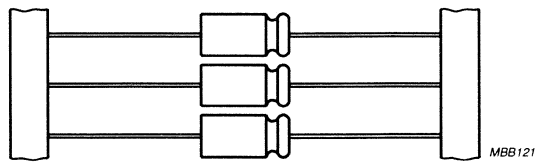


Fig.1 Component outlines.

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	0.47 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	−40 to +85 °C
Leakage current after 2 minutes at 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
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Detail specification	similar to DIN 45910-T126 (without approval), former DIN 41316
Climatic category IEC 68 DIN 40040	 40/085/56 GPF

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 values on request	
68	6 x 10			

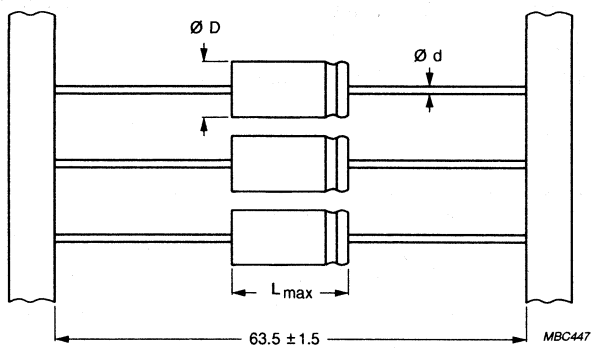
A

Non-solid Al - electrolytic capacitors Axial, Low Leakage Current

ALC 065

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 mm, insulated with a blue plastic sleeve.

Table 2 Dimensions in mm; mass in g

CASE SIZE Ø D_{nom} x L_{nom} (mm)	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

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.

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	
									TAPED ON REEL	
(V)	(µF)	(mm)		(mA)	(µA)		(Ω)	(Ω)	−10/+50% Form BR	±20% Form BR
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

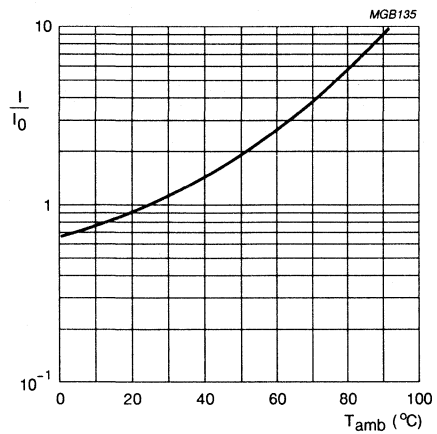
A

Non-solid Al - electrolytic capacitors Axial, Low Leakage Current

ALC 065

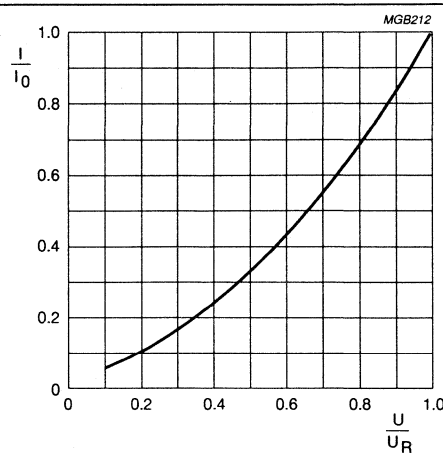
Leakage current

After 2 minutes at U_R $I_{L2} \leq 0.002\ C_R \times U_R$ or 0.7 µA (whichever is greater)



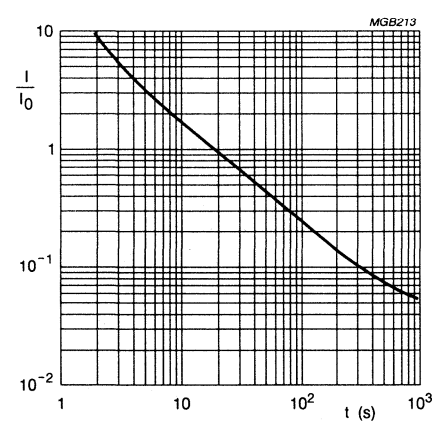
I_0 = leakage current during continuous operation at 20 °C and U_R.

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.



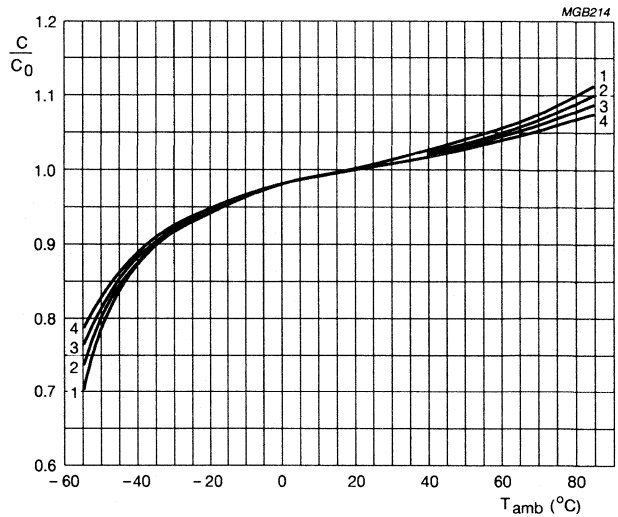
I_0 = leakage current as specified in Table 3.

Fig.5 Typical multiplier of leakage current (I/I_0) as a function of time.

Voltage

Surge voltage for short periods	$U_s \leq 1.6 \times U_R$
Reverse voltage	$U_{rev} \leq 1$ V

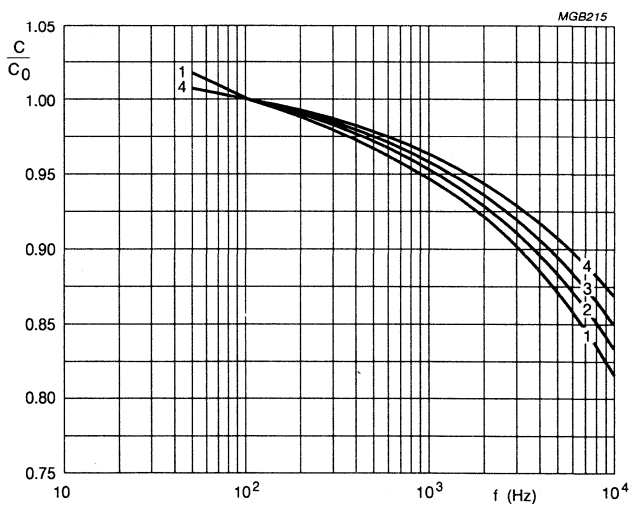
Capacitance (C)



Curve 1: 6.3 V
Curve 2: 10 V
Curve 3: 16 V
Curve 4: 25 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



Curve 1: 6.3 V
Curve 2: 10 V
Curve 3: 16 V
Curve 4: 25 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.7 Multiplier of capacitance (C/C_0) as a function of frequency.

A

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.

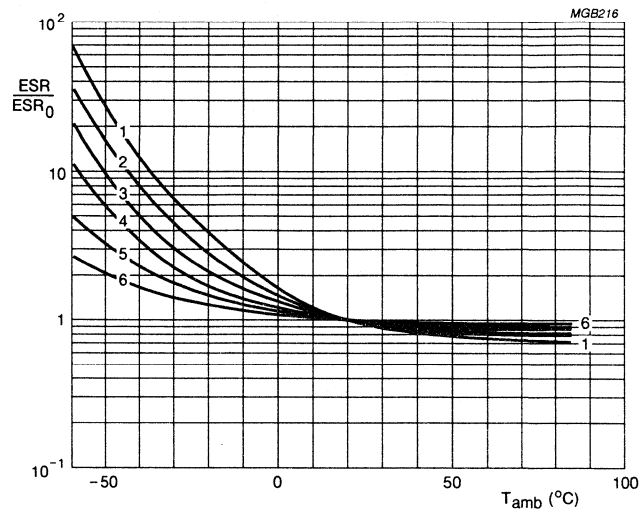


Fig.8 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature.

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.

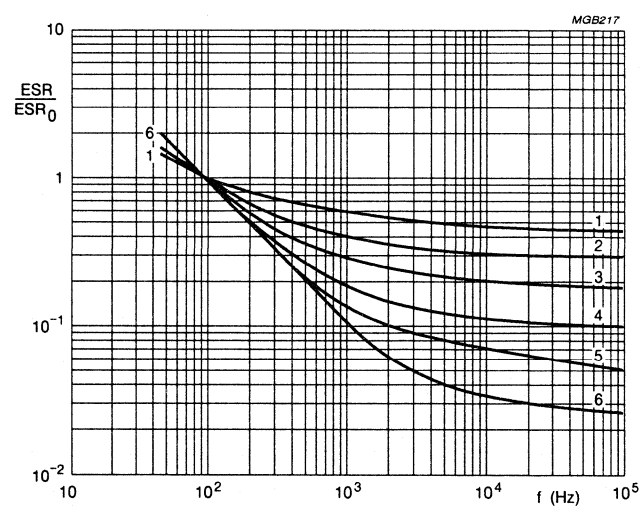


Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of frequency.

Equivalent series inductance (ESL)

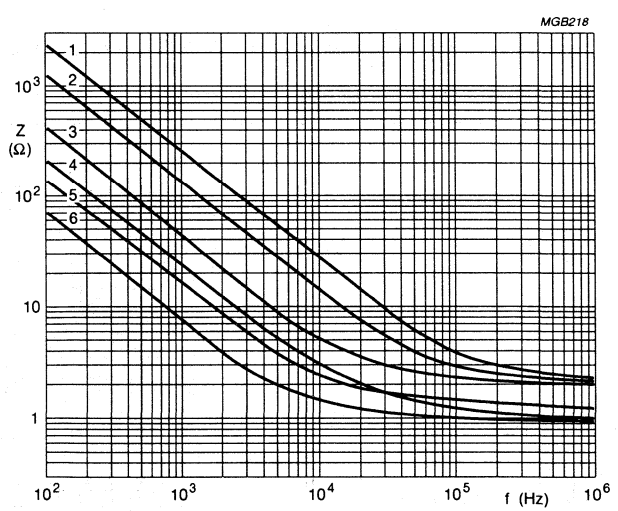
Table 4 Equivalent series inductance, typical values

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

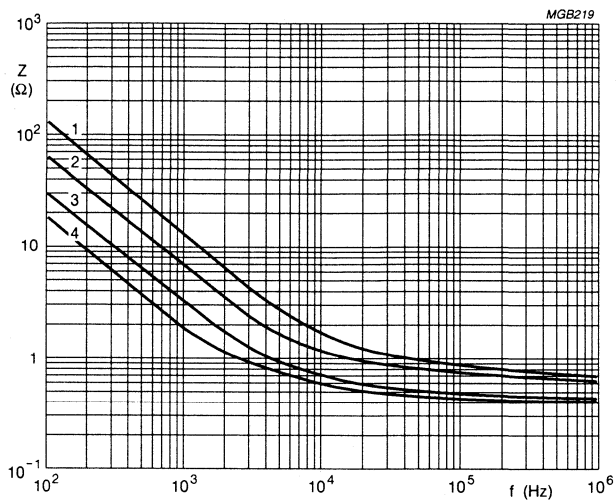
T_{amb}	$z = Z \times C_R(\Omega\,\mu F)$ at 10 kHz			
	6.3 V	10 V	16 V	25 V
+20 °C	≤ 120	≤ 90	≤ 70	≤ 55
–25 °C	≤ 560	≤ 400	≤300	≤180
–40 °C	≤1500	≤1100	≤900	≤500



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 mm.

A



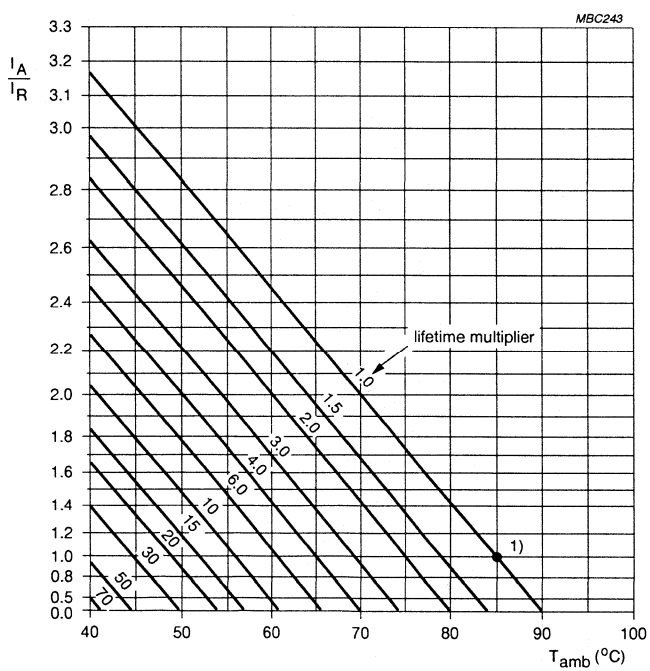
Curve 1: 10 µF
Curve 2: 22 µF
Curve 3: 47 µF
Curve 4: 68 µF.

Fig.11 Typical impedance as a function of frequency at 20 °C; case size 6 x 10 mm.

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).

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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/ CECC 30 300 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 $I_{L2} \leq$ 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/ CECC 30 300 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 Bipolar

AB 137 92

FEATURES

- Non-polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated
- Taped for automatic insertion
- AC-capability without DC bias
- Charge and discharge proof
- Long useful life: 1000 hours at 105 °C
- Miniaturized dimensions.

APPLICATIONS

- Telecommunication, automotive, audio-video and industrial
- Coupling, decoupling, buffering, smoothing and filtering
- For circuits where the polarity is not fixed, or where reverse voltages may occur
- Boards with restricted mounting height, vibration and shock resistant.

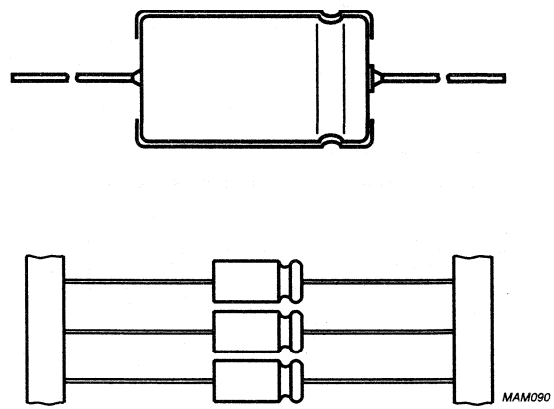

Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	6 x 10 to 10 x 25
Rated capacitance range, C_R	1 to 470 µF
Tolerance on C_R at 100 Hz	–10/+50%
Rated voltage range, U_R	16 to 63 V
Category temperature range	–40 to +105 °C
Endurance test at 105 °C	500 hours
Endurance test at 85 °C	2000 hours
Useful life at 105 °C	1000 hours
Useful life at 40 °C, 1.3 I_R applied	100 000 hours
Shelf life at 0 V; 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300
Climatic category	40/085/56

A

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)			
	16	**25**	**40**	**63**
1.0				6 x 10
2.2				6 x 10
3.3				6 x 10
4.7				6 x 10
10			6 x 10	6.5 x 18
22		6 x 10	6.5 x 18	8 x 18
33	6 x 10			10 x 18
47		6.5 x 18	8 x 18	10 x 25
100	8 x 18	10 x 18	10 x 25	
220	10 x 18	10 x 25		
330	10 x 25			
470	10 x 25			

Note

Please consult your sales representative for more details.

Non-solid Al - electrolytic capacitors
Axial Bipolar Audio-frequency

ABA 137

FEATURES

- Non-polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated
- AC-capability without DC bias
- Low dissipation factor, featuring low sound distortion
- Long useful life: 1500 hours at 105 °C
- LD grade types for extremely low dissipation factor.

APPLICATIONS

- Speaker crossover networks in audio equipment
- For splitting high, middle and low frequencies
- Axial version allows simple wiring in speaker box
- LD grade types for excellent sound quality.

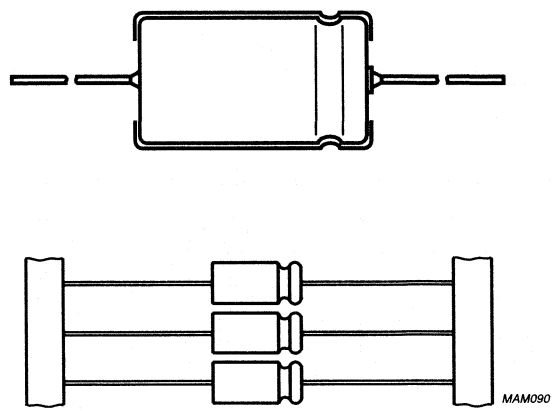

Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	8 x 18 to 10 x 25
Rated capacitance range, C_R	2.2 to 22 µF
Tolerance on C_R at 1 kHz	±15% or ±10%
Rated voltage DC, U_R	40 to 100 V
Max. RMS voltage AC, U_{RMS}	15 to 35 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	150 000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC384-4/CECC 30 300
Detail specification	similar to CECC 30 301-043/DIN 45 910-125 (without certification)
Climatic category	40/105/56

Non-solid Al - electrolytic capacitors
Axial Bipolar Audio-frequency

ABA 137

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

C_R (µF)	U_R (DC); U_{RMS} (AC) (V)		
	40; 15	**63; 23**	**100; 35**
2.2		8 x 18 LD: 10 x 25	8 x 18 LD: 10 x 25
3.3		8 x 18 LD: 10 x 25	10 x 18
4.7	8 x 18	10 x 18 LD: 10 x 25	10 x 18
6.8	8 x 18	10 x 25	10 x 25
10	10 x 18	10 x 25	
15	10 x 25		
22	10 x 25		

Note

Please consult your sales representative for more details.

NOTES

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

AML 138

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve (case sizes 6.3 x 12.7 mm and 7.7 x 12.7 mm are moulded with flame retardant plastic material)
- Mounting ring version (single ended) not insulated
- Case sizes 10 x 30 mm to 21 x 40 mm with pressure relief
- Taped versions up to case size 15 x 30 mm available for automatic insertion
- Charge and discharge proof
- Long useful life: 2000 to 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.

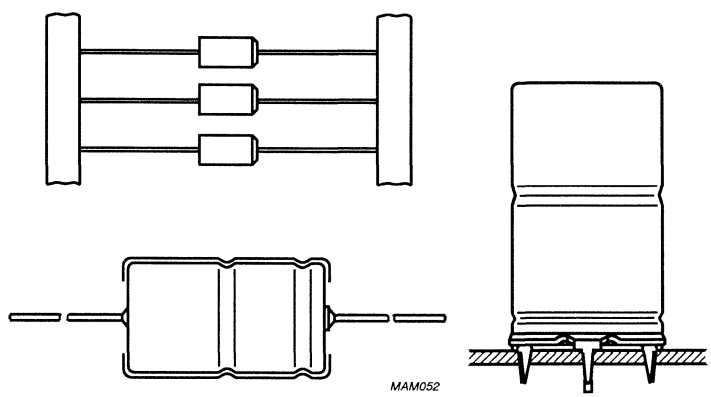

Fig.1 Component outlines.

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
Based on sectional specification	IEC 384-4/CECC 30 300	
Detail specification	similar to DIN 45910-T123 (without approval), former DIN 41257 (with reduced dimensions)	
Climatic category IEC 68 DIN 40040	40/105/56 GMF	

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

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

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						

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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).

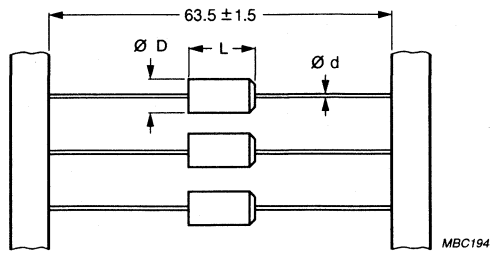
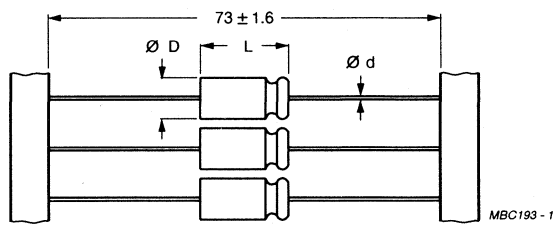
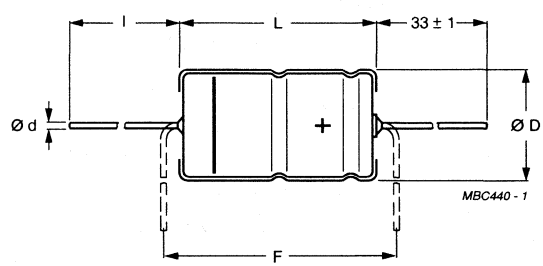


Fig.2 Case sizes 6.3 x 12.7 and 7.7 x 12.7 mm.



Form BR: Taped on reel, case sizes 6.5 x 18 mm to 15 x 30 mm.
Form BA: Taped in box (ammopack), case sizes 6.5 x 18 mm to 10 x 25 mm.

Fig.3 Case sizes 6.5 x 18 mm to 15 x 30 mm.



Form AA: Axial in box.
For case sizes 18 x 40 and 21 x 40 mm, the stated L may be exceeded by 0.7 mm.

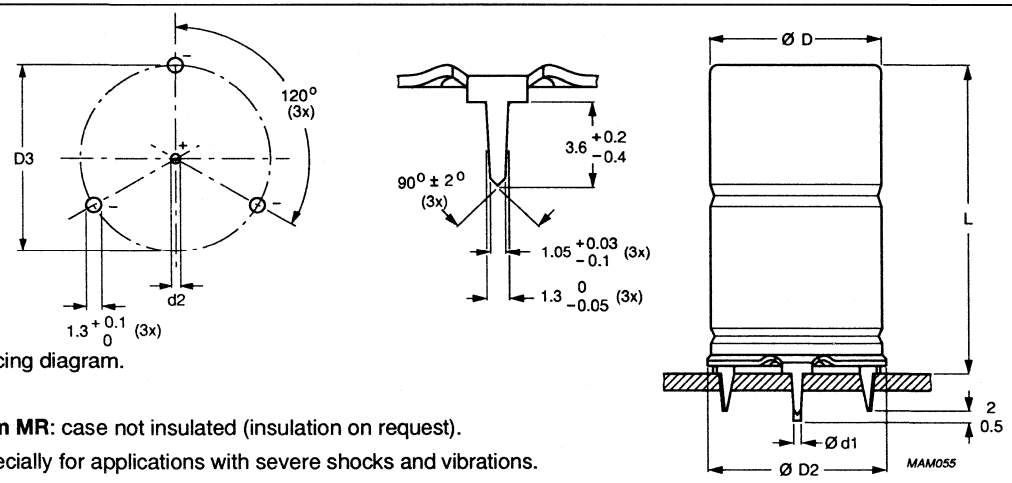
Fig.4 Case sizes 10 x 30 mm to 21 x 40 mm, insulated with a blue plastic sleeve.

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

AML 138

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
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	–	–



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 mm to 21 x 40 mm, 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

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Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

AML 138

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	0.26	0.27	0.18	0.15
	2200	12.5 x 30	750	140	48	0.27	0.14	0.13	0.12
	3300	15 x 30	990	200	70	0.28	0.10	0.1	0.094
	4700	18 x 30	1200	290	98	0.31	0.083	0.088	0.083
	6800	18 x 40	1700	410	140	0.32	0.056	0.049	0.069
	10 000	18 x 40	1900	600	200	0.37	0.048	0.042	0.065
	15 000	21 x 40	2200	900	300	0.51	0.044	0.038	0.063

ORDERING INFORMATION

Ordering Example

Electrolytic Capacitor AML 138
1000 µF/10; ±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

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

AML 138

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	0.19	0.29	0.20	0.18
	1500	12.5 x 30	730	150	52	0.19	0.20	0.14	0.13
	2200	15 x 30	950	210	74	0.21	0.15	0.105	0.103
	3300	18 x 30	1200	320	110	0.23	0.11	0.083	0.088
	4700	18 x 30	1400	450	150	0.28	0.093	0.073	0.082
	6800	18 x 40	1800	660	220	0.28	0.062	0.048	0.065
	10 000	21 x 40	2100	960	320	0.35	0.055	0.044	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	0.14	0.32	0.20	0.18
	1000	12.5 x 30	670	150	54	0.14	0.22	0.14	0.13
	1500	15 x 30	890	230	79	0.15	0.16	0.105	0.105
	2200	18 x 30	1200	330	110	0.16	0.12	0.083	0.088
	3300	18 x 40	1600	500	170	0.17	0.08	0.055	0.069
	4700	18 x 40	1800	710	240	0.20	0.067	0.049	0.065
	6800	21 x 40	2100	1000	340	0.26	0.059	0.045	0.064

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

AML 138

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

A

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

AML 138

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	0.25	0.21
	470	12.5 x 30	550	120	42	0.10	0.33	0.18	0.16
	680	12.5 x 30	650	170	58	0.11	0.25	0.145	0.13
	1000	15 x 30	840	240	84	0.11	0.17	0.105	0.097
	1500	18 x 30	1100	360	120	0.12	0.13	0.085	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	0.12
	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

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

AML 138

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

A

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

AML 138

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

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

AML 138

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

A

Non-solid Al - electrolytic capacitors
Axial Miniature Long Life

AML 138

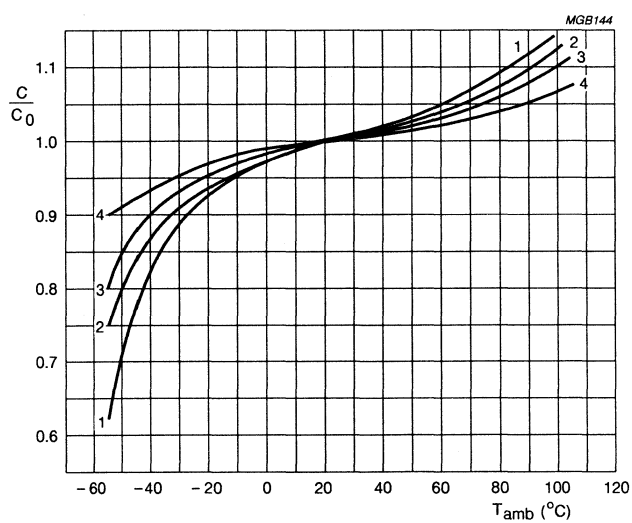
Voltage

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 mm	$I_{L1} \leq 0.02\ C_R \times U_R + 3\ \mu A$
case sizes 6.5 x 18 mm to 21 x 40 mm	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$

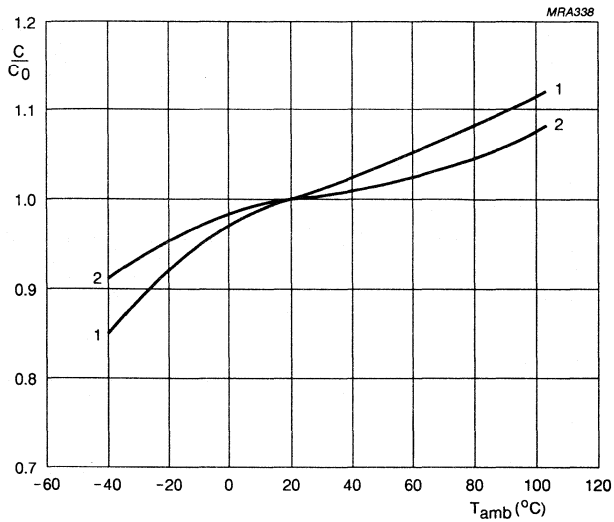
Capacitance (C)



Curve 1: 6.3 and 10 V
Curve 2: 16 V to 40 V
Curve 3: 50 and 63 V
Curve 4: 100 V.

C_0 = capacitance at 20 °C, 100 Hz.

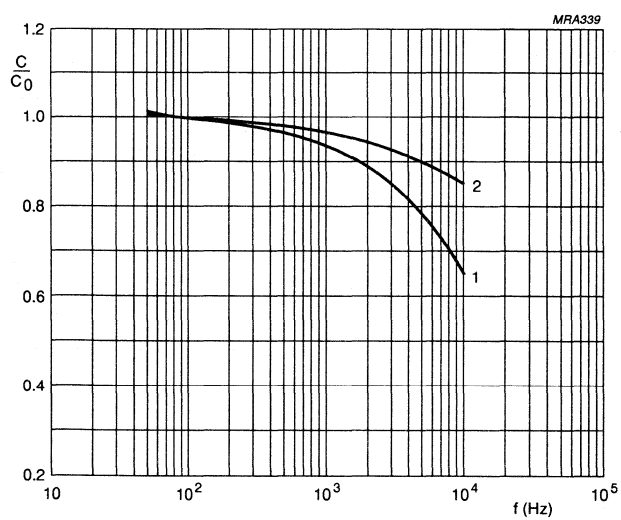
Fig.6 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 6.3 x 12.7 mm to 10 x 25 mm.



Curve 1: 10 V
Curve 2: 100 V.

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 mm to 21 x 40 mm.



Curve 1: 10 V
Curve 2: 100 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.8 Multiplier of capacitance (C/C_0) as a function of frequency.

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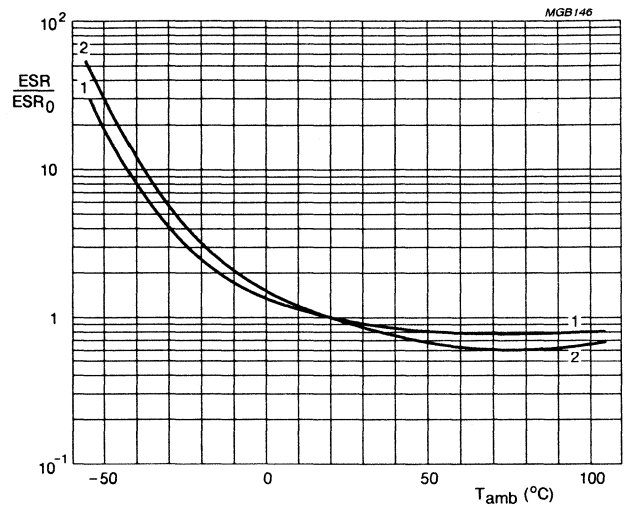
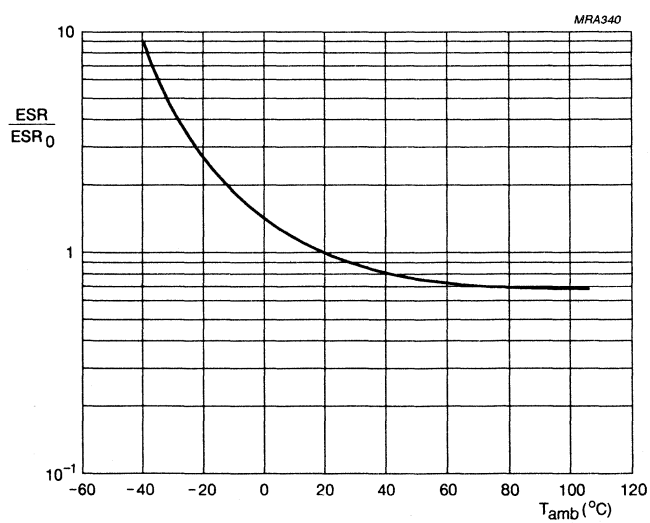
Equivalent series resistance (ESR)



Curve 1: 50 V
Curve 2: 6.3 V; 63 V; 100 V.

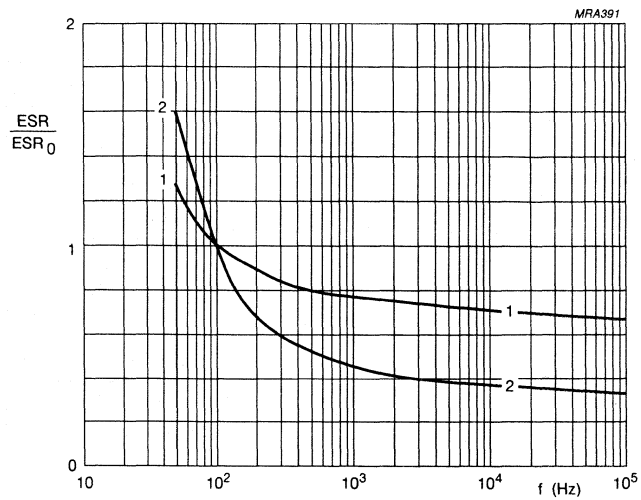
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 6.3 x 12.7 mm to 10 x 25 mm.



ESR_0 = typical ESR at 20 °C, 100 Hz.

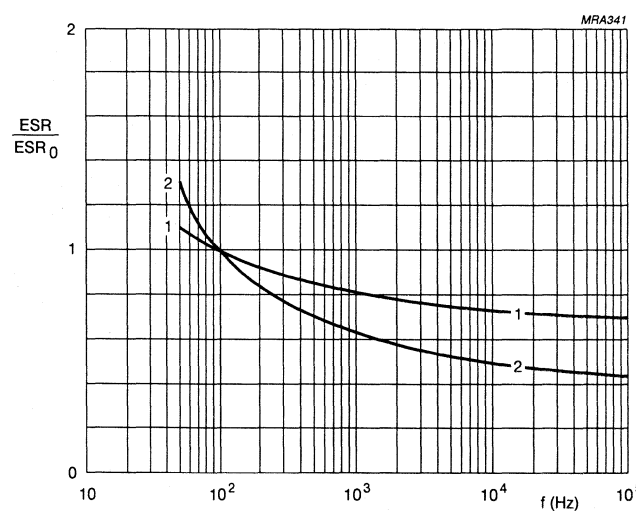
Fig.10 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 10 x 30 mm to 21 x 40 mm.



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 mm to 10 x 25 mm.



Curve 1: 10 V
Curve 2: 100 V.

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 mm to 21 x 40 mm.

A

Equivalent series inductance (ESL)

Table 6 Equivalent series inductance, typical values

CASE SIZE (∅D x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)		CASE SIZE (∅D 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 mm 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

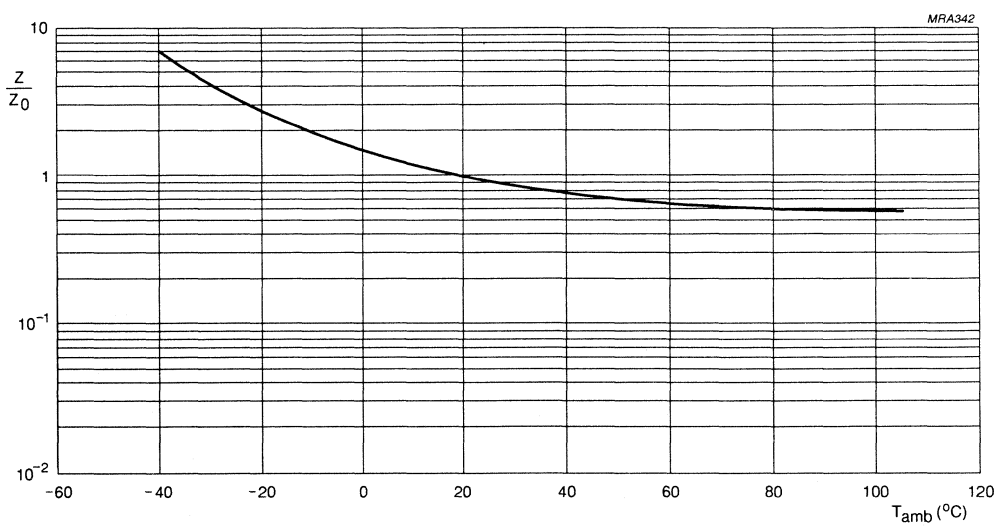


Fig.13 Typical impedance (Z/Z_0) as a function of ambient temperature at 10 kHz; case sizes 10 x 30 mm to 21 x 40 mm.

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.

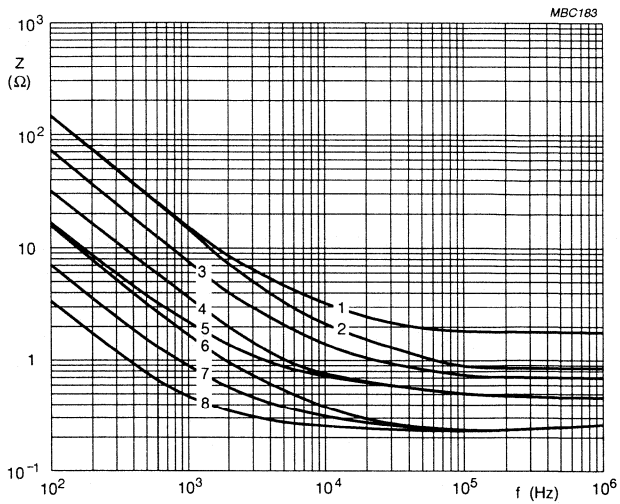


Fig.14 Typical impedance as a function of frequency at 20 °C; case sizes 6.3 x 12.7 mm to 6.5 x 18 mm.

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.

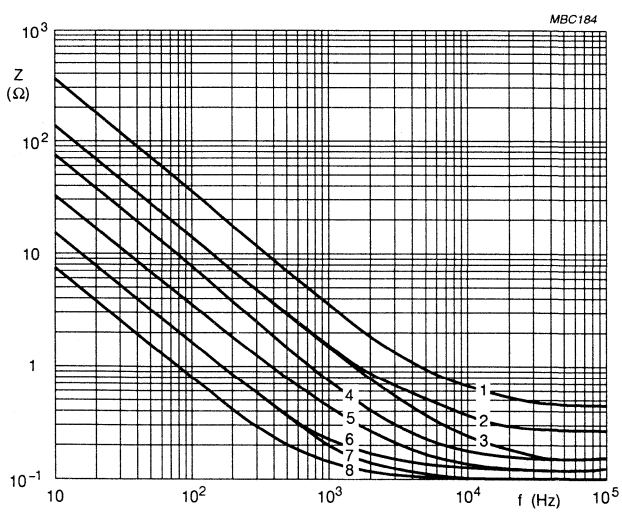


Fig.15 Typical impedance as a function of frequency at 20 °C; case sizes 8 x 18 mm to 10 x 25 mm.

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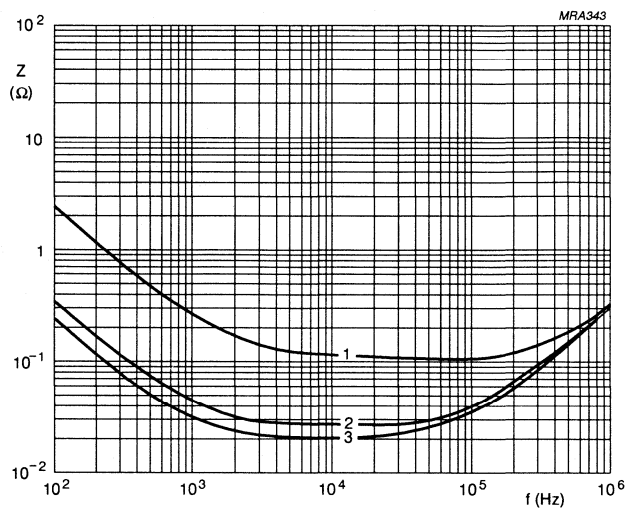
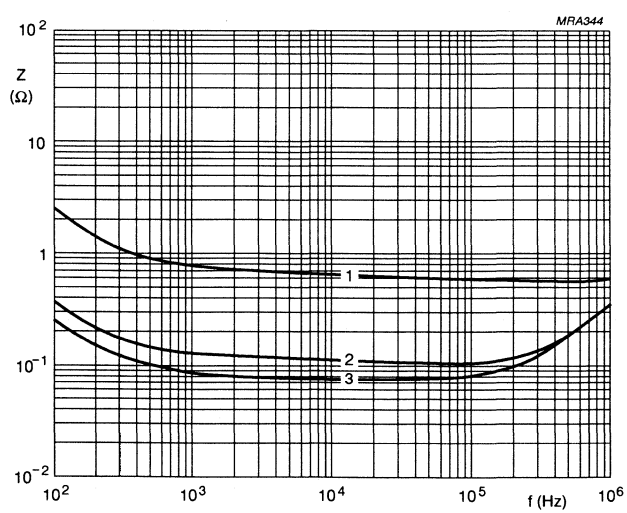


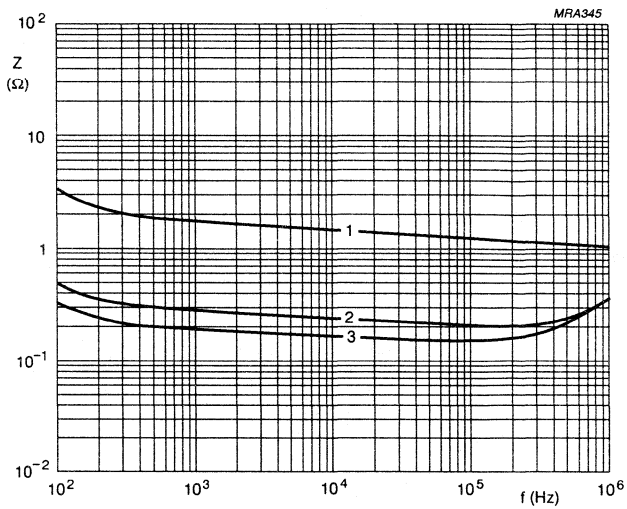
Curve 1: 680 µF, 25 V
Curve 2: 4700 µF, 25 V
Curve 3: 6800 µF, 25 V.

Fig.16 Typical impedance as a function of frequency at 20 °C; case sizes 10 x 30 mm to 21 x 40 mm.



Curve 1: 680 µF, 25 V
Curve 2: 4700 µF, 25 V
Curve 3: 6800 µF, 25 V.

Fig.17 Typical impedance as a function of frequency at –25 °C; case sizes 10 x 30 mm to 21 x 40 mm.



Curve 1: 680 µF, 25 V
Curve 2: 4700 µF, 25 V
Curve 3: 6800 µF, 25 V.

Fig.18 Typical impedance as a function of frequency at –40 °C; case sizes 10 x 30 mm to 21 x 40 mm.

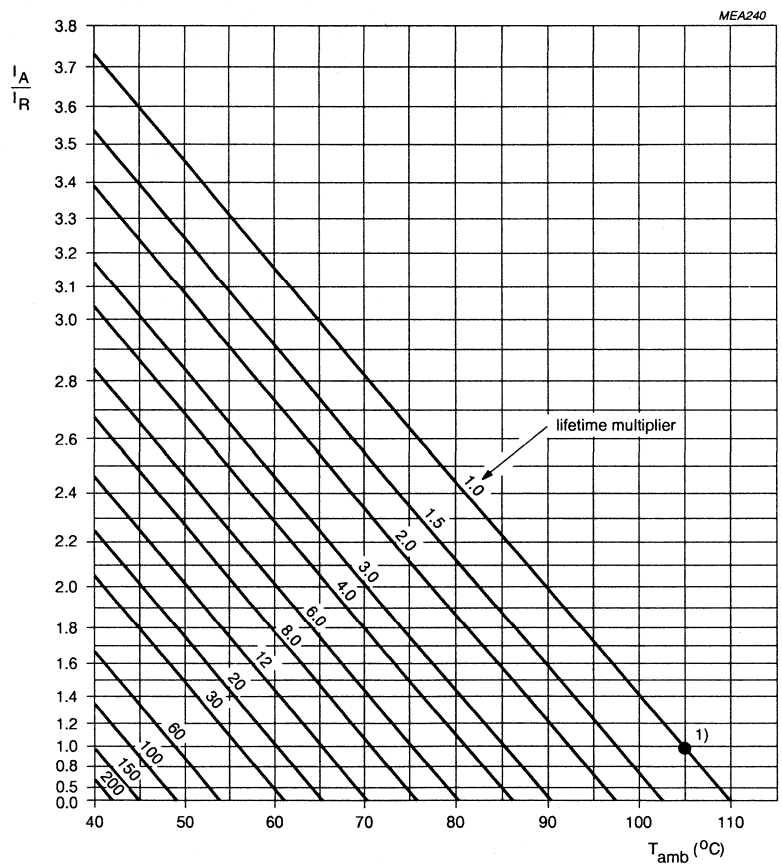
MARKING

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).

A

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 mm to 10 x 25 mm: 2000 hours
case sizes 10 x 30 mm to 21 x 40 mm: 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 V to 10 V	U_R = 16 V to 25 V	U_R = 40 V 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	$U_R \leq$ 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 $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; case sizes: 6.3 x 12.7 to 10 x 25: 2000 hours 10 x 30 to 21 x 40: 5000 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 $I_{L5} \leq$ 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

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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 mm to 21 x 40 mm with pressure relief
- Taped versions up to 15 x 30 mm available for automatic insertion
- Charge and discharge proof
- Long useful life: 10 000 to 15 000 hours at 85 °C, high reliability
- High ripple current capability.

APPLICATIONS

- General industrial, telecommunication, EDP, power supplies
- Coupling, decoupling, timing; smoothing, filtering and buffering in SMPS
- Boards with restricted mounting height, vibration and shock resistant.

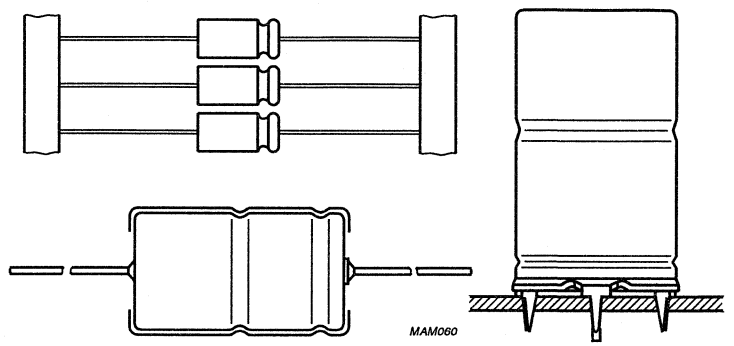

Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (∅ D_{nom} x L_{nom} in mm)	6.5 x 18 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		
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade		
Detail specification	DIN 45910-T 123, former DIN 41257, UTE C031/C033 (without approval)		
Climatic category IEC 68 DIN 40040	40/085/56 GPF		
Approvals	CECC 30 301-056		CECC 30 301-801

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (Ø **D x L** in **mm**). Preferred types in **bold**.

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								

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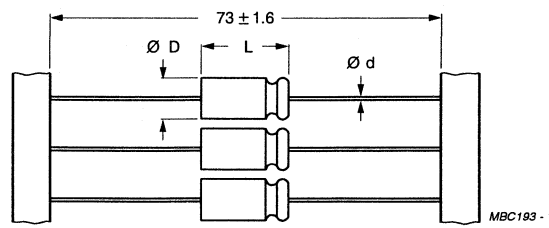
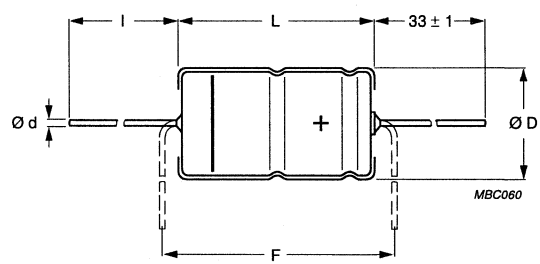
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

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



Form BR: Taped on reel, case sizes 6.5 x 18 mm to 15 x 30 mm.
Form BA: Taped in box (ammopack), case sizes 6.5 x 18 mm to 10 x 25 mm.

Fig.2 Case sizes 6.5 x 18 mm to 15 x 30 mm.



Form AA: Axial in box.
For case sizes 18 x 40 and 21 x 40 mm, the stated L may be exceeded by 0.7 mm.

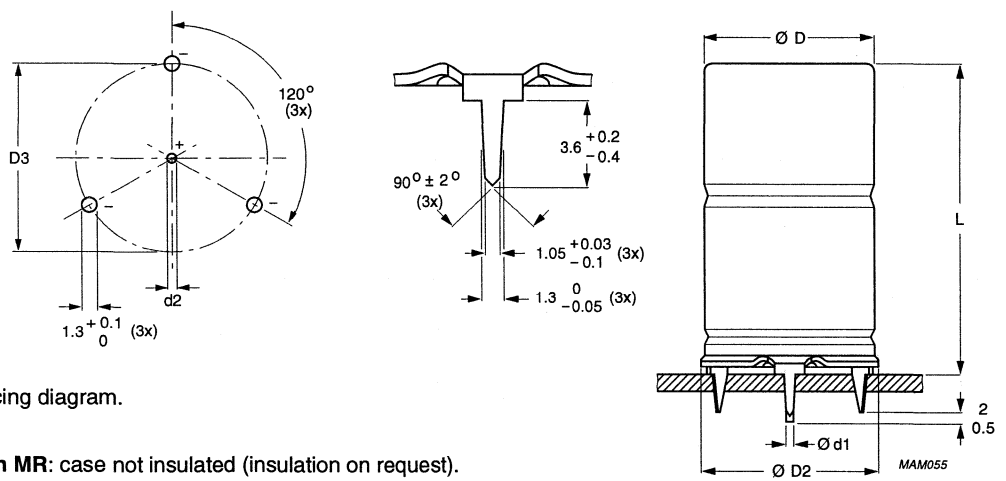
Fig.3 Case sizes 10 x 30 mm to 21 x 40 mm.

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 mm to 21 x 40 mm, 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 –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 ∅ 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	0.61	0.26	0.60
	680	12.5 x 30	460	45	13.6	0.18	0.42	0.20	0.40
	1000	15 x 30	640	64	20	0.18	0.28	0.12	–
	1500	18 x 30	800	94	30	0.22	0.23	0.10	–
	2200	18 x 30	1100	140	44	0.22	0.16	0.09	–
	3300	18 x 40	1300	200	66	0.27	0.13	0.05	–
	4700	21 x 40	1800	290	94	0.27	0.09	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	0.67	0.36	0.60
	470	10 x 25	450	78	19	0.14	0.47	0.26	0.26
	470	12.5 x 30	450	49	15	0.14	0.47	0.26	0.40
	680	15 x 30	550	69	22	0.14	0.33	0.14	–
	1000	15 x 30	780	100	32	0.14	0.22	0.12	–
	1500	18 x 30	950	150	48	0.15	0.16	0.10	–
	2200	18 x 40	1300	220	70	0.15	0.11	0.06	–
	3300	21 x 40	1600	320	110	0.15	0.07	0.05	–
	4700	21 x 40	2300	460	150	0.15	0.05	0.05	–

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

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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	0.8	0.40	0.60
	330	12.5 x 30	410	54	16.5	0.11	0.53	0.30	0.40
	470	12.5 x 30	560	75	24	0.11	0.37	0.20	–
	680	18 x 30	700	106	34	0.11	0.26	0.10	–
	1000	18 x 30	1000	150	50	0.11	0.17	0.10	–
	1500	18 x 40	1100	230	75	0.12	0.13	0.06	–
	2200	21 x 40	1850	330	110	0.13	0.09	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	0.95	0.50	0.60
	220	12.5 x 30	410	57	17.5	0.09	0.65	0.34	0.40
	330	15 x 30	550	83	26	0.09	0.43	0.20	–
	470	15 x 30	700	120	38	0.09	0.30	0.16	–
	680	18 x 30	900	170	54	0.09	0.21	0.10	–
	1000	18 x 40	1200	240	80	0.09	0.14	0.08	–
	1500	21 x 40	1500	360	120	0.10	0.10	0.06	–
	2200	21 x 40	1900	530	180	0.10	0.07	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	1.6	0.80	0.60
	100	10 x 30	300	42	12.6	0.07	1.1	0.60	0.40
	150	15 x 30	350	61	19	0.07	0.74	0.37	–
	220	15 x 30	520	87	28	0.07	0.50	0.25	–
	330	18 x 30	600	130	42	0.07	0.34	0.15	–
	470	18 x 40	970	180	59	0.07	0.24	0.12	–
	680	21 x 40	1000	260	86	0.07	0.16	0.08	–
	1000	21 x 40	1600	380	130	0.07	0.11	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	2.0	1	0.90
	68	12.5 x 30	250	45	13.5	0.06	1.4	0.80	–
	100	15 x 30	380	64	20	0.06	0.95	0.50	–
	150	18 x 30	400	94	30	0.06	0.64	0.35	–
	220	18 x 40	660	140	44	0.06	0.43	0.20	–
	330	18 x 40	700	200	66	0.06	0.29	0.15	–
	470	21 x 40	1200	290	94	0.06	0.20	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 29479	–	–
	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	042 11229	042 21229	–	–
	47	15 x 30	02	042 11479	042 21479	–	042 41479
	100	18 x 30	03	042 11101	–	–	042 41101
	220	21 x 40	05	043 11221	–	–	043 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	042 13229	042 23229	–	–
	47	18 x 30	03	042 13479	–	–	042 43479
	100	21 x 40	05	043 13101	–	–	043 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	042 15109	042 25109	–	–
	22	15 x 30	02	042 15229	042 25229	–	042 45229
	47	18 x 40	04	043 15479	–	–	043 45479
385	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

A

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)
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

Voltage

Surge voltage for short periods
10 V to 250 V types: $U_s \leq 1.15 \times U_R$
350 V 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 mm to 10 x 25 mm:
10 V to 100 V types: $I_{L1} \leq 0.01\ C_R \times U_R + 3$ µA
160 V to 400 V types: $I_{L1} \leq 50$ µA
case sizes 10 x 30 mm to 21 x 40 mm:
10 V to 385 V types: $I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA
400 V types: $I_{L1} \leq 0.009\ C_R \times U_R + 200$ µA

After 5 minutes at U_R
case sizes 6.5 x 18 mm to 10 x 25 mm:
10 V to 100 V types: $I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA
160 V to 400 V types: $I_{L5} \leq 20$ µA
case sizes 10 x 30 mm to 21 x 40 mm:
10 V to 385 V types: $I_{L5} \leq 0.002\ C_R \times U_R$ µA
400 V types: $I_{L5} \leq 0.002\ C_R \times U_R + 100$ µA

Equivalent series inductance (ESL)

Table 6 Equivalent series inductance, typical values

CASE SIZE (Ø x L) (mm)	AXIAL (nH)	SINGLE ENDED (nH)		CASE SIZE (Ø 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

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	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

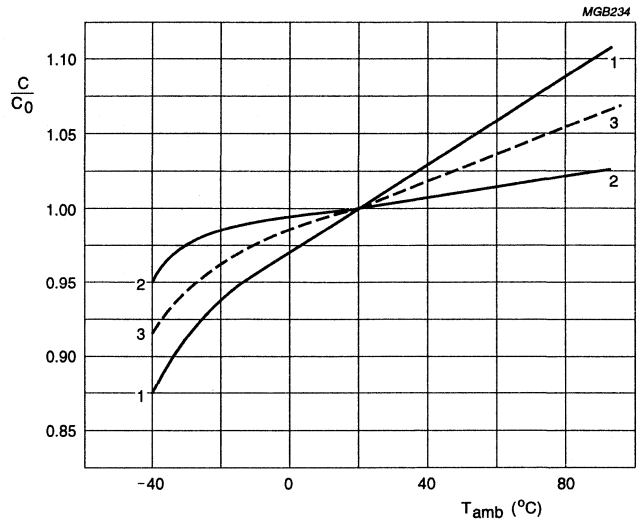
MARKING

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.

