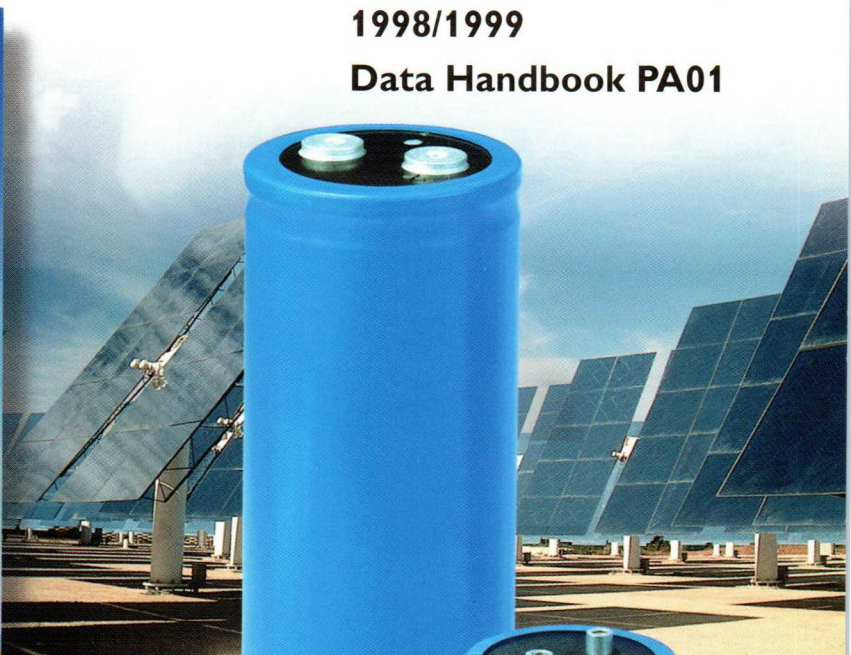


Electrolytic Capacitors

1998/1999

Data Handbook PA01



PHILIPS

Let's make things better.

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.

ISO 9000 certified.

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.

CAUTION
CLEANING SOLVENTS, ADHESIVES, COATING MATERIALS
Some cleaning agents, adhesives or coating materials have an adverse affect on electrolytic capacitors.
For cleaning, varnishing, coating, lacquering, embedding or gluing 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).

Electrolytic Capacitors

TYPE INDEX

Replacement list for withdrawn series

GENERAL DATA

Selection charts; selection guide; general introduction;
product safety; tests and requirements; generic quality flowchart

PACKAGING

Surface Mounting Devices (SMD);
radial leaded devices; axial leaded devices

PRODUCT SPECIFICATIONS

Surface Mounting Devices

SMD

Radial leaded

R

Axial leaded

A

Large types and mounting accessories (Snap-In; DIN-PW; Screw Terminal)

L

Solid Aluminium

SAL

Energy Storage Capacitors (Double layer)

ES

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

Electrolytic Capacitors

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General introduction	23
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Electrolytic capacitors

Type index

Sequence of catalogue numbers

2222	SERIES	PAGE
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021	ASM	315
030/031	AS	334
036	RSP	188
036 92	RB	184
036 93	RBA	186
037	RSM	140
041 to 043	ASH	347
042/043	ASH-ELB	361
044	RSH	158
046	RSL	264
047	RMS	201
048	RML	242
050/052	PED-PW	540
051/053	PEC-PW	522
056/057	PSM-SI	472
058/059	PLL-SI	491
085	CS	86
086/087	PS-ST	574
088/089	PHC-ST	587
097	RLP 7	133
114/115	PED-ST	608
116	RLL	214
117	ASD	306
118	AHT	414
119	AHT-DIN	432
122	SAL-RP	655
123	SAL-A	673
128	SAL-RPM	636
132/133	ALL-DIN	396

Sequence of series names

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ABA	137	372
AHT	118	414
AHT-DIN	119	432
ALL-DIN	132/133	396
AML	138	374
AS	030/031	334
ASD	117	306
ASH	041 to 043	347
ASH-ELB	042/043	361
ASM	021	315
CLL	139	100
CLV	153	113
CS	085	86
DLC	196	702
PEC-PW	051/053	522
PEC-ST	154/155	599
PED-PW	050/052	540
PED-ST	114/115	608
PHC-ST	088/089	587
PLL-PW	162/163	561
PLL-SI	058/059	491
PLL-4TSI	168/169	515
PS-ST	086/087	574
PSM-SI	056/057	472
PSM-4TSI	166/167	508
PUM-SI	157	450
PUL-SI	159	461
RB	036 92	184
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Technical sequence in handbook

	SEQUENCE		PAGE
SMD	085	CS	86
	139	CLL	100
	153	CLV	113
RADIAL	134	RLP 5	126
	097	RLP 7	133
	037	RSM	140
	044	RSH	158
	013	RLC	170
	036 92	RB	184
	036 93	RBA	186
	036	RSP	188
	047	RMS	201
	116	RLL	214
	135	RLI	228
	048	RML	242
	151	RLH	255
	046	RSL	264
	136	RVI	277
AXIAL	165	RHT	294
	117	ASD	306
	021	ASM	315
	030/031	AS	334
	041 to 043	ASH	347
	042/043	ASH-ELB	361
	137 92	AB	370
	137	ABA	372
	138	AML	374
	132/133	ALL-DIN	396
	118	AHT	414
	119	AHT-DIN	432

Electrolytic capacitors

Type index

Sequence of catalogue numbers

2222	SERIES	PAGE
134	RLP 5	126
135	RLI	228
136	RVI	277
137	ABA	372
137 92	AB	370
138	AML	374
139	CLL	100
151	RLH	255
153	CLV	113
154/155	PEC-ST	599
157	PUM-SI	450
159	PUL-SI	461
162/163	PLL-PW	561
165	RHT	294
166/167	PSM-4TSI	508
168/169	PLL-4TSI	515
196	DLC	702

Sequence of series names

SEQUENCE	2222	PAGE
RHT	165	294
RLC	013	170
RLH	151	255
RLI	135	228
RLL	116	214
RLP 5	134	126
RLP 7	097	133
RML	048	242
RMS	047	201
RSH	044	158
RSL	046	264
RSM	037	140
RSP	036	188
RVI	136	277
SAL-A	123	673
SAL-RP	122	655
SAL-RPM	128	636

Technical sequence in handbook

SEQUENCE		PAGE
POWER	157	PUM-SI 450
	159	PUL-SI 461
	056/057	PSM-SI 472
	058/059	PLL-SI 491
	166/167	PSM-4TSI 508
	168/169	PLL-4TSI 515
	051/053	PEC-PW 522
	050/052	PED-PW 540
	162/163	PLL-PW 561
	086/087	PS-ST 574
SAL	088/089	PHC-ST 587
	154/155	PEC-ST 599
	114/115	PED-ST 608
	128	SAL-RPM 636
	122	SAL-RP 655
	123	SAL-A 673
	196	DLC 702

CUSTOMIZED PRODUCTS

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 customized 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 (e.g. for timing applications)
- Deviating capacitance tolerances
- Customized marking
- Packaging deviations
- Higher resistance to shock and vibration.

Electrolytic capacitors

Replacement list
for withdrawn series

REPLACEMENT LIST FOR WITHDRAWN SERIES

WITHDRAWN SERIES			REPLACEMENT SERIES
CATALOGUE NUMBER	VERSION	REMARK	
2222 014	axial	low impedance	021 ASM
2222 015	axial		021 ASM
2222 016	axial		021 ASM
2222 017	axial		021 ASM
2222 032	axial		021 ASM
2222 033	axial		021 ASM
2222 034	radial		RSM 037
2222 035	radial		RSM 037
2222 039	axial	bipolar	137 ABA or 137 92 AB
2222 040	axial	high voltage	041-043 ASH
2222 045	radial		046 RSL or 048 RML
2222 048 95	radial SMD	CLB 048	153 CLV
2222 049	axial	ASC	021 ASM
2222 054	power		056 PSM-SI
2222 055	power		057 PSM-SI
2222 065	axial	low leakage current	021 ASM
2222 106	power		114 PED-ST or 154 PEC-ST
2222 107	power		115 PED-ST or 155 PEC-ST
2222 108	axial		132 ALL-DIN or 138 AML
2222 121	solid axial	SAL-A	123 SAL-A
2222 124	solid radial	cubic, SAL-RQ	128 SAL-RPM
2222 125	solid axial	SAL-AE	—
2222 126	solid SMD	SAL-CP	—
2222 127	solid SMD	SAL-CPL	—
2222 129	solid radial	SAL-RDC	128 SAL-RPM
2222 133	axial	Ø10 × 30 to Ø21 × 40 mm only	041-043 ASH
2222 141	tantalum axial	13 CSR	—
2222 143	tantalum axial	40 SS	—
2222 172	SMD	CLP 172	153 CLV
2222 194	tantalum pearl	TRM	—
2222 195	tantalum SMD	CTS/49MC	—

SELECTION CHARTS

Electrolytic capacitors

Selection charts

SMD ALUMINIUM ELECTROLYTIC CAPACITORS ('CHIPS')

		STANDARD	INDUSTRIAL
		085 CS 1500 hours 85 °C page 86	139 CLL 2000 hours 105 °C page 100
			153 CLV 2000 to 3000 hours 105 °C page 113

CCB095

RADIAL ALUMINIUM ELECTROLYTIC CAPACITORS

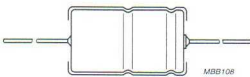
	STANDARD and MINIATURE	SEMI-PROFESSIONAL	LONG-LIFE	EXTRA LONG-LIFE or HIGH TEMPERATURE
smaller dimensions ↓ higher CV per volume	1500 to 3000 hours 85 °C	750 to 2500 hours 105 °C	2000 to 4000 hours 105 °C	1500 hours / 125 °C ≥4000 hours / 105 °C
		036 92 RB <i>bipolar</i> 036 93 RBA <i>bipolar audio</i> page 186		
		013 RLC <i>low leakage</i> page 170	046 RSL <i>maintenance type</i> page 264	165 RHT 125 °C <i>maintenance type</i> page 294
	044 RSH <i>high voltage</i> page 158	135 RLI <i>low Z</i> page 228	151 RLH <i>high voltage</i> page 255	136 RVI 105 °C <i>very low Z</i> page 277
	037 RSM <i>low voltage</i> page 140	page 188 036 RSP page 201	page 214 116 RLL 048 RML page 242	
	page 133 097 RLP 7 H: 7 mm 134 RLP 5 H: 5 mm page 126			

CCB096

Electrolytic capacitors

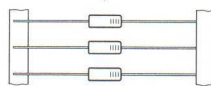
Selection charts

AXIAL ALUMINIUM ELECTROLYTIC CAPACITORS



MBB10R

smaller dimensions
↓
higher CV per volume



MBB12Z

MINIATURE	STANDARD and SEMI-PROFESSIONAL	LONG-LIFE	EXTRA LONG-LIFE or HIGH TEMPERATURE
1500 to 2000 hours 85 °C	2500 to 8000 hours 85 °C	10000 to 15000 hours 85 °C 2000 to 10000 hours 105 °C	4000 hours 125 °C
	page 370 137 92 AB bipolar 137 ABA bipolar audio page 372	042/043 ASH-ELB 600 V/24 hours page 361	
	page 334 030/031 AS 041 ASH page 347	page 396 132/133 ALL-DIN 042/043 ASH page 347	119 AHT-DIN page 432
	page 334 030/031 AS ØD = 3.3 mm 117 ASD page 306	021 ASM page 315	138 AML page 374
			118 AHT page 414

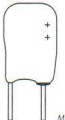
CCB099

SOLID ALUMINIUM (SAL) ELECTROLYTIC CAPACITORS

RADIAL (pearl)



MBB3K3 - 1



ML4655

AXIAL



MBB107

PROFESSIONAL

20000 hours / 125 °C

128 SAL-RPM
H: 9 mm
page 636

122 SAL-RP
H: 12 mm
page 655

123 SAL-A
page 673

CCB110

Electrolytic capacitors

Selection charts

SNAP-IN/DIN-PW CAPACITORS

		ECONOMY	EURO-DIN	LONG-LIFE
		2500 to 12000 hours 85 °C	15000 hours 85 °C	3000 to 10000 hours 105 °C
smaller dimensions higher CV per volume 		051-053 PEC-PW <i>page 522</i>	050-052 PED-PW <i>page 540</i>	162/163 PLL-PW <i>page 561</i>
		166/167 PSM-4TSI <i>page 508</i>		168/169 PLL-4TSI <i>page 515</i>
		056/057 PSM-SI <i>page 472</i>		058/059 PLL-SI <i>page 491</i>
		157 PUM-SI <i>page 450</i>		159 PUL-SI <i>page 461</i>

CCB097

SCREW TERMINAL CAPACITORS

	HIGH CV STANDARD	HIGH RIPPLE	ECONOMY	EURO-DIN
	3000 to 5000 hours 85 °C	4000 to 5000 hours 105 °C	5000 to 12000 hours 85 °C	5000 to 20000 hours 85 °C
	086/087 PS-ST/ PS-STB <i>page 574</i>	088/089 PHC-ST/ PHC-STB <i>page 587</i>	154/155 PEC-ST/ PEC-STB <i>page 599</i>	114/115 PED-ST/ PED-STB <i>page 608</i>

CCB098

SELECTION GUIDE

Electrolytic capacitors

Selection guide

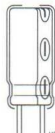
SURFACE MOUNT DEVICES (SMD)

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μ F)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
SMD Aluminium electrolytic capacitors						
 085 CS	low height wave solderable general purpose	0.47 to 22	6.3 to 63	1 500 h/85 °C 40 000 h/40 °C 40/085/56	consumer low profile equipment	86
 139 CLL	moulded extended CV range wave solderable long life	1.0 to 220	6.3 to 100	2 000 h/105 °C 200 000 h/40 °C 55/105/56	automotive telecom general industrial domestic appliances	100
 153 CLV	vertical construction extended CV range long life	0.47 to 1 000	6.3 to 100	2-3 000 h/105 °C 200-300 000 h/40 °C 55/105/65	automotive telecom EDP general industrial portable and lightweight equipment	113

Electrolytic capacitors

Selection guide

RADIAL

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μF)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Standard types						
 134 RLP 5	miniature very low profile height 5 mm general purpose	1.0 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 portable equipment	126
 097 RLP 7	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 portable equipment	133
 037 RSM	high CV/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 audio-video	140
 044 RSH	high voltage long life	1.0 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

Electrolytic capacitors

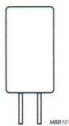
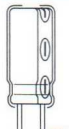
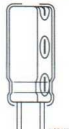
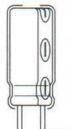
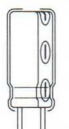
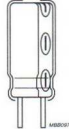
Selection guide

RADIAL (continued)

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (μF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Semi-professional types						
 013 RLC	low leakage current e-pitch 2.5 or 5 mm, all-insulated	0.47 to 470	6.3 to 50	750 h/105 °C 3000 h/85 °C 80000 h/40 °C 55/085/56	audio-video telecom general industrial timing, coupling	170
 036 92 RB	bipolar-general e-pitch 5 mm, all-insulated high CV/volume	10 to 100	16 to 63	1500 h/105 °C 150000 h/40 °C 40/105/56	AC, non-fixed polarity automotive telecom audio-video	184
 036 93 RBA	bipolar e-pitch 5 mm, all-insulated audio-frequency low dissipation factor	1.0 to 22	50	1500 h/105 °C 150000 h/40 °C 40/105/56	audio: speaker crossover network AC applications	186
 036 RSP	high CV/volume long life e-pitch 2.5 or 5 mm, all-insulated	0.47 to 470	6.3 to 160	750 h/105 °C 3000 h/85 °C 80000 h/40 °C 55/085/56	automotive telecom general industrial EDP	188
 047 RMS	high CV/volume high temp. 105 °C long life	100 to 10000	16 to 63	1500 h/105 °C 150000 h/40 °C 40/105/56	audio-video automotive telecom, EDP SMPS	201

Electrolytic capacitors

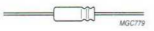
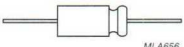
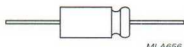
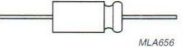
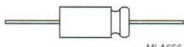
Selection guide

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μF)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Long-life types						
 116 RLL	high CV/volume e-pitch 2.5 or 5 mm, all insulated long life	0.47 to 470	6.3 to 100	2000 h/105 °C 200000 h/40 °C 55/105/56	automotive telecom, EDP general industrial DC-DC converters	214
 135 RLI	low impedance high ripple long life	22 to 10000	6.3 to 100	1500-2500 h/105 °C 150-250000 h/40 °C 55/105/56	general industrial telecom, EDP SMPS DC-DC converters	228
 048 RML	miniature high CV/volume long life	100 to 10000	6.3 to 63	3-4000 h/105 °C 200-260000 h/40 °C 40/105/56	automotive telecom, EDP SMPS stand-by	242
 151 RLH	miniature high CV/volume long life	1 to 220	160 to 450	3-4000 h/105 °C 200-260000 h/40 °C 40/105/56	high-reliability lighting, consumer general industrial filtering	255
 046 RSL	standard dimensions high ripple long life maintenance type	22 to 10000	6.3 to 63	3-4000 h/105 °C 200-260000 h/40 °C 40/105/56	telecom, EDP general industrial SMPS stand-by	264
Extra-long-life types						
 136 RVI	very low impedance very high ripple extra long life	22 to 10000	10 to 100	4-10000 h/105 °C 200-500000 h/40 °C 55/105/56	general industrial telecom, EDP automotive, SMPS DC-DC converters	277
 165 RHT	standard dimensions high temp. 125 °C extra long life maintenance type	22 to 4700	10 to 50	1500 h/125 °C 300000 h/40 °C 40/125/56	automotive outdoor electronics professional telecom, military	294

Electrolytic capacitors

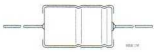
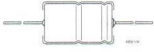
Selection guide

AXIAL

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μF)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Miniature types						
117 ASD 	ultra miniature diameter 3.3 mm general purpose	0.47 to 22	6.3 to 63	2000 h/85 °C 60000 h/40 °C 40/085/56	consumer low height low profile equipment	306
021 ASM 	miniature high CV/volume general purpose long life	0.47 to 15000	6.3 to 100	case length ≤25 mm: 2500 h/85 °C, 70000 h/40 °C case length ≥30 mm: 8000 h/85 °C, 200000 h/40 °C 40/085/56	consumer automotive general industrial audio-video telecom, EDP SMPS	315
Semi-professional types						
030-031 AS 	standard dimensions general purpose long life	0.47 to 1000	6.3 to 100	1500-3000 h/85 °C 40-80000 h/40 °C 40/085/56	consumer, telecom general industrial automotive SMPS	334
041-043 ASH 	high voltage long life 042-043: CECC 30301-801, (without approval)	1.0 to 220	160 to 450	5-15000 h/85 °C 120-240000 h/40 °C 40/085/56	consumer, lighting industrial power supply smoothing	347
042-043 ASH-ELB 	very high voltage 600 V/24 h/25 °C long life	6.8 to 33	450	15000 h/85 °C 45000 h/70 °C 25/085/56	electronic lighting ballast, power supply	361
137 92 AB 	bipolar-general high CV/volume	1.0 to 470	16 to 63	1000 h/105 °C 100000 h/40 °C 40/085/56	AC, non-fixed polarity automotive telecom general industrial	370
137 ABA 	bipolar- audio-frequency low dissipation factor	2.2 to 22	40 to 100	1500 h/105 °C 150000 h/40 °C 40/105/56	audio: speaker crossover network simple wiring AC applications	372

Electrolytic capacitors

Selection guide

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μF)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Long-life types						
 138 AML	miniature high CV/volume high temp. 105 °C long life	1.0 to 15000	6.3 to 100	2-10000 h/105 °C 2-500000 h/40 °C 40/105/56	automotive general industrial telecom, EDP SMPS, stand-by	374
 132/133 ALL-DIN	long life, high reliability high ripple current UTE C031/C033, (without approval)	1.0 to 4700	10 to 350	10-15000 h/85 °C 160 -240000 h/40 °C 40/085/56	telecom EDP general industrial power supply	396
High temperature (extra-long-life) types						
 118 AHT	miniature high CV/volume high temp. 125 °C extra long life	1.0 to 10000	6.3 to 200	4000 h/125 °C 500000 h/40 °C (40)55/125/56	automotive general industrial telecom military	414
 119 AHT-DIN	high temp. 125 °C high ripple current extra long life UTE C031/C033	4.7 to 4700	10 to 200	4000 h/125 °C 500000 h/40 °C 55/125/56	general industrial telecom, SMPS professional outdoor electronics military	432

Electrolytic capacitors

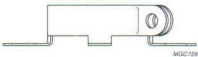
Selection guide

LARGE

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μ F)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Snap-in types						
 157 PUM-SI	very high CV/volume snap-in	56 to 2200	200 to 450	2500 h/85 °C 45000 h/40 °C 40/085/56	general industrial audio-video power supply smoothing	450
 056/057 PSM-SI	high CV/volume snap-in	47 to 68000	10 to 450	12000 h/85 °C 210000 h/40 °C 40/085/56	general industrial audio-video power supply smoothing	472
 159 PUL-SI	very high CV/volume very long life snap-in 105 °C	56 to 1800	200 to 450	3000 h/105 °C 300000 h/40 °C 25/105/56	general industrial audio-video power supply smoothing	461
 058/059 PLL-SI	high CV/volume very long life high temp. 105 °C	33 to 47000	10 to 400	10000 h/105 °C 250000 h/40 °C 40/105/56	general industrial telecom power supply smoothing	491
4-terminal snap-in types						
 166/167 PSM-4TSI	high CV/volume 4 snap-in pins keyed polarity	330 to 68000	10 to 400	10000 h/85 °C 175000 h/40 °C 40/085/56	general industrial power supply smoothing	508
 168/169 PLL-4TSI	high CV/volume 4 snap-in pins keyed polarity high temp. 105 °C	220 to 47000	10 to 400	5000 h/105 °C 125000 h/40 °C 40/105/56	general industrial power supply smoothing	515

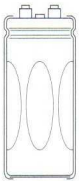
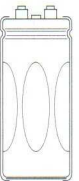
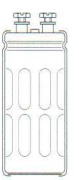
Electrolytic capacitors

Selection guide

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μF)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
PW-pin types						
050/052 PED-PW  	high ripple, low ESR keyed polarity high shock and vibration resistance	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	540
051/053 PEC-PW  	high CV/volume keyed polarity high shock and vibration resistance	68 to 150 000	10 to 400	12 000 h/85 °C 200 000 h/40 °C 40/085/56	general industrial audio-video power supply smoothing	522
162/163 PLL-PW  	high CV/volume very long life high temp. 105 °C keyed polarity high shock and vibration resistance	68 to 150 000	10 to 400	5 000 h/105 °C 150 000 h/40 °C 40/105/56	general industrial telecom power supply smoothing	561
Mounting accessories						
	clamps washers nuts				for large and screw terminal types	629

Electrolytic capacitors

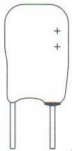
Selection guide

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μF)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Screw terminal/bolt types						
 086/087 PS-ST	high CV/volume high ripple low ESR high shock and vibration resistance	220 to 820 000	16 to 450	3-5000 h/85 °C 120 000 h/40 °C 40/085/56	motor control uninterruptable power supplies welding energy storage in pulse systems	574
 088/089 PHC-ST	high ripple very low ESR high temp. 105 °C high shock and vibration resistance	270 to 820 000	16 to 400	4-5000 h/85 °C 150 000 h/40 °C 40/105/56	motor control uninterruptable power supplies welding energy storage in pulse systems	587
 114/115 PED-ST	very long life high ripple low ESR DIN 45910-T128	150 to 220 000	10 to 400	20 000 h/85 °C 350 000 h/40 °C 40/085/56	general industrial telecom power supply smoothing	608
 154/155 PEC-ST	high CV/volume high ripple	220 to 470 000	10 to 400	12 000 h/85 °C 200 000 h/40 °C 40/085/56	general industrial power supply smoothing	599

Electrolytic capacitors

Selection guide

SOLID ALUMINIUM

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (μF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
 128 SAL-RPM	low profile height 9 mm CECC 30302	0.1 to 68	6.3 to 40	20000 h/125 °C 300000 h/40 °C 55/125/56	general industrial automotive telecom, EDP audio-video	636
 122 SAL-RP	height 12 mm CECC 30302	0.33 to 68	6.3 to 40	20000 h/125 °C 300000 h/40 °C 55/125/56	general industrial automotive telecom, EDP audio-video	655
 123 SAL-A	extremely long life very high reliability CECC 30302-003	1.5 to 2200	6.3 to 40	20000 h/125 °C 450000 h/40 °C 55/125/56	general industrial telecom SMPS military	673
 123 8 SAL-AG	shock-proof 10000 g	1.5 to 2200	6.3 to 40	20000 h/125 °C 450000 h/40 °C 55/125/56	aerospace military	673

Electrolytic capacitors

Selection guide

ENERGY STORAGE CAPACITORS (DOUBLE LAYER)

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (F)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
196 DLC 	high charge density ecologically beneficial maintenance-free	0.047 to 1.0	5.5 or 6.3	1000 h/70 °C or 85 °C 8000 h/40 °C or 23000 h/40 °C 25/070/21 or 25/085/21	energy storage IC memory backup (CMOS) telecom, EDP audio-video	702

CUSTOMIZED PRODUCTS

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 customized 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 (e.g. for timing applications)
- Deviating capacitance tolerances
- Customized marking
- Packaging deviations
- Higher resistance to shock and vibration.

GENERAL INTRODUCTION

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Capacitor principles	25
Electrical behaviour	26
Construction	27
Definitions of the electrical parameters	30
Storage	33
Operational conditions	33
Mounting	41
Marking	42

Electrolytic capacitors

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 ($\tan \delta$)	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
Mounting hole diagram	dessin de montage	Bohrungsraster
Rated capacitance (C_R)	capacité nominale	Nennkapazität
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
Terminal pitch	distance entre les connections	Rastermaß
Terminations	sorties	Anschlüsse
Useful life	durée de vie	Brauchbarkeitsdauer
Visual examination	examen visuel	Sichtkontrolle

Electrolytic capacitors

General introduction

CAPACITOR PRINCIPLES

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

$$Q = C \times U$$

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 dielectric layer, thus:

$$C = \epsilon_0 \times \epsilon_r \times \frac{A}{d}$$

where:

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

ϵ_r = relative dielectric constant (dimensionless)

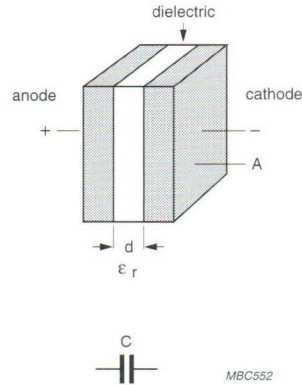
A = surface area (m²)

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

Energy content of a capacitor

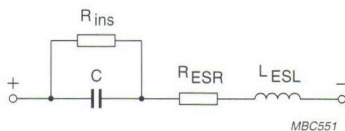
The energy content of a capacitor is given by:

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



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.

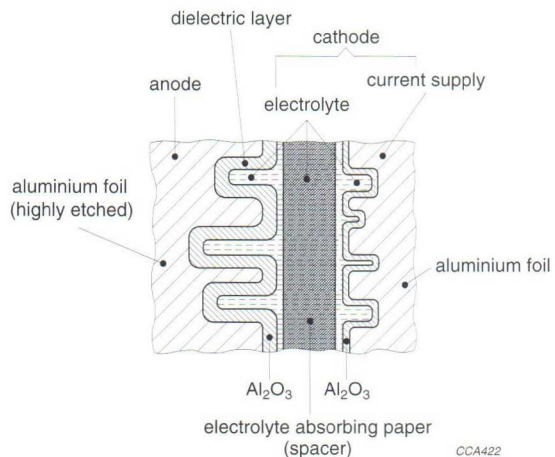


Fig.2 Equivalent circuit of an electrolytic capacitor.

Electrolytic capacitors

General introduction

ELECTRICAL BEHAVIOUR

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

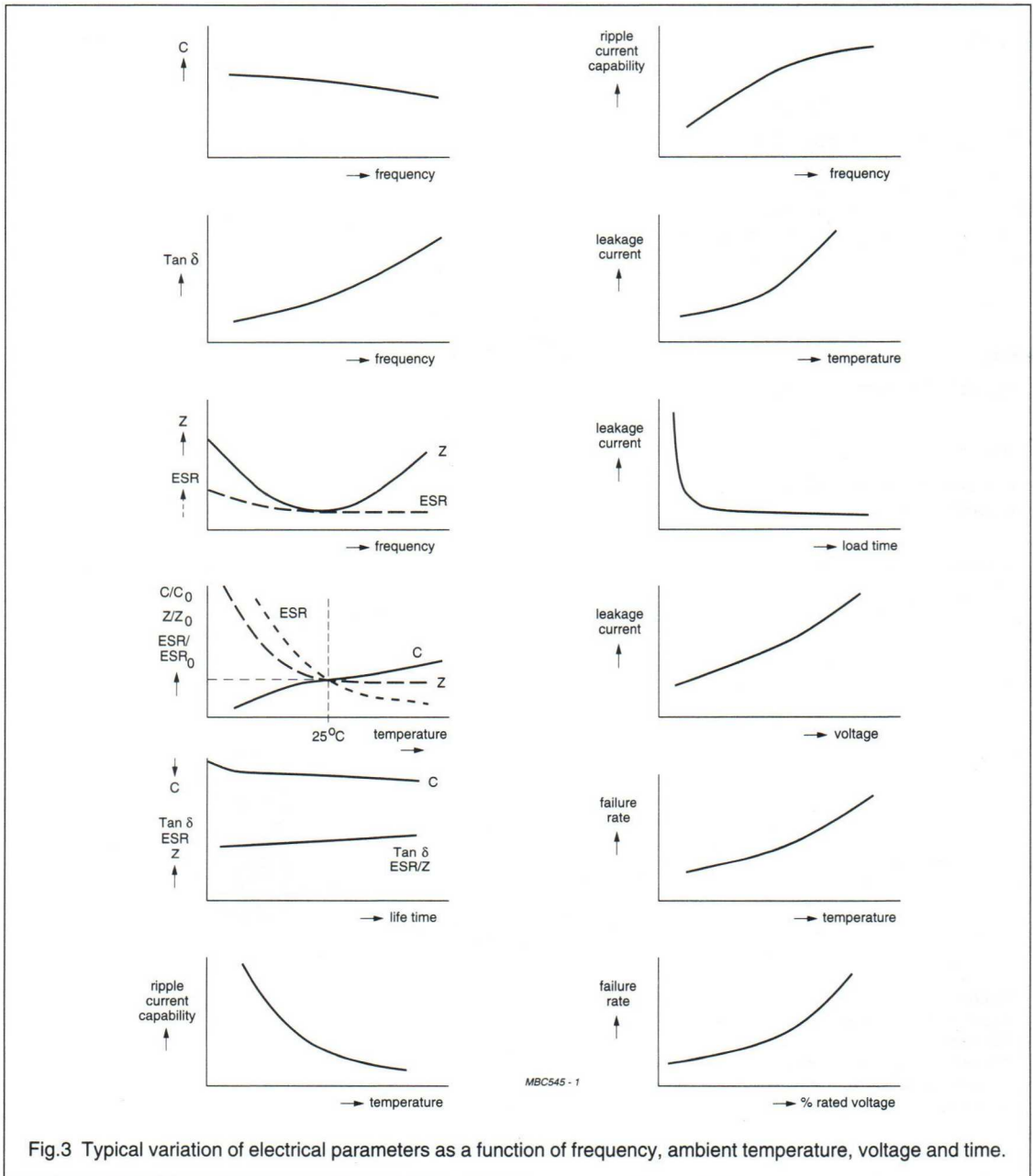


Fig.3 Typical variation of electrical parameters as a function of frequency, ambient temperature, voltage and time.

Electrolytic capacitors

General introduction

CONSTRUCTION

Examples

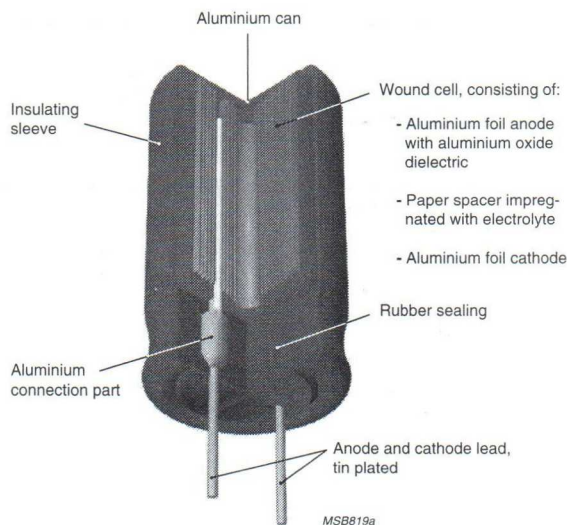


Fig.4 Radial Aluminium.

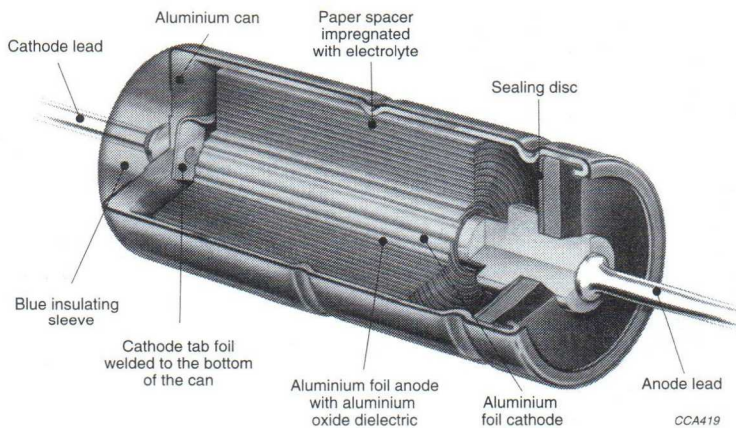


Fig.5 Axial Aluminium.

Electrolytic capacitors

General introduction

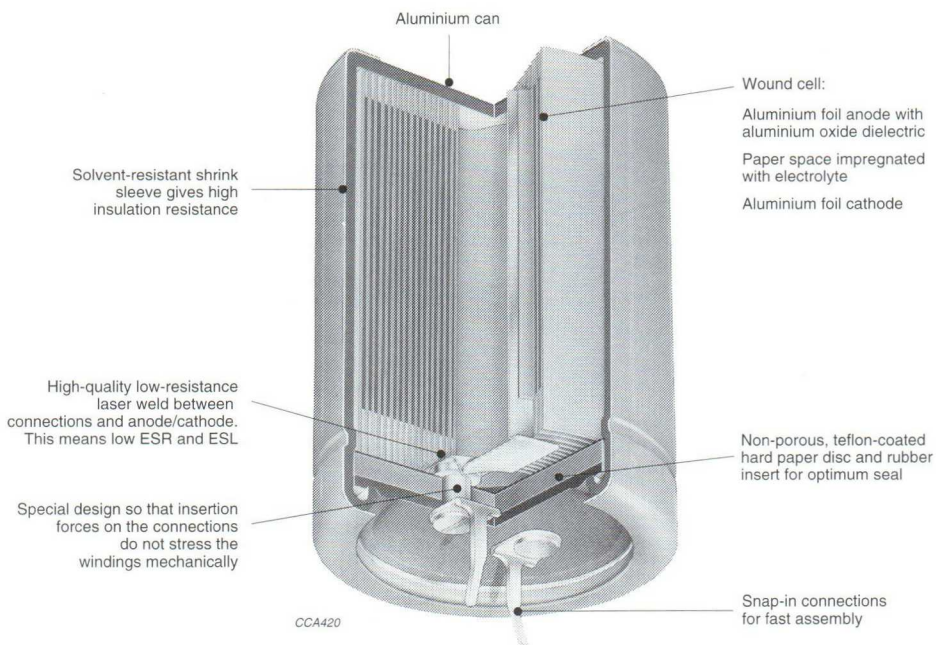


Fig.6 Large Aluminium, snap-in.

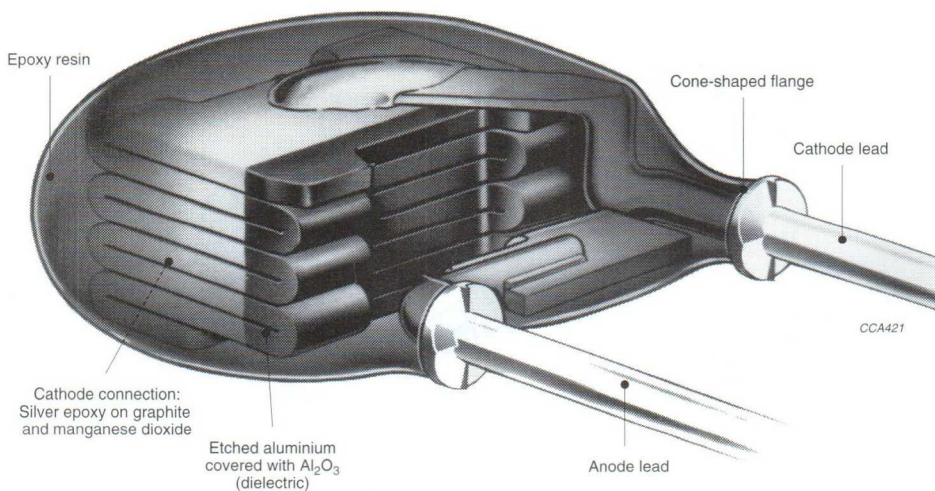


Fig.7 Solid Aluminium (SAL), radial.

Electrolytic capacitors

General introduction

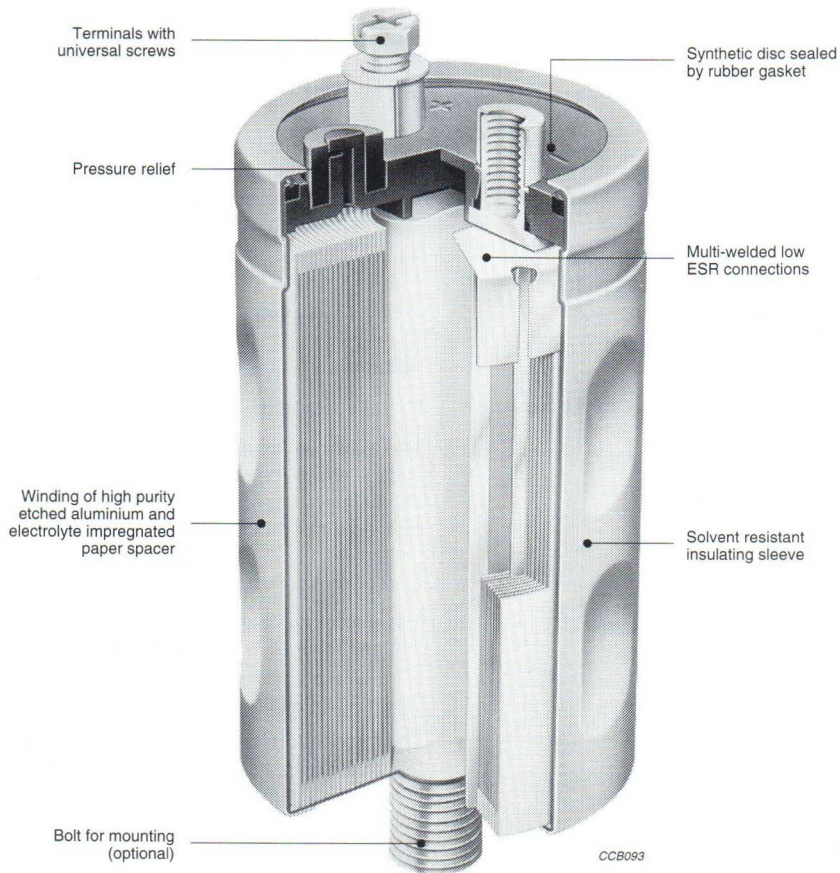


Fig.8 Large Aluminium, screw terminal.

Electrolytic capacitors

General introduction

DEFINITIONS OF ELECTRICAL PARAMETERS

Sequence of measurement for tests are in accordance with "IEC 384-4":

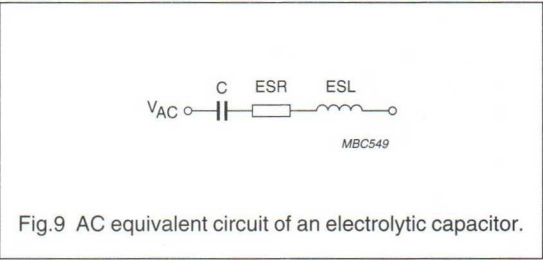
- 1. Leakage current (I_L)
- 2. Capacitance (C_R)
- 3. Dissipation factor ($\tan \delta$ or ESR)
- 4. Impedance (Z).

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.9.

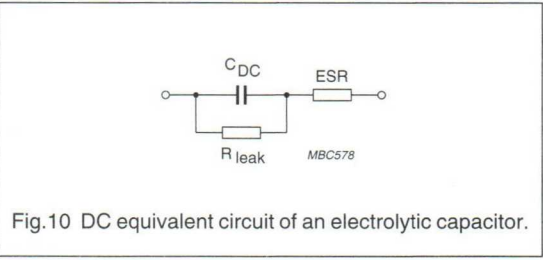
Standard measuring frequencies for electrolytic capacitors are 100 or 120 Hz.



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" (withdrawn).

At any given time, the DC capacitance is higher than the AC capacitance.



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

-20/+20%	-10/+50%	-10/+30%	-10/+10%
M	T	Q	K

These values depend on the relevant series.

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.

Electrolytic capacitors

General introduction

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.9.

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.9.

DISSIPATION FACTOR (TANGENT OF LOSS ANGLE; $\tan \delta$)

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

$$\tan \delta = \text{ESR} \times 2 \pi f C \text{ (approximation formula)}$$

IMPEDANCE (Z)

The impedance (Z) of an electrolytic capacitor is given by capacitance, ESR and ESL in accordance with the following equation (see Fig.11):

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

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" and "CECC 30300") 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 30300".

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 shall be carried out in accordance with "CECC 30300 subclause 4.1".

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.

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.

Electrolytic capacitors

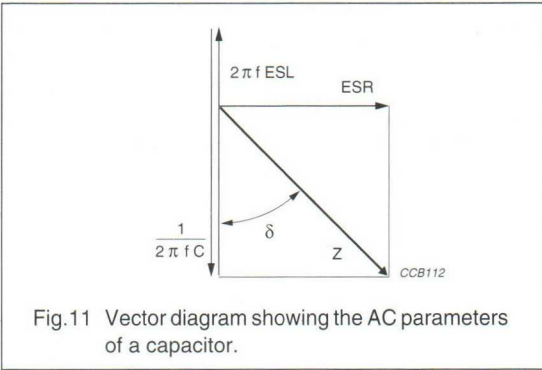
General introduction

Table 1 Typical multiplier of operational leakage current as a function of ambient temperature (as far as allowed for the corresponding series)

SYMBOL	MULTIPLIER									
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

Table 2 Typical multiplier of operational leakage current as a function of applied voltage

SYMBOL	MULTIPLIER									
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	



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 waveform of the alternating current.

The maximum RMS value of this alternating current, which is permitted to pass through the capacitor during its entire specified useful life (at defined frequency and defined ambient temperature), is called **rated ripple current** (I_R).

The rated ripple current is specified in the relevant detail specifications at 100 or 120 Hz (in special cases at 100 kHz) and at upper category temperature.

Usually the rated ripple current will cause a temperature increase of the capacitor's surface of approximately 3 or 5 K (dependent on series) compared with ambient temperature. A further temperature increase of 3 or 5 K will be found in the core of the capacitor.

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

$P = I_R^2 \text{ ESR}$

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

$$P = \Delta T \times A \times \beta; I_R = \sqrt{\frac{\Delta T \times A \times \beta}{\text{ESR}}}$$

I_R can be determined by the equation:

$$I_R = \sqrt{\frac{\Delta T \times A \times \beta}{\text{ESR}}}$$

where:

ΔT = difference of temperature between ambient and case surface

A = geometric surface area of the capacitor

β = specific heat conductivity, dependent on the size of the capacitor.

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.

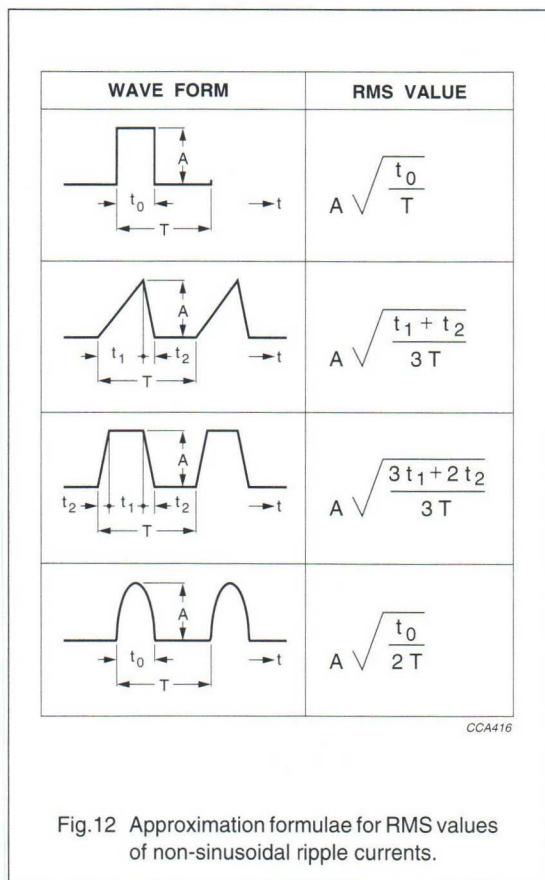
Electrolytic capacitors

General introduction

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 vectorial sum of the currents thus found may not exceed the applicable ripple current.

For some frequently occurring waveforms, approximation formulae are stated in Fig.12 for calculating the corresponding RMS value.



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:

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 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" and "CECC 30300 subclause 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 30300" 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.

Electrolytic capacitors

General introduction

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.