A

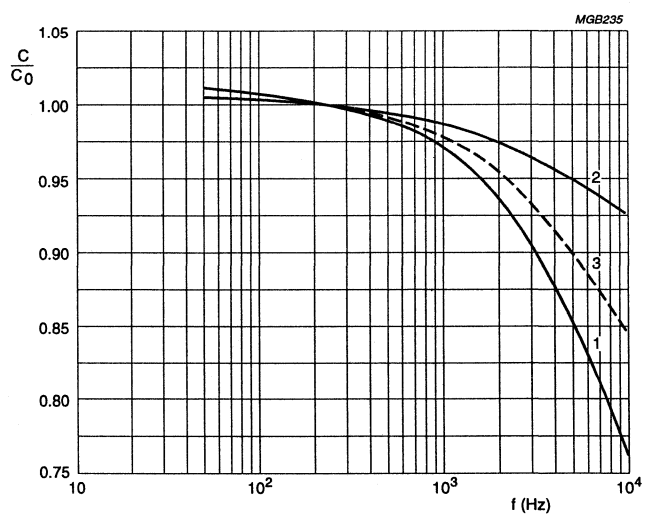
Capacitance (C)



Curve 1: 10 V
Curve 2: 63 V
Curve 3: ≥100 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature.

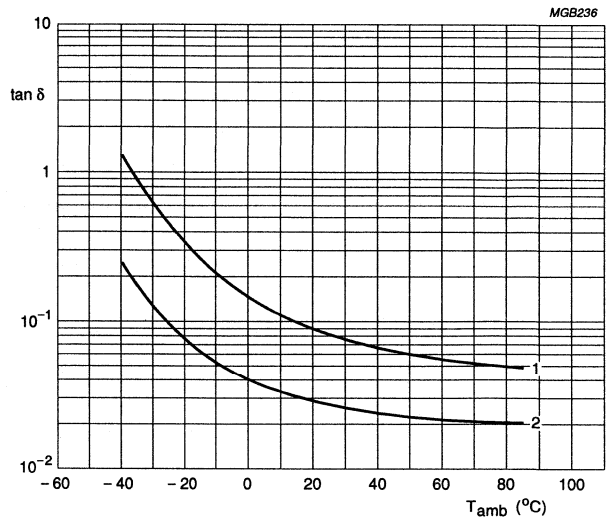


Curve 1: 10 V
Curve 2: 63 V
Curve 3: ≥100 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Multiplier of capacitance (C/C_0) as a function of frequency.

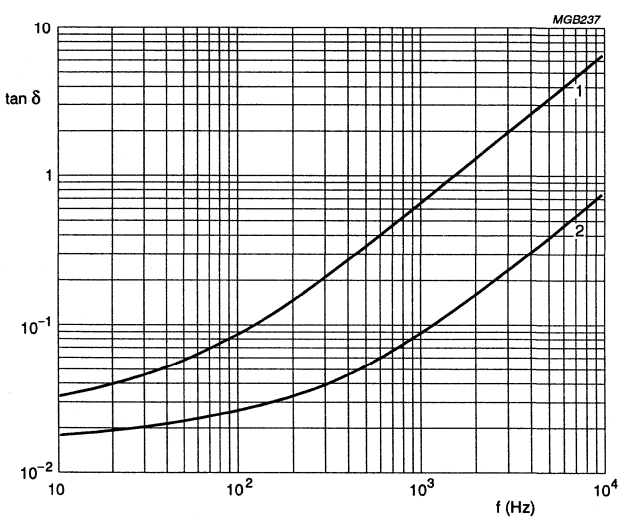
Dissipation factor (tan δ)



Curve 1: 16 V
Curve 2: 100 V.

Frequency = 100 Hz.

Fig.7 Typical tan δ as a function of ambient temperature, case sizes 6.5 x 18 mm to 10 x 25 mm.



Curve 1: 16 V
Curve 2: 100 V.

Ambient temperature = 20 °C.

Fig.8 Typical tan δ as a function of frequency, case sizes 6.5 x 18 mm to 10 x 25 mm.

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.

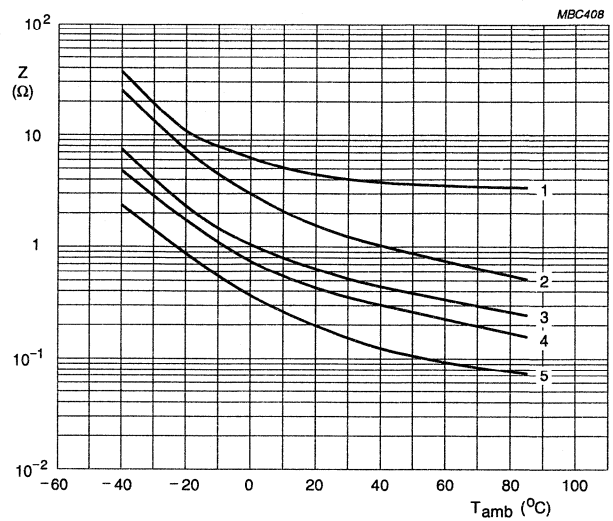


Fig.9 Typical impedance as a function of ambient temperature; case sizes 6.5 x 18 mm to 10 x 25 mm.

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.

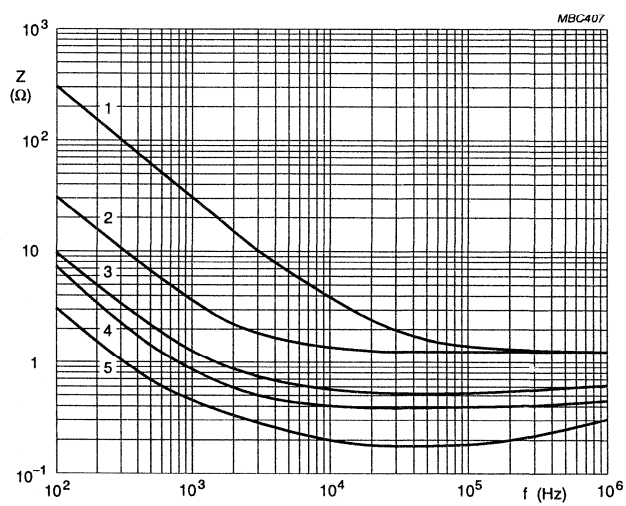
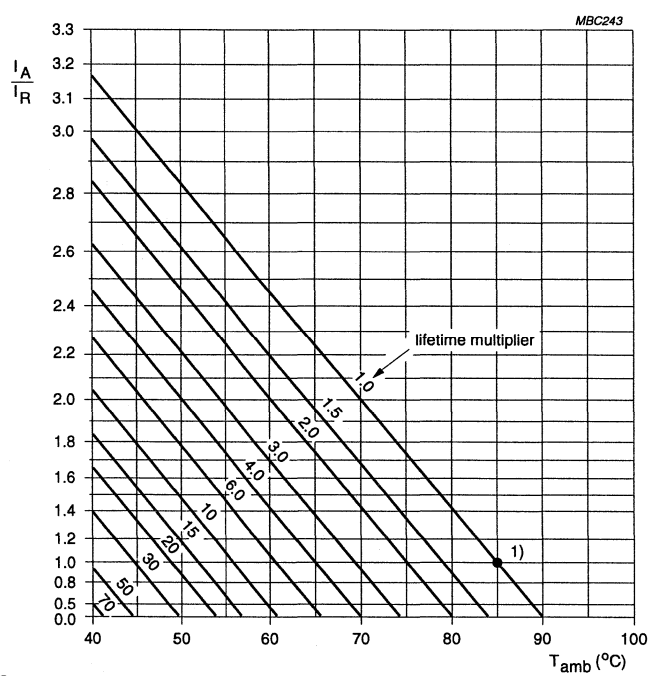


Fig.10 Typical impedance as a function of frequency; case sizes 6.5 x 18 mm to 10 x 25 mm.

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 V to 16 V	U_R = 25 V to 63 V	U_R = 100 V 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 mm: 10 000 hours
case sizes 10 x 18 mm to 21 x 40 mm: 15 000 hours.

Fig.11 Multiplier of useful life as a function of ambient temperature and ripple current load (I_A/I_R).

A

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 mm: 6000 hours 10 x 18 mm to 21 x 40 mm: 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 $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; case sizes: 6.5 x 18 and 8 x 18 mm: 10 000 hours 10 x 18 mm to 21 x 40 mm: 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 $I_{L5} \leq$ 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} = 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

NOTES

Non-solid Al - electrolytic capacitors
Axial High Temperature

AHT 118

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 mm to 21 x 40 mm with pressure relief
- Taped versions up to case size 15 x 30 mm 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.

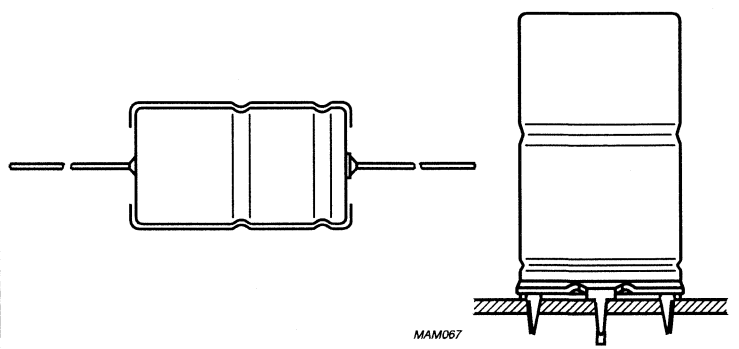


Fig.1 Component outlines.

QUICK REFERENCE DATA

Case sizes (Ø 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, with no I_R applied	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	
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade	
Detail specification	similar to DIN 45910-T123 (without approval), former DIN 41257 - with reduced dimensions	
Climatic category IEC 68 DIN 40040	 40/125/56 GKD	 55/125/56 FKD

Non-solid Al - electrolytic capacitors
Axial High Temperature

AHT 118

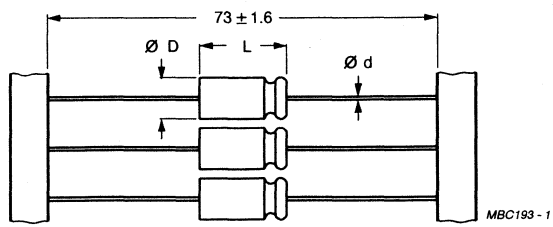
Table 1 Selection chart for $C_R U_R$ and relevant nominal case sizes (∅ **D x L** in **mm**). Preferred types in **bold**.

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 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							

A

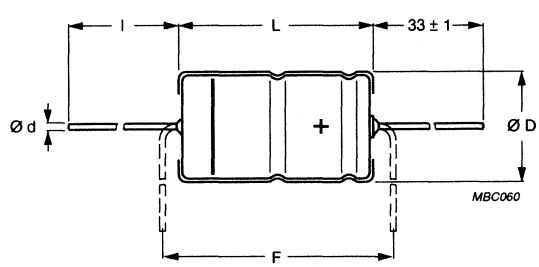
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

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



Form BR: Taped on reel, case sizes 6.5 x 18 mm to 15 x 30 mm.
Form BA: Taped in box (ammopack), case sizes 6.5 x 18 mm to 10 x 25 mm.

Fig.2 Case sizes 6.5 x 18 mm to 15 x 30 mm.

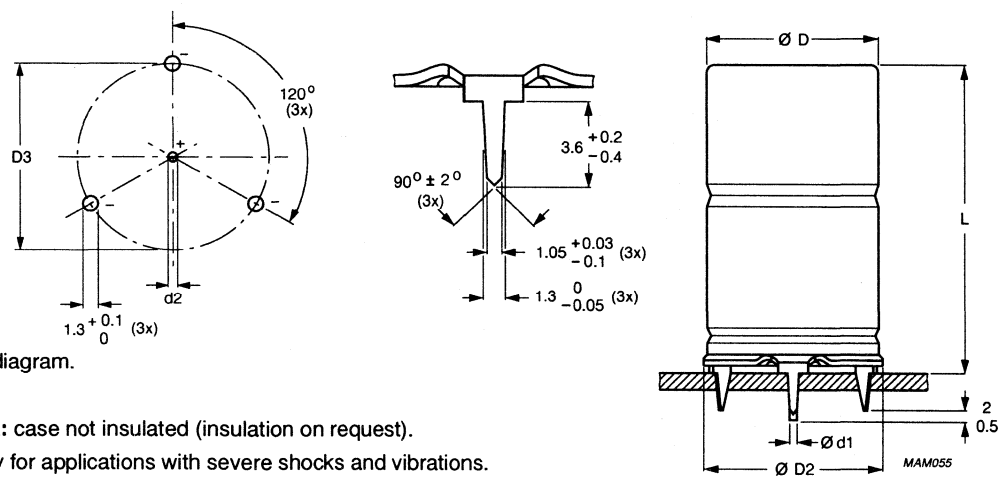


Form AA: Axial in box.
For case sizes 18 x 40 and 21 x 40 mm, the stated limit may be exceeded by 0.7 mm.

Fig.3 Case sizes 10 x 30 mm to 21 x 40 mm.

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.
For dimensions see Table 3.

Fig.4 Case sizes 15 x 30 mm to 21 x 40 mm, 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

Non-solid Al - electrolytic capacitors
Axial High Temperature

AHT 118

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

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

A

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)	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

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
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

A

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)	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

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
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

A

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)	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

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 $T_{amb} \leq 85$ °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	$I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA or 20 µA (whichever is greater)
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA

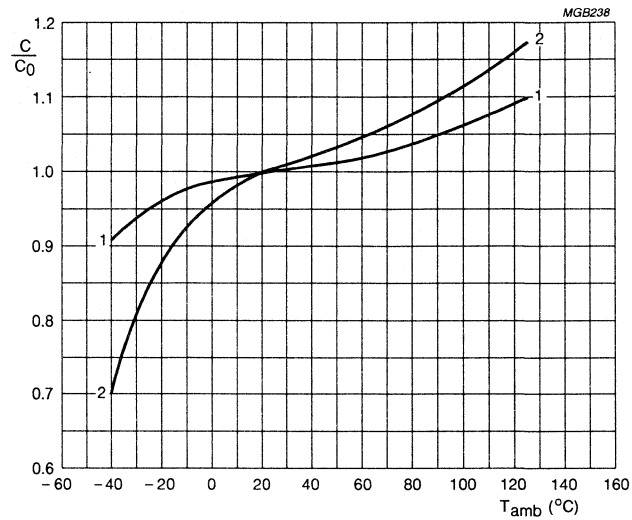
Non-solid Al - electrolytic capacitors
Axial High Temperature

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 90005

A

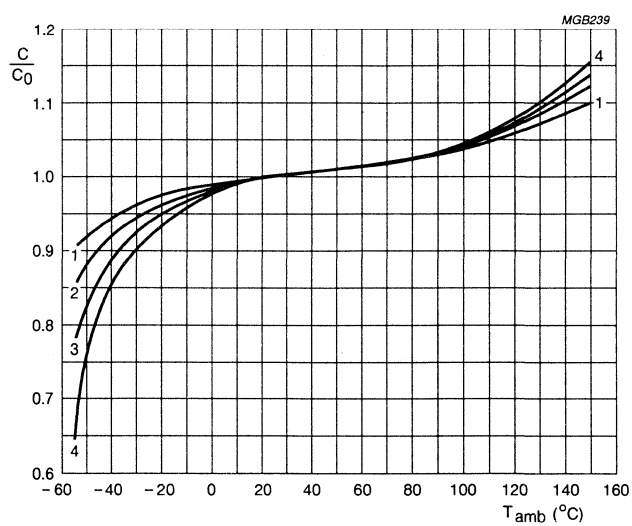
Capacitance (C)



Curve 1: 63 V
Curve 2: 6.3 V.

C_0 = capacitance at 20 °C, 100 Hz.

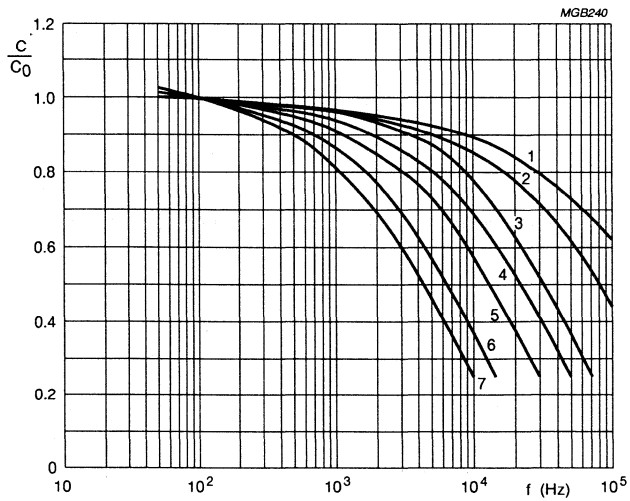
Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 6.5 x 18 mm to 10 x 25 mm.



Curve 1: 100 V; 200 V
Curve 2: 40 V; 63 V
Curve 3: 16 V; 25 V
Curve 4: 6.3 V; 10 V.

C_0 = capacitance at 20 °C, 100 Hz.

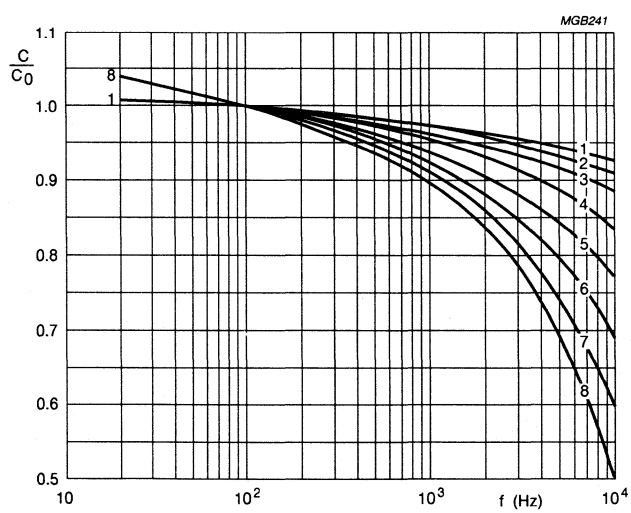
Fig.6 Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes 10 x 30 mm to 21 x 40 mm.



Curve 1: 63 V to 200 V, (<15 µF)
Curve 2: 63 V; 100 V, (≥15 µF)
Curve 3: 40 V
Curve 4: 24 V
Curve 5: 16 V
Curve 6: 10 V
Curve 7: 6.3 V.

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 mm to 10 x 25 mm.



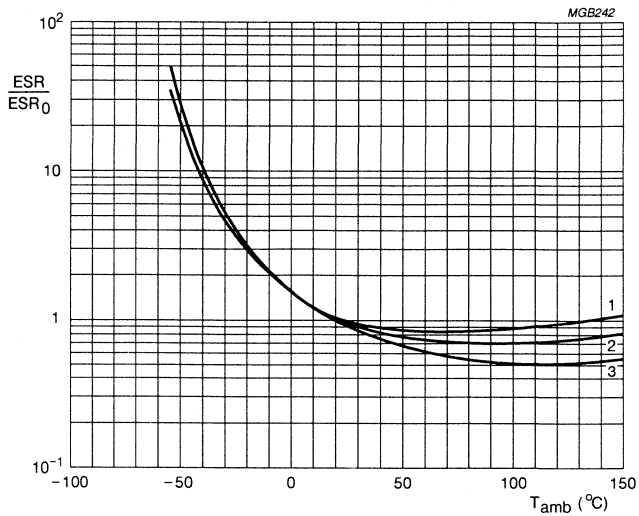
Curve 1: 200 V
Curve 2: 100 V
Curve 3: 63 V
Curve 4: 40 V
Curve 5: 25 V
Curve 6: 16 V
Curve 7: 10 V
Curve 8: 6.3 V.

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 mm to 21 x 40 mm.

A

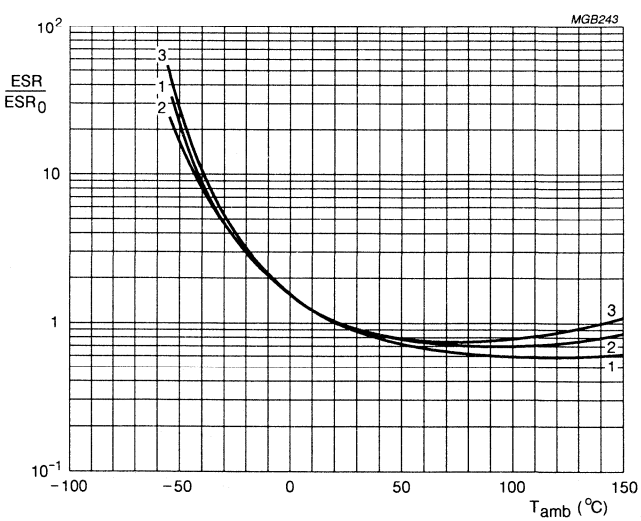
Equivalent series resistance (ESR)



Curve 1: 100 V; 200 V
Curve 2: 25 V; 40 V; 63 V
Curve 3: 6.3 V; 10 V; 16 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

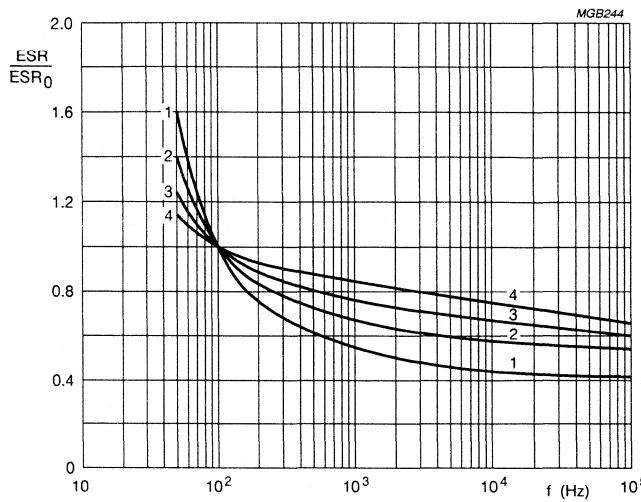
Fig.9 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 6.5 x 1 mm to 15 x 30 mm.



Curve 1: 6.3 V; 10 V; 16 V
Curve 2: 25 V; 40 V; 63 V
Curve 3: 100 V; 200 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

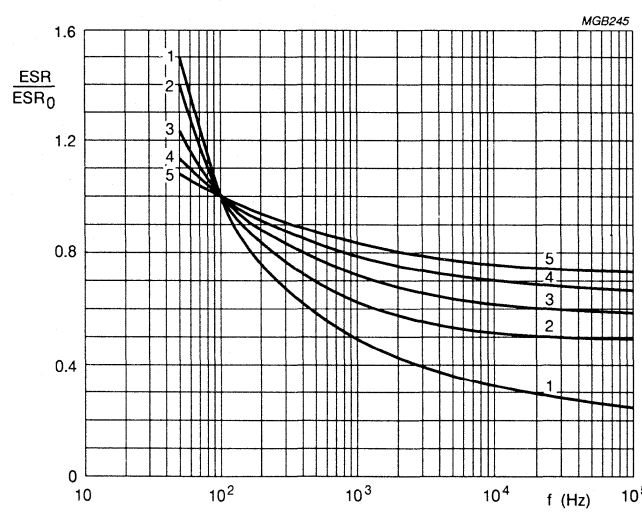
Fig.10 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 18 x 30 mm to 21 x 40 mm.



Curve 1: 63 V; 100 V, (≥15 µF)
Curve 2: 40 V
Curve 3: 25 V
Curve 4: 6.3 V; 10 V; 16 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 6.5 x 18 mm to 10 x 25 mm.



Curve 1: 200 V
Curve 2: 100 V
Curve 3: 40 V; 63 V
Curve 4: 16 V; 25 V
Curve 5: 6.3 V; 10 V.

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 mm to 21 x 40 mm.

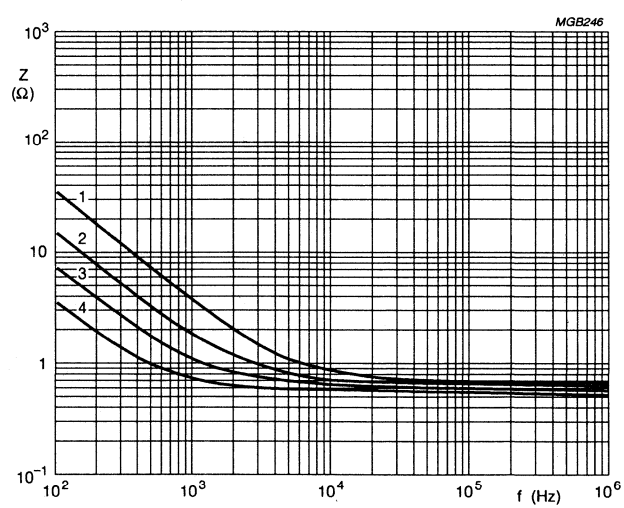
A

Equivalent series inductance (ESL)

Table 7 Equivalent series inductance, typical values

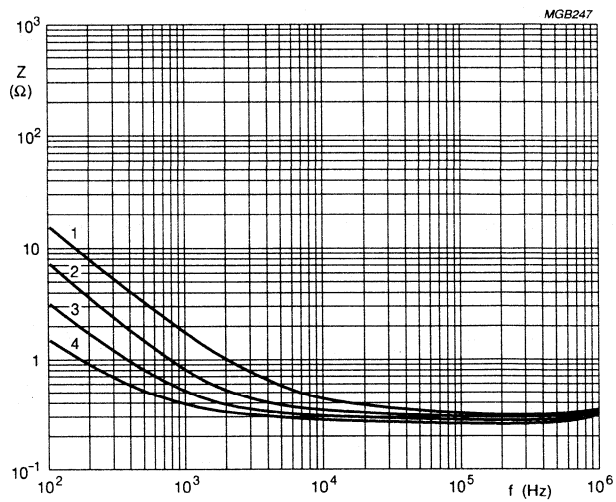
CASE SIZE ∅ x L (mm)	AXIAL (nH)	SINGLE ENDED (nH)
6.5 x 18	15	–
8 x 18	35	–
10 x 18	69	–
10 x 25	38	–
10 x 30	38	–
12.5 x 30	46	–
15 x 30	48	39
18 x 30	50	39
18 x 40	54	39
21 x 40	59	39

Impedance (Z)



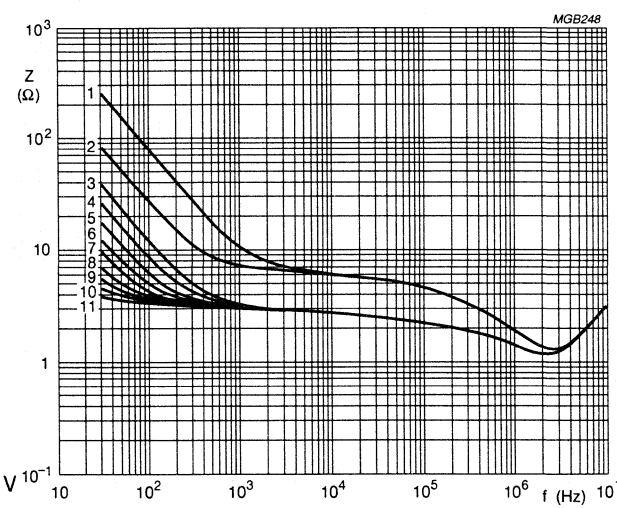
Curve 1: 47 µF
Curve 2: 100 µF
Curve 3: 220 µF
Curve 4: 470 µF.

Fig.13 Typical impedance as a function of frequency at 20 °C; case size 8 x 18 mm.



Curve 1: 100 µF
Curve 2: 220 µF
Curve 3: 470 µF
Curve 4: 1000 µF.

Fig.14 Typical impedance as a function of frequency at 20 °C; case size 10 x 25 mm.



Curve 1: 22 µF, 200 V
Curve 2: 68 µF, 100 V
Curve 3: 150 µF, 63 V
Curve 4: 220 µF, 63 V
Curve 5: 330 µF, 40 V
Curve 6: 470 µF, 40 V
Curve 7: 680 µF, 25 V
Curve 8: 1000 µF, 25 V and 1000 µF, 16 V
Curve 9: 1500 µF, 16 V and 1500 µF, 10 V
Curve 10: 2200 µF, 10 V and 2200 µF, 6.3 V
Curve 11: 3300 µF, 6.3 V.

Fig.15 Typical impedance as a function of frequency at –40 °C; case size 12.5 x 30 mm.

A

Curve 1: 22 µF, 200 V
Curve 2: 68 µF, 100 V
Curve 3: 150 µF, 63 V
Curve 4: 220 µF, 63 V
Curve 5: 330 µF, 40 V
Curve 6: 470 µF, 40 V
Curve 7: 680 µF, 25 V
Curve 8: 1000 µF, 25 V and 1000 µF, 16 V
Curve 9: 1500 µF, 16 V and 1500 µF, 10 V
Curve 10: 2200 µF, 10 V and 2200 µF, 6.3 V
Curve 11: 3300 µF, 6.3 V.

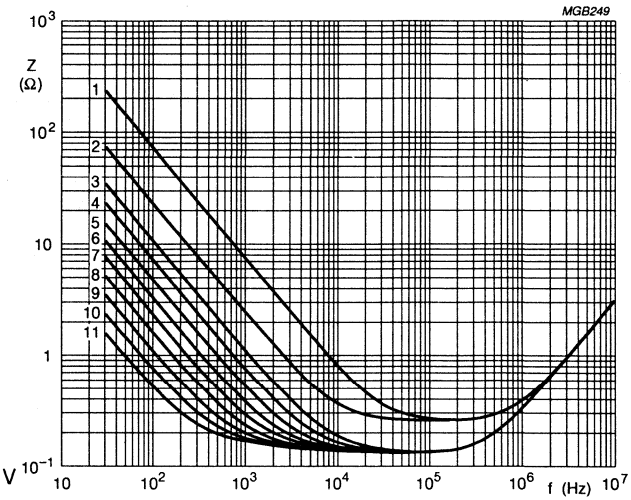


Fig.16 Typical impedance as a function of frequency at 20 °C; case size 12.5 x 30 mm.

Curve 1: 47 µF, 200 V
Curve 2: 220 µF, 100 V
Curve 3: 470 µF, 63 V
Curve 4: 1000 µF, 40 V
Curve 5: 2200 µF, 25 V
Curve 6: 3300 µF, 18 V
Curve 7: 4700 µF, 10 V
Curve 8: 6800 µF, 6.3 V.

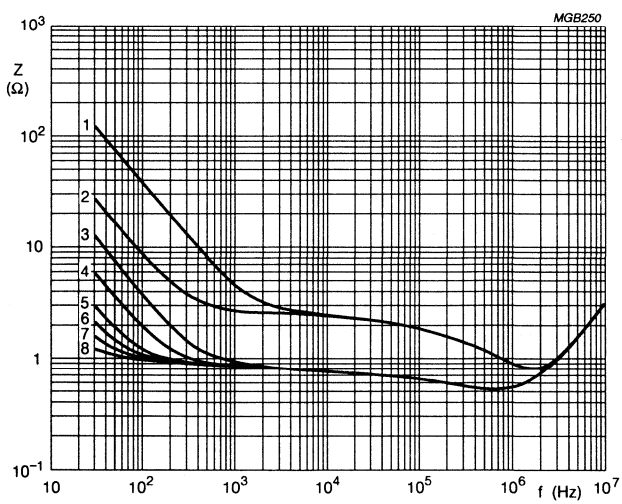


Fig.17 Typical impedance as a function of frequency at −40 °C; case size 18 x 30 mm.

Curve 1: 47 µF, 200 V
Curve 2: 220 µF, 100 V
Curve 3: 470 µF, 63 V
Curve 4: 1000 µF, 40 V
Curve 5: 2200 µF, 25 V
Curve 6: 3300 µF, 18 V
Curve 7: 4700 µF, 10 V
Curve 8: 6800 µF, 6.3 V.

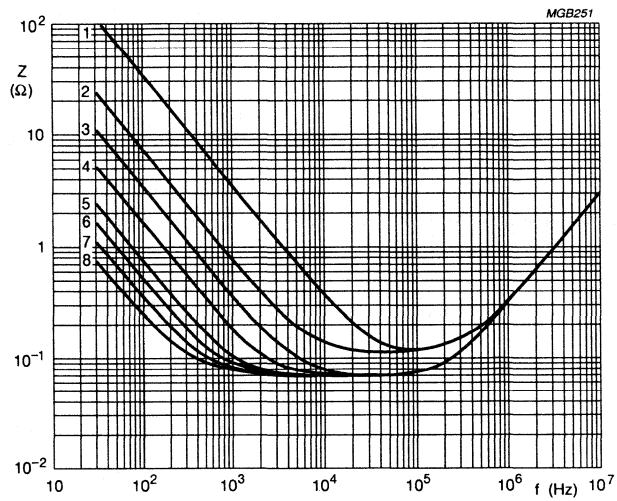


Fig.18 Typical impedance as a function of frequency at 20 °C; case size 18 x 30 mm.

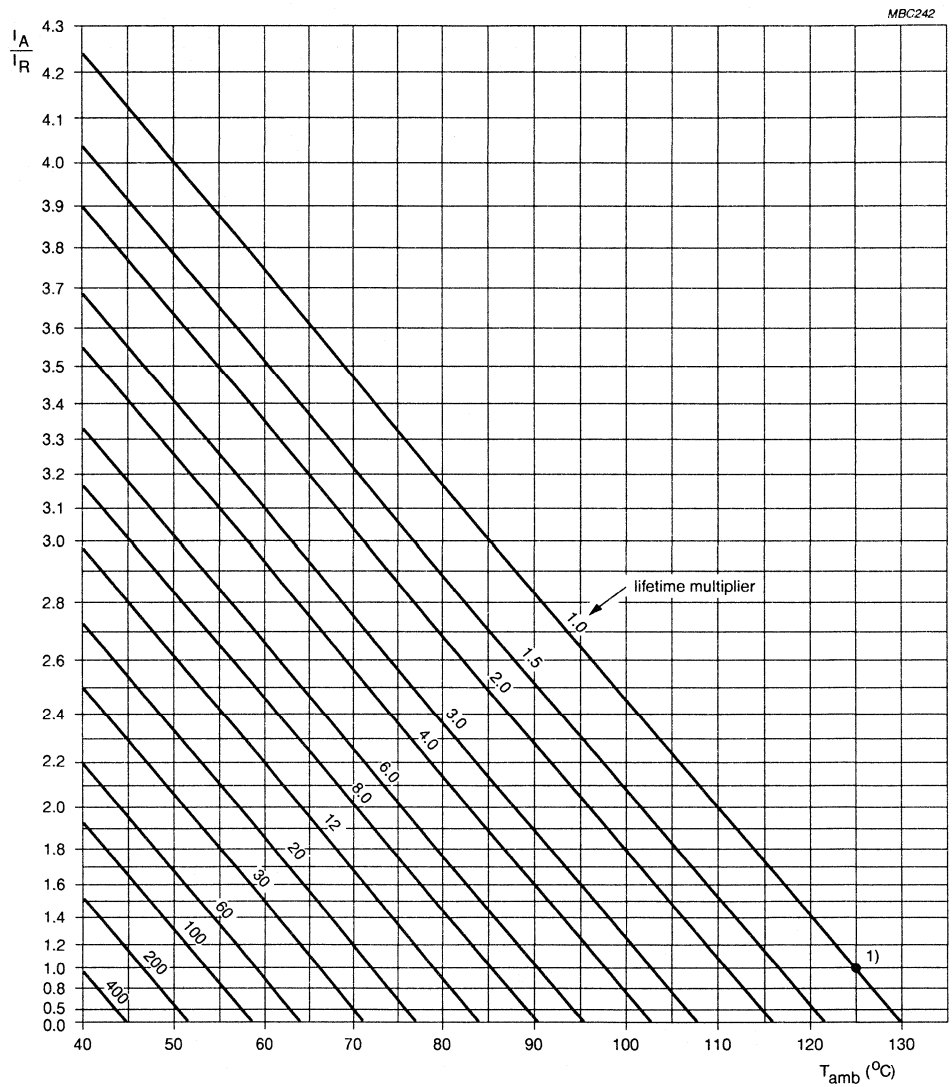
MARKING

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.

A

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 V to 25 V	U_R = 40 V to 63 V	U_R = 100 V 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	$U_R \leq 6.3$ 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} = 125 °C; U_R and I_R applied; 4000 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} = 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	$\Delta C/C$, tan δ, Z: for requirements see Endurance test above $I_{L5} \leq 2$ 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	$\Delta C/C$ ±20% tan $\delta \leq$ spec. limit I_{L5} ≤ spec. limit

A

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 mm to 21 x 40 mm with pressure relief
- Taped versions up to case size 15 x 30 mm 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.

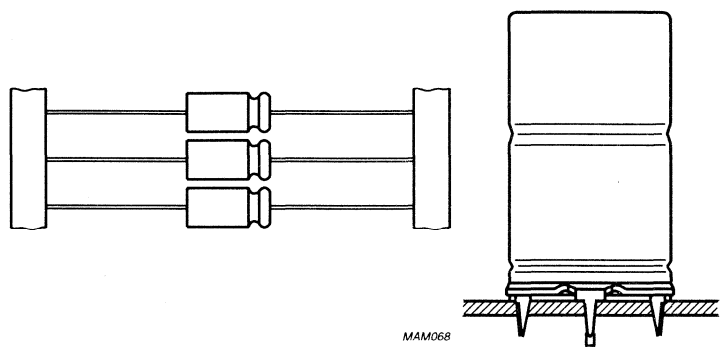


Fig.1 Component outlines.

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, with no I_R applied	500 hours	1000 hours
Endurance test at 125 °C	2000 hours	4000 hours (100 V: 3000 hours)
Useful life at 125 °C	4000 hours	5000 hours (100 V: 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	
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade	
Detail specification	similar to DIN 45910-T123 (without approval), former 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) UTE CO31/CO33

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 types in **bold.**

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					

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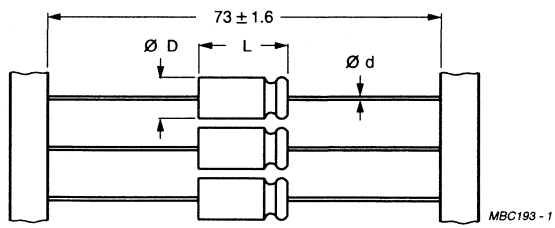
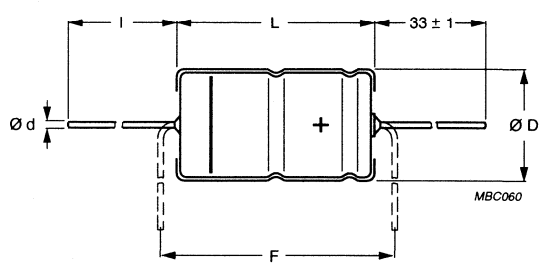
MECHANICAL DATA, PACKING QUANTITIES and AVAILABLE FORMS

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



Form BR: Taped on reel, case sizes 6.5 x 18 mm to 15 x 30 mm.
Form BA: Taped in box (ammopack), case sizes 6.5 x 18 mm to 10 x 25 mm.

Fig.2 Case sizes 6.5 x 18 mm to 15 x 30 mm.



Form AA: Axial in box.
For case sizes 18 x 30 and 21 x 40 mm, the stated L_{max} may be exceeded by 0.7 mm.

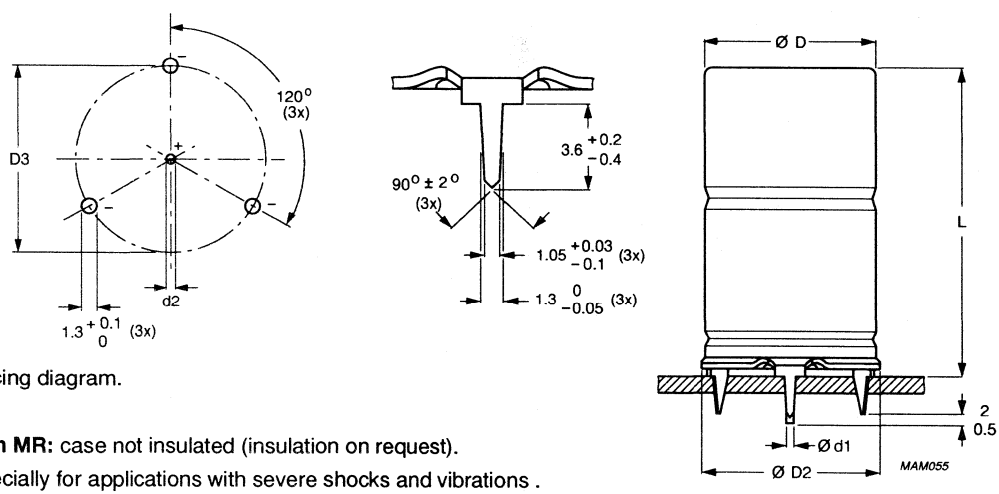
Fig.3 Case sizes 10 x 30 mm to 21 x 40 mm.

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	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 .
For dimensions see Table 3.

Fig.4 Case sizes 15 x 30 mm to 21 x 40 mm, 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

Non-solid Al - electrolytic capacitors
Axial High Temperature, DIN-based

AHT-DIN 119

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

A

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	–

A

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 $T_{amb} \leq 85$ °C	16 V	25 V	40 V	63 V	100 V	125 V	250 V

Leakage current

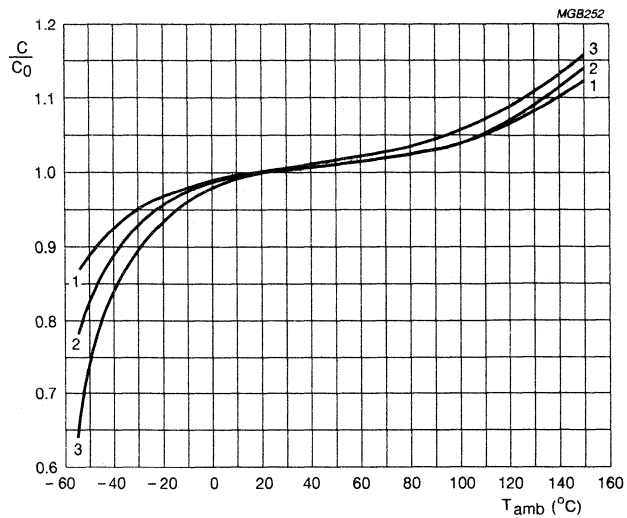
After 1 minute at U_R

10 V to 40 V	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$, or 10 µA (whichever is greater)
63 V 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 V 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)

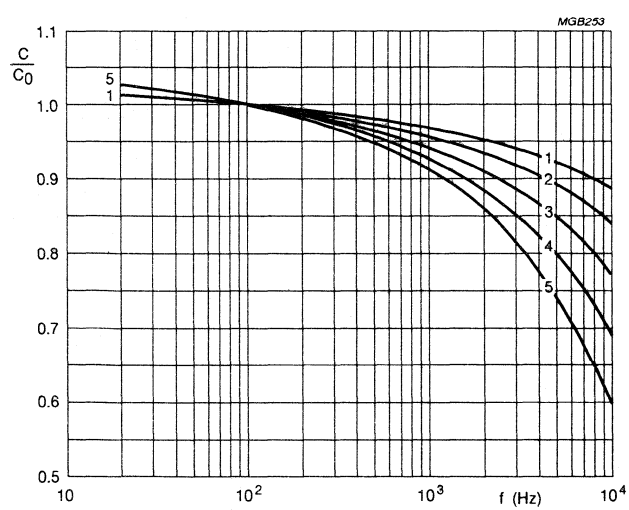
Capacitance (C)



Curve 1: 63 V to 200 V
Curve 2: 25 V; 40 V
Curve 3: 10 V; 16 V.

C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Multiplier of capacitance (C/C_0) as a function of ambient temperature.



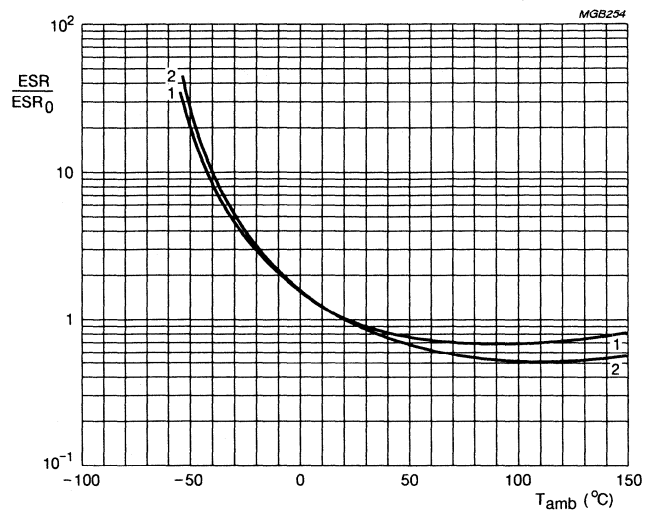
Curve 1: 63 V to 200 V
Curve 2: 40 V
Curve 3: 25 V
Curve 4: 16 V
Curve 5: 10 V.

C_0 = capacitance at 20 °C; 100 Hz.

Fig.6 Multiplier of capacitance (C/C_0) as a function of frequency.

A

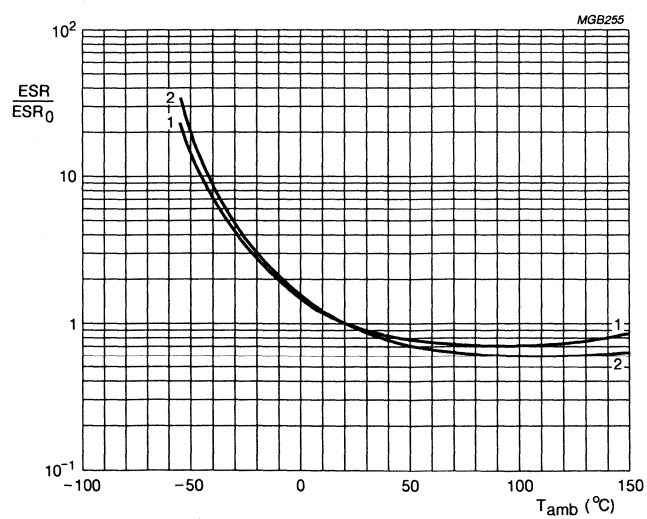
Equivalent series resistance (ESR)



Curve 1: 25 V to 200 V
Curve 2: 10 V; 16 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

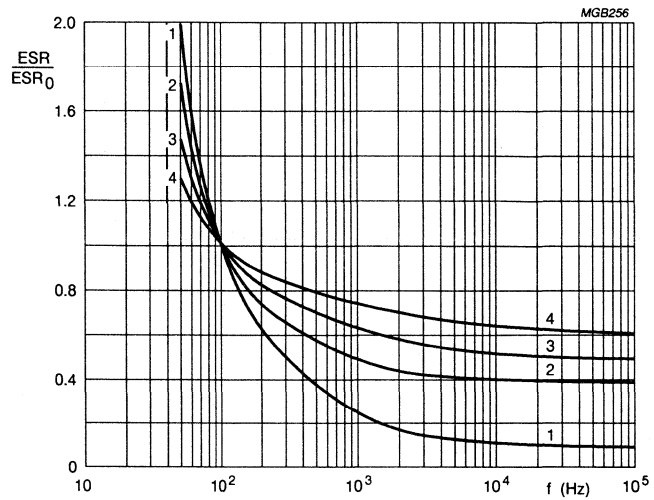
Fig.7 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 6.5 x 18 mm to 15 x 30 mm.



Curve 1: 25 V to 100 V
Curve 2: 10 V; 16 V.

ESR_0 = typical ESR at 20 °C, 100 Hz.

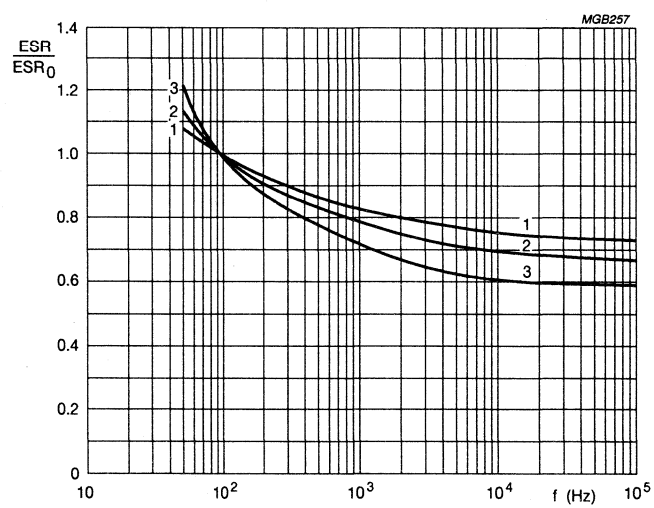
Fig.8 Multiplier of ESR (ESR/ESR_0) as a function of ambient temperature; case sizes 18 x 30 mm to 21 x 40 mm.



Curve 1: 63 V, (<10 µF) and 200 V
Curve 2: 63 V, (≥10 µF) and 100 V
Curve 3: 25 V; 40 V
Curve 4: 10 V; 16 V.

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 mm to 10 x 25 mm.



Curve 1: 10 V
Curve 2: 16 V; 25 V
Curve 3: 40 V to 100 V.

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 mm to 21 x 40 mm.

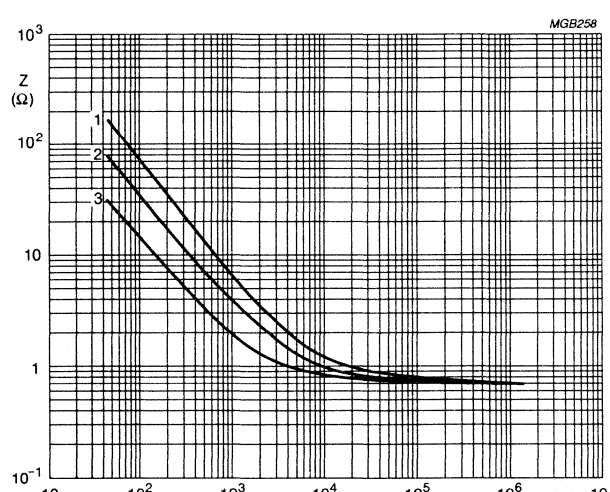
A

Equivalent series inductance (ESL)

Table 7 Equivalent series inductance, typical values

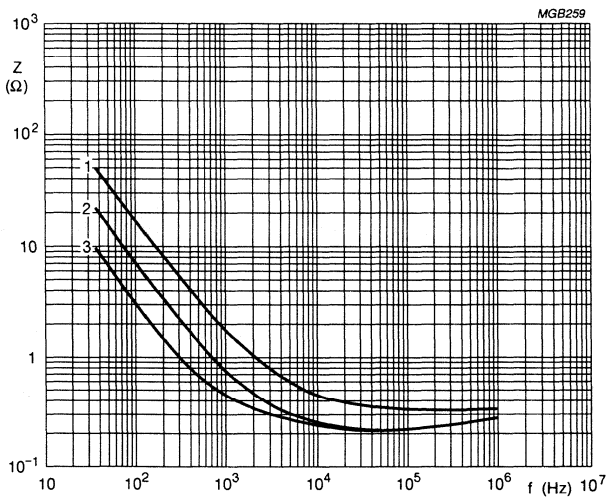
CASE SIZE ∅ x L (mm)	AXIAL (nH)	SINGLE ENDED (nH)
6.5 x 18	15	–
8 x 18	35	–
10 x 18	69	–
10 x 25	38	–
10 x 30	38	–
12.5 x 30	46	–
15 x 30	48	39
18 x 30	50	39
18 x 40	54	39
21 x 40	59	39

Impedance (Z)



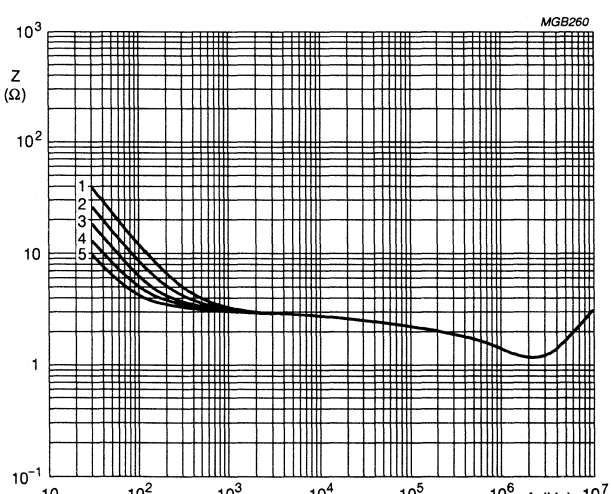
Curve 1: 22 µF
Curve 2: 47 µF
Curve 3: 100 µF.

Fig.11 Typical impedance as a function of frequency at 20 °C; case size 8 x 18 mm.



Curve 1: 100 µF
Curve 2: 220 µF
Curve 3: 470 µF.

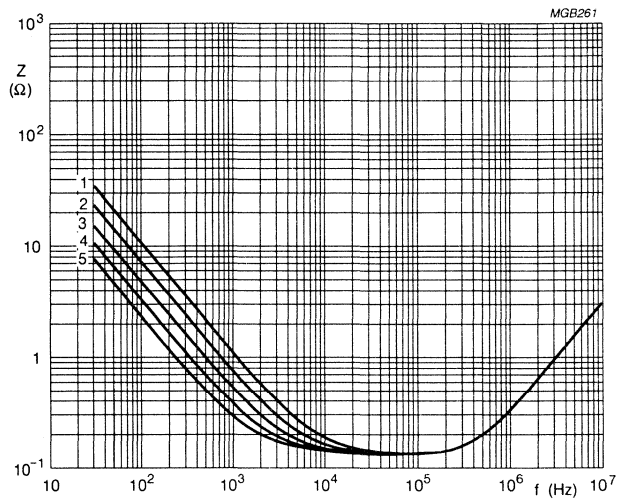
Fig.12 Typical impedance as a function of frequency at 20 °C; case size 10 x 25 mm.



Curve 1: 150 µF, 40 V
Curve 2: 220 µF, 40 V; 25 V
Curve 3: 330 µF, 25 V; 16 V
Curve 4: 470 µF, 25 V; 16 V; 10 V
Curve 5: 680 µF, 10 V.

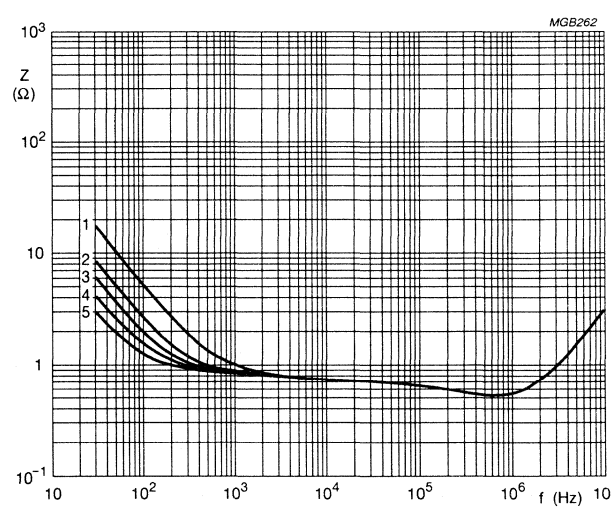
Fig.13 Typical impedance as a function of frequency at –40 °C; case size 12.5 x 30 mm.