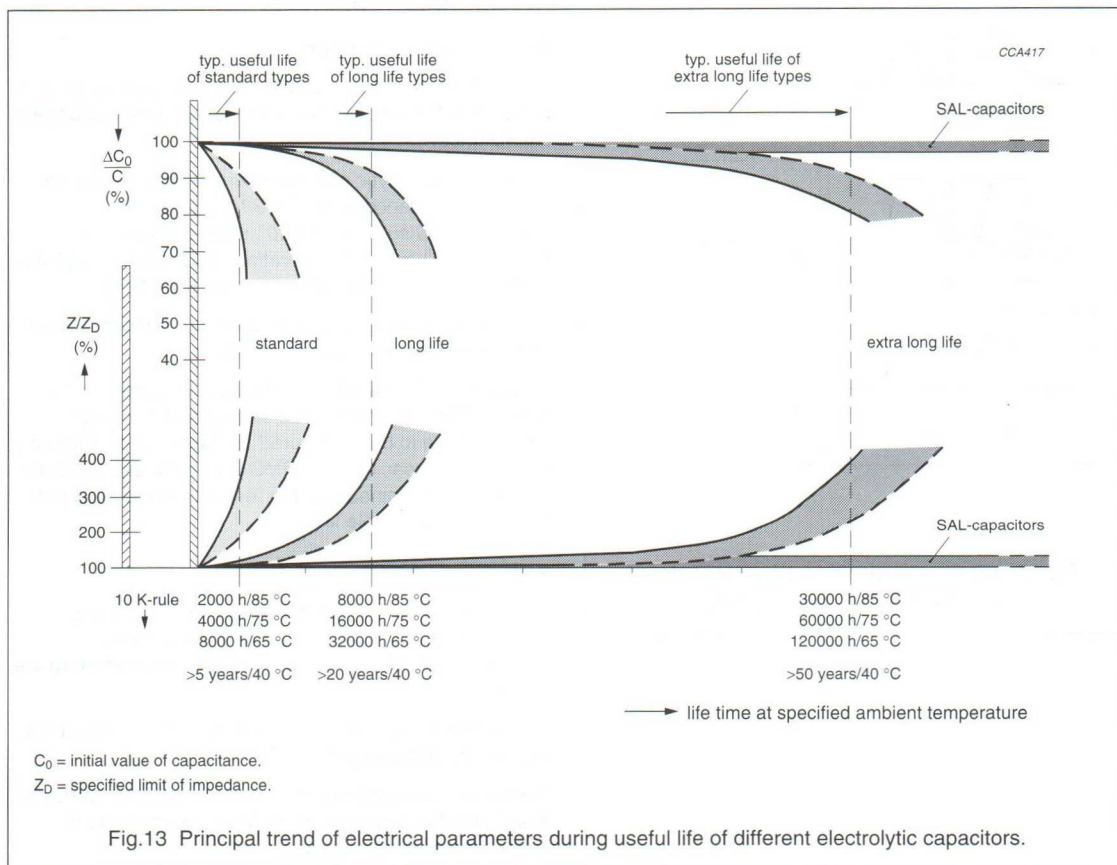
Figure 13 shows the principal electrical consequences of this electrolyte loss: increasing impedance and decreasing capacitance at the end of useful life, for different non-solid types.

Due to the fact that no liquid electrolyte is used in solid aluminium electrolytic capacitors, the associated failure mechanism does not occur.

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.



Electrolytic capacitors

General introduction

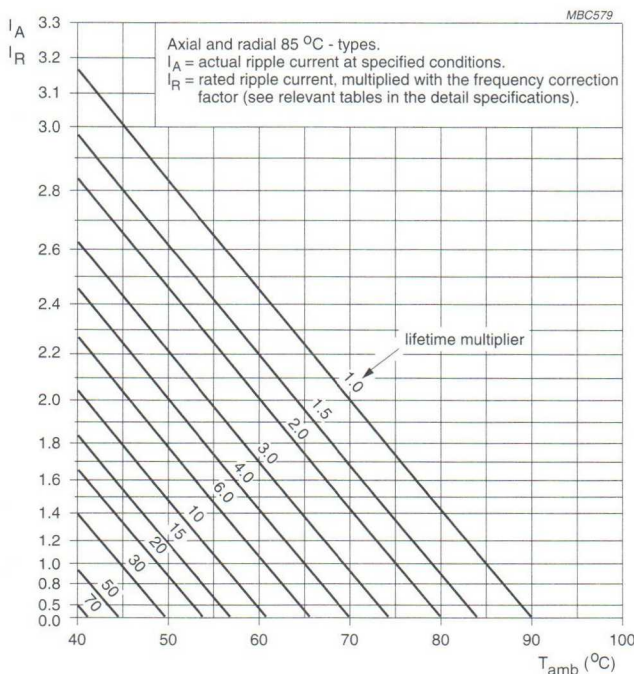
CALCULATION OF USEFUL LIFE BY MEANS OF
'LIFE-TIME NOMOGRAMS'

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.

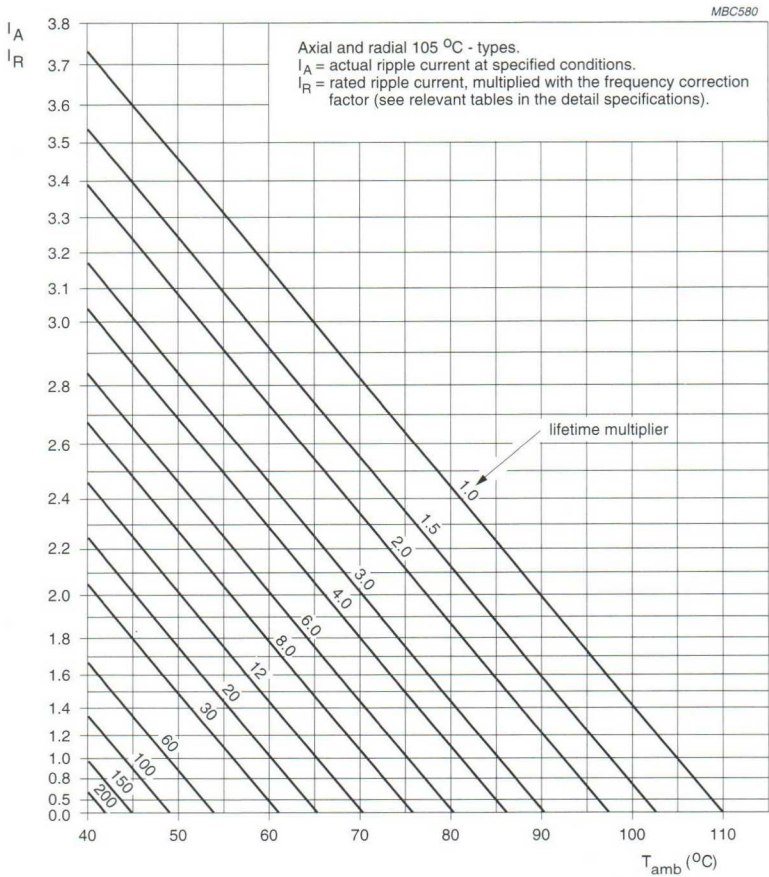
At the intersection of these two operational conditions the appropriate multiplier (correction factor) for useful life can be read. The useful life under certain conditions shall be calculated by multiplying (or dividing respectively) the specified useful life, with the resultant correction factor.

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.



Axial and radial 85 °C types.

Fig.14 Typical example of a life-time nomogram: useful life as a function of ambient temperature and ripple current load.



Axial and radial 105 °C types.

Fig.15 Typical example of a life-time nomogram: useful life as a function of ambient temperature and ripple current load.

Electrolytic capacitors

General introduction

EXAMPLES FOR THE USE OF '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):

- 1. for a capacitor with a specified useful life of 2000 hours at 85 °C?
- 2. 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 °C type this is '30' (see Fig.14) and for the 105 °C type it is '90' (see Fig.15).

Resulting useful life is thus:

- 1. for 85 °C type: 30×2000 hours = 60000 hours or about 7 years
- 2. for 105 °C type: 90×2000 hours = 180000 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. 100000 hours), consisting of 1000 hours at 75 °C + 9000 hours at 65 °C + 90000 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:

- 1. >2970 hours at 85 °C i.e. a 3000 hours/85 °C type, or
- 2. >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:

- 1. for 85 °C types this is max. 59 °C
- 2. 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 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

Electrolytic capacitors

General introduction

Table 4 Life-time calculation in "Example 2"

LIFE CONDITIONS	85 °C TYPES (see Fig.14)	105 °C TYPES (see Fig.15)
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
90000 hours at 40 °C	90000/80 = 1125 hours	90000/250 = 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:

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

or

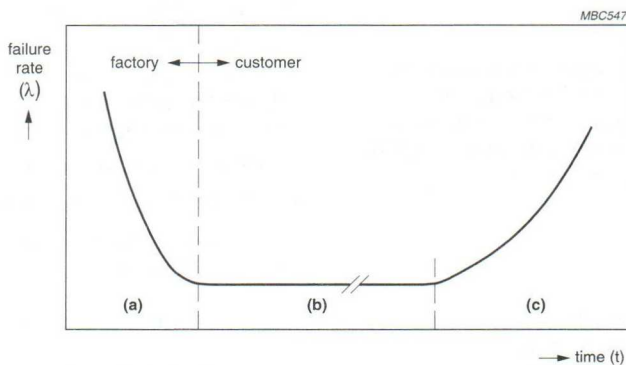
$$\lambda = \frac{\text{failure percentage (\%)}}{100 \times \text{duration}}$$

$MTBF = \frac{1}{\lambda}$ however, for an individual component it is not

longer than the specified useful life.

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.16).



- a) Initial failure period ('infant mortality').
- b) Random failure period (= useful life period).
- c) Wear-out failure period.

Fig.16 Failure rate (λ) as a function of time ('bathtub' curve).

Electrolytic capacitors

General introduction

There are 3 periods in a typical capacitor life cycle:

1. 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.
2. 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.
3. 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: $T_{amb} = 40^\circ\text{C}$ and $U = 0.5 U_R$.

For other operational conditions, λ has to be converted correspondingly with the aid of Figs 17 and 18, 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.

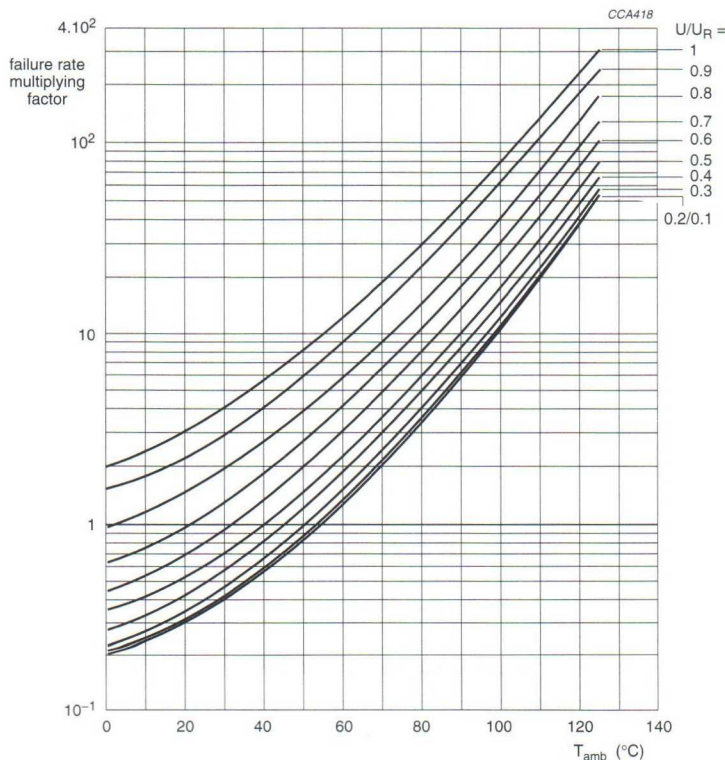


Fig.17 Conversion factors for failure rate (λ) as a function of ambient temperature (T_{amb}) and voltage ratio (U/U_R) for non-solid electrolytic capacitors.

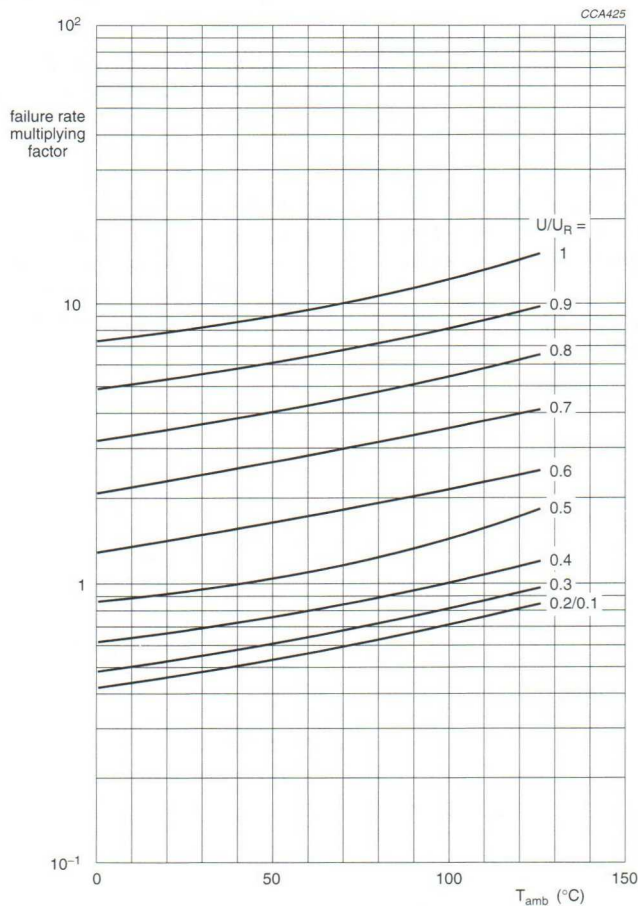


Fig.18 Conversion factors for failure rate (λ) as a function of ambient temperature (T_{amb}) and voltage ratio (U/U_R) for SAL electrolytic capacitors.

Table 5 Example of climatic categories

Example:	40 /	085 /	56	
	40			lower category temperature (here: $-40\text{ }^{\circ}\text{C}$)
		085		upper category temperature (here: $+85\text{ }^{\circ}\text{C}$)
			56	duration of test 'damp heat, steady state' (here: 56 days)

Electrolytic capacitors

General introduction

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.

Code letter meanings

1 st letter:	lower category temperature F: -55 °C; G: -40 °C; H: -25 °C
2 nd letter:	upper category temperature P: +85 °C; M: +100 (+105) °C; K: +125 °C
3 rd letter:	maximum humidity conditions (see Table 6)

MOUNTING

Mounting position of non-solid Al-electrolytic capacitors

Snap-in and printed wiring (PW) as well as solder lug (SL) 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 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 (pressure relief on the upper side) 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:

$$R_{\text{sym}} \text{ (in k}\Omega\text{)} = 10000/C_R \text{ (in }\mu\text{F)}$$

Combined series/parallel connection

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

Electrolytic capacitors

General introduction

MARKING

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

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 letter code in accordance with "IEC 62", e.g. T for $-10/+50\%$ M for $\pm 20\%$ K for $\pm 10\%$ 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.

1 st digit	2 nd digit
D = 1993	1 = January
E = 1994	2 = February
F = 1995	...
H = 1996	9 = September
J = 1997	O = October
K = 1998	N = November
L = 1999	D = December

example:

F5 = produced in 1995, May

production date may also be stated as year/week code

example: 9525 = produced in 1995, 25th week

Date code may also be stamped in the case.

Factory code indicating the factory of origin

Polarity identification strip, band or negative symbol ('-' sign) to indicate the negative terminal and/or a '+' sign to identify the positive terminal.

PRODUCT SAFETY



Electrolytic capacitors

Product safety

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, leakage of electrolyte 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.

GUIDELINES

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 <i>"This Handbook, Section Tests and Requirements"</i>. 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 <i>"This Handbook, Section Tests and Requirements"</i>.	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, wherever possible, electrolytic capacitors should be placed at the coolest positions on the board (please ensure that electrolytic capacitors are placed away from 'heating' components such as power resistors, switching diodes/transistors or transformers). Exceeding the permitted temperature range may cause early failures.	detail specification

Electrolytic capacitors

Product safety

PARAMETER	IMPORTANT INFORMATION – PRODUCT SAFETY	MORE DETAILS
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 <i>"This Handbook, Section Tests and Requirements"</i>) frequent charge-discharge operation is allowed. The resulting current through the capacitor may not exceed the ripple current limit. Electrolytic capacitors are not suitable for flash applications.	TESTS AND REQUIREMENTS
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
PC BOARD DESIGN	Conducting tracks or lands should not be located under upright mounted electrolytic capacitors; short circuits under the capacitor with danger of fire could be the result.	
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 AND TRANSPORT	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. Packages with electrolytic capacitors should be handled with care, or bent leads and/or incorrect taping dimensions could be the result.	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 ≤ 12000 m. Minimum air pressure: 8.5 kPa for short periods (in accordance with <i>"IEC 384-4, subclause 4.11.4"</i>).	TESTS AND REQUIREMENTS

Electrolytic capacitors

Product safety

PARAMETER	IMPORTANT INFORMATION – PRODUCT SAFETY	MORE DETAILS
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 printed-circuit or bending of the component after soldering. Care should be taken when the manual bending of terminals or mounted capacitors is required. For maximum allowed mechanical load and time of application, see this data handbook, Section <i>“Tests and Requirements”</i>. Mechanically damaged capacitors may not be used. Pressure relief should have enough space to function correctly.	TESTS AND REQUIREMENTS
SOLDERING	Keep soldering temperature and time under control. For maximum soldering conditions, see Chapter <i>“Tests and Requirements”</i>. Additional temperature load e.g. for curing the glue of Surface Mounting Devices (SMDs) 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. Reflow soldering is only suitable for SMD components.	TESTS AND REQUIREMENTS
BOARD CLEANING	No guarantees can be given with regard to solvents based on halogenated hydrocarbons or ozone depleting chemicals (ODCs). Warning: such solvents are hazardous to the environment. Component cleaning using solvents such as demineralized or distilled water, isopropanol, methanol, ethanol and propanol 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 (or 70 °C for products with an upper category temperature of 70 °C) for at least 5 minutes. For further information regarding the application of solvent temperatures exceeding the temperature mentioned in <i>“IEC 68-2-45”</i>, consult your local Philips Components sales organization.	
ADHESIVES, COATING MATERIALS	Some adhesives and coating materials affect capacitors adversely. For varnishing, coating, lacquering, embedding or gluing 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. When applying such materials, ensure that the rubber area is not completely sealed off.	

Electrolytic capacitors

Product safety

PARAMETER	IMPORTANT INFORMATION – PRODUCT SAFETY	MORE DETAILS
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; please consult your local Philips Components sales organization. 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 discoloration 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

TESTS AND REQUIREMENTS

This chapter contains an abridged version of tests and requirements given in "IEC 384-4" or "CECC 30300" respectively. Series specific tests and requirements are given in the relevant detail specification of this data handbook. Correct sequence of measurement for electrical parameters in accordance with "IEC 384-4":

1. Leakage current
2. Capacitance
3. Tan δ or ESR
4. Impedance.

Table 1 Non-solid aluminium types

NAME OF TEST	IEC 384-4/ CECC 30300 subclause	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	no visible damage; marking legible $\Delta C/C: \pm 5\%$
Solderability	4.6	Ta	solder bath: 235 °C; 2 s; immersed up to 2 mm from the body; non-activated flux	no visible damage; marking legible $\geq 95\%$ tinning
Rapid change of temperature	4.7	Na	for power capacitors: 5 cycles of 3 hours at lower and upper category temperature for axial, radial and SMD capacitors: 5 cycles of 30 minutes at lower and upper category temperature	no visible damage; no leakage of electrolyte
Vibration (note 1)	4.8	Fc	10 to 500 Hz; 0.75 mm or 10 g (whichever is less); 3 directions; 2 hours per direction Form MR types: 10 to 55 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

Electrolytic capacitors

Tests and requirements

NAME OF TEST	IEC 384-4/ CECC 30300 subclause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Bump (note 1)	4.9	Eb	40 g; 2 directions; 4000 bumps total Form MR types: 40 g; 2 directions; 1000 bumps total	no visible damage; no leakage of electrolyte $\Delta C/C: \pm 5\%$ with respect to initial measurement
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 4.11.7	Qc	1 minute in water at 90 °C final measurement after climatic sequence	no continuous chain of bubbles no visible damage; no leakage of electrolyte; marking legible leakage current ≤ stated limit $\tan \delta \leq 1.2 \times \text{stated limit}$ $\Delta C/C: \pm 10\%$
Insulation resistance	4.3.5		external insulation: foil method	insulation resistance ≥ 100 MΩ
Voltage proof	4.3.6		external insulation: foil method; 1000 V for 1 minute	no breakdown or flashover

Note

- For vibration and bump testing, the components shall be mounted by their terminations (with mounting accessories where applicable). The following capacitors shall also be clamped by their body:
 - Radial types: $\varnothing D_{\text{nom}} \geq 12.5 \text{ mm}$; $L_{\text{nom}} \geq 15 \text{ mm}$
 - Axial types: $\varnothing D_{\text{nom}} \geq 12.5 \text{ mm}$; $L_{\text{nom}} \geq 30 \text{ mm}$.

Electrolytic capacitors

Tests and requirements

Non-solid aluminium types (continued)

NAME OF TEST	IEC 384-4/ CECC 30300 subclause	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 $\leq$ stated limit $\tan \delta \leq 1.2 \times$ stated limit insulation resistance $>100 \text{ M}\Omega$; no breakdown or flashover below 1000 V $\Delta C/C: \pm 10\%$
Endurance	4.13		for test duration, refer to the relevant data sheet in this data handbook; at upper category temperature; U_R applied	no visible damage; no leakage of electrolyte; marking legible leakage current $\leq$ stated limit insulation resistance $>100 \text{ M}\Omega$; no breakdown or flashover below 1000 V $U_R \leq 6.3 \text{ V}$; $\Delta C/C: +15/-30\%$; U_R 10 to 160 V; $\Delta C/C: \pm 15\%$; $U_R \geq 200 \text{ V}$; $\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.3 \times$ stated limit impedance $\leq 2 \times$ stated limit
Surge	4.14		from source of $1.15 \times U_R$ for $U_R \leq 315 \text{ V}$ or $1.1 \times U_R$ for $U_R > 315 \text{ V}$; $RC = 0.1 \pm 0.05 \text{ s}$; 1000 cycles of 30 s on, 330 s off, at upper category temperature	no visible damage; no leakage of electrolyte leakage current $\leq$ stated limit $\tan \delta \leq$ stated limit $\Delta C/C: \pm 15\%$
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 $\leq$ stated limit $\tan \delta \leq$ stated limit $\Delta C/C: \pm 10\%$
Pressure relief (only for types with vent)	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 500 hours at upper category temperature; for longer test duration (shelf life), refer to the relevant data sheet in this data handbook	no visible damage; no leakage of electrolyte leakage current $\leq 2 \times$ stated limit $\tan \delta \leq 1.2 \times$ stated limit $\Delta C/C: \pm 10\%$

Electrolytic capacitors

Tests and requirements

NAME OF TEST	IEC 384-4/ CECC 30300 subclause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Storage at low temperature	4.18	Ab	72 hours at the lower category temperature	no visible damage; no leakage of electrolyte leakage current $\leq$ stated limit $\tan \delta \leq$ stated limit $\Delta C/C: \pm 10\%$
Characteristics at high and low temperatures	4.19		step 1: reference measurement of impedance at 20 °C and 100 Hz	
		Aa	step 2: measurement at lower category temperature	impedance at 100 Hz: $\leq 7 \times$ value of step 1 for $U_R \leq 6.3$ V or $U_R > 160$ V; $\leq 5 \times$ value of step 1 for 6.3 V $< U_R \leq 16$ V; $\leq 4 \times$ value of step 1 for 16 V $< U_R \leq 160$ V
		Ba	step 3: measurement at upper category temperature	leakage current: $\leq 10 \times$ stated limit at 125 °C; $\leq 8 \times$ stated limit at 105 °C; $\leq 5 \times$ stated limit at 85 °C; $\leq 3 \times$ 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 $\Delta C/C: \pm 10\%$
Additional tests in accordance with IEC 384-1 and EN 130000				
Solvent resistance	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
Passive flammability	4.38	IEC 695-2-2	needle flame test	category of flammability: B

Electrolytic capacitors

Tests and requirements

Table 2 Solid aluminium types, SAL

NAME OF TEST	IEC 384-4/ CECC 30300 subclause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Robustness of terminations: Tensile strength Bending Torsion (axial types)	4.4	Ua Ub Uc	loading force; note 1: 10 N for 10 s loading force; note 1: 5 N; two consecutive bends two successive rotations of 180° in opposite direction; 5 s duration per rotation	no visible damage no visible damage no visible damage
Resistance to soldering heat	4.5	Tb (method 1A)	radial types: solder bath: 260 °C; 10 s	no visible damage; markings legible
		Tb (method 1B)	axial types: solder bath 350 °C for 3.5 s	$\Delta C/C$: $\pm 5\%$ with respect to initial measurement
Solderability	4.6	Ta (method 1)	solder bath: 235 °C; 2 s; immersed up to 2 mm from the body; non-activated flux	no visible damage; marking legible $\geq 95\%$ tinning
Rapid change of temperature	4.7	Na	5 cycles of 30 minutes at lower and upper category temperature	no visible damage leakage current $\tan \delta$ 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 $\Delta C/C$: $\pm 5\%$ with respect to initial measurement
			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 $\Delta C/C$: $\pm 5\%$ with respect to initial measurement
Bump (note 2)	4.9	Eb	40 g; 2 directions; 4000 bumps total	no visible damage $\Delta C/C$: $\pm 5\%$ with respect to initial measurement
Shock (note 2)	4.10	Ea	123 SAL-AG: acceleration: 29400 m/sec ² or 3000 g; duration of pulse: 0.2 ms; total number of shocks: 18	no visible damage $\Delta C/C$: $\pm 5\%$ with respect to initial measurement

Notes

1. SPECIAL PLIERS MUST BE USED TO PROTECT 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.

Electrolytic capacitors

Tests and requirements

Solid aluminium types, SAL (continued)

NAME OF TEST	IEC 384-4/ CECC 30300 subclause	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	no breakdown, flashover, or harmful deformation of case no visible damage; markings legible leakage current $\leq$ stated limit $\tan \delta$ and $Z \leq 1.2 \times$ stated limit axial types: $\Delta C/C$: $\pm 5\%$ with respect to initial measurement radial types: $\Delta C/C$: $\pm 10\%$ with respect to initial measurement
Damp heat, cyclic	4.11.2	Db	1 cycle (55 °C $\rightarrow$ 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	
Low air pressure	4.11.4	M	5 minutes at 25 $\pm$ 10 °C; atmospheric pressure: 8.5 kPa; U_R applied during last minute of test	
Damp heat, cyclic	4.11.5 4.11.7	Db	5 cycles (55 °C $\rightarrow$ 25 °C) of 24 hours each; 25 °C; RH 95 to 100%; no voltage applied final measurements after climatic sequence	
Damp heat, steady state	4.12	Ca	56 days at 40 °C; RH 90 to 95%; no voltage applied	no visible damage; markings legible leakage current $\leq$ stated limit $\tan \delta$ and $Z \leq 1.2 \times$ stated limit $\Delta C/C$: $\pm 10\%$ of initial measurement
Insulation resistance	4.3.5		external insulation: foil method	insulation resistance $\geq 100 \text{ M}\Omega$
Voltage proof	4.3.6		external insulation: foil method; 1000 V for 1 minute	no breakdown or flashover

Electrolytic capacitors

Tests and requirements

Solid aluminium types, SAL (continued)

NAME OF TEST	IEC 384-4/ CECC 30300 subclause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Endurance	4.13		for test duration, refer to the relevant data sheet in this data handbook; at upper category temperature; U_R applied (note 1)	no visible damage; markings legible leakage current $\leq$ stated limit $\Delta C/C$: $\pm 10\%$ with respect to initial measurement $\tan \delta$ and $Z \leq 1.2 \times$ stated limit
Endurance (additional) SAL-A			2000 hours at 175°C ; maximum $0.63 \times U_R$ applied	axial types: insulation resistance $\geq 100\text{ M}\Omega$; no breakdown or flashover at 1000 V leakage current $\leq$ stated limit $\Delta C/C$: $\pm 20\%$ with respect to initial measurement $\tan \delta \leq 1.5 \times$ stated limit $Z \leq 2.5 \times$ stated limit
Surge	4.14		applied voltage source of $1.15 \times U_R$ (note 1) at 125°C ; 1000 cycles; 30 s on, 330 s off	no visible damage leakage current $\leq$ stated limit $\tan \delta \leq$ stated limit
				axial types: $\Delta C/C$: $\pm 5\%$ with respect to initial measurement radial types: $\Delta C/C$: $\pm 10\%$ with respect to initial measurement
Reverse voltage	4.15		$0.15 \times U_R$ (note 1) in reverse polarity at 125°C , for 125 hours, followed by U_R (note 1) in forward polarity at 125°C for 125 hours	leakage current $\leq$ stated limit $\Delta C/C$: $\pm 10\%$ with respect to initial measurement $\tan \delta$ and $Z \leq$ stated limit
Reverse voltage (additional): Radial types			$0.30 \times U_R$ (note 1) in reverse polarity at 125°C for 125 hours, followed by U_R (note 1) in forward polarity at 125°C for 125 hours	leakage current stated limit $\Delta C/C$: $\pm 10\%$ with respect to initial measurement $\tan \delta$ and $Z \leq$ stated limit
Reverse voltage (additional): SAL-A			$0.30 \times U_R$ in reverse polarity at 125°C for 2000 hours	leakage current $\leq$ stated limit $\Delta C/C$: $\pm 10\%$ with respect to initial measurement $\tan \delta$ and $Z \leq$ stated limit

Electrolytic capacitors

Tests and requirements

NAME OF TEST	IEC 384-4/ CECC 30300 subclause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Storage at upper category temperature	4.17	Ba	500 hours at upper category temperature	no visible damage leakage current $\leq$ stated limit $\Delta C/C$: $\pm 10\%$ with respect to initial measurement
Long storage ≥ 1 year (additional)			at ambient temperature	leakage current $\leq$ stated limit
Characteristics at high and low temperature	4.19		step 1: reference measurement at 20 °C of capacitance, $\tan \delta$ and impedance at 100 Hz	
			step 2: measurement at -55 °C; capacitance, $\tan \delta$ and impedance at 100 Hz	$\Delta C/C$: $\pm 20\%$ with respect to value in step 1 impedance ratio (100 Hz) $\leq 2 \times$ the value of step 1 $\tan \delta \leq 2 \times$ the stated limit
			step 3: measurement at 125 °C; capacitance, leakage current and $\tan \delta$	leakage current $\leq 15 \times$ the stated limit; notes 2 and 3 $\Delta C/C$: $\pm 20\%$ of the value measured in step 1 $\tan \delta \leq$ 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 $\Delta C/C$: $\pm 5\%$ with respect to initial measurement
Additional tests in accordance with IEC 384-1 and EN 130000				
Solvent resistance	4.31	Xa	immersion: 5 $\pm$ 0.5 minutes with or without ultrasonic at 55 $\pm$ 0.5 °C solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected
Passive flammability	4.38	IEC 695-2-2	needle flame test	category of flammability: B

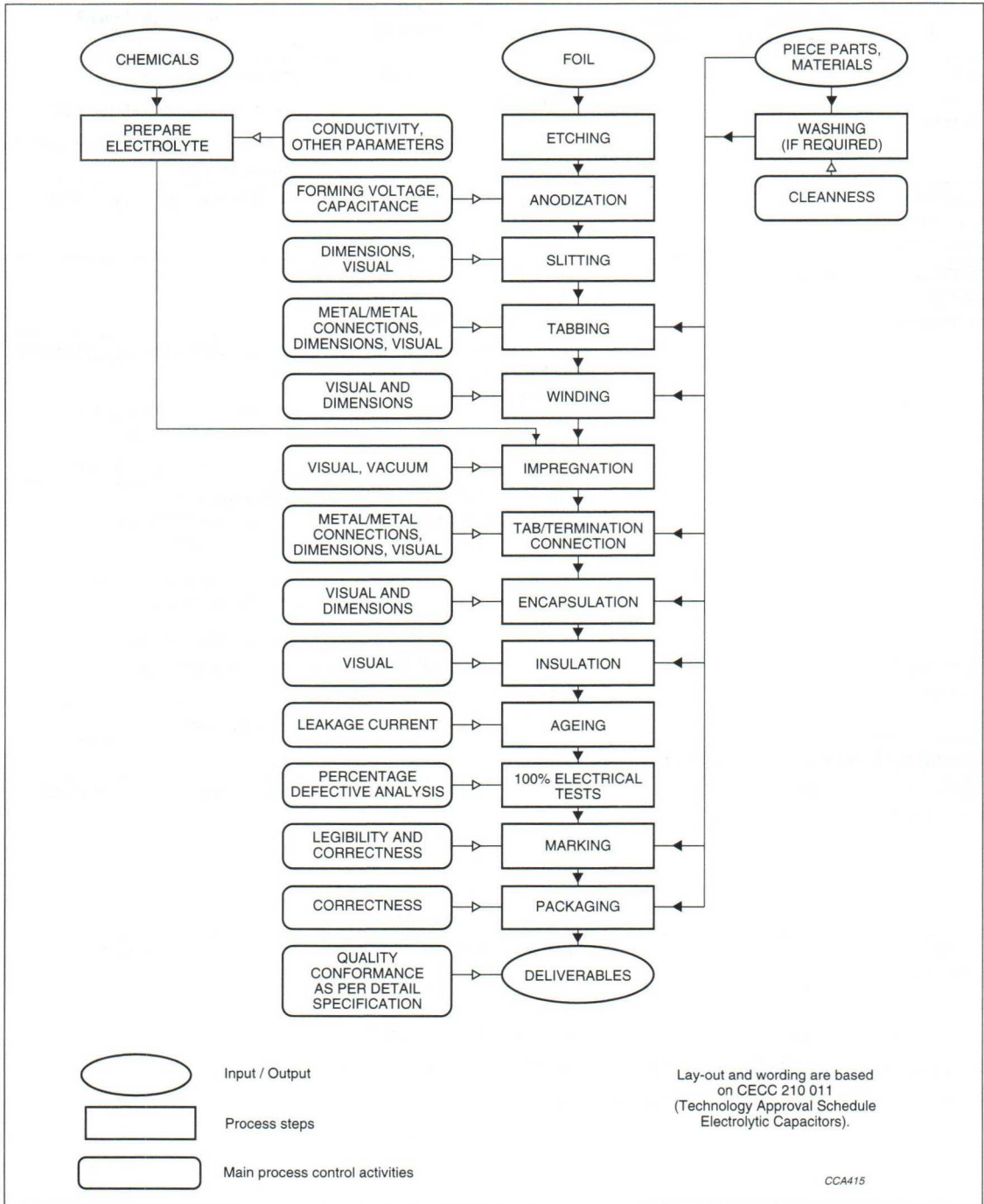
Notes

1. 25 V for 35 and 40 V versions (capacitor types 122 SAL-RP and 128 SAL-RPM).
2. For capacitors type 122 SAL-RP and 128 SAL-RPM, 40 V version: $< 8 \times$ the stated limit.
3. Leakage current for 123 SAL-A: $\leq 1.5 \times U_R \times C_R$.

Electrolytic capacitors

Quality flowchart

GENERIC QUALITY FLOWCHART FOR NON-SOLID ELECTROLYTIC CAPACITORS



PACKAGING - SURFACE MOUNTING DEVICES (SMD)

SMD Electrolytic capacitors

Packaging

TAPE AND REEL DATA

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

- 085 CS
- 139 CLL

For catalogue numbers, refer to the relevant detail specification in this data handbook.

Philips SMD aluminium electrolytic capacitors are available in taped version based on "IEC 286-3". They are most suitable for use on automatic placement machines and are supplied in blister tape on reel.

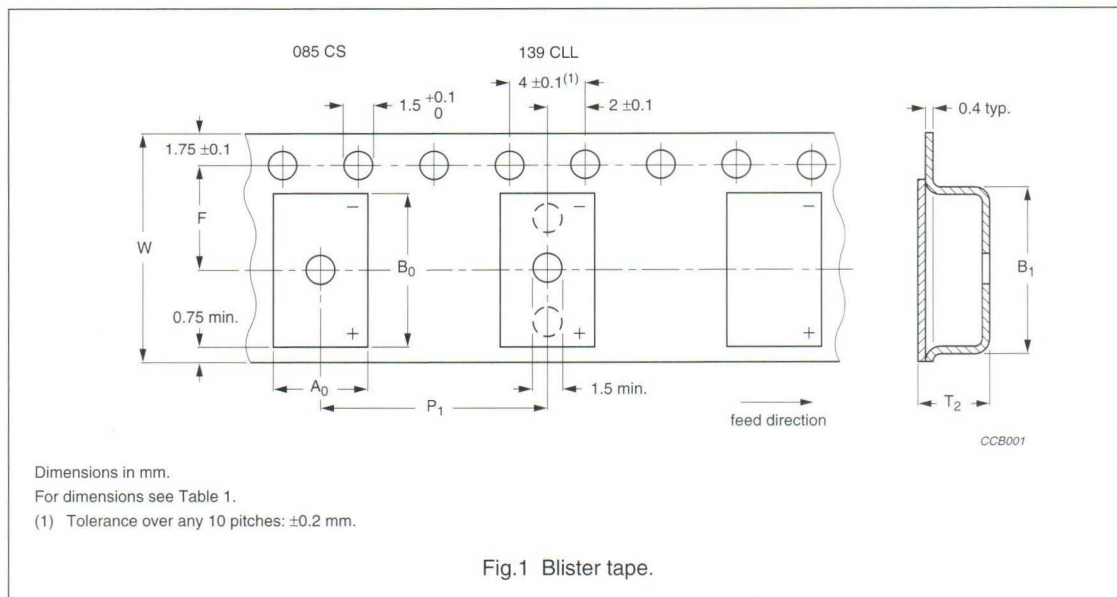


Fig.1 Blister tape.

Table 1 Physical dimensions of blister tape (in mm) and packaging quantities; see Fig.1

PARAMETER	085 CS		139 CLL		TOLERANCE
Case code	1a	1	2	3	—
Case size:					
L _{nom}	8.8	11.9	14.3	14.3	—
W _{nom}	3.7	3.7	6.2	7.6	—
H _{nom}	3.9	3.9	6.9	8.2	—
W	16	24	24	24	±0.3
T ₂	4.9	4.9	7.7	9.1	max.
F	7.5	11.5	11.5	11.5	±0.1
P ₁	8	8	12	12	±0.1
A ₀	4.1	4.1	6.5	7.9	±0.2
B ₀	9.3	12.5	14.8	14.8	±0.2
B ₁	10	13.2	15.5	15.5	max.
Quantity per reel	2000	2000	700	700	—

SMD Electrolytic capacitors

Packaging

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

- 153 CLV

For catalogue numbers, refer to the relevant detail specification in this data handbook.

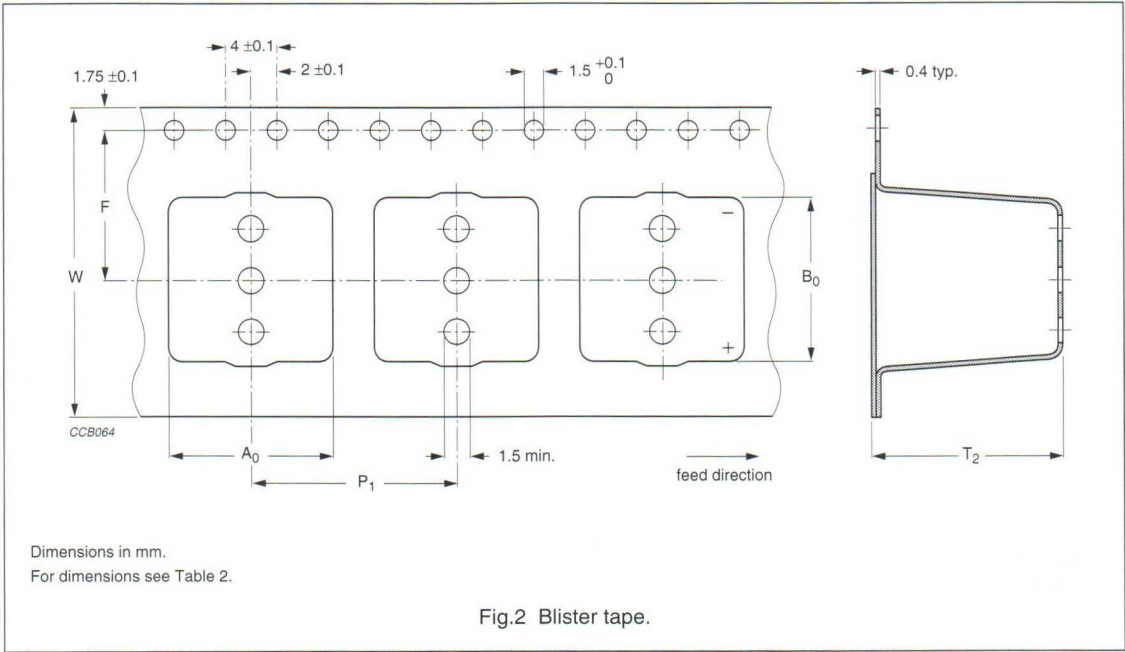


Table 2 Physical dimensions of blister tape (in mm) and packaging quantities; see Fig.2

PARAMETER	153 CLV								TOLERANCE
Case code	0405	0505	0605	0807	0810	1010	1012	1014	—
Case size:									
L _{nom}	4.0	5.0	6.3	8.0	8.0	10.0	10.0	10.0	—
W _{nom}	4.0	5.0	6.3	8.0	8.0	10.0	10.0	10.0	—
H _{nom}	5.3	5.3	5.3	6.5	10.0	10.0	12.0	14.0	—
W	12	12	16	16	24	24	24	24	±0.3
T ₂	5.8	5.8	5.8	6.8	11.0	11.0	13.0	15.0	max.
F	5.5	5.5	7.5	7.5	11.5	11.5	11.5	11.5	±0.1
P ₁	8	12	12	12	16	16	16	16	±0.1
A ₀	5.0	6.0	7.0	8.7	8.7	10.7	10.8	10.8	±0.2
B ₀	5.0	6.0	7.0	8.7	8.7	10.7	10.8	10.8	±0.2
Quantity per reel	2000	1000	1000	1000	500	500	250	250	—

SMD Electrolytic capacitors

Packaging

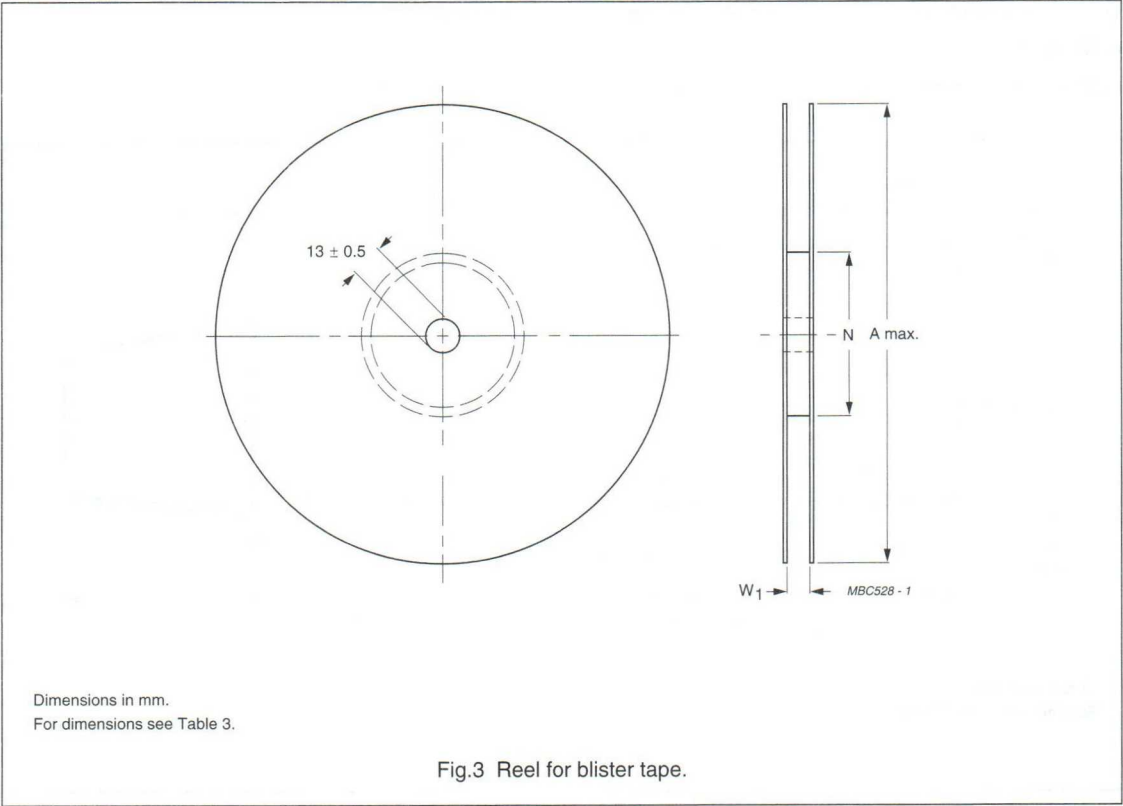


Table 3 Reel dimensions; see Fig.3

TAPE WIDTH (mm)	A MAX. (mm)			N MIN. (mm)	W ₁ (mm)
	085 CS 139 CLL	153 CLV			
		CASE SIZE ≥1012	CASE SIZE ≤1010		
12	—	—	380	50	14
16	330	—	380	50	18
24	330	330	380	50	26

PACKAGING - RADIAL LEADED DEVICES

Radial electrolytic capacitors

Packaging

TAPING

Philips radial, aluminium and solid aluminium electrolytic capacitors in sizes up to $\varnothing D = 16$ mm, are available in taped versions corresponding to "IEC 286-2" or "JIS C 0805" respectively. They are most suitable for use on automatic insertion machines, mounting robots or cutting and forming equipment and are supplied in boxes (ammopacks).