A



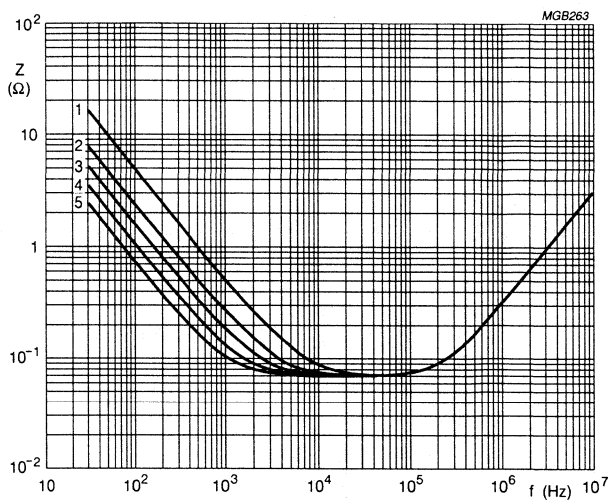
Curve 1: 150 µF, 40 V
Curve 2: 220 µF, 40 V; 25 V
Curve 3: 330 µF, 25 V; 16 V
Curve 4: 470 µF, 25 V; 16 V; 10 V
Curve 5: 680 µF, 10 V.

Fig.14 Typical impedance as a function of frequency at 20 °C; case size 12.5 x 30 mm.



Curve 1: 330 µF, 63 V
Curve 2: 680 µF, 40 V; 25 V
Curve 3: 1000 µF, 25 V
Curve 4: 1500 µF, 16 V; 10 V
Curve 5: 2200 µF, 10 V.

Fig.15 Typical impedance as a function of frequency at −40 °C; case size 18 x 30 mm.



Curve 1: 330 µF, 63 V
Curve 2: 680 µF, 40 V; 25 V
Curve 3: 1000 µF, 25 V
Curve 4: 1500 µF, 16 V; 10 V
Curve 5: 2200 µF, 10 V.

Fig.16 Typical impedance as a function of frequency at 20 °C; case size 18 x 30 mm.

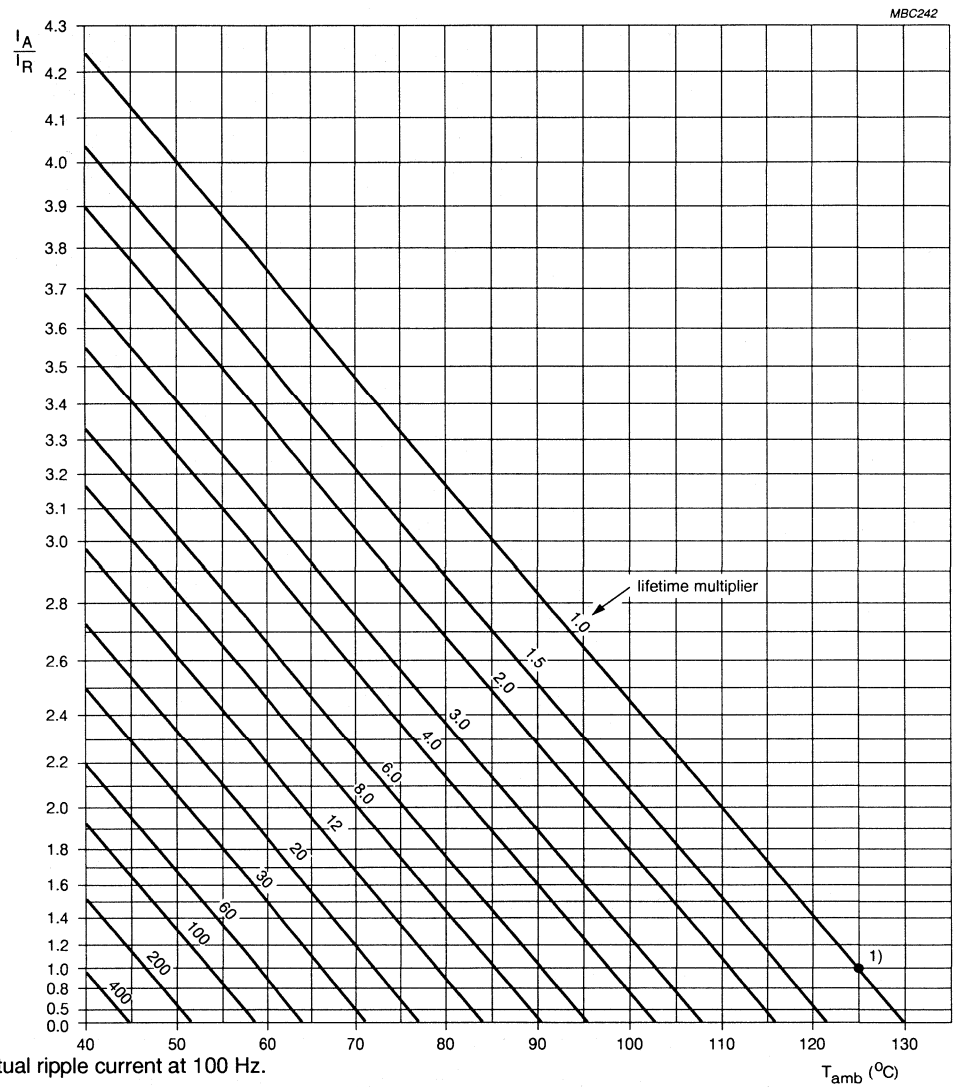
MARKING

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.

A

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:
case sizes 6.5 x 18 to 10 x 25: 4000 hours
case sizes 10 x 30 to 21 x 40: 5000 hours; (100 V: 4000 hours).

Fig.17 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 = 10 and 16 V	U_R = 25 and 40 V	U_R = 63 V 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

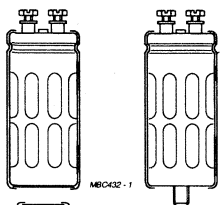
General tests and requirements are specified in chapter "Tests and Requirements".

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: 4000 hours, (100 V: 3000 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; case sizes: 6.5 x 18 to 10 x 25: 4000 hours 10 x 30 to 21 x 40: 5000 hours, (100 V: 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

A

POWER ELECTROLYTIC CAPACITORS



ECONOMY	*EURO-DIN*	*LONG-LIFE*
10 000-12 000 hours 85 °C	15-20 000 hours 85 °C	5-10 000 hours 105 °C
PEC-ST **PEC-STB** **154-155** *page 644*	**PED-ST** **PED-STB** **114-115** *page 624*	
PEC-PW **PEC-SL** **PEC-SLB** **051-053** *page 591*	**PED-PW** **PED-SL** **PED-SLB** **050-052** *page 570*	**PLL-PW** **PLL-SL** **PLL-SLB** **162-163** *page 610*
PSM-SI **056-057** *page 518*		**PLL-SI** **058-059** *page 538*
PSM-4TSI **166-167** *page 557*		**PLL-4TSI** **168-169** *page 564*

MBB746 - 2

P

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
- Pressure relief on the top of the aluminium case
- Charge and discharge proof
- Long useful life: 12 000 hours at 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.

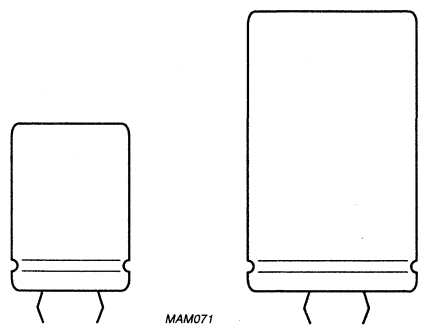


Fig.1 Component outlines.

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 (450 V: 2000 hours)	
Useful life at 85 °C	12 000 hours (450 V: 5000 hours)	
Useful life at U_R, 40 °C and 1.4 x I_R applied	210 000 hours (450 V: 90 000 hours)	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade	
Detail specification	CECC 30 301-806 (in preparation)	
Climatic category IEC 68 DIN 40040	 40/085/56 GPF	

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD 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**							

Preferred types in **bold**.

P

Table 2 Selection chart for C_R, U_R and relevant nominal case sizes (**∅D 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 30**
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 **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 30 x 35
180		22 x 35	25 x 45	25 x 45	
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
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**				

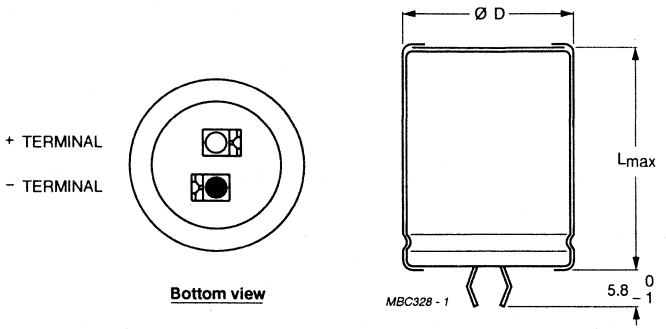
Preferred types in **bold**.

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

PSM-SI 056/057

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.

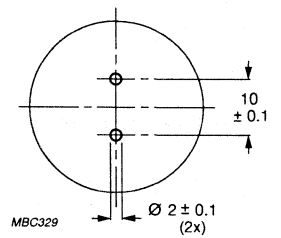


Fig.3 Piercing diagram.

Table 3 Dimensions in mm; mass in g

CASE SIZE $\varnothing D_{nom}$ x L_{nom}	CODE	$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)	OUTER BOX DIMENSIONS L x B x H
22 x 25	2225	23	27	12	100	260 x 250 x 39
22 x 30	2230	23	32	16	100	260 x 250 x 44
22 x 35	2235	23	37	20	100	260 x 250 x 49
22 x 40	2240	23	42	23	100	260 x 250 x 54
25 x 30	2530	26.5	32	22	100	290 x 280 x 44
25 x 35	2535	26.5	37	24	100	290 x 280 x 49
25 x 40	2540	26.5	42	27	100	290 x 280 x 54
25 x 45	2545	26.5	47	32	100	290 x 280 x 59
25 x 50	2550	26.5	52	38	100	290 x 280 x 64
30 x 30	3030	31.5	32	30	100	340 x 330 x 44
30 x 35	3035	31.5	37	35	100	340 x 330 x 49
30 x 40	3040	31.5	42	40	100	340 x 330 x 54
30 x 45	3045	31.5	47	45	100	340 x 330 x 59
30 x 50	3050	31.5	52	50	100	340 x 330 x 64
35 x 30	3530	36.5	32	40	50	390 x 198 x 44
35 x 35	3535	36.5	37	48	50	390 x 198 x 49
35 x 40	3540	36.5	42	55	50	390 x 198 x 54
35 x 45	3545	36.5	47	63	50	390 x 198 x 59
35 x 50	3550	36.5	52	72	50	390 x 198 x 64

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Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-In

PSM-SI 056/057

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. Preferred types in **bold**.

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	548	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**

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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	224	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. Preferred types in **bold.**

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 . . . . .
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**

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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**

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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 . . . . .
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**
450	**47**	**22 x 30**	**2230**	0.26	131	45	5600	4400	**057 67479**
	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
	120	25 x 40	2540	0.55	328	112	2100	1700	057 47121
	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
	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**
	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**

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

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).

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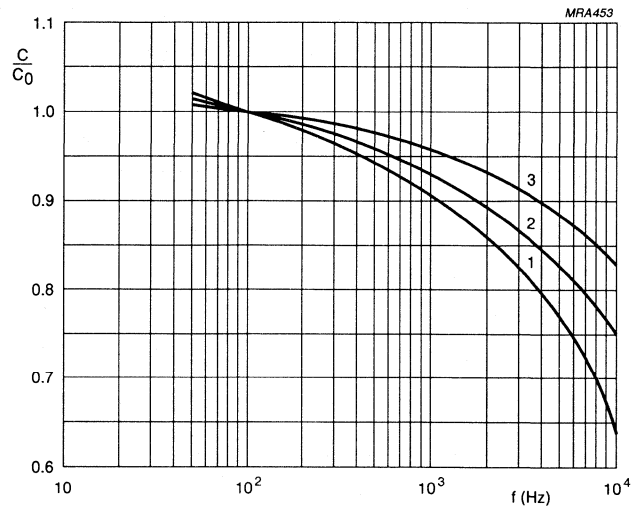
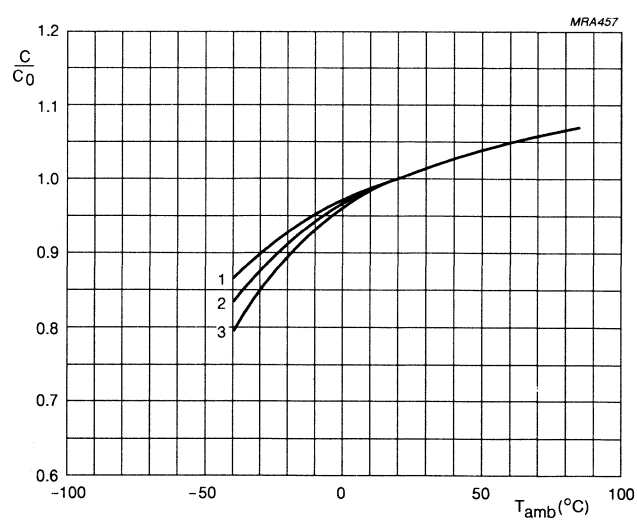
Capacitance (C)



Curve 1: 10 and 16 V
Curve 2: 25 V; 35 V; 40 V
Curve 3: ≥50 V.

C/C_0 = capacitance at 20 °C and 100 Hz.

Fig.4 Multiplier of typical capacitance (C/C_0) as a function of frequency.

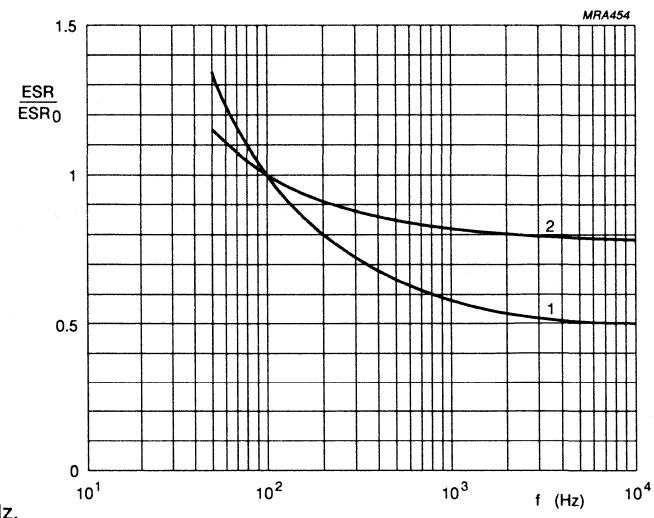


Curve 1: 50 V to 100 V
Curve 2: 200 V
Curve 3: ≥250 and ≤40 V.

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.

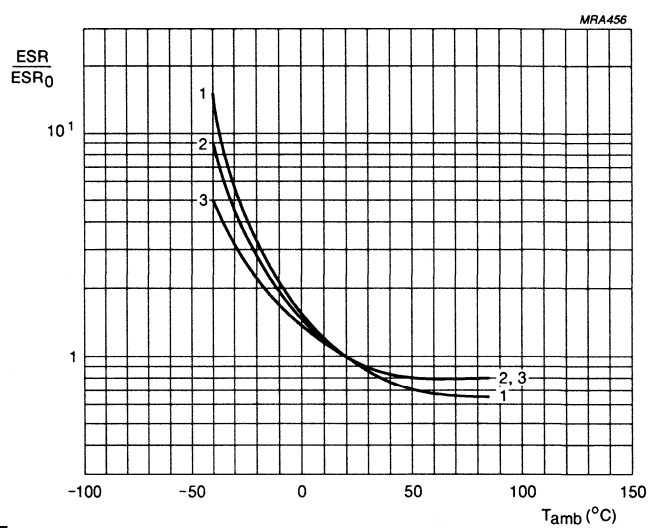
Equivalent series resistance (ESR)



Curve 1: >100 V
Curve 2: ≤100 V.

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

Fig.6 Multiplier of typical ESR (ESR/ESR_0) as a function of frequency.

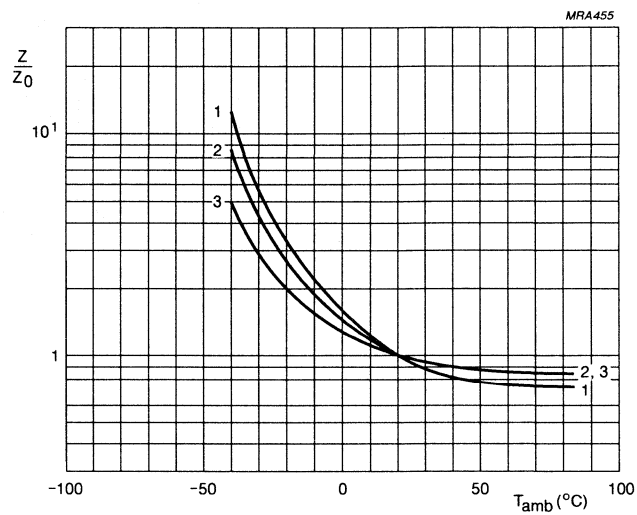


Curve 1: ≥250 V
Curve 2: 200 V
Curve 3: ≤100 V.

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.

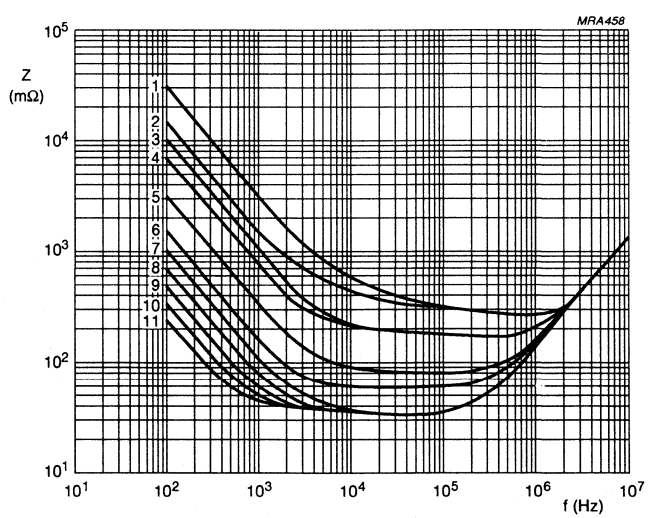
Impedance (Z)



Curve 1: ≥250 V
Curve 2: 200 V
Curve 3: ≤100 V.

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.



Curve 1: 47 µF
Curve 2: 100 µF
Curve 3: 150 µF
Curve 4: 220 µF
Curve 5: 470 µF
Curve 6: 1000 µF
Curve 7: 1500 µF
Curve 8: 2200 µF
Curve 9: 3300 µF
Curve 10: 4700 µF
Curve 11: 6800 µF.

Fig.9 Typical impedance as a function of frequency at +20 °C; case size Ø22 x 25 mm.

Curve 1: 68 µF
Curve 2: 150 µF
Curve 3: 220 µF
Curve 4: 330 µF
Curve 5: 680 µF
Curve 6: 1500 µF
Curve 7: 2200 µF
Curve 8: 3300 µF
Curve 9: 4700 µF
Curve 10: 6800 µF
Curve 11: 10 000 µF.

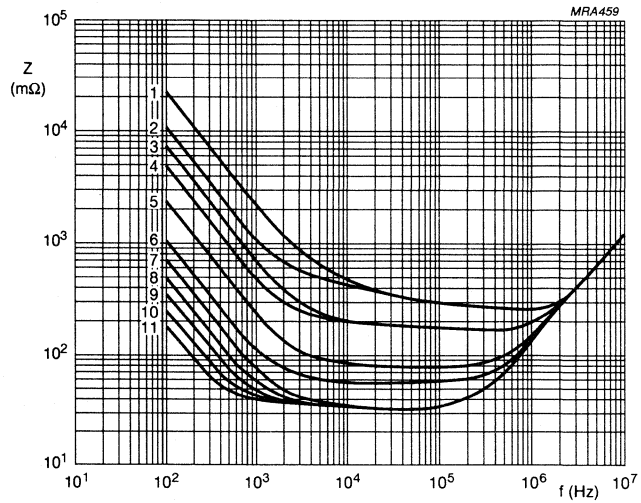


Fig.10 Typical impedance as a function of frequency at +20 °C; case size ∅22 x 30 mm.

Curve 1: 100 µF
Curve 2: 220 µF
Curve 3: 330 µF
Curve 4: 470 µF
Curve 5: 1000 µF
Curve 6: 2200 µF
Curve 7: 3300 µF
Curve 8: 4700 µF
Curve 9: 6800 µF
Curve 10: 10 000 µF
Curve 11: 15 000 µF.

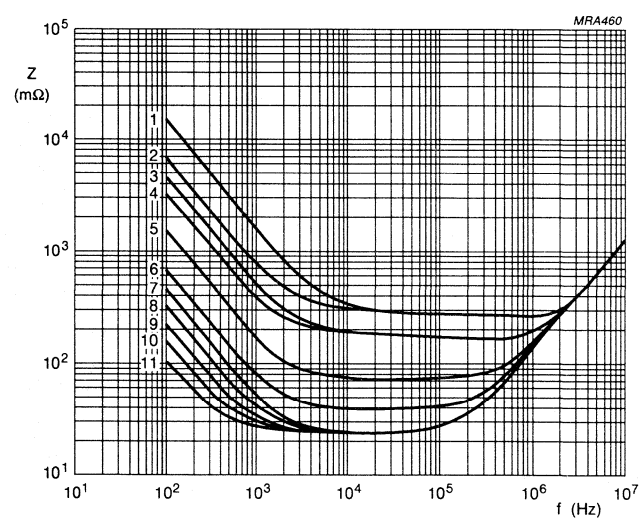


Fig.11 Typical impedance as a function of frequency at +20 °C; case sizes ∅25 x 30 and 22 x 40 mm.

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Curve 1: 150 µF
Curve 2: 330 µF
Curve 3: 470 µF
Curve 4: 680 µF
Curve 5: 1500 µF
Curve 6: 3300 µF
Curve 7: 4700 µF
Curve 8: 6800 µF
Curve 9: 10 000 µF
Curve 10: 15 000 µF
Curve 11: 22 000 µF.

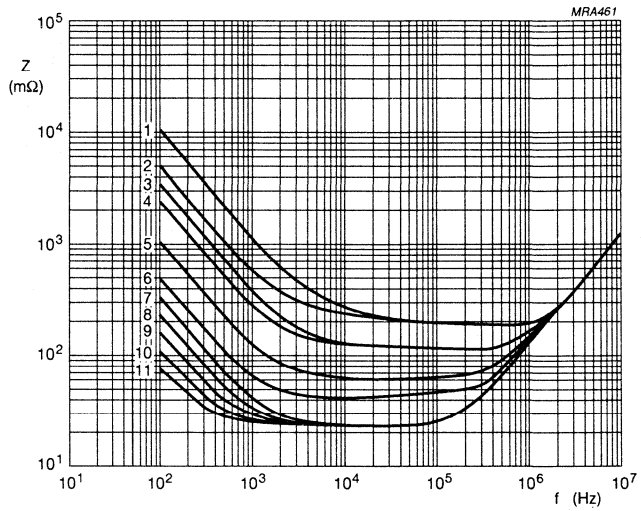

Fig.12 Typical impedance as a function of frequency at +20 °C; case sizes ∅30 x 30 and 25 x 40 mm.

Curve 1: 220 µF
Curve 2: 470 µF
Curve 3: 680 µF
Curve 4: 1000 µF
Curve 5: 2200 µF
Curve 6: 4700 µF
Curve 7: 6800 µF
Curve 8: 10 000 µF
Curve 9: 15 000 µF
Curve 10: 22 000 µF
Curve 11: 33 000 µF.

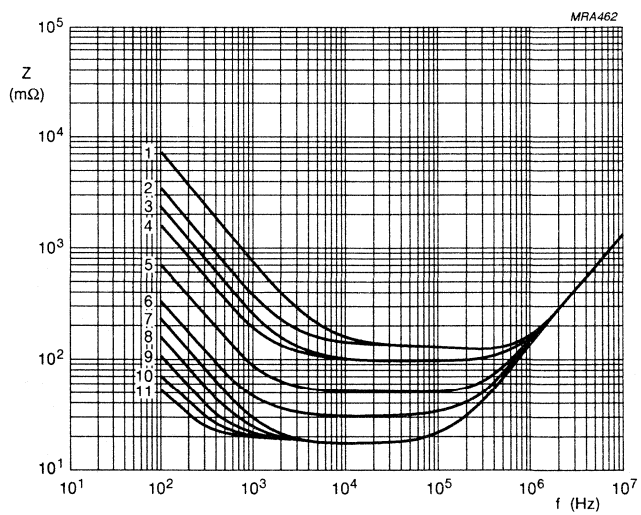

Fig.13 Typical impedance as a function of frequency at +20 °C; case sizes ∅30 x 40 and 25 x 50 mm.

Curve 1: 330 µF
Curve 2: 680 µF
Curve 3: 1000 µF
Curve 4: 1500 µF
Curve 5: 3300 µF
Curve 6: 6800 µF
Curve 7: 10 000 µF
Curve 8: 15 000 µF
Curve 9: 22 000 µF
Curve 10: 33 000 µF
Curve 11: 47 000 µF.

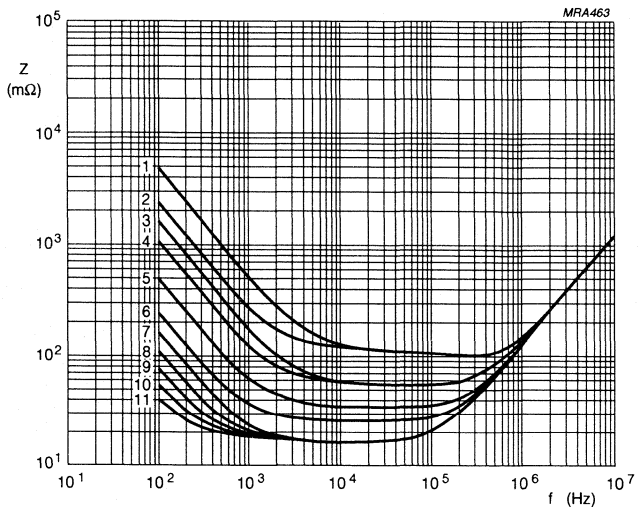

Fig.14 Typical impedance as a function of frequency at +20 °C; case sizes Ø35 x 40 and 30 x 50 mm.

Curve 1: 470 µF
Curve 2: 1000 µF
Curve 3: 1500 µF
Curve 4: 2200 µF
Curve 5: 4700 µF
Curve 6: 10 000 µF
Curve 7: 15 000 µF
Curve 8: 22 000 µF
Curve 9: 33 000 µF
Curve 10: 47 000 µF
Curve 11: 68 000 µF.

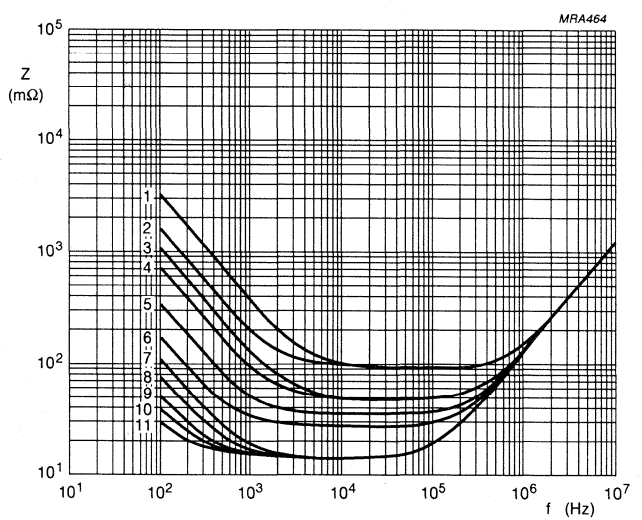

Fig.15 Typical impedance as a function of frequency at +20 °C; case size Ø35 x 50 mm.

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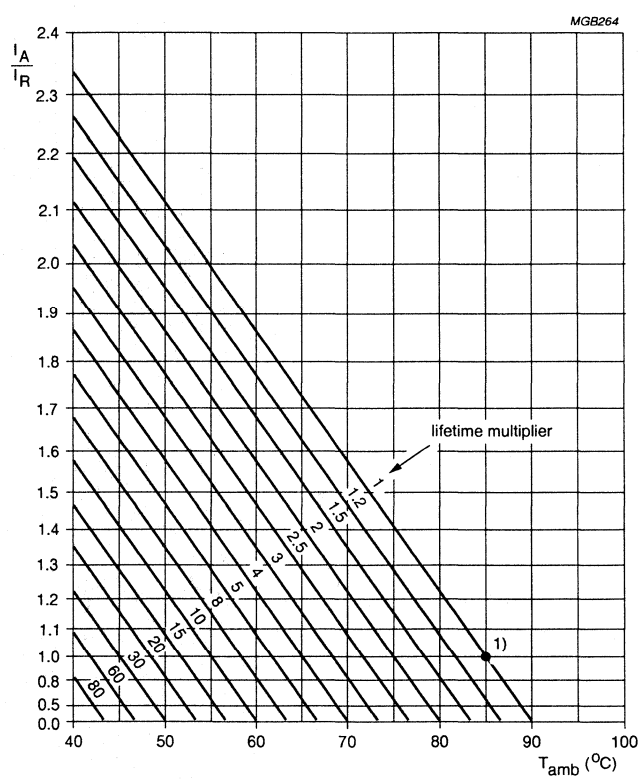
RIPPLE CURRENT and USEFUL LIFE

Table 6 Multiplier of ripple current I_R as a function of frequency.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10 V to 35 V	U_R = 40 V to 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: 12 000 hours; (450 V types: 5000 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 (450 V types: 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; 12 000 hours (450 V types: 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 $I_{L5} \leq$ 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

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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
- Pressure relief in the top of the aluminium case
- Charge and discharge proof
- Very long useful life: up to 10 000 hours at 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.

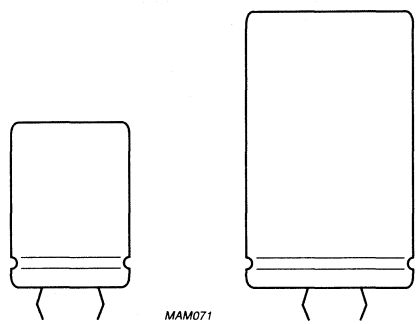

Fig.1 Component outlines.

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	≤50 V: 2000 hours; ≥63 V: 5000 hours	
Useful life at 105 °C	≤50 V: 5000 hours; ≥63 V: 10 000 hours	
Useful life at U_R, 40 °C and 1.9 x I_R applied	≤50 V: 125 000 hours; ≥63 V: 250 000 hours	
Shelf life at 0 V, 105 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade	
Detail specification	CECC 30 301-807 (in preparation)	
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 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**							

Preferred types in **bold**.

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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	
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
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**
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**			

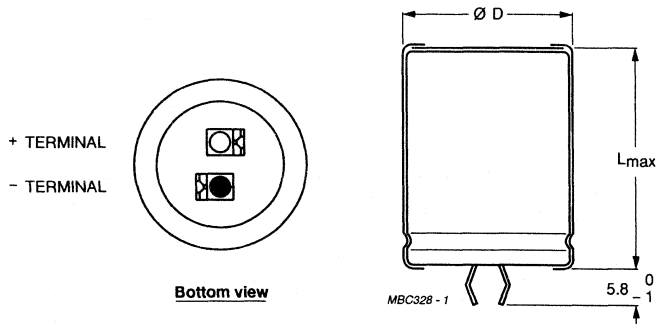
Preferred types in **bold**.

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.

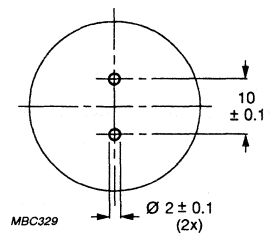


Fig.3 Piercing diagram.

Table 3 Dimensions in mm; mass in g

CASE SIZE $\varnothing D_{nom}$ x L_{nom}	CODE	$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)	OUTER BOX DIMENSIONS L x B x H
22 x 25	2225	23	27	12	100	260 x 250 x 39
22 x 30	2230	23	32	16	100	260 x 250 x 44
22 x 35	2235	23	37	20	100	260 x 250 x 49
22 x 40	2240	23	42	23	100	260 x 250 x 54
25 x 30	2530	26.5	32	22	100	290 x 280 x 44
25 x 35	2535	26.5	37	24	100	290 x 280 x 49
25 x 40	2540	26.5	42	27	100	290 x 280 x 54
25 x 45	2545	26.5	47	32	100	290 x 280 x 59
25 x 50	2550	26.5	52	38	100	290 x 280 x 64
30 x 30	3030	31.5	32	30	100	340 x 330 x 44
30 x 35	3035	31.5	37	35	100	340 x 330 x 49
30 x 40	3040	31.5	42	40	100	340 x 330 x 54
30 x 45	3045	31.5	47	45	100	340 x 330 x 59
30 x 50	3050	31.5	52	50	100	340 x 330 x 64
35 x 30	3530	36.5	32	40	50	390 x 198 x 44
35 x 35	3535	36.5	37	48	50	390 x 198 x 49
35 x 40	3540	36.5	42	55	50	390 x 198 x 54
35 x 45	3545	36.5	47	63	50	390 x 198 x 59
35 x 50	3550	36.5	52	72	50	390 x 198 x 64

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Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

PLL-SI 058/059

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

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 . . . . .
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

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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 ∅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 . . . . .
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	92	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

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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 . . . . .
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: $I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA

After 5 minutes at U_R: $I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA

Equivalent series inductance (ESL)

Typical ESL for all case sizes: 19 nH

Maximum ESL for all case sizes: 25 nH

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Non-solid Al - electrolytic capacitors
Power Long Life Snap-In

PLL-SI 058/059

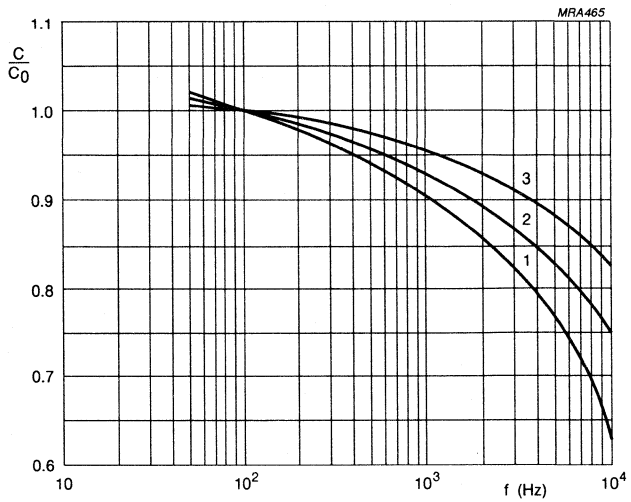
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222 . . . . .
400	47	22 x 30	2230	0.30	117	42	4260	3490	059 56479
	68	22 x 35	2235	0.38	167	58	2950	2420	059 36689
	68	25 x 30	2530	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
	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
	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).

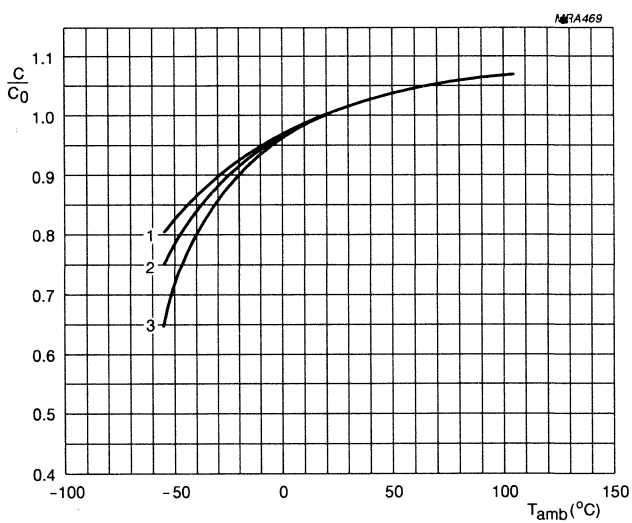
Capacitance (C)



Curve 1: 10 and 16 V
Curve 2: 25 V; 35 V; 40 V
Curve 3: ≥50 V.

C/C_0 = capacitance at 20 °C and 100 Hz.

Fig.4 Multiplier of typical capacitance (C/C_0) as a function of frequency.



Curve 1: 50 V to 100 V
Curve 2: 200 V
Curve 3: ≥250 V and ≤40 V.

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.

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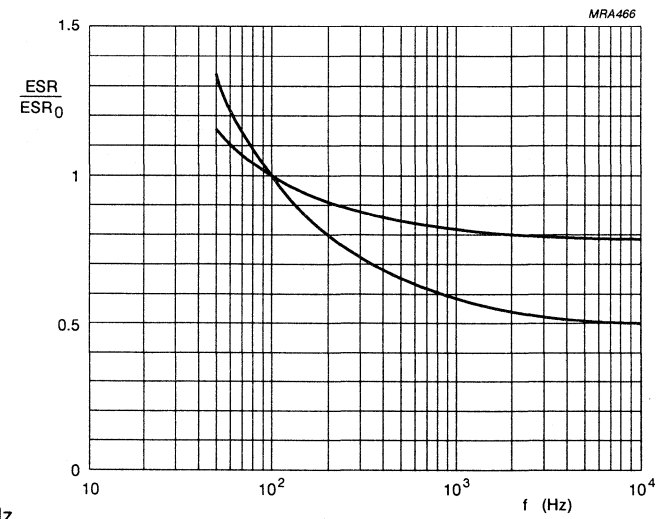
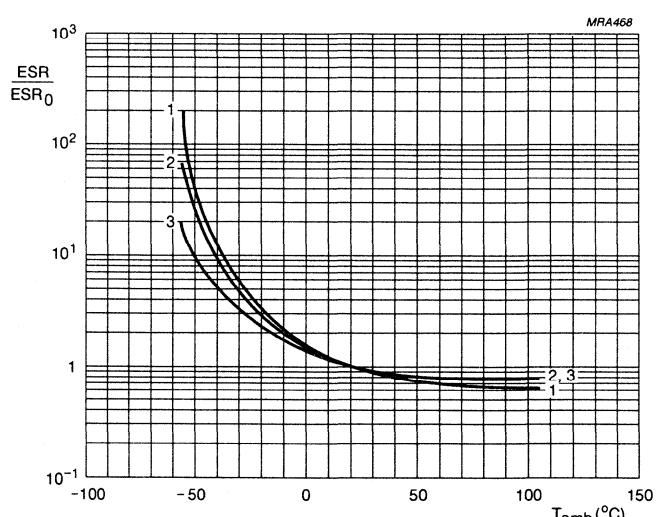
Equivalent series resistance (ESR)



Curve 1: 10 V to 100 V
Curve 2: 200 V to 400 V.

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

Fig.6 Multiplier of typical ESR (ESR/ESR_0) as a function of frequency.

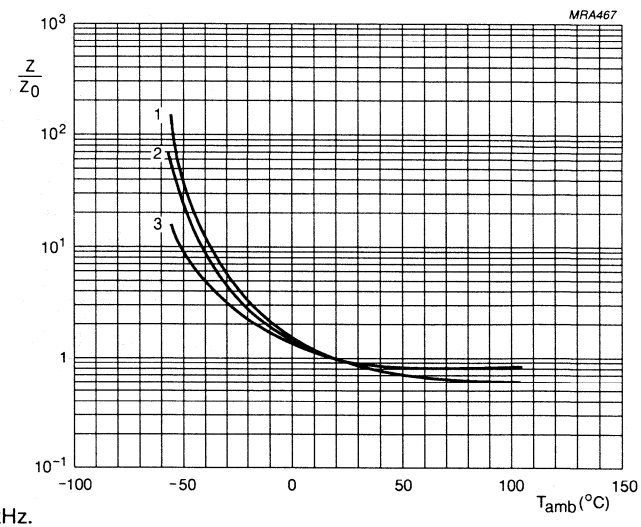


Curve 1: ≥250 V
Curve 2: 200 V
Curve 3: ≤100 V.

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.

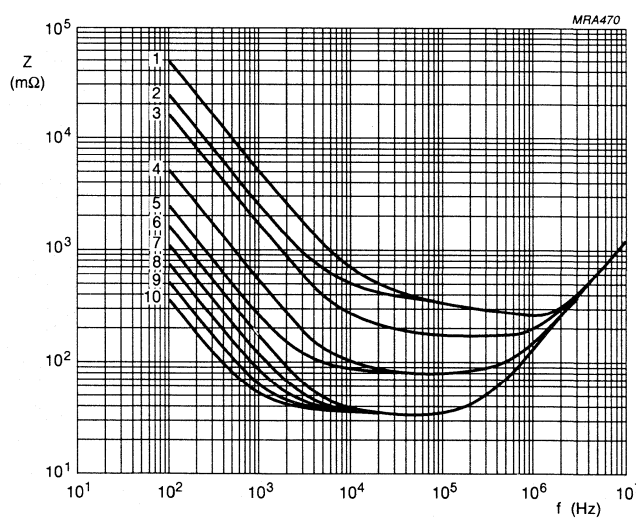
Impedance (Z)



Curve 1: ≥250 V
Curve 2: 200 V
Curve 3: ≤100 V.

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.



Curve 1: 33 µF
Curve 2: 68 µF
Curve 3: 100 µF
Curve 4: 330 µF
Curve 5: 680 µF
Curve 6: 1000 µF
Curve 7: 1500 µF
Curve 8: 2200 µF
Curve 9: 3300 µF
Curve 10: 4700 µF.

Fig.9 Typical impedance as a function of frequency at +20 °C; case size Ø22 x 25 mm.

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Curve 1: 47 µF
Curve 2: 100 µF
Curve 3: 150 µF
Curve 4: 470 µF
Curve 5: 1000 µF
Curve 6: 1500 µF
Curve 7: 2200 µF
Curve 8: 3300 µF
Curve 9: 4700 µF
Curve 10: 6800 µF.

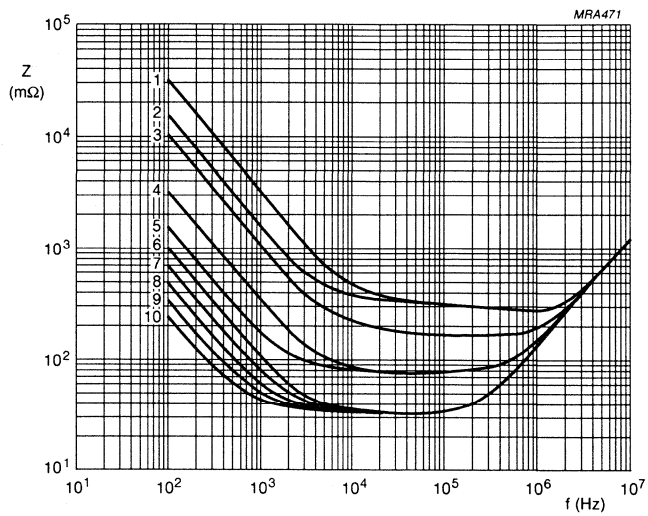

Fig.10 Typical impedance as a function of frequency at +20 °C; case size ∅22 x 30 mm.

Curve 1: 68 µF
Curve 2: 150 µF
Curve 3: 220 µF
Curve 4: 680 µF
Curve 5: 1500 µF
Curve 6: 2200 µF
Curve 7: 3300 µF
Curve 8: 4700 µF
Curve 9: 6800 µF
Curve 10: 10 000 µF.

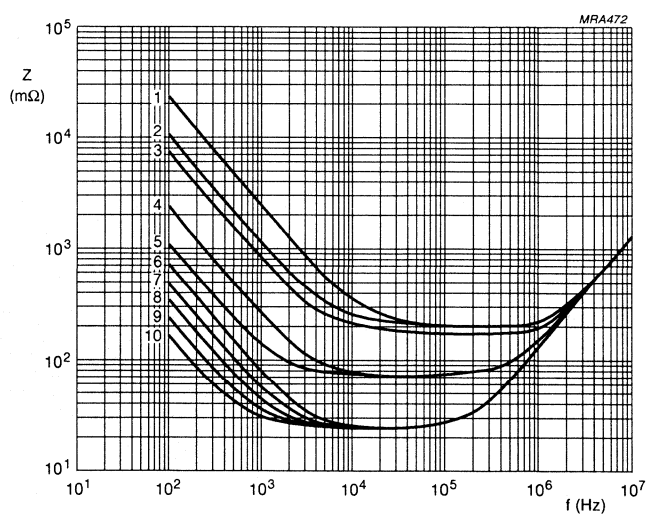

Fig.11 Typical impedance as a function of frequency at +20 °C; case sizes ∅25 x 30 and 22 x 40 mm.

Curve 1: 100 µF
Curve 2: 220 µF
Curve 3: 330 µF
Curve 4: 1000 µF
Curve 5: 2200 µF
Curve 6: 3300 µF
Curve 7: 4700 µF
Curve 8: 6800 µF
Curve 9: 10 000 µF
Curve 10: 15 000 µF.

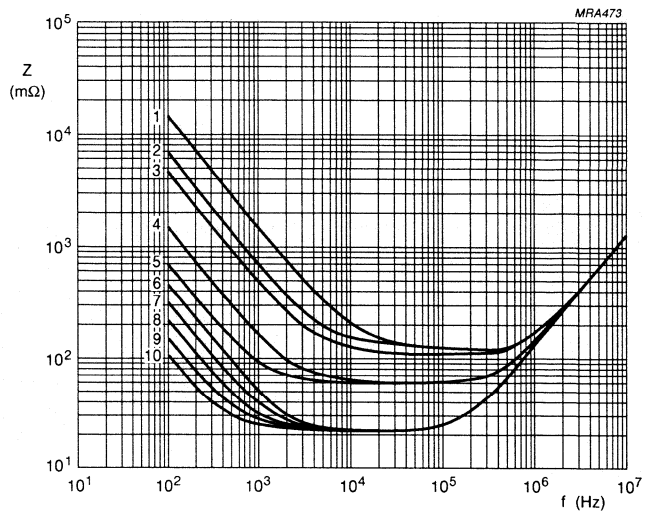

Fig.12 Typical impedance as a function of frequency at +20 °C; case sizes ∅30 x 30 and 25 x 40 mm.

Curve 1: 150 µF
Curve 2: 330 µF
Curve 3: 470 µF
Curve 4: 1500 µF
Curve 5: 3300 µF
Curve 6: 4700 µF
Curve 7: 6800 µF
Curve 8: 10 000 µF
Curve 9: 15 000 µF
Curve 10: 22 000 µF.

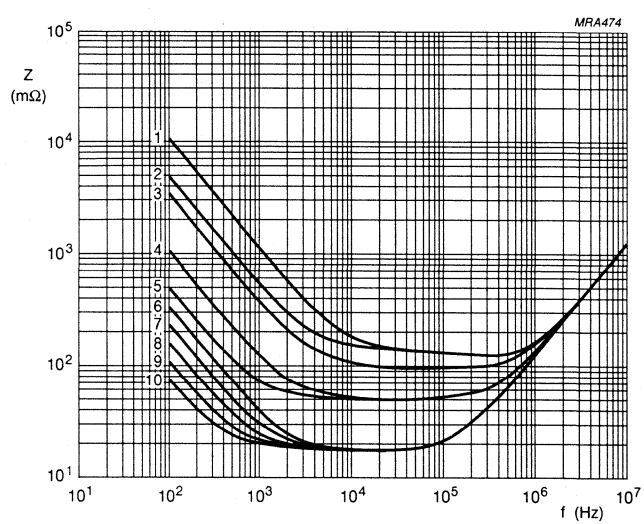

Fig.13 Typical impedance as a function of frequency at +20 °C; case sizes ∅30 x 40 and 25 x 50 mm.

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Curve 1: 220 µF
Curve 2: 470 µF
Curve 3: 680 µF
Curve 4: 2200 µF
Curve 5: 4700 µF
Curve 6: 6800 µF
Curve 7: 10 000 µF
Curve 8: 15 000 µF
Curve 9: 22 000 µF
Curve 10: 33 000 µF.

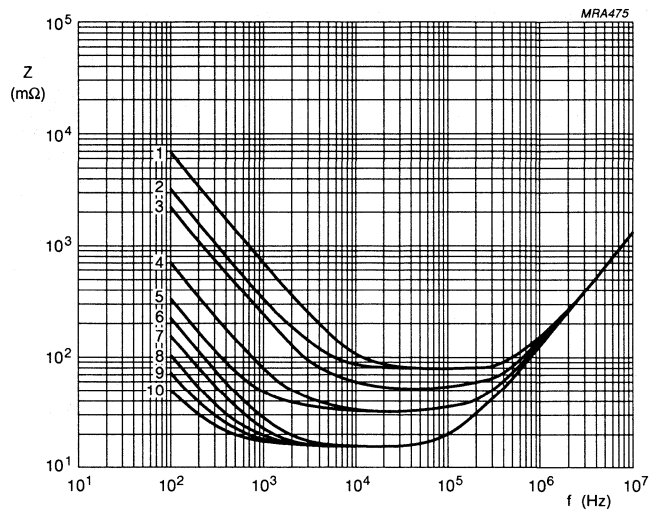


Fig.14 Typical impedance as a function of frequency at +20 °C; case sizes ∅35 x 40 and 30 x 50 mm.

Curve 1: 330 µF
Curve 2: 680 µF
Curve 3: 1000 µF
Curve 4: 3300 µF
Curve 5: 6800 µF
Curve 6: 10 000 µF
Curve 7: 15 000 µF
Curve 8: 22 000 µF
Curve 9: 33 000 µF
Curve 10: 47 000 µF.

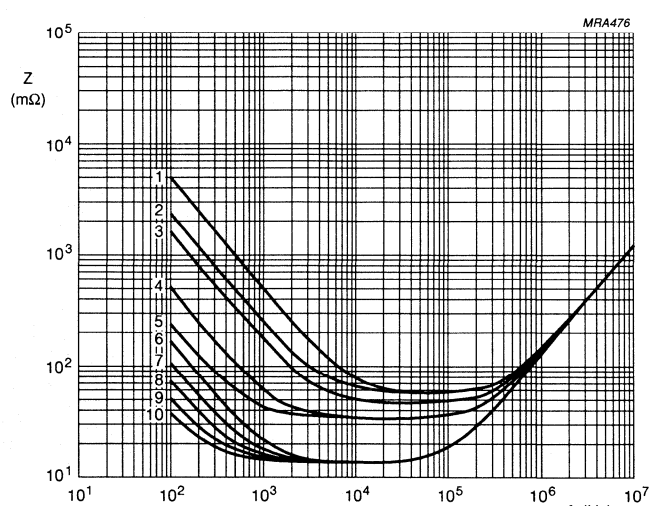
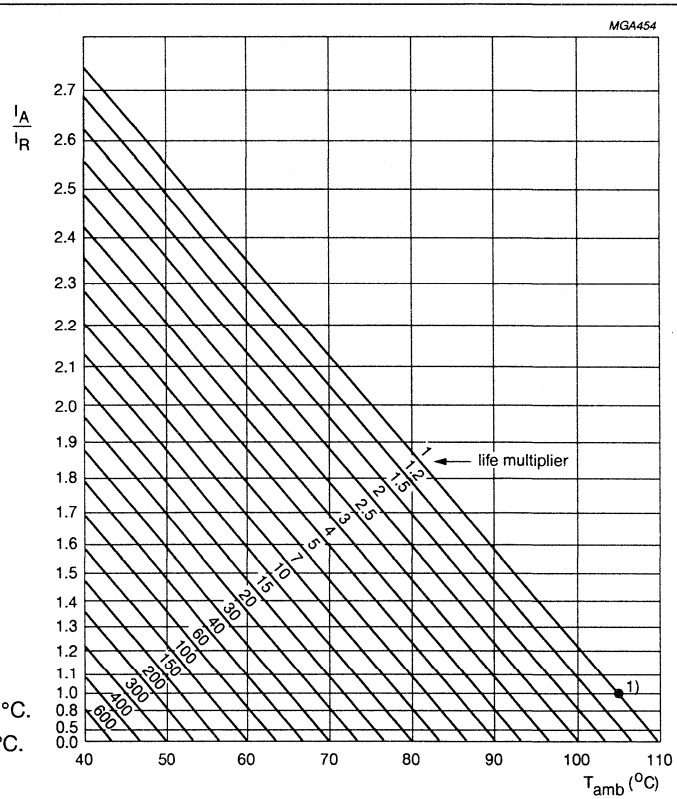


Fig.15 Typical impedance as a function of frequency at +20 °C; case size ∅35 x 50 mm.

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 V to 35 V	U_R = 40 V to 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: 5000 hours for ≤50 V types; 10 000 hours for ≥63 V types.

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

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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; ≤50 V: 2000 hours ≥63 V: 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} = 105 °C; U_R and I_R applied; ≤50 V: 5000 hours ≥63 V: 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} = 105 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit $I_{L5} \leq 2$ x spec. limit

Non-solid Al - electrolytic capacitors
Power Standard Miniature 4-Terminal Snap-In

PSM-4TSI 166/167

FEATURES

- Keyed polarity obtained by 4 snap-in terminals
- Extremely high shock and vibration capability
- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Pressure relief on the top of the aluminium case
- Charge and discharge proof
- Long useful life: 10 000 hours at 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
- For excellent mounting stability.

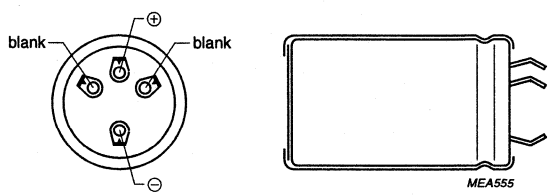


Fig.1 Component outlines.

QUICK REFERENCE DATA

	166	167
Case size ($\varnothing D_{nom}$ x L_{nom} in mm)	35 x 40; 35 x 50	35 x 40; 35 x 45; 35 x 50
Rated capacitance range (E6/E12 series), C_R	3300 to 68 000 µF	330 to 1500 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	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	
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade	
Climatic category IEC 68 DIN 40040	40/085/56 GPF	

P

Non-solid Al - electrolytic capacitors
Power Standard Miniature 4-Terminal Snap-In

PSM-4TSI 166/167

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD x L** in **mm**) for 166 series

C_R (µF)	U_R (V)							
	10	**16**	**25**	**35**	**40**	**50**	**63**	**100**
3300								35 x 40
4700								35 x 50
6800							35 x 40	
10 000						35 x 40	35 x 50	
15 000				35 x 40	35 x 40	35 x 50		
22 000			35 x 40	35 x 50	35 x 50			
33 000		35 x 40	35 x 50					
47 000	35 x 40	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 167 series

C_R (µF)	U_R (V)			
	200	**250**	**385**	**400**
330			35 x 40	35 x 40
390				35 x 45
470			35 x 45 35 x 50	35 x 50
680		35 x 40		
820		35 x 45		
1000	35 x 40	35 x 50		
1200	35 x 45			
1500	35 x 50			

Non-solid Al - electrolytic capacitors
Power Standard Miniature 4-Terminal Snap-In

PSM-4TSI 166/167

MECHANICAL DATA and PACKING QUANTITIES

Dimensions in mm.

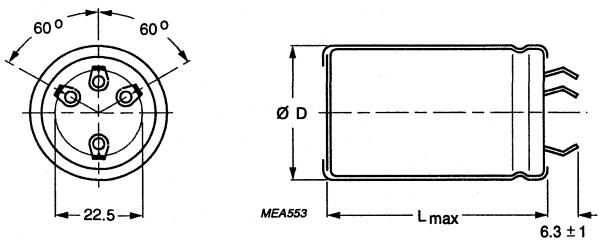
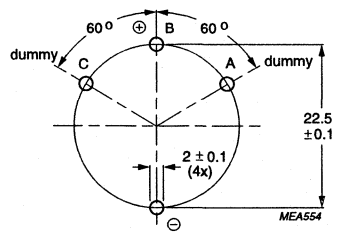


Fig.2 4-Terminal Snap-in.



Dummy terminals (A and C) must be free from the electrical circuit.

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)	OUTER BOX DIMENSIONS L x B x H
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE					
35 x 40	3540	36.5	42	55	50	390 x 198 x 54
35 x 45	3545	36.5	47	63	50	390 x 198 x 59
35 x 50	3550	36.5	52	72	50	390 x 198 x 64

P

Non-solid Al - electrolytic capacitors
Power Standard Miniature 4-Terminal Snap-In

PSM-4TSI 166/167

ELECTRICAL DATA and ORDERING INFORMATION

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
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 capacitor
PSM-4TSI 166/167
15 000 µF/35 V; ±20%
Case size 35 x 40 mm
Catalogue number: 2222 166 50153.

Table 4 Electrical data and ordering information for 166/167 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	47 000	35 x 40	3540	5.10	2824	944	31	26	166 54473
	68 000	35 x 50	3550	5.88	4084	1364	28	23	166 54683
16	33 000	35 x 40	3540	5.02	3172	1060	32	28	166 55333
	47 000	35 x 50	3550	5.34	4516	1508	34	32	166 55473
25	22 000	35 x 40	3540	4.48	3304	1104	40	28	166 56223
	33 000	35 x 50	3550	4.98	4954	1654	39	33	166 56333
35	15 000	35 x 40	3540	4.32	3154	1054	43	28	166 50153
	22 000	35 x 50	3550	5.33	4624	1544	34	24	166 50223
40	15 000	35 x 40	3540	4.05	3604	1204	49	41	166 57153
	22 000	35 x 50	3550	4.86	5284	1764	40	33	166 57223
50	10 000	35 x 40	3540	4.05	3004	1004	49	42	166 51103
	15 000	35 x 50	3550	4.98	4504	1504	39	33	166 51153
63	6800	35 x 40	3540	4.01	2574	861	50	42	166 58682
	10 000	35 x 50	3550	5.00	3784	1264	39	33	166 58103
100	3300	35 x 40	3540	2.84	1984	664	100	95	166 59332
	4700	35 x 50	3550	3.59	2024	677	75	70	166 59472
200	1000	35 x 40	3540	2.85	1204	404	160	135	167 52102
	1200	35 x 45	3545	2.98	1444	484	150	130	167 42122
	1500	35 x 50	3550	3.66	1804	604	120	105	167 52152
250	680	35 x 40	3540	2.60	1024	344	240	145	167 53681
	820	35 x 45	3545	2.70	1234	414	195	128	167 43821
	1000	35 x 50	3550	3.12	1504	504	160	105	167 53102
385	330	35 x 40	3540	2.11	766	258	480	280	167 58331
	470	35 x 45	3545	2.29	1089	366	340	220	167 48471
	470	35 x 50	3550	2.76	1089	366	340	220	167 58471
400	330	35 x 40	3540	2.11	796	268	480	280	167 56331
	390	35 x 45	3545	2.08	940	316	410	265	167 46391
	470	35 x 50	3550	2.76	1132	380	340	220	167 56471

Non-solid Al - electrolytic capacitors
Power Standard Miniature 4-Terminal Snap-In

PSM-4TSI 166/167

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

Marking

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

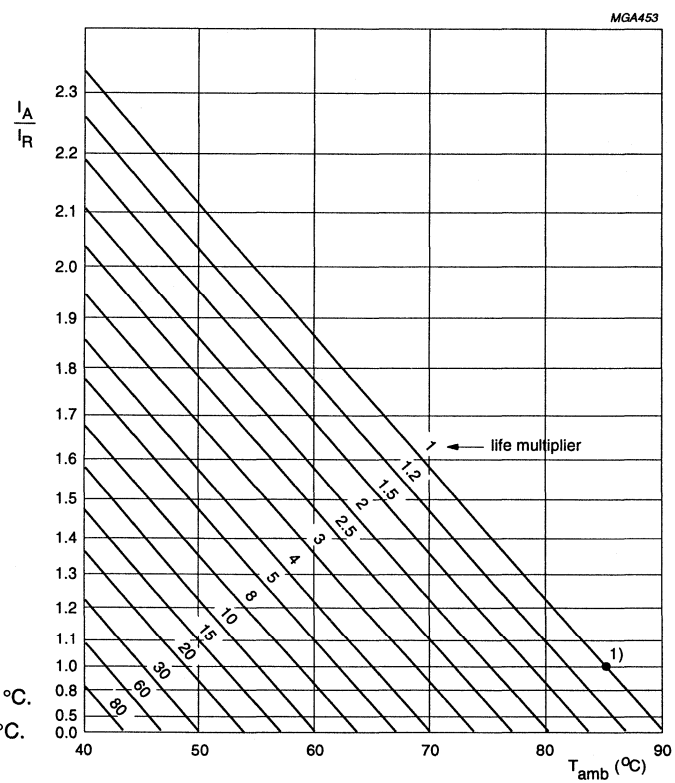
- Rated capacitance
- Tolerance code on rated capacitance (M for ±20%)
- Rated voltage
- Climatic category (in accordance with IEC 68)
- Date code (year and week) in accordance with IEC 62
- Code for factory of origin
- Name of manufacturer
- '–' sign to indicate the negative terminal, visible from the 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).

P

RIPPLE CURRENT and USEFUL LIFE

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

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10 V to 35 V	U_R = 40 V to 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.4 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 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 Long Life 4-Terminal Snap-In

PLL-4TSI 168/169

FEATURES

- Keyed polarity obtained by 4 snap-in terminals
- Extremely high shock and vibration capability
- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Pressure relief on the top of the aluminium case
- Charge and discharge proof
- Very long useful life: 5000 hours at 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
- For excellent mounting stability.

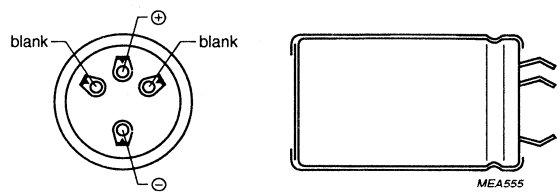


Fig.1 Component outlines.

QUICK REFERENCE DATA

	168	169
Case size ($\varnothing D_{nom}$ x L_{nom} in mm)	35 x 40; 35 x 50	35 x 40; 35 x 45; 35 x 50
Rated capacitance range (E6/E12 series), C_R	2200 to 47 000 µF	220 to 1000 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	2000 hours	
Useful life at 105 °C	5000 hours	
Useful life at U_R, 40 °C and 1.9 x I_R applied	125 000 hours	
Shelf life at 0 V, 105 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade	
Climatic category IEC 68 DIN 40040	40/105/56 GMF	

Non-solid Al - electrolytic capacitors
Power Long Life 4-Terminal Snap-In

PLL-4TSI 168/169

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD x L** in **mm**) for 168 series

C_R (µF)	U_R (V)							
	10	**16**	**25**	**35**	**40**	**50**	**63**	**100**
2200								35 x 40
3300								35 x 50
4700							35 x 40	
6800						35 x 40	35 x 50	
10 000				35 x 40	35 x 40	35 x 50		
15 000			35 x 40	35 x 50	35 x 50			
22 000		35 x 40	35 x 50					
33 000	35 x 40	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 169 series

C_R (µF)	U_R (V)			
	200	**250**	**385**	**400**
220			35 x 40	35 x 40
270			35 x 45	35 x 45
330			35 x 50	35 x 50
470		35 x 40		
680	35 x 40	35 x 45; 35 x 50		
820	35 x 45			
1000	35 x 50			

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MECHANICAL DATA and PACKING QUANTITIES

Dimensions in mm.

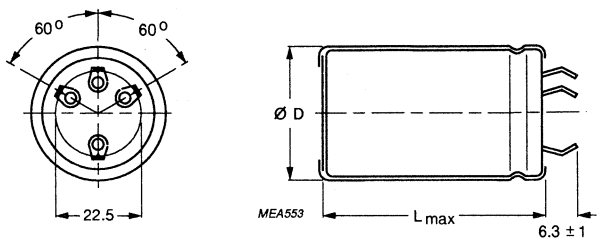
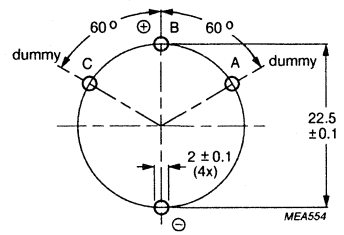


Fig.2 4-Terminal Snap-in.



Dummy terminals (A and C) must be free from the electrical circuit.

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)	OUTER BOX DIMENSIONS L x B x H
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE					
35 x 40	3540	36.5	42	55	50	390 x 198 x 54
35 x 45	3545	36.5	47	63	50	390 x 198 x 59
35 x 50	3550	36.5	52	72	50	390 x 198 x 64

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).

Non-solid Al - electrolytic capacitors
Power Long Life 4-Terminal Snap-In

PLL-4TSI 168/169

ELECTRICAL DATA and ORDERING INFORMATION

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
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 capacitor
PLL-4TSI 168/169
15 000 µF/25 V; ±20%
Case size 35 x 40 mm
Catalogue number: 2222 168 56153.

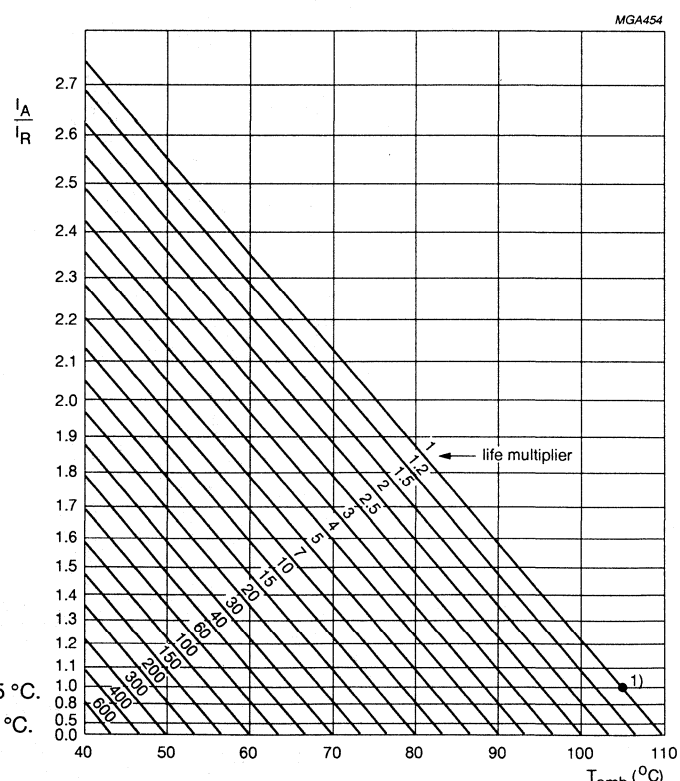
Table 4 Electrical data and ordering information for 168/169 series

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	33 000	35 x 40	3540	5.15	1984	664	30	24	168 54333
	47 000	35 x 50	3550	6.23	2824	944	24	21	168 54473
16	22 000	35 x 40	3540	5.07	2116	708	31	24	168 55223
	33 000	35 x 50	3550	6.23	3172	1060	25	21	168 55333
25	15 000	35 x 40	3540	4.91	2254	754	33	24	168 56153
	22 000	35 x 50	3550	6.07	3304	1104	27	21	168 56223
35	10 000	35 x 40	3540	4.18	2104	704	46	29	168 50103
	15 000	35 x 50	3550	5.21	3154	1054	36	24	168 50153
40	10 000	35 x 40	3540	4.18	2404	804	46	29	168 57103
	15 000	35 x 50	3550	5.21	3604	1204	36	24	168 57153
50	6800	35 x 40	3540	4.01	2044	684	49	30	168 51682
	10 000	35 x 50	3550	5.04	3004	1004	38	24	168 51103
63	4700	35 x 40	3540	3.65	1781	596	60	45	168 58472
	6800	35 x 50	3550	4.58	2574	861	46	35	168 58682
100	2200	35 x 40	3540	3.05	1324	444	86	65	168 59222
	3300	35 x 50	3550	3.84	1984	664	64	50	168 59332
200	680	35 x 40	3540	1.91	820	276	235	155	169 52681
	820	35 x 45	3545	2.18	988	332	195	150	169 42821
	1000	35 x 50	3550	2.45	1204	404	160	125	169 52102
250	470	35 x 40	3540	1.82	709	239	270	155	169 53471
	680	35 x 45	3545	2.25	1024	344	190	125	169 43681
	680	35 x 50	3550	2.30	1024	344	190	125	169 53681
385	220	35 x 40	3540	1.35	512	173	545	275	169 58221
	270	35 x 45	3545	1.57	627	212	445	245	169 48271
	330	35 x 50	3550	1.75	766	258	365	200	169 58331
400	220	35 x 40	3540	0.94	532	180	930	760	169 56221
	270	35 x 45	3545	1.07	652	220	770	630	169 46271
	330	35 x 50	3550	1.25	796	260	620	510	169 56331

RIPPLE CURRENT and USEFUL LIFE

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

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10 V to 35 V	U_R = 40 V to 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: 5 000 hours.

Fig.4 Life expectancy (useful life) as a function of ripple current load I_A/I_R and 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	

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

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; 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} = 105 °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 $I_{L5} \leq$ 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} = 105 °C; no voltage applied; 500 hours after test : U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit $I_{L5} \leq 2$ x spec. limit

P

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
- Pressure relief on the top of the aluminium case or in the sealing for bolt versions
- Charge and discharge proof
- Very long useful life: 15 000 hours at 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.

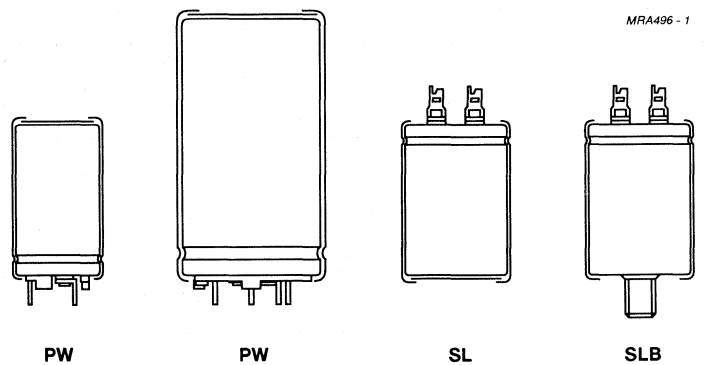


Fig.1 Component outlines.

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	
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade	
Detail specification	DIN 45910-T129 former DIN 41238	
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)	

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					

Preferred types in **bold**.

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**		

Preferred types in **bold**.

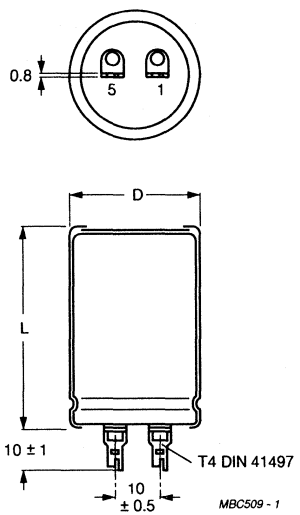
P

Non-solid Al - electrolytic capacitors
Power Eurodin Printed Wiring

PED-PW 050/052

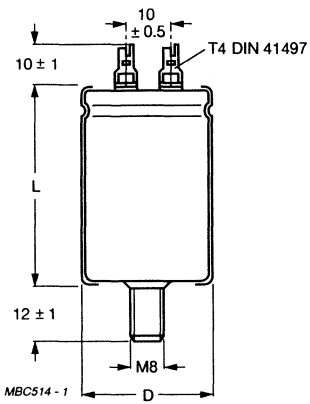
MECHANICAL DATA and PACKING QUANTITIES

Dimensions in mm.



1 = positive terminal; 5 = negative terminal.
See chapter, "Mounting Accessories".

Fig.2 Solder-lug version (SL).



1 = positive terminal; 5 = negative terminal.
See chapter, "Mounting Accessories".

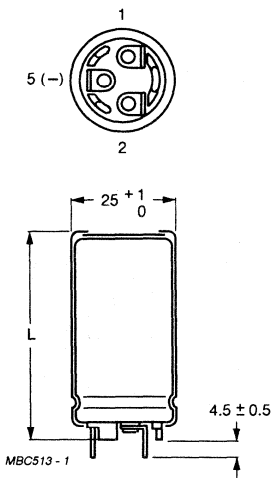
Fig.3 Solder-lug-bolt version (SLB).

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)	OUTER BOX DIMENSIONS L x B x H
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE					
25 x 35	1	26	36.3	24	100	290 x 280 x 69
25 x 45	2	26	46.3	28	100	290 x 280 x 79
30 x 45	3	31	46.3	38	100	340 x 330 x 79
35 x 45	4	36	46.3	51	50	390 x 198 x 79
35 x 55	5	36	56.3	66	50	390 x 198 x 89
40 x 55	7	41	56.3	82	50	440 x 223 x 89
40 x 75	8	41	76.3	110	50	440 x 223 x 109
40 x 105	9	41	106.3	176	50	440 x 223 x 139

Non-solid Al - electrolytic capacitors
Power Eurodin Printed Wiring

PED-PW 050/052



1 = positive terminal; 5 = negative terminal.

Fig.4 Printed wiring pin version, case diameter 25 mm.

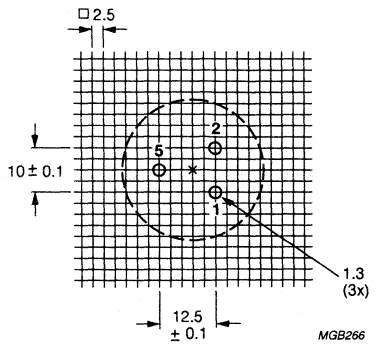
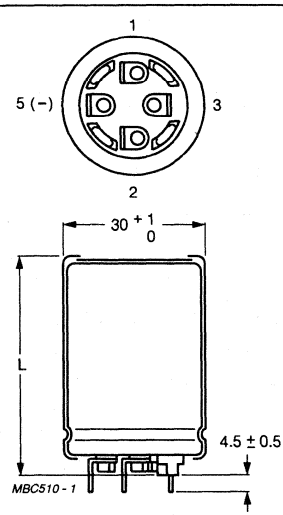


Fig.5 Piercing diagram viewed from component side.



1 = positive terminal; 5 = negative terminal.

Fig.6 Printed wiring pin version, case diameter 30 mm.

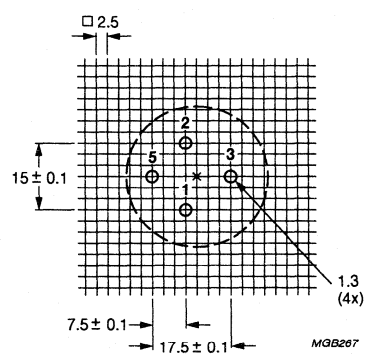
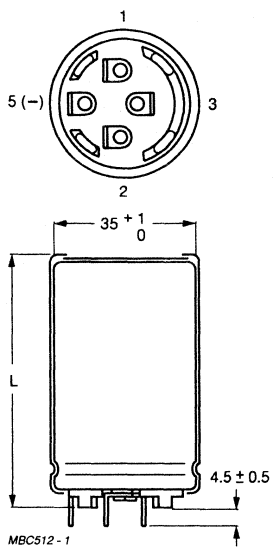


Fig.7 Piercing diagram viewed from component side.

Non-solid Al - electrolytic capacitors
Power Eurodin Printed Wiring

PED-PW 050/052



1 = positive terminal; 5 = negative terminal.

Fig.8 Printed wiring pin version, case diameter 35 mm.

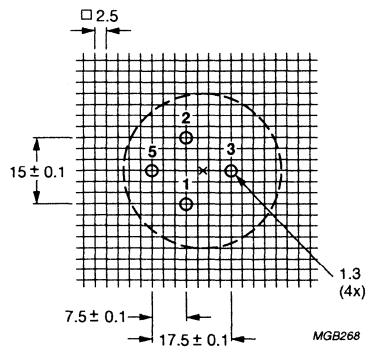
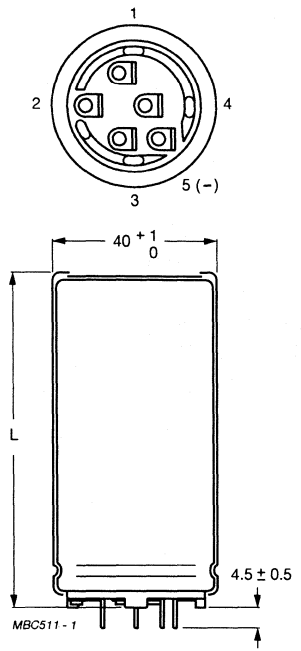


Fig.9 Piercing diagram viewed from component side.

Table 4 PW versions, dimensions in mm; mass in g

CASE		ØD$_{max}$	L$_{max}$	APPROX. MASS	PACKING QUANTITIES (units per box)	OUTER BOX DIMENSIONS L x B x H
SIZE ØD$_{nom}$ x L$_{nom}$	CODE					
25 x 35	1	26	39.3	24	100	290 x 280 x 49
25 x 45	2	26	49.3	28	100	290 x 280 x 59
30 x 45	3	31	49.3	38	100	340 x 330 x 59
35 x 45	4	36	49.3	51	50	390 x 198 x 59
35 x 55	5	36	59.3	66	50	390 x 198 x 69
40 x 45	6	41	49.3	78	50	440 x 223 x 59
40 x 55	7	41	59.3	82	50	440 x 223 x 69
40 x 75	8	41	79.3	110	50	440 x 223 x 89
40 x 105	9	41	109.3	176	50	440 x 223 x 119



1 = positive terminal; 5 = negative terminal.

Fig.10 Printed wiring pin version, case diameter 40 mm.

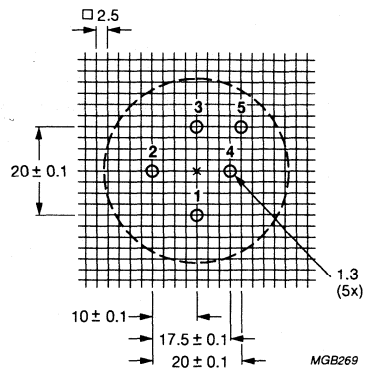


Fig.11 Piercing diagram viewed from component side.

Mounting

The capacitors may be mounted in any position with or without a mounting clamp. When a number of capacitors are connected in a bank, they must not be closer together than 15 mm, when no derating of ripple current and/or temperature is applied.

Pin numbers 2, 3 and 4 (if present) should be at the same potential as the case. If the case has to be at a specified potential, it should be connected to the negative terminal only.

P

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/+30%
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 ∅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 ... .
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 ∅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 ... .
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

P

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

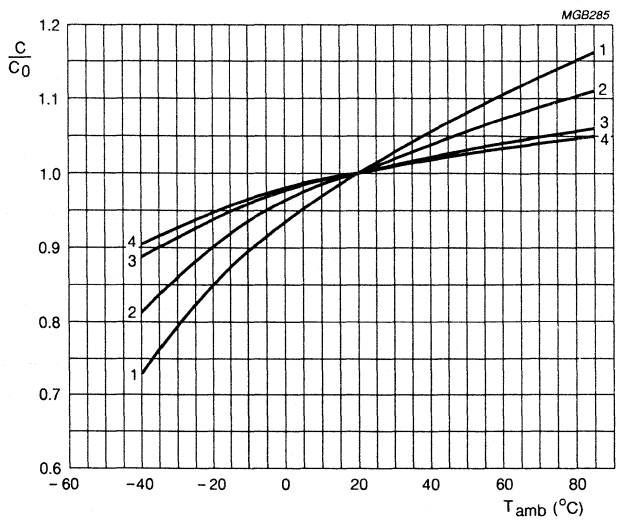
Note

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)



Curve 1: 10 V
Curve 2: 25 V
Curve 3: 63 V
Curve 4: 100 V; 250 V; 385 V.

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 ∅25 mm	25 nH
Maximum ESL for case sizes ∅30 and 35 mm	30 nH
Maximum ESL for case sizes ∅40 mm	35 nH

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Equivalent series resistance (ESR)

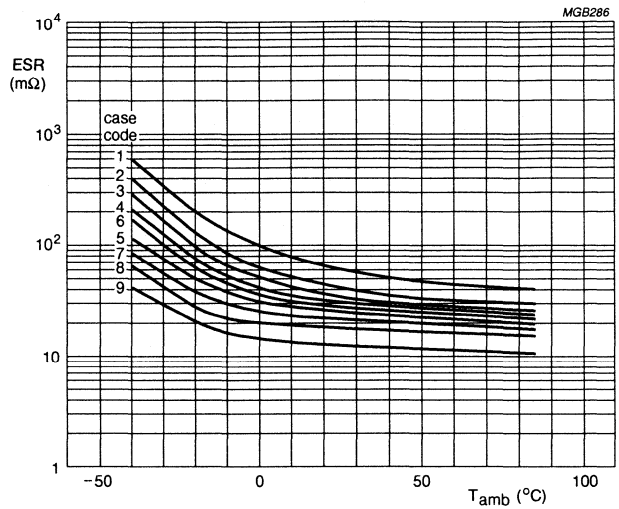

Fig.13 Typical ESR as a function of temperature at 100 Hz and U_R = 10 V.

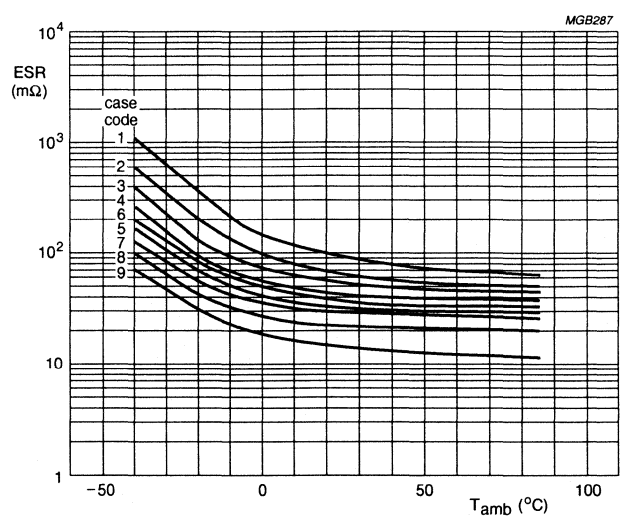

Fig.14 Typical ESR as a function of temperature at 100 Hz and U_R = 63 V.

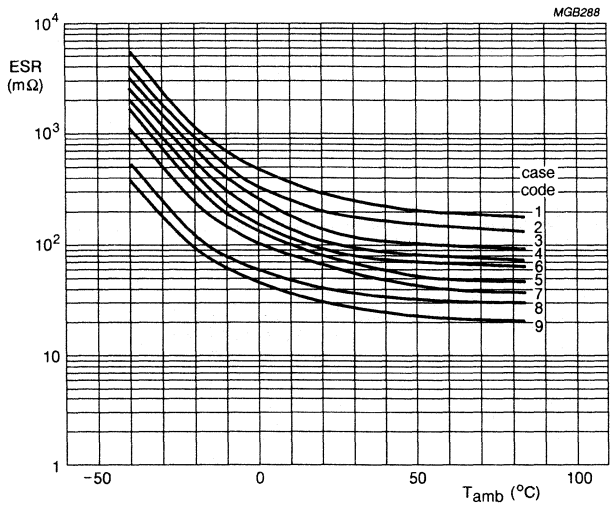

Fig.15 Typical ESR as a function of temperature at 100 Hz and U_R = 100 V.

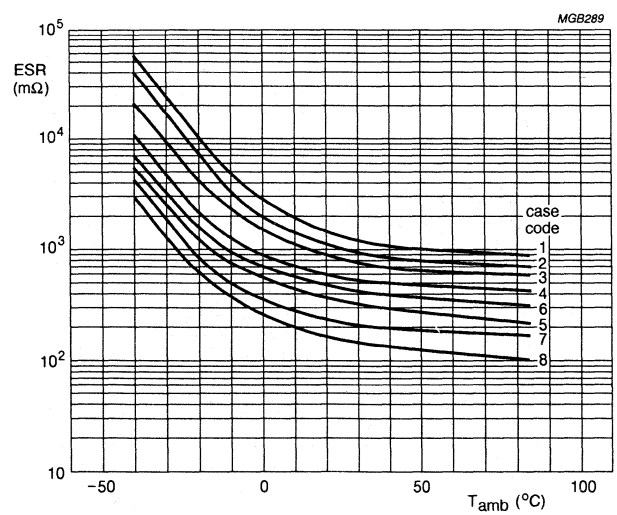

Fig.16 Typical ESR as a function of temperature at 100 Hz and U_R = 385 V.

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Impedance (Z)

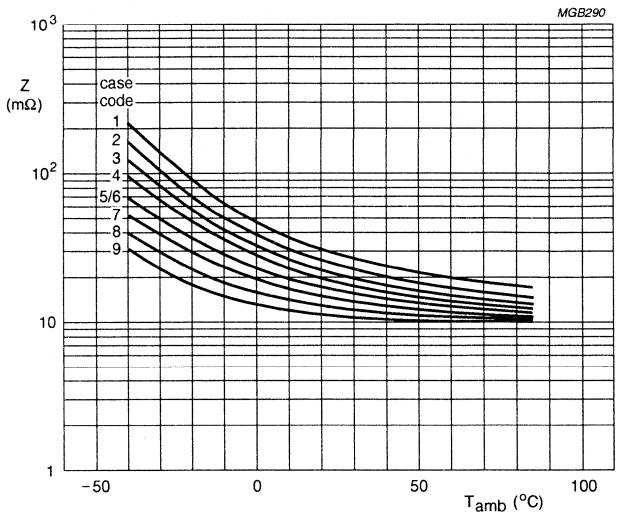

Fig.17 Typical impedance as a function of temperature at 10 kHz and U_R = 10 V.

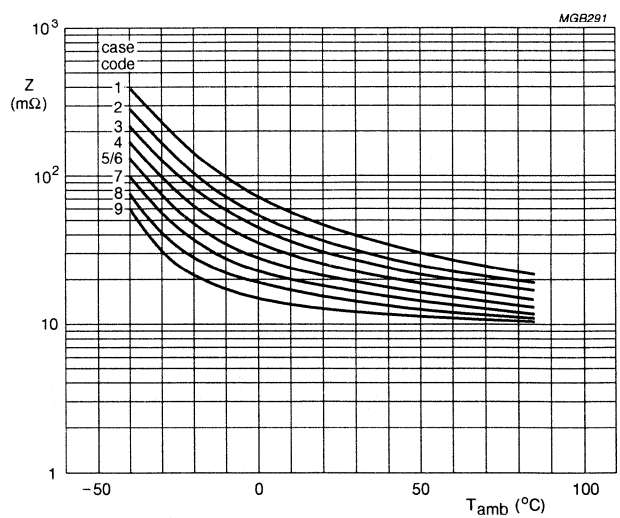

Fig.18 Typical impedance as a function of temperature at 10 kHz and U_R = 63 V.

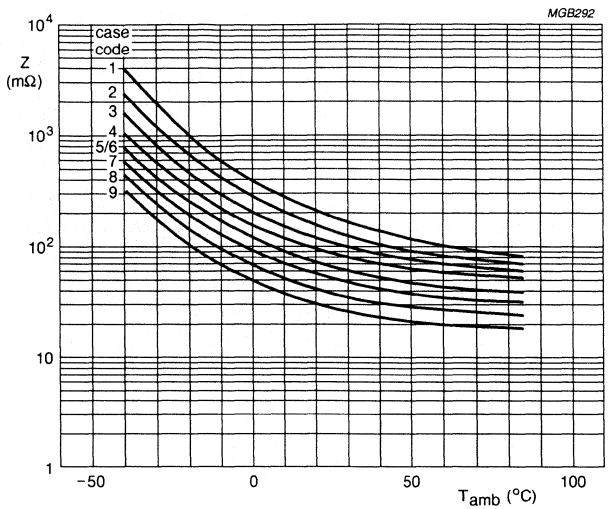

Fig.19 Typical impedance as a function of temperature at 10 kHz and U_R = 100 V.

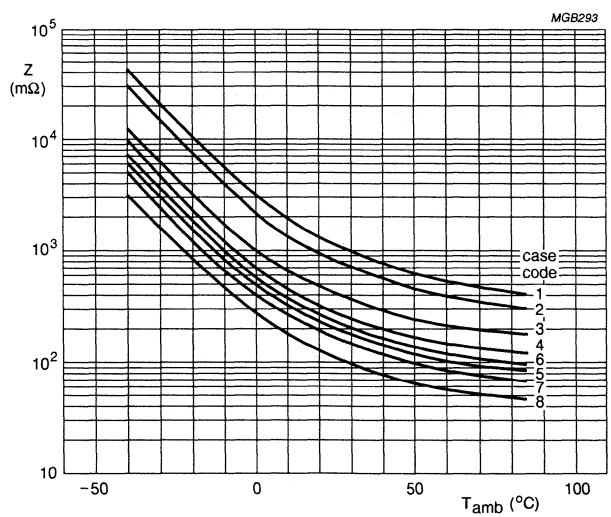

Fig.20 Typical impedance as a function of temperature at 10 kHz and U_R = 385 V.

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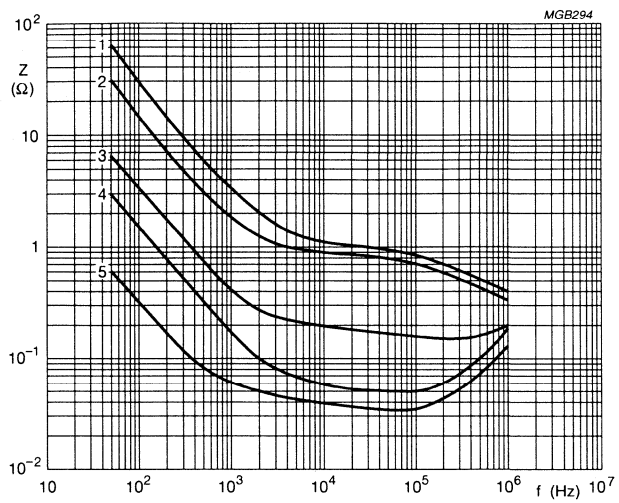
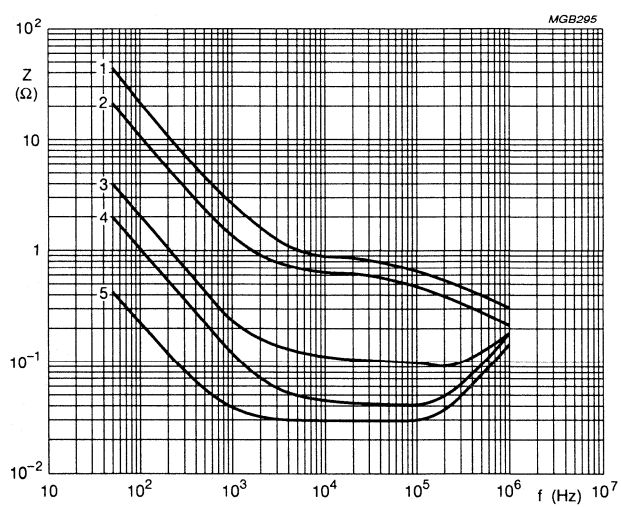


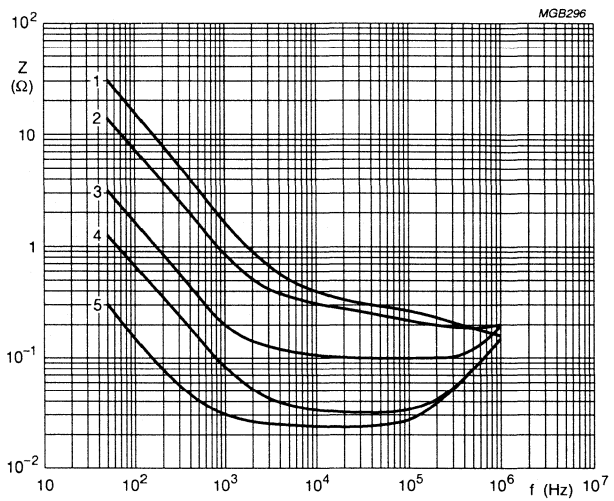
Curve 1: 47 µF, 385 V
Curve 2: 100 µF, 250 V
Curve 3: 470 µF, 100 V
Curve 4: 1000 µF, 63 V
Curve 5: 4700 µF, 10 V.

Fig.21 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size ∅25 x 35 mm.



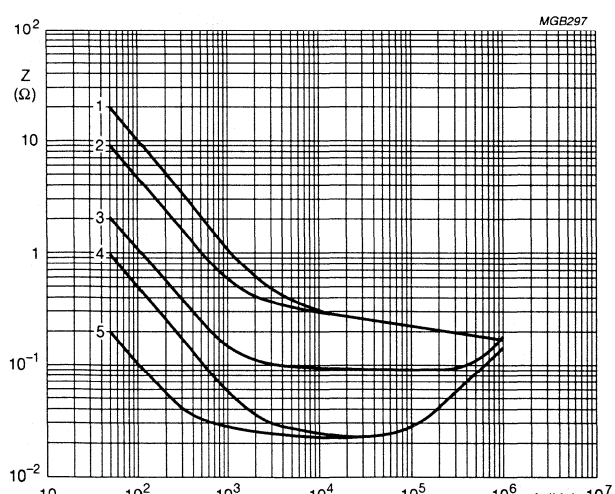
Curve 1: 68 µF, 385 V
Curve 2: 150 µF, 250 V
Curve 3: 680 µF, 100 V
Curve 4: 1500 µF, 63 V
Curve 5: 6800 µF, 10 V.

Fig.22 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size ∅25 x 45 mm.



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 mm.



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 mm.

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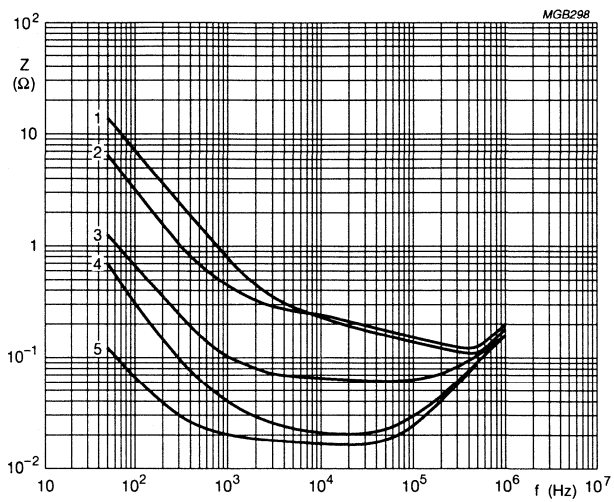
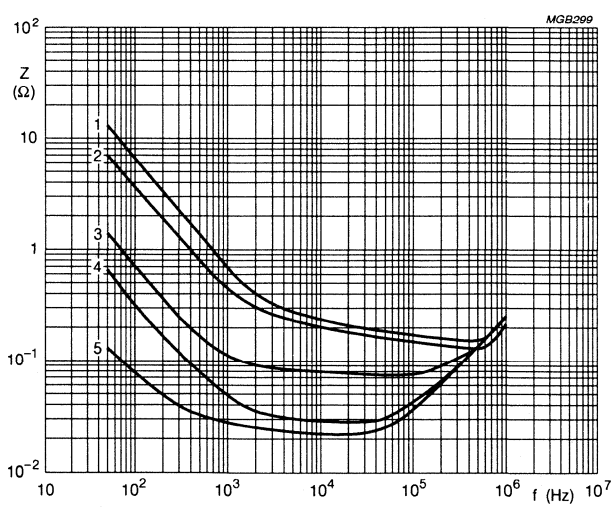


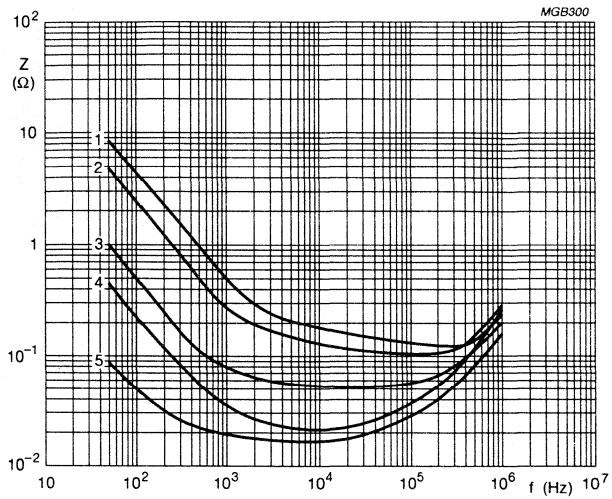
Curve 1: 220 µF, 385 V
Curve 2: 470 µF, 250 V
Curve 3: 2200 µF, 100 V
Curve 4: 4700 µF, 63 V
Curve 5: 22 000 µF, 10 V.

Fig.25 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 55 mm.



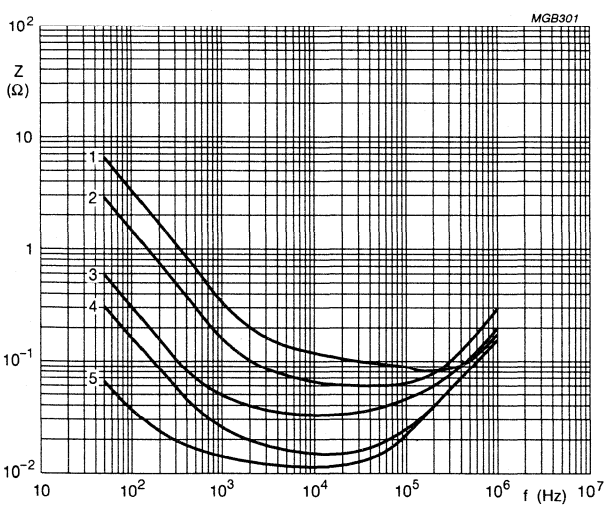
Curve 1: 220 µF, 385 V
Curve 2: 470 µF, 250 V
Curve 3: 2200 µF, 100 V
Curve 4: 4700 µF, 63 V
Curve 5: 22 000 µF, 10 V.

Fig.26 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø40 x 45 mm.



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 mm.



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 mm.

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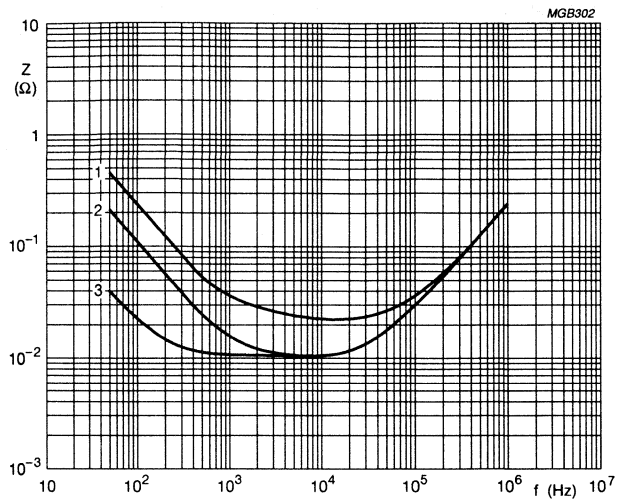


Curve 1: 6800 µF, 100 V
Curve 2: 15 000 µF, 63 V
Curve 3: 68 000 µF, 10 V.

Fig.29 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size ∅40 x 105 mm.

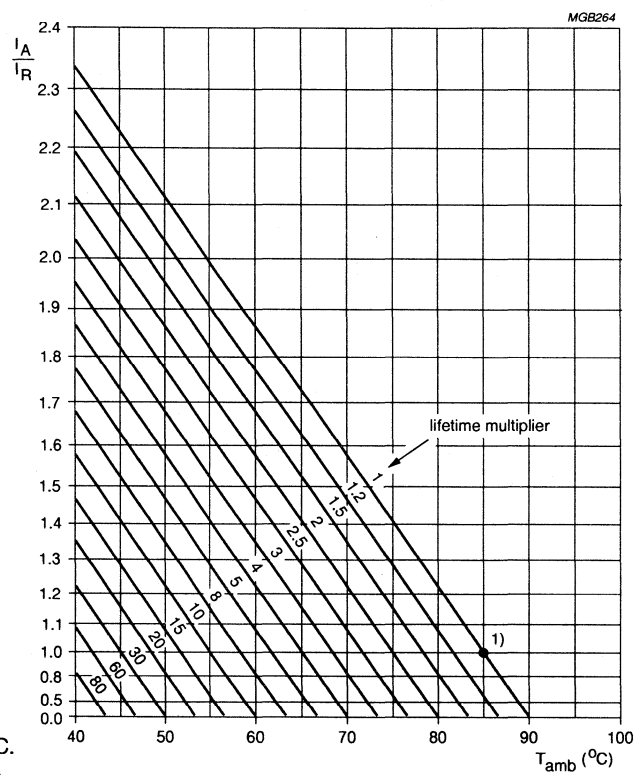
MARKING

- 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/or side of the capacitor
- Code number
- Code for basic specification (in accordance with IEC 384-4-1, CECC 30 301).

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.

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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 $I_{L5} \leq$ spec. limit
Useful life	CECC 30 301 amendment 2640 sub clause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 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 $I_{L5} \leq$ 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 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
- Pressure relief in the top of the aluminium case or in the sealing for bolt versions
- Charge and discharge proof
- Long useful life: 12 000 hours at 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.

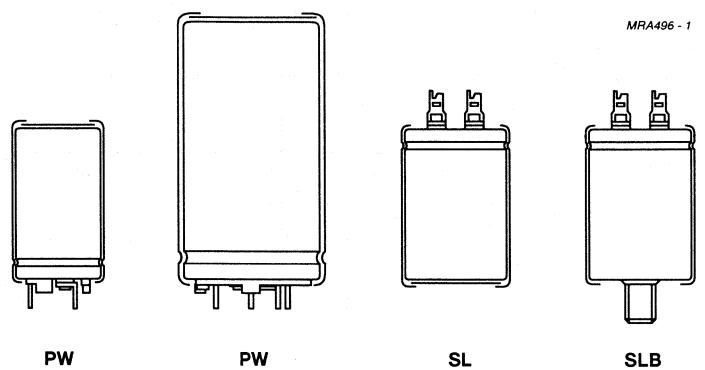

Fig.1 Component outlines.

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	
Based on sectional specification	IEC 384-4, CECC 30 300, LL grade	
Detail specification	DIN 45910-T129 (without approval) former DIN 41238	
Climatic category IEC 68 DIN 40040	40/085/56 GPF	
Approvals	France: liste LNZ 44-04	

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Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**∅D 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								

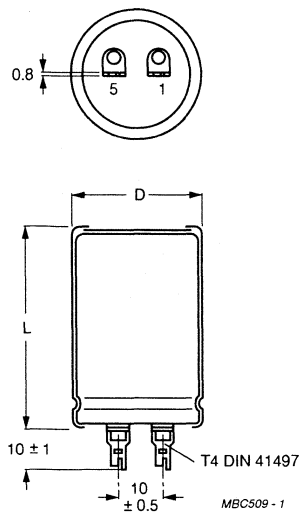
Preferred types in **bold**.

Non-solid Al - electrolytic capacitors
Power Economic Printed Wiring

PEC-PW 051/053

MECHANICAL DATA and PACKING QUANTITIES

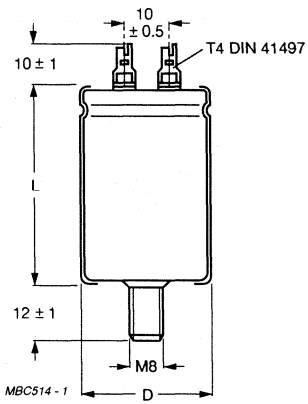
Dimensions in mm.



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)	OUTER BOX DIMENSIONS L x B x H
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE					
25 x 35	1	26	36.3	24	100	290 x 280 x 69
25 x 45	2	26	46.3	28	100	290 x 280 x 79
30 x 45	3	31	46.3	38	100	340 x 330 x 79
35 x 45	4	36	46.3	51	50	390 x 198 x 79
35 x 55	5	36	56.3	66	50	390 x 198 x 89
40 x 55	7	41	56.3	82	50	440 x 223 x 89
40 x 75	8	41	76.3	110	50	440 x 223 x 109
40 x 105	9	41	106.3	176	50	440 x 223 x 139

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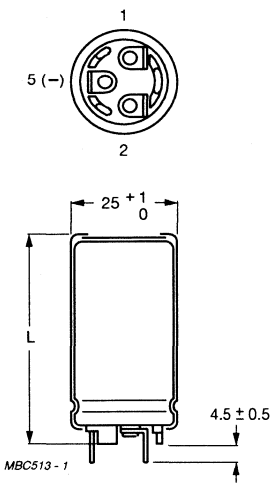


1 = positive terminal; 5 = negative terminal.

Fig.4 Printed wiring pin version, case diameter 25 mm.

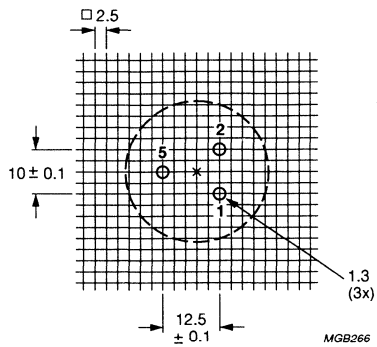
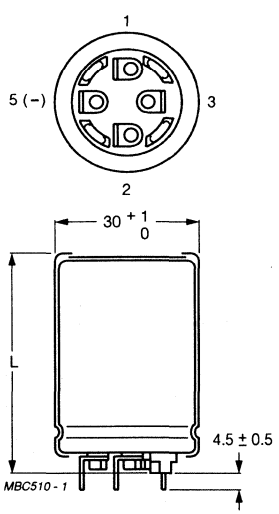


Fig.5 Piercing diagram viewed from component side.



1 = positive terminal; 5 = negative terminal.

Fig.6 Printed wiring pin version, case diameter 30 mm.

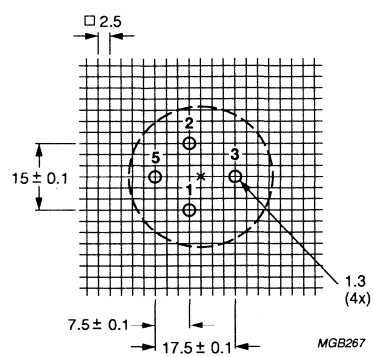
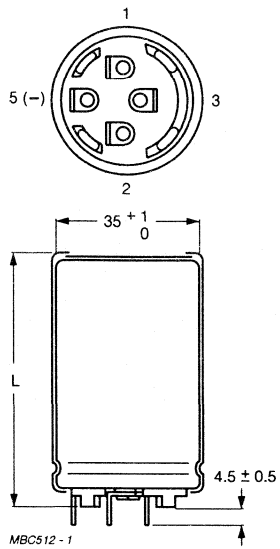


Fig.7 Piercing diagram viewed from component side.

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.

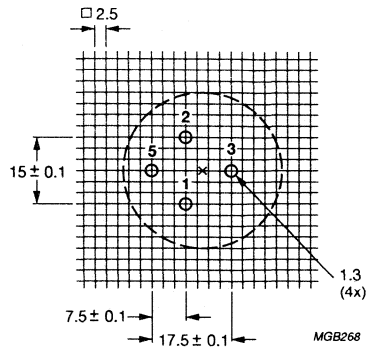


Fig.9 Piercing diagram viewed from component side.

Table 3 PW versions, dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)	OUTER BOX DIMENSIONS L x B x H
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE					
25 x 35	1	26	39.3	24	100	290 x 280 x 49
25 x 45	2	26	49.3	28	100	290 x 280 x 59
30 x 45	3	31	49.3	38	100	340 x 330 x 59
35 x 45	4	36	49.3	51	50	390 x 198 x 59
35 x 55	5	36	59.3	66	50	390 x 198 x 69
40 x 45	6	41	49.3	78	50	440 x 223 x 59
40 x 55	7	41	59.3	82	50	440 x 223 x 69
40 x 75	8	41	79.3	110	50	440 x 223 x 89
40 x 105	9	41	109.3	176	50	440 x 223 x 119

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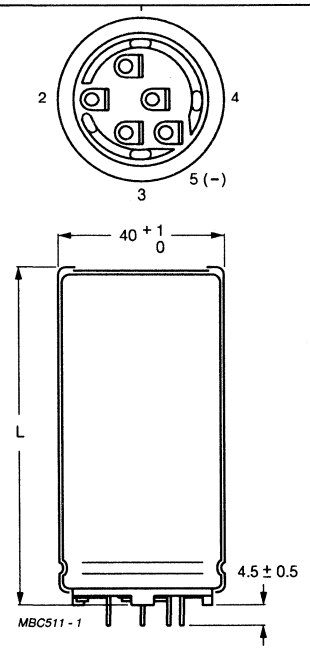

1 = positive terminal; 5 = negative terminal.

Fig.10 Printed wiring pin version, case diameter 40 mm.

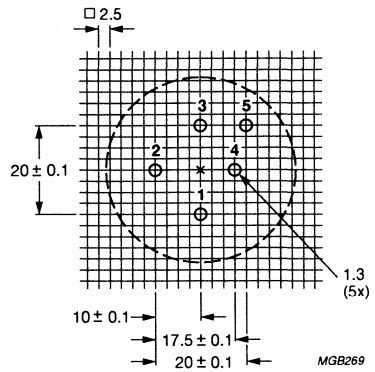

Fig.11 Piercing diagram viewed from component side.

Mounting

The capacitors may be mounted in any position with or without a mounting clamp. When a number of capacitors are connected in a bank, they must not be closer together than 15 mm, when no derating of ripple current and/or temperature is applied.

Pin numbers 2, 3 and 4 (if present) should be at the same potential as the case. If the case has to be at a specified potential, it should be connected to the negative terminal only.

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. Preferred types in **bold**.

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 ∅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 ... .
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. Preferred types in **bold**.

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....

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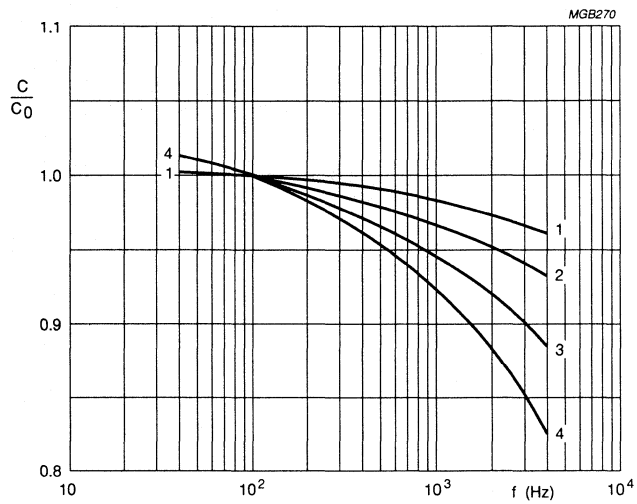
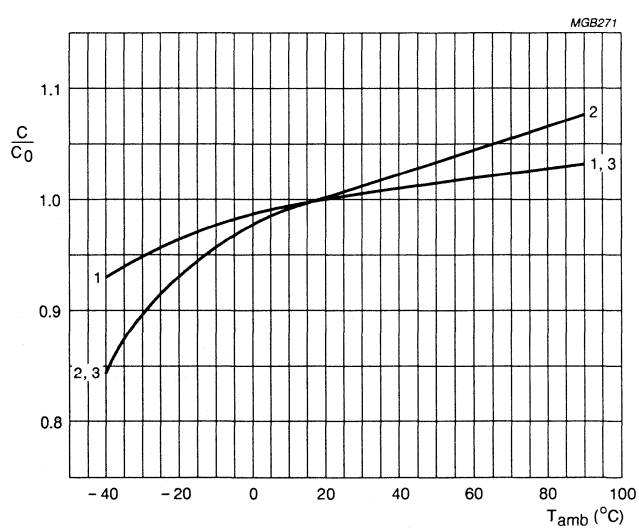
Capacitance (C)



Curve 1: 100 and 200 V
Curve 2: 40 and 63 V
Curve 3: 25 and 385 V
Curve 4: 10 and 16 V.