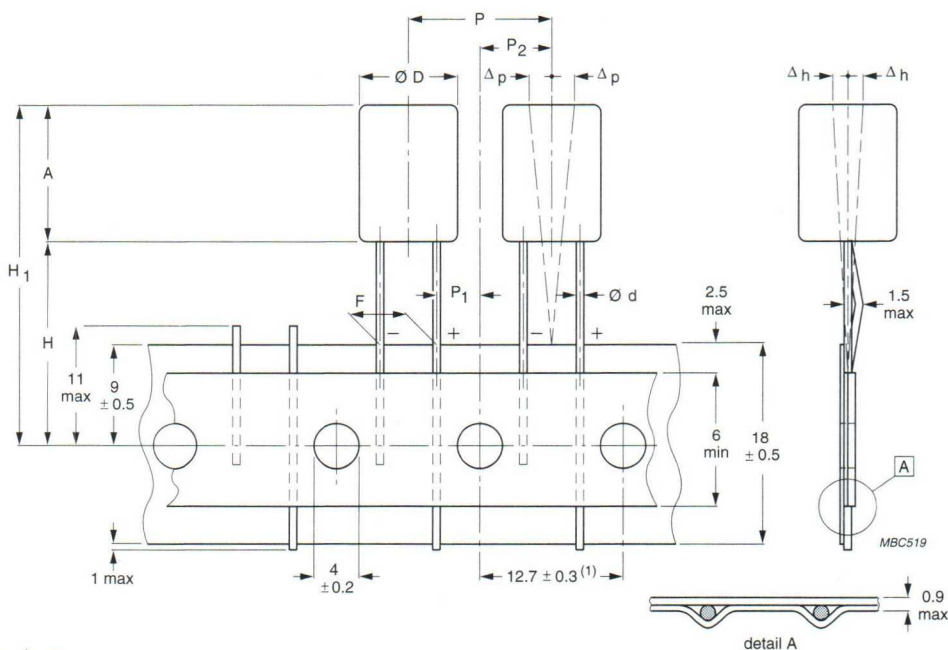
CAUTION

Packages must be handled with care to avoid bent leads.

For catalogue numbers, refer to the relevant detail specification in this data handbook.

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

- 013 RLC
- 036 RSP
- 036 92 RB
- 036 93 RBA
- 116 RLL



Dimensions in mm.

Form TNA: case $\varnothing D \times L = 5 \times 11$ mm; $F = 2.5$ mm.

Form TFA: case $\varnothing D \times L = 8.2 \times 11$ mm; $F = 5$ mm.

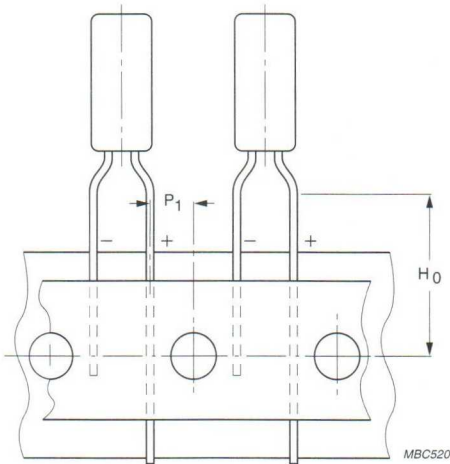
For dimensions see Table 1.

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

Fig.1 Capacitors on tape, straight leads.

Radial electrolytic capacitors

Packaging



Dimensions in mm.
Form TFA: case $\varnothing D \times L = 5 \times 11$ mm; F = 5 mm.
For dimensions see Table 1.

Fig.2 Capacitors on tape, formed leads.

Table 1 Dimensions of capacitors on tape; see Figs 1 and 2

PARAMETER	NOMINAL CASE SIZE (ØD × L) in mm			TOLERANCE
	FORM TNA: F = 2.5 mm	FORM TFA: F = 5 mm		
	5 × 11 (straight leads) (mm)	5 × 11 (formed leads) (mm)	8.2 × 11 (straight leads) (mm)	
ØD	5.5	5.5	8.7	max.
A	12	12	12	max.
Ød	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.

Radial electrolytic capacitors

Packaging

Series 013 RLC, 036 RSP, 036 92 RB, 036 93 RBA and 116 RLL (continued)

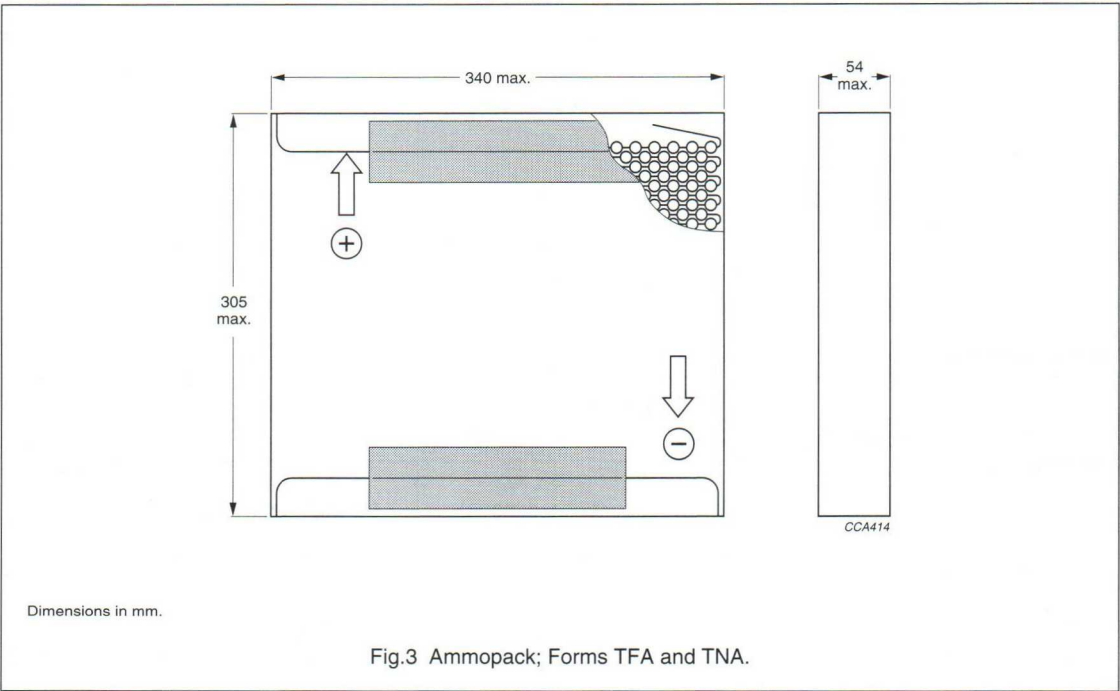
QUANTITIES PER PACKAGING UNIT

Table 2 Number of capacitors per packaging unit

NOMINAL CASE SIZE ($\varnothing D \times L$) (mm)	CASE CODE	BULK PER BOX		TAPED AMMOPACK ⁽¹⁾	
		FORM CA	FORM CB	FORM TFA	FORM TNA
5 × 11	11	1000	1000	2000	2000
8.2 × 11	13	1000	1000	1000	1000

Note

1. Ammopack taping (Form TFA) case $\varnothing D \times L = 8.2 \times 11$ 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.



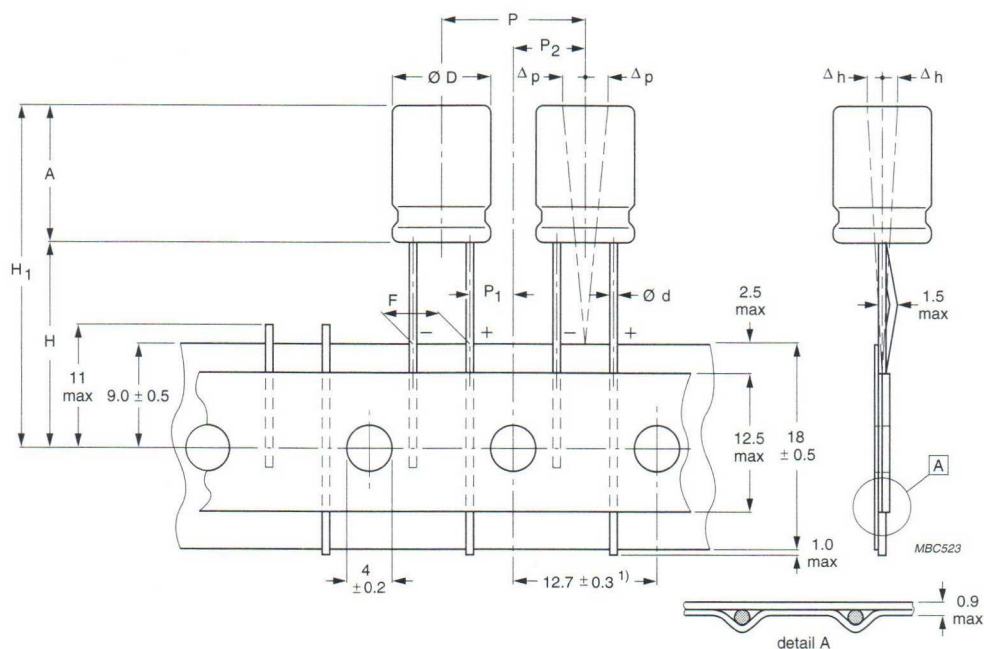
Radial electrolytic capacitors

Packaging

The information contained within this part is valid for the following series with a case $\varnothing D = 3$ to 8 mm:

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

For catalogue numbers, refer to the relevant detail specification in this data handbook.



Dimensions in mm.

Form TNA:

Case $\varnothing D \times L = 5 \times 11$ mm; $F = 2.5$ mm (leads slightly bent).

Case $\varnothing D \times L = 6.3 \times 11$ mm; $F = 2.5$ mm.

Case $\varnothing D \times L = 8 \times 12$ mm; $F = 3.5$ mm.

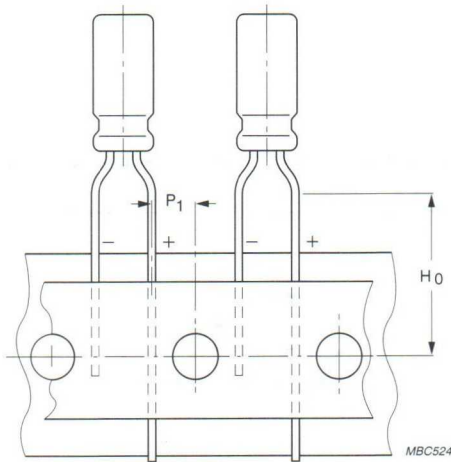
For dimensions see Table 3.

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

Fig.4 Capacitors on tape, straight leads.

Radial electrolytic capacitors

Packaging



Dimensions in mm.
Form TFA: F = 5 mm.
Case $\varnothing D \times L = 5 \times 11, 6.3 \times 11$ and 8×12 mm.
For dimensions see Table 3.

Fig.5 Capacitors on tape, formed leads.

Table 3 Dimensions of capacitors on tape; see Figs 4 and 5

PARAMETER	NOMINAL CASE SIZE (ØD × L) in mm						TOLERANCE
	FORM TNA			FORM TFA			
	5 × 11 (mm)	6.3 × 11 (mm)	8 × 12 (mm)	5 × 11 (mm)	6.3 × 11 (mm)	8 × 12 (mm)	
ØD	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.
Ød	0.5	0.5	0.6	0.5	0.5	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.

Radial electrolytic capacitors

Packaging

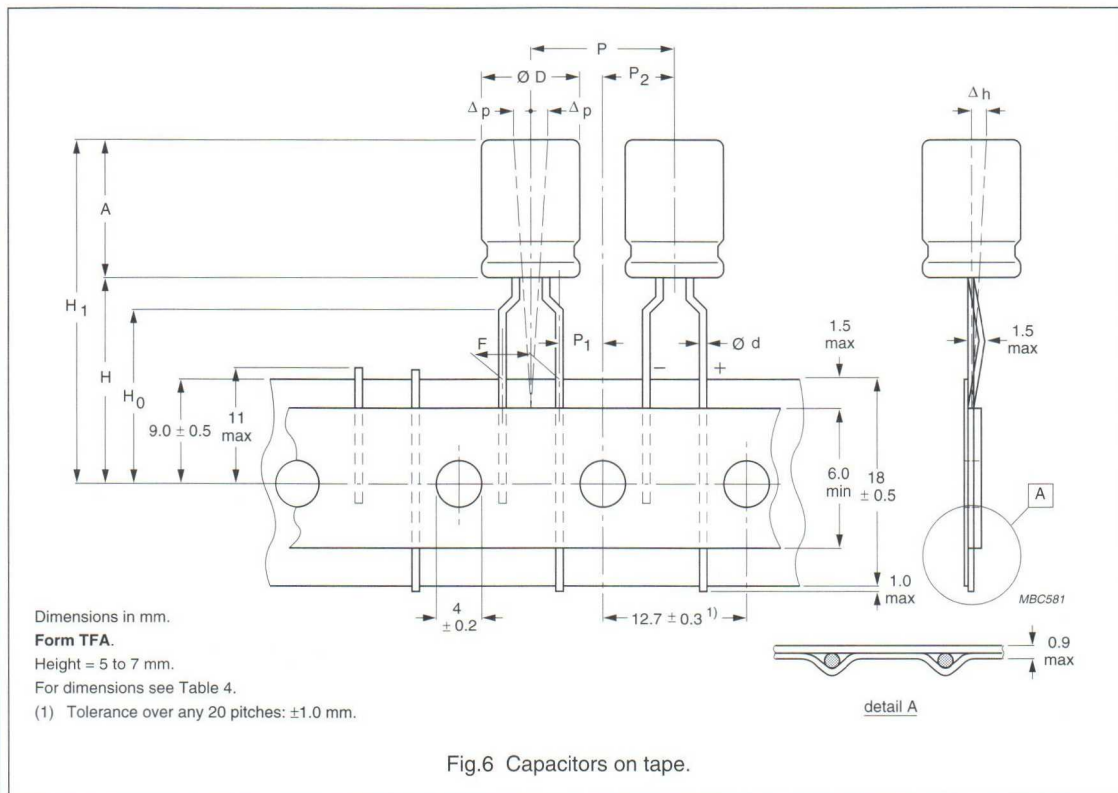
Series 134 RLP 5, 097 RLP 7, 037 RSM, 044 RSH and 135 RLI, $\varnothing D = 3$ to 8 mm (continued)

Fig.6 Capacitors on tape.

Table 4 Dimensions of capacitors on tape; see Fig.6

PARAMETER	NOMINAL CASE SIZE (ØD × L) in mm									TOLERANCE
	FORM TFA									
	3 × 5 (mm)	3.5 × 5 (mm)	4 × 5 (mm)	5 × 5 (mm)	6.3 × 5 (mm)	4 × 7 (mm)	5 × 7 (mm)	6.3 × 7 (mm)	7 × 7 (mm)	
ØD	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.
Ød	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.

Radial electrolytic capacitors

Packaging

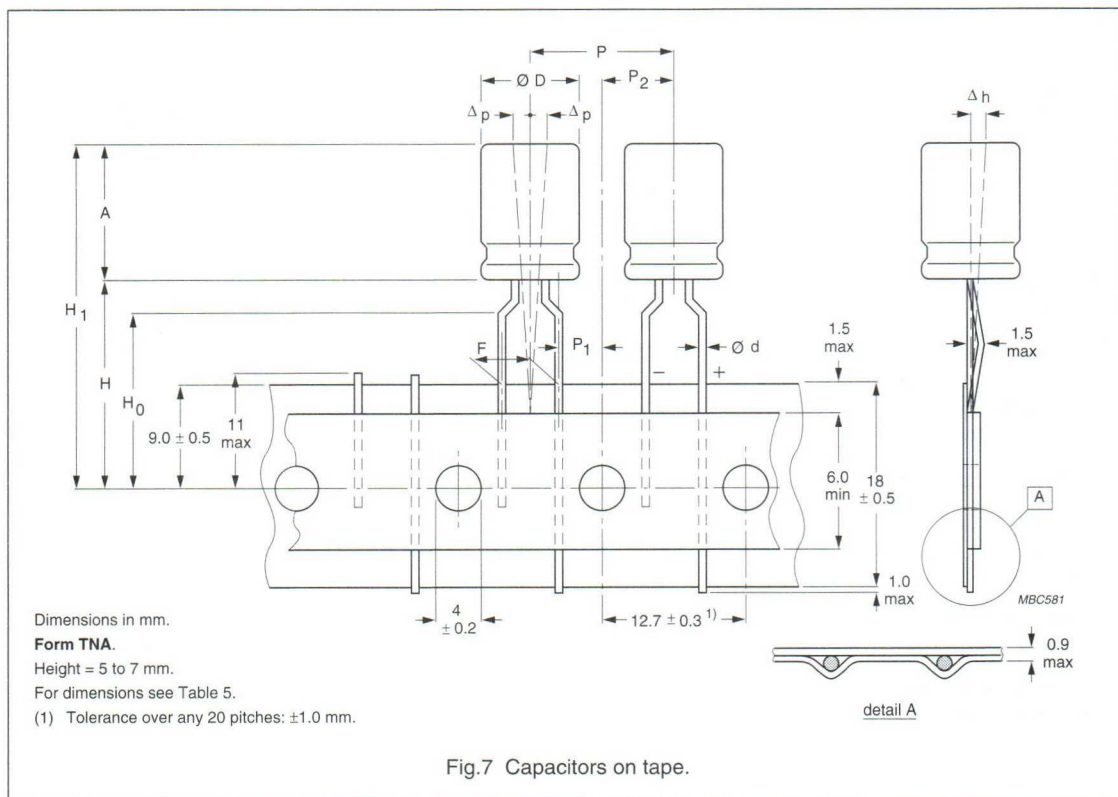
Series 134 RLP 5, 097 RLP 7, 037 RSM, 044 RSH and 135 RLI, $\varnothing D = 3$ to 8 mm (continued)

Fig.7 Capacitors on tape.

Table 5 Dimensions of capacitors on tape; see Fig.7

PARAMETER	NOMINAL CASE SIZE (ØD × L) in mm							TOLERANCE
	FORM TNA							
	4 × 5 (mm)	5 × 5 (mm)	6.3 × 5 (mm)	4 × 7 (mm)	5 × 7 (mm)	6.3 × 7 (mm)	7 × 7 (mm)	
ØD	4.5	5.5	6.8	4.5	5.5	6.8	7.5	max.
A	6.0	6.0	6.0	8.0	8.0	8.0	8.0	max.
Ød	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	±1.0
P ₁	5.1	5.1	5.1	5.1	5.1	5.1	5.1	±0.7
P ₂	6.35	6.35	6.35	6.35	6.35	6.35	6.35	±1.0
F	2.5	2.5	2.5	2.5	2.5	2.5	2.5	+0.8/–0.2
Δh	0	0	0	0	0	0	0	±2.0
Δp	0	0	0	0	0	0	0	±1.3
H	17.5	18.5	18.5	17.5	18.5	18.5	18.5	±0.75
H ₀	16	–	–	–	–	–	–	±0.5
H ₁	32.2	32.2	32.2	32.2	32.2	32.2	32.2	max.

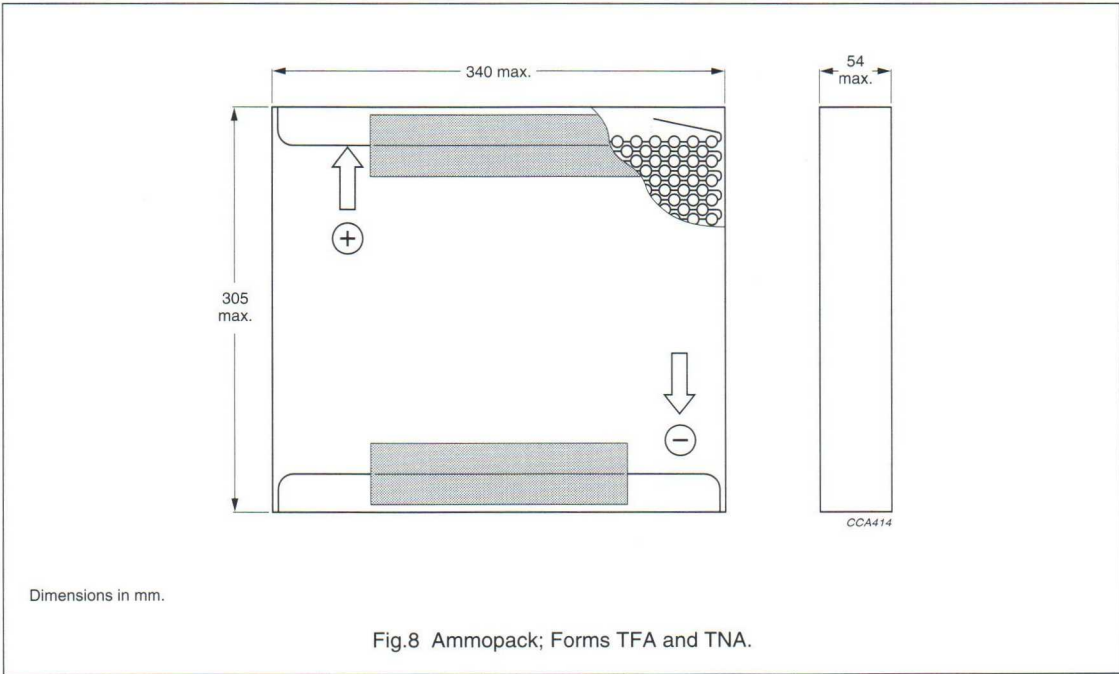
Radial electrolytic capacitors

Packaging

QUANTITIES PER PACKAGING UNIT

Table 6 Number of capacitors per packaging unit

NOMINAL CASE SIZE ($\varnothing D \times L$) (mm)	CASE CODE	BULK PER BOX	TAPED AMMOPACK	
		FORM CA	FORM TFA	FORM TNA
3 × 5	51	3000	3000	—
3.5 × 5	52	3000	3000	—
4 × 5	53	2000	2000	2000
5 × 5	54	2000	2000	2000
6.3 × 5	55	2000	2000	2000
4 × 7	71	2000	2000	2000
5 × 7	72	1000	2000	2000
6.3 × 7	73	1000	2000	2000
7 × 7	74	1000	1000	1000
5 × 11	11	3000	2000	2000
6.3 × 11	12	2000	2000	2000
8 × 12	13	1000	1000	1000



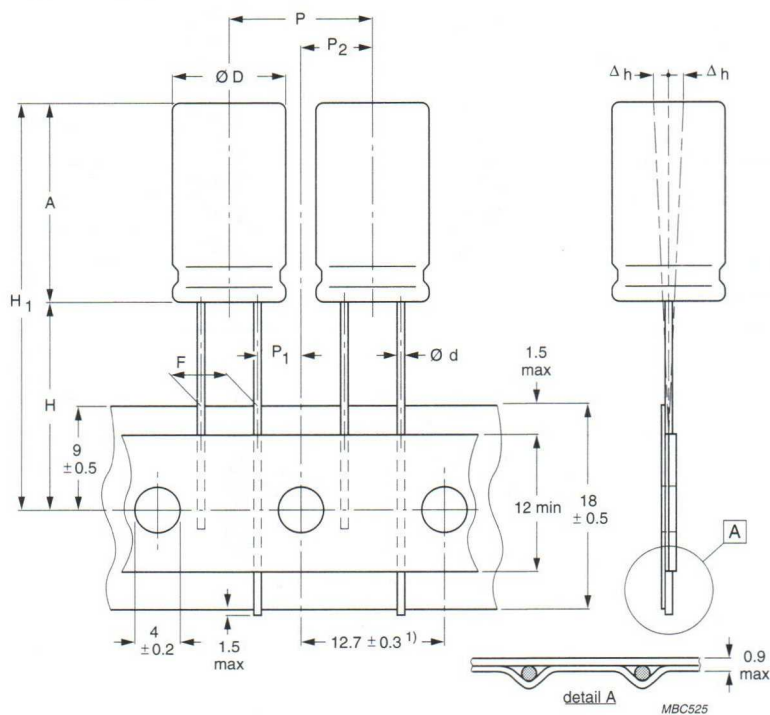
Radial electrolytic capacitors

Packaging

The information contained in this part is valid for the following series with a case $\varnothing D = 10$ to 16 mm:

- | | | |
|-----------|-----------|-----------|
| • 037 RSM | • 047 RMS | • 136 RVI |
| • 044 RSH | • 048 RML | • 151 RLH |
| • 046 RSL | • 135 RLI | • 165 RHT |

For catalogue numbers, refer to the relevant detail specification in this data handbook.



Dimensions in mm.

Case $\varnothing D = 10$ mm.

For dimensions see Table 7.

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

Fig.9 Capacitors on tape.

Radial electrolytic capacitors

Packaging

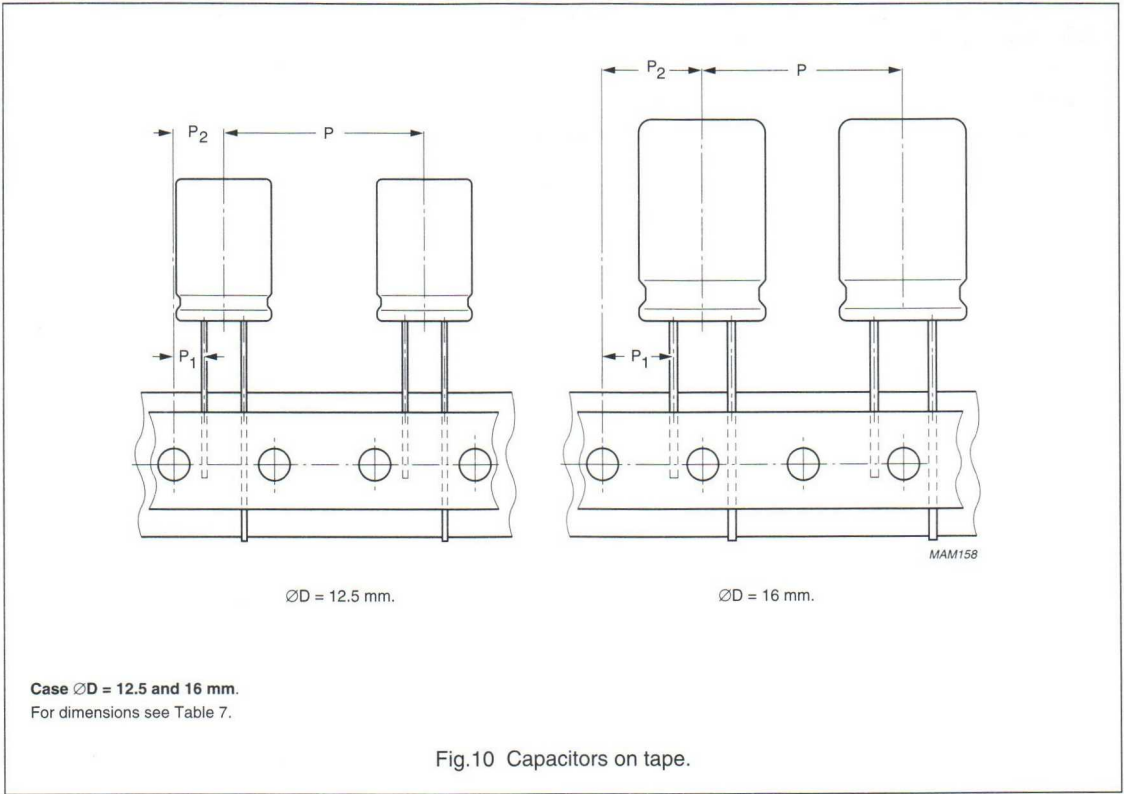


Table 7 Dimensions of capacitors on tape; see Figs 9 and 10

PARAMETER	NOMINAL CASE SIZE ($\varnothing D \times L$) in mm								TOLERANCE
	10 × 12 (mm)	10 × 16 (mm)	10 × 20 (mm)	12.5 × 20 (mm)	12.5 × 25 (mm)	16 × 20 (mm)	16 × 25 (mm)	16 × 31 (mm)	
$\varnothing D$	10.5	10.5	10.5	13.0	13.0	16.5	16.5	16.5	max.
A	13.5	17.5	22	22	27	22	27	33.5	max.
$\varnothing d$	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.8	± 0.05
P	12.7	12.7	12.7	25.4	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	8.95	± 0.7
P_2	6.35	6.35	6.35	6.35	6.35	12.7	12.7	12.7	± 1.3
F	5.0	5.0	5.0	5.0	5.0	7.5	7.5	7.5	$+0.8/-0.2$
Δh	0	0	0	0	0	0	0	0	± 3.0
H	18.5	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	68	75	max.

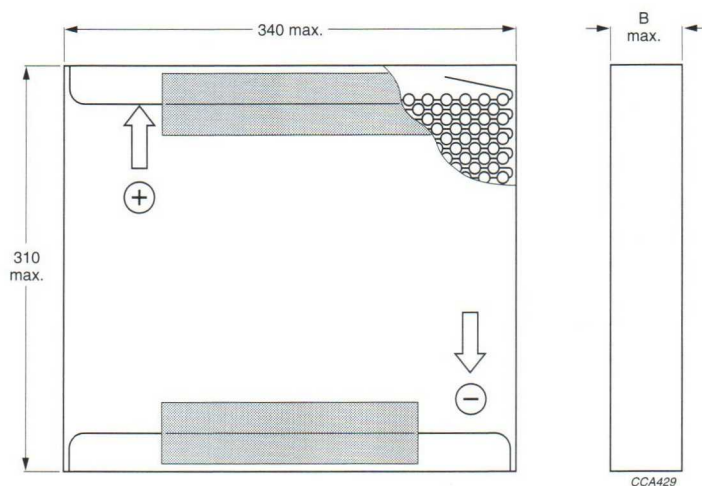
Radial electrolytic capacitors

Packaging

Series 037 RSM, 044 RSH, 046 RSL, 047 RMS, 048 RML, 135 RLI, 136 RVI, 151 RLH and 165 RHT
with a case $\varnothing D = 10$ to 16 mm (continued)

QUANTITIES PER PACKAGING UNIT

Refer to the relevant detail specification in this data handbook.



Dimensions in mm.
For dimension B, see Table 7.

Fig.11 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.

Radial electrolytic capacitors

Packaging

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

- 122 SAL-RP
- 128 SAL-RPM

For catalogue numbers, refer to the relevant detail specification in this data handbook.

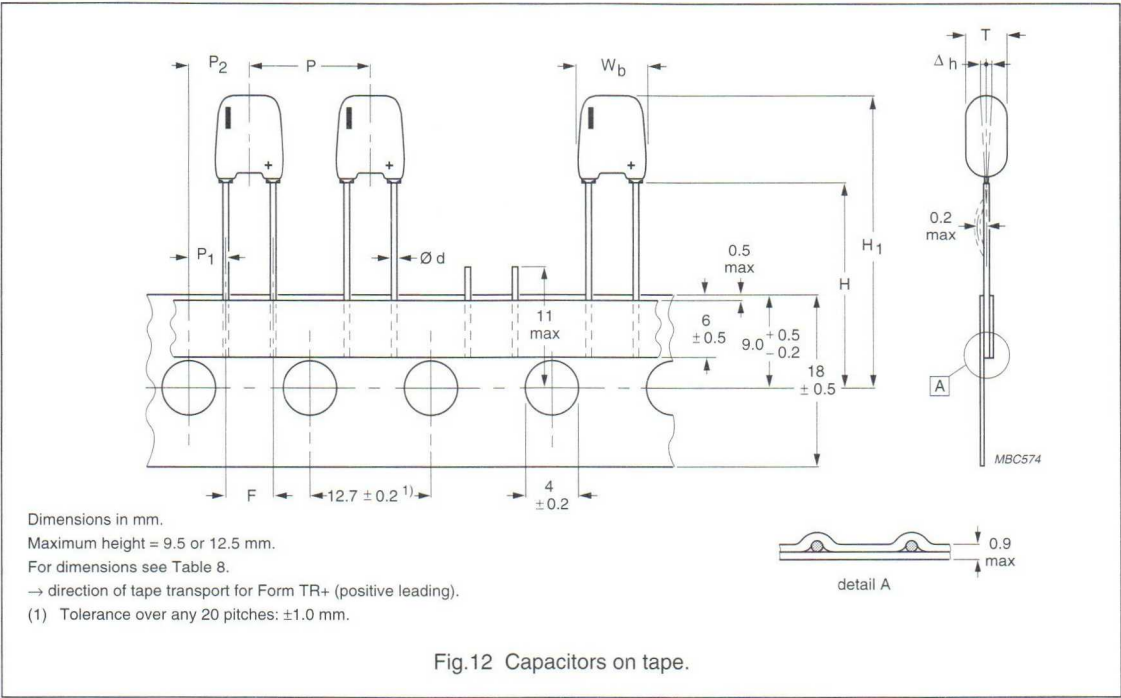


Table 8 Tape dimensions (in mm) for solid radial capacitors; see Fig.12

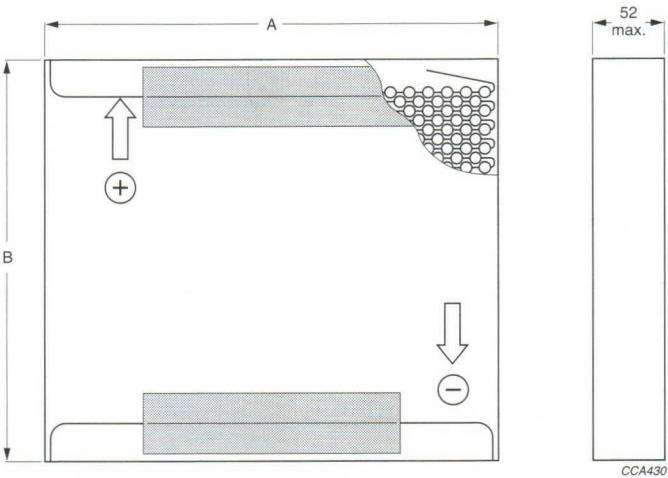
PARAMETER	122 SAL-RP MAX. HEIGHT 12.5 mm				128 SAL-RPM MAX. HEIGHT 9.5 mm						TOLERANCE
	CASE CODE				CASE CODE						
	1	2	3	4	10	20	30	40	50	60	
T	3.5	4.5	5.0	6.0	3.0	3.5	4.0	5.0	5.0	6.0	max.
W _b	8.0	8.0	8.0	8.0	7.0	7.0	7.0	7.0	8.0	8.0	max.
Ød	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	+0.02/-0
P	12.7	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.

Radial electrolytic capacitors

Packaging

Table 9 Ammopack dimensions for the relevant case codes

PARAMETER	122 SAL-RP	128 SAL-RPM	A _{max} (mm)	B _{max} (mm)
Case code	1 and 2	10; 20 and 30	340	266
	3 and 4	40; 50 and 60	340	176



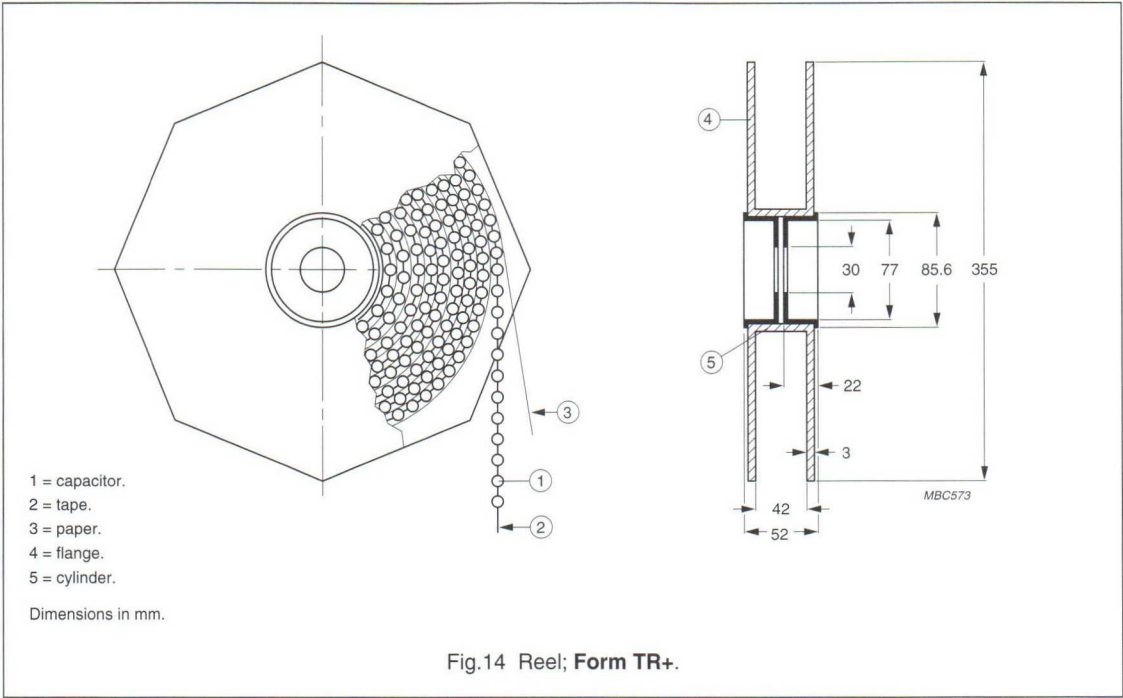
CCA430

Dimensions in mm.
PREFERRED PACKING.
For dimensions see Table 9.

Fig.13 Ammopack; Form TFA.

Radial electrolytic capacitors

Packaging



QUANTITIES PER PACKAGING UNIT

Table 10 Number of capacitors per packaging unit

CASE SIZE $H_{max} \times W_{max} \times T_{max}$ (mm)	CASE CODE	BULK PER BOX		TAPED PER REEL	TAPED PER BOX
		FORM CA	FORM CB	FORM TR+	FORM TFA
12.5 × 8.0 × 3.5	1	1000	1000	2000	2000
12.5 × 8.0 × 4.5	2	1000	1000	2000	2000
12.5 × 8.0 × 5.0	3	1000	1000	1000	1000
12.5 × 8.0 × 6.0	4	800	1000	1000	1000
9.5 × 7.0 × 3.0	10	1000	1000	2000	2000
9.5 × 7.0 × 3.5	20	1000	1000	2000	2000
9.5 × 7.0 × 4.0	30	1000	1000	2000	2000
9.5 × 7.0 × 5.0	40	1000	1000	1000	1000
9.5 × 8.0 × 5.0	50	1000	1000	1000	1000
9.5 × 8.0 × 6.0	60	1000	1000	1000	1000

PACKAGING - AXIAL LEADED DEVICES

Axial electrolytic capacitors

Packaging

TAPING

Philips axial, aluminium and solid aluminium electrolytic capacitors in sizes up to $\varnothing D = 15$ mm, are available in taped version corresponding to "IEC 286-1".

They are most suitable for use on automatic insertion machines, cutting and forming equipment and are supplied in box (ammopack preferred), or on reel.

CAUTION

Packages must be handled with care to avoid bent leads.

For catalogue numbers, refer to the relevant detail specification in this data handbook.

Tape, reel and ammpack data

Table 1 Taping dimensions; see Figs 1 and 2

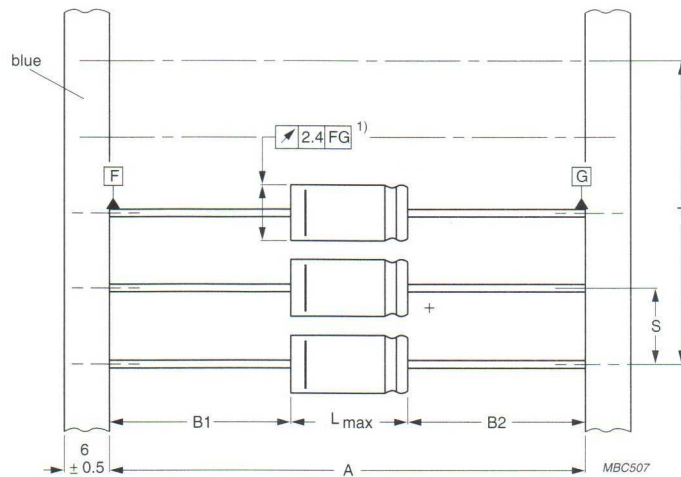
NOMINAL CASE SIZE ($\varnothing D \times L$) (mm)	CASE CODE	A (mm)	S (mm)	T FOR NUMBER (n)		L _{max} (mm)	C (mm)	D (mm)
				n < 50	50 < n < 100			
Non-solid types								
3.3 × 8	1a	63.5 ±1.5 ⁽¹⁾	5 ±0.4	5(n-1) ±2	5(n-1) ±4	9	83.5	94.5
3.3 × 11	1	63.5 ±1.5 ⁽¹⁾	5 ±0.4	5(n-1) ±2	5(n-1) ±4	12	83.5	94.5
4.5 × 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 × 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 × 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 × 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 × 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 × 18	4	73 ±1.6 ⁽¹⁾	10 ±0.4	10(n-1) ±2	10(n-1) ±4	18.5	88.5	99.5
8 × 18	5	73 ±1.6 ⁽¹⁾	10 ±0.4	10(n-1) ±2	10(n-1) ±4	18.5	88.5	99.5
10 × 18	6	73 ±1.6 ⁽¹⁾	15 ±0.75	15(n-1) ±2	15(n-1) ±4	18.5	88.5	99.5
10 × 25	7	73 ±1.6	15 ±0.75	15(n-1) ±2	15(n-1) ±4	25.0	88.5	99.5
10 × 30	00	73 ±1.6	15 ±0.75	15(n-1) ±2	15(n-1) ±4	30.5	90	100
12.5 × 30	01	73 ±1.6	15 ±0.75	15(n-1) ±2	15(n-1) ±4	30.5	90	100
15 × 30	02	73 ±1.6	20 ±0.75	20(n-1) ±2	20(n-1) ±4	30.5	90	100
Solid types								
6.5 × 15	1	73 ±1.6	10 ±0.4	10(n-1) ±2	10(n-1) ±4	15.3	90	100
7.5 × 20	2A	73 ±1.6	10 ±0.4	10(n-1) ±2	10(n-1) ±4	20.4	90	100
9 × 22.5	4	73 ±1.6	10 ±0.4	10(n-1) ±2	10(n-1) ±4	23.3	90	100
10 × 31.5	5	73 ±1.6	15 ±0.75	15(n-1) ±2	15(n-1) ±4	32	90	100
12.5 × 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.

Axial electrolytic capacitors

Packaging



Dimensions in mm.

Case $\varnothing D \times L = 3.3 \times 8$ to 15×30 mm.

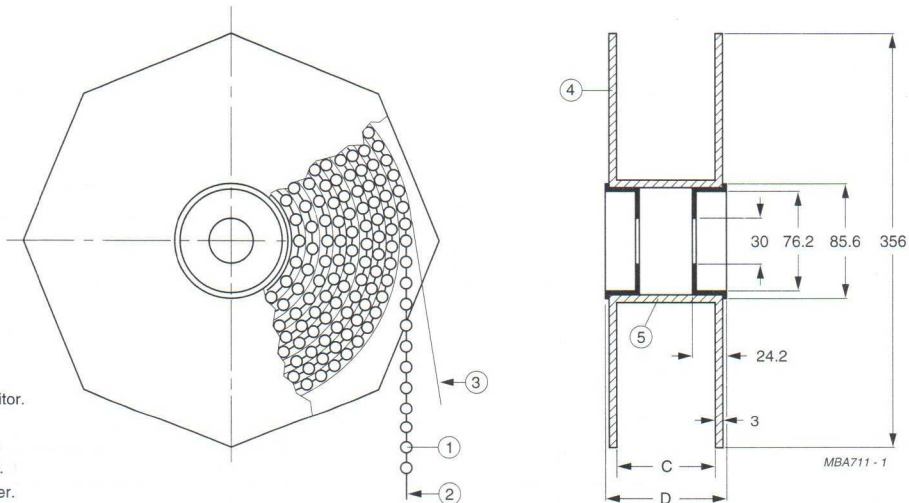
$B1 - B2 = \text{max. } 1.4$ mm.

The negative capacitor terminals are connected to the blue tape.

For dimensions A, S, T and L, see Table 1.

(1) Not for case $\varnothing D \times L = 15 \times 30$ mm.

Fig.1 Axial capacitors on tape.



1 = capacitor.

2 = tape.

3 = paper.

4 = flange.

5 = cylinder.

Dimensions in mm.

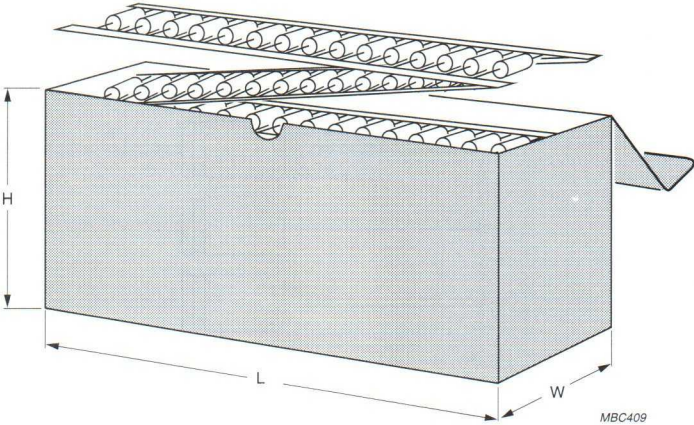
Case $\varnothing D \times L = 3.3 \times 8$ to 15×30 mm.

For dimensions C and D see Table 1.

Fig.2 Reel dimensions.

Axial electrolytic capacitors

Packaging



PREFERRED PACKING.
Case $\varnothing D \times L = 3.3 \times 8$ to 10×25 mm.
For dimensions L, W and H see Table 2.

Fig.3 Ammpack.