C/C_0 = capacitance at 20 °C and 100 Hz.

Fig.12 Multiplier of typical capacitance (C/C_0) as a function of frequency.

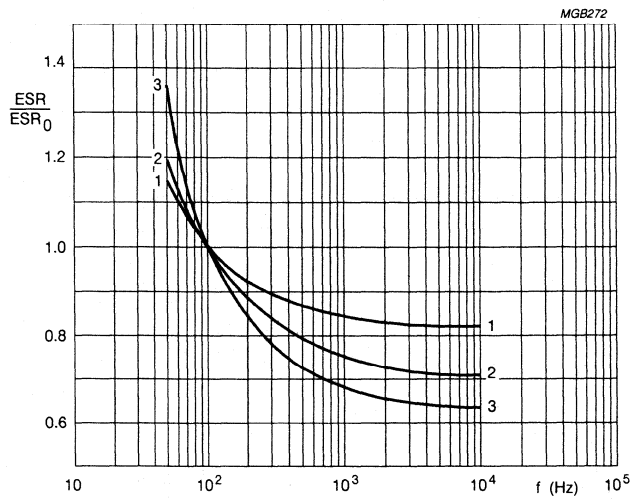


Curve 1: 100 and 200 V
Curve 2: 10 V; 16 V; 25 V; 40 V; 63 V
Curve 3: 385 V.

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.

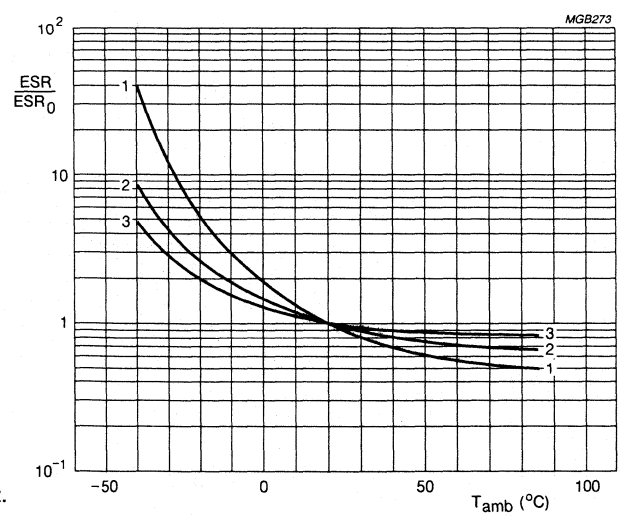
Equivalent series resistance (ESR)



Curve 1: 10 V; 16 V; 25 V
Curve 2: 40 V; 63 V; 385 V
Curve 3: 100 and 200 V.

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 and 200 V
Curve 3: 10 V 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 mm).

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Curve 1: 385 V
Curve 2: 200 V
Curve 3: 100 V
Curve 4: 10 V to 63 V.

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

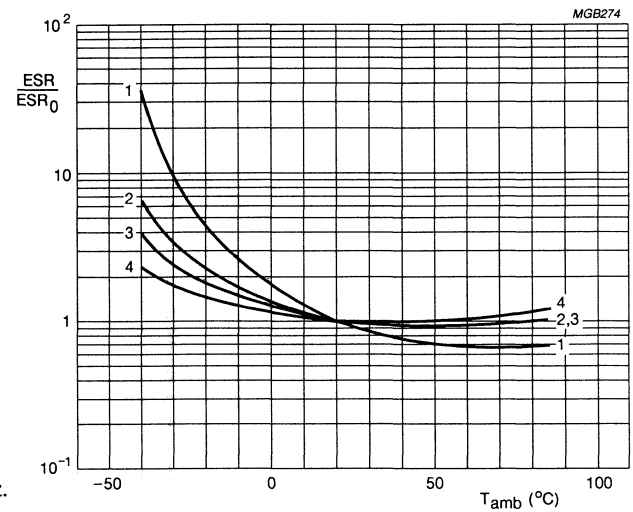

Fig.16 Multiplier of typical ESR (ESR/ESR_0) as a function of ambient temperature (case sizes Ø35 x 55, Ø40 x 45, Ø40 x 55, Ø40 x 75 and Ø40 x 105 mm).

Impedance (Z)

Curve 1: 385 V
Curve 2: 200 V
Curve 3: 100 V
Curve 4: 10 V to 63 V.

Z_0 = typical impedance at 20 °C and 10 kHz.

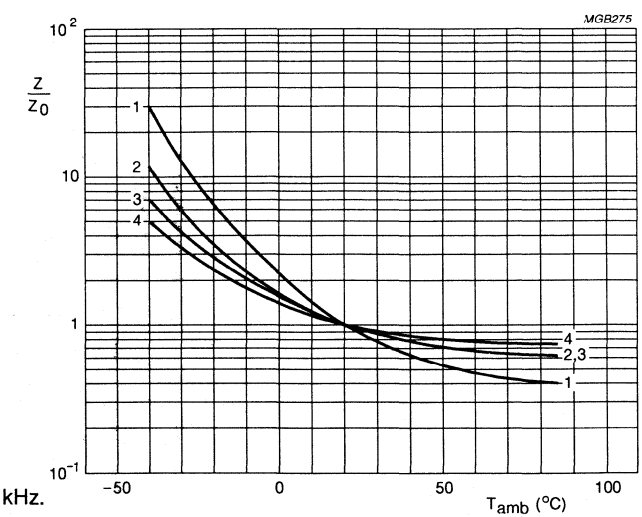

Fig.17 Multiplier of typical impedance (Z/Z_0) as a function of ambient temperature (case sizes Ø25 x 35, Ø25 x 45, Ø30 x 45 and Ø35 x 45 mm).

Curve 1: 385 V
Curve 2: 200 V
Curve 3: 100 V
Curve 4: 10 V to 63 V.

Z_0 = typical impedance at 20 °C and 10 kHz.

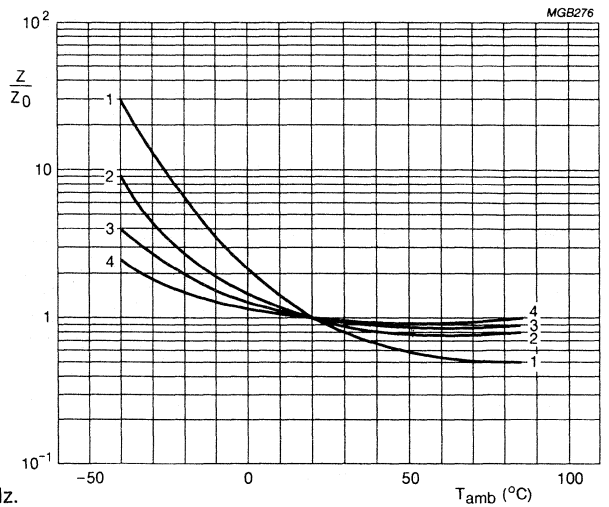

Fig.18 Multiplier of typical impedance (Z/Z_0) as a function of ambient temperature (case sizes Ø35 x 55, Ø40 x 45, Ø40 x 55, Ø40 x 75 and Ø40 x 105 mm).

Curve 1: 68 µF, 385 V
Curve 2: 150 µF, 200 V
Curve 3: 680 µF, 100 V
Curve 4: 2200 µF, 63 V.
Curve 5: 3300 µF, 40 V
Curve 6: 4700 µF, 25 V
Curve 7: 6800 µF, 16 V
Curve 8: 10 000 µF, 10 V.

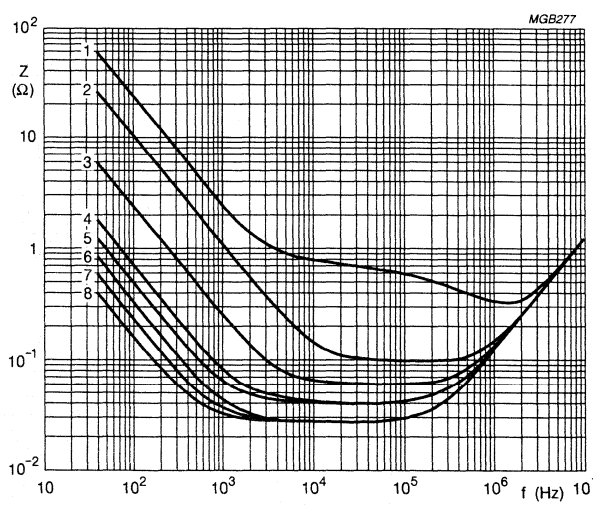

Fig.19 Typical impedance as a function of frequency at +20 °C; case size Ø25 x 35 mm.

Curve 1: 100 µF, 385 V
Curve 2: 220 µF, 200 V
Curve 3: 1000 µF, 100 V
Curve 4: 3300 µF, 63 V.
Curve 5: 4700 µF, 40 V
Curve 6: 6800 µF, 25 V
Curve 7: 10 000 µF, 16 V
Curve 8: 15 000 µF, 10 V.

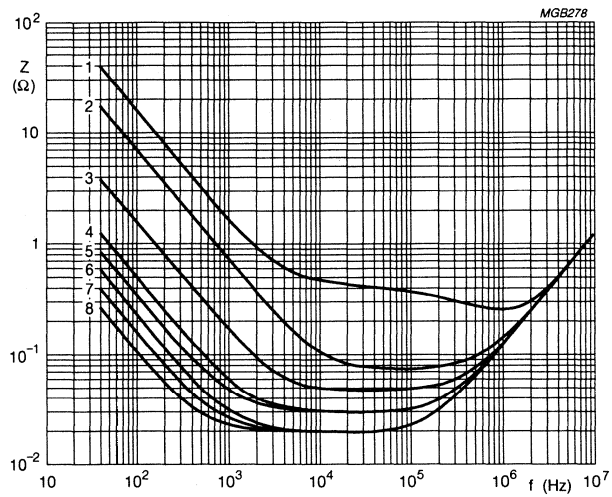

Fig.20 Typical impedance as a function of frequency at +20 °C; case size Ø25 x 45 mm.

Curve 1: 150 µF, 385 V
Curve 2: 330 µF, 200 V
Curve 3: 1500 µF, 100 V
Curve 4: 4700 µF, 63 V
Curve 5: 6800 µF, 40 V
Curve 6: 10 000 µF, 25 V
Curve 7: 15 000 µF, 16 V
Curve 8: 22 000 µF, 10 V.

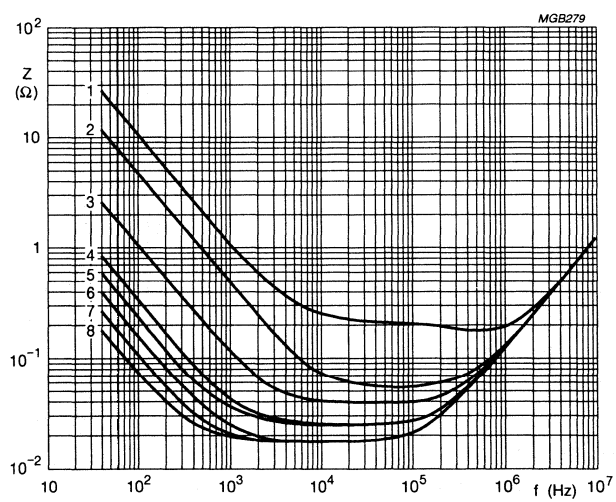

Fig.21 Typical impedance as a function of frequency at +20 °C; case size Ø30 x 45 mm.

Curve 1: 220 µF, 385 V
Curve 2: 470 µF, 200 V
Curve 3: 2200 µF, 100 V
Curve 4: 6800 µF, 63 V.
Curve 5: 10 000 µF, 40 V
Curve 6: 15 000 µF, 25 V
Curve 7: 22 000 µF, 16 V
Curve 8: 33 000 µF, 10 V.

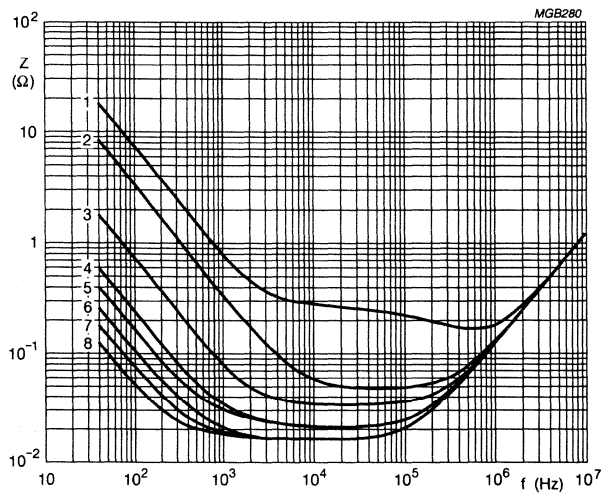

Fig.22 Typical impedance as a function of frequency at +20 °C; case size Ø35 x 45 mm.

Curve 1: 330 µF, 385 V
Curve 2: 680 µF, 200 V
Curve 3: 3300 µF, 100 V
Curve 4: 10 000 µF, 63 V.
Curve 5: 15 000 µF, 40 V
Curve 6: 22 000 µF, 25 V
Curve 7: 33 000 µF, 16 V
Curve 8: 47 000 µF, 10 V.

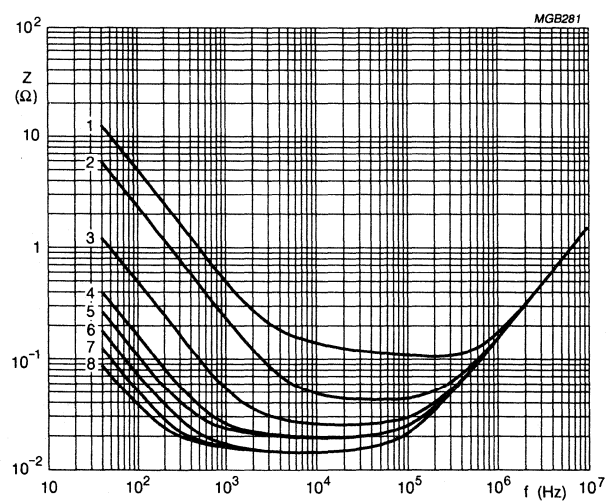

Fig.23 Typical impedance as a function of frequency at +20 °C; case sizes Ø35 x 55 and Ø40 x 45 mm.

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Curve 1: 470 µF, 385 V
Curve 2: 1000 µF, 200 V
Curve 3: 4700 µF, 100 V
Curve 4: 22 000 µF, 40 V.
Curve 5: 33 000 µF, 25 V
Curve 6: 47 000 µF, 16 V
Curve 7: 68 000 µF, 10 V.

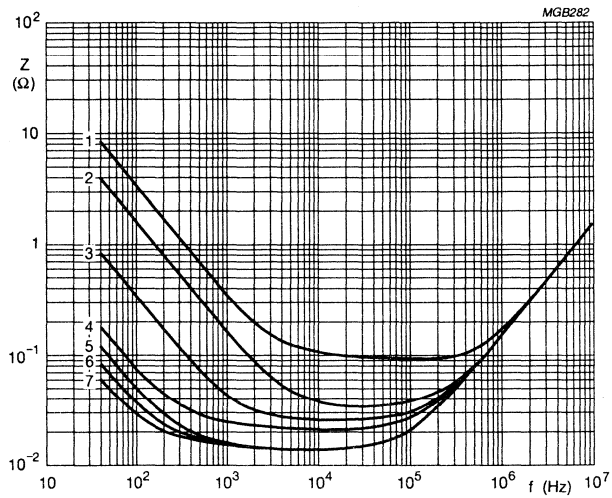

Fig.24 Typical impedance as a function of frequency at +20 °C; case size Ø40 x 55 mm.

Curve 1: 680 µF, 385 V
Curve 2: 1500 µF, 200 V
Curve 3: 6800 µF, 100 V
Curve 4: 15 000 µF, 63 V.
Curve 5: 33 000 µF, 40 V
Curve 6: 47 000 µF, 25 V
Curve 7: 68 000 µF, 16 V
Curve 8: 100 000 µF, 10 V.

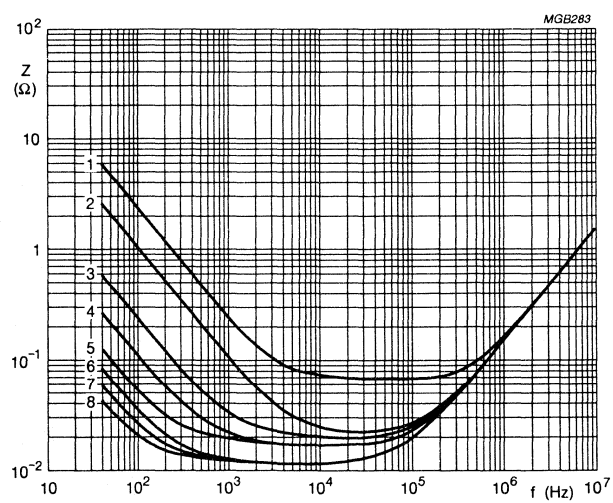

Fig.25 Typical impedance as a function of frequency at +20 °C; case size Ø40 x 75 mm.

Curve 1: 1000 µF, 385 V
Curve 2: 2200 µF, 200 V
Curve 3: 10 000 µF, 100 V
Curve 4: 22 000 µF, 63 V.
Curve 5: 47 000 µF, 40 V
Curve 6: 68 000 µF, 25 V
Curve 7: 1000 000 µF, 16 V
Curve 8: 150 000 µF, 10 V.

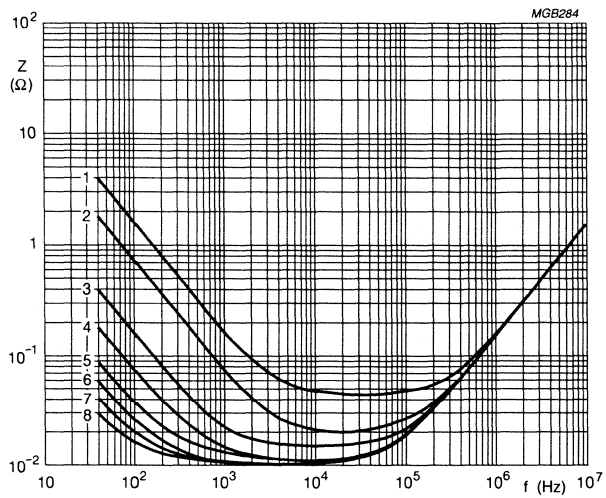

Fig.26 Typical impedance as a function of frequency at +20 °C; case size ∅40 x 105 mm.

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	$I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA
After 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA

Equivalent series inductance (ESL)

Maximum ESL for case sizes ∅25	25 nH
Maximum ESL for case sizes ∅30 and 35	30 nH
Maximum ESL for case sizes ∅40	35 nH

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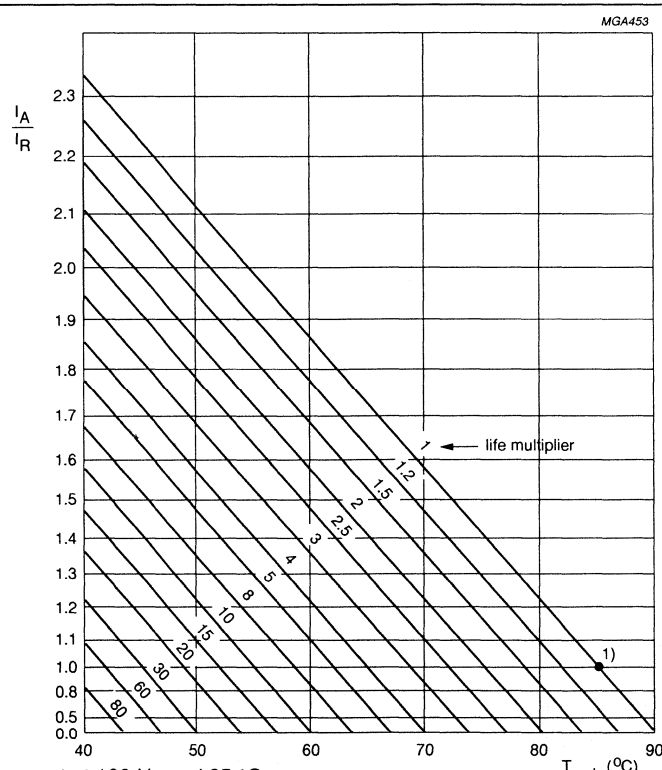
RIPPLE CURRENT and USEFUL LIFE

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.

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/or side of the capacitor
- Code number
- Code for basic specification (in accordance with IEC 384-4-1, CECC 30 301).

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; 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 $I_{L5} \leq$ 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

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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
- Pressure relief on the top of the aluminium case, or in the sealing for bolt versions
- Charge and discharge proof
- Very long useful life: 5000 hours at 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.

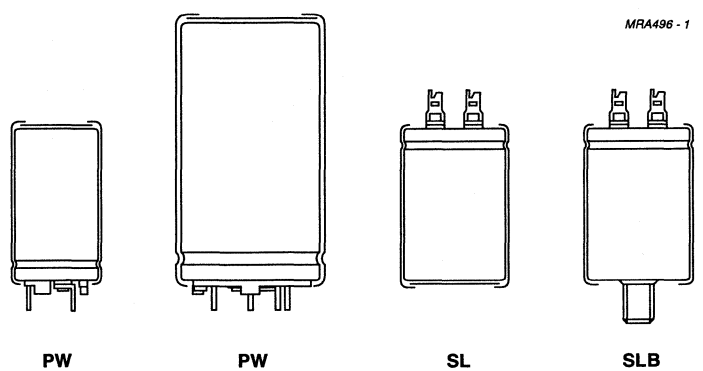

Fig.1 Component outlines.

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	
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade	
Detail specification	similar to DIN 45910-T129, former DIN 41238	
Climatic category IEC 68 DIN 40040	40/105/56 GMF	

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163

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							

Preferred types in **bold**.

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Table 2 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD 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				

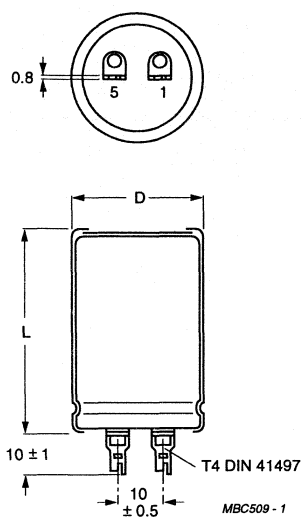
Preferred types in **bold**.

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/or side of the capacitor
- Code number
- Code for basic specification (in accordance with IEC 384-4-1,CECC 30 301).

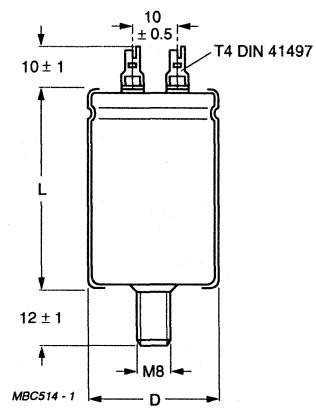
MECHANICAL DATA and PACKING QUANTITIES

Dimensions in mm.



1 = positive terminal; 5 = negative terminal.
Accessories are specified in chapter "Mounting Accessories".

Fig.2 Solder-lug version (SL).



1 = positive terminal; 5 = negative terminal.
Accessories are specified in chapter "Mounting Accessories".

Fig.3 Solder-lug-bolt version (SLB).

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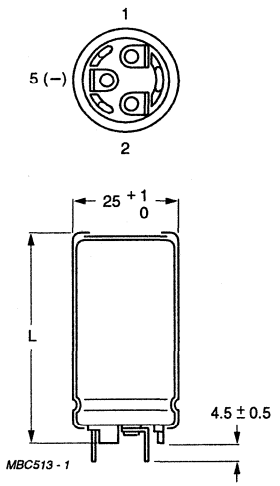
Table 3 SL and SLB versions, dimensions in mm; mass in g

CASE SIZE $\varnothing D_{nom}$ x L_{nom}	CODE	$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)	OUTER BOX DIMENSIONS L x B x H
25 x 35	1	26	36.3	24	100	290 x 280 x 69
25 x 45	2	26	46.3	28	100	290 x 280 x 79
30 x 45	3	31	46.3	38	100	340 x 330 x 79
35 x 45	4	36	46.3	51	50	390 x 198 x 79
35 x 55	5	36	56.3	66	50	390 x 198 x 89
40 x 55	7	41	56.3	82	50	440 x 223 x 89
40 x 75	8	41	76.3	110	50	440 x 223 x 109
40 x 105	9	41	106.3	176	50	440 x 223 x 139

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.

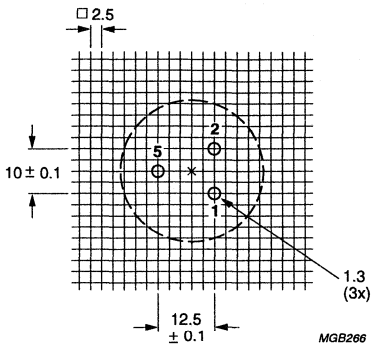
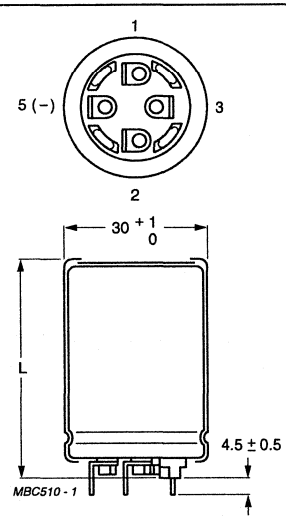


Fig.5 Piercing diagram viewed from component side.



1 = positive terminal; 5 = negative terminal.

Fig.6 Printed wiring pin version, case diameter 30 mm.

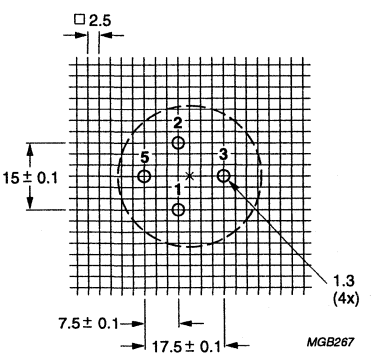
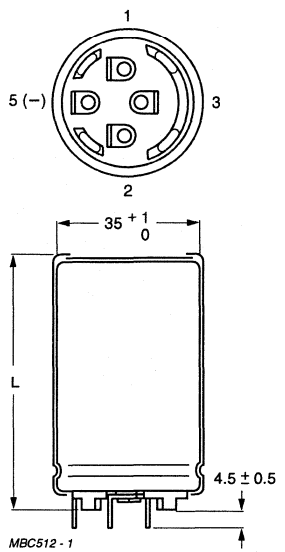


Fig.7 Piercing diagram viewed from component side.



1 = positive terminal; 5 = negative terminal.

Fig.8 Printed wiring pin version, case diameter 35 mm.

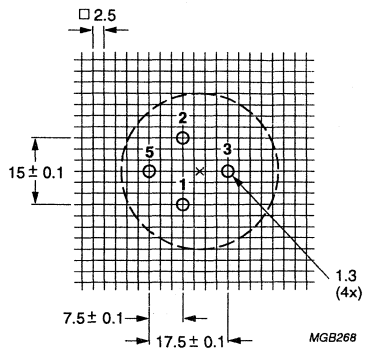


Fig.9 Piercing diagram viewed from component side.

Mounting

The capacitors may be mounted in any position with or without a mounting clamp. When a number of capacitors are connected in a bank, they must not be closer together than 15 mm, when no derating of ripple current and/or temperature is applied.

Pin numbers 2, 3 and 4 (if present) should be at the same potential as the case. If the case has to be at a specified potential, it should be connected to the negative terminal only.

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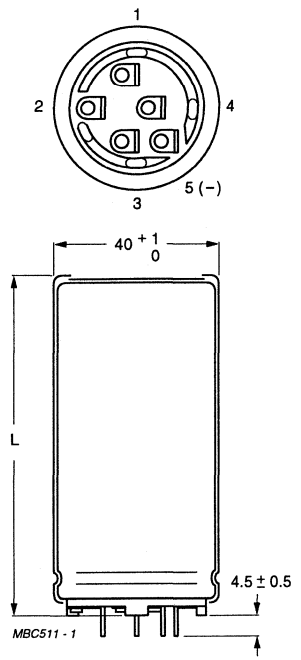
Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163



1 = positive terminal; 5 = negative terminal.

Fig.10 Printed wiring pin version, case diameter 40 mm.

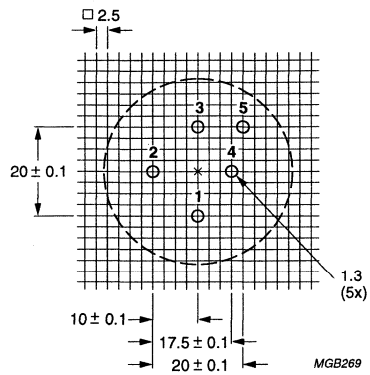


Fig.11 Piercing diagram viewed from component side.

Table 4 PW versions, dimensions in mm; mass in g

CASE		⌀D_{max}	L_{max}	APPROX. MASS	PACKING QUANTITIES (units per box)	OUTER BOX DIMENSIONS L x B x H
SIZE ⌀D_{nom} x L_{nom}	CODE					
25 x 35	1	26	39.3	24	100	290 x 280 x 49
25 x 45	2	26	49.3	28	100	290 x 280 x 59
30 x 45	3	31	49.3	38	100	340 x 330 x 59
35 x 45	4	36	49.3	51	50	390 x 198 x 59
35 x 55	5	36	59.3	66	50	390 x 198 x 69
40 x 45	6	41	49.3	78	50	440 x 223 x 59
40 x 55	7	41	59.3	82	50	440 x 223 x 69
40 x 75	8	41	79.3	110	50	440 x 223 x 89
40 x 105	9	41	109.3	176	50	440 x 223 x 119

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 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 (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

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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 (µA)	I_{L5} 5 min (µA)	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 (µA)	I_{L5} 5 min (µA)	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
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

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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 (µA)	I_{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222 ... .
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
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....

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163

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 mm	25 nH
Maximum ESL for case sizes Ø30 and 35 mm	30 nH
Maximum ESL for case sizes Ø40 mm	35 nH

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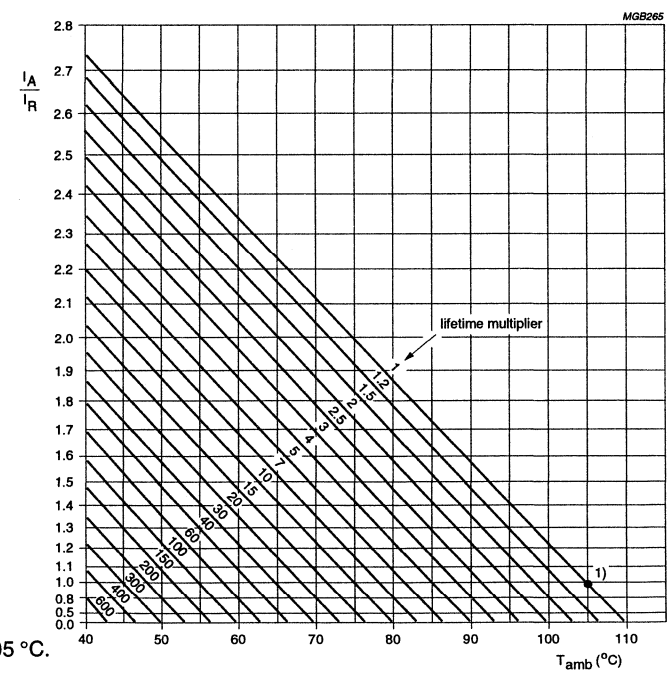
RIPPLE CURRENT and USEFUL LIFE

Table 7 Multiplier of ripple current I_R as a function of frequency.

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10 V to 35 V	U_R = 40 V to 100 V	U_R = 160 V to 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 $I_{L5} \leq$ 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

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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)
- Pressure relief 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 at 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.

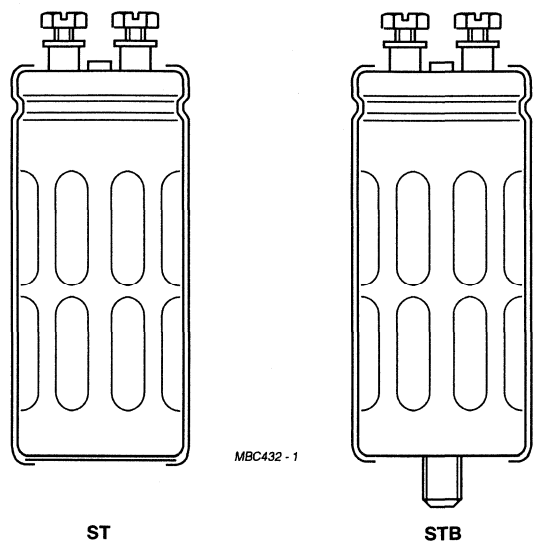


Fig.1 Component outline.

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 (400 V: 2000 hours)	
Useful life at 85 °C	20 000 hours (400 V: 5000 hours)	
Useful life at U_R, 40 °C, 1.4 x I_R applied	350 000 hours (400 V: 90 000 hours)	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4-1/CECC 30 300, LL grade	
Detail specification	DIN 45910-T128 (without approval) former DIN 41248	
Climatic category IEC 68 DIN 40040 NF C93-001	 40/085/56 GPF 554	

Table 1 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD 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					

Preferred types in **bold**.

Table 2 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD 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			

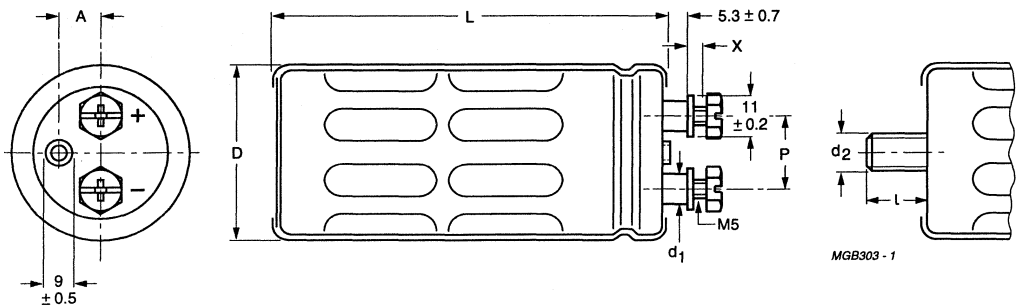
Preferred types in **bold**.

Non-solid Al - electrolytic capacitors
Power Eurodin Screw Terminals

PED-ST 114/115

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.

Accessories are specified in chapter "Mounting Accessories".

Fig.2 Screw terminal/screw terminal bolt.

Table 3 Dimensions in mm; mass in g

CASE		$\varnothing D_{max}$	L_{max}	P (±0.1)	A	d_1 (±0.2)	d_2 x l	MASS	PACKING QUANTITIES (per box)	OUTER BOX DIMENSIONS L x B x H
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE									
35 x 60	10	36.5	63	13.0	8.4	8.0	M8 x 12	≈55	25	196 x 192 x 110
35 x 80	11	36.5	83	13.0	8.4	8.0	M8 x 12	≈80	25	196 x 192 x 115
35 x 105	12a	36.5	108	13.0	8.4	8.0	M8 x 12	≈110	25	196 x 192 x 140
50 x 80	14	51.5	83	22.0	14.3	8.0	M12 x 16	≈160	25	293 x 273 x 115
50 x 105	15a	51.5	108	22.0	14.3	8.0	M12 x 16	≈210	25	293 x 273 x 140
65 x 105	16a	66.5	108	28.5	19.0	9.6	M12 x 16	≈370	10	368 x 151 x 140
75 x 105	17	76.5	108	32.0	21.0	9.6	M12 x 16	≈535	10	418 x 173 x 140

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

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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	15.0	28.5	6.00	2.00	11	7	11	114 19103
	15 000	65 x 105	15.8	30.0	9.00	3.00	10	6	10	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....).

For accessories, refer to chapter "Mounting Accessories".

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	1.0	1.8	0.36	0.12	730	450	935	115 16151
	220	35 x 80	1.4	2.6	0.53	0.18	520	310	630	115 16221
	330	35 x 105	1.9	3.6	0.79	0.26	340	210	425	115 16331
	470	50 x 80	2.7	5.1	1.13	0.38	200	140	300	115 16471
	680	50 x 105	3.6	6.9	1.63	0.54	140	100	205	115 16681
	1000	65 x 105	5.1	9.7	2.40	0.80	95	65	125	115 16102
	1500	65 x 105	5.7	10.6	3.60	1.20	80	45	95	115 16152
	2200	75 x 105	7.3	13.8	5.28	1.76	55	40	75	115 16222

Note

1. Catalogue number applies to the ST version; for STB version replace 8th digit by "5" (2222 114/115 5....).

For accessories, refer to chapter "Mounting Accessories".

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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	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).

Equivalent series resistance (ESR)

Curve 1: case code 10
Curve 2: case code 11
Curve 3: case code 12a
Curve 4: case code 14
Curve 5: case code 15a
Curve 6: case code 16a; 100 000 µF
Curve 7: case code 16a; 150 000 µF
Curve 8: case code 17.

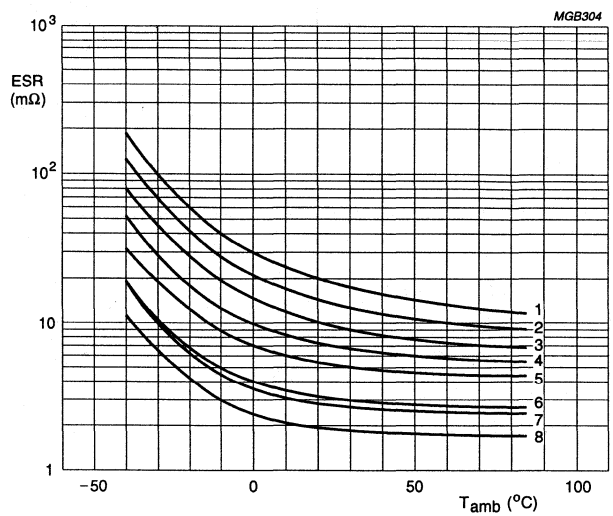

Fig.3 Typical ESR as a function of temperature at 100 Hz and U_R = 10 V.

Curve 1: case code 10; 2200 µF
Curve 2: case code 10; 3300 µF
Curve 3: case code 11
Curve 4: case code 12a
Curve 5: case code 14
Curve 6: case code 15a
Curve 7: case code 16a; 22 000 µF
Curve 8: case code 16a; 33 000 µF
Curve 9: case code 17.

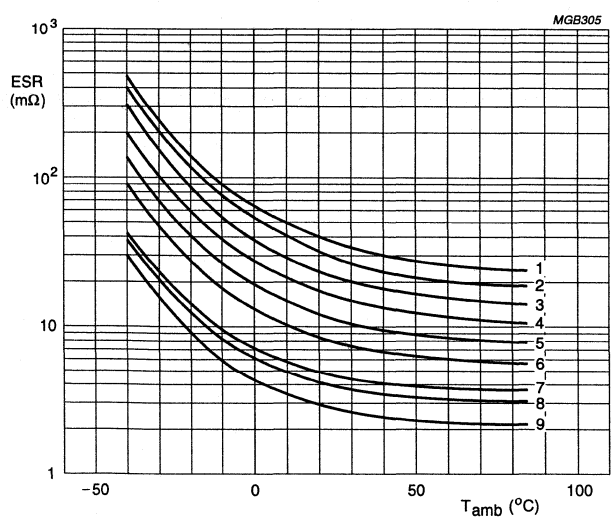

Fig.4 Typical ESR as a function of temperature at 100 Hz and U_R = 63 V.

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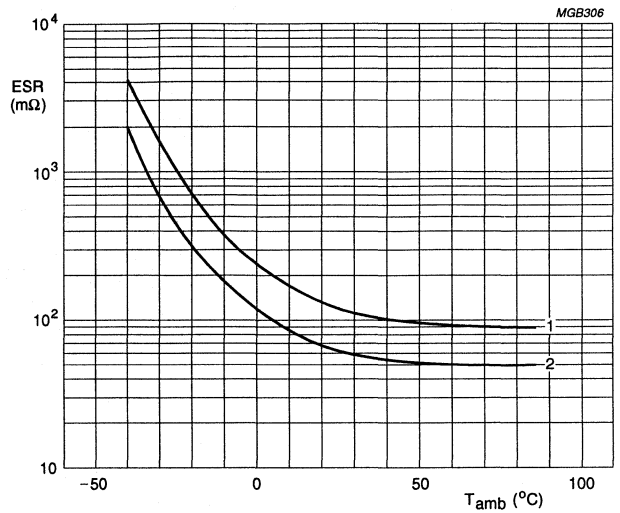
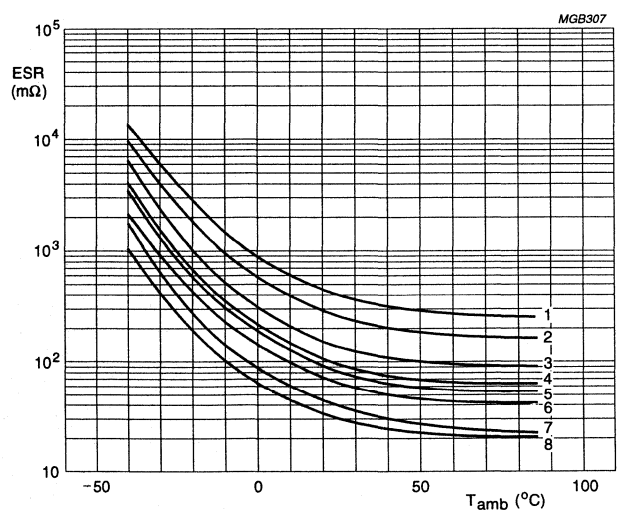


Curve 1: case code 14
Curve 2: case code 15a.

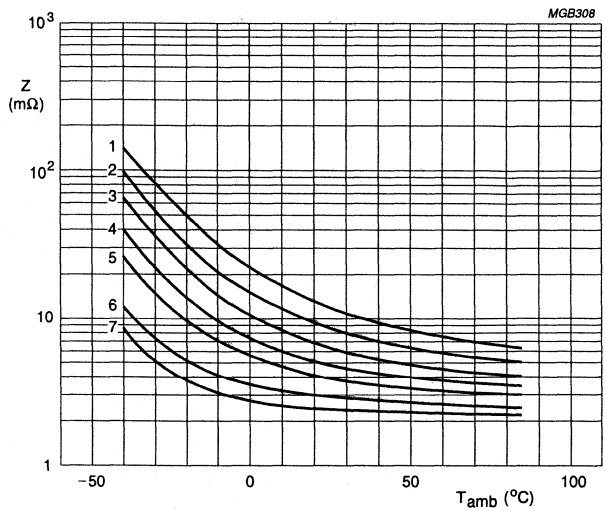
Fig.5 Typical ESR as a function of temperature at 100 Hz and U_R = 250 V.



Curve 1: case code 10
Curve 2: case code 11
Curve 3: case code 12a
Curve 4: case code 14
Curve 5: case code 15a
Curve 6: case code 16a; 1000 µF
Curve 7: case code 16a; 1500 µF
Curve 8: case code 17.

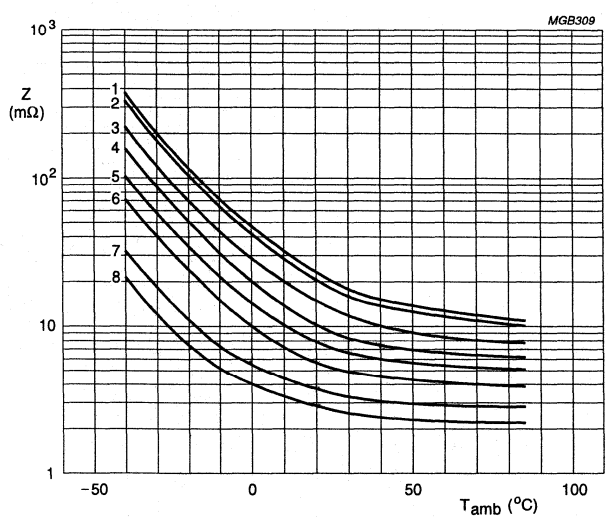
Fig.6 Typical ESR as a function of temperature at 100 Hz and U_R = 385 V.

Impedance (Z)



Curve 1: case code 10
Curve 2: case code 11
Curve 3: case code 12a
Curve 4: case code 14
Curve 5: case case code 15a
Curve 6: case code 16a
Curve 7: case code 17.

Fig.7 Typical impedance as a function of temperature at 20 kHz and U_R = 10 V.



Curve 1: case code 10; 2200 µF
Curve 2: case code 10; 3300 µF
Curve 3: case code 11
Curve 4: case code 12a
Curve 5: case code 14
Curve 6: case code 15a
Curve 7: case code 16a
Curve 8: case code 17.

Fig.8 Typical impedance as a function of temperature at 20 kHz and U_R = 63 V.

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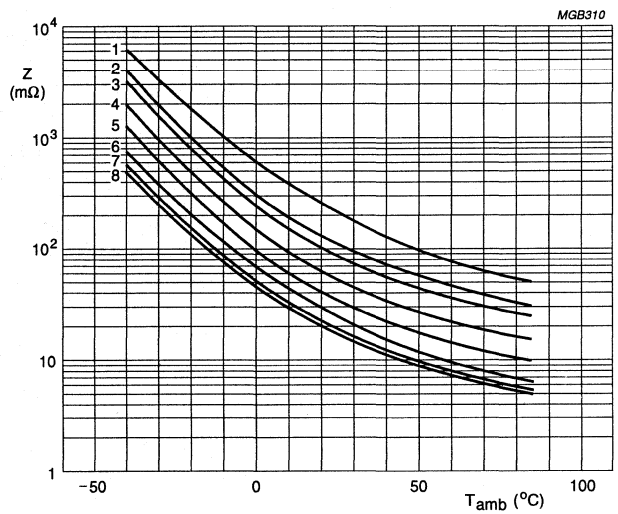
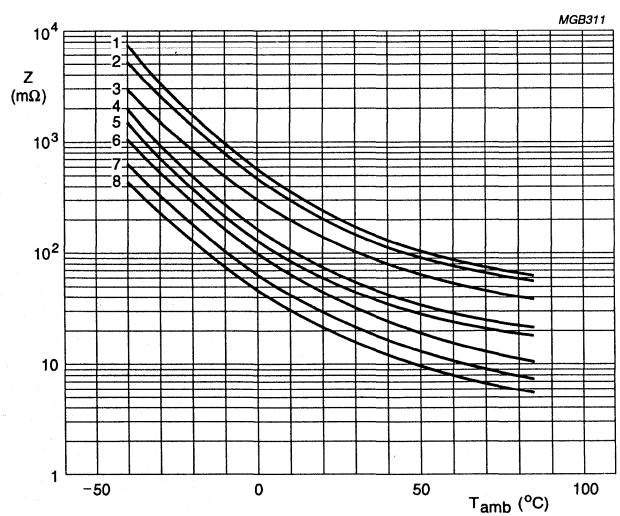


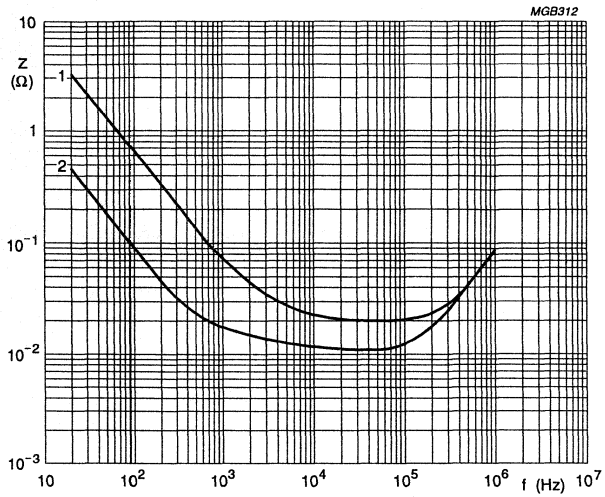
Curve 1: case code 10
Curve 2: case code 11
Curve 3: case code 12a
Curve 4: case code 14
Curve 5: case code 15a
Curve 6: case code 16a; 2200 µF
Curve 7: case code 16a; 3300 µF
Curve 8: case code 17.

Fig.9 Typical impedance as a function of temperature at 20 kHz and U_R = 250 V.



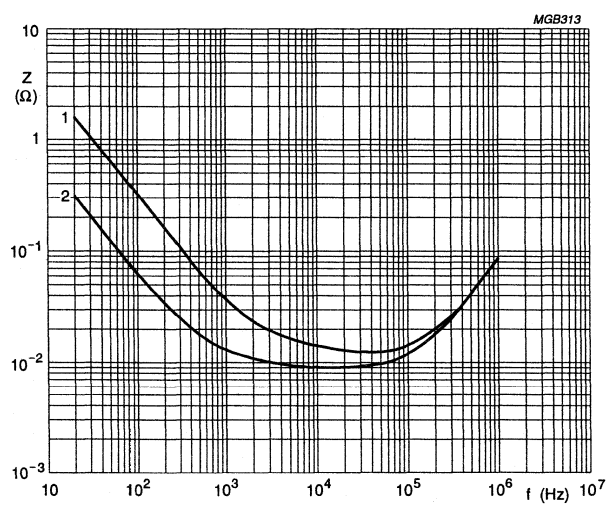
Curve 1: case code 10
Curve 2: case code 11
Curve 3: case code 12a
Curve 4: case code 14
Curve 5: case code 15a
Curve 6: case code 16a; 1000 µF
Curve 7: case code 16a; 1500 µF
Curve 8: case code 17.

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 mm.



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 mm.

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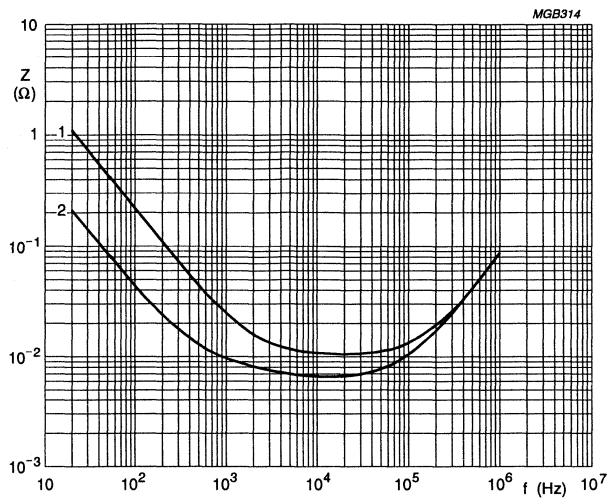
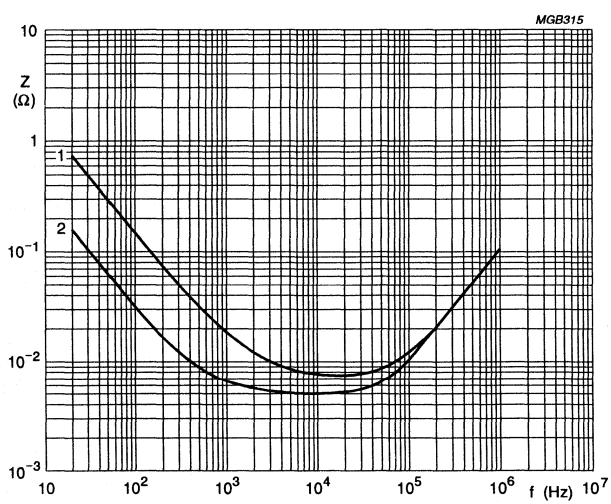


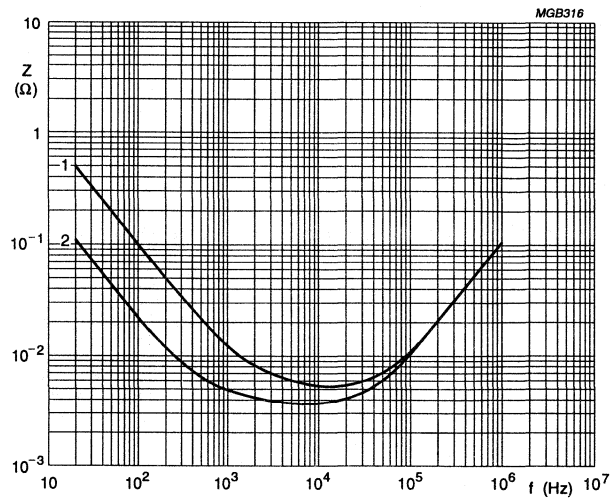
Curve 1: 6800 µF, 63 V
Curve 2: 33 000 µF, 10 V.

Fig.13 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 105 mm.



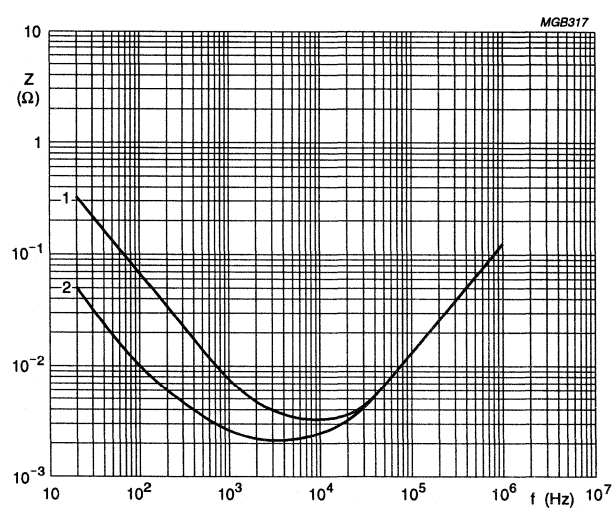
Curve 1: 10 000 µF, 63 V
Curve 2: 47 000 µF, 10 V.

Fig.14 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø50 x 80 mm.



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 mm.



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 mm.

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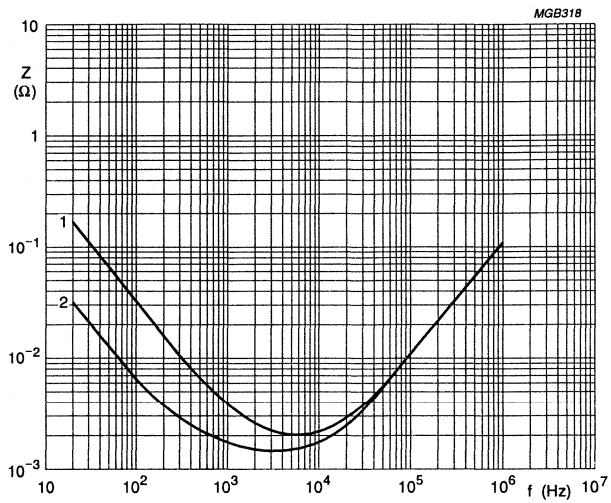
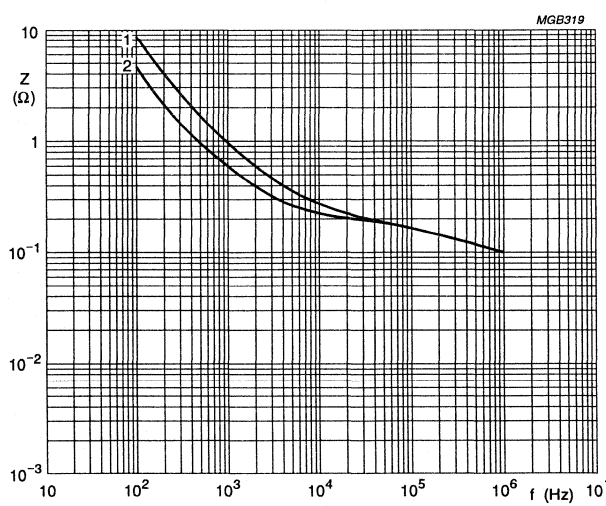


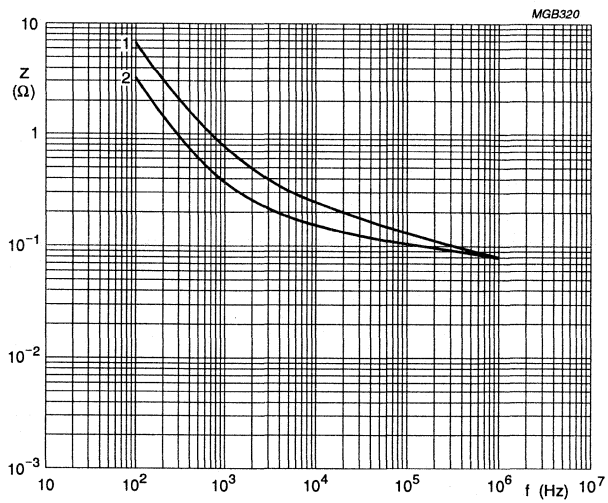
Curve 1: 47 000 µF, 63 V
Curve 2: 220 000 µF, 10 V.

Fig.17 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø75 x 105 mm.



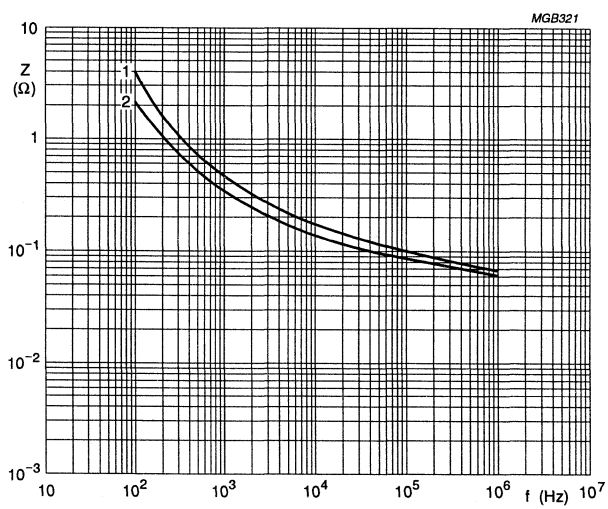
Curve 1: 150 µF, 385 V
Curve 2: 330 µF, 250 V.

Fig.18 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø35 x 60 mm.



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 mm.



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 mm.

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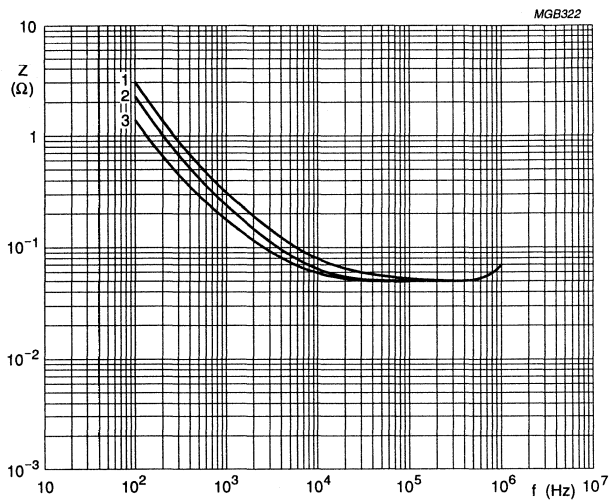
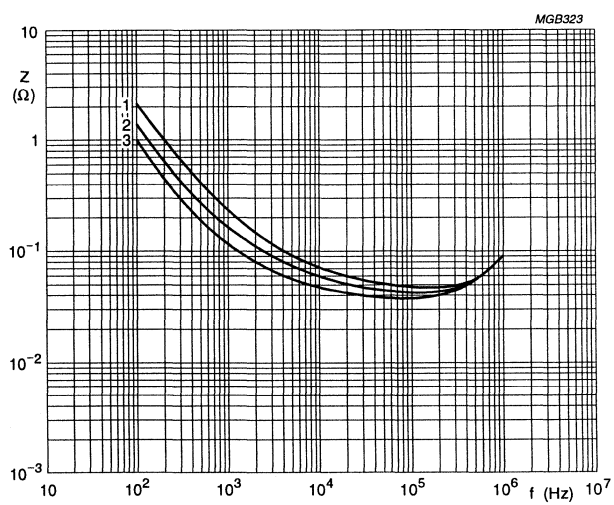


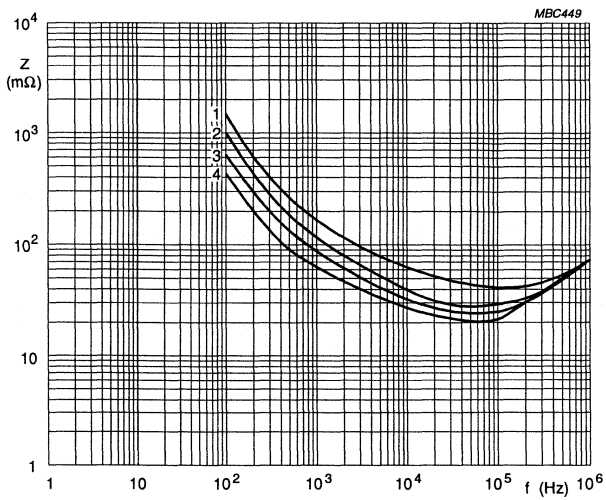
Curve 1: 470 µF, 385 V
Curve 2: 1000 µF, 250 V
Curve 3: 680 µF, 350 V.

Fig.21 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø50 x 80 mm.



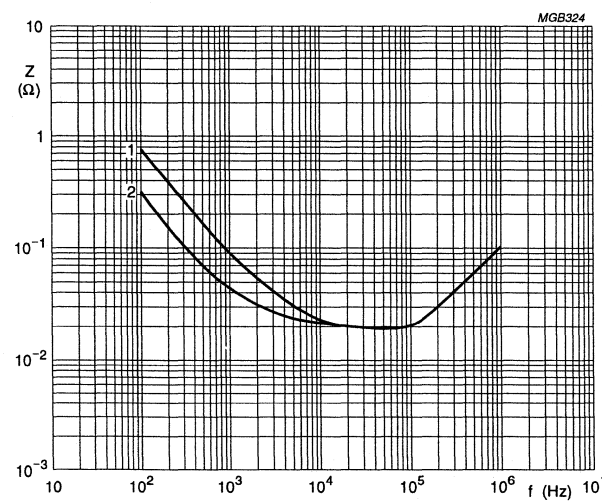
Curve 1: 680 µF, 385 V
Curve 2: 1000 µF, 350 V
Curve 3: 1500 µF, 250 V.

Fig.22 Typical impedance as a function of frequency at T_{amb} = 20 °C; case size Ø50 x 105 mm.



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 mm.



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 mm.

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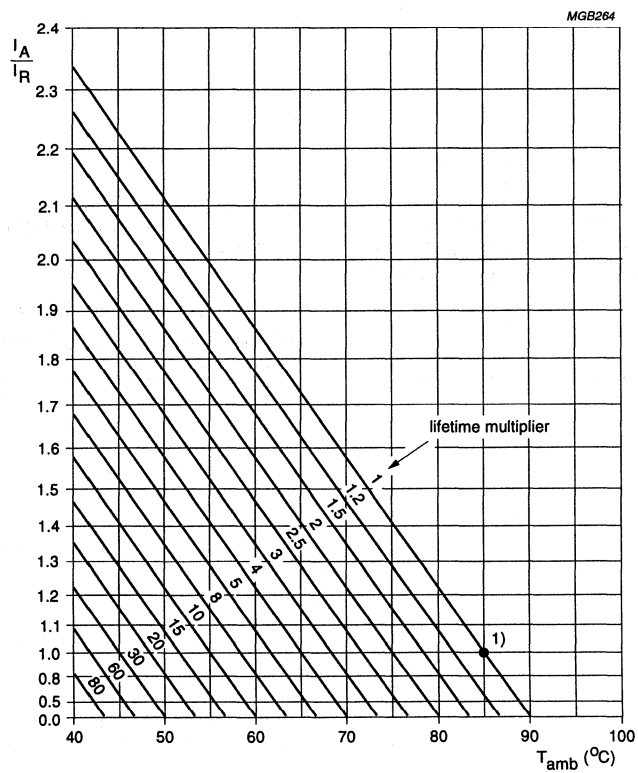
RIPPLE CURRENT and USEFUL LIFE

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. (5000 hours for 400 V types)

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; 8000 hours (400 V: 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; 20 000 hours (400 V: 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 $I_{L5} \leq$ 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

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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)
- Pressure relief in the sealing
- Charge and discharge proof
- Long useful life: 12 000 hours at 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.

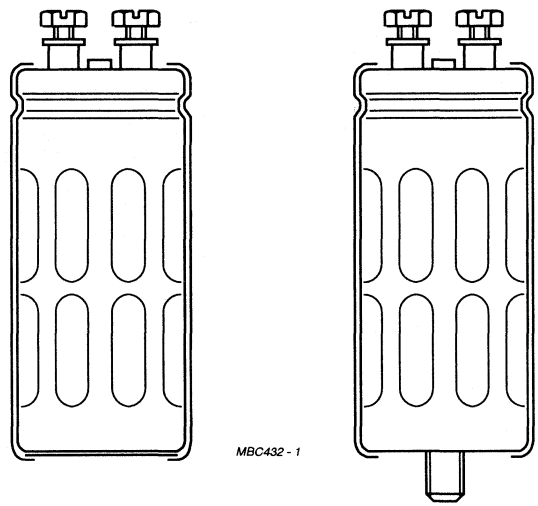

Fig.1 Component outlines.

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 (400 V: 2000 hours)	
Useful life at 85 °C	12 000 hours (400 V: 5000 hours)	
Useful life at U_R, 40 °C, 1.4 x I_R applied	200 000 hours (400 V: 90 000 hours)	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30 300, 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 (**ØD 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					

Preferred types in **bold**.

Table 2 Selection chart for C_R, U_R and relevant nominal case sizes (**ØD 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				

Preferred types in **bold**.

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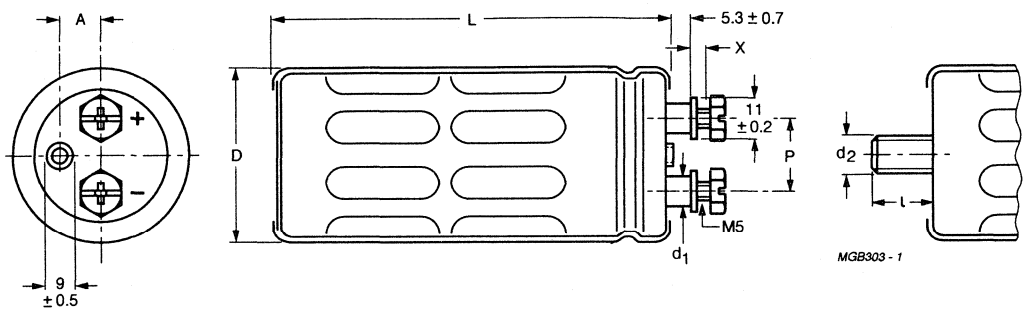
Non-solid Al - electrolytic capacitors
Power Economic Screw Terminals

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 accessories, refer to chapter "Mounting Accessories".

The capacitors are delivered with screws and washers.

Fig.2 Screw terminal/screw terminal bolt.

Table 3 Dimensions in mm; mass in g

CASE										
SIZE $\varnothing D_{nom}$ x L_{nom}	CODE	$\varnothing D_{max}$	L_{max}	P (±0.1)	A	d_1 (±0.2)	d_2 x l	MASS	PACKING QUANTITIES (per box)	OUTER BOX DIMENSIONS L x B x H
35 x 60	10	36.5	63	13.0	8.4	8.0	M8 x 12	≈55	25	196 x 192 x 110
35 x 80	11	36.5	83	13.0	8.4	8.0	M8 x 12	≈80	25	196 x 192 x 115
35 x 105	12a	36.5	108	13.0	8.4	8.0	M8 x 12	≈110	25	196 x 192 x 140
50 x 80	14	51.5	83	22.0	14.3	8.0	M12 x 16	≈160	25	293 x 273 x 115
50 x 105	15a	51.5	108	22.0	14.3	8.0	M12 x 16	≈210	25	293 x 273 x 140
65 x 105	16a	66.5	108	28.5	19.0	9.6	M12 x 16	≈370	10	368 x 151 x 140
75 x 105	17	76.5	108	32.0	21.0	9.6	M12 x 16	≈535	10	418 x 173 x 140

Non-solid Al - electrolytic capacitors
Power Economic Screw Terminals

PEC-ST 154/155

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	14	11	16.5	154 14473
	68 000	35 x 80	8.7	16.5	4.08	1.36	11	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	14	10	15	154 15333
	47 000	35 x 80	8.7	16.5	4.51	1.51	11	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

Note

1. Catalogue number applies to the ST version; for STB version replace 8th digit by "5" (2222 154/155 5....).

For accessories, refer to chapter "Mounting Accessories".

P

Non-solid Al - electrolytic capacitors
Power Economic Screw Terminals

PEC-ST 154/155

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D 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 18153
	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	3.8	7.2	1.98	0.66	50	35	55	154 19332
	4700	35 x 80	5.3	10.0	2.82	0.94	35	25	40	154 19472
	6800	35 x 105	7.1	13.5	4.08	1.36	25	18	28	154 19682
	10 000	50 x 80	8.9	16.9	6.00	2.00	18	13	20	154 19103
	15 000	50 x 105	11.5	21.8	9.00	3.00	14	10	16	154 19153
	22 000	65 x 105	18.2	34.5	13.20	4.40	7.5	6	9	154 19223
	33 000	75 x 105	24.1	45.7	19.80	6.60	5.0	4	6	154 19333
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

Table 5 Electrical data and ordering information for 155 series

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D 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	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
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	1.0	2.0	0.53	0.18	650	475	955	155 16221
	330	35 x 80	1.5	2.9	0.79	0.27	430	320	635	155 16331
	470	35 x 80	1.8	3.4	1.13	0.38	300	220	445	155 16471
	680	35 x 105	2.4	4.6	1.63	0.54	210	150	310	155 16681
	1000	50 x 80	3.4	6.5	2.40	0.80	125	90	210	155 16102
	1500	50 x 105	4.7	8.9	3.60	1.20	85	60	140	155 16152
	2200	65 x 105	6.5	12.4	5.28	1.76	58	40	95	155 16222
	3300	75 x 105	7.6	14.5	7.92	2.64	50	35	70	155 16332

Note

1. Catalogue number applies to the ST version; for STB version replace 8th digit by "5" (2222 154/155 5....).

For accessories, refer to chapter "Mounting Accessories".

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 ∅35 mm	18 nH
Typical ESL for case sizes ∅50 mm	25 nH
Typical ESL for case size ∅65 mm	27 nH
Typical ESL for case size ∅75 mm	29 nH

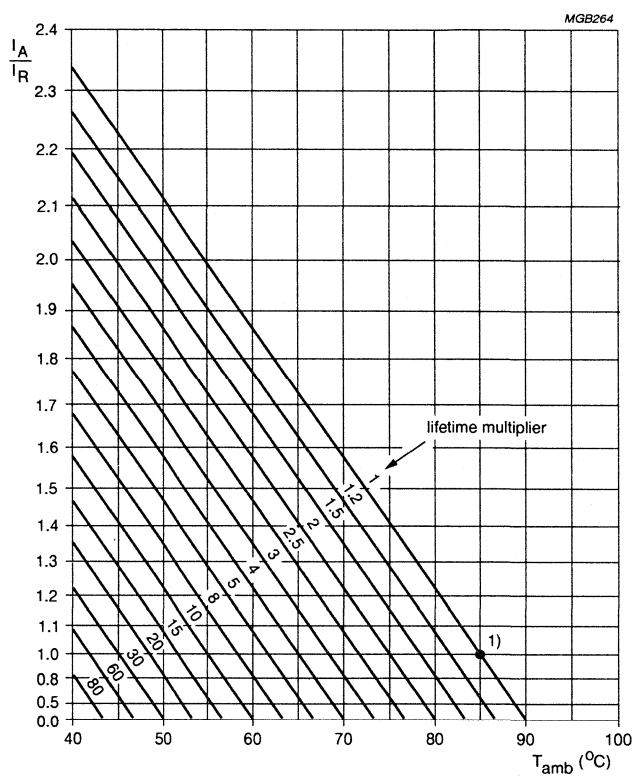
MARKING

- 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).

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: 12 000 hours. (5000 hours for 400 V types)

Fig.3 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 (400 V: 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; 12 000 hours (400 V: 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 $I_{L5} \leq$ 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

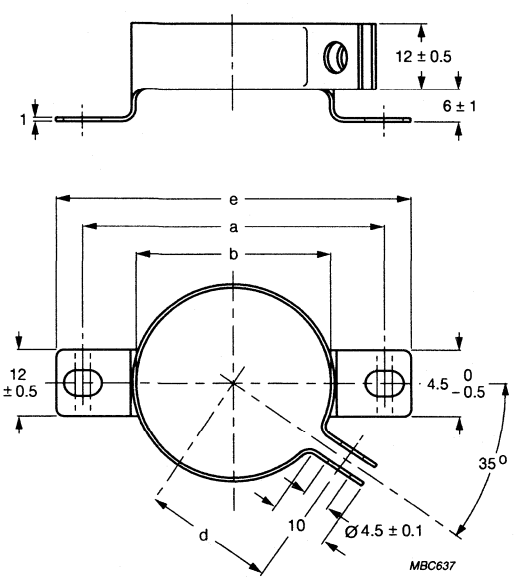
Non-solid Al - Electrolytic Capacitors — Mounting Accessories

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.

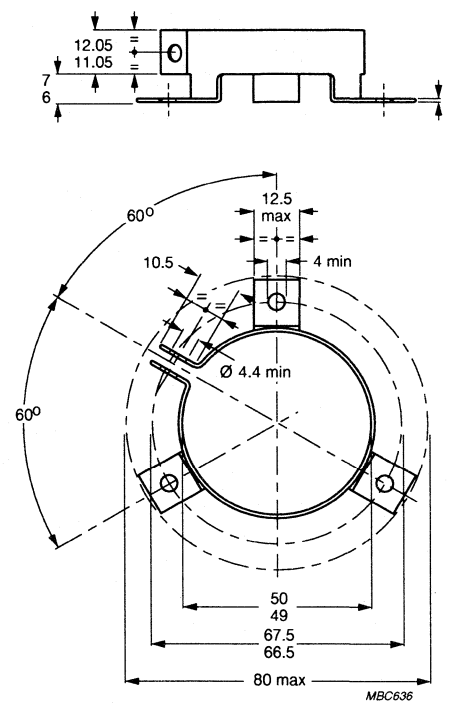
Note

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



Dimensions in mm.
Catalogue number: 4322 043 04272.

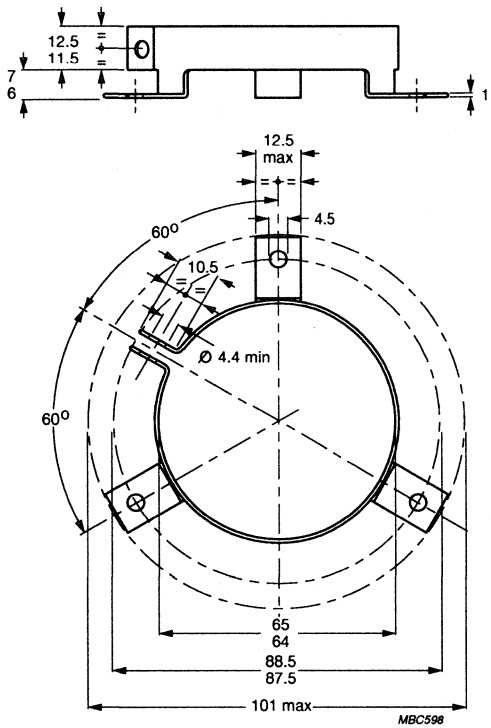
Fig.1 Clamp for case diameter of 35 mm.



Dimensions in mm.
Catalogue number: 4322 043 04281.

Fig.2 Clamp for case diameter of 50 mm.

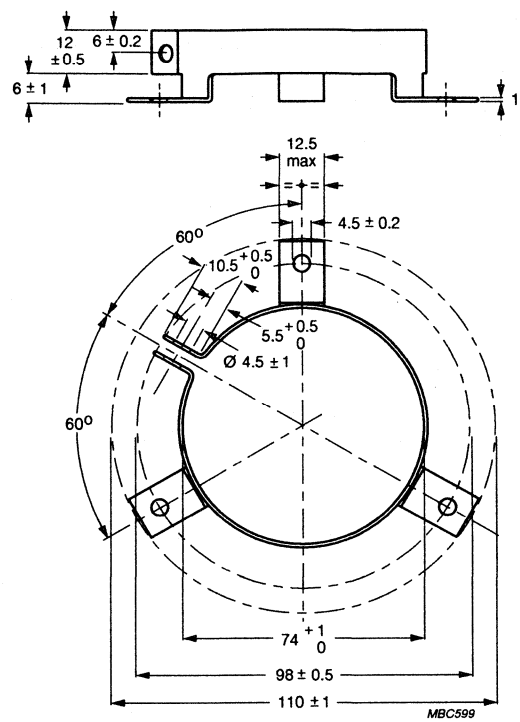
P



Dimensions in mm.

Catalogue number: 4322 043 04291.

Fig.3 Clamp for case diameter of 65 mm.



Dimensions in mm.

Catalogue number: 4322 043 12991.

Fig.4 Clamp for case diameter of 75 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).

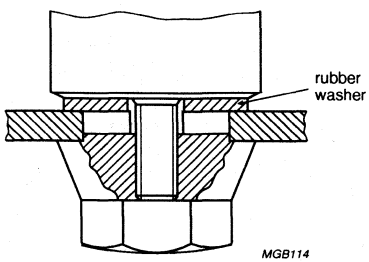
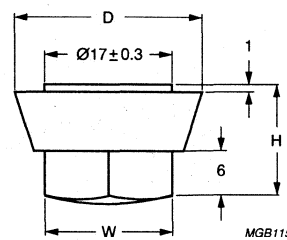


Fig.5 Insulated mounting.



Dimensions in mm.

Fig.6 Synthetic cap nut; see Table 1 for dimensions D, H and W.

Table 1 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.

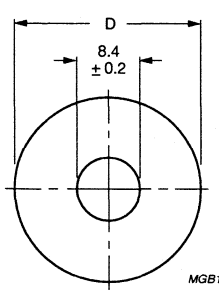


Fig.7 Rubber washer; thickness 2 mm.

Table 2 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 13001

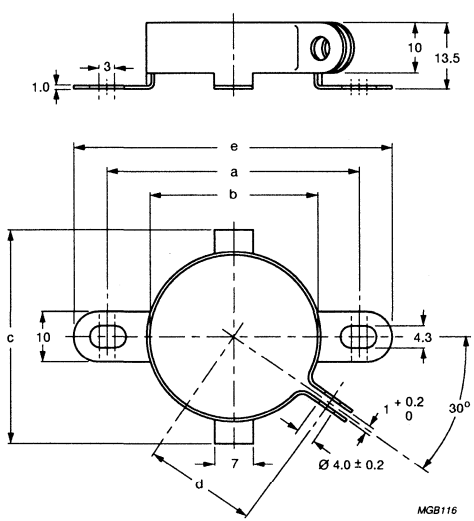
P

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.

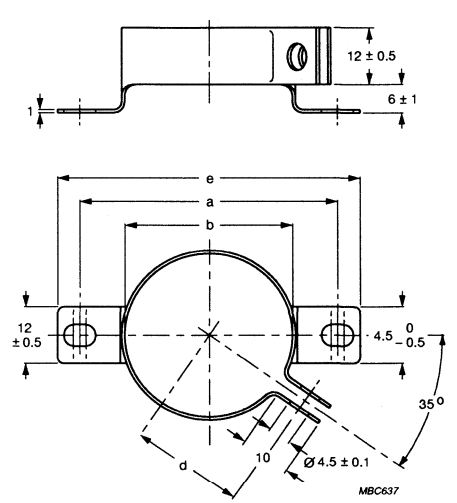
Note

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



Dimensions in mm.

Fig.8 Clamp for case diameters 25, 30 and 40 mm.



Dimensions in mm.

Fig.9 Clamp for case diameter 35 mm.

Table 3 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.

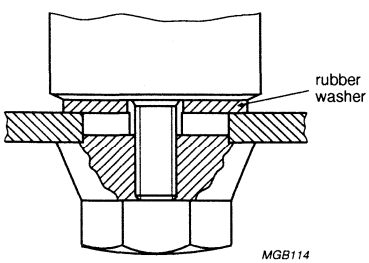
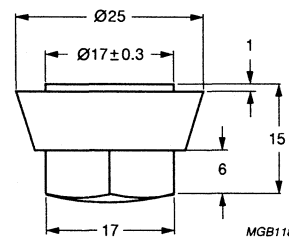


Fig.10 Cross section of bolt.



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

Fig.11 Synthetic cap nut M8.

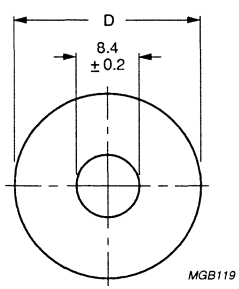


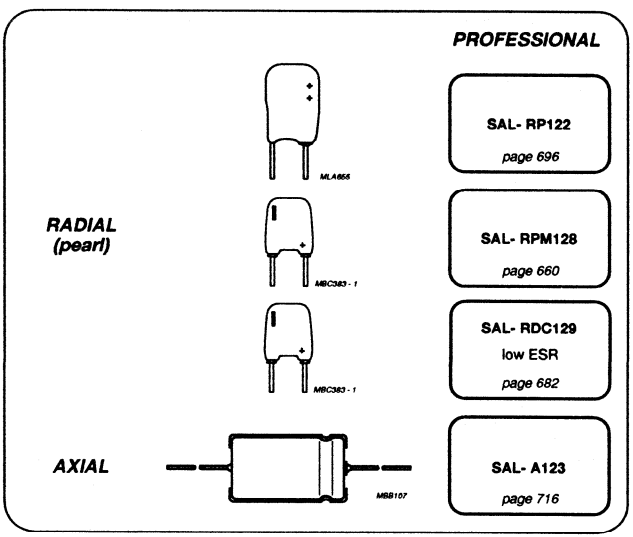
Fig.12 Rubber washer (thickness 2 mm).

Table 4 Rubber washer ordering codes

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

P

SOLID ALUMINIUM (SAL) ELECTROLYTIC CAPACITORS



SA

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 at 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.

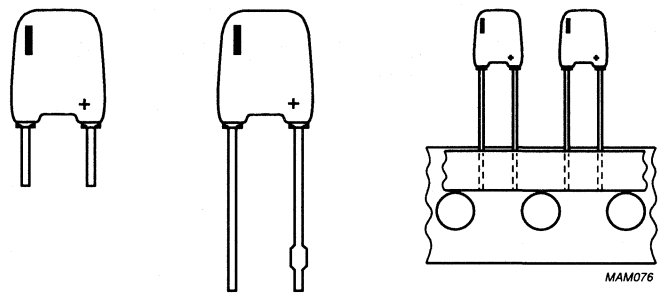


Fig.1 Component outlines.

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_C = 6.3 to 25 V for U_R = 6.3 to 40 V	 –55 to +125 °C –55 to +85 °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
Based on sectional specification	IEC 384-4/CECC 30 300
Detail specification	IEC 384-4-2, CECC 30 302
Climatic category IEC 68 DIN 40040 NF C20-600	 55/125/56 FKD 434

Solid Al - electrolytic capacitors
Solid Al, Radial Pearl Miniature

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

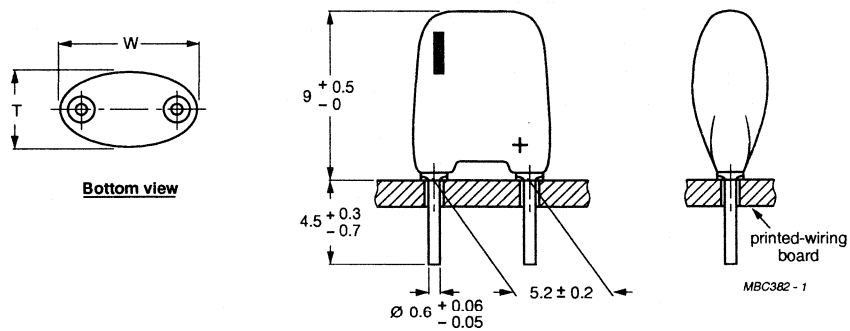
C_R (µF)	U_R (V) at T_{amb} = 85 °C					
	6.3	**10**	**16**	**25**	**35**	**40**
	U_C (V) at T_{amb} = 125 °C					
	6.3	**10**	**16**	**25**	**25**	**25**
0.1						9.5 x 7 x 3
0.15						9.5 x 7 x 3
0.22						9.5 x 7 x 3.5
0.33					9.5 x 7 x 3.5	9.5 x 7 x 4
0.47					9.5 x 7 x 4	9.5 x 7 x 5
0.68				9.5 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
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**					

Preferred types in **bold**.

SA

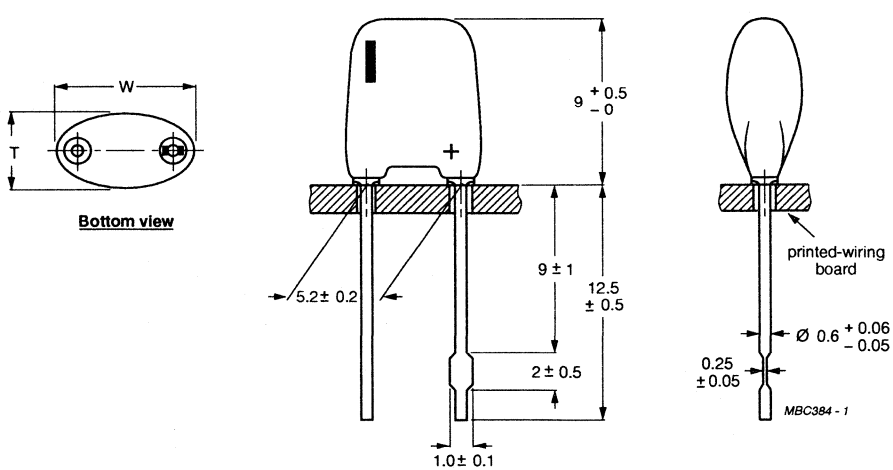
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

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.

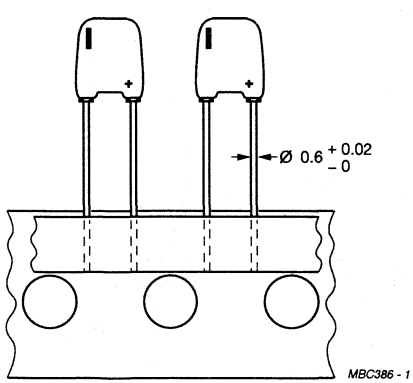
Table 2 Dimensions in mm; mass in g

CASE		APPROX. MASS	PACKING QUANTITIES			
SIZE H_{max} x W_{max} x T_{max}	CODE		FORM CA (note 1)	FORM CB (note 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
- '+' sign to identify the anode terminal
- Vertical '–' 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.

SA

Solid Al - electrolytic capacitors
Solid Al, Radial Pearl Miniature

SAL-RPM 128

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 128 series. Preferred types in **bold**.

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

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. Preferred types in **bold**.

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

SA

Solid Al - electrolytic capacitors
Solid Al, Radial Pearl Miniature

SAL-RPM 128

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

Solid Al - electrolytic capacitors
Solid Al, Radial Pearl Miniature

SAL-RPM 128

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....	128 8....

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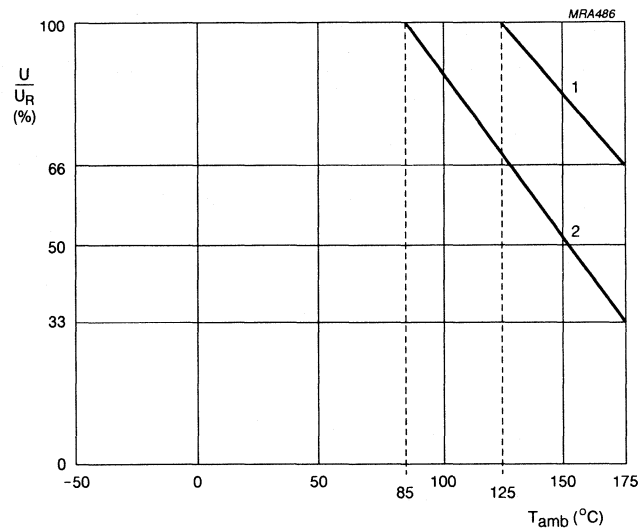
Solid Al - electrolytic capacitors
Solid Al, Radial Pearl Miniature

SAL-RPM 128

Voltage



Curve 1: U_R = 6.3 V to 25 V
Curve 2: U_R = 35 and 40 V.

Fig.5 Maximum permissible voltage up to 175 °C.

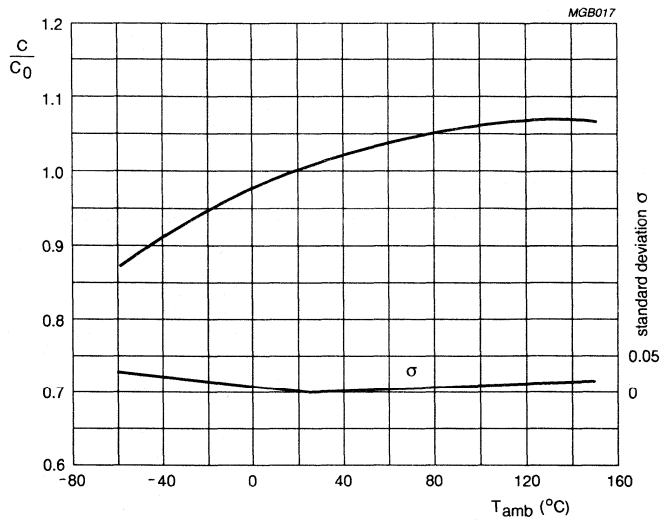
Surge voltage for short periods	$U_s \leq 1.15 \cdot U_R$	
Reverse voltage	$U_{rev} < 0.3 \cdot U_R$	
Max. peak AC voltage, reverse voltage applied	≤2 V	
Max. peak AC voltage, without reverse voltage applied		
	$T_{amb} \leq 85$ °C	85 °C $< T_{amb} \leq 125$ °C
at f ≤ 0.1 Hz	0.30 x U_R	0.15 x U_R
at 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

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.

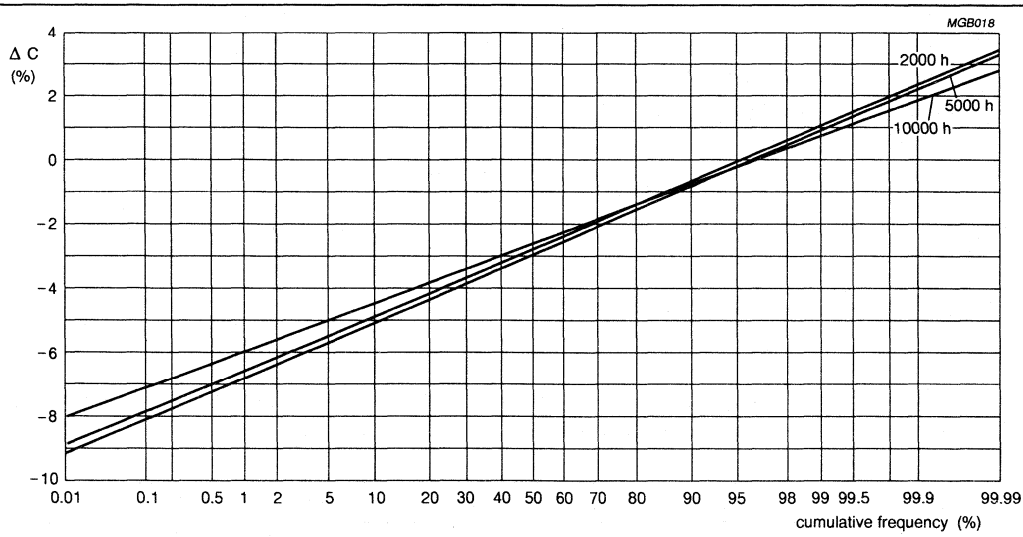


Fig.7 Change of capacitance after endurance test.

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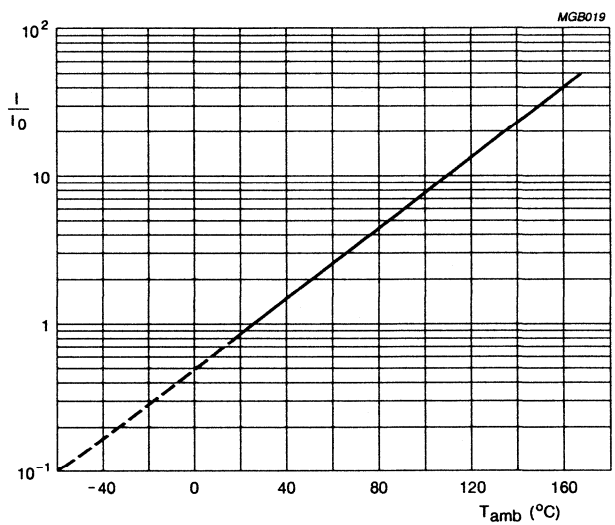
Leakage current

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 after 15 s at U_R and T_{amb} = 25 °C

6.3 V to 16 V versions	approx. 0.2 x value stated in Table 3
25 V to 40 V versions	approx. 0.1 x value stated in Table 3



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.

Typical parameter change after endurance test at T_{amb} = 125 °C.

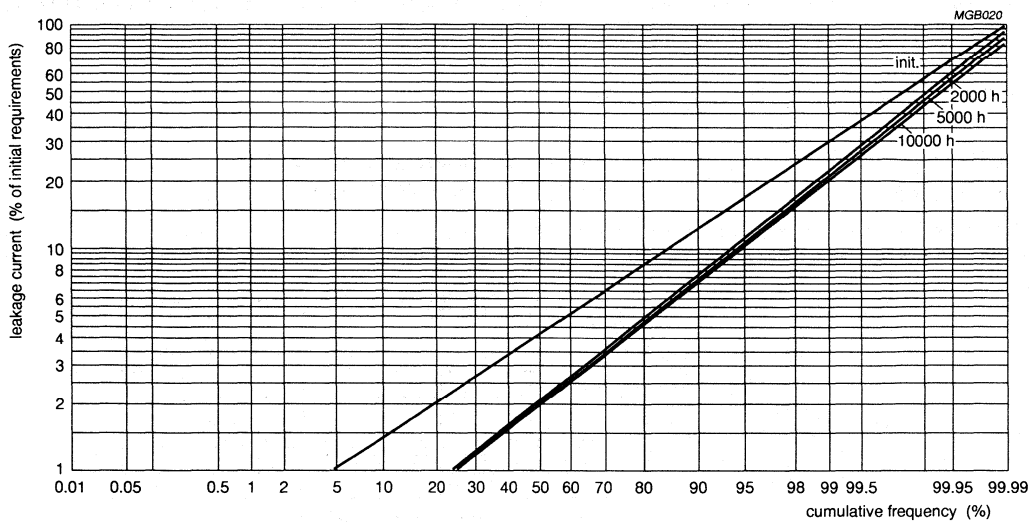
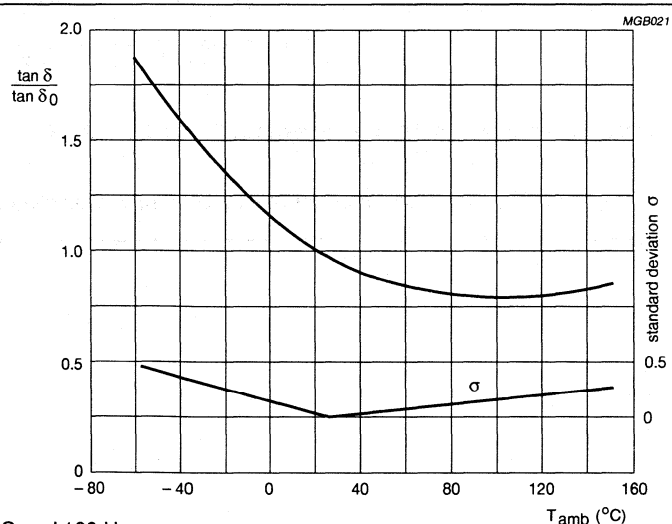


Fig.9 Leakage current after endurance test.

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.

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Typical parameter change after endurance test at T_{amb} = 125 °C.

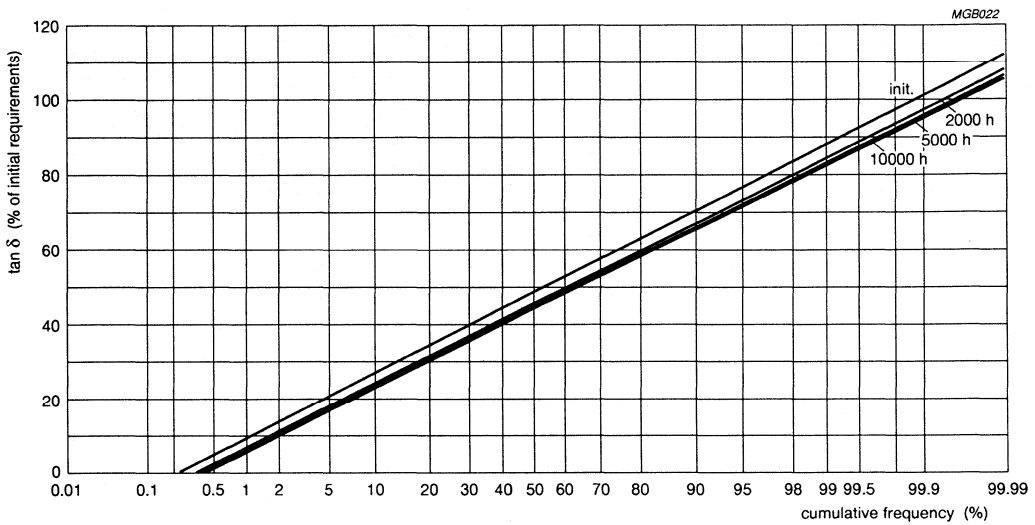
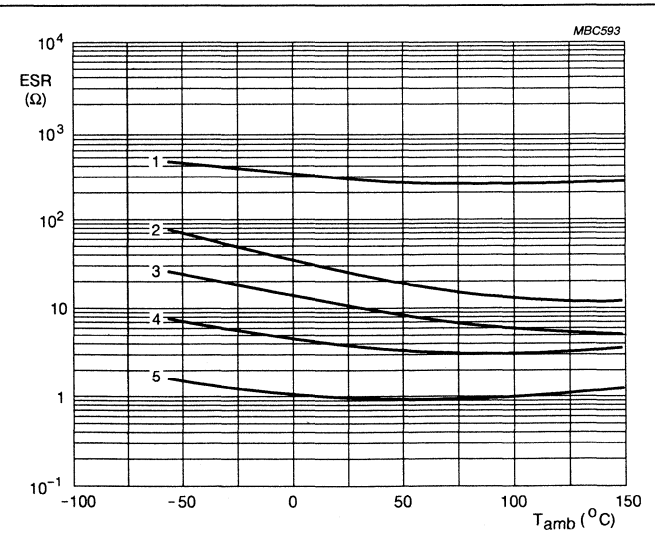


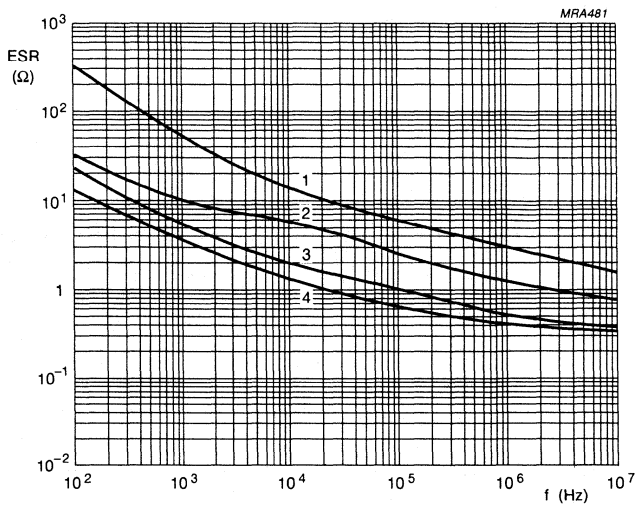
Fig.11 Tan δ after endurance test.

Equivalent series resistance (ESR)



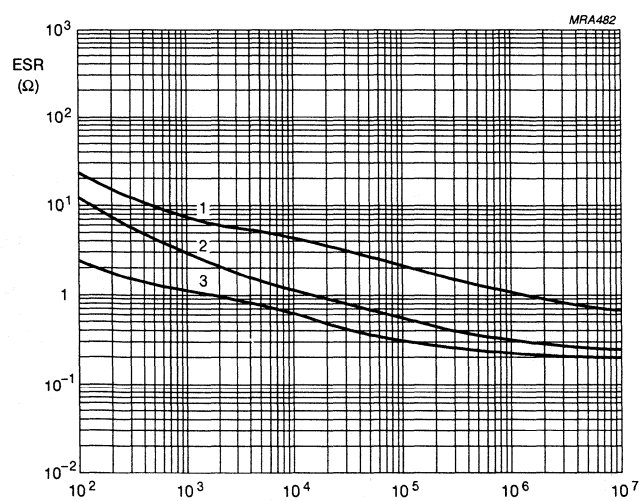
Curve 1: 0.1 µF, 40 V
Curve 2: 1.5 µF, 40 V
Curve 3: 3.3 µF, 25 V
Curve 4: 10 µF, 6.3 V
Curve 5: 22 µF, 10 V.

Fig.12 Typical ESR as a function of temperature at 100 Hz.



Curve 1: 0.22 µF, 40 V
Curve 2: 1.5 µF, 25 V
Curve 3: 2.2 µF, 16 V
Curve 4: 10 µF, 6.3 V.

Fig.13 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 7 x 3.5 mm.



Curve 1: 2.2 µF, 25 V
Curve 2: 4.7 µF, 16 V
Curve 3: 22 µF, 6.3 V.

Fig.14 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 7 x 4 mm.

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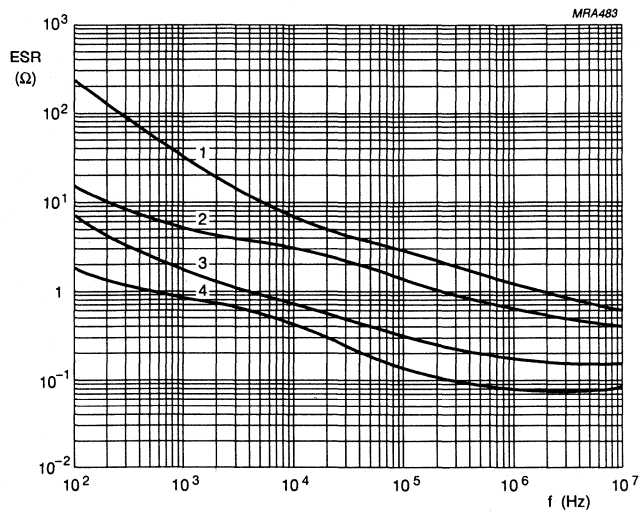
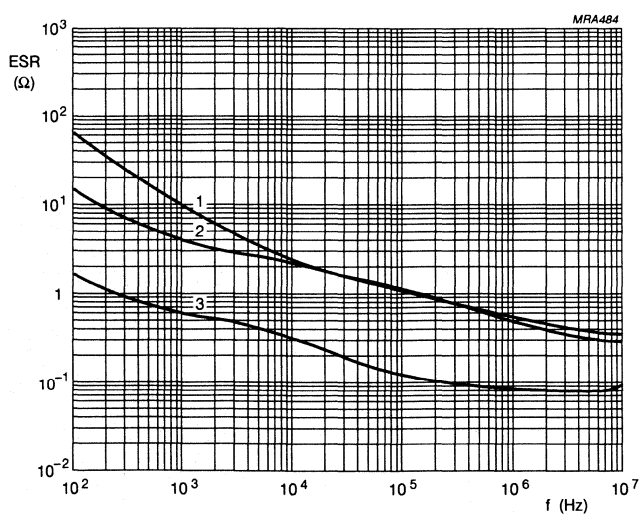


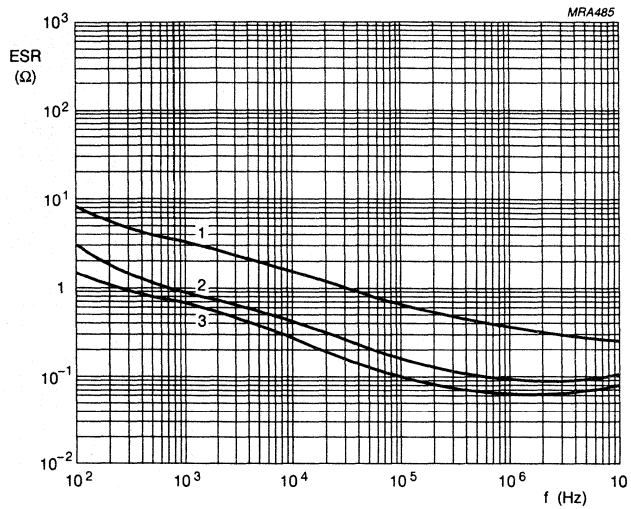
Curve 1: 0.47 µF, 40 V
Curve 2: 3.3 µF, 25 V
Curve 3: 10 µF, 16 V
Curve 4: 33 µF, 6.3 V.

Fig.15 Typical ESR as a function of frequency at T_{amb} = 25 °C; case sizes 9.5 x 7 x 5 mm.



Curve 1: 1 µF, 40 V
Curve 2: 4.7 µF, 25 V
Curve 3: 47 µF, 6.3 V.

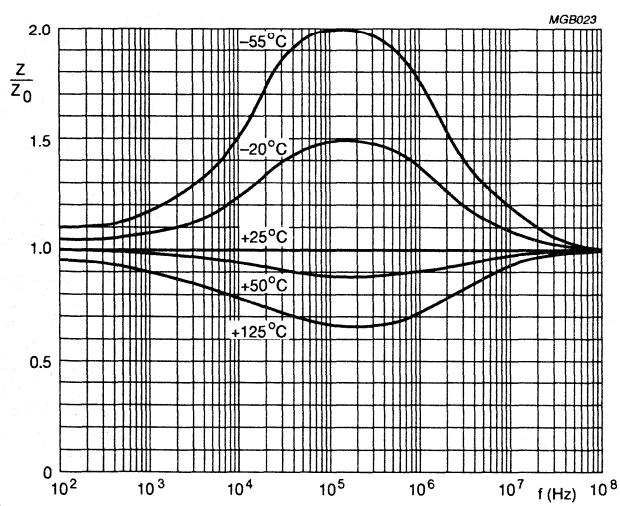
Fig.16 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 8 x 5 mm.



Curve 1: 10 µF, 25 V
Curve 2: 22 µF, 16 V
Curve 3: 68 µF, 6.3 V.

Fig.17 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 8 x 6 mm.

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.

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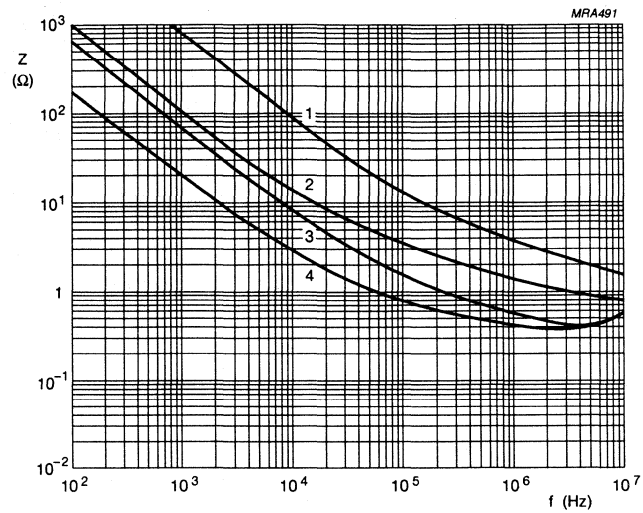
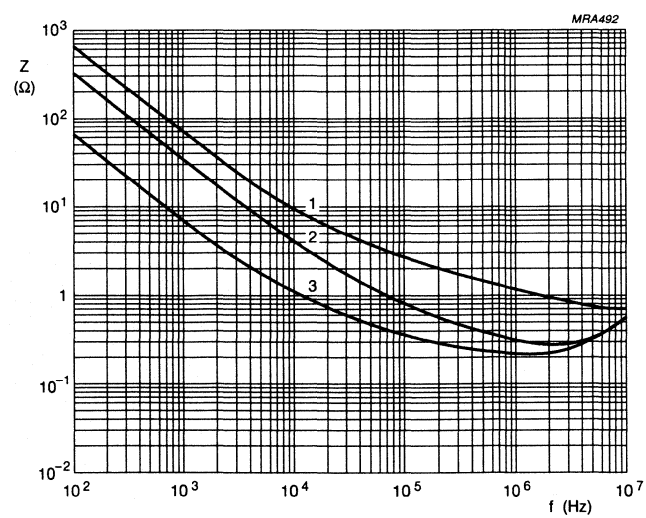


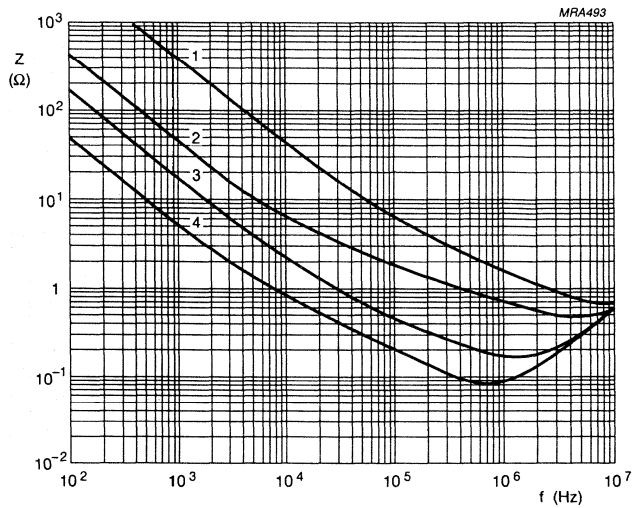
Curve 1: 0.22 µF, 40 V
Curve 2: 1.5 µF, 25 V
Curve 3: 2.2 µF, 16 V
Curve 4: 10 µF, 6.3 V.