Table 2 Nominal outer dimensions of ammpack; see Fig.3

NOMINAL CASE SIZE ($\varnothing D \times L$) (mm)	CASE CODE	L (mm)	W (mm)	H (mm)
Non-solid types				
3.3 × 8	1a	282	92	64
3.3 × 11	1	282	92	64
4.5 × 10	2	282	92	116
6 × 10	3	415	92	107
6.3 × 12.7	(2)	415	92	107
7.7 × 12.7	(3)	415	92	107
8 × 11	5a	415	92	107
6.5 × 18	4	415	98	127
8 × 18	5	415	98	127
10 × 18	6	415	98	159
10 × 25	7	415	98	159

Axial electrolytic capacitors

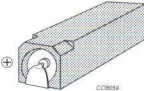
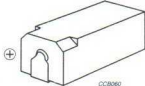
Packaging

QUANTITIES PER PACKAGING UNIT

Table 3 Number of capacitors per packaging unit

NOMINAL CASE SIZE (ØD × L) (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 × 8	1a	1000	4000	—	—
3.3 × 11	1	1000	4000	—	—
4.5 × 10	2	1000	3000	—	—
6 × 10	3	1000	1000	—	—
6.3 × 12.7	(2)	1000	1000	—	—
7.7 × 12.7	(3)	500	500	—	—
8 × 11	5a	500	500	—	—
6.5 × 18	4	1000	1000	—	—
8 × 18	5	500	500	—	—
10 × 18	6	500	500	—	—
10 × 25	7	500	500	—	—
10 × 30	00	—	500	200	—
12.5 × 30	01	—	400	200	—
15 × 30	02	—	250	200	200
18 × 30	03	—	—	200	200
18 × 40	04	—	—	100	100
21 × 40	05	—	—	100	100
Solid types					
6.5 × 15	1	—	800	100	—
7.5 × 20	2A	—	800	100	—
9 × 22.5	4	—	500	100	—
10 × 31.5	5	—	500	100	—
12.5 × 31.5	6	—	400	100	—

SMD ALUMINIUM ELECTROLYTIC CAPACITORS ('CHIPS')

		STANDARD	INDUSTRIAL
 CCB054	 CCB060	085 CS 1500 hours 85 °C page 86	139 CLL 2000 hours 105 °C page 100
 CCA716			153 CLV 2000 to 3000 hours 105 °C page 113

CCB095

Aluminium electrolytic capacitors

SMD (Chip) Standard

085 CS

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
- Charge and discharge proof
- Supplied in blister tape on reel.

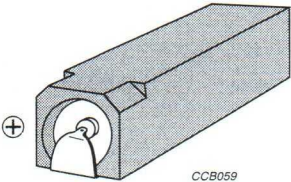
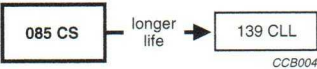


Fig.1 Component outline.

APPLICATIONS

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



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes (L × W × H in mm)	8.8 × 3.7 × 3.9 and 11.9 × 3.7 × 3.9
Rated capacitance range, C _R	0.47 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	1 000 hours
Useful life at 85 °C	1 500 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 32300
Climatic category IEC 68	40/085/56

Aluminium electrolytic capacitors
SMD (Chip) Standard

085 CS

Selection chart for C_R, U_R and relevant nominal case sizes (L × W × H in mm)

Preferred types in **bold**.

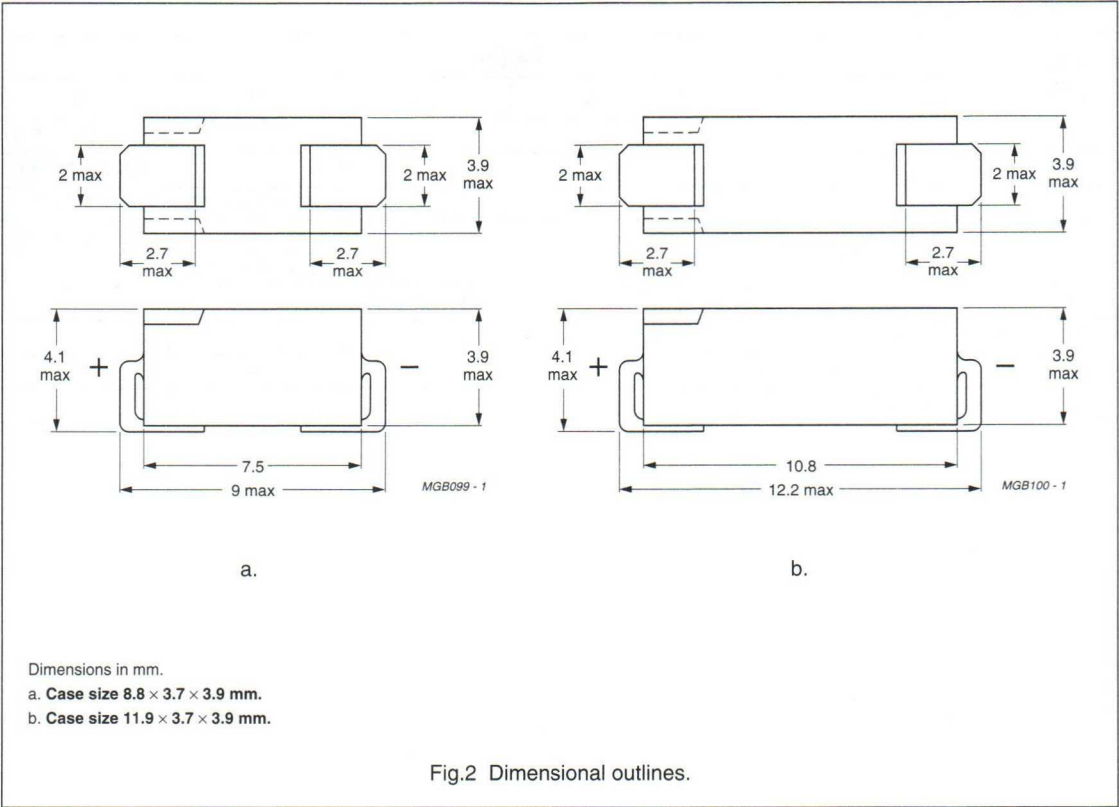
C _R (μF)	U _R (V)					
	6.3	10	16	25	40	63
0.47	—	—	—	—	—	8.8 × 3.7 × 3.9
1.0	—	—	—	—	—	8.8 × 3.7 × 3.9
2.2	—	—	—	—	8.8 × 3.7 × 3.9	11.9 × 3.7 × 3.9
3.3	—	—	—	8.8 × 3.7 × 3.9	—	11.9 × 3.7 × 3.9
4.7	—	—	8.8 × 3.7 × 3.9	—	11.9 × 3.7 × 3.9	—
6.8	—	8.8 × 3.7 × 3.9	—	11.9 × 3.7 × 3.9	—	—
10	8.8 × 3.7 × 3.9	—	11.9 × 3.7 × 3.9	—	—	—
15	—	11.9 × 3.7 × 3.9	—	—	—	—
22	11.9 × 3.7 × 3.9	—	—	—	—	—

SMD

Aluminium electrolytic capacitors
SMD (Chip) Standard

085 CS

MECHANICAL DATA



PACKAGING QUANTITIES

- Tape on reel packaging:
2000 per reel.

MARKING

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

- Rated capacitance (in μF)
- Rated voltage code (see Table 1), the U_R code letter indicates the position of the decimal point in the capacitance value
- Name of manufacturer (PHILIPS)
- ‘-’ sign indicating the cathode.
The anode is identified by bevelled edges.

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 1 Rated voltage marking code

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

Aluminium electrolytic capacitors
SMD (Chip) Standard

085 CS

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

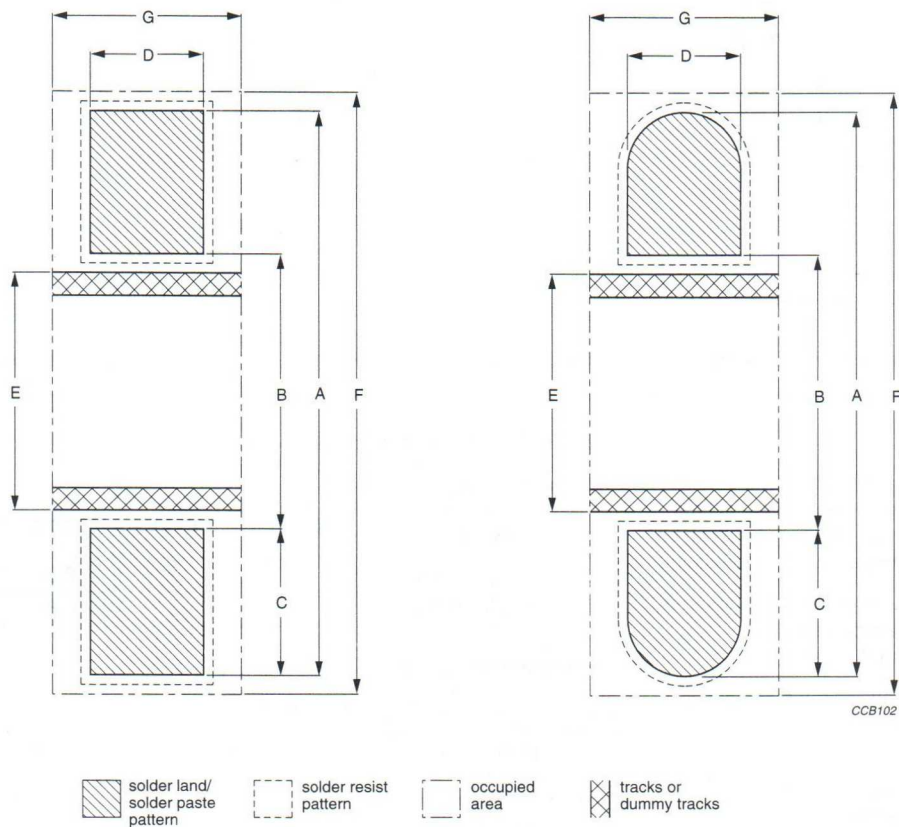


Fig.3 Recommended pad dimensions for reflow and wave soldering; see Table 2.

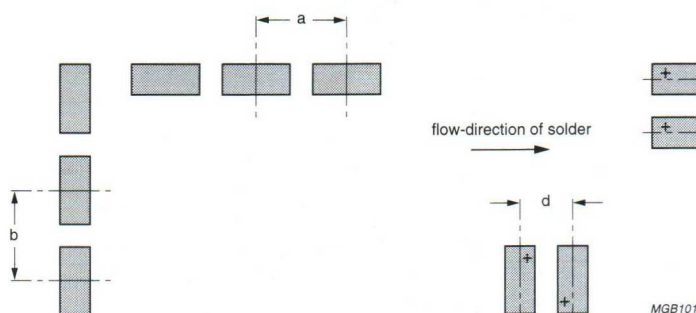
Table 2 Recommended soldering pad dimensions in mm (placement accuracy ± 0.25 mm); see Fig.3

NOMINAL CASE SIZE L $\times$ W $\times$ H (mm)	FOR REFLOW SOLDERING							FOR WAVE SOLDERING						
	A	B	C	D	E	F	G	A	B	C	D	E	F	G
8.8 $\times$ 3.7 $\times$ 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 $\times$ 3.7 $\times$ 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

Aluminium electrolytic capacitors

SMD (Chip) Standard

085 CS



For dimensions a, b, c and d, refer to Table 3.

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

Fig.4 Minimum distances between 085 CS 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 5, 6 and 7.

Any temperature/time curve which does not exceed the specified maximum curves may be applied.

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.8.

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

Table 3 Minimum distances between capacitors; see Fig.4

NOMINAL CASE SIZE $L \times W \times H$ (mm)	a_{min} (mm)	b_{min} (mm)	c_{min} (mm)	d_{min} (mm)
$8.8 \times 3.7 \times 3.9$	12	12	6.8	6.8
$11.9 \times 3.7 \times 3.9$	15	15	6.8	6.8

Maximum temperature load

Table 4 Curing conditions for SMD-glue

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

Aluminium electrolytic capacitors

SMD (Chip) Standard

085 CS

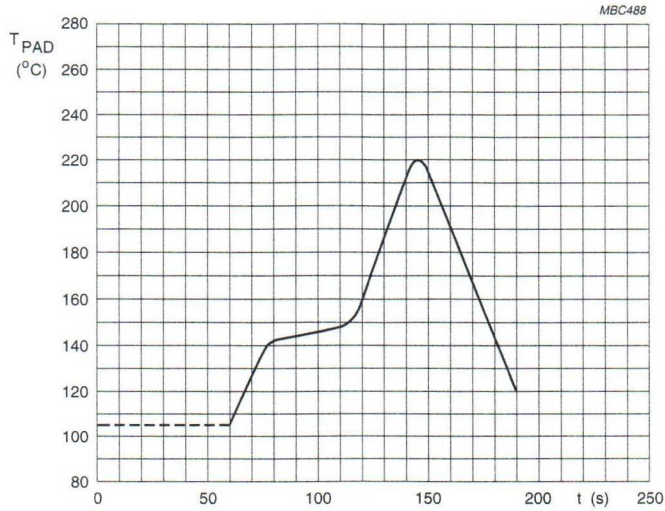


Fig.5 Maximum temperature load during infrared reflow soldering.

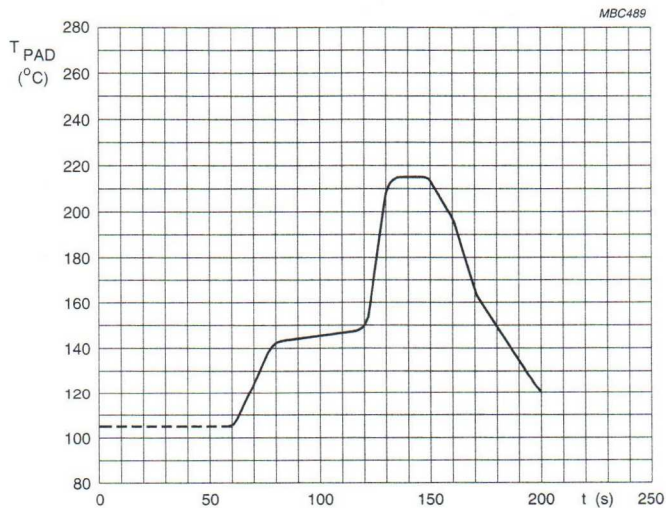


Fig.6 Maximum temperature load during vapour phase reflow soldering.

SMD

Aluminium electrolytic capacitors

SMD (Chip) Standard

085 CS

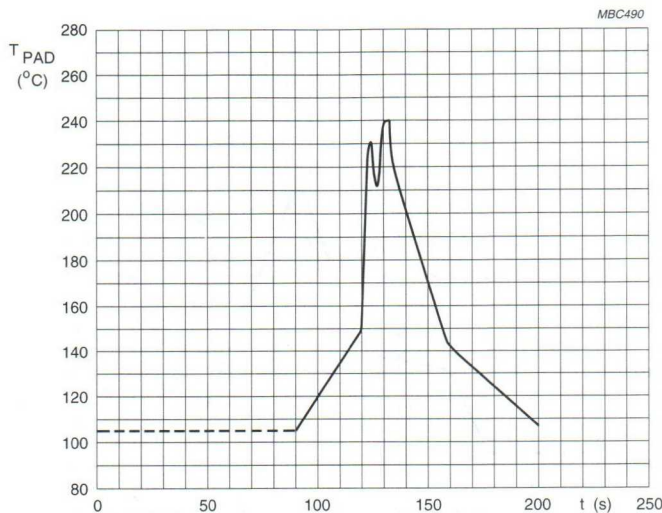


Fig. 7 Maximum temperature load during (double-) wave soldering.

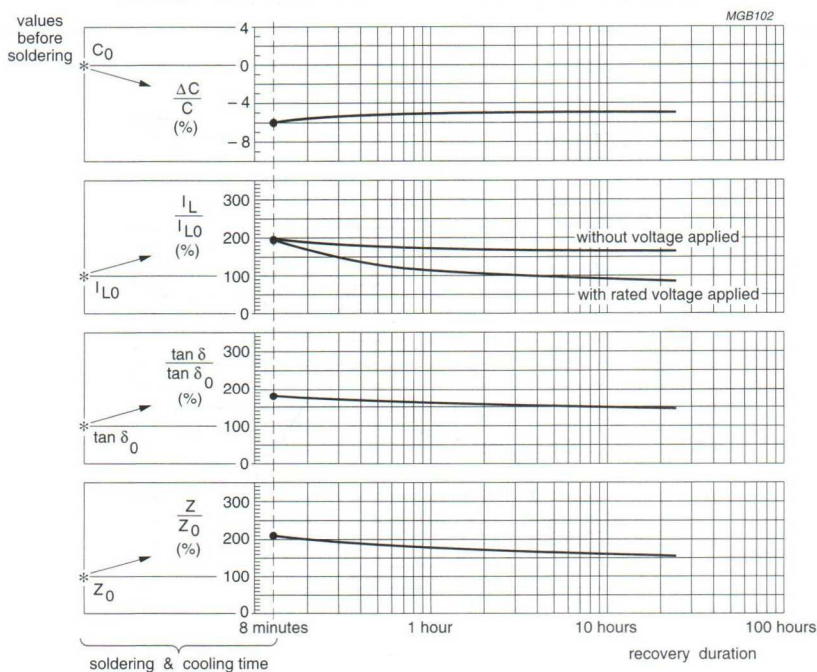


Fig. 8 Typical drift of electrical parameters after soldering under maximum conditions, and subsequent recovery.

Aluminium electrolytic capacitors
SMD (Chip) Standard

085 CS

Ordering example

Electrolytic capacitor 085 series
10 $\mu\text{F}/16\text{ V}$; $-10/+50\%$
Nominal case size: $11.9 \times 3.7 \times 3.9\text{ mm}$;
Form BR
Catalogue number: 2222 085 25109.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 5 apply at $T_{\text{amb}} = 20\text{ }^{\circ}\text{C}$,
 $P = 86\text{ to }106\text{ kPa}$, $\text{RH} = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz (tolerance $-10\text{ to }+50\%$ or $\pm 20\%$)
I_R	rated RMS ripple current at 100 Hz, $85\text{ }^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\text{Tan } \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\text{tan } \delta_{\text{max}}$ and C_R)
Z	max. impedance at 10 kHz

Table 5 Electrical data and catalogue numbers; preferred types in bold

U_R 100 Hz (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $L \times W \times H$ (mm)	CASE CODE	I_R 100 Hz $85\text{ }^{\circ}\text{C}$ (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\text{Tan } \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222	
										$-10/+50\%$	$\pm 20\%$
6.3	10.0	$8.8 \times 3.7 \times 3.9$	1a	11	4	3.1	0.30	48	20	085 23109	085 63109
	22	$11.9 \times 3.7 \times 3.9$	1	20	6	3.3	0.30	22	9	085 23229	085 63229
10	6.8	$8.8 \times 3.7 \times 3.9$	1a	10	4	3.1	0.25	59	24	085 24688	085 64688
	15	$11.9 \times 3.7 \times 3.9$	1	18	6	3.3	0.25	27	11	085 24159	085 64159
16	4.7	$8.8 \times 3.7 \times 3.9$	1a	9	5	3.2	0.20	68	26	085 25478	085 65478
	10	$11.9 \times 3.7 \times 3.9$	1	16	6	3.3	0.20	32	12	085 25109	085 65109
25	3.3	$8.8 \times 3.7 \times 3.9$	1a	8	5	3.2	0.18	87	27	085 26338	085 66338
	6.8	$11.9 \times 3.7 \times 3.9$	1	14	6	3.3	0.18	42	13	085 26688	085 66688
40	2.2	$8.8 \times 3.7 \times 3.9$	1a	7	5	3.2	0.16	120	32	085 27228	085 67228
	4.7	$11.9 \times 3.7 \times 3.9$	1	13	7	3.4	0.16	54	15	085 27478	085 67478
63	0.47	$8.8 \times 3.7 \times 3.9$	1a	4	4	3.1	0.10	340	120	085 28477	085 68477
	1.0	$8.8 \times 3.7 \times 3.9$	1a	6	4	3.1	0.12	190	55	085 28108	085 68108
	2.2	$11.9 \times 3.7 \times 3.9$	1	11	6	3.3	0.14	87	25	085 28228	085 68228
	3.3	$11.9 \times 3.7 \times 3.9$	1	13	7	3.4	0.14	68	17	085 28338	085 68338

SMD

Aluminium electrolytic capacitors

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085 CS

Additional electrical data

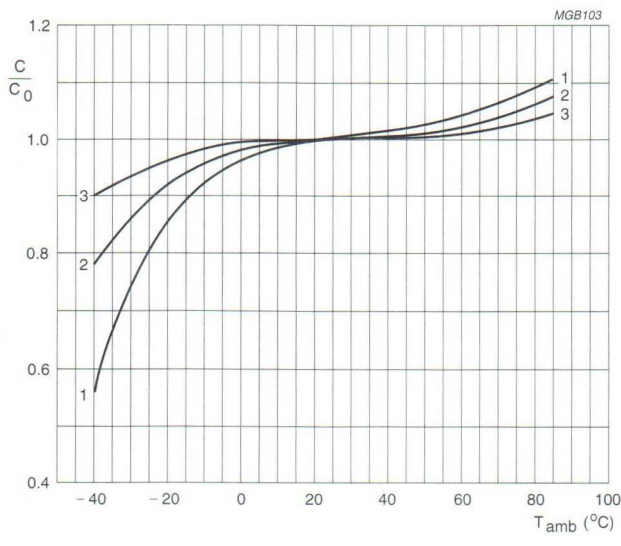
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.02C_R \times U_R + 3 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 3 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	nominal case size $8.8 \times 3.7 \times 3.9 \text{ mm}$	typ. 11 nH
	nominal case size $11.9 \times 3.7 \times 3.9 \text{ mm}$	typ. 13 nH

Aluminium electrolytic capacitors

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Capacitance (C)



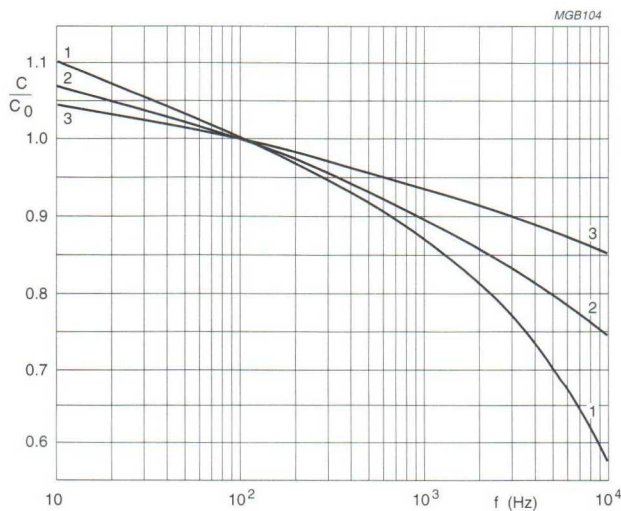
Curve 1: 6.3 V.

Curve 2: 25 V.

Curve 3: 63 V.

 C_0 = capacitance at 20 °C, 100 Hz.

Fig.9 Typical multiplier of capacitance 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.10 Typical multiplier of capacitance as a function of frequency.

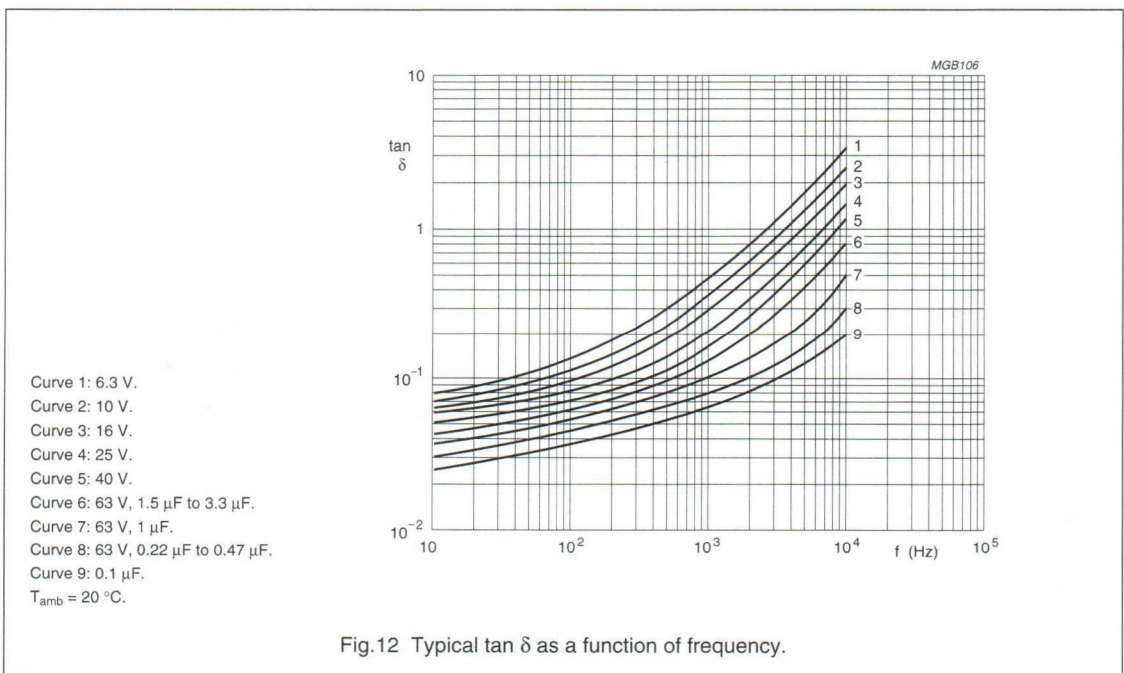
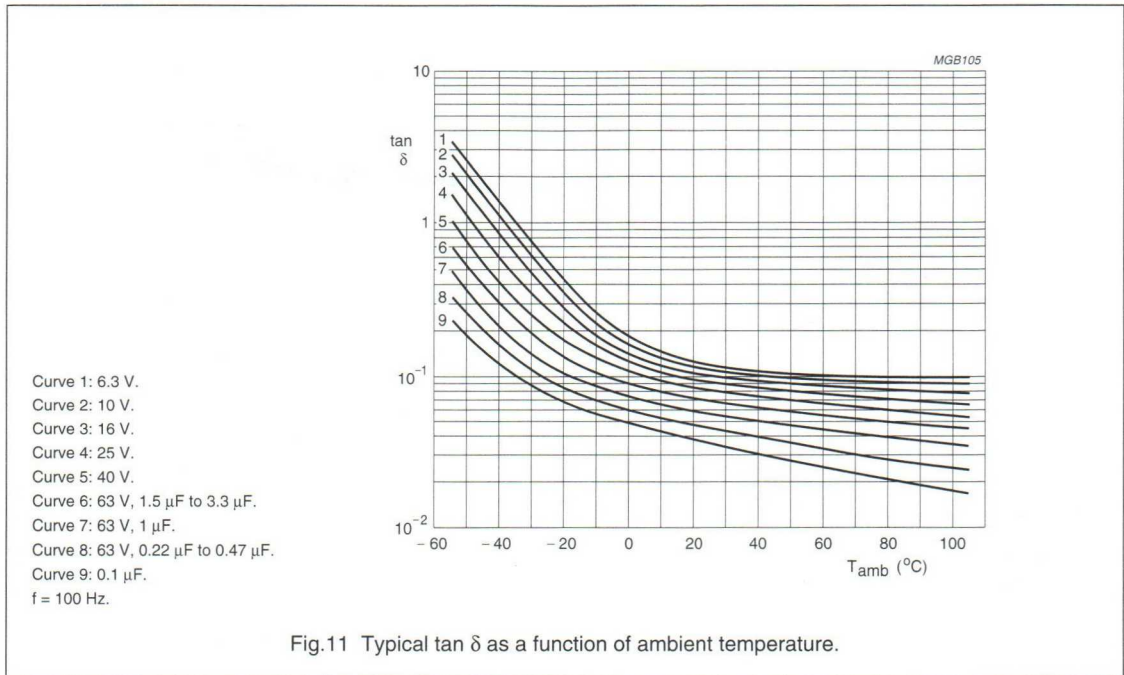
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Dissipation factor ($\tan \delta$)



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Impedance (Z)

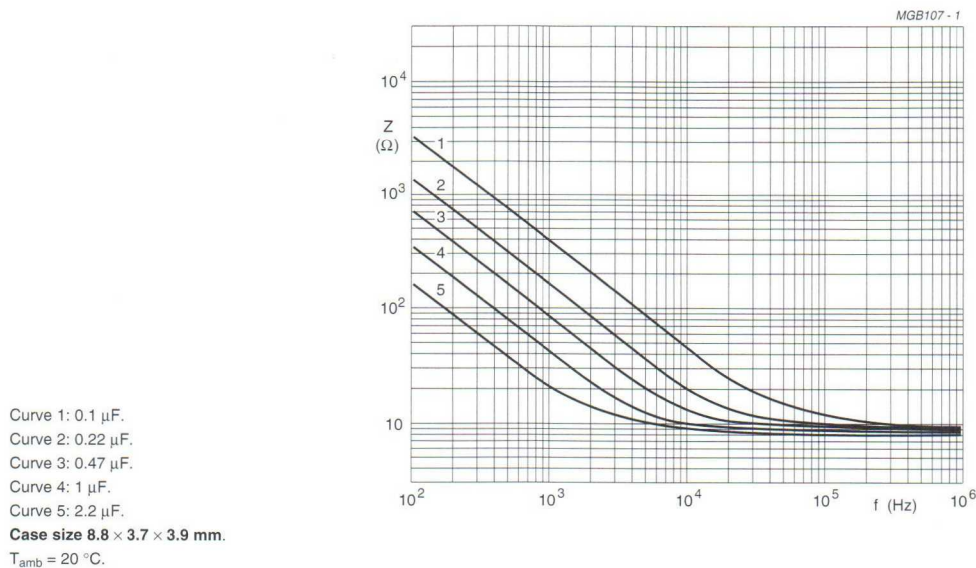


Fig.13 Typical impedance as a function of frequency.

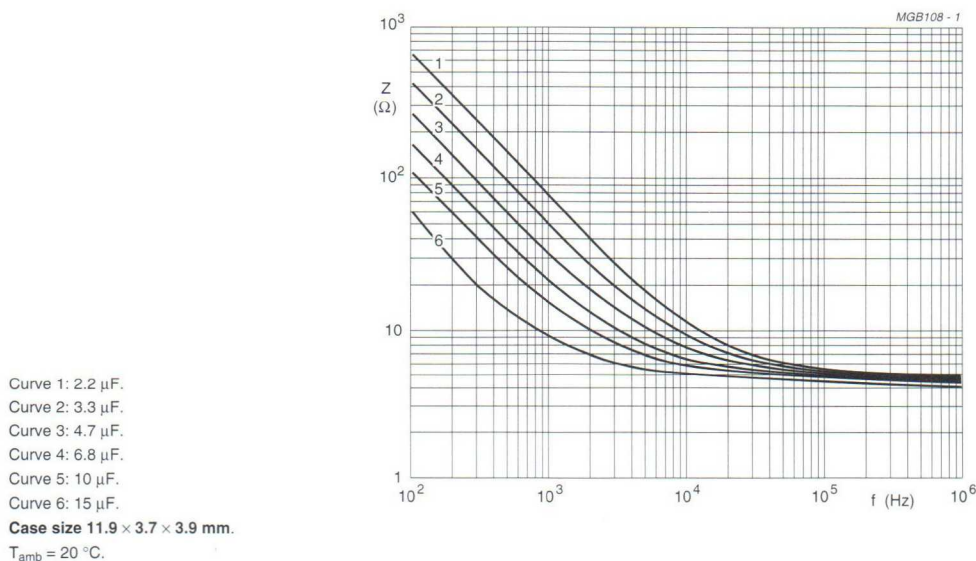


Fig.14 Typical impedance as a function of frequency.

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Aluminium electrolytic capacitors

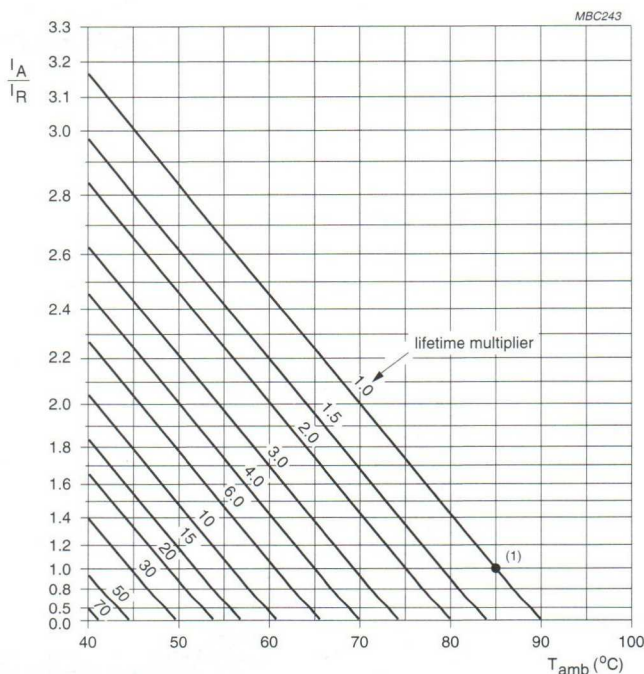
SMD (Chip) Standard

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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		
	$U_R = 6.3$ to 16 V	$U_R = 25$ to 40 V	$U_R = 63$ V
50	0.8	0.75	0.7
100	1.0	1.0	1.0
300	1.2	1.3	1.55
1000	1.35	1.55	1.9
3000	1.45	1.7	2.3
≥ 10000	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.15 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

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085 CS

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 7 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Mounting	IEC 384-18, subclause 4.3	shall be performed prior to tests mentioned below; method: reflow or (double-) wave soldering; for maximum temperature load refer to Chapter "Mounting"	$\Delta C/C: \pm 10\%$ $\tan \delta \leq \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$
Endurance	IEC 384-18/ CECC 32300, subclause 4.15	$T_{\text{amb}} = 85^\circ\text{C}$; U_R applied; 1000 hours	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{\text{amb}} = 85^\circ\text{C}$; U_R and I_R applied; 1500 hours	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-18/ CECC 32300, subclause 4.17	$T_{\text{amb}} = 85^\circ\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$

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Aluminium electrolytic capacitors

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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.

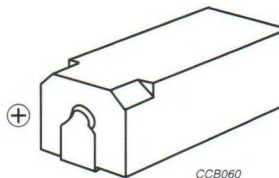
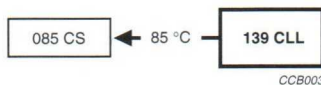


Fig.1 Component outline.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes (L × W × H in mm)	14.3 × 6.2 × 6.9 and 14.3 × 7.6 × 8.2
Rated capacitance range, C _R	1.0 to 220 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
Useful life at 105 °C	2000 hours
Useful life at 40 °C; 1.3 × I _R applied	200000 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 32300
Climatic category IEC 68	55/105/56

Aluminium electrolytic capacitors

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Selection chart for C_R , U_R and relevant nominal case sizes (L × W × H in mm)

Preferred types in **bold**.

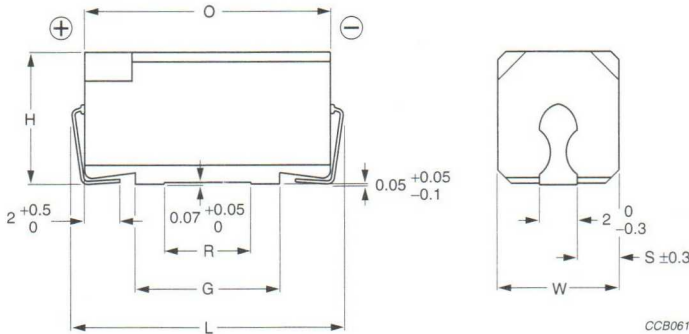
C_R (μF)	U_R (V)							
	6.3	10	16	25	40	50	63	100
1	—	—	—	—	—	—	—	14.3 × 6.2 × 6.9
2.2	—	—	—	—	—	—	14.3 × 6.2 × 6.9	14.3 × 6.2 × 6.9
3.3	—	—	—	—	—	—	14.3 × 6.2 × 6.9	14.3 × 7.6 × 8.2
4.7	—	—	—	—	—	—	14.3 × 6.2 × 6.9	14.3 × 7.6 × 8.2
10	—	—	—	14.3 × 6.2 × 6.9	—	14.3 × 6.2 × 6.9	14.3 × 7.6 × 8.2	—
15	—	—	—	—	14.3 × 6.2 × 6.9	14.3 × 7.6 × 8.2	—	—
22	—	—	—	14.3 × 6.2 × 6.9	—	14.3 × 7.6 × 8.2	—	—
33	—	—	—	14.3 × 6.2 × 6.9	14.3 × 7.6 × 8.2	—	—	—
47	—	—	14.3 × 6.2 × 6.9	14.3 × 7.6 × 8.2	—	—	—	—
68	—	14.3 × 6.2 × 6.9	—	—	—	—	—	—
100	14.3 × 6.2 × 6.9	—	14.3 × 7.6 × 8.2	—	—	—	—	—
150	—	14.3 × 7.6 × 8.2	—	—	—	—	—	—
220	14.3 × 7.6 × 8.2	—	—	—	—	—	—	—

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MECHANICAL DATA



Dimensions in mm.
For dimensions see Table 1.

Fig.2 Dimensional outline.

Table 1 Physical dimensions, mass and packaging quantities; see Fig.2

NOMINAL CASE SIZE L × W × H (mm)	CASE CODE	L _{max} (mm)	W _{max} (mm)	H _{max} (mm)	O _{max} (mm)	S (mm)	G _{max} (mm)	R _{min} (mm)	MASS (g)	PACKAGING QUANTITIES PER REEL
14.3 × 6.2 × 6.9	2	14.5	6.3	7.05	13.0	2.15	7.5	4.7	≈0.95	700
14.3 × 7.6 × 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.

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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 2.

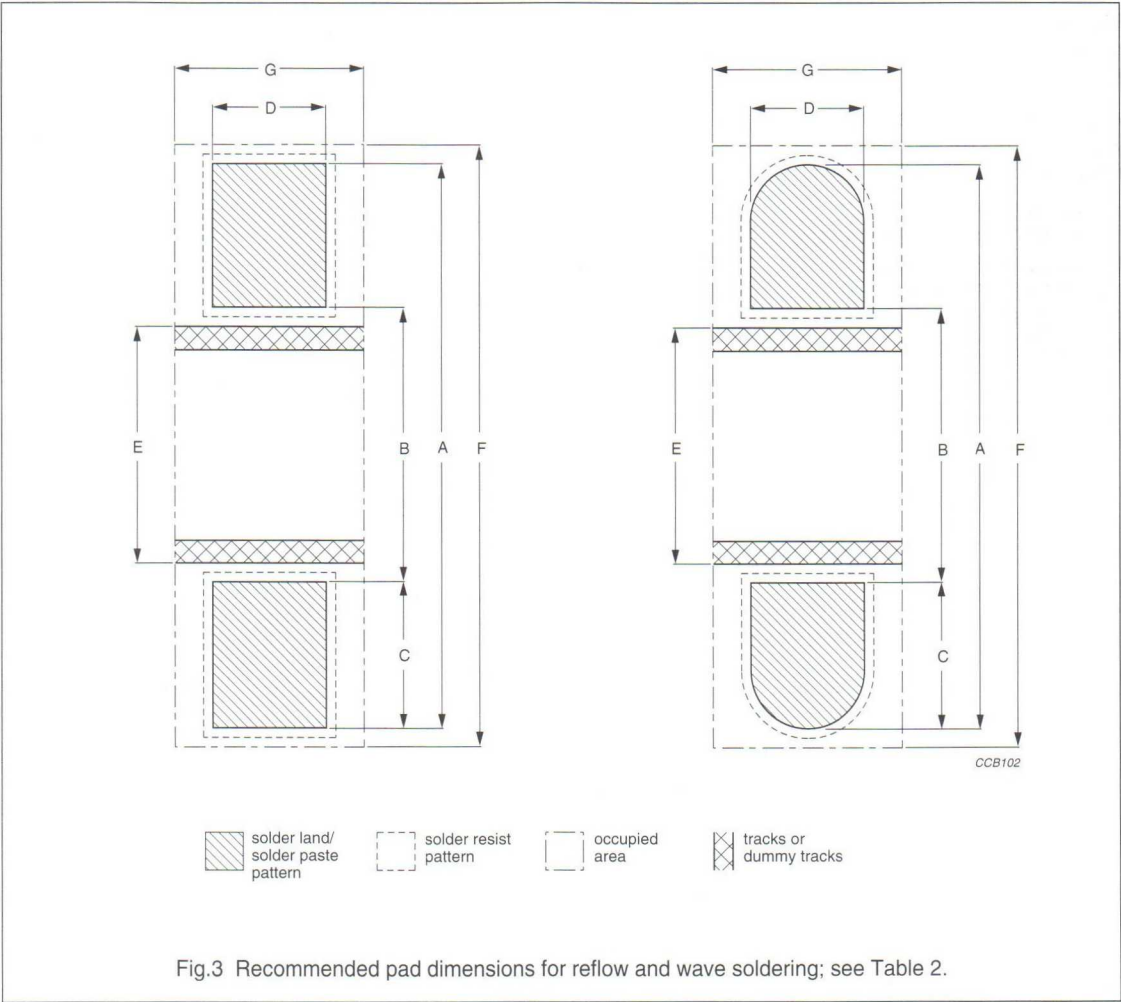


Table 2 Recommended soldering pad dimensions in mm (placement accuracy ± 0.25 mm); see Fig.3

NOMINAL CASE SIZE L $\times$ W $\times$ H (mm)	FOR REFLOW SOLDERING							FOR WAVE SOLDERING						
	A	B	C	D	E	F	G	A	B	C	D	E	F	G
14.3 $\times$ 6.2 $\times$ 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 $\times$ 7.6 $\times$ 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

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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.

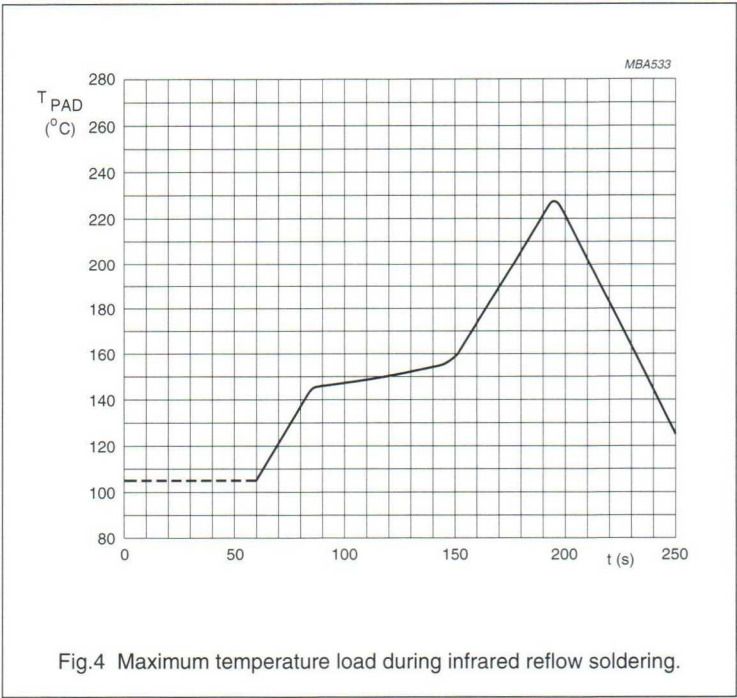
Any temperature versus time curve which does not exceed the specified maximum curves may be applied.

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

Maximum temperature load

Table 3 Curing conditions for SMD-glue

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



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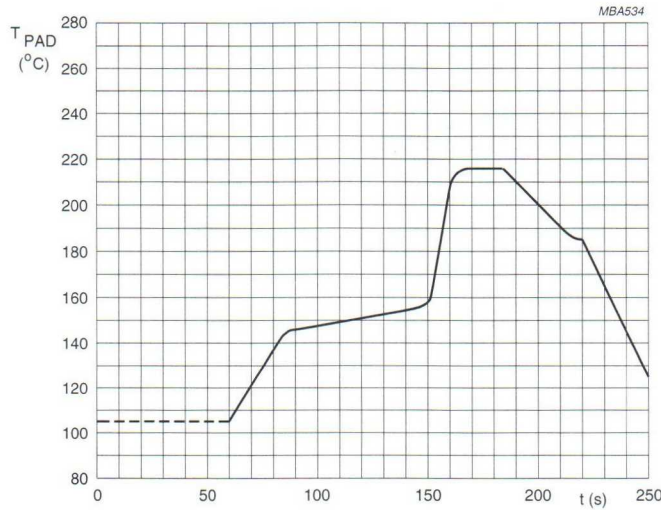


Fig.5 Maximum temperature load during vapour phase reflow soldering.

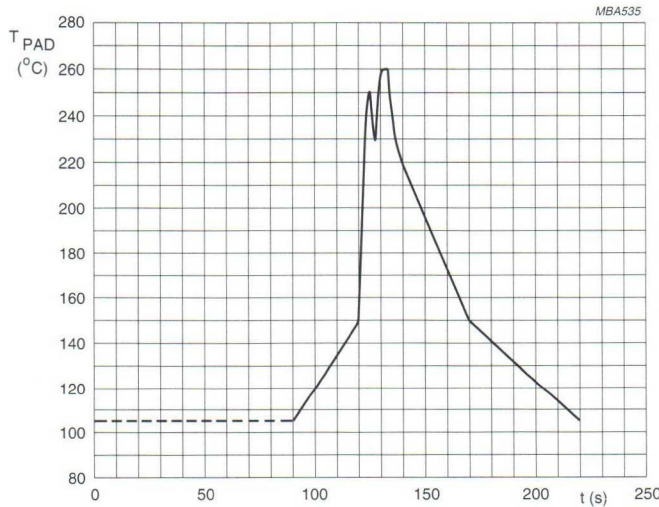


Fig.6 Maximum temperature load during (double-) wave soldering.

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 4 apply at

 $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .**Ordering example**

Electrolytic capacitor 139 series

100 $\mu\text{F}/16\text{ V}$; $\pm 20\%$

Nominal case size:

14.3 $\times$ 7.6 $\times$ 8.2 mm; taped on reel

Catalogue number: 2222 139 65101.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, $105\text{ }^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and C_R)
Z	max. impedance at 10 kHz

Table 4 Electrical data and ordering information; preferred types in **bold**

U_R (V)	C_R 100 H z (μF)	NOMINAL CASE SIZE L $\times$ W $\times$ H (mm)	CASE CODE	I_R 100 Hz 105 $^{\circ}\text{C}$ (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222
6.3	100	14.3 $\times$ 6.2 $\times$ 6.9	2	79	16	4.3	0.24	3.8	3.0	139 63101
	220	14.3 $\times$ 7.6 $\times$ 8.2	3	120	32	5.8	0.24	1.7	1.4	139 63221
10	68	14.3 $\times$ 6.2 $\times$ 6.9	2	71	17	4.4	0.20	4.7	2.9	139 64689
	150	14.3 $\times$ 7.6 $\times$ 8.2	3	110	33	6.0	0.20	2.1	1.3	139 64151
16	47	14.3 $\times$ 6.2 $\times$ 6.9	2	66	18	4.5	0.16	5.4	3.4	139 65479
	100	14.3 $\times$ 7.6 $\times$ 8.2	3	100	35	6.2	0.16	2.5	1.6	139 65101
25	10	14.3 $\times$ 6.2 $\times$ 6.9	2	40	8	3.5	0.09	14	12	139 66109
	22	14.3 $\times$ 6.2 $\times$ 6.9	2	48	14	4.1	0.14	10	5.5	139 66229
	33	14.3 $\times$ 6.2 $\times$ 6.9	2	59	19	4.7	0.14	6.8	3.7	139 66339
	47	14.3 $\times$ 7.6 $\times$ 8.2	3	79	27	5.4	0.14	4.7	2.6	139 66479
40	15	14.3 $\times$ 6.2 $\times$ 6.9	2	45	15	4.2	0.11	12	6	139 67159
	33	14.3 $\times$ 7.6 $\times$ 8.2	3	75	29	5.6	0.11	5.3	2.7	139 67339
50	10	14.3 $\times$ 6.2 $\times$ 6.9	2	40	13	4.0	0.09	14	7	139 61109
	15	14.3 $\times$ 7.6 $\times$ 8.2	3	56	18	4.5	0.09	9.5	4.7	139 61159
	22	14.3 $\times$ 7.6 $\times$ 8.2	3	67	25	5.2	0.09	6.5	3.2	139 61229
63	2.2	14.3 $\times$ 6.2 $\times$ 6.9	2	19	6	3.3	0.09	65	25	139 68228
	3.3	14.3 $\times$ 6.2 $\times$ 6.9	2	23	7	3.4	0.09	43	21	139 68338
	4.7	14.3 $\times$ 6.2 $\times$ 6.9	2	28	9	3.6	0.09	30	17	139 68478
	10	14.3 $\times$ 7.6 $\times$ 8.2	3	48	16	4.3	0.08	13	8	139 68109
100	1.0	14.3 $\times$ 6.2 $\times$ 6.9	2	12	5	3.2	0.09	140	55	139 69108
	2.2	14.3 $\times$ 6.2 $\times$ 6.9	2	19	7	3.4	0.09	65	29	139 69228
	3.3	14.3 $\times$ 7.6 $\times$ 8.2	3	27	10	3.7	0.08	39	17	139 69338
	4.7	14.3 $\times$ 7.6 $\times$ 8.2	3	33	12	3.9	0.08	27	11	139 69478

Aluminium electrolytic capacitors
SMD (Chip) Long Life

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Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.02C_R \times U_R + 3 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 3 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	nominal case size $14.3 \times 6.2 \times 6.9 \text{ mm}$	typ. 18 nH
	nominal case size $14.3 \times 7.6 \times 8.2 \text{ mm}$	typ. 28 nH

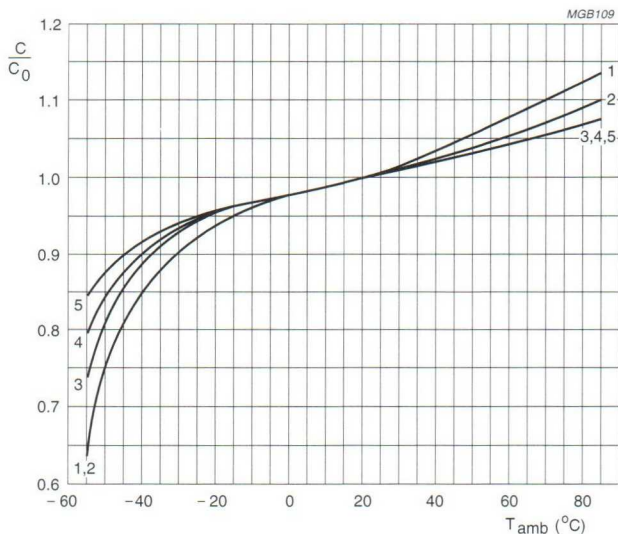
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Aluminium electrolytic capacitors

SMD (Chip) Long Life

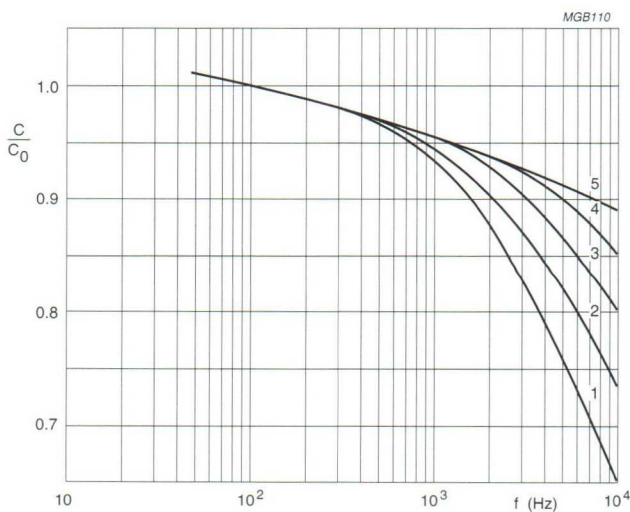
139 CLL

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 $^{\circ}\text{C}$, 100 Hz.

Fig.7 Typical multiplier of capacitance as a function of ambient temperature.



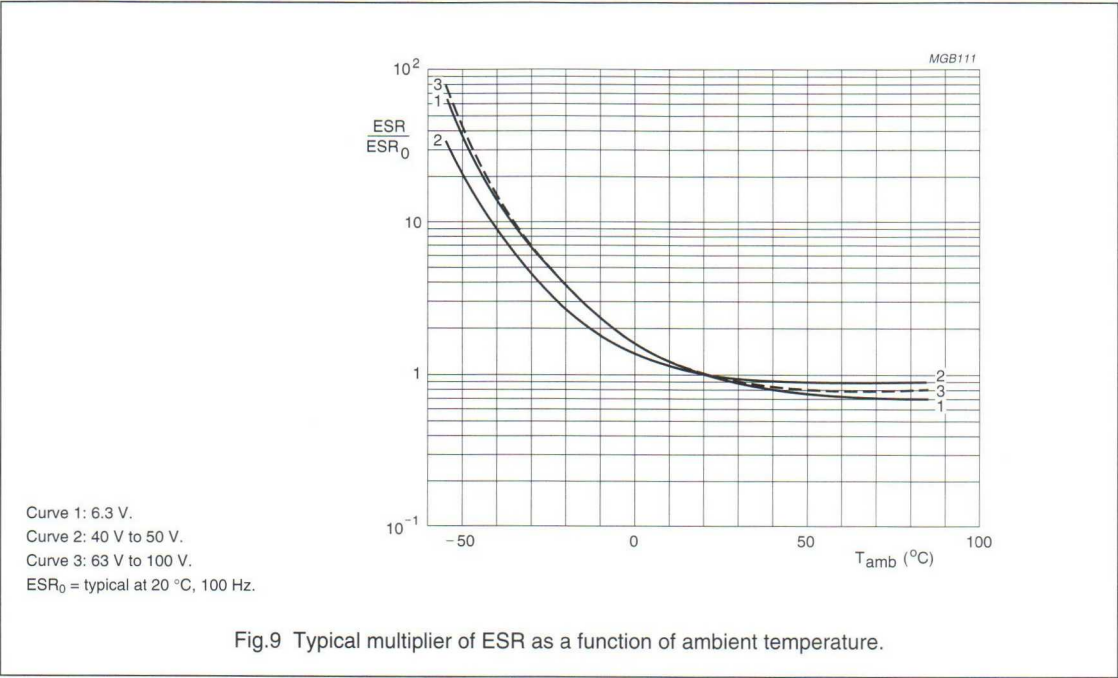
Curve 1: 6.3 V.
 Curve 2: 10 V.
 Curve 3: 16 V.
 Curve 4: 25 V.
 Curve 5: 40 V to 100 V.
 C_0 = capacitance at 20 $^{\circ}\text{C}$, 100 Hz.

Fig.8 Typical multiplier of capacitance as a function of frequency.

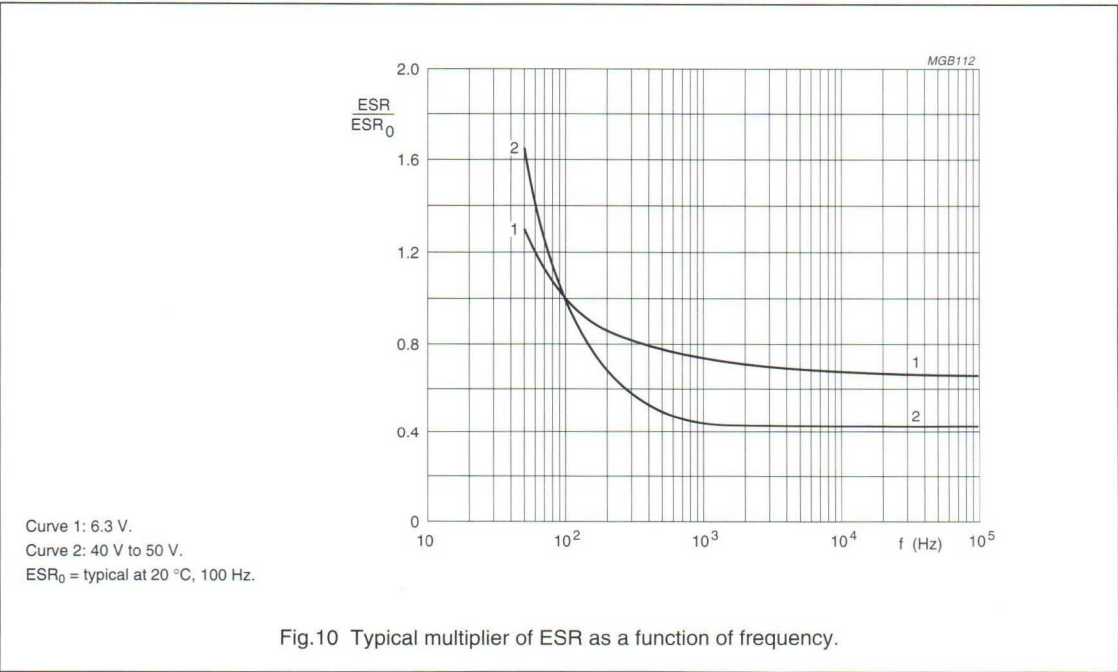
Aluminium electrolytic capacitors
SMD (Chip) Long Life

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Equivalent series resistance (ESR)



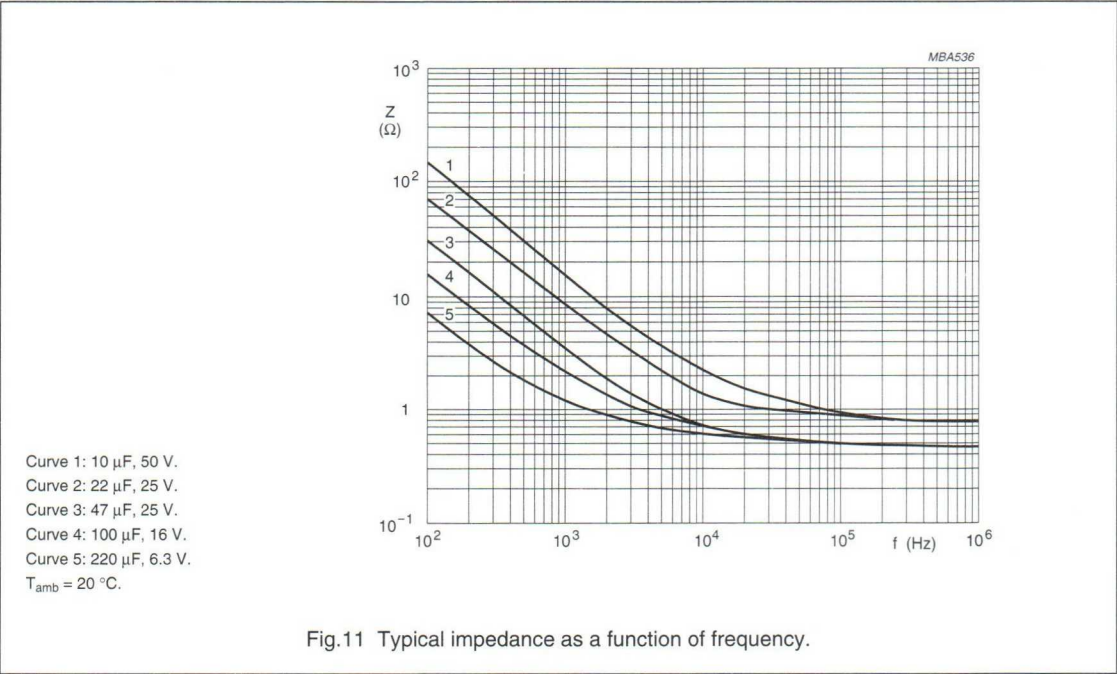
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Aluminium electrolytic capacitors
SMD (Chip) Long Life

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Impedance (Z)



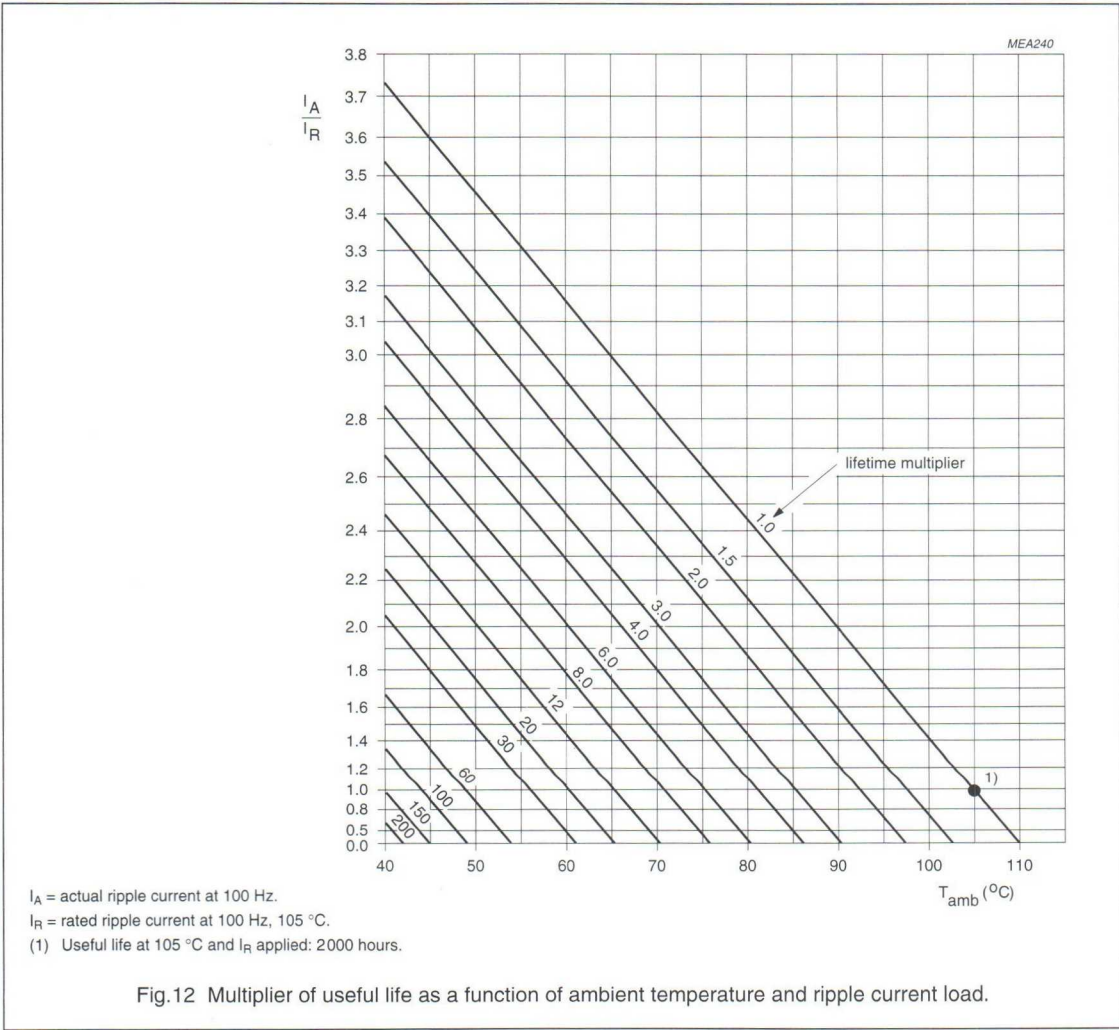
Aluminium electrolytic capacitors
SMD (Chip) Long Life

139 CLL

RIPPLE CURRENT AND USEFUL LIFE

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

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3$ to 16 V	$U_R = 25$ to 50 V	$U_R = 63$ 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
≥ 10000	1.2	1.3	1.4



Aluminium electrolytic capacitors

SMD (Chip) Long Life

139 CLL

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 6 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Mounting	IEC 384-18, subclause 4.3	shall be performed prior to tests mentioned below; reflow or (double-) wave soldering; for maximum temperature load refer to Chapter "Mounting"	$\Delta C/C: \pm 5\%$ $\tan \delta \leq \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Endurance	IEC 384-18/ CECC 32300, subclause 4.15	$T_{\text{amb}} = 105^\circ\text{C}$; U_R applied; 1000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C: +15/-30\%$ $U_R = 10\text{ to }100\text{ V}$; $\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{\text{amb}} = 105^\circ\text{C}$; U_R and I_R applied; 2000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C: +45/-50\%$ $U_R = 10\text{ to }100\text{ V}$; $\Delta C/C: \pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-18/ CECC 32300, subclause 4.17	$T_{\text{amb}} = 105^\circ\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	for requirements see 'Endurance test' above

Aluminium electrolytic capacitors

SMD (Chip) Long Life Vertical

153 CLV

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid, self healing
- SMD-version with base plate, vertical construction requiring minimum board space, reflow solderable
- High CV per unit volume
- Long useful life: 2000 to 3000 hours at 105 °C
- Charge and discharge proof, no peak current limitation
- Supplied in blister tape on reel.

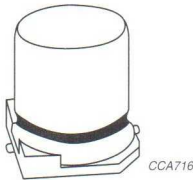
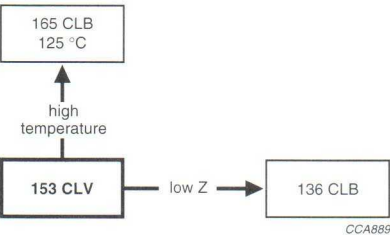


Fig.1 Component outline.

APPLICATIONS

- SMD technology, for high mounting density
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Telecommunications, general industrial, EDP, automotive, portable and lightweight equipment.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes (L × W × H in mm)	4.0 × 4.0 × 5.3 to 10 × 10 × 14
Rated capacitance range, C _R	0.47 to 1000 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: case sizes 4.0 × 4.0 × 5.3 to 6.3 × 6.3 × 5.3 case sizes 8.0 × 8.0 × 6.5 to 10 × 10 × 14	1000 hours 2000 hours
Useful life at 105 °C: case sizes 4.0 × 4.0 × 5.3 to 6.3 × 6.3 × 5.3 case sizes 8.0 × 8.0 × 6.5 to 10 × 10 × 14	2000 hours 3000 hours
Useful life at 40 °C; 1.3 × I _R applied: case sizes 4.0 × 4.0 × 5.3 to 6.3 × 6.3 × 5.3 case sizes 8.0 × 8.0 × 6.5 to 10 × 10 × 14	200000 hours 300000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification (without approval)	IEC 384-18/CECC 32300
Climatic category IEC 68	55/105/56

SMD

Aluminium electrolytic capacitors

SMD (Chip) Long Life Vertical

153 CLV

Selection chart for C_R , U_R and relevant nominal case sizes ($L \times W \times H$ in mm)

Preferred types in **bold**.

C_R (μF)	U_R (V)							
	6.3	10	16	25	35	50	63	100
0.47 ⁽¹⁾	—	—	—	—	—	4.0 × 4.0 × 5.3	—	—
1.0	—	—	—	—	—	4.0 × 4.0 × 5.3	—	—
2.2	—	—	—	—	—	4.0 × 4.0 × 5.3	—	—
3.3	—	—	—	—	—	4.0 × 4.0 × 5.3	—	—
4.7	—	—	—	—	4.0 × 4.0 × 5.3	5.0 × 5.0 × 5.3	—	—
10	—	—	4.0 × 4.0 × 5.3	—	5.0 × 5.0 × 5.3	6.3 × 6.3 × 5.3	—	10 × 10 × 12
22	4.0 × 4.0 × 5.3	—	5.0 × 5.0 × 5.3	—	6.3 × 6.3 × 5.3	8.0 × 8.0 × 6.5	—	10 × 10 × 12
33	—	5.0 × 5.0 × 5.3	—	6.3 × 6.3 × 5.3	8.0 × 8.0 × 6.5	8.0 × 8.0 × 10	—	10 × 10 × 14
47	5.0 × 5.0 × 5.3	—	6.3 × 6.3 × 5.3	8.0 × 8.0 × 6.5	—	8.0 × 8.0 × 10	10 × 10 × 12	—
100	6.3 × 6.3 × 5.3	—	8.0 × 8.0 × 6.5	8.0 × 8.0 × 10	—	10 × 10 × 10	10 × 10 × 14	—
	—	—	—	—	—	10 × 10 × 12	—	—
220	—	8.0 × 8.0 × 10	10 × 10 × 10	10 × 10 × 12	10 × 10 × 12	—	—	—
330	8.0 × 8.0 × 10	10 × 10 × 10	10 × 10 × 12	10 × 10 × 14	—	—	—	—
470	10 × 10 × 10	10 × 10 × 12	10 × 10 × 14	—	—	—	—	—
680	10 × 10 × 12	10 × 10 × 14	—	—	—	—	—	—
1000	10 × 10 × 14	—	—	—	—	—	—	—

Note

- For lower CV-values, see "data handbook PA06, Ceramic Capacitors".

Aluminium electrolytic capacitors

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PACKAGING

Supplied in blister tape on reel. For general packaging information refer to this data handbook, Section "Packaging".

Table 1 Tape and reel dimensions

CASE CODE	PITCH P ₁ (mm)	TAPE WIDTH W (mm)	TAPE THICKNESS T ₂ (mm)	REEL DIA. (mm)	PACKAGING QUANTITY PER REEL
0405	8	12	5.8	380	2000
0505	12	12	5.8	380	1000
0605	12	16	5.8	380	1000
0807	12	16	6.8	380	1000
0810	16	24	11	380	500
1010	16	24	11	380	500
1012	16	24	13	330	250
1014	16	24	15	330	250

MARKING

- Rated capacitance (in μF)
- Rated voltage (in V)
- Black mark or '-' sign indicating the cathode (the anode is identified by bevelled edges).

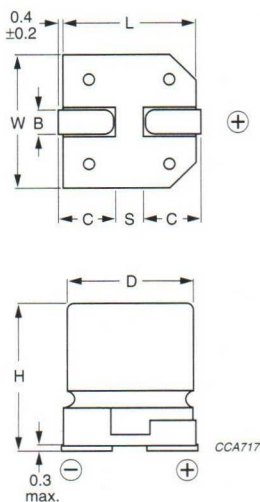
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Aluminium electrolytic capacitors

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MECHANICAL DATA



Dimensions in mm.

Fig.2 Dimensional outline.

Table 2 Physical dimensions, mass and packaging quantities; see Fig.2

NOMINAL CASE SIZE L × W × H (mm)	CASE CODE	L _{max} (mm)	W _{max} (mm)	H _{max} (mm)	∅D (mm)	B _{max} (mm)	S (mm)	C (mm)	MASS (g)	PACKAGING QUANTITIES PER REEL
4.0 × 4.0 × 5.3	0405	4.5	4.5	5.5	4.0	0.8	1.0	2.0 ± 0.2	≈ 0.13	2000
5.0 × 5.0 × 5.3	0505	5.5	5.5	5.5	5.0	0.8	1.4	2.3 ± 0.2	≈ 0.20	1000
6.3 × 6.3 × 5.3	0605	6.8	6.8	5.5	6.3	0.8	2.0	2.7 ± 0.2	≈ 0.30	1000
8.0 × 8.0 × 6.5	0807	8.6	8.6	6.8	8.0	0.8	2.3	3.4 ± 0.2	≈ 0.50	1000
8.0 × 8.0 × 10	0810	8.6	8.6	10.5	8.0	1.1	3.1	3.0 ± 0.2	≈ 1.00	500
10 × 10 × 10	1010	10.6	10.6	10.5	10.0	1.1	4.7	3.3 ± 0.2	≈ 1.30	500
10 × 10 × 12	1012	10.6	10.6	12.3	10.0	1.2	4.5	3.9 ± 0.2	≈ 1.40	250
10 × 10 × 14	1014	10.6	10.6	14.3	10.0	1.2	4.5	3.9 ± 0.2	≈ 1.50	250

Aluminium electrolytic capacitors
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MOUNTING

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

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.

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 refer to Fig.4.

Any temperature versus time curve which does not exceed the specified maximum curves may be applied.

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

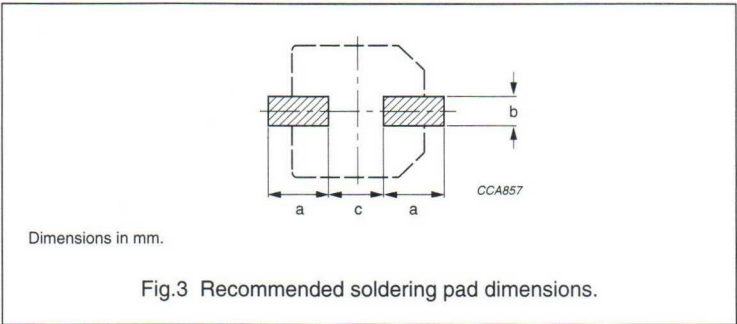


Fig.3 Recommended soldering pad dimensions.

Table 3 Recommended soldering pad dimensions

CASE CODE	a (mm)	b (mm)	c (mm)
0405	2.6	1.6	1.0
0505	3.0	1.6	1.4
0605	3.5	1.6	1.9
0807	4.0	1.6	2.1
0810	3.5	2.5	3.0
1010	4.0	2.5	4.0
1012	4.3	2.5	4.0
1014	4.3	2.5	4.0

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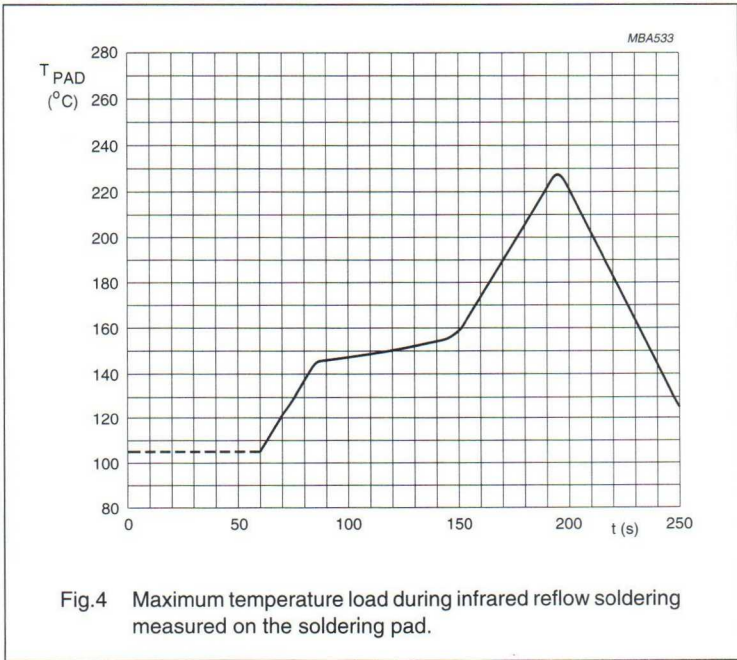


Fig.4 Maximum temperature load during infrared reflow soldering measured on the soldering pad.

Aluminium electrolytic capacitors

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 4 apply at

 $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 or 120 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 or 120 Hz, $105\text{ }^{\circ}\text{C}$
I_{L2}	max. leakage current after 2 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 or 120 Hz
ESR	equivalent series resistance at 100 kHz

Ordering example

Electrolytic capacitor 153 series

100 $\mu\text{F}/25\text{ V}$; $\pm 20\%$

Nominal case size:

8 $\times$ 8 $\times$ 10 mm; taped on reel

Catalogue number: 2222 153 66101.

Table 4 Electrical data and ordering information; preferred types in **bold**

U_R (V)	C_R (μF)	NOMINAL CASE SIZE L $\times$ W $\times$ H (mm)	CASE CODE	I_R 105 $^{\circ}\text{C}$ (mA)	I_{L2} 2 min (μA)	$\tan \delta$	ESR 100 kHz (Ω)	CATALOGUE NUMBER 2222
6.3	22	4.0 $\times$ 4.0 $\times$ 5.3	0405	21	3.0	0.30	8	153 63229
	47	5.0 $\times$ 5.0 $\times$ 5.3	0505	36	3.0	0.30	4	153 63479
	100	6.3 $\times$ 6.3 $\times$ 5.3	0605	61	6.3	0.30	2	153 63101
	330	8.0 $\times$ 8.0 $\times$ 10	0810	180	21	0.30	0.5	153 63331
	470	10 $\times$ 10 $\times$ 10	1010	320	30	0.30	0.3	153 63471
	680	10 $\times$ 10 $\times$ 12	1012	340	43	0.24	0.29	153 63681
	1000	10 $\times$ 10 $\times$ 14	1014	400	63	0.24	0.24	153 63102
10	33	5.0 $\times$ 5.0 $\times$ 5.3	0505	31	3.3	0.26	4	153 64339
	220	8.0 $\times$ 8.0 $\times$ 10	0810	180	22	0.26	0.5	153 64221
	330	10 $\times$ 10 $\times$ 10	1010	320	33	0.26	0.3	153 64331
	470	10 $\times$ 10 $\times$ 12	1012	330	47	0.19	0.29	153 64471
	680	10 $\times$ 10 $\times$ 14	1014	380	68	0.19	0.24	153 64681
16	10	4.0 $\times$ 4.0 $\times$ 5.3	0405	16	3.0	0.22	8	153 65109
	22	5.0 $\times$ 5.0 $\times$ 5.3	0505	28	3.5	0.22	4	153 65229
	47	6.3 $\times$ 6.3 $\times$ 5.3	0605	47	7.5	0.22	2.2	153 65479
	100	8.0 $\times$ 8.0 $\times$ 6.5	0807	110	16	0.22	1.2	153 65101
	220	10 $\times$ 10 $\times$ 10	1010	320	35	0.22	0.3	153 65221
	330	10 $\times$ 10 $\times$ 12	1012	330	53	0.16	0.29	153 65331
	470	10 $\times$ 10 $\times$ 14	1014	370	75	0.16	0.25	153 65471
25	33	6.3 $\times$ 6.3 $\times$ 5.3	0605	44	8.3	0.16	2.2	153 66339
	47	8.0 $\times$ 8.0 $\times$ 6.5	0807	110	12	0.16	1.2	153 66479
	100	8.0 $\times$ 8.0 $\times$ 10	0810	180	25	0.16	0.5	153 66101
	220	10 $\times$ 10 $\times$ 12	1012	270	55	0.14	0.29	153 66221
	330	10 $\times$ 10 $\times$ 14	1014	300	83	0.14	0.27	153 66331

Aluminium electrolytic capacitors

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U_R (V)	C_R (μ F)	NOMINAL CASE SIZE L $\times$ W $\times$ H (mm)	CASE CODE	I_R 105 °C (mA)	I_{L2} 2 min (μ A)	Tan δ	ESR 100 kHz (Ω)	CATALOGUE NUMBER 2222
35	4.7	4.0 $\times$ 4.0 $\times$ 5.3	0405	14	3.0	0.13	8	153 60478
	10	5.0 $\times$ 5.0 $\times$ 5.3	0505	23	3.5	0.13	4	153 60109
	22	6.3 $\times$ 6.3 $\times$ 5.3	0605	50	7.7	0.13	2.2	153 60229
	33	8.0 $\times$ 8.0 $\times$ 6.5	0807	110	12	0.13	1.2	153 60339
	220	10 $\times$ 10 $\times$ 12	1012	270	77	0.12	0.29	153 60221
50	0.47	4.0 $\times$ 4.0 $\times$ 5.3	0405	5	3.0	0.12	12	153 61477
	1.0	4.0 $\times$ 4.0 $\times$ 5.3	0405	7	3.0	0.12	12	153 61108
	2.2	4.0 $\times$ 4.0 $\times$ 5.3	0405	10	3.0	0.12	12	153 61228
	3.3	4.0 $\times$ 4.0 $\times$ 5.3	0405	12	3.0	0.12	12	153 61338
	4.7	5.0 $\times$ 5.0 $\times$ 5.3	0505	17	3.0	0.12	6	153 61478
	10	6.3 $\times$ 6.3 $\times$ 5.3	0605	26	5.0	0.12	3	153 61109
	22	8.0 $\times$ 8.0 $\times$ 6.5	0807	110	11.0	0.12	1.2	153 61229
	33	8.0 $\times$ 8.0 $\times$ 10	0810	180	17	0.12	0.5	153 61339
	47	8.0 $\times$ 8.0 $\times$ 10	0810	180	24	0.12	0.5	153 61479
	100	10 $\times$ 10 $\times$ 10	1010	320	50	0.12	0.3	153 61101
63	47	10 $\times$ 10 $\times$ 12	1012	220	30	0.09	0.29	153 68479
	100	10 $\times$ 10 $\times$ 14	1014	240	63	0.09	0.41	153 68101
100	10	10 $\times$ 10 $\times$ 12	1012	150	10	0.07	0.9	153 69109
	22	10 $\times$ 10 $\times$ 12	1012	150	25	0.07	0.9	153 69229
	33	10 $\times$ 10 $\times$ 14	1014	170	33	0.07	0.65	153 69339

Additional electrical data

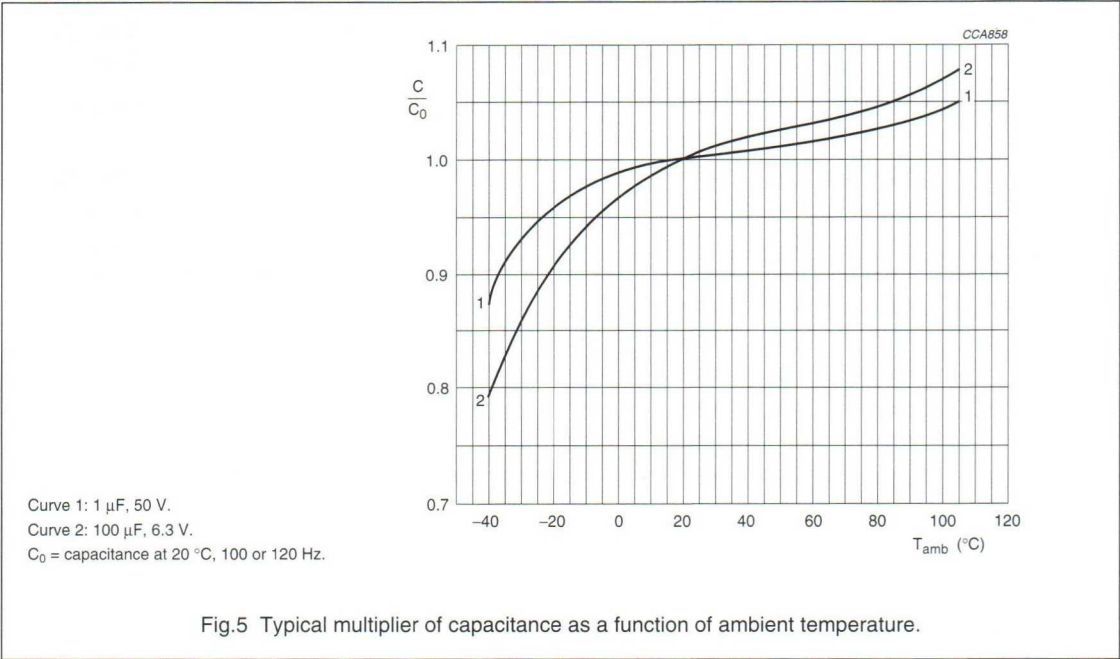
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods	IEC 384-18, subclause 4.14	$U_s \leq 1.15 \times U_R$
Reverse voltage for short periods	IEC 384-18, subclause 4.16	$U_{rev} \leq 1$ V
Current		
Leakage current	after 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$ or 3 μ A, whichever is greater
Inductance		
Equivalent series inductance (ESL)	case codes 0405 to 0605	typ. 10 nH
	case codes 0807 to 1010	typ. 15 nH
	case codes 1012 and 1014	typ. 16 nH

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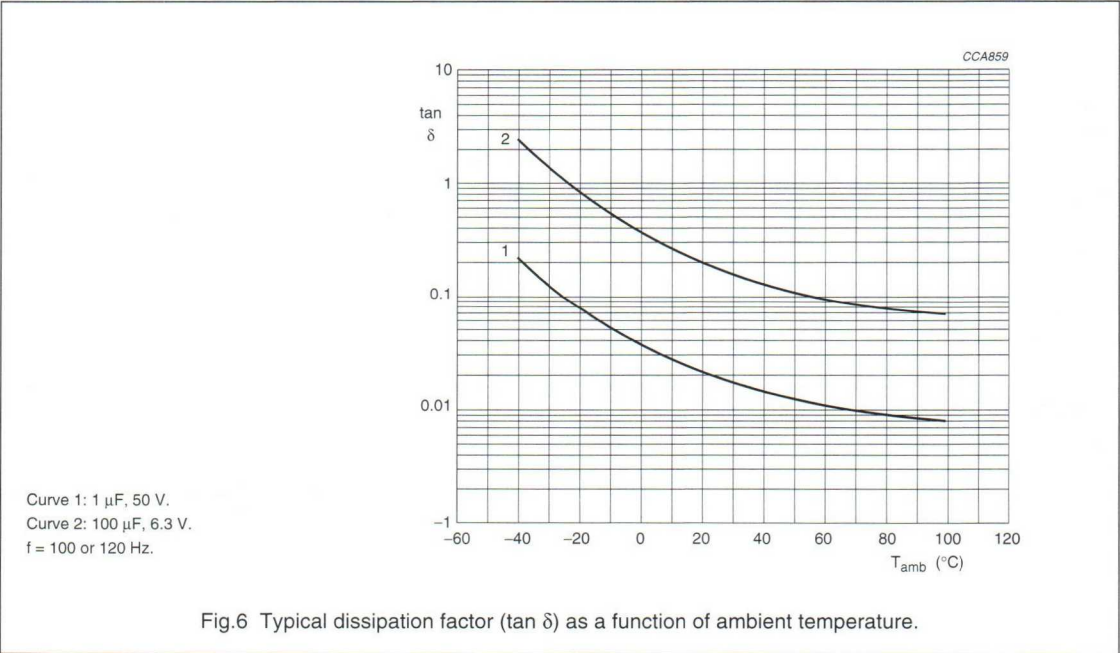
Aluminium electrolytic capacitors
SMD (Chip) Long Life Vertical

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Capacitance (C)



Dissipation factor ($\tan \delta$)



Aluminium electrolytic capacitors

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Equivalent series resistance (ESR)

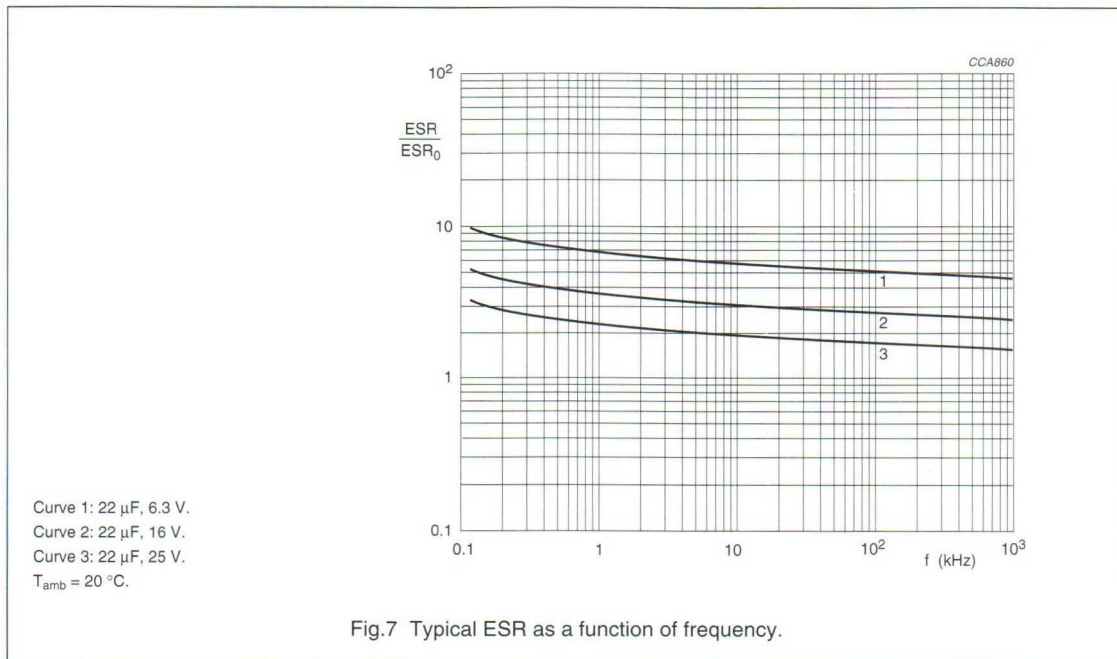


Fig.7 Typical ESR as a function of frequency.

Impedance (Z)

SMD

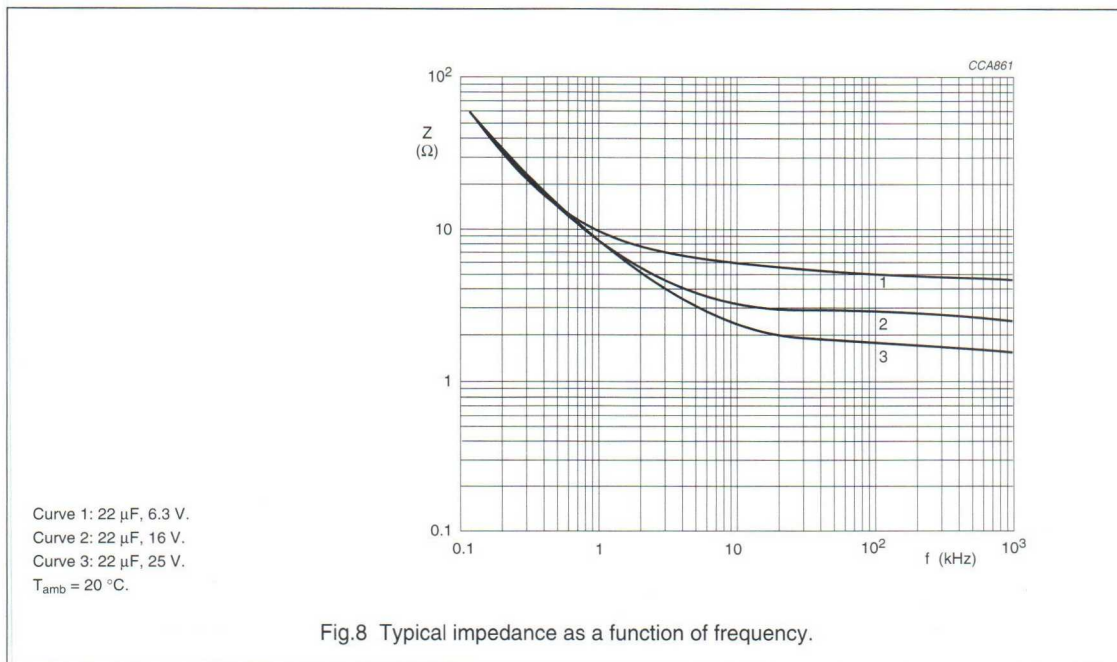


Fig.8 Typical impedance as a function of frequency.

Aluminium electrolytic capacitors

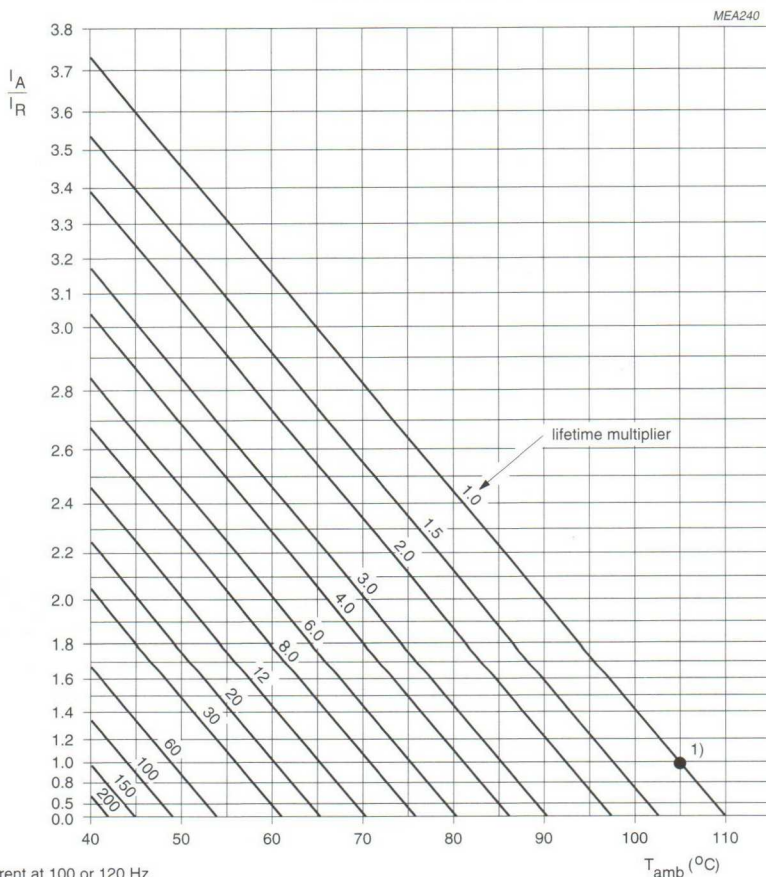
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RIPPLE CURRENT AND USEFUL LIFE

Table 5 Multiplier of ripple current (I_R) as a function of frequency; I_{R0} = ripple current at 100 or 120 Hz

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3$ to 16 V	$U_R = 25$ or 35 V	$U_R = 50$ to 100 V
50 or 60	0.80	0.80	0.80
100 or 120	1.00	1.00	1.00
300	1.10	1.15	1.20
1000	1.15	1.25	1.35
3000	1.20	1.35	1.45
≥ 10000	1.25	1.40	1.50



I_A = actual ripple current at 100 or 120 Hz.