Fig.19 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 7 x 3.5 mm.



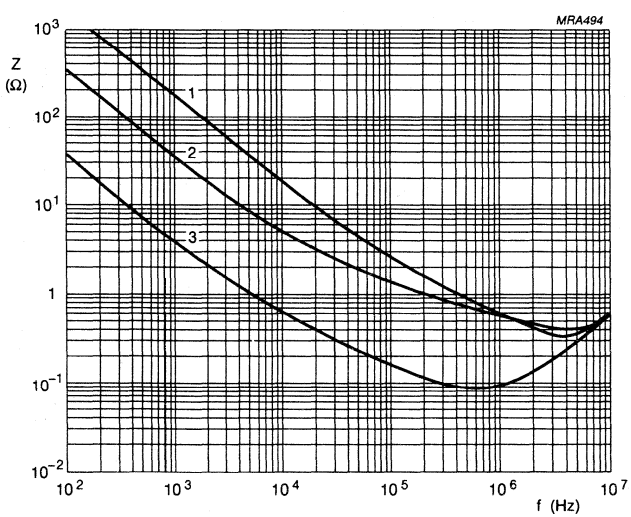
Curve 1: 2.2 µF, 25 V
Curve 2: 4.7 µF, 16 V
Curve 3: 22 µF, 6.3 V.

Fig.20 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 7 x 4 mm.



Curve 1: 0.47 µF, 40 V
Curve 2: 3.3 µF, 25 V
Curve 3: 10 µF, 16 V
Curve 4: 33 µF, 6.3 V.

Fig.21 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 7 x 5 mm.



Curve 1: 1 µF, 40 V
Curve 2: 4.7 µF, 25 V
Curve 3: 47 µF, 6.3 V.

Fig.22 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size 9.5 x 8 x 5 mm.

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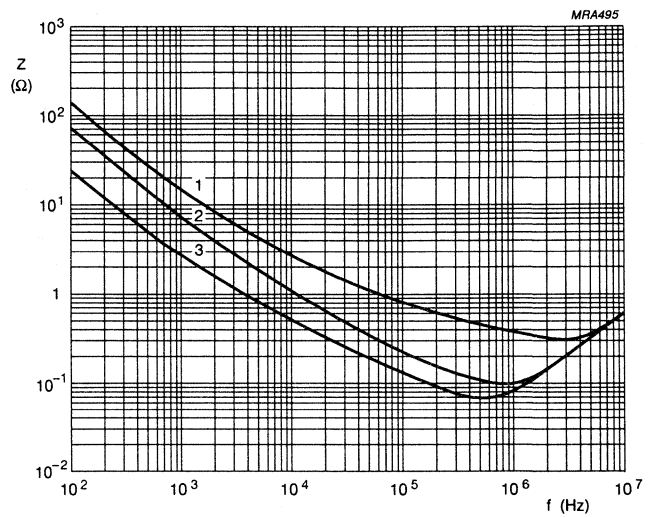

Curve 1: 10 µF, 25 V
Curve 2: 22 µF, 16 V
Curve 3: 68 µF, 6.3 V.

Fig.23 Typical impedance 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 mm to 9.5 x 7 x 5 mm	9 to 14 nH
Typical ESL for; case sizes 9.5 x 8 x 5 and 9.5 x 8 x 6 mm	11 to 16 nH
Maximum ESL for all; case sizes	20 nH

Maximum power dissipation

case sizes 9.5 x 7 x 3 mm to 9.5 x 7 x 5 mm: P_{125} = 88 mW
case size 9.5 x 8 x 5 and 9.5 x 8 x 6 mm: P_{125} = 104 mW.

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	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit $Z \leq 1.2$ x spec. limit $I_{L5} \leq$ 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	$\Delta C/C \leq 15\%$ tan $\delta \leq 1.5$ x spec. limit $Z \leq 1.5$ x spec. limit $I_{L5} \leq$ 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	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit $I_{L5} \leq 1$ 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	$\Delta C/C \leq 5\%$ no short or open circuit no visible damage
Solvent resistance test	IEC 68-2-45, test XA IEC 653	immersion: 5 ±0.5 minutes with or without ultrasonic at 55 ±5 °C Solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected

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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
Passive flammability test	IEC 695-2-2	capacitor mounted to a vertical printed-circuit 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

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 at 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.

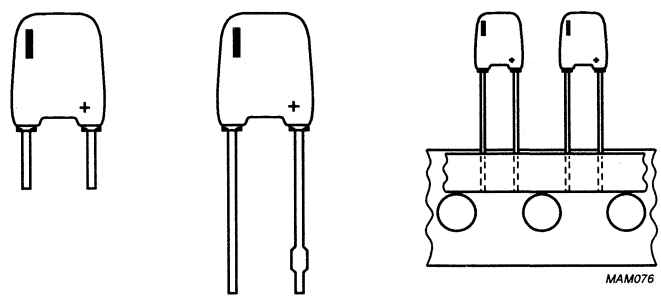

Fig.1 Component outlines.

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_C = 6.3 to 25 V for U_R = 6.3 to 40 V	 –55 to +125 °C –55 to +85 °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
Based on sectional specification	IEC 384-4/CECC 30 300
Detail specification	IEC 384-4-2, CECC 30 302
Climatic category IEC 68 DIN 40040 NF C20-600	 55/125/56 FKD 434

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) at T_{amb} = 85 °C					
	6.3	10	16	25	35	40
	U_C (V) at T_{amb} = 125 °C					
	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					

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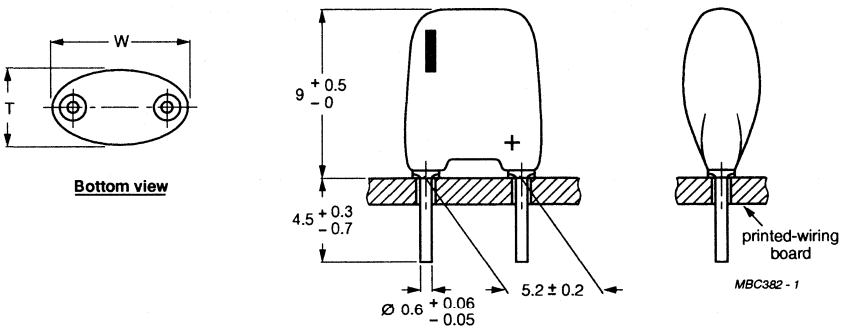
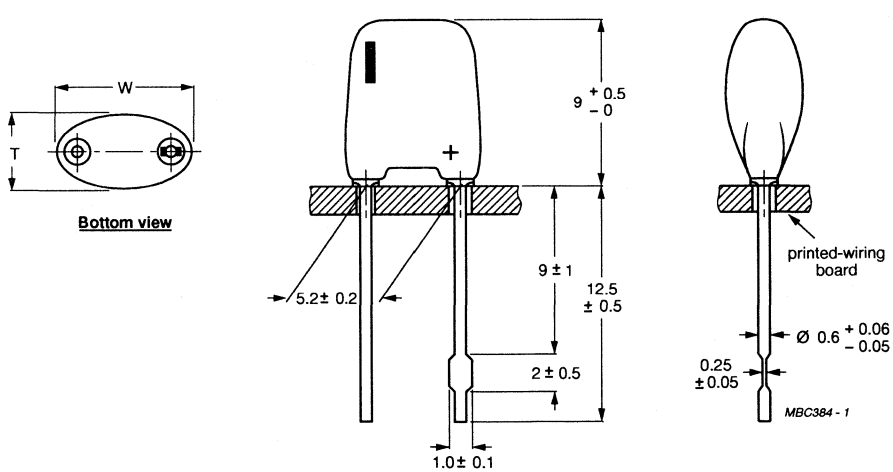
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

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-circuit 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.

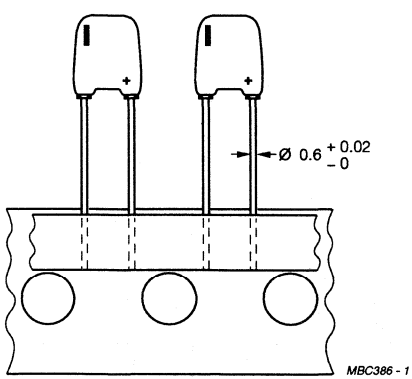
Table 2 Dimensions in mm; mass in g

CASE		APPROX. MASS	PACKING QUANTITIES			
SIZE H_{max} x W_{max} x T_{max}	CODE		FORM CA (note 1)	FORM CB (note 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
- '+' sign to identify the anode terminal
- Vertical '-' 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.

SAL

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
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

SAL

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....	129 8....

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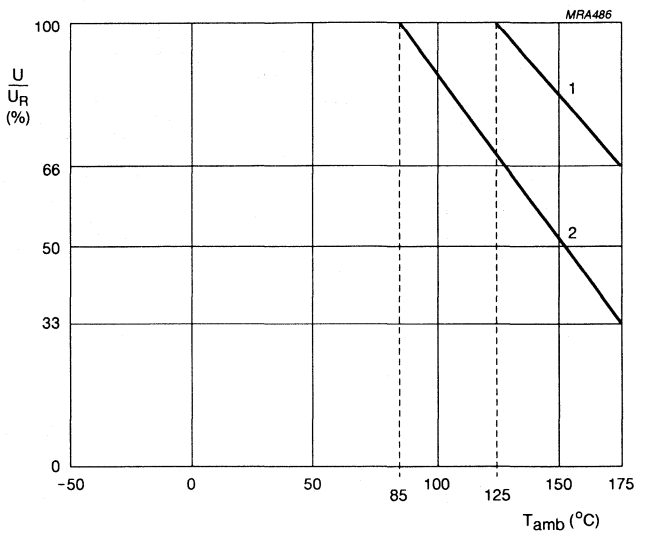
Voltage



Curve 1: U_R = 35 and 40 V
Curve 2: U_R = 6.3 to 25 V.

Fig.5 Maximum permissible voltage up to 175 °C.

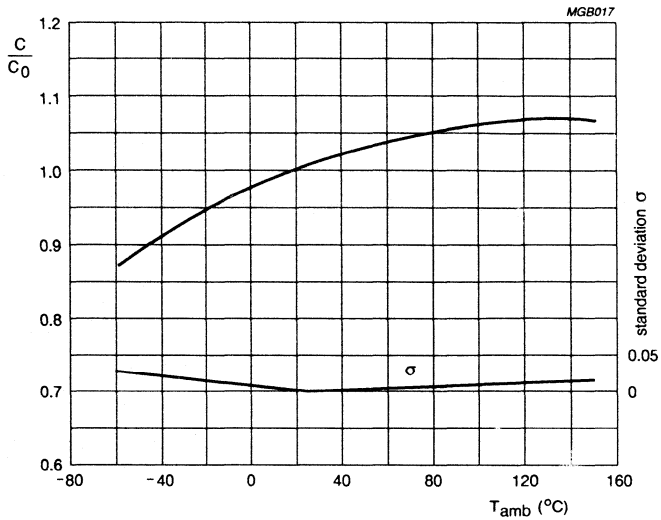
Surge voltage for short periods	$U_s \leq 1.15 \cdot U_R$	
Reverse voltage	$U_{rev} < 0.3 \cdot U_R$	
Max. peak AC voltage, reverse voltage applied	≤2 V	
Max. peak AC voltage, without reverse voltage applied		
	$T_{amb} \leq 85$ °C	85 °C $< T_{amb} \leq 125$ °C
at f ≤ 0.1 Hz	0.30 x U_R	0.15 x U_R
at 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

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

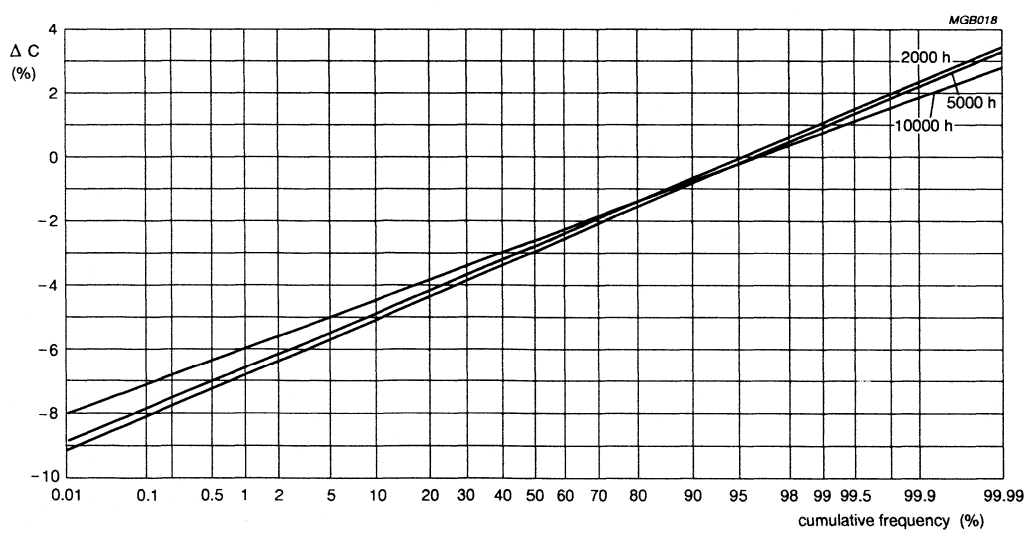


Fig.7 Change of capacitance after endurance test.

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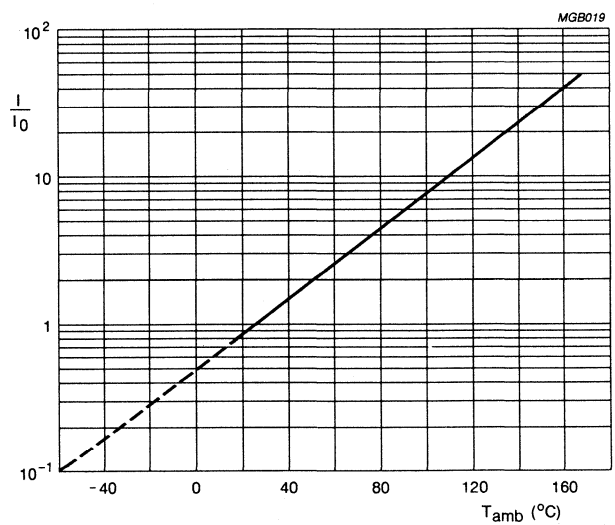
Leakage current

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 after 15 s at U_R and T_{amb} = 25 °C

6.3 V to 16 V versions	approx. 0.2 x value stated in Table 3
25 V to 40 V versions	approx. 0.1 x value stated in Table 3



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.

Typical parameter change after endurance test at T_{amb} = 125 °C

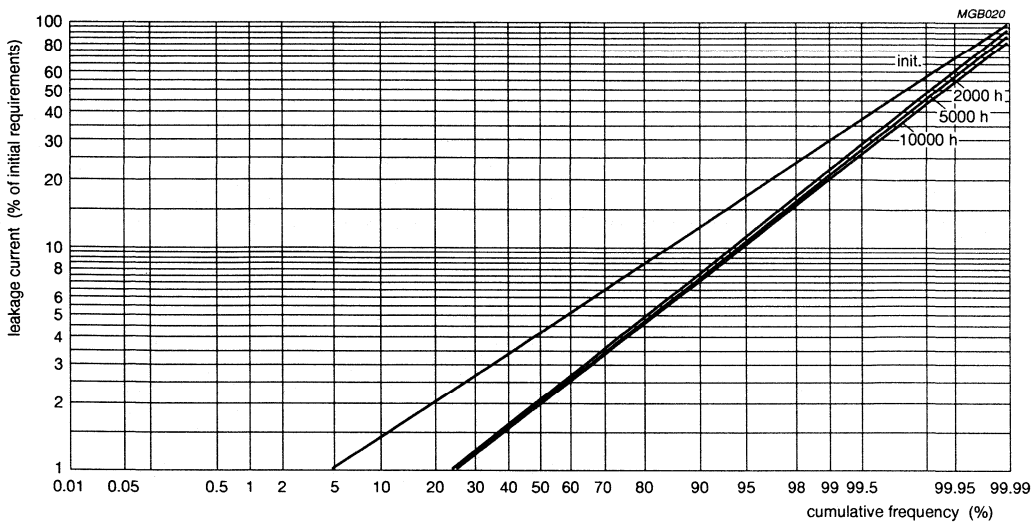
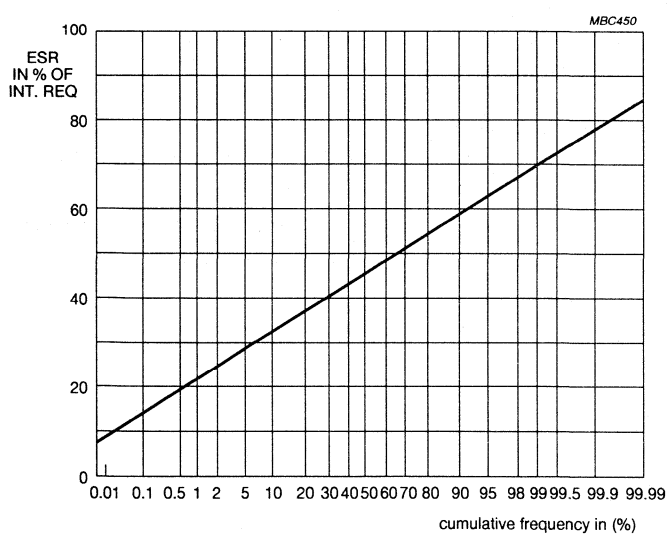


Fig.9 Leakage current after endurance test.

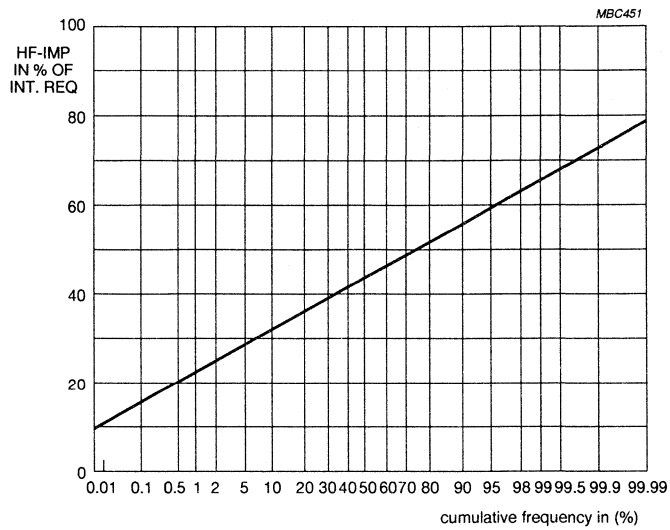
Equivalent series resistance (ESR)



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 mm to 9.5 x 7 x 5 mm	9 to 14 nH
Typical ESL for case sizes 9.5 x 8 x 5 and 9.5 x 8 x 6 mm	11 to 16 nH
Maximum ESL for all case sizes	20 nH

Maximum power dissipation

case sizes 9.5 x 7 x 3.5 mm to 9.5 x 7 x 5 mm: P_{125} = 88 mW
case size 9.5 x 8 x 5 mm and 9.5 x 8 x 6 mm: P_{125} = 104 mW.

SPECIFIC TESTS and REQUIREMENTS (under consideration)

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

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 at 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.

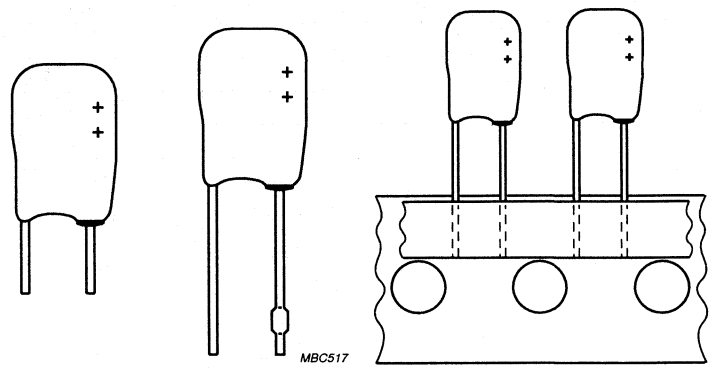


Fig.1 Component outlines.

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%
Rated voltage range, U_R	6.3 to 40 V
Category temperature range for U_C = 6.3 to 25 V for U_R = 6.3 to 40 V	 –55 to +125 °C –55 to +85 °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
Based on sectional specification	IEC 384-4/CECC 30 300
Detail specification	IEC 384-4-2/CECC 30 302
Climatic category IEC 68 DIN 40040 NF C20-600	 55/125/56 FKD 434
Approvals	Liste LNZ 44-04 COS-B Gam-t-1

Solid Al - electrolytic capacitors
Solid Al, Radial Pearl

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) at T_{amb} = 85 °C					
	6.3	**10**	**16**	**25**	**35**	**40**
	U_C (V) at T_{amb} = 125 °C					
	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	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
3.3			12.5 x 8 x 3.5	**12.5 x 8 x 4.5**	12.5 x 8 x 6	
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		
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					

Peferred types in **bold**.

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MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

Dimensions in mm.

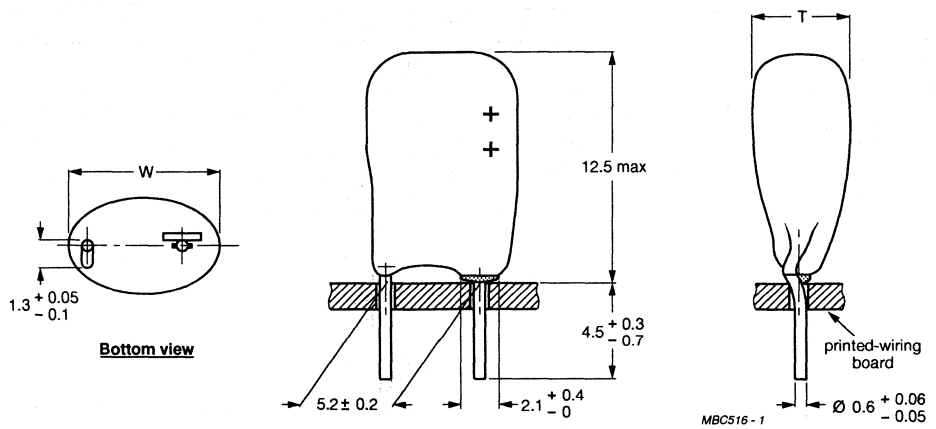
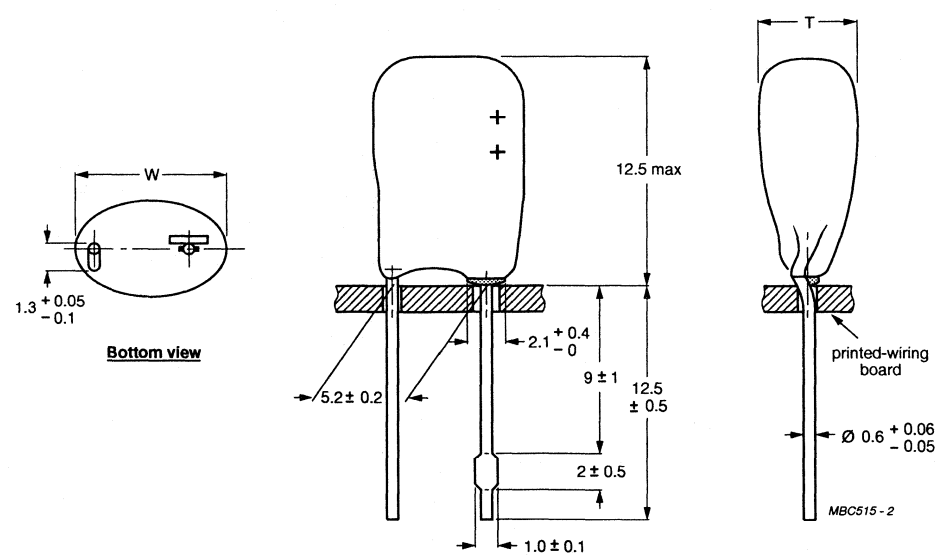


Fig.2 **Form CB**: Short leads, in boxes.



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.

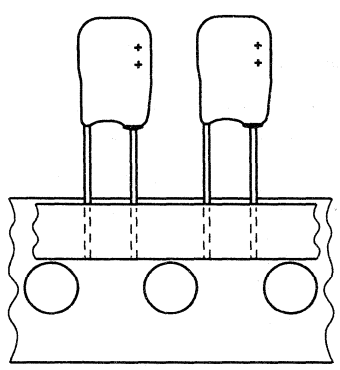
Table 2 Dimensions in mm; mass in g

CASE		APPROX. MASS	PACKING QUANTITIES			
SIZE H_{max} x W_{max} x T_{max}	CODE		FORM CA (note 1)	FORM CB (note 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.

Mounting

When bending, cutting or straightening the leads, ensure that the capacitor body is relieved of stress.
Bending after soldering must be avoided.

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.

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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. Preferred types in **bold**.

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

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. Preferred types in **bold.**

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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Solid Al - electrolytic capacitors
Solid Al, Radial Pearl

SAL-RP 122

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

Solid Al - electrolytic capacitors
Solid Al, Radial Pearl

SAL-RP 122

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....	122 8....

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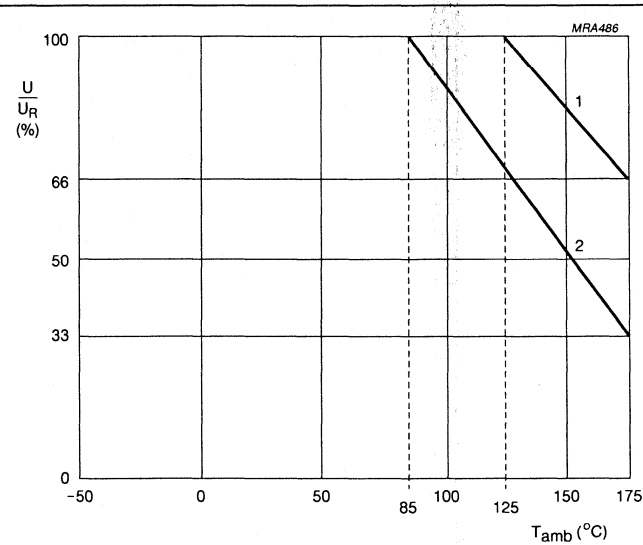
Voltage



Curve 1: U_R = 6.3 V to 25 V
Curve 2: U_R = 35 and 40 V.

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)

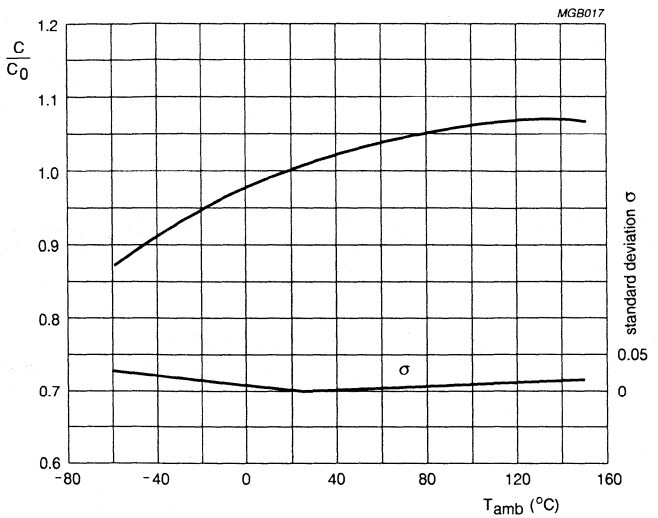
Applying the max. RMS ripple current given in Table 3 will cause a device temperature of 138 °C. The 100 kHz values in Table 3 for other temperatures are to be calculated with the following I_R multipliers:

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 mm to 12.5 x 8 x 5 mm: P_{125} = 88 mW
case size 12.5 x 8 x 6 mm: 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.

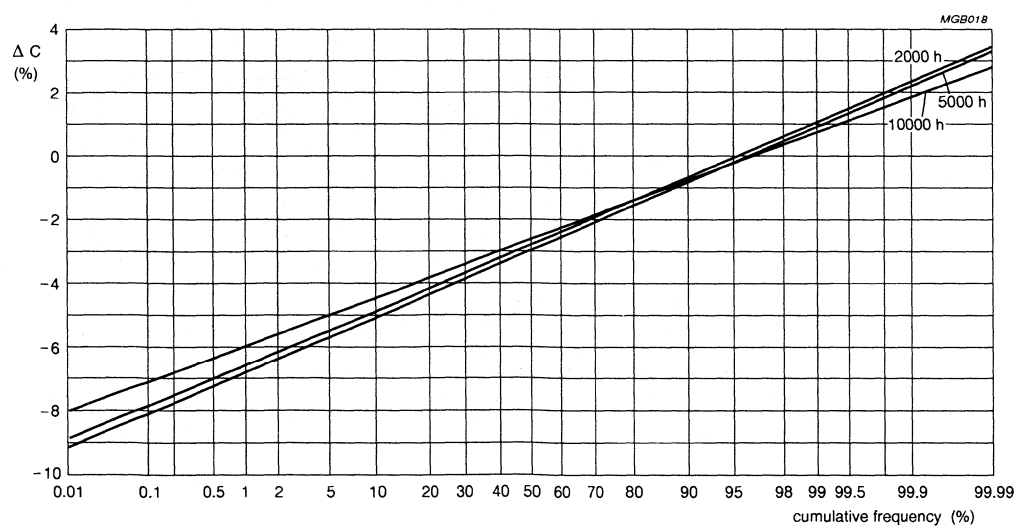


Fig.7 Change of capacitance after endurance test.

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Equivalent series inductance (ESL), f = 10 MHz

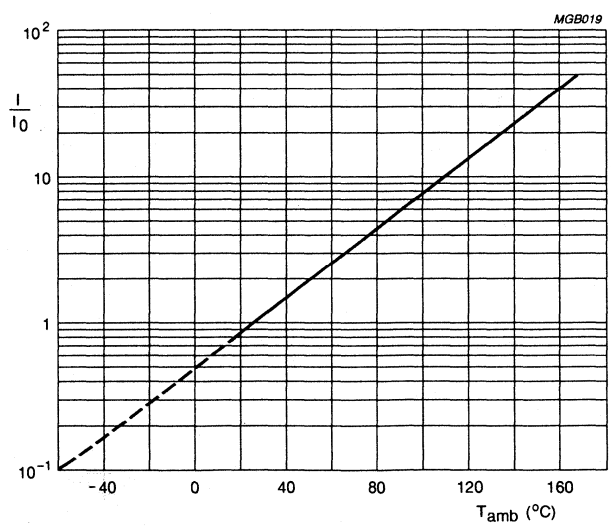
Typical ESL for case sizes 12.5 x 8 x 3.5 mm to 12.5 x 8 x 4.5 mm	9 to 14 nH
Typical ESL for case sizes 12.5 x 8 x 5 mm and 12.5 x 8 x 6 mm	11 to 16 nH
Maximum ESL for all case sizes	20 nH

Leakage current

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 after 15 s at U_R and T_{amb} = 25 °C

6.3 V to 16 V versions	approx. 0.2 x value stated in Table 3
25 V to 40 V versions	approx. 0.1 x value stated in Table 3



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.

Typical parameter change after endurance test at T_{amb} = 125 °C.

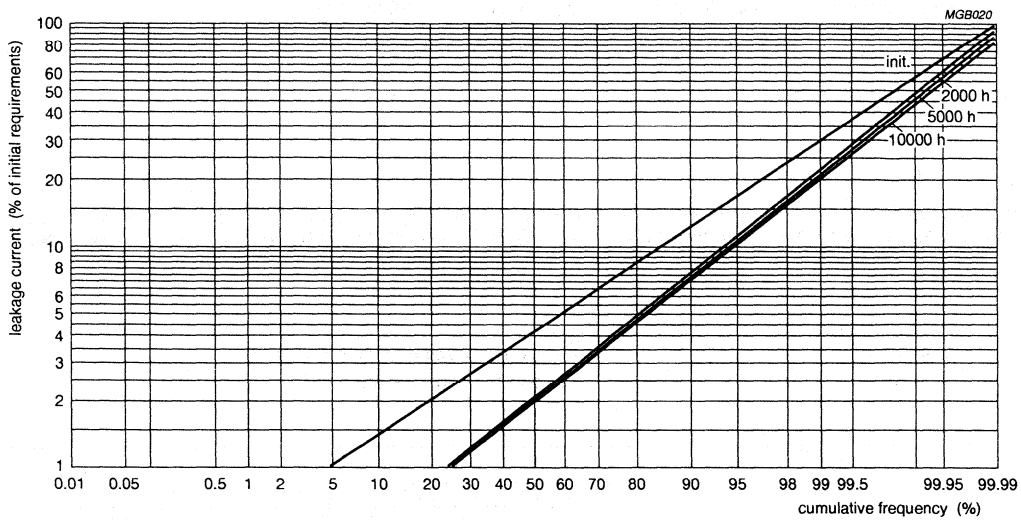
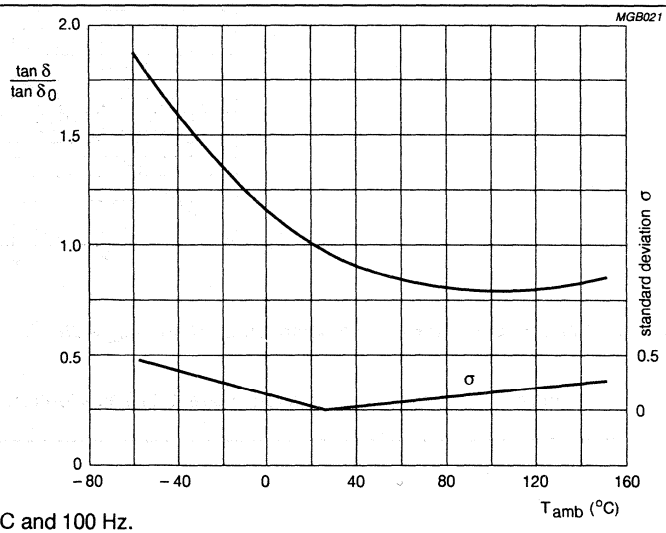


Fig.9 Leakage current after endurance test.

Dissipation factor (tan δ)



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

Fig.10 Typical multiplier of dissipation factor (tan δ/tan δ_0) as a function of temperature.

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Typical parameter change after endurance test at T_{amb} = 125 °C.

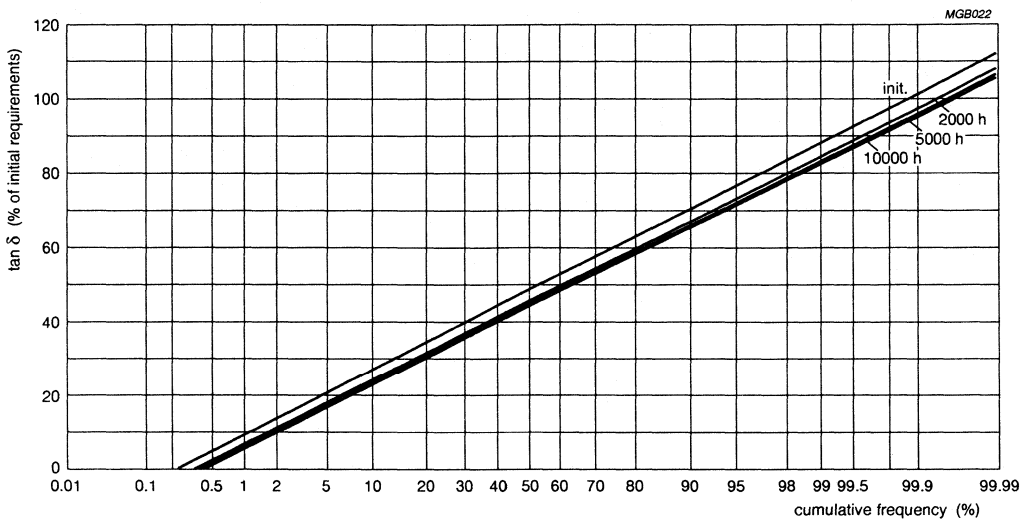
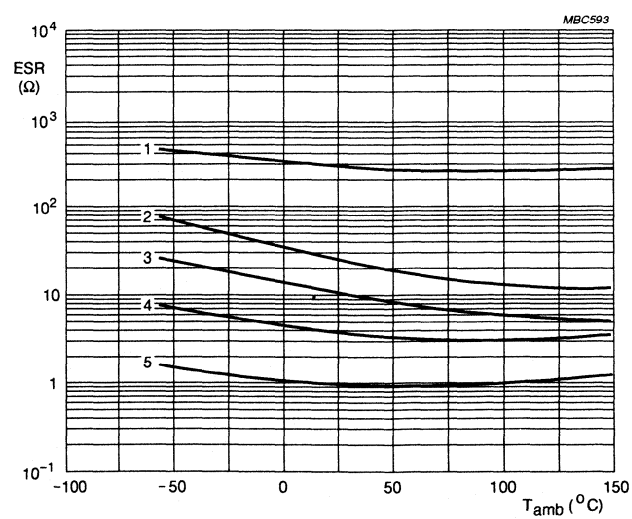


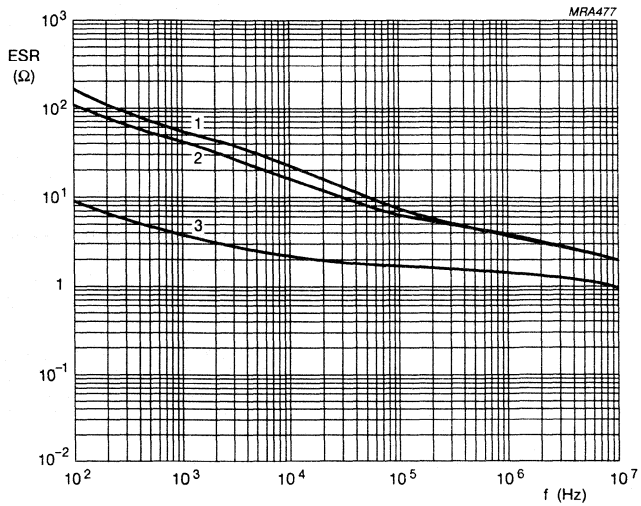
Fig.11 Tan δ after endurance test.

Equivalent series resistance (ESR)



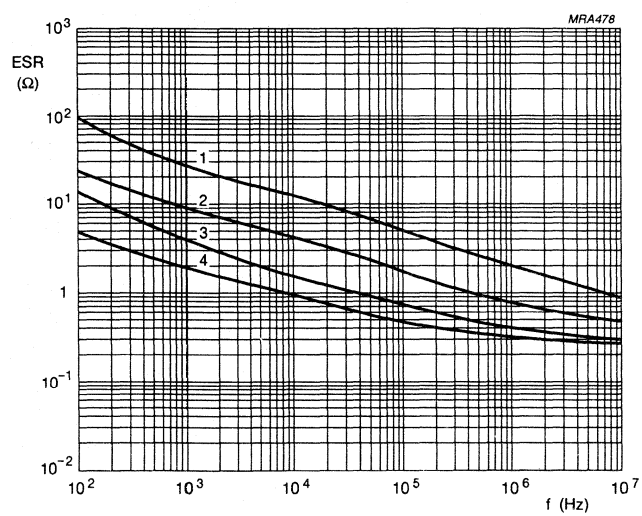
Curve 1: 0.1 µF, 40 V
Curve 2: 1.5 µF, 40 V
Curve 3: 3.3 µF, 25 V
Curve 4: 10 µF, 6.3 V
Curve 5: 22 µF, 10 V.

Fig.12 Typical ESR as a function of temperature at 100 Hz.



Curve 1: 0.33 µF, 40 V
Curve 2: 0.68 µF, 25 V
Curve 3: 10 µF, 6.3 V.

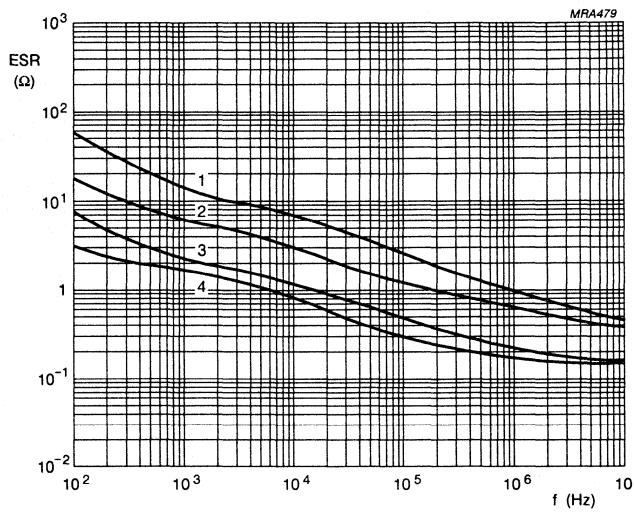
Fig.13 Typical ESR as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 3.5 mm.



Curve 1: 0.47 µF, 25 V
Curve 2: 2.2 µF, 25 V
Curve 3: 4.7 µF, 16 V
Curve 4: 22 µF, 6.3 V.

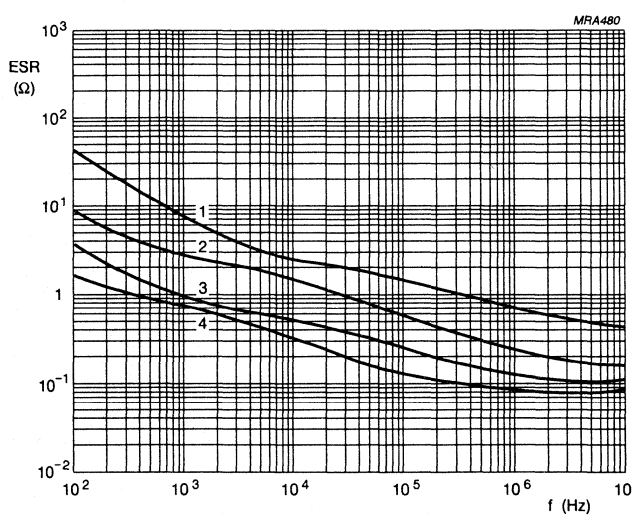
Fig.14 Typical ESR as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 4.5 mm.

SAL



Curve 1: 1.0 µF, 40 V
Curve 2: 4.7 µF, 25 V
Curve 3: 10 µF, 16 V
Curve 4: 33 µF, 6.3 V.

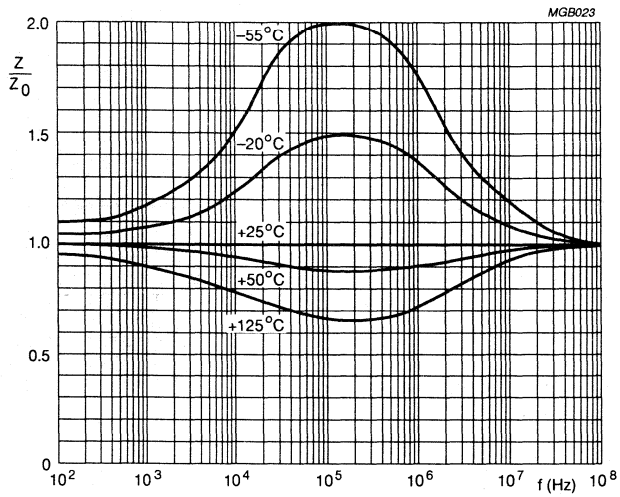
Fig.15 Typical ESR as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 5 mm.



Curve 1: 1.5 µF, 40 V
Curve 2: 6.8 µF, 25 V
Curve 3: 15 µF, 16 V
Curve 4: 68 µF, 6.3 V.

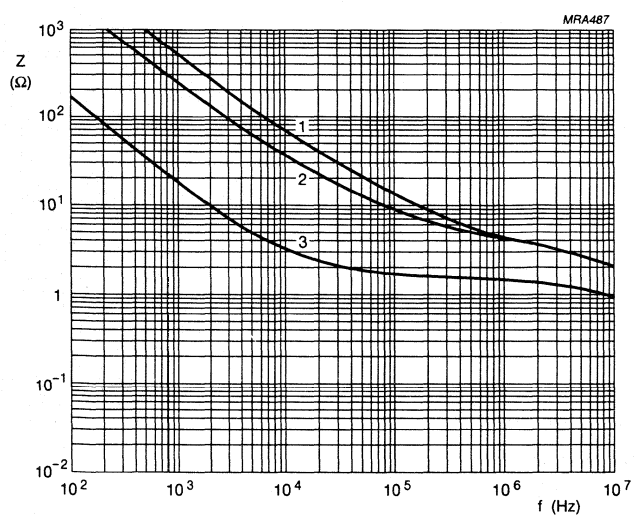
Fig.16 Typical ESR as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 6 mm.

Impedance (Z)



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

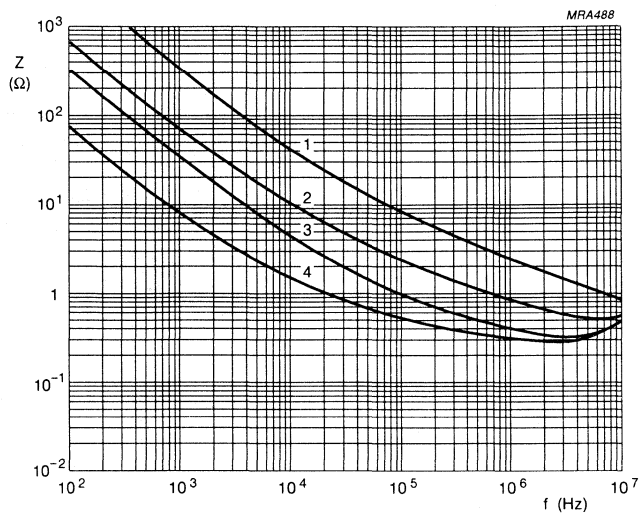
Fig.17 Typical multiplier of impedance (Z/Z_0) as a function of frequency at different temperatures.



Curve 1: 0.33 µF, 40 V
Curve 2: 0.68 µF, 25 V
Curve 3: 10 µF, 6.3 V.

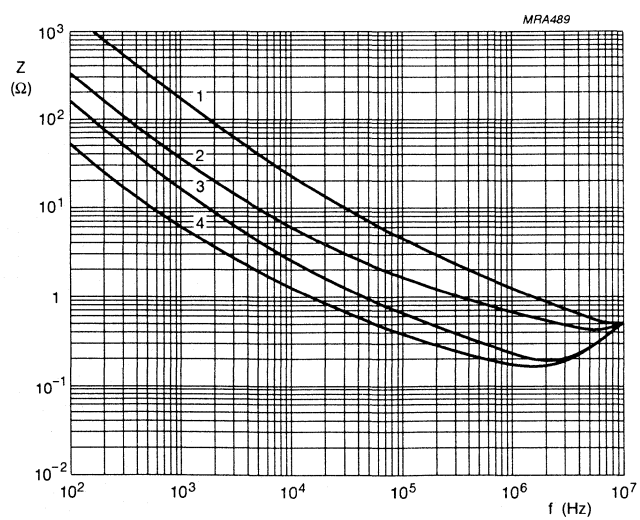
Fig.18 Typical impedance as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 3.5 mm.

SAL



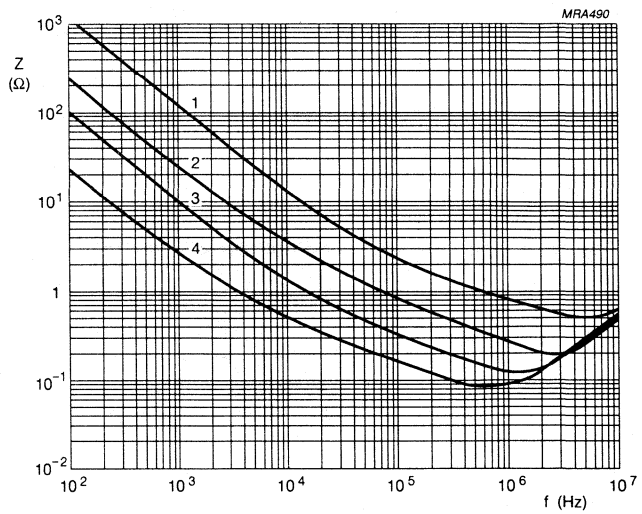
Curve 1: 0.47 µF, 25 V
Curve 2: 2.2 µF, 25 V
Curve 3: 4.7 µF, 16 V
Curve 4: 22 µF, 6.3 V.

Fig.19 Typical impedance as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 4.5 mm.



Curve 1: 1.0 µF, 40 V
Curve 2: 4.7 µF, 25 V
Curve 3: 10 µF, 16 V
Curve 4: 33 µF, 6.3 V.

Fig.20 Typical impedance as a function of frequency at T_{amb} = 25 °C; case dimensions 12.5 x 8 x 5 mm.



Curve 1: 1.5 µF, 40 V
Curve 2: 6.8 µF, 25 V
Curve 3: 15 µF, 16 V
Curve 4: 68 µF, 6.3 V.

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

SA

TEST		PROCEDURE (quick reference)	REQUIREMENTS
Name of test	**Reference**		
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	$\Delta C/C \leq 5\%$ no short or open circuit no visible damage
Solvent resistance test	IEC 68-2-45, test XA IEC 653	immersion: 5 ±0.5 minutes with or without ultrasonic at 55 ±5 °C Solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected
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; $\Delta C/C < 5\%$ $\tan \delta \leq 1.2$ x spec. limit $Z \leq 1.2$ x spec. limit $I_{L5} \leq 1.5$ 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

Solid Al - electrolytic capacitors
Solid Al, Axial

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 at 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.

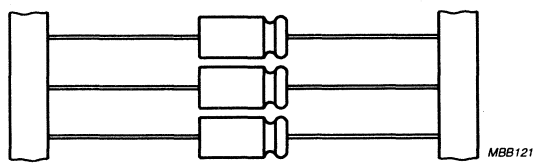


Fig.1 Component outline.

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
Based on sectional specification	IEC 384-4, CECC 30 300
Detail specification	IEC 384-4-2, CECC 30 302
Climatic category IEC 68 DIN 40040 NF C20-600	 55/125/56 FKD 434
Approvals	CNET LNZ 44-04 COS-C (PTT) Gam-t-1(MIL)

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**
1.0							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							

Preferred types in **bold**.

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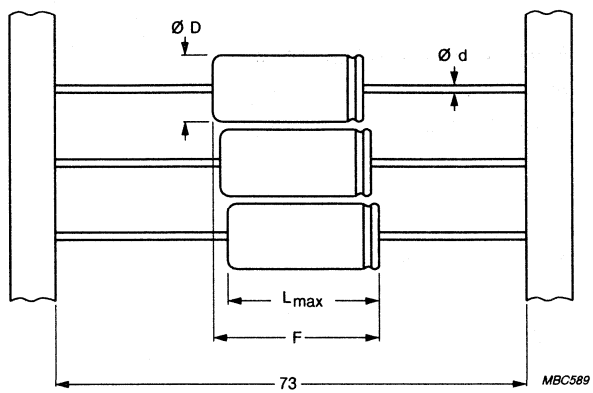
MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES

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 (note 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
12.9 x 32.0	6	35.0	0.8	7	100	400

Note

1. Add 10% for SAL-AG epoxy-filled versions.

Solid Al - electrolytic capacitors
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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. Preferred types in **bold**.

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

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. Preferred types in **bold**.

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

SA

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)	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
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
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

SAl

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

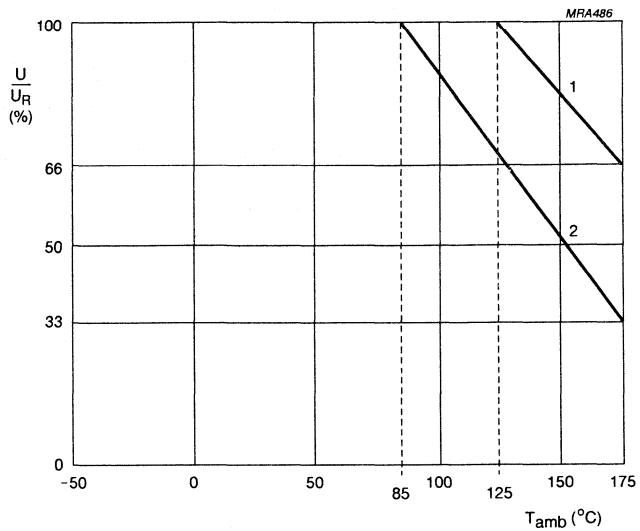
U_R (V)	C_R 100 Hz (µF)	MAXIMUM CASE SIZE ØD x L (mm)	CATALOGUE NUMBER 2222 . . . . . [1] SAL-A FORM BA tol. ±20%	SAL-A FORM BR tol. ±20%	SAL-A FORM BA tol. ±10%	SAL-AG FORM BA tol. ±10%, level S
35	**1.0**	**6.7 x 15.3**	**123 10108**	123 20108	123 40108	123 80108
	1.5	6.7 x 15.3	123 10158	123 20158	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....

Voltage



Curve 1: 6.3 V to 25 V
Curve 2: 35 and 40 V.

Fig.3 Max. permissible voltage up to 175 °C.

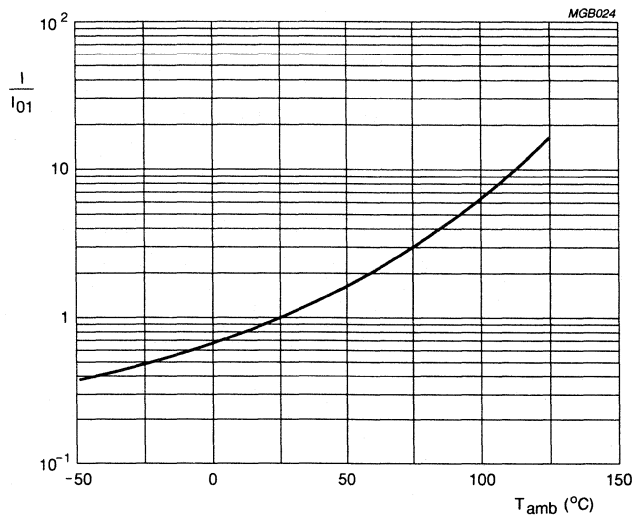
Surge voltage for short periods	$U_s \leq 1.15 \cdot U_R$	
Reverse voltage	$U_{rev} < 0.3 \cdot U_R$	
Max. peak AC voltage, reverse voltage applied	≤2 V	
Max. peak AC voltage, without reverse voltage applied		
	$T_{amb} \leq 85$ °C	85 °C $< T_{amb} \leq 125$ °C
at f ≤ 0.1 Hz	0.30 x U_R	0.15 x U_R
at 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:

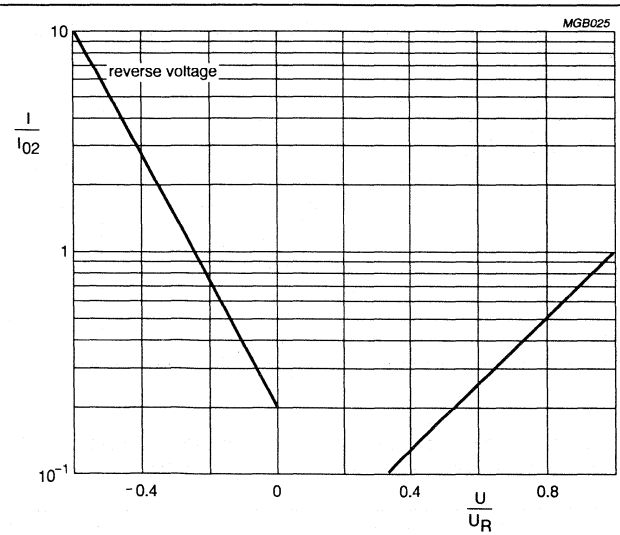
T_{amb}	25 °C	40 °C	65 °C	85 °C	105 °C	125 °C
I_R multiplier	1.1	1.0	0.88	0.75	0.59	0.37

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.