I_R = rated ripple current at 100 or 120 Hz, $105^{\circ}C$.

For case codes 0405 to 1010 max. $I_A/I_R = 2.4$.

(1) Useful life at $105^{\circ}C$ and I_R applied: 2000 hours for case codes 0405 to 0605; 3000 hours for case codes 0807 to 1014.

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

SMD (Chip) Long Life Vertical

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this data handbook, Section "Tests and Requirements".

Table 6 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Mounting	IEC 384-18, subclause 4.3	shall be performed prior to tests mentioned below; reflow soldering; for maximum temperature load refer to Chapter "Mounting"	$\Delta C/C: \pm 10\%$ $\tan \delta \leq \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Endurance	IEC 384-18/ CECC 32300, subclause 4.15	$T_{\text{amb}} = 105^\circ\text{C}$; U_R applied; 1 000 hours, case codes 0405 to 0605 2 000 hours, case codes 0807 to 1014	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{\text{amb}} = 105^\circ\text{C}$; U_R and I_R applied; 2 000 hours, case codes 0405 to 0605 3 000 hours, case codes 0807 to 1014	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-18/ CECC 32300, subclause 4.17	$T_{\text{amb}} = 105^\circ\text{C}$; no voltage applied; 1 000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	for requirements see 'Endurance test' above

SMD

RADIAL ALUMINIUM ELECTROLYTIC CAPACITORS

	STANDARD and MINIATURE	SEMI-PROFESSIONAL	LONG-LIFE	EXTRA LONG-LIFE or HIGH TEMPERATURE
	1500 to 3000 hours 85 °C	750 to 2500 hours 105 °C	2000 to 4000 hours 105 °C	1500 hours / 125 °C ≥4000 hours / 105 °C
		page 184 036 92 RB bipolar 036 93 RBA bipolar audio page 186		
		013 RLC low leakage page 170	046 RSL maintenance type page 264	165 RHT 125 °C maintenance type page 294
	044 RSH high voltage page 158	135 RLI low Z page 228	151 RLH high voltage page 255	136 RVI 105 °C very low Z page 277
	037 RSM low voltage page 140	page 188 036 RSP 047 RMS page 201	page 214 116 RLL 048 RML page 242	
	page 133 097 RLP 7 H: 7 mm 134 RLP 5 H: 5 mm page 126			

CCB096

Aluminium electrolytic capacitors

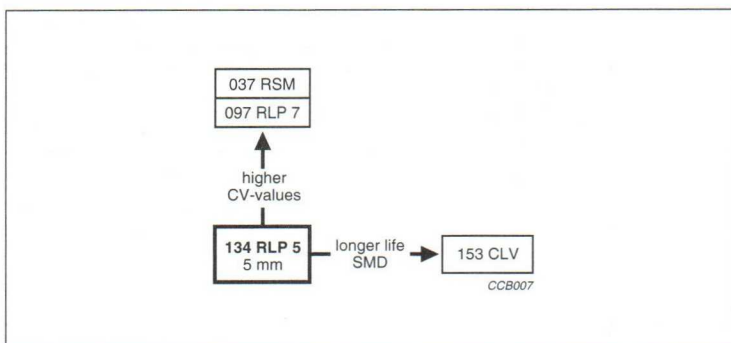
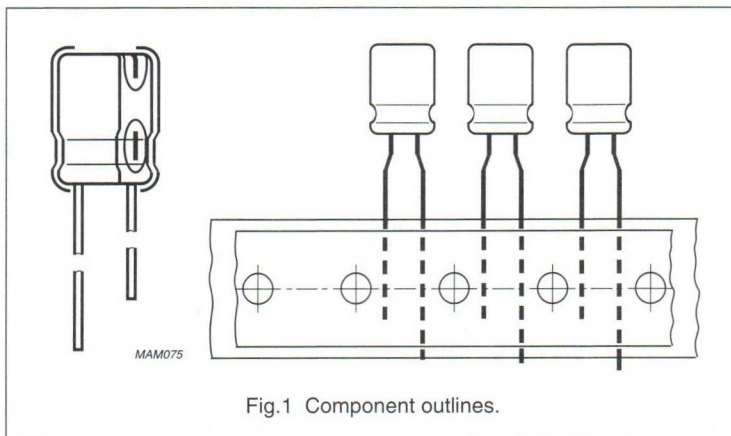
Radial Low Profile, 5 mm

134 RLP 5**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
- High mounting density
- Portable and mobile equipment (very small size and very low mass), low profile equipment.

**QUICK REFERENCE DATA**

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	3×5 to 6.3×5
Rated capacitance range, C_R	1.0 to 100 μF
Tolerance on C_R	$\pm 20\%$
Rated voltage range, U_R	6.3 to 50 V
Category temperature range	-40 to $+85$ $^{\circ}C$
Endurance test at 85 $^{\circ}C$	1000 hours
Useful life at 85 $^{\circ}C$	1500 hours
Useful life at 40 $^{\circ}C$, $1.4 \times I_R$ applied	40000 hours
Shelf life at 0 V, 85 $^{\circ}C$	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/085/56

Aluminium electrolytic capacitors

Radial Low Profile, 5 mm

134 RLP 5

Selection chart for C_R, U_R and relevant nominal case sizes (∅D × L in mm)

Preferred types in **bold**.

C _R (μF)	U _R (V)					
	6.3	10	16	25	35	50
1.0	—	—	—	—	—	3 × 5
2.2	—	—	—	—	3 × 5	3.5 × 5
3.3	—	—	—	3 × 5	—	4 × 5
4.7	—	—	—	3.5 × 5	4 × 5	5 × 5
10	—	—	3.5 × 5	—	5 × 5	6.3 × 5
22	4 × 5	—	5 × 5	—	6.3 × 5	—
33	—	5 × 5	—	6.3 × 5	—	—
47	5 × 5	—	6.3 × 5	—	—	—
100	6.3 × 5	—	—	—	—	—

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".



Aluminium electrolytic capacitors
Radial Low Profile, 5 mm

134 RLP 5

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

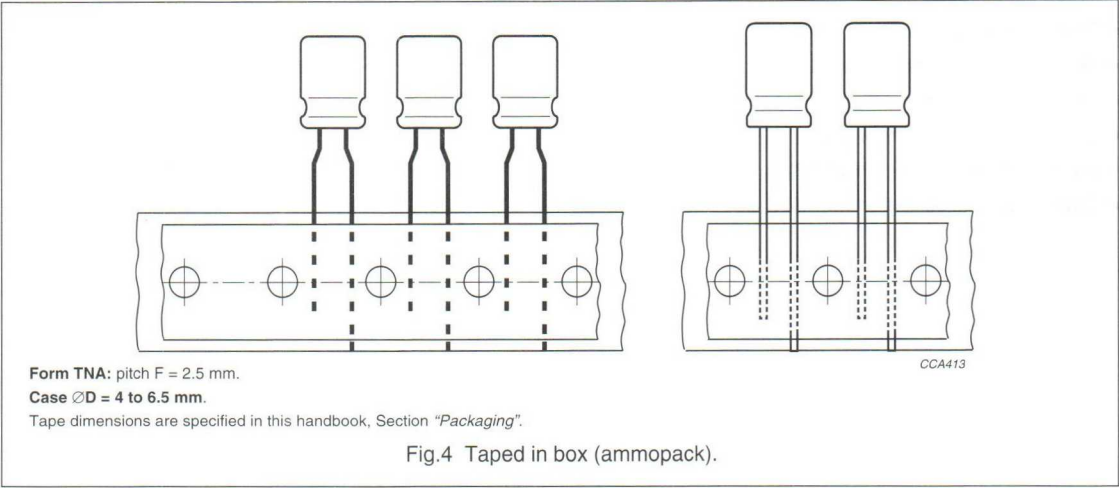
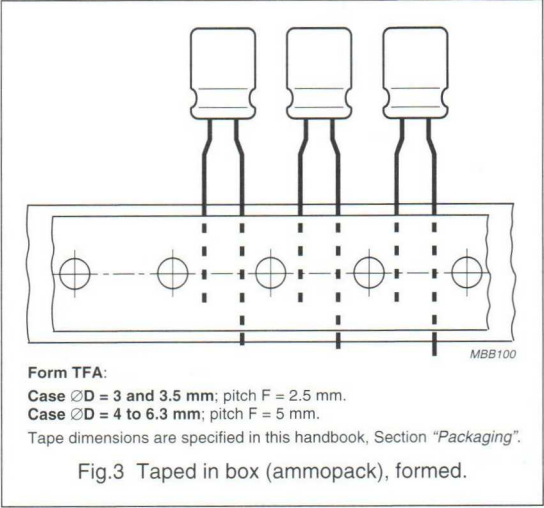
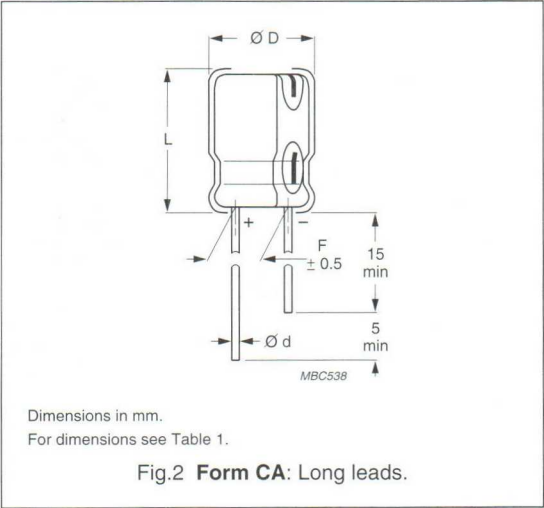


Table 1 Physical dimensions and packaging quantities; see Figs 2, 3 and 4

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	PACKAGING QUANTITIES		
						FORM CA	FORM TFA	FORM TNA
3 × 5	51	0.40	3.5	6.0	1.0 ± 0.3	3000	3000	—
3.5 × 5	52	0.40	4.0	6.0	1.0 ± 0.3	3000	3000	—
4 × 5	53	0.45	4.5	6.0	1.5 ± 0.5	2000	2000	2000
5 × 5	54	0.45	5.5	6.0	2.0 ± 0.5	2000	2000	2000
6.3 × 5	55	0.45	6.8	6.0	2.5 ± 0.5	2000	2000	2000

Aluminium electrolytic capacitors
Radial Low Profile, 5 mm

134 RLP 5

Ordering example

Electrolytic capacitor 134 series

22 μ F/16 V; $\pm 20\%$

Nominal case size: Ø5 × 5 mm; Form TFA

Catalogue number: 2222 134 35229.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{\text{amb}} = 20^{\circ}\text{C}$,

P = 86 to 106 kPa, RH = 45 to 75%.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 120 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 120 Hz, 85 °C
I_{L2}	max. leakage current after 2 minutes at U_R
$\tan \delta$	max. dissipation factor at 120 Hz
ESR	equivalent series resistance at 120 Hz (calculated from $\tan \delta_{\max}$ and C_R)
Z	max. impedance at 10 kHz and 100 kHz

Table 2 Electrical data and ordering information; preferred types in **bold**

U _R (V)	C _R 120 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	CATALOGUE NUMBER 2222					
										BULK LONG LEADS		TAPED AMMOPACK			
										FORM CA	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	22 47 100	4 × 5 5 × 5 6.3 × 5	53 54 55	23 38 60	3 3 7	0.24 0.24 0.24	14 6.8 3.2	12 6.7 4.4	11	134 53229 134 53479 134 53101	1.5 2.0 2.5	134 33229 134 33479 134 33101	5.0 5.0 5.0	134 73229 134 73479 134 73101	2.5 2.5 2.5
10	33	5 × 5	54	35	4	0.20	8.0	7.7	6.0	134 54339	2.0	134 34339	5.0	134 74339	2.5
16	10 22 47	3.5 × 5 5 × 5 6.3 × 5	52 54 55	17 32 50	3 4 8	0.16 0.16 0.16	21 9.6 4.5	18 8.0 5.2	17 6.4 4.2	134 55109 134 55229 134 55479	1.0 2.0 2.5	134 35109 134 35229 134 35479	2.5 5.0 5.0	— 134 75229 134 75479	— 2.5 2.5
25	3.3 4.7 33	3 × 5 3.5 × 5 6.3 × 5	51 52 55	9.5 12 45	3 3 9	0.14 0.14 0.14	56 40 5.6	29 22 6.0	24 19 4.6	134 56338 134 56478 134 56339	1.0 1.0 2.5	134 36338 134 36478 134 36339	2.5 2.5 5.0	— — 134 76339	— — 2.5

Aluminium electrolytic capacitors

Radial Low Profile, 5 mm

134 RLP 5

CATALOGUE NUMBER															
2222															
U _R 120 Hz (V)	C _R 120 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	TAPED AMMOPACK					
										BULK LONG LEADS		FORM TFA	F (mm)	FORM TNA	F (mm)
										FORM CA	F (mm)				
35	2.2	3 × 5	51	8.3	3		72	48	41	134 50228	1.0	134 30228	2.5	—	—
	4.7	4 × 5	53	15	3		34	31	27	134 50478	1.5	134 30478	5.0	134 30478	2.5
	10	5 × 5	54	25	4		16	21	17	134 50109	2.0	134 30109	5.0	134 30109	2.5
	22	6.3 × 5	55	40	8		7.2	13	11	134 50229	2.5	134 30229	5.0	134 30229	2.5
50	1.0	3 × 5	51	6.2	3		130	70	50	134 51108	1.0	134 31108	2.5	—	—
	2.2	3.5 × 5	52	10	3		60	44	33	134 51228	1.0	134 31228	2.5	—	—
	3.3	4 × 5	53	14	3		40	36	25	134 51338	1.5	134 31338	5.0	134 31338	2.5
	4.7	5 × 5	54	19	3		28	29	22	134 51478	2.0	134 31478	5.0	134 31478	2.5
	10	6.3 × 5	55	29	5		13	19	14	134 51109	2.5	134 31109	5.0	134 31109	2.5

Additional electrical data

DESCRIPTION	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1\text{ V}$
Current		
Leakage current	after 2 minutes at U_R	$I_{L2} \leq 0.01 C_R \times U_R$ or $3\text{ }\mu\text{A}$ (whichever is greater)

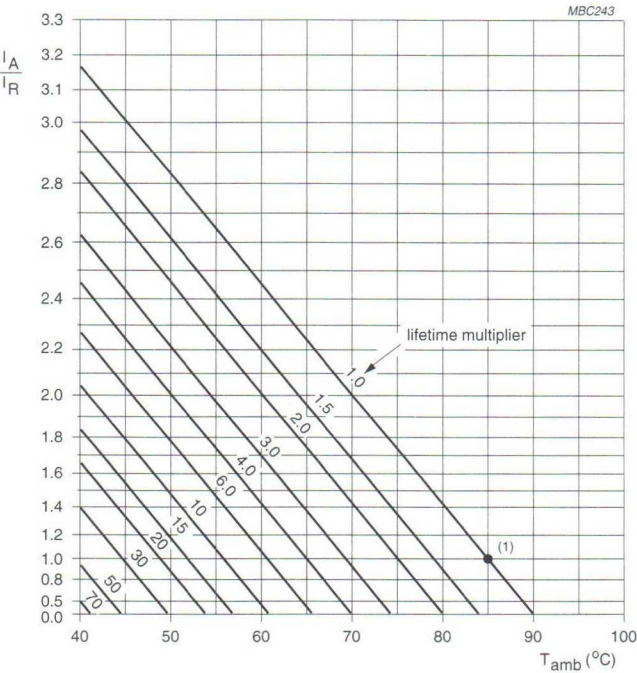
Aluminium electrolytic capacitors
Radial Low Profile, 5 mm

134 RLP 5

RIPPLE CURRENT AND USEFUL LIFE

Table 3 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.
(1) Useful life at 85 °C and I_R applied: 1500 hours.

Fig.5 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Radial Low Profile, 5 mm

134 RLP 5

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300, subclause 4.13	$T_{amb} = 85\text{ °C}$; U_R applied; 1000 hours	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{amb} = 85\text{ °C}$; U_R and I_R applied; 1500 hours	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300, subclause 4.17	$T_{amb} = 85\text{ °C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C, \tan \delta, Z$: for requirements see 'Endurance test' above $I_{L2} \leq \text{spec. limit}$

Aluminium electrolytic capacitors Radial Low Profile, 7 mm

097 RLP 7

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 CV-product per unit volume.

APPLICATIONS

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

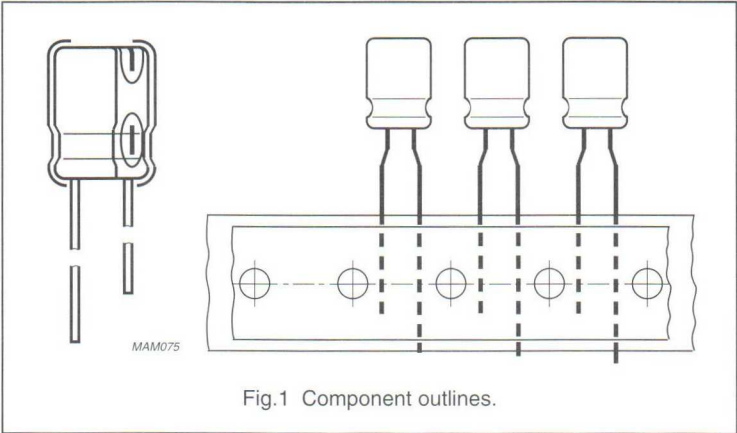
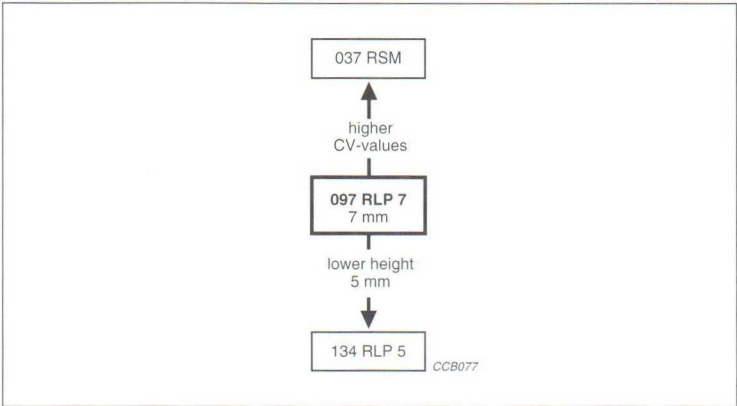


Fig.1 Component outlines.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	4×7 to 7×7
Rated capacitance range, C_R	0.1 to 220 μF
Tolerance on C_R	$\pm 20\%$
Rated voltage, U_R	6.3 to 63 V
Category temperature range	-40 to $+85$ $^{\circ}C$
Endurance test at 85 $^{\circ}C$	1 000 hours
Useful life at 85 $^{\circ}C$	1 500 hours
Useful life at 40 $^{\circ}C$, $1.4 \times I_R$ applied	40 000 hours
Shelf life at 0 V, 85 $^{\circ}C$	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/085/56

Aluminium electrolytic capacitors

Radial Low Profile, 7 mm

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

C_R (μF)	U_R (V)						
	6.3	10	16	25	35	50	63
0.10	—	—	—	—	—	—	4×7
0.22	—	—	—	—	—	—	4×7
0.47	—	—	—	—	—	—	4×7
1.0	—	—	—	—	—	—	4×7
2.2	—	—	—	—	—	—	4×7
3.3	—	—	—	—	—	4×7	5×7
4.7	—	—	—	—	4×7	5×7	6.3×7
10	—	—	4×7	—	5×7	6.3×7	7×7
22	4×7	—	5×7	—	6.3×7	7×7	—
33	—	5×7	—	6.3×7	7×7	—	—
47	5×7	—	6.3×7	7×7	—	—	—
100	—	6.3×7	7×7	—	—	—	—
220	7×7	—	—	—	—	—	—

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".

Aluminium electrolytic capacitors Radial Low Profile, 7 mm

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

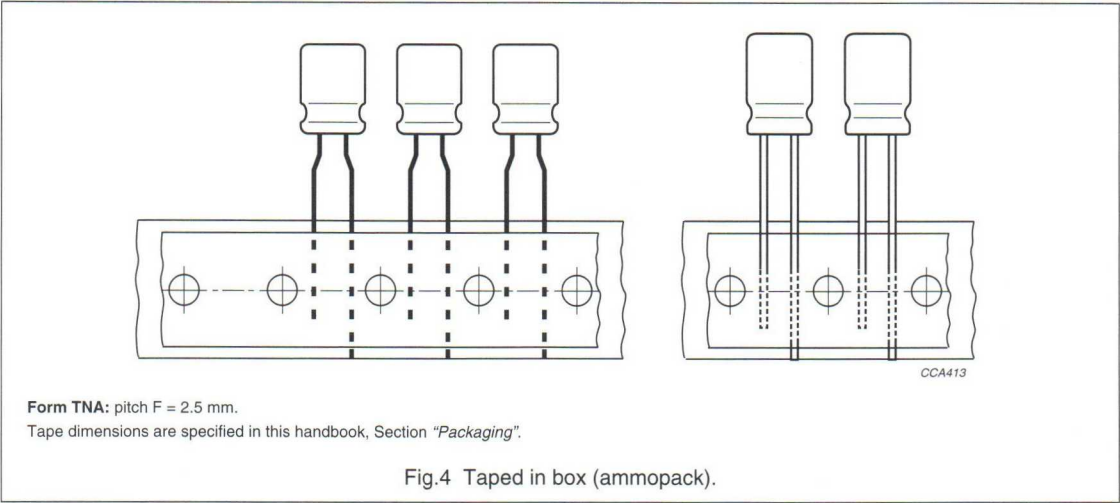
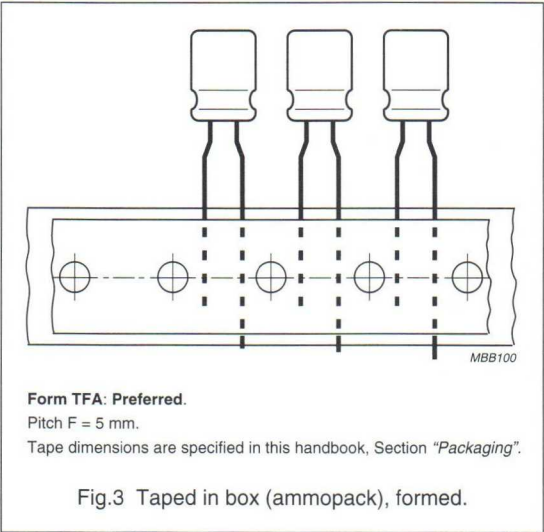
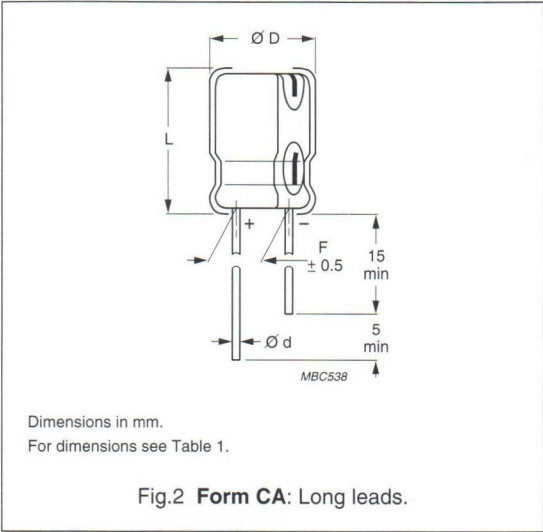


Table 1 Physical dimensions and packaging quantities; see Figs 2, 3 and 4

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	PACKAGING QUANTITIES		
						FORM CA	FORM TFA	FORM TNA
4 × 7	71	0.45	4.5	8	1.5 ± 0.5	2000	2000	2000
5 × 7	72	0.45	5.5	8	2.0 ± 0.5	1000	2000	2000
6.3 × 7	73	0.45	6.8	8	2.5 ± 0.5	1000	2000	2000
7 × 7	74	0.45	7.5	8	2.5 ± 0.5	1000	1000	1000

Aluminium electrolytic capacitors

Radial Low Profile, 7 mm

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Ordering example

Electrolytic capacitor 097 series
100 $\mu\text{F}/16\text{ V}$; $\pm 20\%$
Nominal case size: $\varnothing 7 \times 7\text{ mm}$; Form TFA
Catalogue number: 2222 097 35101.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{\text{amb}} = 20\text{ }^{\circ}\text{C}$,
 $P = 86\text{ to }106\text{ kPa}$, $RH = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 120 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 120 Hz, $85\text{ }^{\circ}\text{C}$
I_{L2}	max. leakage current after 2 minutes at U_R
$\tan \delta$	max. dissipation factor at 120 Hz
ESR	equivalent series resistance at 120 Hz (calculated from $\tan \delta_{\text{max}}$ and C_R)
Z	max. impedance at 10 kHz and 100 kHz

Table 2 Electrical data and ordering information; preferred types in **bold**

U_R (V)	C_R 120 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 120 Hz $85\text{ }^{\circ}\text{C}$ (mA)	I_{L2} 2 min (μA)	$\tan \delta$ 120 Hz	ESR 120 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER					
										BULK LONG LEADS		TAPED AMMOPACK			
										FORM CA	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	22	4 × 7	71	31	3	0.24	14	9.6	8.4	097 53229	1.5	097 33229	5.0	097 73229	2.5
	47	5 × 7	72	47	3	0.24	6.8	5	4.6	097 53479	2.0	097 33479	5.0	097 73479	2.5
	220	7 × 7	74	95	14	0.24	1.4	2	1.8	097 53221	2.5	097 33221	5.0	097 73221	2.5
10	33	5 × 7	72	43	4	0.20	8.0	4	3.7	097 54339	2.0	097 34339	5.0	097 74339	2.5
	100	6.3 × 7	73	80	10	0.20	2.7	2.3	2.2	097 54101	2.5	097 34101	5.0	097 74101	2.5
16	10	4 × 7	71	25	3	0.16	21	11	10	097 55109	1.5	097 35109	5.0	097 75109	2.5
	22	5 × 7	72	39	4	0.16	9.6	6	5	097 55229	2.0	097 35229	5.0	097 75229	2.5
	47	6.3 × 7	73	59	8	0.16	4.5	4	3.5	097 55479	2.5	097 35479	5.0	097 75479	2.5
	100	7 × 7	74	97	16	0.16	2.1	3	2.5	097 55101	2.5	097 35101	5.0	097 75101	2.5
25	33	6.3 × 7	73	53	9	0.14	5.6	3.3	2.6	097 56339	2.5	097 36339	5.0	097 76339	2.5
	47	7 × 7	74	71	12	0.14	4.0	2.5	1.9	097 56479	2.5	097 36479	5.0	097 76479	2.5

Aluminium electrolytic capacitors

Radial Low Profile, 7 mm

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CATALOGUE NUMBER 2222															
U _R (V)	C _R 120 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	TAPED AMMOPACK					
										BULK LONG LEADS		F		FORM TNA	
										FORM CA	F (mm)	FORM TFA	F (mm)		
35	4.7	4 × 7	71	20	3	0.12	34	12	10	097 50478	1.5	097 30478	5.0	097 70478	2.5
	10	5 × 7	72	30	4	0.12	16	6.5	5.6	097 50109	2.0	097 30109	5.0	097 70109	2.5
	22	6.3 × 7	73	47	8	0.12	7.2	3.3	3	097 50229	2.5	097 30229	5.0	097 70229	2.5
	33	7 × 7	74	64	12	0.12	4.8	2.9	2.6	097 50339	2.5	097 30339	5.0	097 70339	2.5
50	3.3	4 × 7	71	18	3	0.10	40	16	14	097 51338	1.5	097 31338	5.0	097 71338	2.5
	4.7	5 × 7	72	23	3	0.10	28	12	10	097 51478	2.0	097 31478	5.0	097 71478	2.5
	10	6.3 × 7	73	34	5	0.10	13	6.2	5.5	097 51109	2.5	097 31109	5.0	097 71109	2.5
	22	7 × 7	74	57	11	0.10	6.0	3.2	2.9	097 51229	2.5	097 31229	5.0	097 71229	2.5
63	0.10	4 × 7	71	1.3	3	0.08	1100	238	170	097 58107	1.5	097 38107	5.0	097 78107	2.5
	0.22	4 × 7	71	2.9	3	0.08	480	138	110	097 58227	1.5	097 38227	5.0	097 78227	2.5
	0.47	4 × 7	71	7.9	3	0.08	230	88	66	097 58477	1.5	097 38477	5.0	097 78477	2.5
	1	4 × 7	71	11	3	0.08	110	42	36	097 58108	1.5	097 38108	5.0	097 78108	2.5
	2.2	4 × 7	71	17	3	0.08	48	22	19	097 58228	1.5	097 38228	5.0	097 78228	2.5
	3.3	5 × 7	72	21	3	0.08	32	16	14	097 58338	2.0	097 38338	5.0	097 78338	2.5
	4.7	6.3 × 7	73	26	3	0.08	23	12	10	097 58478	2.5	097 38478	5.0	097 78478	2.5
	10	7 × 7	74	43	7	0.08	11	6.2	5.5	097 58109	2.5	097 38109	5.0	097 78109	2.5

Additional electrical data

DESCRIPTION	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 2 minutes at U _R	$I_{L2} \leq 0.01 C_R \times U_R \text{ or } 3 \mu\text{A (whichever is greater)}$

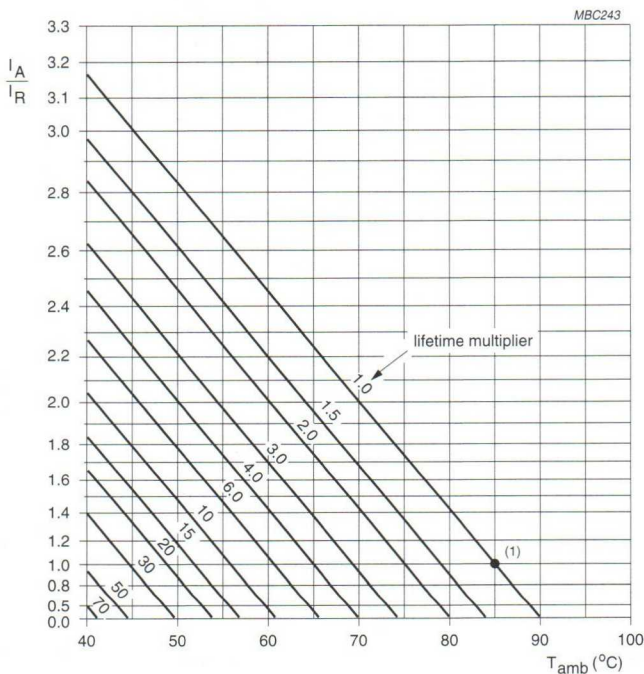
Aluminium electrolytic capacitors
Radial Low Profile, 7 mm

097 RLP 7

RIPPLE CURRENT AND USEFUL LIFE

Table 3 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.
(1) Useful life at 85 °C and I_R applied: 1500 hours.

Fig.5 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Radial Low Profile, 7 mm

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30 300, subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$, U_R applied; 1000 hours	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$, U_R and I_R applied; 1500 hours	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300, subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L2} \leq \text{spec. limit}$

Aluminium electrolytic capacitors

Radial Standard Miniature

037 RSM

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, insulated with a blue vinyl sleeve
- Pressure relief for case
 $\varnothing D \geq 6.3\text{ mm}$
- Charge and discharge proof
- Miniaturized, high CV-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).

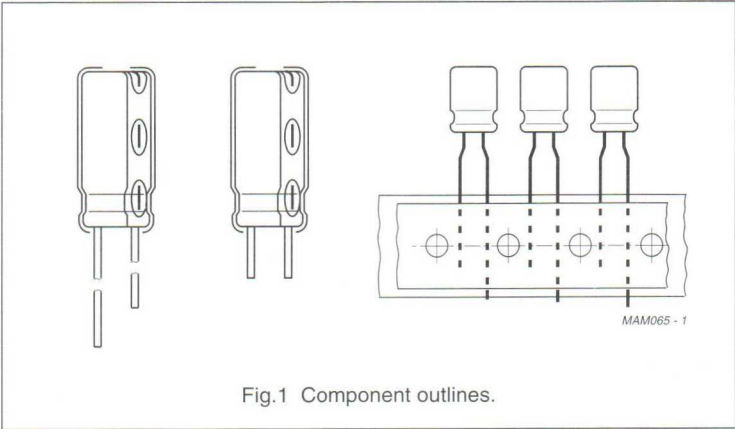
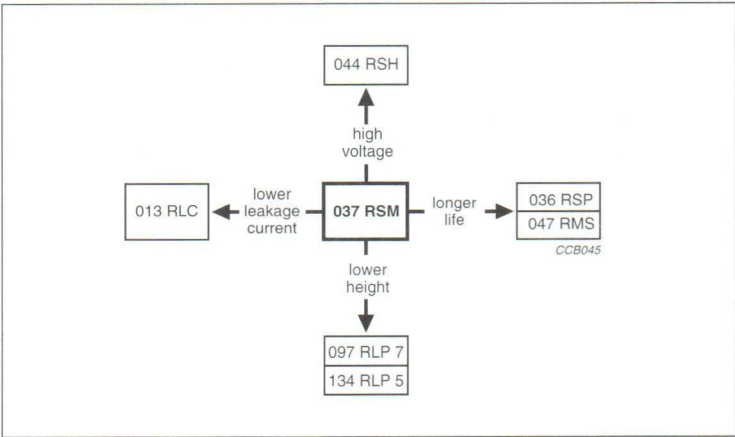


Fig.1 Component outlines.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	5 × 11 to 16 × 31
Rated capacitance range, C_R	0.47 to 10000 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, $1.4 \times I_R$ applied	70000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/085/56

Aluminium electrolytic capacitors

Radial Standard Miniature

037 RSM

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ 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 × 11	5 × 11
1.0	—	—	—	—	—	—	—	5 × 11	5 × 11
2.2	—	—	—	—	—	—	—	5 × 11	5 × 11
3.3	—	—	—	—	—	—	—	5 × 11	5 × 11
4.7	—	—	—	—	—	—	—	5 × 11	5 × 11
10	—	—	—	—	—	—	5 × 11	5 × 11	6.3 × 11
22	—	—	—	—	—	—	5 × 11	6.3 × 11	8 × 12
33	—	—	—	—	5 × 11	6.3 × 11	—	6.3 × 11	10 × 12
47	—	—	—	5 × 11	—	6.3 × 11	6.3 × 11	8 × 12	10 × 16
68	—	—	5 × 11	6.3 × 11	—	—	8 × 12	10 × 12	—
100	—	5 × 11	6.3 × 11	6.3 × 11	—	—	8 × 12	10 × 12	10 × 20
150	—	6.3 × 11	—	8 × 12	—	10 × 12	—	10 × 16	—
220	—	6.3 × 11	8 × 12	8 × 12	10 × 12	—	10 × 16	10 × 20	12.5 × 25
330	6.3 × 11	—	8 × 12	10 × 12	10 × 16	—	10 × 20	12.5 × 20	16 × 25
470	—	8 × 12	10 × 12	10 × 16	10 × 20	12.5 × 20	12.5 × 20	12.5 × 25	16 × 31
680	—	—	10 × 16	—	12.5 × 20	12.5 × 25	12.5 × 25	16 × 25	—
1000	10 × 12	10 × 16	10 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 25	16 × 31	—
1500	10 × 20	—	12.5 × 20	12.5 × 25	16 × 25	—	—	—	—
2200	12.5 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 31	—	—	—	—
3300	12.5 × 20	12.5 × 25	16 × 25	16 × 31	—	—	—	—	—
4700	—	16 × 25	16 × 31	—	—	—	—	—	—
6800	—	16 × 31	—	—	—	—	—	—	—
10000	16 × 31	—	—	—	—	—	—	—	—

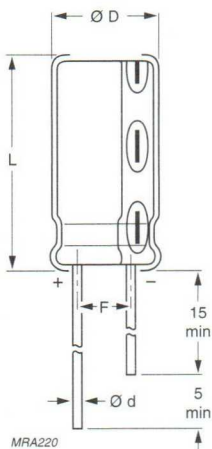
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Aluminium electrolytic capacitors

Radial Standard Miniature

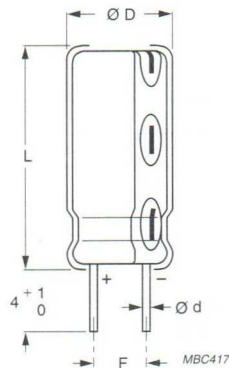
037 RSM

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.
For dimensions see Table 1.

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



Dimensions in mm.
For dimensions see Table 1.

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

Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

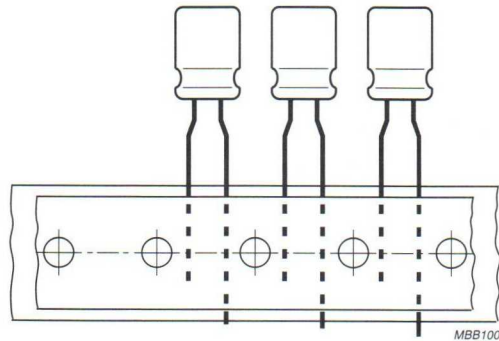
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA, TNA
5 × 11	11	0.5	5.5	12.5	2.0 ± 0.5	≈ 0.4	3000	—	2000
6.3 × 11	12	0.5	6.8	12.5	2.5 ± 0.5	≈ 0.6	2000	—	2000
8 × 12	13	0.6	8.5	13.0	3.5 ± 0.5	≈ 1.1	1000	—	1000
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	1000	500
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	1000	1000	500
10 × 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	1000	500	500
12.5 × 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	1000	2000	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	500	2000	500
16 × 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	500	1000	250
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	200	1000	250

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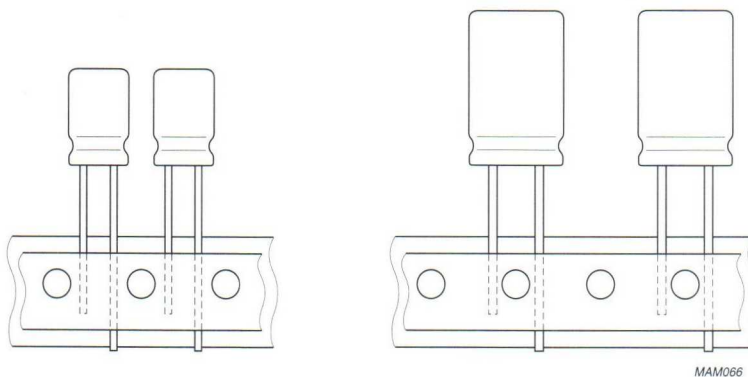
Taped products


Form TFA:

Case $\varnothing D = 5$ to 8 mm; pitch $F = 5$ mm.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.4 Taped in box (ammopack), formed.


Form TNA:

Case $\varnothing D = 5$ mm; pitch $F = 2.5$ mm (leads slightly bent).

Case $\varnothing D = 6.3$ mm; pitch $F = 2.5$ mm.

Case $\varnothing D = 8$ mm; pitch $F = 3.5$ mm.

Form TFA:

Case $\varnothing D = 10$ and 12.5 mm; pitch $F = 5$ mm.

Case $\varnothing D = 16$ mm; pitch $F = 7.5$ mm.

Fig.5 Taped in box (ammopack), straight leads.

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 2, 4, 6 and 8 apply at $T_{\text{amb}} = 20\text{ }^{\circ}\text{C}$, $P = 86$ to 106 kPa , $\text{RH} = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, $85\text{ }^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{\text{max}}$ and C_R)
Z	max. impedance at 10 kHz

Table 2 Electrical data; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz $85\text{ }^{\circ}\text{C}$ (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
6.3	330	6.3×11	12	280	24	7.2	0.24	1.2	1.8
	1000	10×12	14	530	66	16	0.24	0.38	0.6
	1500	10×20	16	730	98	22	0.25	0.27	0.4
	2200	12.5×20	17	990	140	31	0.26	0.19	0.27
	3300	12.5×20	17	1150	210	45	0.28	0.14	0.18
	10000	16×31	20	2250	630	130	0.42	0.07	0.07
10	100	5×11	11	140	13	5	0.20	3.2	4.5
	150	6.3×11	12	180	18	6	0.20	2.1	3.0
	220	6.3×11	12	250	25	7.4	0.20	1.4	2.0
	470	8×12	13	410	50	12	0.20	0.68	0.96
	1000	10×16	15	630	100	23	0.20	0.32	0.45
	2200	12.5×20	17	1050	220	47	0.22	0.16	0.20
	3300	12.5×25	18	1350	330	69	0.24	0.12	0.14
	4700	16×25	19	1800	470	97	0.28	0.09	0.10
	6800	16×31	20	2200	680	140	0.32	0.07	0.07

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ORDERING INFORMATION

Ordering example

Electrolytic capacitor 037 series

1000 µF/16 V; ±20%

Nominal case size: Ø10 × 20 mm; Form TFA

Catalogue number: 2222 037 35102.