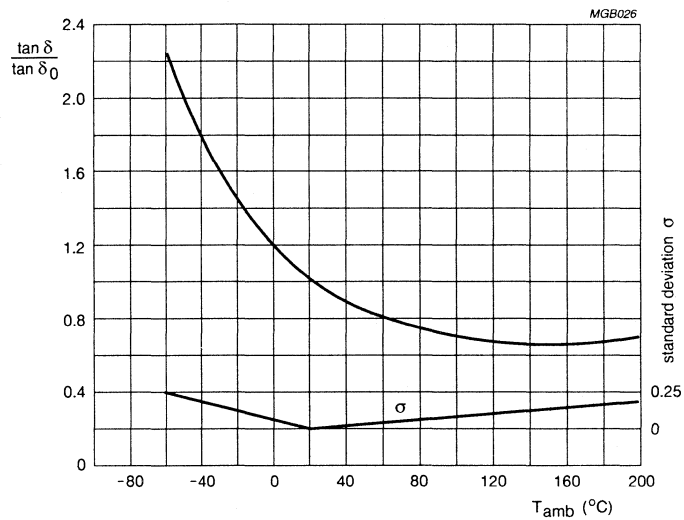
Fig.5 Typical multiplier of leakage current (I/I_{02}) as a function of U/U_R.

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

Fig.6 Typical multiplier of dissipation factor (tan δ/tan δ_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.

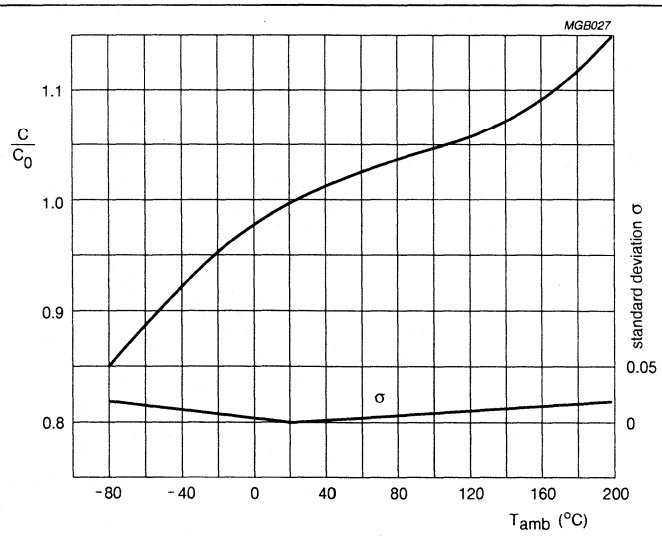
Maximum power dissipation

CASE SIZE $\varnothing D_{max}$ x L_{max} (mm)	$P_{max} = P_{125}$ (W)
∅6.7 x 15.3	0.13
∅7.6 x 20.4	0.16
∅9.3 x 23.3	0.21
∅10.3 x 32.0	0.26
∅12.9 x 32.0	0.32

Equivalent series inductance (ESL), f = 10 MHz

CASE SIZE $\varnothing D_{max}$ x L_{max} (mm)	PITCH (mm)	MAX. ESL (nH)	TYP. ESL (nH)
∅6.7 x 15.3	20.3	30	15 to 23
∅7.6 x 20.4	25.4	30	16 to 24
∅9.3 x 23.3	27.9	35	20 to 27
∅10.3 x 32.0	35.6	40	26 to 33
∅12.9 x 32.0	35.6	55	32 to 49

Capacitance (C)



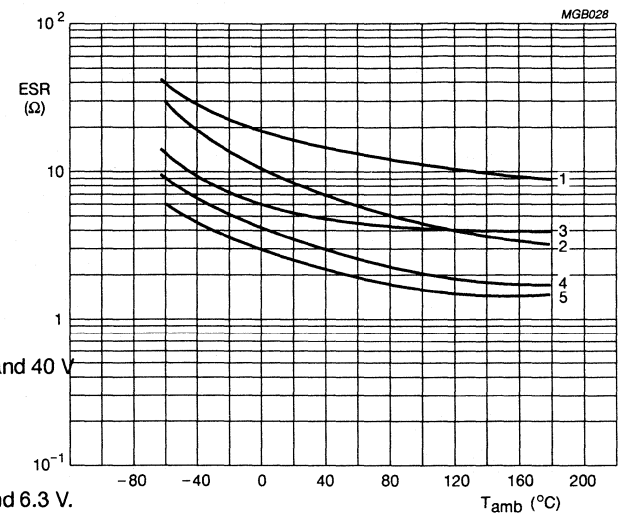
C_0 = capacitance at 25 °C and 100 Hz.

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

SA

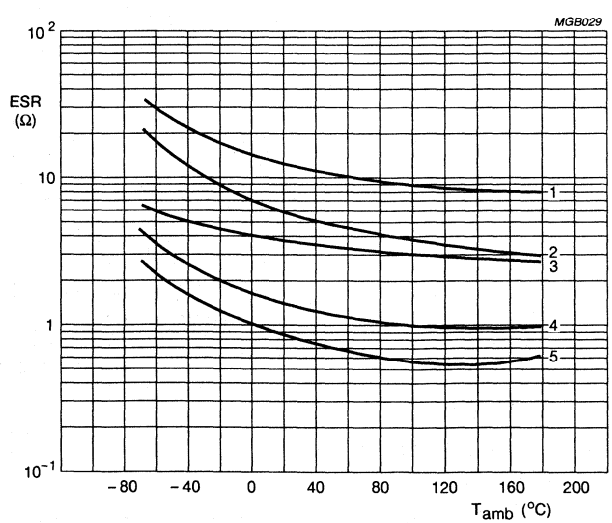
Equivalent series resistance (ESR)

Typical ESR: see Figs 8 to 17; the standard deviation is 20% of each value.



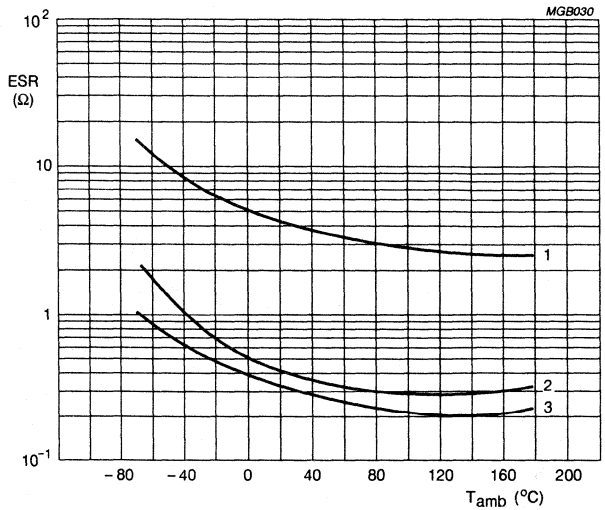
Curve 1: 10 µF, 20 and 25 V; 6.8 µF, 35 and 40 V
Curve 2: 10 µF, 16 V
Curve 3: 22 µF, 16 V
Curve 4: 33 µF, 10 V
Curve 5: 47 µF, 6.3 and 10 V; 68 µF, 4 and 6.3 V.

Fig.8 Typical ESR as a function of ambient temperature at 100 Hz, case size Ø6.7 x 15.3 mm.



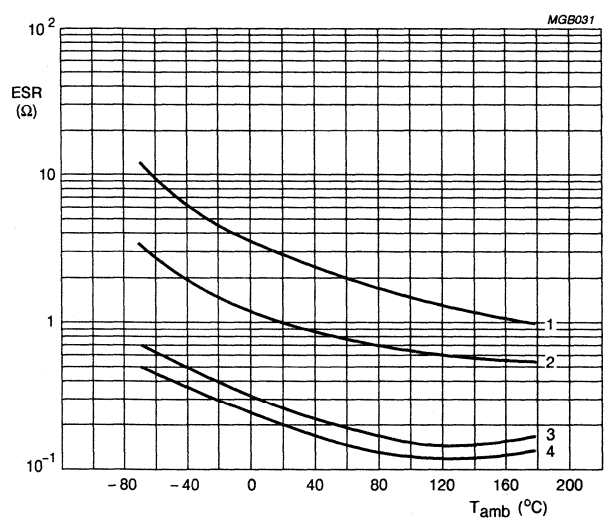
Curve 1: 10 µF, 35 and 40 V
Curve 2: 33 µF, 25 V
Curve 3: 47 µF, 20 and 25 V
Curve 4: 68 µF, 10 V; 150 µF, 6.3 V
Curve 5: 100 µF, 10 V.

Fig.9 Typical ESR as a function of ambient temperature at 100 Hz, case size Ø7.6 x 20.4 mm.



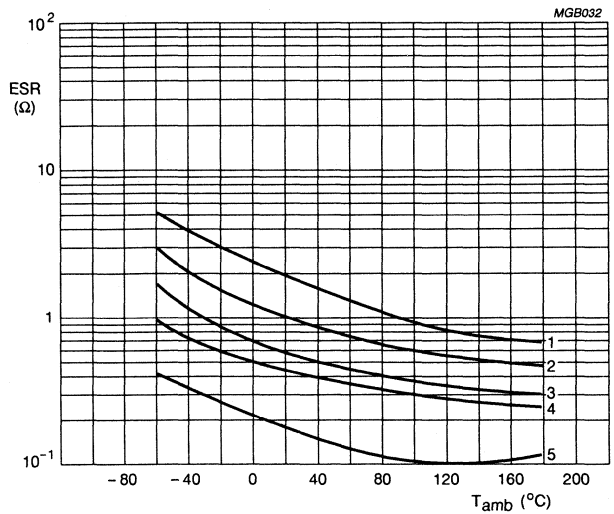
Curve 1: 33 µF, 35 and 40 V
Curve 2: 220 µF, 10 V; 330 µF, 6.3 V
Curve 3: 470 µF, 4 V.

Fig.10 Typical ESR as a function of ambient temperature at 100 Hz, case size ∅9.3 x 23.3 mm.



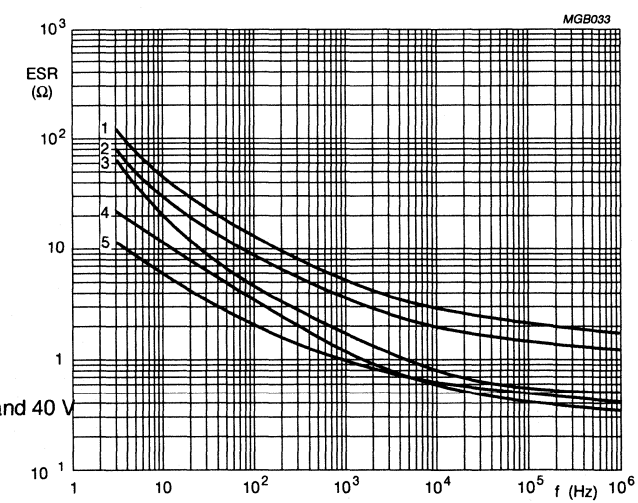
Curve 1: 68 µF, 35 and 40 V
Curve 2: 150 µF, 20 and 25 V
Curve 3: 330 µF, 10 V
Curve 4: 470 µF, 10 V.

Fig.11 Typical ESR as a function of ambient temperature at 100 Hz, case size ∅10.3 x 32.0 mm.



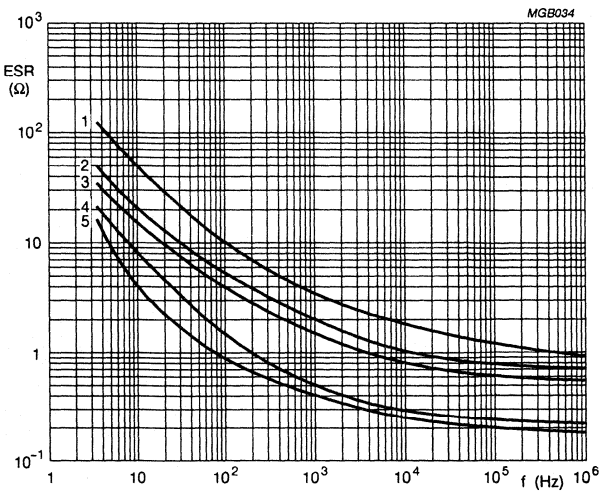
Curve 1: 100 µF, 35 and 40 V
Curve 2: 150 µF, 35 V
Curve 3: 220 µF, 25 V
Curve 4: 470 µF, 16 V
Curve 5: 680 µF, 10 V; 1000 µF, 6.3 V.

Fig.12 Typical ESR as a function of ambient temperature at 100 Hz, case size Ø12.9 x 32.0 mm.



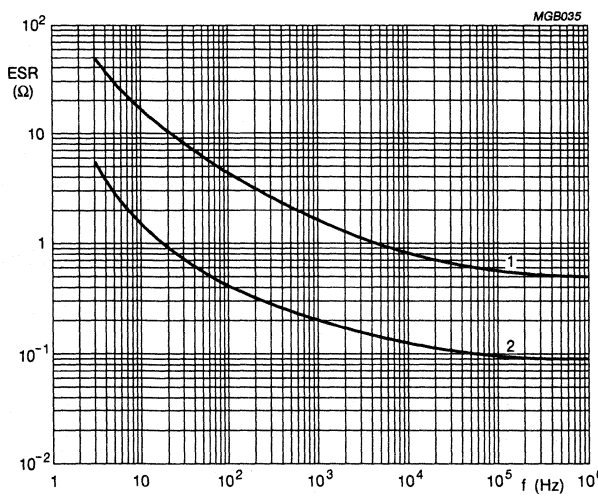
Curve 1: 10 µF, 20 and 25 V; 6.8 µF, 35 and 40 V
Curve 2: 10 µF, 16 V
Curve 3: 22 µF, 16 V
Curve 4: 33 µF, 10 V
Curve 5: 47 µF, 6.3 and 10 V; 68 µF, 4 and 6.3 V.

Fig.13 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size Ø6.7 x 15.3 mm.



Curve 1: 10 µF, 35 and 40 V
Curve 2: 33 µF, 25 V
Curve 3: 47 µF, 20 and 25 V
Curve 4: 68 µF, 10 V; 150 µF, 6.3 V
Curve 5: 100 µF, 10 V.

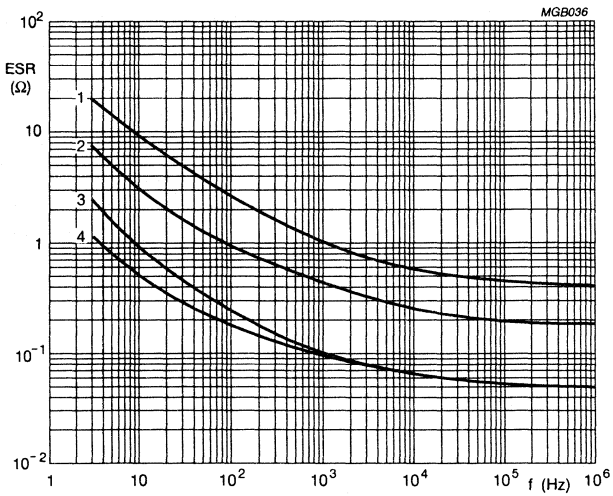
Fig.14 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size Ø7.6 x 20.4 mm.



Curve 1: 33 µF, 35 and 40 V
Curve 2: 220 µF, 10 V; 330 µF, 6.3 V; 470 µF, 4 V.

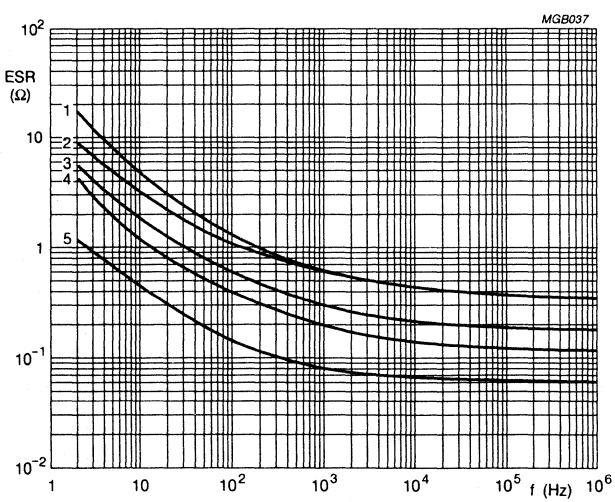
Fig.15 Typical ESR as a function of frequency at T_{amb} = 25 °; case size Ø9.3 x 23.3 mm.

SAL



Curve 1: 68 µF, 35 and 40 V
Curve 2: 150 µF, 20 and 25 V
Curve 3: 330 µF, 10 V
Curve 4: 470 µF, 10 V.

Fig.16 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size Ø10.3 x 32.0 mm.

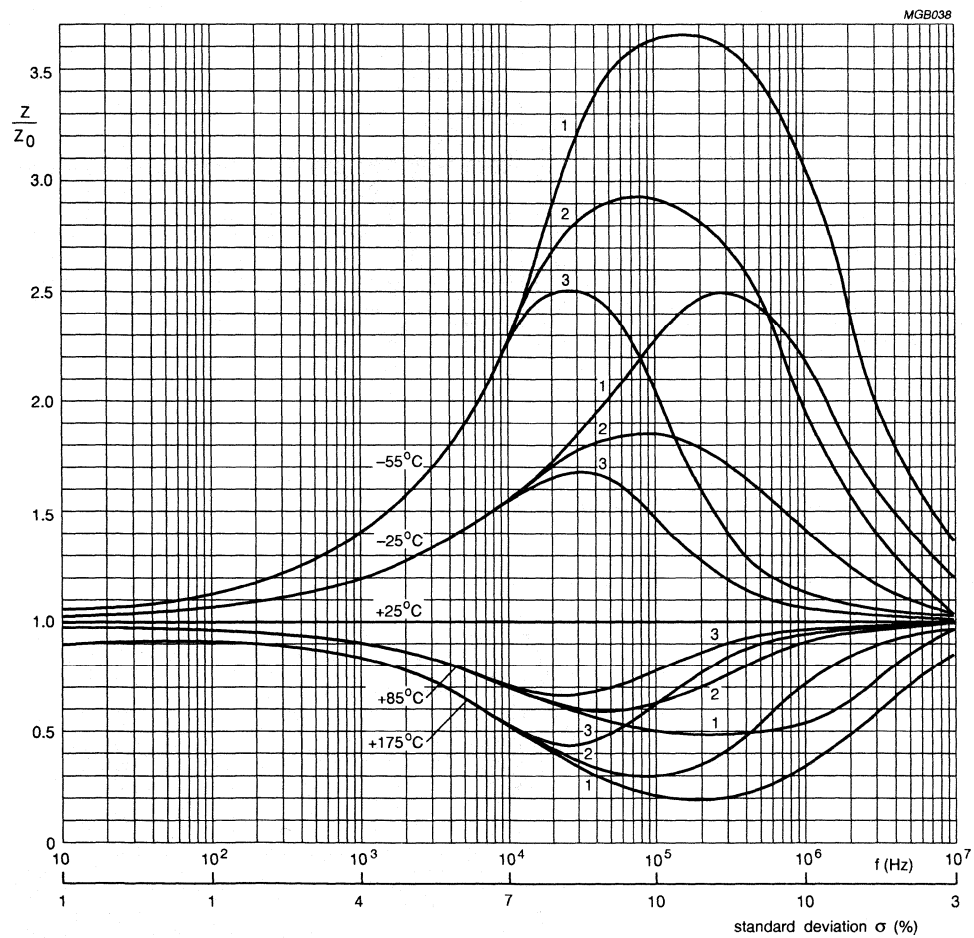


Curve 1: 100 µF, 35 and 40 V
Curve 2: 150 µF, 35 V
Curve 3: 220 µF, 25 V
Curve 4: 470 µF, 16 V
Curve 5: 680 µF, 10 V; 1000 µF, 6.3.

Fig.17 Typical ESR as a function of frequency at T_{amb} = 25 °C; case size Ø12.9 x 32.0 mm.

Impedance (Z)

Typical impedance at 100 kHz and T_{amb} = 25 °C: 0.5 x value stated in Table 3 .

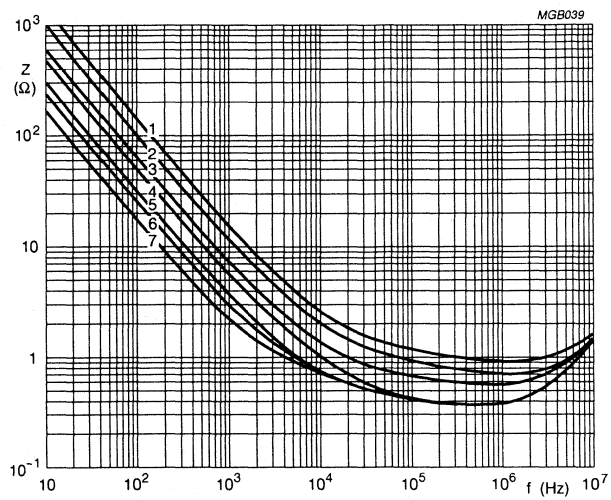


Curve 1: case sizes Ø6.7 x 15.3 and Ø7.6 x 20.4 mm; 16 V to 40 V
Curve 2: case sizes Ø6.7 x 15.3 and Ø7.6 x 20.4 mm; 4 V to 10 V
Curve 3: case sizes Ø9.3 x 32.0, Ø10.3 x 32.0 and Ø12.9 x 32.0 mm.

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

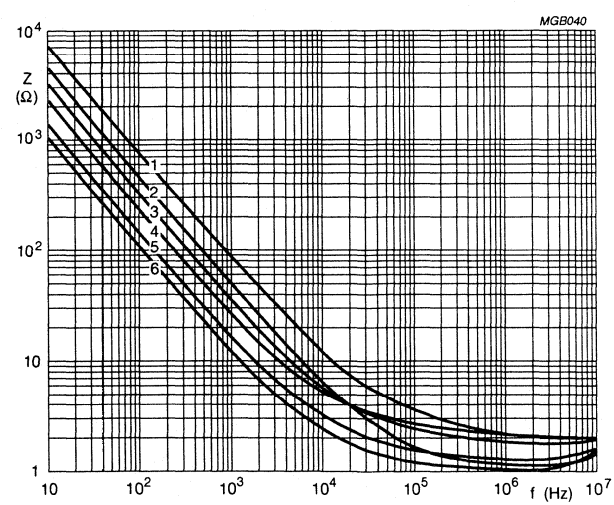
Fig.18 Typical multiplier of impedance (Z/Z_0) as a function of frequency at different ambient temperatures.

SAL



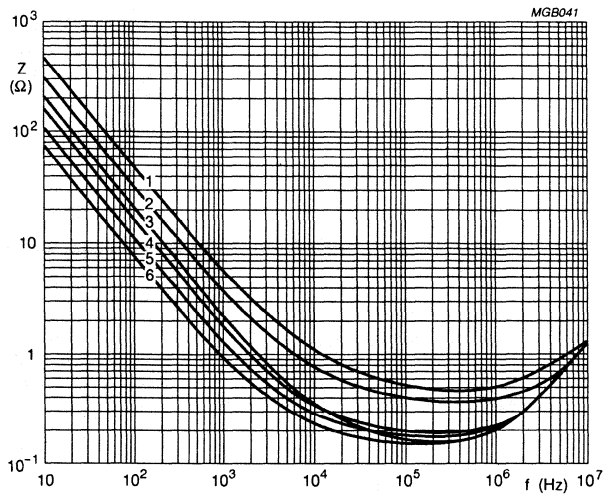
Curve 1: 10 µF, 16 V
Curve 2: 15 µF, 16 V
Curve 3: 22 µF, 16 V
Curve 4: 33 µF, 10 V
Curve 5: 47 µF, 6.3 and 10 V
Curve 6: 68 µF, 4 and 6.3 V
Curve 7: 100 µF, 4 V.

Fig.19 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø6.7 x 15.3 mm; U_R = 4 V to 16 V.



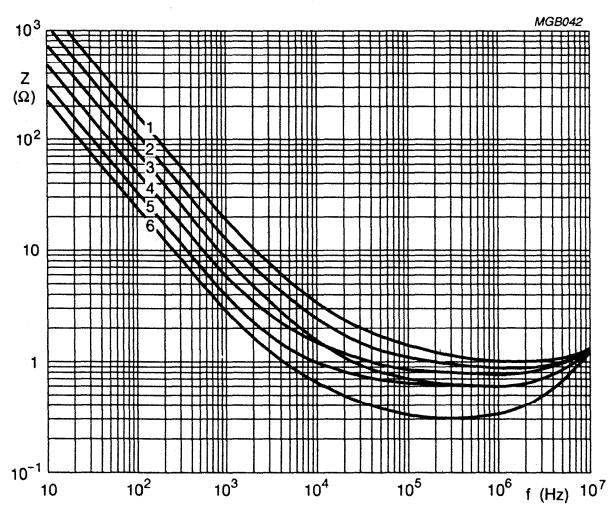
Curve 1: 2.2 µF, 35 and 40 V
Curve 2: 3.3 µF, 40 V
Curve 3: 4.7 µF, 35 and 40 V
Curve 4: 6.8 µF, 35 and 40 V
Curve 5: 10 µF, 20 and 25 V
Curve 6: 15 µF, 20 and 25 V.

Fig.20 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø6.7 x 15.3 mm; U_R = 20 V to 40 V.



Curve 1: 33 µF, 16 V
Curve 2: 47 µF, 16 V
Curve 3: 68 µF, 10 V
Curve 4: 100 µF, 10 V
Curve 5: 150 µF, 6.3 V
Curve 6: 220 µF, 4 V.

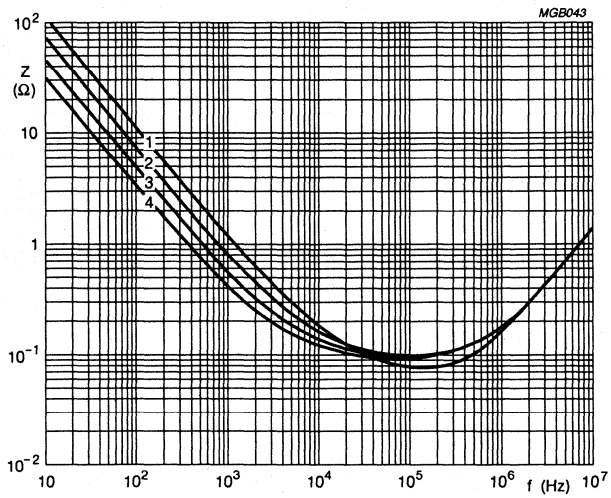
Fig.21 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø7.6 x 20.4 mm; U_R = 4 V to 16 V.



Curve 1: 10 µF, 35 and 40 V
Curve 2: 15 µF, 35 and 40 V
Curve 3: 22 µF, 25 and 35 V
Curve 4: 33 µF, 25 V
Curve 5: 47 µF, 20 and 25 V
Curve 6: 68 µF, 16 V.

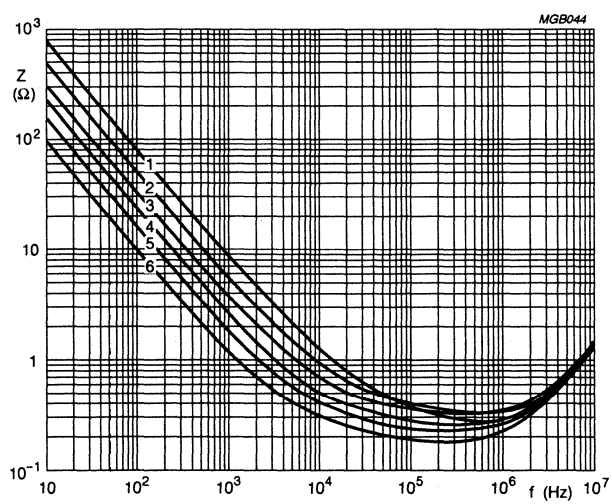
Fig.22 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø7.6 x 20.4 mm; U_R = 16 V to 40 V.

SAL



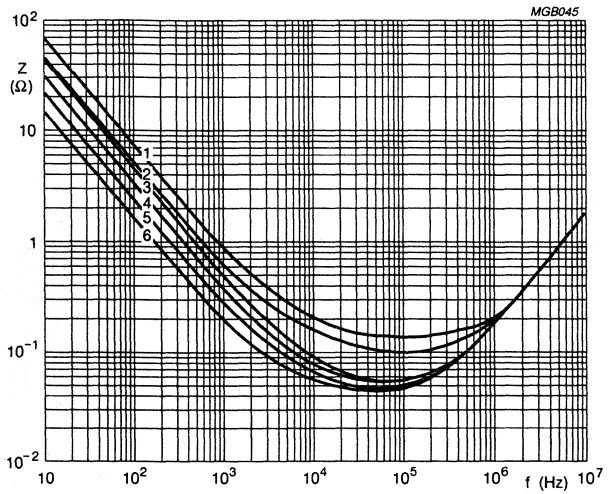
Curve 1: 150 µF, 10 V
Curve 2: 220 µF, 10 V
Curve 3: 330 µF, 6.3 V
Curve 4: 470 µF, 4 V.

Fig.23 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø9.3 x 23.3 mm; U_R = 4 V to 10 V.



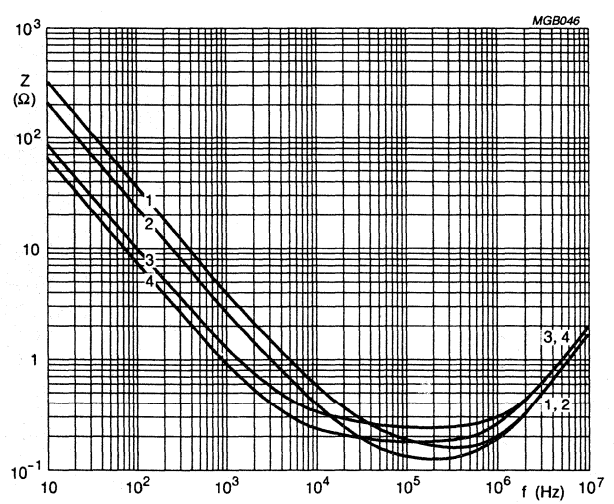
Curve 1: 22 µF, 40 V
Curve 2: 33 µF, 35 and 40 V
Curve 3: 47 µF, 35 V
Curve 4: 68 µF, 25 V
Curve 5: 100 µF, 16, 20 and 25 V
Curve 6: 150 µF, 16 V.

Fig.24 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø9.3 x 23.3 mm; U_R = 16 V to 40 V.



Curve 1: 220 µF, 16 V
Curve 2: 330 µF, 16 V
Curve 3: 330 µF, 10 V
Curve 4: 470 µF, 10 V
Curve 5: 680 µF, 6.3 V
Curve 6: 1000 µF, 4 V.

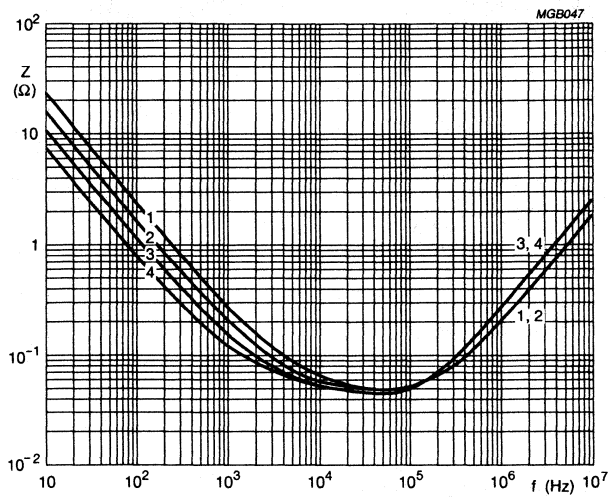
Fig.25 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size ∅10.3 x 32.0 mm; U_R = 4 V to 16 V.



Curve 1: 47 µF, 40 V
Curve 2: 68 µF, 35 and 40 V
Curve 3: 150 µF, 20 and 25 V
Curve 4: 220 µF, 20 V.

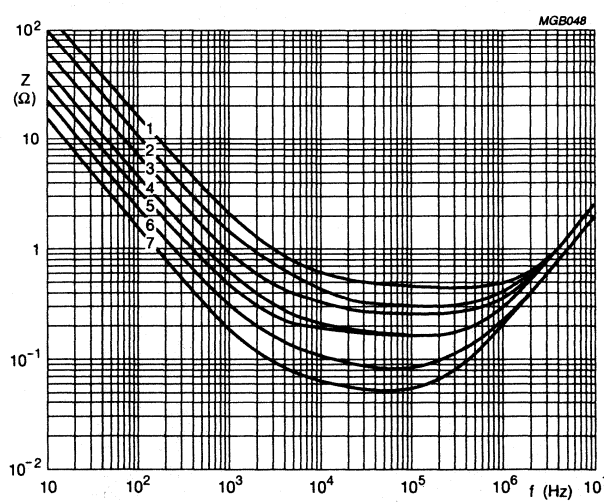
Fig.26 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size ∅10.3 x 32.0 mm; U_R = 20 V to 40 V.

SAL



Curve 1: 680 µF, 10 V
Curve 2: 1000 µF, 6.3 V
Curve 3: 1500 µF, 6.3 V
Curve 4: 2200 µF, 4 V.

Fig.27 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø12.9 x 32.0 mm; U_R = 4 V to 10 V.



Curve 1: 100 µF, 35 and 40 V
Curve 2: 150 µF, 35 V
Curve 3: 220 µF, 25 V
Curve 4: 330 µF, 20 V
Curve 5: 470 µF, 16 and 20 V
Curve 6: 680 µF, 16 V
Curve 7: 1000 µF, 10 V.

Fig.28 Typical impedance as a function of frequency at T_{amb} = 25 °C; case size Ø12.9 x 32.0 mm; 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	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit $Z \leq 1.2$ x spec. limit $I_{L5} \leq$ 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	$\Delta C/C \leq 15\%$ tan $\delta \leq 1.5$ x spec. limit $Z \leq 1.5$ x spec. limit $I_{L5} \leq$ 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	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.2$ x spec. limit $I_{L5} \leq 1$ 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	$\Delta C/C \leq 5\%$ no short or open circuit no visible damage
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 $\delta \leq 1.2$ x spec. limit $Z \leq 1.2$ x spec. limit $I_{L5} \leq 1.5$ x spec. limit
Severe rapid change of temperature		100 cycles of 15 minutes at –40 °C and +125 °C	$\Delta C/C \leq \pm 10\%$ tan $\delta \leq 1.6$ x spec. limit $Z \leq 1.6$ x spec. limit $I_{L5} \leq 1$ x spec.limit
Solvent resistance test	IEC 68-2-45, test XA IEC 653	immersion: 5 ±0.5 minutes with or without ultrasonic at 55 ±5 °C Solvents: demineralized water and/or calgonite solution (20 g/l)	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

SAL

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 Typical capability	ΔC/C: tan δ: Z: DC leakage current: general: up to 80 g at 10 to 3000 Hz (also at 125 °C)	≤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
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	

ENERGY STORAGE CAPACITORS

ES

Double layer capacitors DLC 196

FEATURES

- Polarized capacitor with high charge density, alternative product to re-chargeable backup batteries
- Dielectric: electric double layer
- Radial leads, cylindrical case, insulated with a blue vinyl sleeve
- Available in both vertical and low-profile version
- Unlimited charge and discharge cycle numbers
- No charge-discharge control circuitry necessary
- Maintenance-free, no periodic replacement or service necessary
- Ecologically beneficial (no Cd, no Li).

APPLICATIONS

- Energy storage, for backup of semiconductor memories (CMOS) in all fields of electronics
- Telecommunication, audio-video, EDP, general industrial, clock and timer systems.

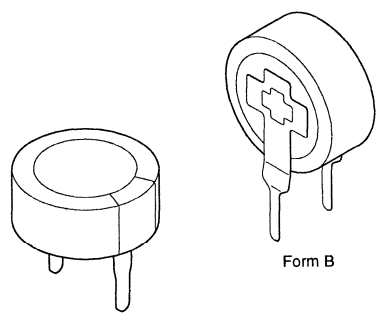


Fig.1 Component outlines.

QUICK REFERENCE DATA

Series	Standard	High voltage	High temperature	Vertical, miniaturized
Outline	Form A	Form A	Form A	Form B
Case sizes (ØD x L in mm)	13 x 7 and 21 x 7.5 mm	13 x 9 and 21 x 9 mm	13 x 9 and 21 x 9 mm	11.5 x 13 mm (vertical)
Rated capacitance range, C_R	0.047 to 1.0 F	0.047 to 0.68 F	0.047 to 0.68 F	0.047 to 0.33 F
Tolerance on C_R	–20 to +80%			
Rated voltage, U_R	5.5 V	6.3 V	5.5 V	5.5 V
Maximum surge voltage, U_S	6.3 V	7.0 V	6.3 V	6.3 V
Category temperature range	–25 to +70 °C	–25 to +70 °C	–25 to +85 °C	–25 to +70 °C
Useful life at U_R	1000 hours at upper category temperature			
Shelf life at 0 V	1000 hours at upper category temperature			
Climatic category IEC 68	25/070/21	25/070/21	25/085/21	25/070/21

Table 1 Selection chart for $C_R U_R$, upper category temperature (UCT), relevant nominal case sizes (ØD x L in mm) and Form.

C_R (F)	FORM	U_R = 5.5 V		U_R = 6.3 V
		UCT = 85 °C	UCT = 70 °C	UCT = 70 °C
0.047	A	13 x 9	13 x 7	13 x 9
	B	–	11.5 x 13	–
0.1	A	13 x 9	13 x 7	13 x 9
	B	–	11.5 x 13	–
0.22	A	–	13 x 7	–
	B	–	11.5 x 13	–
0.33	A	–	13 x 7	–
	B	–	11.5 x 13	–
0.47	A	21 x 9	21 x 7.5	21 x 9
	B	–	–	–
0.68	A	21 x 9	–	21 x 9
	B	–	–	–
1.0	A	–	21 x 7.5	–
	B	–	–	–

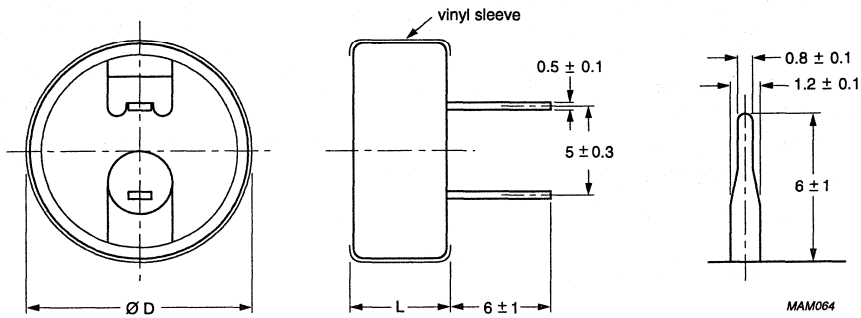
MARKING

The capacitors are marked with the following information:

- Rated capacitance in F
- Rated voltage in V
- Name of manufacturer, PHILIPS
- Date code, in accordance with IEC 62
- Negative terminal identification
- Upper category temperature (at 85 °C types only).

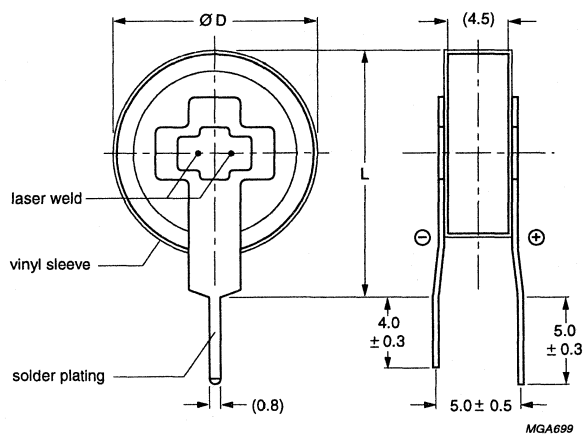
ES

MECHANICAL DATA, AVAILABLE FORMS and PACKING QUANTITIES



Dimensions in mm.

Fig.2 **Form A**: Low profile.



Dimensions in mm.

Fig.3 **Form B**: Vertical.

Table 2 Dimensions in mm; mass in g.

CASE SIZE $\varnothing D_{nom}$ x L_{nom}	CASE CODE	FORM	$\varnothing D_{max}$	L_{max}	APPROX. MASS	PACKING QUANTITIES
11.5 x 13	1	B	11.8	13.5	1.5	2000
13 x 7	2	A	13.5	7.5	2.8	1000
13 x 9	3	A	13.5	9.5	3.4	1000
21 x 7.5	4	A	21.5	8.0	7.1	500
21 x 9	5	A	21.5	9.5	8.8	500

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 and RH = 45 to 75%.

C_R = rated capacitance, tolerance –20/+80%, measured by constant current discharge method

UCT = upper category temperature

I_L = max. leakage current after 30 minutes at U_R

R_I = max. internal resistance at 1 kHz

For test methods refer to chapter, "MEASURING of CHARACTERISTICS".

Ordering example

Double layer capacitor
DLC 196 1.0 F/5.5 V
Case size 21 x 7.5 mm; Form A
Catalogue number 2222 196 12105

Table 3 Electrical data and ordering information. Preferred types in **bold**.

U_R (V)	C_R (F)	CASE SIZE $\varnothing D_{nom}$ x L_{nom} (mm)	CASE CODE	FORM	UCT (°C)	I_L 30 min (µA)	R_I 1 kHz (Ω)	CATALOGUE NUMBER
Standard series								
5.5	**0.047**	**13 x 7**	**2**	**A**	70	69	120	**2222 196 12473**
	0.1	**13 x 7**	**2**	**A**	70	100	75	**2222 196 12104**
	0.22	**13 x 7**	**2**	**A**	70	135	75	**2222 196 12224**
	0.33	**13 x 7**	**2**	**A**	70	182	75	**2222 196 12334**
	0.47	**21 x 7.5**	**4**	**A**	70	216	30	**2222 196 12474**
	1.0	**21 x 7.5**	**4**	**A**	70	315	30	**2222 196 12105**
High temperature series								
5.5	0.047	13 x 9	3	A	85	69	300	2222 196 22473
	0.1	13 x 9	3	A	85	100	200	2222 196 22104
	0.47	21 x 9	5	A	85	216	50	2222 196 22474
	0.68	21 x 9	5	A	85	260	50	2222 196 22684
Vertical, miniaturized series								
5.5	0.047	11.5 x 13	1	B	70	69	120	2222 196 32473
	0.1	11.5 x 13	1	B	70	100	75	2222 196 32104
	0.22	11.5 x 13	1	B	70	135	75	2222 196 32224
	0.33	11.5 x 13	1	B	70	182	75	2222 196 32334
High voltage series								
6.3	0.047	13 x 9	3	A	70	69	300	2222 196 13473
	0.1	13 x 9	3	A	70	100	200	2222 196 13104
	0.47	21 x 9	5	A	70	216	50	2222 196 13474
	0.68	21 x 9	5	A	70	260	50	2222 196 13684

ES

MEASURING of CHARACTERISTICS

Capacitance (C)

Capacitance shall be measured by constant current discharge method.

Discharge current as a function of rated capacitance.

Rated capacitance, C_R (F)	0.047	0.1	0.22	0.33	0.47	0.68	1.0
Discharge current, I_D (mA)	0.1				1.0		

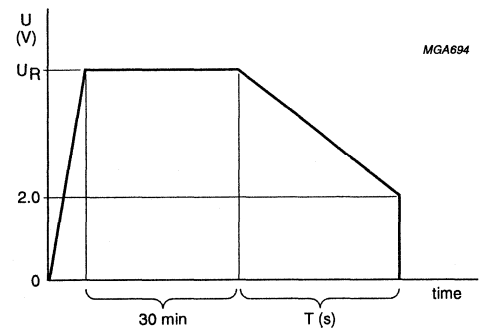


Fig.4 Voltage diagram for capacitance measurement.

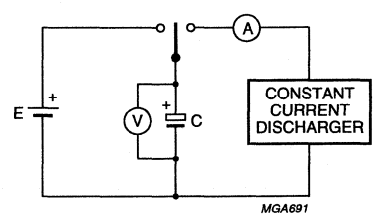


Fig.5 Test circuit for capacitance measurement.

Capacitance value C_R is given by discharge current I_D, time T and rated voltage U_R, according to the following equation:

$$C\,(F) = \frac{I_D\,(mA) \times 10^{-3} \times T\,(s)}{U_R\,(V) - 2}$$

Internal resistance (R_i) at 1 kHz

$$R_i\,(\Omega) = \frac{V_C\,(V)}{10^{-3}}$$

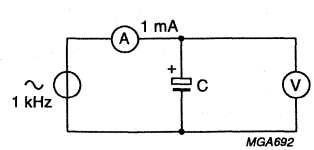


Fig.6 Test circuit for R_i measurement.

Leakage current (I_L)

Leakage current shall be measured after 30 minutes application of rated voltage U_R.

$$I_L\,(\mu A) = \frac{V\,(V)}{10^{-4}}$$

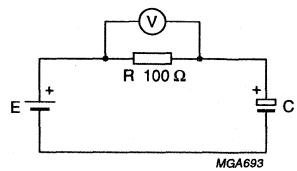
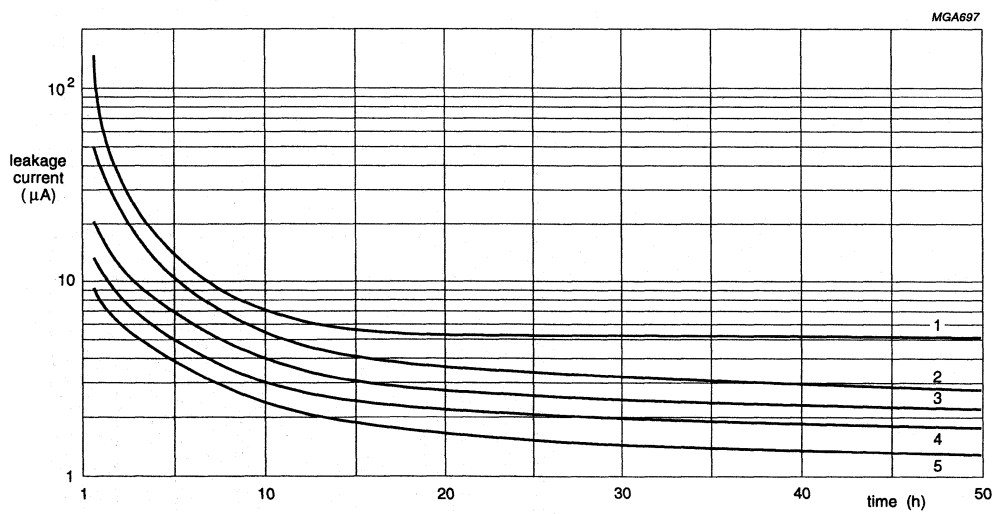


Fig.7 Test circuit for leakage current.



Curve 1: 1.0 F, 5.5 V
Curve 2: 0.47 F, 5.5 V
Curve 3: 0.22 F, 5.5 V
Curve 4: 0.1 F, 5.5 V
Curve 5: 0.047 F, 5.5 V.

Fig.8 Typical leakage current as a function of time (at 5.5 V; series resistance 100 Ω).

ES

DISCHARGE CHARACTERISTICS

Backup time of DLC 196 capacitors depends on minimum memory holding voltage and discharge current (corresponding with the current consumption of the load).
For minimum backup times of standard and vertical miniaturized series, refer to Figs 9 and 10.

Curve 1: 1.0 F, 5.5 V
Curve 2: 0.47 F, 5.5 V
Curve 3: 0.22 F, 5.5 V
Curve 4: 0.1 F, 5.5 V
Curve 5: 0.047 F, 5.5 V.

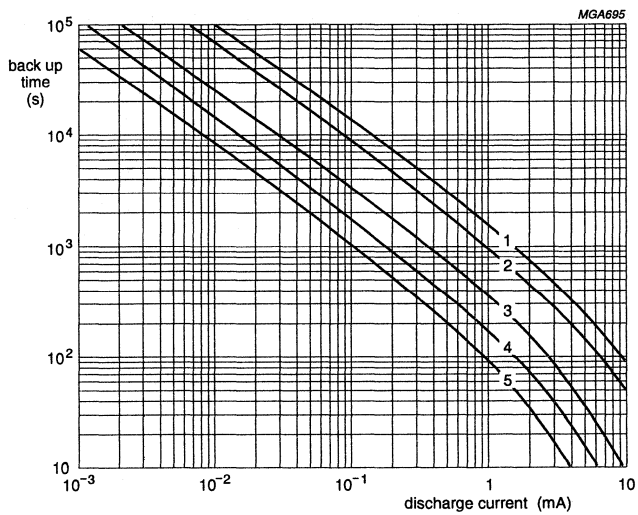


Fig.9 Typical backup time as a function of discharge current (voltage drop from 5.0 V to 3.5 V).

Curve 1: 1.0 F, 5.5 V
Curve 2: 0.47 F, 5.5 V
Curve 3: 0.22 F, 5.5 V
Curve 4: 0.1 F, 5.5 V
Curve 5: 0.047 F, 5.5 V.

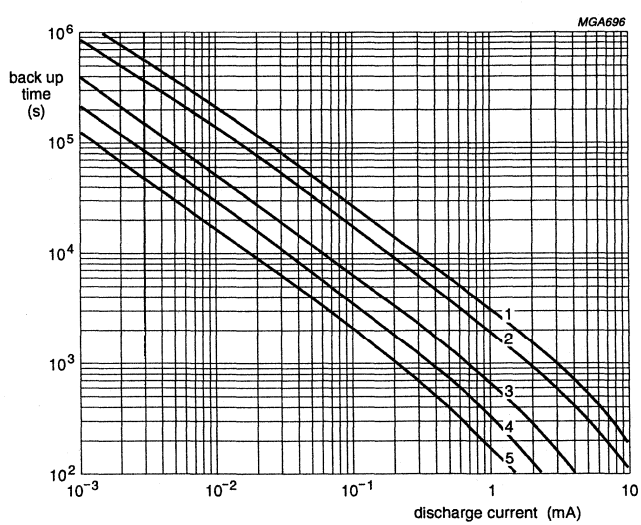


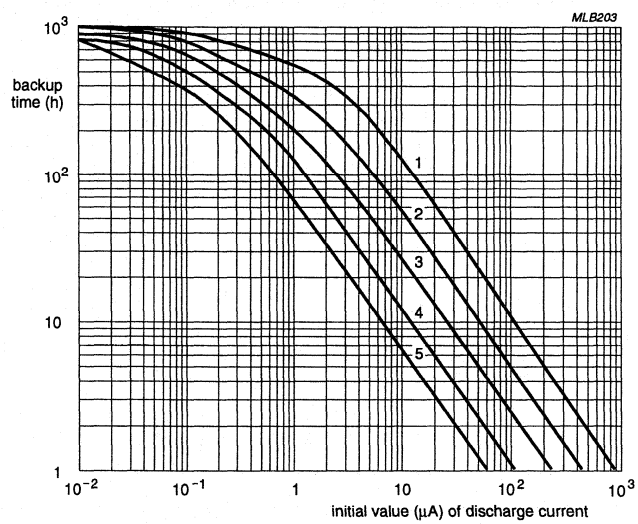
Fig.10 Typical backup time as a function of discharge current (voltage drop from 5.0 V to 2.0 V).

Figure 11 shows the backup time when a DLC capacitor is discharged by a constant resistance.

The horizontal axis shows the initial value of discharge current if 5 V is connected to the capacitor via a fixed series resistor.

Example: 1 μA corresponds to 5 MΩ and 0.1 μA corresponds to 50 MΩ.

The vertical axis shows that period of time during which the voltage drops from 5 V to 2 V.



Curve 1: 1.0 F, 5.5 V
Curve 2: 0.47 F, 5.5 V
Curve 3: 0.22 F, 5.5 V
Curve 4: 0.1 F, 5.5 V
Curve 5: 0.047 F, 5.5 V.

Fig.11 Typical backup time for discharge from 5.0 V to 2.0 V by means of a fixed resistor.

TESTS and REQUIREMENTS

Table 4 Standard and vertical miniaturized series (5.5 V; 70 °C).

NAME of TEST	IEC 384-4/ CECC 30 300 sub clause	PROCEDURE (quick reference)	REQUIREMENTS
Robustness of terminations	4.4	tensile strength; application of loading force for 10 seconds: 20 N (standard series) 5 N (vertical miniaturized series)	no breaks
Resistance to soldering heat	4.5	solder bath; 260 °C; 5 seconds	$\Delta C/C$ ±10% R_i and $I_L \leq$ spec. limit
Solderability	4.6	solder bath; 235 °C; 2 seconds	≥75% tinning
Vibration	4.8	10 to 55 Hz; 1.5 mm; 3 directions; 2 hours per direction	$\Delta C/C$ ±10% R_i and $I_L \leq$ spec. limit
Damp heat, steady state	4.12	500 hours at 55 °C; RH 90 to 95%; no voltage applied	$\Delta C/C$ ±30% $R_i \leq 4$ x spec. limit $I_L \leq 2$ x spec. limit
Endurance	4.13	T_{amb} = 70 °C; 5.5 V applied; 1000 hours	$\Delta C/C$ ±30% $R_i \leq 4$ x spec. limit $I_L \leq 2$ x spec. limit
Storage at upper category temperature	4.17	T_{amb} = 70 °C; no voltage applied; 1000 hours	$\Delta C/C$ ±30% $R_i \leq 4$ x spec. limit $I_L \leq 2$ x spec. limit
Self discharge	–	24 hours storage at room temperature after application of 5 V for 1 hour	remaining voltage ≥4 V
Characteristics at high and low temperature	4.19	step 1: reference measurement at +20 °C of C, R_i and I_L step 2: measurement at –25 °C step 3: measurement at +20 °C step 4: measurement at +70 °C step 5: measurement at +20 °C	$\Delta C/C$ ±30% of +20 °C value $R_i \leq 5$ x the +20 °C value $I_L \leq 4$ x the +20 °C value

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Data handbook system

DATA HANDBOOK SYSTEM

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