Table 3 Ordering information; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	330	12	037 90021	2.5	—	—	037 90027	5.0	037 90028	2.5
	1000	14	037 53102	5.0	037 63102	5.0	037 33102	5.0	—	—
	1500	16	037 53152	5.0	037 63152	5.0	037 33152	5.0	—	—
	2200	17	037 53222	5.0	037 63222	5.0	037 33222	5.0	—	—
	3300	17	037 53332	5.0	037 63332	5.0	037 33332	5.0	—	—
	10000	20	037 53103	7.5	037 63103	7.5	037 33103	7.5	—	—
10	100	11	037 54101	2.0	—	—	037 34101	5.0	037 74101	2.5
	150	12	037 54151	2.5	—	—	037 34151	5.0	037 74151	2.5
	220	12	037 90029	2.5	—	—	037 90036	5.0	037 90037	2.5
	470	13	037 54471	3.5	—	—	037 34471	5.0	037 74471	3.5
	1000	15	037 54102	5.0	037 64102	5.0	037 34102	5.0	—	—
	2200	17	037 54222	5.0	037 64222	5.0	037 34222	5.0	—	—
	3300	18	037 54332	5.0	037 64332	5.0	037 34332	5.0	—	—
	4700	19	037 54472	7.5	037 64472	7.5	037 34472	7.5	—	—
	6800	20	037 54682	7.5	037 64682	7.5	037 34682	7.5	—	—

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ELECTRICAL DATA (continued)**Table 4** Electrical data continued; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
16	68	5 × 11	11	130	14	5.2	0.16	3.7	4.7
	100	6.3 × 11	12	180	19	6.2	0.16	2.5	3.2
	220	8 × 12	13	300	38	10	0.16	1.2	1.5
	330	8 × 12	13	370	56	14	0.16	0.77	0.97
	470	10 × 12	14	420	78	18	0.16	0.54	0.68
	680	10 × 16	15	520	110	25	0.16	0.37	0.47
	1000	10 × 20	16	740	160	35	0.16	0.25	0.32
	1500	12.5 × 20	17	900	240	51	0.17	0.18	0.21
	2200	12.5 × 25	18	1200	360	73	0.18	0.13	0.15
	3300	16 × 25	19	1650	530	109	0.20	0.10	0.10
	4700	16 × 31	20	2100	760	150	0.24	0.08	0.07
25	47	5 × 11	11	120	15	5.4	0.14	4.7	4.7
	68	6.3 × 11	12	130	20	6.4	0.14	3.3	3.2
	100	6.3 × 11	12	190	28	8	0.14	2.2	2.2
	150	8 × 12	13	230	41	11	0.14	1.5	1.5
	220	8 × 12	13	320	58	14	0.14	1.0	1.0
	330	10 × 12	14	410	86	20	0.14	0.68	0.67
	470	10 × 16	15	510	120	26	0.14	0.47	0.47
	1000	12.5 × 20	17	910	250	53	0.14	0.22	0.22
	1500	12.5 × 25	18	1100	380	78	0.15	0.16	0.15
	2200	16 × 25	19	1500	550	110	0.16	0.12	0.10
	3300	16 × 31	20	1900	830	170	0.18	0.09	0.07
35	33	5 × 11	11	110	15	5.3	0.12	5.8	4.5
	220	10 × 12	14	330	80	18	0.12	0.87	0.68
	330	10 × 16	15	450	120	26	0.12	0.58	0.45
	470	10 × 20	16	590	170	36	0.12	0.41	0.32
	680	12.5 × 20	17	830	240	51	0.12	0.28	0.22
	1000	12.5 × 25	18	1050	350	73	0.12	0.19	0.15
	1500	16 × 25	19	1400	530	110	0.13	0.14	0.10
	2200	16 × 31	20	1750	770	160	0.14	0.10	0.07

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ORDERING INFORMATION (continued)**Table 5** Ordering information continued; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
16	68	11	037 55689	2.0	—	—	037 35689	5.0	037 75689	2.5
	100	12	037 55101	2.5	—	—	037 35101	5.0	037 75101	2.5
	220	13	037 55221	3.5	—	—	037 35221	5.0	037 75221	3.5
	330	13	037 90038	3.5	—	—	037 90045	5.0	037 90046	3.5
	470	14	037 55471	5.0	037 65471	5.0	037 35471	5.0	—	—
	680	15	037 55681	5.0	037 65681	5.0	037 35681	5.0	—	—
	1000	16	037 55102	5.0	037 65102	5.0	037 35102	5.0	—	—
	1500	17	037 55152	5.0	037 65152	5.0	037 35152	5.0	—	—
	2200	18	037 55222	5.0	037 65222	5.0	037 35222	5.0	—	—
	3300	19	037 55332	7.5	037 65332	7.5	037 35332	7.5	—	—
	4700	20	037 55472	7.5	037 65472	7.5	037 35472	7.5	—	—
25	47	11	037 56479	2.0	—	—	037 36479	5.0	037 76479	2.5
	68	12	037 56689	2.5	—	—	037 36689	5.0	037 76689	2.5
	100	12	037 90047	2.5	—	—	037 90054	5.0	037 90055	2.5
	150	13	037 56151	3.5	—	—	037 36151	5.0	037 76151	3.5
	220	13	037 56221	3.5	—	—	037 36221	5.0	037 76221	3.5
	330	14	037 56331	5.0	037 66331	5.0	037 36331	5.0	—	—
	470	15	037 56471	5.0	037 66471	5.0	037 36471	5.0	—	—
	1000	17	037 56102	5.0	037 66102	5.0	037 36102	5.0	—	—
	1500	18	037 56152	5.0	037 66152	5.0	037 36152	5.0	—	—
	2200	19	037 56222	7.5	037 66222	7.5	037 36222	7.5	—	—
	3300	20	037 56332	7.5	037 66332	7.5	037 36332	7.5	—	—
35	33	11	037 50339	2.0	—	—	037 30339	5.0	037 70339	2.5
	220	14	037 50221	5.0	037 60221	5.0	037 30221	5.0	—	—
	330	15	037 50331	5.0	037 60331	5.0	037 30331	5.0	—	—
	470	16	037 50471	5.0	037 60471	5.0	037 30471	5.0	—	—
	680	17	037 50681	5.0	037 60681	5.0	037 30681	5.0	—	—
	1000	18	037 50102	5.0	037 60102	5.0	037 30102	5.0	—	—
	1500	19	037 50152	7.5	037 60152	7.5	037 30152	7.5	—	—
	2200	20	037 50222	7.5	037 60222	7.5	037 30222	7.5	—	—

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ELECTRICAL DATA (continued)**Table 6** Electrical data continued; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
40	33	6.3 × 11	12	110	16	5.6	0.12	5.8	3.9
	47	6.3 × 11	12	130	22	6.8	0.12	4.1	2.8
	150	10 × 12	14	250	63	15	0.12	1.3	0.87
	470	12.5 × 20	17	670	190	41	0.12	0.41	0.28
	680	12.5 × 25	18	850	280	57	0.12	0.28	0.19
	1000	16 × 25	19	1200	400	83	0.12	0.19	0.13
50	10	5 × 11	11	65	8	4	0.10	16	9.5
	22	5 × 11	11	95	14	5.2	0.10	7.2	4.3
	47	6.3 × 11	12	150	27	7.7	0.10	3.4	2.0
	68	8 × 12	13	190	37	10	0.10	2.3	1.4
	100	8 × 12	13	260	53	13	0.10	1.6	0.95
	220	10 × 16	15	400	110	25	0.10	0.72	0.43
	330	10 × 20	16	580	170	36	0.10	0.48	0.29
	470	12.5 × 20	17	740	240	50	0.10	0.34	0.20
	680	12.5 × 25	18	950	340	71	0.10	0.23	0.14
	1000	16 × 25	19	1350	500	100	0.10	0.16	0.10

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ORDERING INFORMATION (continued)

Table 7 Ordering information continued; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
40	33	12	037 57339	2.5	—	—	037 37339	5.0	037 77339	2.5
	47	12	037 57479	2.5	—	—	037 37479	5.0	037 77479	2.5
	150	14	037 57151	5.0	037 67151	5.0	037 37151	5.0	—	—
	470	17	037 57471	5.0	037 67471	5.0	037 37471	5.0	—	—
	680	18	037 57681	5.0	037 67681	5.0	037 37681	5.0	—	—
	1000	19	037 57102	7.5	037 67102	7.5	037 37102	7.5	—	—
50	10	11	037 51109	2.0	—	—	037 31109	5.0	037 71109	2.5
	22	11	037 90056	2.0	—	—	037 90063	5.0	037 90064	2.5
	47	12	037 90065	2.5	—	—	037 90072	5.0	037 90073	2.5
	68	13	037 51689	3.5	—	—	037 31689	5.0	037 71689	3.5
	100	13	037 51101	3.5	—	—	037 31101	5.0	037 71101	3.5
	220	15	037 51221	5.0	037 61221	5.0	037 31221	5.0	—	—
	330	16	037 51331	5.0	037 61331	5.0	037 31331	5.0	—	—
	470	17	037 51471	5.0	037 61471	5.0	037 31471	5.0	—	—
	680	18	037 51681	5.0	037 61681	5.0	037 31681	5.0	—	—
	1000	19	037 51102	7.5	037 61102	7.5	037 31102	7.5	—	—

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ELECTRICAL DATA (continued)

Table 8 Electrical data continued; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)
63	0.47	5 × 11	11	11	3.3	3.1	0.09	300	170
	1.0	5 × 11	11	16	3.6	3.1	0.09	140	80
	2.2	5 × 11	11	29	4.4	3.3	0.09	65	36
	3.3	5 × 11	11	35	5.1	3.4	0.09	43	24
	4.7	5 × 11	11	45	6.0	3.6	0.09	30	17
	10	5 × 11	11	70	9.3	4.3	0.09	14	8.0
	22	6.3 × 11	12	110	17	5.8	0.09	6.5	3.6
	33	6.3 × 11	12	140	24	7.2	0.09	4.3	2.4
	47	8 × 12	13	190	33	8.9	0.09	3.0	1.7
	68	10 × 12	14	200	46	12	0.09	2.1	1.2
	100	10 × 12	14	260	66	16	0.09	1.4	0.80
	150	10 × 16	15	320	98	22	0.09	0.95	0.53
	220	10 × 20	16	460	140	31	0.09	0.65	0.36
	330	12.5 × 20	17	650	210	45	0.09	0.43	0.24
	470	12.5 × 25	18	850	300	62	0.09	0.30	0.17
	680	16 × 25	19	1150	430	89	0.09	0.21	0.12
	1000	16 × 31	20	1550	630	130	0.09	0.14	0.08
100	0.47	5 × 11	11	12	3.5	3.1	0.07	237	130
	1.0	5 × 11	11	22	4	3.2	0.07	111	60
	2.2	5 × 11	11	33	5.2	3.4	0.07	51	27
	3.3	5 × 11	11	40	6.3	3.7	0.07	34	18
	4.7	5 × 11	11	48	7.7	3.9	0.07	24	13
	10	6.3 × 11	12	80	13	5	0.07	11	6.0
	22	8 × 12	13	130	25	7.4	0.07	5.1	2.7
	33	10 × 12	14	160	36	9.6	0.07	3.4	1.8
	47	10 × 16	15	210	50	12	0.07	2.4	1.3
	100	10 × 20	16	350	100	23	0.07	1.1	0.60
	220	12.5 × 25	18	580	220	47	0.07	0.51	0.27
	330	16 × 25	19	710	330	69	0.07	0.34	0.18
	470	16 × 31	20	900	470	97	0.07	0.24	0.13

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ORDERING INFORMATION (continued)**Table 9** Ordering information continued; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
63	0.47	11	037 58477	2.0	—	—	037 38477	5.0	037 78477	2.5
	1.0	11	037 58108	2.0	—	—	037 38108	5.0	037 78108	2.5
	2.2	11	037 58228	2.0	—	—	037 38228	5.0	037 78228	2.5
	3.3	11	037 58338	2.0	—	—	037 38338	5.0	037 78338	2.5
	4.7	11	037 58478	2.0	—	—	037 38478	5.0	037 78478	2.5
	10	11	037 58109	2.0	—	—	037 38109	5.0	037 78109	2.5
	22	12	037 58229	2.5	—	—	037 38229	5.0	037 78229	2.5
	33	12	037 90074	2.5	—	—	037 90081	5.0	037 90082	2.5
	47	13	037 58479	3.5	—	—	037 38479	5.0	037 78479	3.5
	68	14	037 58689	5.0	037 68689	5.0	037 38689	5.0	—	—
	100	14	037 58101	5.0	037 68101	5.0	037 38101	5.0	—	—
	150	15	037 58151	5.0	037 68151	5.0	037 38151	5.0	—	—
	220	16	037 58221	5.0	037 68221	5.0	037 38221	5.0	—	—
	330	17	037 58331	5.0	037 68331	5.0	037 38331	5.0	—	—
	470	18	037 58471	5.0	037 68471	5.0	037 38471	5.0	—	—
	680	19	037 58681	7.5	037 68681	7.5	037 38681	7.5	—	—
	1000	20	037 58102	7.5	037 68102	7.5	037 38102	7.5	—	—
100	0.47	11	037 59477	2.0	—	—	037 39477	5.0	037 79477	2.5
	1.0	11	037 59108	2.0	—	—	037 39108	5.0	037 79108	2.5
	2.2	11	037 59228	2.0	—	—	037 39228	5.0	037 79228	2.5
	3.3	11	037 59338	2.0	—	—	037 39338	5.0	037 79338	2.5
	4.7	11	037 59478	2.0	—	—	037 39478	5.0	037 79478	2.5
	10	12	037 59109	2.5	—	—	037 39109	5.0	037 79109	2.5
	22	13	037 59229	3.5	—	—	037 39229	5.0	037 79229	3.5
	33	14	037 59339	5.0	037 69339	5.0	037 39339	5.0	—	—
	47	15	037 59479	5.0	037 69479	5.0	037 39479	5.0	—	—
	100	16	037 59101	5.0	037 69101	5.0	037 39101	5.0	—	—
	220	18	037 59221	5.0	037 69221	5.0	037 39221	5.0	—	—
	330	19	037 59331	7.5	037 69331	7.5	037 39331	7.5	—	—
	470	20	037 59471	7.5	037 69471	7.5	037 39471	7.5	—	—

R

Aluminium electrolytic capacitors

Radial Standard Miniature

037 RSM

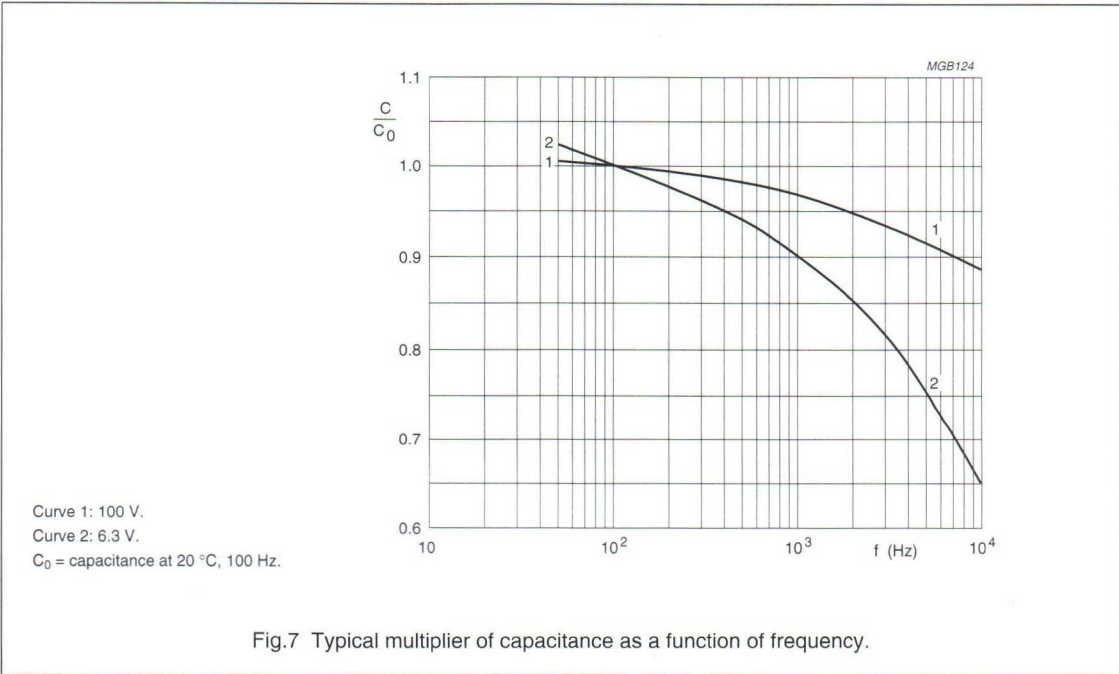
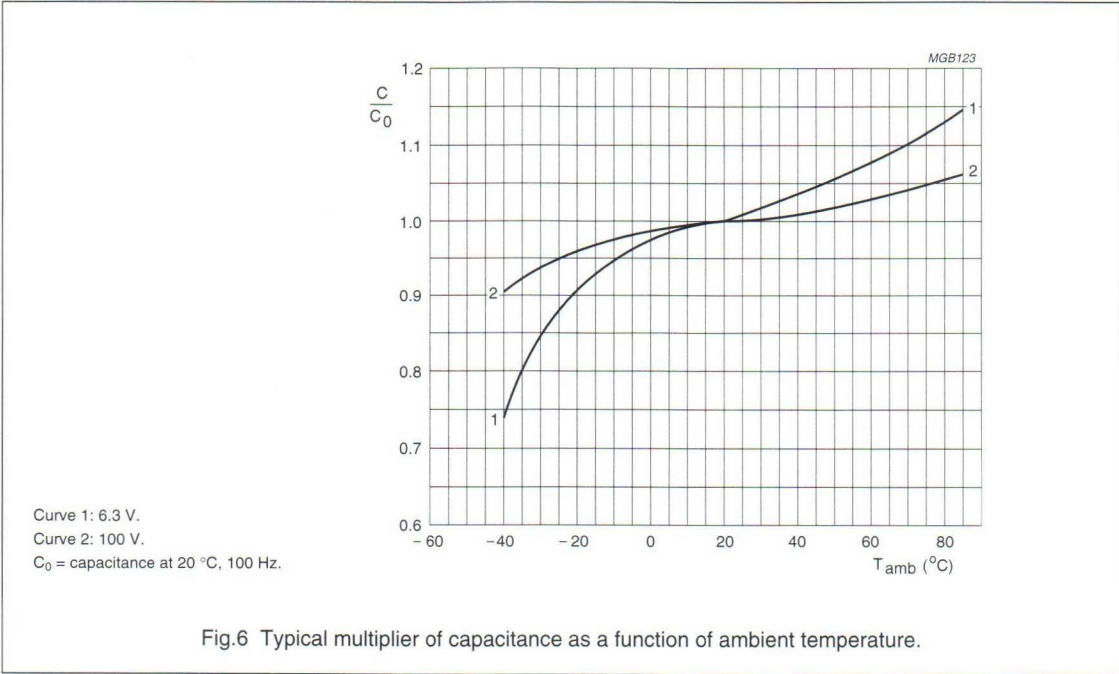
ELECTRICAL DATA (continued)**Additional electrical data**

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 3 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D \leq 8 \text{ mm}$	typ. 13 nH
	case $\varnothing D = 10 \text{ mm}$	typ. 16 nH
	case $\varnothing D \geq 12.5 \text{ mm}$	typ. 18 nH

Aluminium electrolytic capacitors
Radial Standard Miniature

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Capacitance (C)



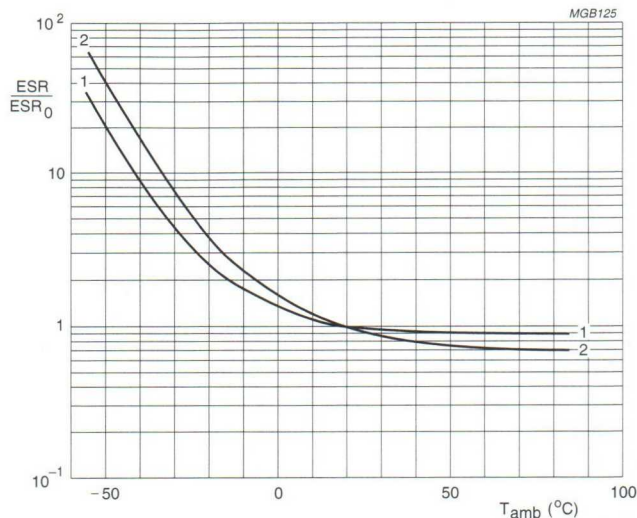
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Aluminium electrolytic capacitors

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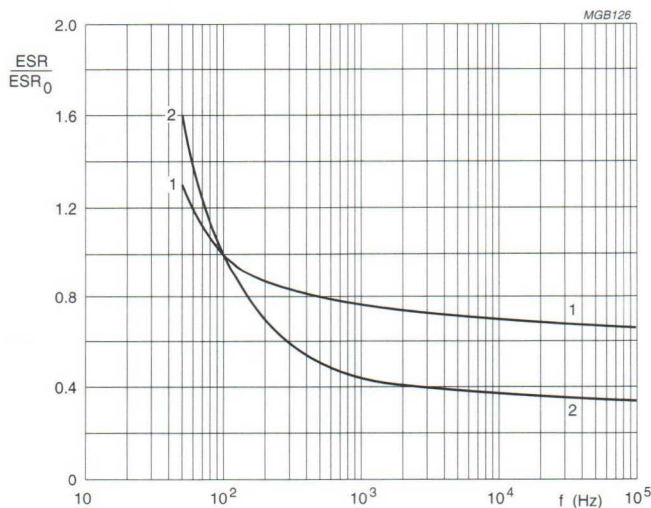
037 RSM

Equivalent series resistance (ESR)



Curve 1: 63 V (≥4.7 μF).
 Curve 2: 10 V.
 ESR₀ = typical at 20 °C, 100 Hz.

Fig.8 Typical multiplier of ESR as a function of ambient temperature.



Curve 1: 6.3 V.
 Curve 2: 63 V (≥4.7 μF).
 ESR₀ = typical at 20 °C, 100 Hz.

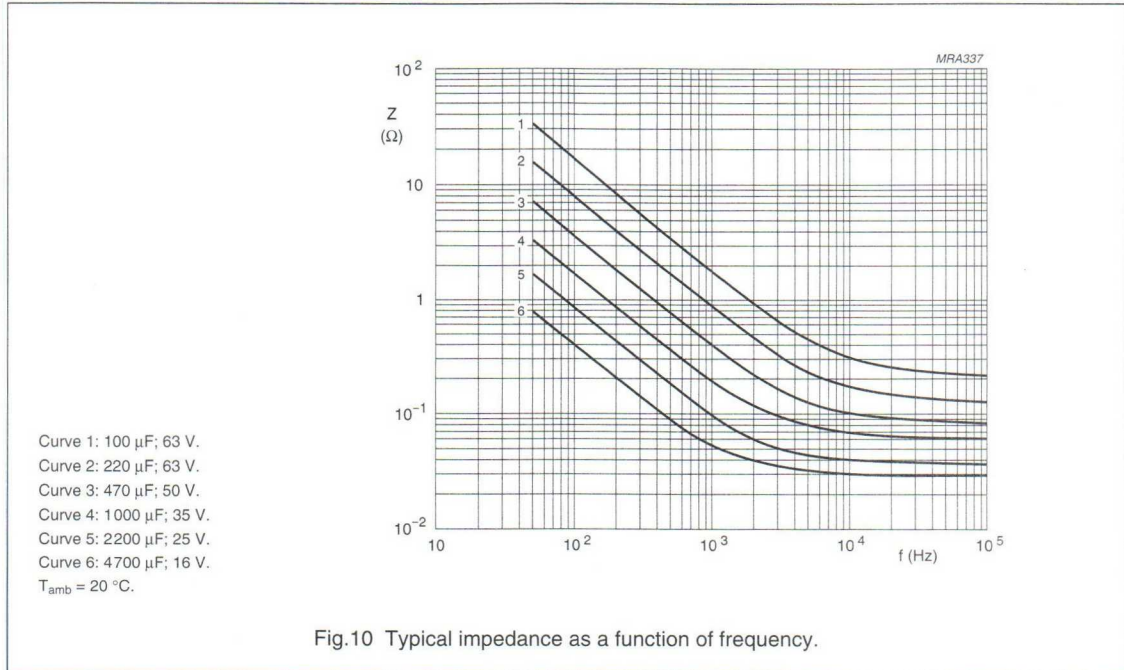
Fig.9 Typical multiplier of ESR as a function of frequency.

Aluminium electrolytic capacitors

Radial Standard Miniature

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Impedance (Z)



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.

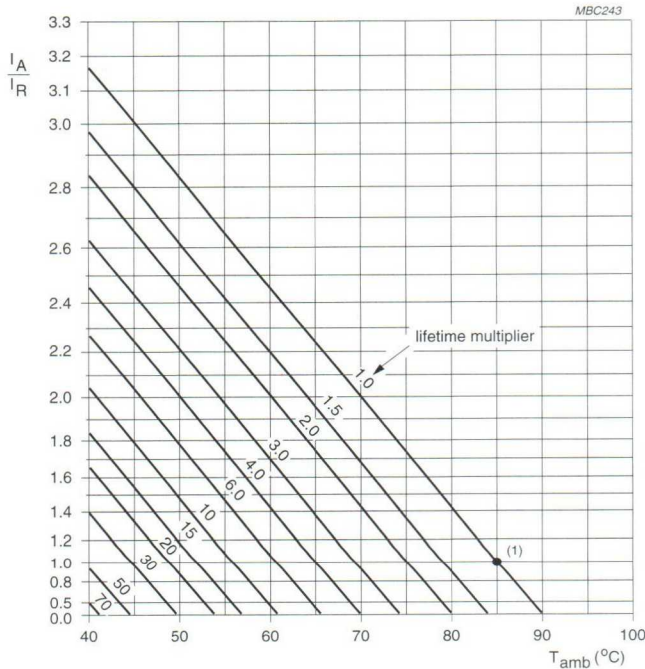
Aluminium electrolytic capacitors
Radial Standard Miniature

037 RSM

RIPPLE CURRENT AND USEFUL LIFE

Table 10 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 100 Hz

FREQUENCY (Hz)	I _R MULTIPLIER		
	U _R = 6.3 to 10 V	U _R = 16 to 35 V	U _R = 40 to 100 V
50	0.9	0.85	0.8
100	1.0	1.0	1.0
300	1.12	1.2	1.25
1000	1.2	1.3	1.4
3000	1.25	1.35	1.5
≥10000	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.11 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Radial Standard Miniature

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 11 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +15/–30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 20\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 2500 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +45/–50% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$

R

Aluminium electrolytic capacitors Radial Standard, High Voltage

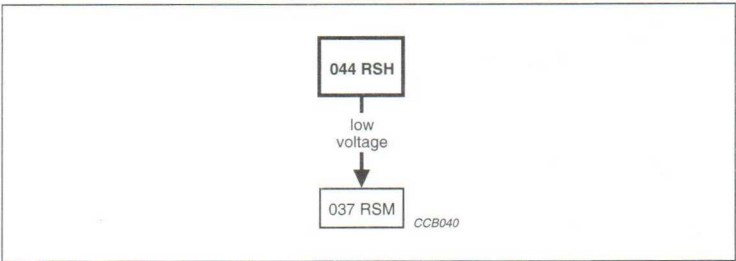
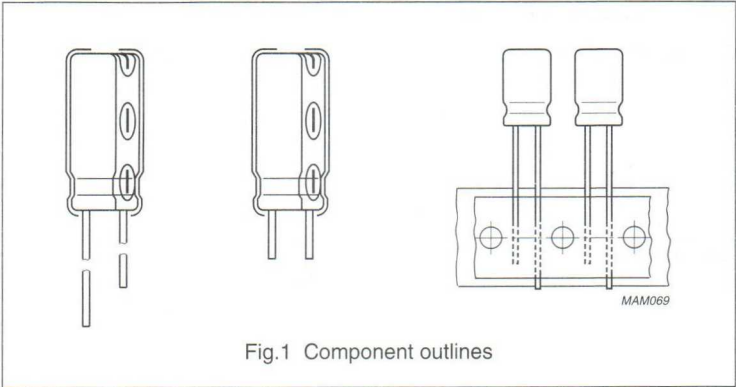
044 RSH

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.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	6.3 × 11 to 16 × 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, $1.4 \times I_R$ applied	80000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	≤400 V: 40/085/56; 450 V: 25/085/56

Aluminium electrolytic capacitors

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)
Preferred types in **bold**.

C_R (μF)	U_R (V)					
	160	200	250	350	400	450
1.0	—	—	6.3×11	—	8×12	10×12
2.2	—	—	8×12	10×12	10×12	10×16
4.7	—	10×12	10×12	10×16	10×20	12.5×20
10	10×16	10×16	10×20	12.5×20	12.5×20	12.5×25
22	10×20	10×20	12.5×25	12.5×25	16×25	16×31
47	—	12.5×25	16×25	16×31	—	—
100	16×25	16×31	—	—	—	—

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.

Aluminium electrolytic capacitors
Radial Standard, High Voltage

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

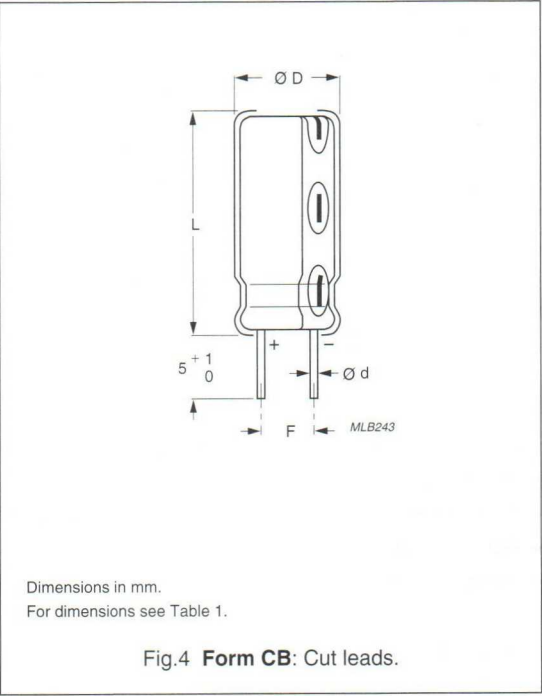
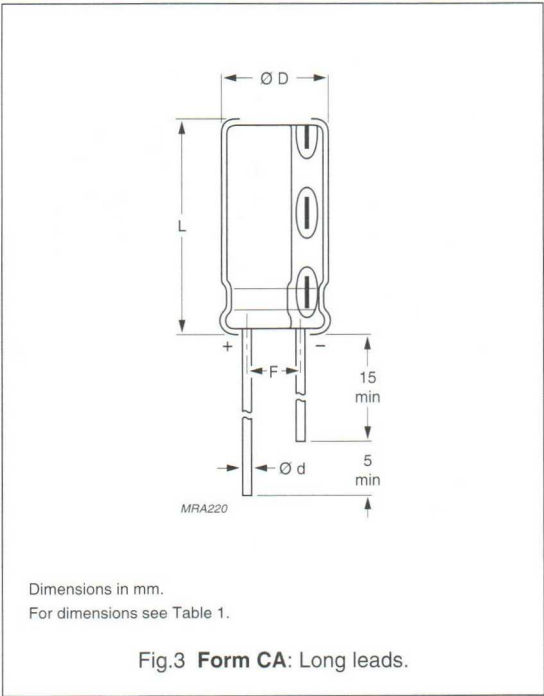


Table 1 Physical dimensions, mass and packaging quantities; see Figs 3 and 4

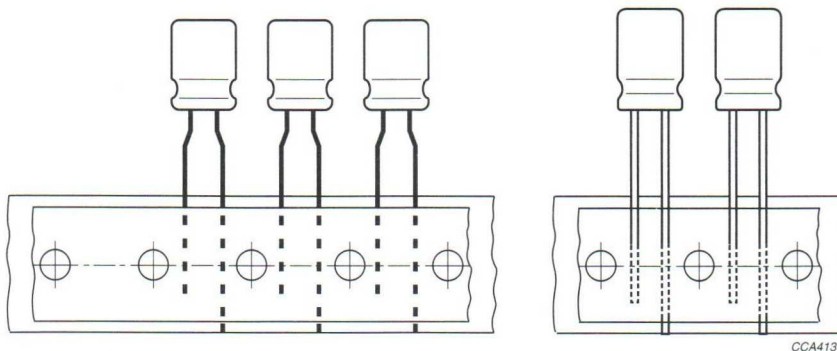
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA, TNA
6.3 × 11	12	0.5	6.8	12.5	2.5 ± 0.5	≈ 0.6	2000	2000	2000
8 × 12	13	0.6	8.5	13.0	3.5 ± 0.5	≈ 1.1	1000	2000	1000
10 × 12	14	0.6	10.5	14.0	5.0 ± 0.5	≈ 1.6	2000	1500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	2000	1500	800
10 × 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	2000	1500	800
12.5 × 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	1000	1500	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	1000	1500	500
16 × 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	500	500	—
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	500	500	—

Aluminium electrolytic capacitors

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Taped products



CCA413

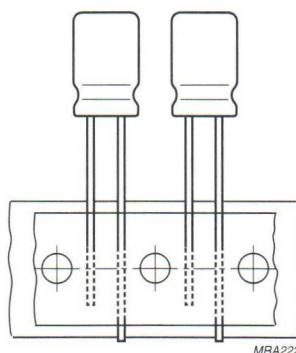
Form TFA: formed, pitch $F = 5$ mm.

Form TNA: pitch $F = 2.5$ or 3.5 mm.

Case $\varnothing D = 6.3$ and 8 mm.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.5 Taped in box (ammopack).



MRA222

Form TFA: pitch $F = 5$ mm.

Case $\varnothing D = 10$ and 12.5 mm.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.6 Taped in box (ammopack).

R

Aluminium electrolytic capacitors

Radial Standard, High Voltage

044 RSH

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 2 and 4 apply at $T_{amb} = 20\text{ °C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
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
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and C_R)
Z	max. impedance at 10 kHz and $+20$ or -25 °C

Table 2 Electrical data; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz $+20\text{ °C}$ (Ω)	Z 10 kHz -25 °C (Ω)
160	10	10×16	15	83	120	54	0.14	22	12	180
	22	10×20	16	140	180	83	0.14	10	5.5	82
	100	16×25	19	380	550	270	0.14	2.2	1.8	26
200	4.7	10×12	14	51	96	43	0.14	47	26	380
	10	10×16	15	85	130	60	0.14	22	12	180
	22	10×20	16	140	200	96	0.14	10	5.5	82
	47	12.5×25	18	230	350	170	0.14	4.7	2.6	38
	100	16×31	20	400	670	330	0.14	2.2	1.5	22
250	1.0	6.3×11	12	17	55	23	0.14	220	110	1800
	2.2	8×12	13	30	73	32	0.14	100	55	820
	4.7	10×12	14	51	110	48	0.14	47	26	380
	10	10×20	16	95	150	68	0.14	22	12	180
	22	12.5×25	18	160	240	110	0.14	10	5.5	82
	47	16×25	19	260	420	210	0.14	4.7	2.6	38
350	2.2	10×12	14	39	86	38	0.13	94	39	550
	4.7	10×16	15	63	120	55	0.13	44	18	260
	10	12.5×20	17	120	180	83	0.13	21	8.5	120
	22	12.5×25	18	180	300	150	0.13	9.4	3.9	55
	47	16×31	20	320	560	280	0.13	4.4	2.3	31

Aluminium electrolytic capacitors

Radial Standard, High Voltage

044 RSH

ORDERING INFORMATION**Ordering example**

Electrolytic capacitor 044 series

47 μ F/250 V; $\pm 20\%$ Nominal case size: $\varnothing 16 \times 25$ mm; Form CB

Catalogue number: 2222 044 63479.

Table 3 Ordering information; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
160	10	15	044 51109	5.0	044 61109	5.0	044 31109	5.0	—	—
	22	16	044 51229	5.0	044 61229	5.0	044 31229	5.0	—	—
	100	19	044 51101	7.5	044 61101	7.5	—	—	—	—
200	4.7	14	044 52478	5.0	044 62478	5.0	044 32478	5.0	—	—
	10	15	044 52109	5.0	044 62109	5.0	044 32109	5.0	—	—
	22	16	044 52229	5.0	044 62229	5.0	044 32229	5.0	—	—
	47	18	044 90516	5.0	044 90517	5.0	044 90519	5.0	—	—
	100	20	044 52101	7.5	044 62101	7.5	—	—	—	—
250	1.0	12	044 90501	2.5	—	—	044 90506	5.0	044 90507	2.5
	2.2	13	044 90015	3.5	—	—	044 90019	5.0	044 90529	3.5
	4.7	14	044 53478	5.0	044 63478	5.0	044 33478	5.0	—	—
	10	16	044 53109	5.0	044 63109	5.0	044 33109	5.0	—	—
	22	18	044 53229	5.0	044 63229	5.0	044 33229	5.0	—	—
	47	19	044 53479	7.5	044 63479	7.5	—	—	—	—
350	2.2	14	044 55228	5.0	044 65228	5.0	044 35228	5.0	—	—
	4.7	15	044 55478	5.0	044 65478	5.0	044 35478	5.0	—	—
	10	17	044 55109	5.0	044 65109	5.0	044 35109	5.0	—	—
	22	18	044 90525	5.0	044 90526	5.0	044 90528	5.0	—	—
	47	20	044 55479	7.5	044 65479	7.5	—	—	—	—

R

Aluminium electrolytic capacitors

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ELECTRICAL DATA (continued)**Table 4** Electrical data continued; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz +20 °C (Ω)	Z 10 kHz -25 °C (Ω)
400	1.0	8 × 12	13	22	64	27	0.15	240	85	1200
	2.2	10 × 12	14	39	93	41	0.15	110	39	550
	4.7	10 × 20	16	70	130	58	0.15	51	18	260
	10	12.5 × 20	17	110	190	90	0.15	24	8.5	120
	22	16 × 25	19	200	330	160	0.15	11	3.9	55
450	1.0	10 × 14	14	25	67	29	0.26	410	120	2000
	2.2	10 × 16	15	42	99	45	0.26	190	55	910
	4.7	12.5 × 20	17	75	130	62	0.26	88	26	380
	10	12.5 × 25	18	120	210	100	0.26	41	12	260
	22	16 × 31	20	210	370	180	0.26	19	5.5	82

Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods	$U_R = 160$ to 250 V	$U_S \leq 1.15 \times U_R$
	$U_R = 350$ to 450 V	$U_S \leq 1.1 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	after 1 minute at U_R :	
	$CV \leq 1000 \mu C$	$I_{L1} \leq 0.06 C_R \times U_R + 40 \mu A$
	$CV > 1000 \mu C$	$I_{L1} \leq 0.03 C_R \times U_R + 70 \mu A$
	after 5 minutes at U_R :	
	$CV \leq 1000 \mu C$	$I_{L5} \leq 0.03 C_R \times U_R + 15 \mu A$
	$CV > 1000 \mu C$	$I_{L5} \leq 0.015 C_R \times U_R + 30 \mu A$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 6.3$ and 8 mm	typ. 13 nH
	case $\varnothing D = 10$ mm	typ. 16 nH
	case $\varnothing D \geq 12.5$ mm	typ. 18 nH

Aluminium electrolytic capacitors

Radial Standard, High Voltage

044 RSH

ORDERING INFORMATION (continued)

Table 5 Ordering information continued; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
400	1.0	13	044 56108	3.5	—	—	044 36108	5.0	044 76108	3.5
	2.2	14	044 56228	5.0	044 66228	5.0	044 36228	5.0	—	—
	4.7	16	044 56478	5.0	044 66478	5.0	044 36478	5.0	—	—
	10	17	044 56109	5.0	044 66109	5.0	044 36109	5.0	—	—
	22	19	044 56229	7.5	044 66229	7.5	—	—	—	—
450	1.0	14	044 57108	5.0	044 67108	5.0	044 37108	5.0	—	—
	2.2	15	044 57228	5.0	044 67228	5.0	044 37228	5.0	—	—
	4.7	17	044 57478	5.0	044 67478	5.0	044 37478	5.0	—	—
	10	18	044 57109	5.0	044 67109	5.0	044 37109	5.0	—	—
	22	20	044 57229	7.5	044 67229	7.5	—	—	—	—

Aluminium electrolytic capacitors

Radial Standard, High Voltage

044 RSH

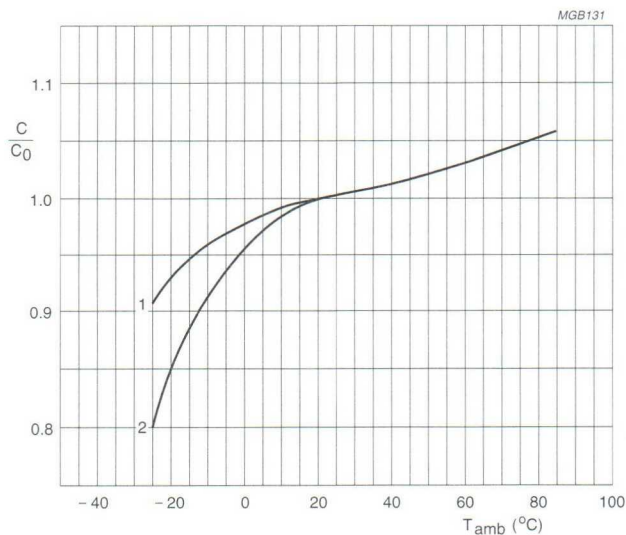
ELECTRICAL DATA (continued)**Capacitance (C)**

Fig.7 Typical multiplier of capacitance as a function of ambient temperature.

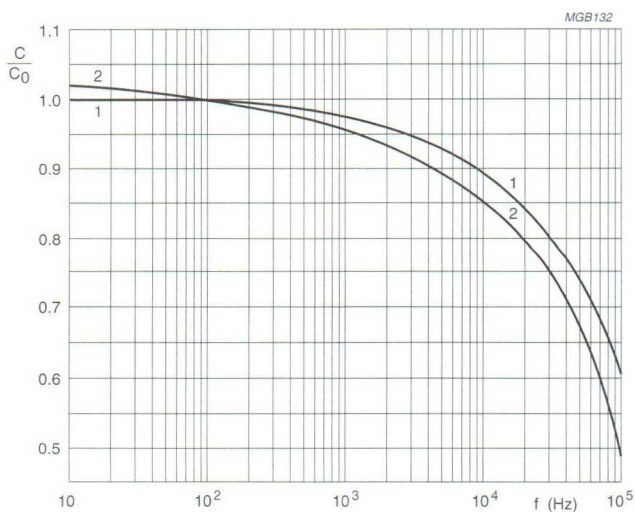


Fig.8 Typical multiplier of capacitance as a function of frequency.

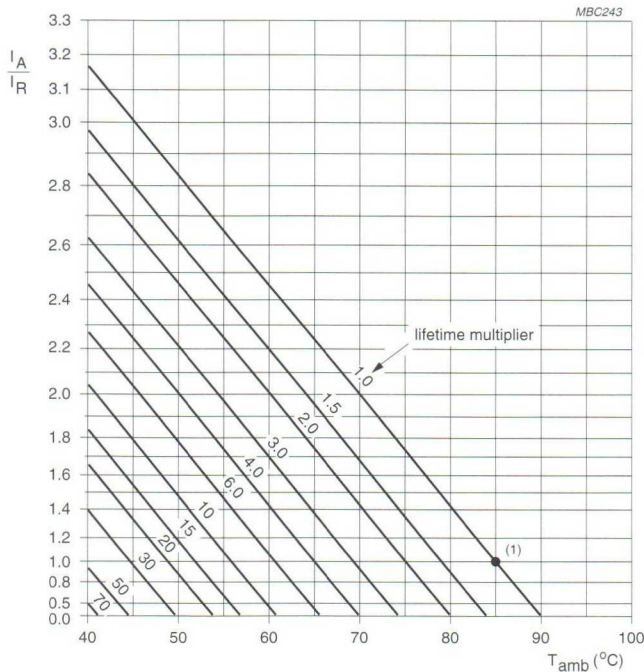
Aluminium electrolytic capacitors
Radial Standard, High Voltage

044 RSH

RIPPLE CURRENT AND USEFUL LIFE

Table 6 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = 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
≥ 10000	1.5



I_A = actual ripple current at 100 Hz.

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

(1) Useful life at 85 °C and I_R applied: 3000 hours.

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Radial Standard, High Voltage

044 RSH

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 7 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ °C}$; U_R applied; 2000 hours	$\Delta C/C: \pm 20\%$ $\leq 400\text{ V}$: $\tan \delta \leq 2 \times \text{spec. limit}$ 450 V : $\tan \delta \leq 1.5 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ °C}$; U_R and I_R applied; 3000 hours	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ °C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$

Aluminium electrolytic capacitors
Radial Standard, High Voltage

044 RSH

NOTES

Aluminium electrolytic capacitors

Radial Low Leakage Current

013 RLC

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 CV-product per unit volume
- Low leakage current, low energy consumption.

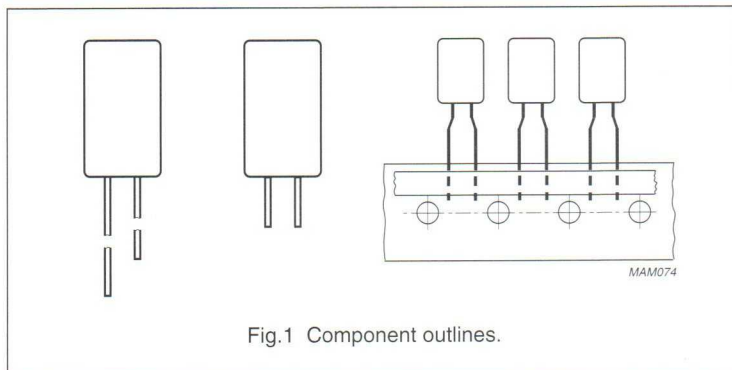
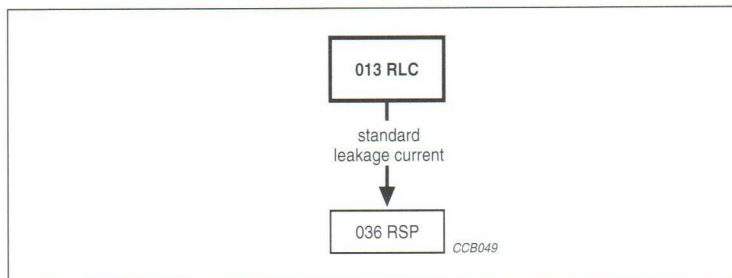


Fig.1 Component outlines.

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.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	5×11 and 8.2×11
Rated capacitance range, C_R	0.47 to 470 μF
Tolerance on C_R	$\pm 20\%$; $\pm 10\%$ available on request
Rated voltage range, U_R	6.3 to 50 V
Category temperature range	-40 to $+85$ $^{\circ}C$
Leakage current after 2 minutes: $U_R = 6.3$ to 25 V $U_R = 35$ and 50 V	$0.002C_R \times U_R$ or $0.7 \mu A$ (whichever is greater) $0.002C_R \times U_R + 1 \mu A$
Endurance test at 85 $^{\circ}C$	2000 hours
Useful life at 105 $^{\circ}C$	750 hours
Useful life at 85 $^{\circ}C$	3000 hours
Useful life at 40 $^{\circ}C$, $1.4 \times I_R$ applied	80000 hours
Shelf life at 0 V, 85 $^{\circ}C$	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/085/56

Aluminium electrolytic capacitors

Radial Low Leakage Current

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)Preferred types in **bold**.

C_R (μF)	U_R (V)					
	6.3	10	16	25	35	50
0.47	—	—	—	—	—	5 × 11
1.0	—	—	—	5 × 11	—	5 × 11
2.2	—	—	—	5 × 11	—	5 × 11
3.3	—	—	—	5 × 11	—	5 × 11
4.7	—	—	—	5 × 11	—	5 × 11
10	—	—	—	5 × 11	—	5 × 11
22	—	—	—	5 × 11	—	5 × 11
33	—	—	5 × 11	—	5 × 11	8.2 × 11
47	—	5 × 11	5 × 11	8.2 × 11	—	8.2 × 11
68	—	5 × 11	—	—	—	8.2 × 11
100	—	5 × 11	8.2 × 11	—	8.2 × 11	—
220	—	8.2 × 11	—	—	—	—
330	8.2 × 11	—	—	—	—	—
470	8.2 × 11	—	—	—	—	—

Aluminium electrolytic capacitors
Radial Low Leakage Current

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

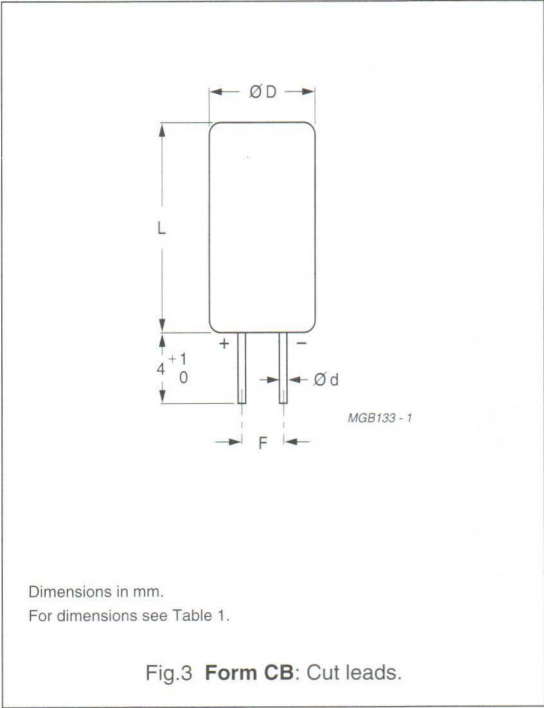
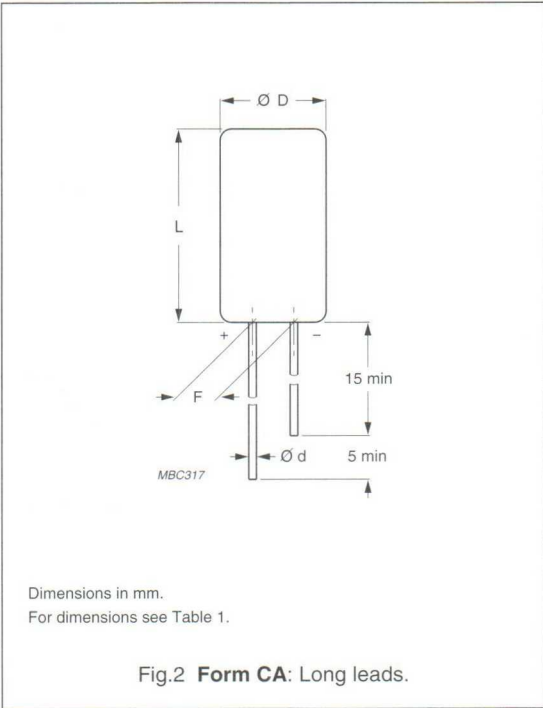


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

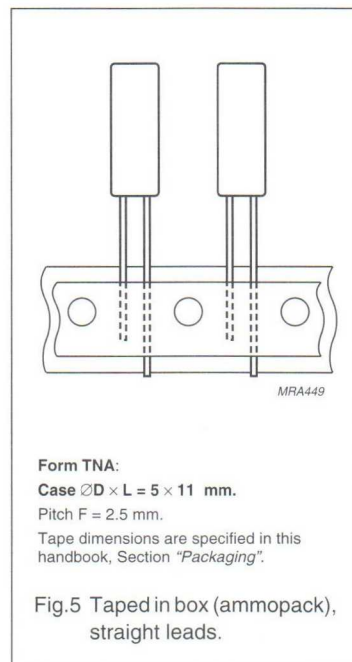
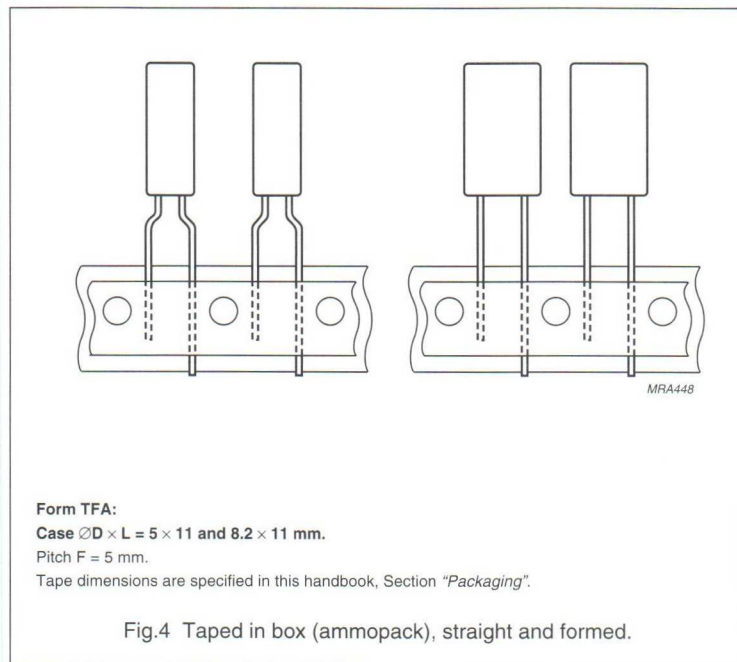
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES	
							FORM CA, CB	FORM TFA, TNA
5 × 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	2000
8.2 × 11	13	0.6	8.7	12	5.0 ± 0.5	≈ 1.1	1000	1000

Aluminium electrolytic capacitors

Radial Low Leakage Current

013 RLC

Taped products



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.

Aluminium electrolytic capacitors

Radial Low Leakage Current

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 2 and 4 apply at $T_{amb} = 20\text{ °C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L2}	max. leakage current after 2 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and C_R)
Z	max. impedance at 10 kHz and $+20$, -25 or -40 °C

Table 2 Electrical data; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L2} 2 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz $+20\text{ °C}$ (Ω)	Z 10 kHz -25 °C (Ω)	Z 10 kHz -40 °C (Ω)
6.3	330	8.2×11	13	210	4.2	0.2	1.0	0.9	5.2	15
	470	8.2×11	13	250	5.9	0.2	0.7	0.64	3.5	10
10	47	5×11	11	75	1.0	0.16	5.4	2.8	15	53
	68	5×11	11	90	1.4	0.16	3.7	2.5	13	47
	100	5×11	11	110	2.0	0.16	2.5	1.7	9.0	25
	220	8.2×11	13	190	4.4	0.16	1.2	0.9	5.2	15
16	33	5×11	11	70	1.1	0.13	6.3	2.8	14	52
	47	5×11	11	85	1.5	0.13	4.4	2.1	9.5	36
	100	8.2×11	13	150	3.2	0.13	2.1	1.0	5.5	17
25	1.0	5×11	11	5	0.7	0.06	95	40	130	400
	2.2	5×11	11	10	0.7	0.06	43	18	59	180
	3.3	5×11	11	18	0.7	0.06	29	12	39	120
	4.7	5×11	11	25	0.7	0.06	20	8.5	27	85
	10	5×11	11	50	0.7	0.06	9.5	4.0	17	65
	22	5×11	11	75	1.1	0.08	5.8	2.7	15	56
	47	8.2×11	13	130	2.4	0.08	2.7	1.3	6.5	17
35	33	5×11	11	70	3.3	0.13	6.3	2.8	14	52
	100	8.2×11	13	150	8.0	0.13	2.1	1.0	5.5	17

Aluminium electrolytic capacitors

Radial Low Leakage Current

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ORDERING INFORMATION

Ordering example

Electrolytic capacitor 013 series

100 µF/16 V; ±20%

Nominal case size: Ø8.2 × 11 mm; Form TFA

Catalogue number: 2222 013 35101.

Table 3 Ordering information; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	330	13	013 53331	5.0	013 63331	5.0	013 33331	5.0	—	—
	470	13	013 53471	5.0	013 63471	5.0	013 33471	5.0	—	—
10	47	11	013 54479	2.5	—	—	013 34479	5.0	013 74479	2.5
	68	11	013 54689	2.5	—	—	013 34689	5.0	013 74689	2.5
	100	11	013 54101	2.5	—	—	013 34101	5.0	013 74101	2.5
	220	13	013 54221	5.0	013 64221	5.0	013 34221	5.0	—	—
16	33	11	013 55339	2.5	—	—	013 35339	5.0	013 75339	2.5
	47	11	013 55479	2.5	—	—	013 35479	5.0	013 75479	2.5
	100	13	013 55101	5.0	013 65101	5.0	013 35101	5.0	—	—
25	1.0	11	013 56108	2.5	—	—	013 36108	5.0	013 76108	2.5
	2.2	11	013 56228	2.5	—	—	013 36228	5.0	013 76228	2.5
	3.3	11	013 56338	2.5	—	—	013 36338	5.0	013 76338	2.5
	4.7	11	013 56478	2.5	—	—	013 36478	5.0	013 76478	2.5
	10	11	013 56109	2.5	—	—	013 36109	5.0	013 76109	2.5
	22	11	013 56229	2.5	—	—	013 36229	5.0	013 76229	2.5
	47	13	013 56479	5.0	013 66479	5.0	013 36479	5.0	—	—
35	33	11	013 50339	5.0	—	—	013 30339	5.0	013 70339	2.5
	100	13	013 50101	5.0	013 60101	5.0	013 30101	5.0	—	—

R

Aluminium electrolytic capacitors

Radial Low Leakage Current

013 RLC

ELECTRICAL DATA (continued)**Table 4** Electrical data continued; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85°C (mA)	I_{L2} 2 min (μ A)	$\tan \delta$ 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 × 11	11	5	1.1	0.06	200	85	230	850
	1.0	5 × 11	11	10	1.1	0.06	95	40	130	400
	2.2	5 × 11	11	20	1.2	0.06	43	18	59	180
	3.3	5 × 11	11	32	1.3	0.06	29	12	39	120
	4.7	5 × 11	11	38	1.5	0.06	20	8.5	27	85
	10	5 × 11	11	55	2.0	0.06	9.5	4.0	17	65
	22	5 × 11	11	75	3.2	0.08	5.8	2.7	15	56
	33	8.2 × 11	13	110	4.3	0.06	2.9	1.4	7.0	18
	47	8.2 × 11	13	130	5.7	0.08	2.7	1.3	6.5	17
	68	8.2 × 11	13	150	7.8	0.08	1.9	1.2	6.0	17

Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_S \leq 1.3 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 2 minutes at U_R : $U_R = 6.3 \text{ to } 25 \text{ V}$ $U_R = 35 \text{ and } 50 \text{ V}$	$I_{L2} \leq 0.002 C_R \times U_R \text{ or } 0.7 \mu\text{A}$ (whichever is greater) $I_{L2} \leq 0.002 C_R \times U_R + 1 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D \times L = 5 \times 11 \text{ mm}$	typ. 13 nH
	case $\varnothing D \times L = 8.2 \times 11 \text{ mm}$	typ. 16 nH

Aluminium electrolytic capacitors

Radial Low Leakage Current

013 RLC

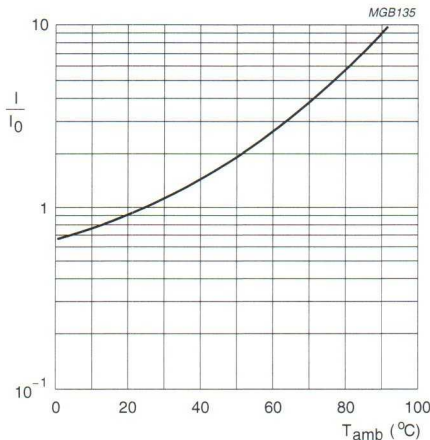
ORDERING INFORMATION (continued)**Table 5** Ordering information continued; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
50	0.47	11	013 51477	2.5	—	—	013 31477	5.0	013 71477	2.5
	1.0	11	013 51108	2.5	—	—	013 31108	5.0	013 71108	2.5
	2.2	11	013 51228	2.5	—	—	013 31228	5.0	013 71228	2.5
	3.3	11	013 51338	2.5	—	—	013 31338	5.0	013 71338	2.5
	4.7	11	013 51478	2.5	—	—	013 31478	5.0	013 71478	2.5
	10	11	013 51109	2.5	—	—	013 31109	5.0	013 71109	2.5
	22	11	013 51229	2.5	—	—	013 31229	5.0	013 71229	2.5
	33	13	013 51339	5.0	013 61339	5.0	013 31339	5.0	—	—
	47	13	013 51479	5.0	013 61479	5.0	013 31479	5.0	—	—
	68	13	013 51689	5.0	013 61689	5.0	013 31689	5.0	—	—

Aluminium electrolytic capacitors
Radial Low Leakage Current

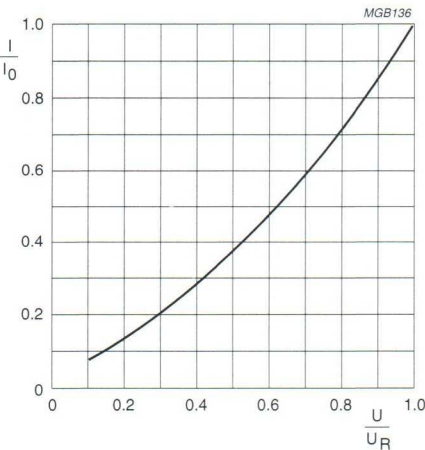
013 RLC

ELECTRICAL DATA (continued)



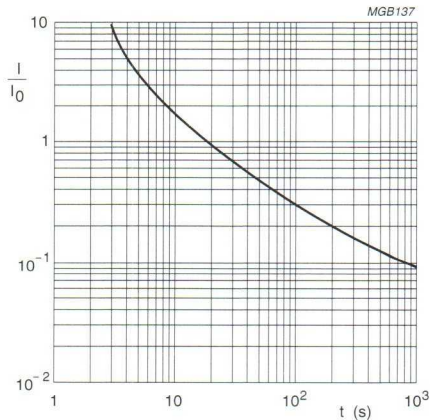
I_0 = leakage current during continuous operation at 20 °C and U_R .

Fig.6 Typical multiplier of leakage current as a function of ambient temperature.



I_0 = leakage current during continuous operation at 20 °C and U_R .

Fig.7 Typical multiplier of leakage current as a function of U/U_R .



I_0 = leakage current.
Leakage current after 2 minutes (I_{L2}) is specified in Tables 2 and 4.

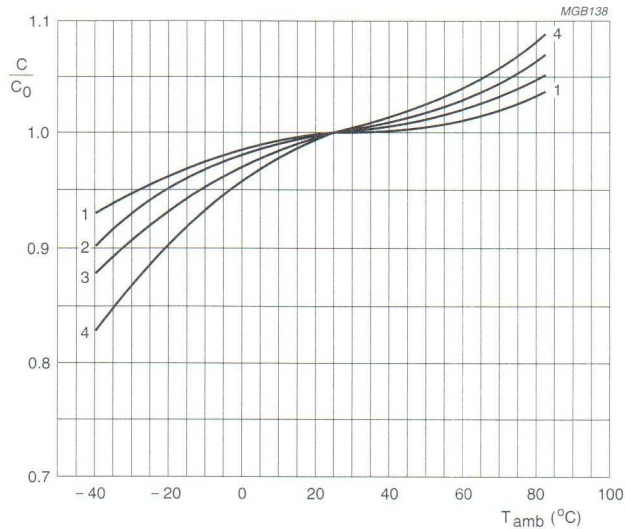
Fig.8 Typical multiplier of leakage current as a function of time.

Aluminium electrolytic capacitors

Radial Low Leakage Current

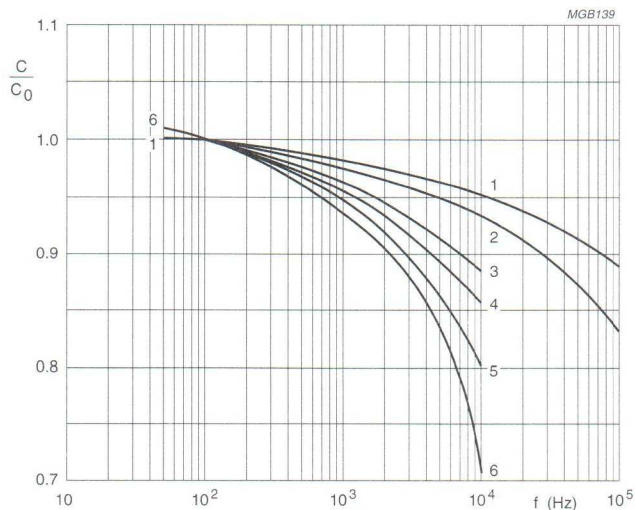
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Capacitance (C)



Curve 1: 25 and 50 V; 0.22 to 2.2 μ F.
 Curve 2: 25 and 50 V; 3.3 to 6.8 μ F.
 Curve 3: 25 and 50 V; 10 to 68 μ F.
 Curve 4: 6.3 V; 10 V; 16 V; 35 V.
 C_0 = capacitance at 20 °C, 100 Hz.

Fig.9 Typical multiplier of capacitance as a function of ambient temperature.



Curve 1: 25 and 50 V; 0.22 to 2.2 μ F.
 Curve 2: 25 and 50 V; 3.3 to 6.8 μ F.
 Curve 3: 25 and 50 V; 10 and 15 μ F.
 Curve 4: 25 and 50 V; 22 to 68 μ F.
 Curve 5: 16 and 35 V.
 Curve 6: 6.3 and 10 V.
 C_0 = capacitance at 20 °C, 100 Hz.

Fig.10 Typical multiplier of capacitance as a function of frequency.

Aluminium electrolytic capacitors

Radial Low Leakage Current

013 RLC

Equivalent series resistance (ESR)

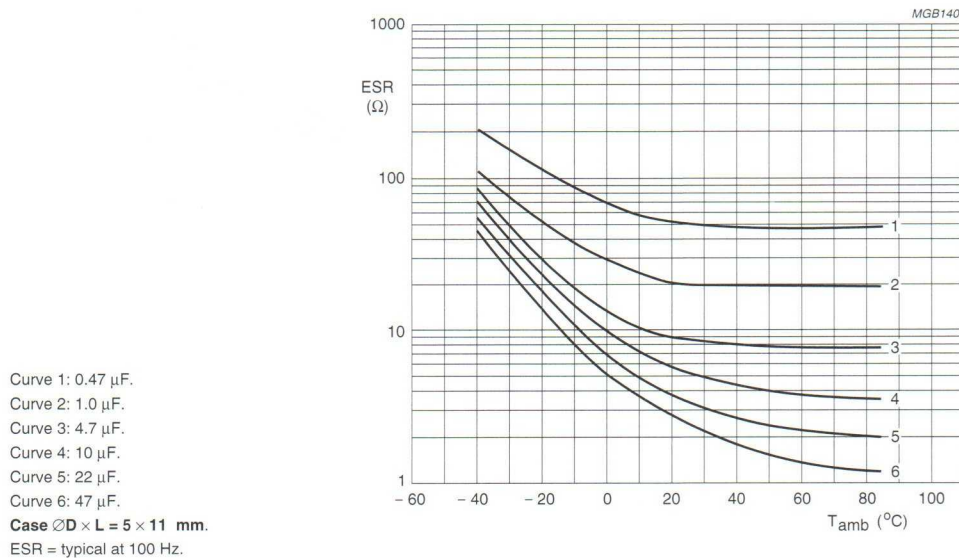


Fig.11 Typical ESR as a function of ambient temperature.

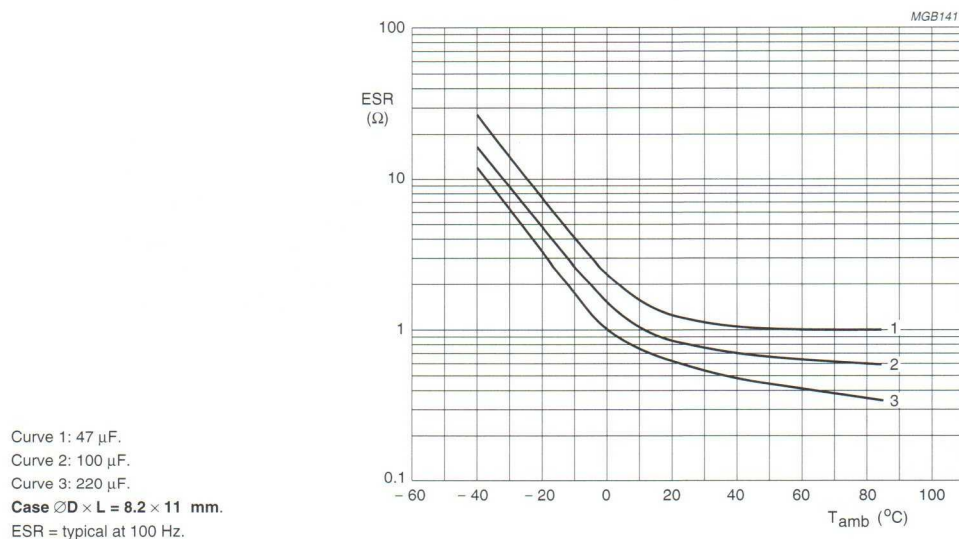


Fig.12 Typical ESR as a function of ambient temperature.

Aluminium electrolytic capacitors

Radial Low Leakage Current

013 RLC

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 .

Case $\varnothing D \times L = 5 \times 11$ mm.

$T_{\text{amb}} = 20$ °C.

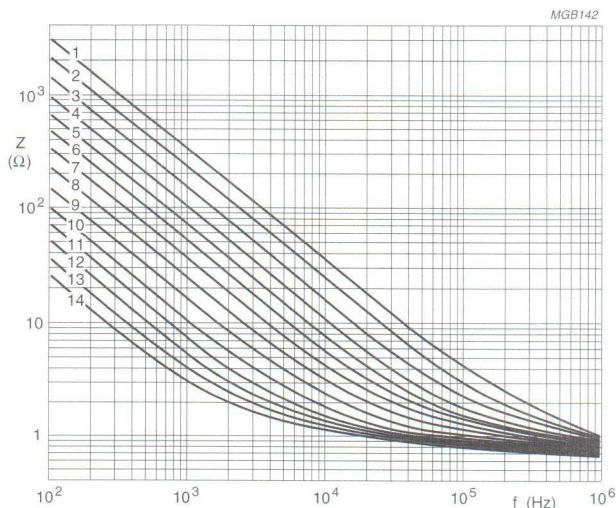


Fig.13 Typical impedance as a function of frequency.

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

Case $\varnothing D \times L = 8.2 \times 11$ mm.

$T_{\text{amb}} = 20$ °C.

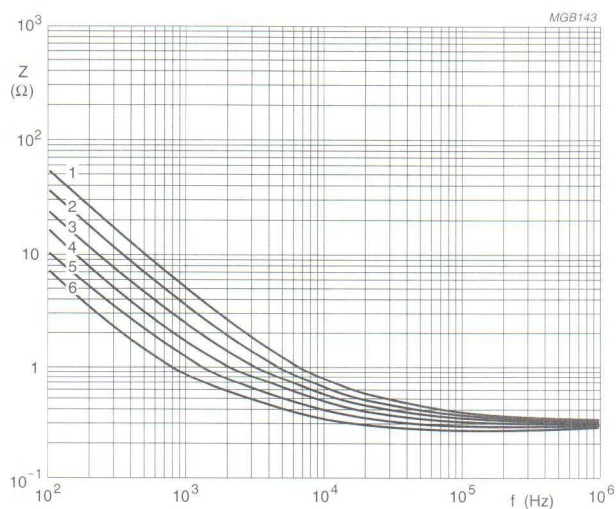


Fig.14 Typical impedance as a function of frequency.

R

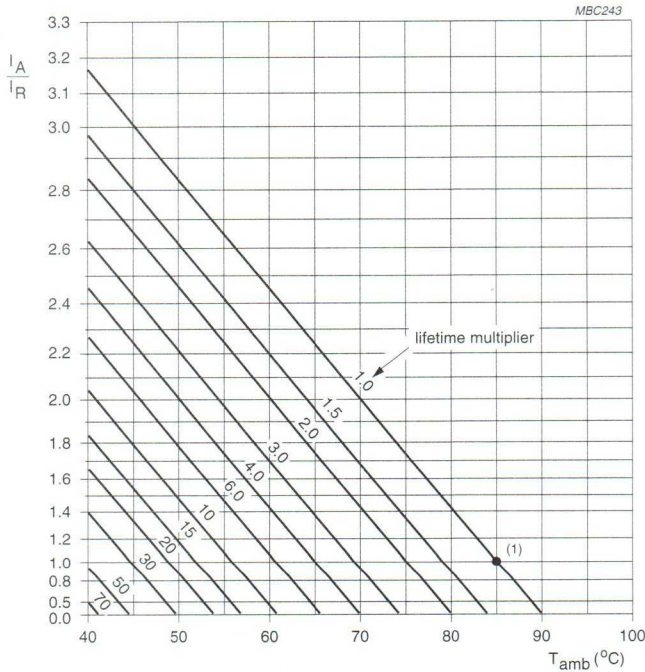
Aluminium electrolytic capacitors Radial Low Leakage Current

013 RLC

RIPPLE CURRENT AND USEFUL LIFE

Table 6 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 85 °C, 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3 \text{ V}$	$U_R = 10, 16 \text{ and } 35 \text{ V}$	$U_R = 25 \text{ and } 50 \text{ V}$
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
≥ 10000	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.15 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors
Radial Low Leakage Current

013 RLC

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section “Tests and Requirements”.

Table 7 Test procedures and requirements

TEST		PROCEDURE	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300, subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +15/–30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 3000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +45/–50% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see ‘Endurance test’ above $I_{L2} \leq 2 \times \text{spec. limit}$

R

Aluminium electrolytic capacitors

Radial Bipolar

036 92 RB

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).

REMARK

Please consult your sales representative for more details.

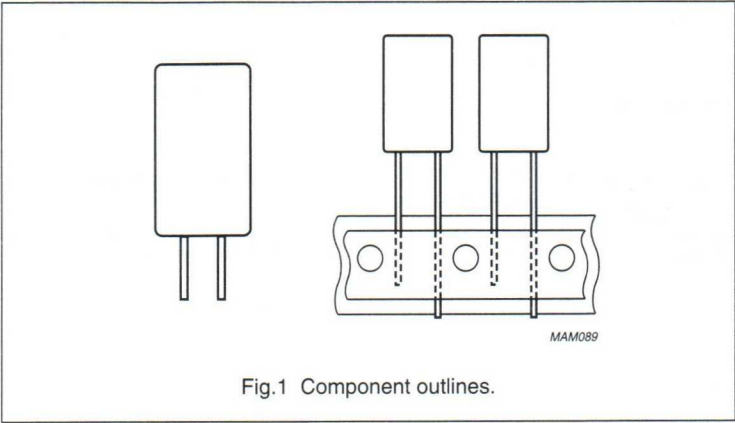
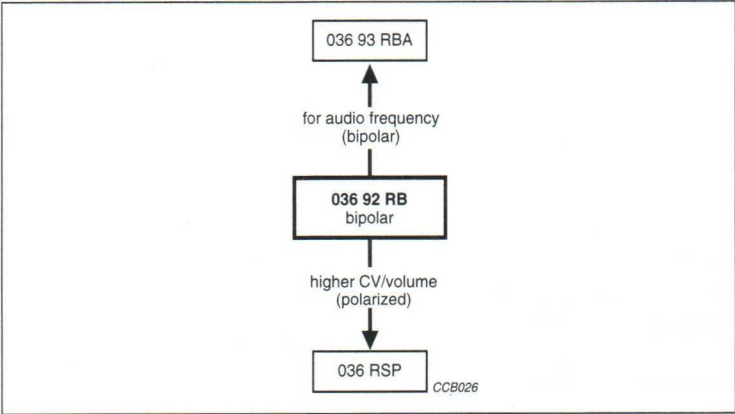


Fig.1 Component outlines.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	8.2 × 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, $1.4 \times I_R$ applied	150000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/105/56

Aluminium electrolytic capacitors

Radial Bipolar

036 92 RB

Selection chart for C_R, U_R and relevant nominal case sizes (∅D × L in mm)

C _R (μF)	U _R (V)			
	16	40	50	63
10	–	–	–	8.2 × 11
22	–	–	–	8.2 × 11
33	–	–	8.2 × 11	–
47	–	8.2 × 11	–	–
100	8.2 × 11	–	–	–

R

Aluminium electrolytic capacitors

Radial Bipolar Audio-frequency

036 93 RBA

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.

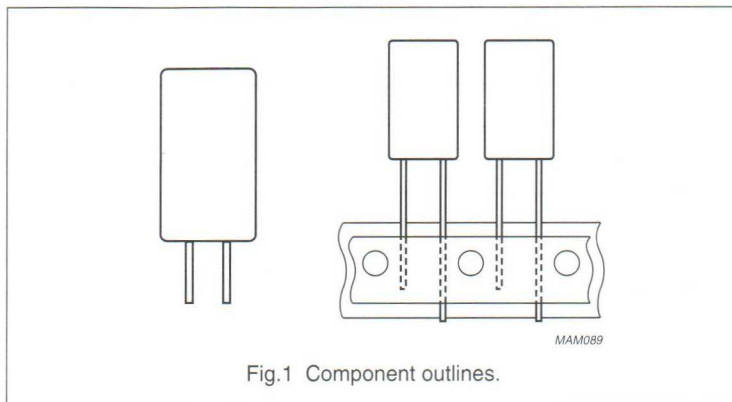


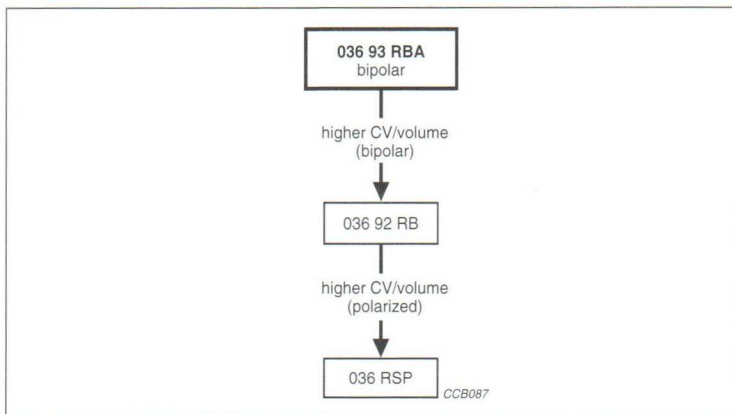
Fig.1 Component outlines.

APPLICATIONS

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

REMARK

Please consult your sales representative for more details.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	8.2×11 (pitch 5 mm)
Rated capacitance range, C_R (E6 series)	1 to 22 μF
Tolerance on C_R at 1 kHz	$\pm 10\%$
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, $1.4 \times I_R$ applied	150000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/105/56

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Bipolar Audio-frequency

036 93 RBA

NOTES

Aluminium electrolytic capacitors

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036 RSP**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 CV-product per unit volume
- Reduced leakage current.

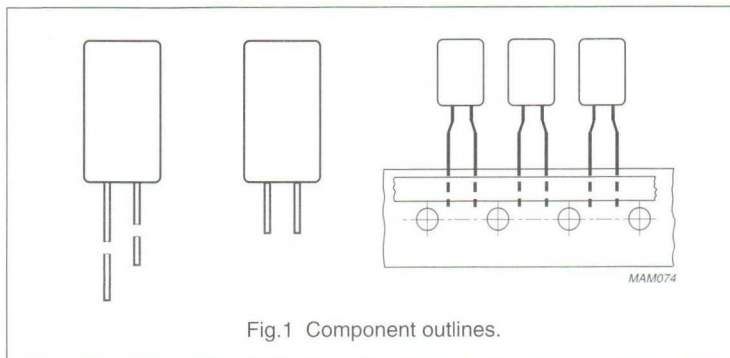
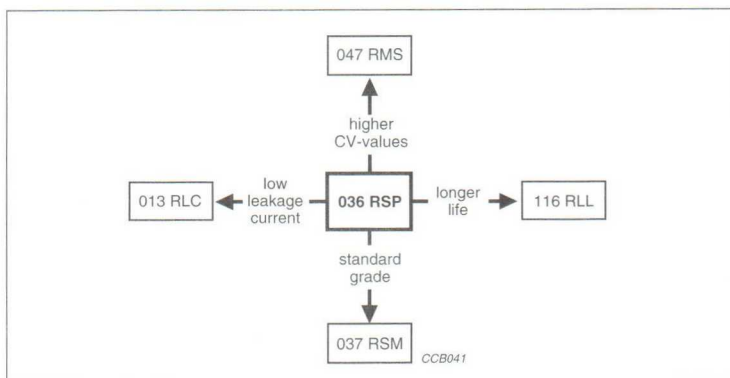


Fig.1 Component outlines.

APPLICATIONS

- Automotive, telecommunication, industrial, EDP and audio-video
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Portable and mobile equipment (small size, low mass).

**QUICK REFERENCE DATA**

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	5×11 and 8.2×11
Rated capacitance range, C_R	0.47 to 470 μF
Tolerance on C_R	$\pm 20\%$ ($\pm 10\%$ on request)
Rated voltage range, U_R	6.3 to 160 V
Category temperature range	-55 to $+85$ $^{\circ}C$
Endurance test at 85 $^{\circ}C$	2000 hours
Useful life at 105 $^{\circ}C$	750 hours
Useful life at 85 $^{\circ}C$	3000 hours
Useful life at 40 $^{\circ}C$, $1.4 \times I_R$ applied	80000 hours
Shelf life at 0 V, 85 $^{\circ}C$	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300
Climatic category IEC 68	55/085/56

Aluminium electrolytic capacitors

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ 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 × 11	—	—
1.0	—	—	—	—	—	—	—	5 × 11	—	—
2.2	—	—	—	—	—	—	—	5 × 11	—	8.2 × 11
3.3	—	—	—	—	—	—	—	5 × 11	—	—
4.7	—	—	—	—	—	—	—	5 × 11	—	8.2 × 11
6.8	—	—	—	—	—	—	—	5 × 11	—	—
10	—	—	—	—	—	—	5 × 11	5 × 11	8.2 × 11	—
	—	—	—	—	—	—	—	8.2 × 11	—	—
15	—	—	—	—	—	5 × 11	—	5 × 11	—	—
22	—	—	—	—	5 × 11	—	—	5 × 11	8.2 × 11	—
	—	—	—	—	—	—	—	8.2 × 11	—	—
33	—	—	5 × 11	—	—	—	5 × 11	8.2 × 11	—	—
47	—	5 × 11	—	—	5 × 11	—	8.2 × 11	8.2 × 11	—	—
68	—	—	—	5 × 11	—	8.2 × 11	—	8.2 × 11	—	—
100	5 × 11	—	5 × 11	8.2 × 11	—	—	8.2 × 11	—	—	—
150	—	5 × 11	8.2 × 11	—	8.2 × 11	—	—	—	—	—
220	—	8.2 × 11	8.2 × 11	8.2 × 11	—	—	—	—	—	—
330	8.2 × 11	—	8.2 × 11	—	—	—	—	—	—	—
470 ⁽¹⁾	—	8.2 × 11	—	—	—	—	—	—	—	—

Note

- For higher CV-values see data sheet "047 RMS".

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

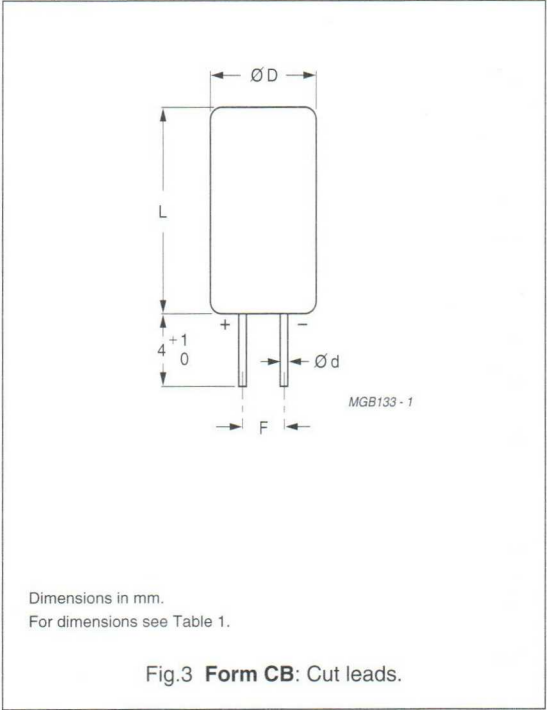
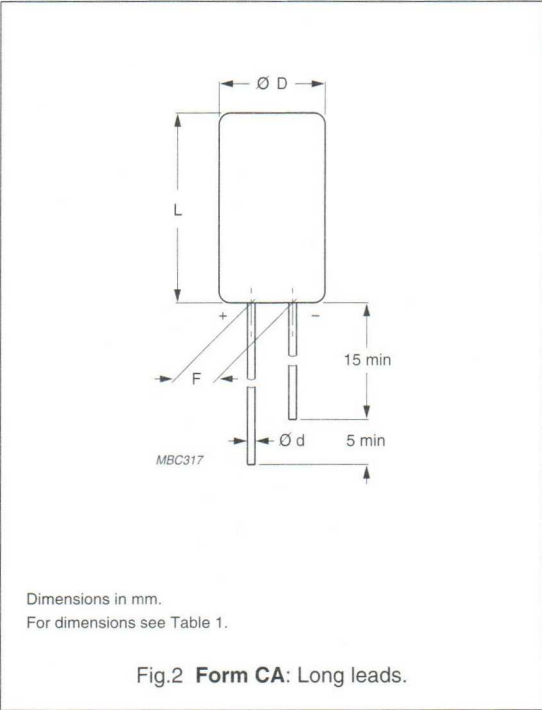


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

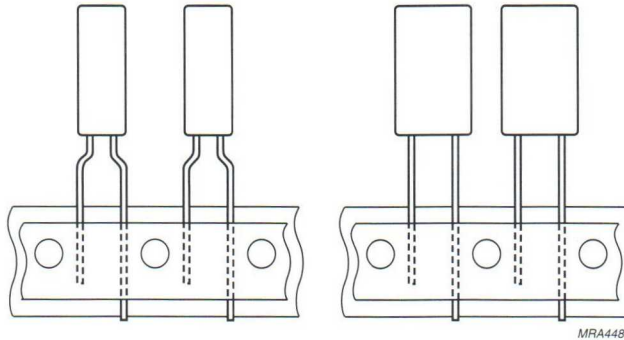
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES	
							FORM CA, CB	FORM TFA, TNA
5 × 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	2000
8.2 × 11	13	0.6	8.7	12	5.0 ± 0.5	≈ 1.1	1000	1000

Aluminium electrolytic capacitors

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Taped products

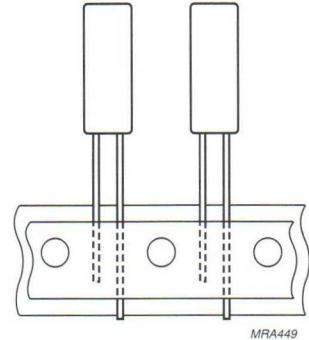

Form TFA:

Pitch F = 5 mm.

Case $\varnothing D \times L = 5 \times 11$ and 8.2×11 mm.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.4 Taped in box (ammopack).


Form TNA:

Pitch F = 2.5 mm.

Case $\varnothing D \times L = 5 \times 11$ mm only.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.5 Taped in box (ammopack).

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.

Aluminium electrolytic capacitors

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 2 and 4 apply at $T_{amb} = 20\text{ °C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
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
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and C_R)
Z	max. impedance at 10 kHz and 20, -25 or -40 °C

Table 2 Electrical data; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 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	5×11	11	130	7	3.6	0.20	3.2	1.7	9.0	25
	330	8.2×11	13	300	16	5.1	0.20	1.0	0.52	2.7	7.6
10	47	5×11	11	95	6	3.5	0.16	5.4	2.8	12	32
	150	5×11	11	150	12	4.5	0.20	2.1	1.3	8.0	21
	220	8.2×11	13	260	17	5.2	0.16	1.2	0.59	2.6	6.8
	470	8.2×11	13	400	31	7.7	0.20	0.68	0.43	2.6	6.8
16	33	5×11	11	90	7	3.5	0.14	6.8	2.7	12	33
	100	5×11	11	160	13	4.6	0.16	2.5	1.6	7.5	20.0
	150	8.2×11	13	230	18	5.4	0.14	1.5	0.6	2.7	7.3
	220	8.2×11	13	280	24	6.5	0.16	1.2	0.55	2.5	6.8
	330	8.2×11	13	390	35	8.3	0.16	0.7	0.48	2.3	6.1
25	68	5×11	11	140	13	4.7	0.14	3.3	1.8	8.2	22
	100	8.2×11	13	210	18	5.5	0.12	1.9	0.7	3.0	9.0
	220	8.2×11	13	310	36	8.5	0.14	1	0.55	2.6	6.8
35	22	5×11	11	87	8	3.8	0.10	7.2	2.7	11	34
	47	5×11	11	130	13	4.6	0.12	4.1	1.9	8.5	23
	150	8.2×11	13	270	35	8.3	0.12	1.3	0.6	2.7	7.3
40	15	5×11	11	72	7	3.6	0.10	11	3.7	15	47
	68	8.2×11	13	180	20	5.7	0.10	2.3	0.81	3.2	10
50	10	5×11	11	60	6	3.5	0.08	13	4.5	16	58
	33	5×11	11	110	13	4.7	0.10	4.8	2.1	9.1	27
	47	8.2×11	13	160	18	5.4	0.08	2.7	0.96	3.4	12
	100	8.2×11	13	250	33	8.0	0.10	1.6	0.7	3.0	9.0

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ORDERING INFORMATION

Ordering example

Electrolytic capacitor 036 series

100 μ F/16 V; $\pm 20\%$ Nominal case size: $\varnothing 5 \times 11$ mm; Form TFA

Catalogue number: 2222 036 35101.

Table 3 Ordering information; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	100	11	036 53101	2.5	—	—	036 33101	5.0	036 73101	2.5
	330	13	036 53331	5.0	036 63331	5.0	036 33331	5.0	—	—
10	47	11	036 54479	2.5	—	—	036 34479	5.0	036 74479	2.5
	150	11	036 54151	2.5	—	—	036 34151	5.0	036 74151	2.5
	220	13	036 54221	5.0	036 64221	5.0	036 34221	5.0	—	—
	470	13	036 54471	5.0	036 64471	5.0	036 34471	5.0	—	—
16	33	11	036 55339	2.5	—	—	036 35339	5.0	036 75339	2.5
	100	11	036 55101	2.5	—	—	036 35101	5.0	036 75101	2.5
	150	13	036 55151	5.0	036 65151	5.0	036 35151	5.0	—	—
	220	13	036 55221	5.0	036 65221	5.0	036 35221	5.0	—	—
	330	13	036 55331	5.0	036 65331	5.0	036 35331	5.0	—	—
25	68	11	036 56689	2.5	—	—	036 36689	5.0	036 76689	2.5
	100	13	036 56101	5.0	036 66101	5.0	036 36101	5.0	—	—
	220	13	036 56221	5.0	036 66221	5.0	036 36221	5.0	—	—
35	22	11	036 90001	2.5	—	—	036 90027	5.0	036 90389	2.5
	47	11	036 90094	2.5	—	—	036 90098	5.0	036 90391	2.5
	150	13	036 90099	5.0	036 90101	5.0	036 90103	5.0	—	—
40	15	11	036 57159	2.5	—	—	036 37159	5.0	036 77159	2.5
	68	13	036 57689	5.0	036 67689	5.0	036 37689	5.0	—	—
50	10	11	036 90004	2.5	—	—	036 90028	5.0	036 90392	2.5
	33	11	036 90104	2.5	—	—	036 90108	5.0	036 90393	2.5
	47	13	036 90011	5.0	036 90012	5.0	036 90031	5.0	—	—
	100	13	036 90109	5.0	036 90111	5.0	036 90113	5.0	—	—

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ELECTRICAL DATA (continued)**Table 4** Electrical data continued; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	$\tan \delta$ 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 × 11	11	5	4	3	0.06	200	85	280	850
	1.0	5 × 11	11	11	4	3.1	0.06	95	40	130	400
	2.2	5 × 11	11	25	4	3.1	0.06	43	18	59	180
	3.3	5 × 11	11	38	5	3.2	0.06	29	12	39	120
	4.7	5 × 11	11	45	5	3.3	0.06	20	8.5	27	85
	6.8	5 × 11	11	55	6	3.4	0.06	14	5.9	19	59
	10	5 × 11	11	70	7	3.6	0.06	9.5	4.0	13	40
	10	8.2 × 11	13	120	7	3.6	0.04	6.5	2.8	7	19
	15	5 × 11	11	80	9	3.9	0.07	7.4	3.1	12	36
	22	5 × 11	11	100	11	4.4	0.08	5.8	2.7	10	32
	22	8.2 × 11	13	150	11	4.4	0.05	3.6	1.4	5.1	15
	33	8.2 × 11	13	160	16	5.1	0.06	2.9	1.2	3.9	12
	47	8.2 × 11	13	190	21	6.0	0.07	2.4	1.0	3.5	11
	68	8.2 × 11	13	210	29	7.3	0.08	1.9	0.88	3.2	10
100	10	8.2 × 11	13	80	9	4	0.06	9.5	3.5	15	45
	22	8.2 × 11	13	110	16	5.2	0.06	4.3	1.8	7.3	23
160	2.2	8.2 × 11	13	45	75	15	0.05	36	14	70	170
	4.7	8.2 × 11	13	62	115	21	0.07	24	9.6	60	150

Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_S \leq 1.15 U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute: $U_R = 6.3 \text{ to } 100 \text{ V}$ $U_R = 160 \text{ V}$	$I_{L1} \leq 0.006 C_R \times U_R + 3 \mu\text{A}$ $I_{L1} \leq 0.1 C_R \times U_R + 40 \mu\text{A}$
	after 5 minutes: $U_R = 6.3 \text{ to } 100 \text{ V}$ $U_R = 160 \text{ V}$	$I_{L5} \leq 0.001 C_R \times U_R + 3 \mu\text{A}$ $I_{L5} \leq 0.015 C_R \times U_R + 10 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D \times L = 5 \times 11 \text{ mm}$	typ. 13 nH
	case $\varnothing D \times L = 8.2 \times 11 \text{ mm}$	typ. 16 nH

Aluminium electrolytic capacitors

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ORDERING INFORMATION (continued)**Table 5** Ordering information continued; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
63	0.47	11	036 58477	2.5	—	—	036 38477	5.0	036 78477	2.5
	1.0	11	036 58108	2.5	—	—	036 38108	5.0	036 78108	2.5
	2.2	11	036 58228	2.5	—	—	036 38228	5.0	036 78228	2.5
	3.3	11	036 58338	2.5	—	—	036 38338	5.0	036 78338	2.5
	4.7	11	036 58478	2.5	—	—	036 38478	5.0	036 78478	2.5
	6.8	11	036 58688	2.5	—	—	036 38688	5.0	036 78688	2.5
	10	11	036 58109	2.5	—	—	036 38109	5.0	036 78109	2.5
	10	13	036 90036	5.0	036 90041	5.0	036 90181	5.0	—	—
	15	11	036 58159	2.5	—	—	036 38159	5.0	036 78159	2.5
	22	11	036 58229	2.5	—	—	036 38229	5.0	036 78229	2.5
	22	13	036 90117	5.0	036 90118	5.0	036 90139	5.0	—	—
	33	13	036 58339	5.0	036 68339	5.0	036 38339	5.0	—	—
	47	13	036 58479	5.0	036 68479	5.0	036 38479	5.0	—	—
	68	13	036 58689	5.0	036 68689	5.0	036 38689	5.0	—	—
100	10	13	036 59109	5.0	036 69109	5.0	036 39109	5.0	—	—
	22	13	036 59229	5.0	036 69229	5.0	036 39229	5.0	—	—
160	2.2	13	036 90333	5.0	036 90334	5.0	036 90336	5.0	—	—
	4.7	13	036 90337	5.0	036 90338	5.0	036 90341	5.0	—	—

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ELECTRICAL DATA (continued)

Capacitance (C)

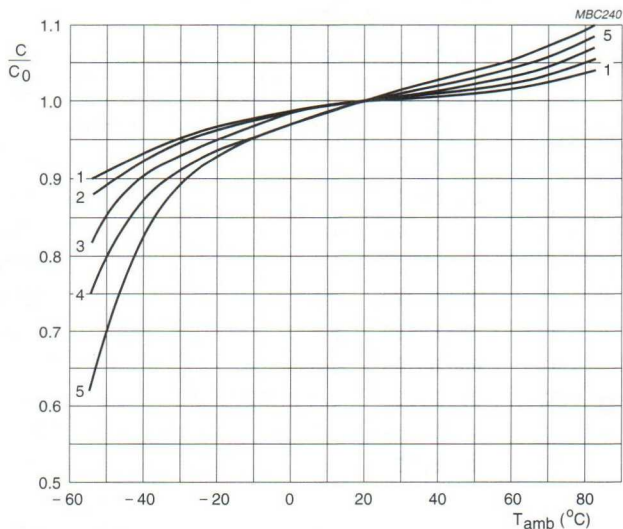


Fig.6 Typical multiplier of capacitance as a function of ambient temperature.

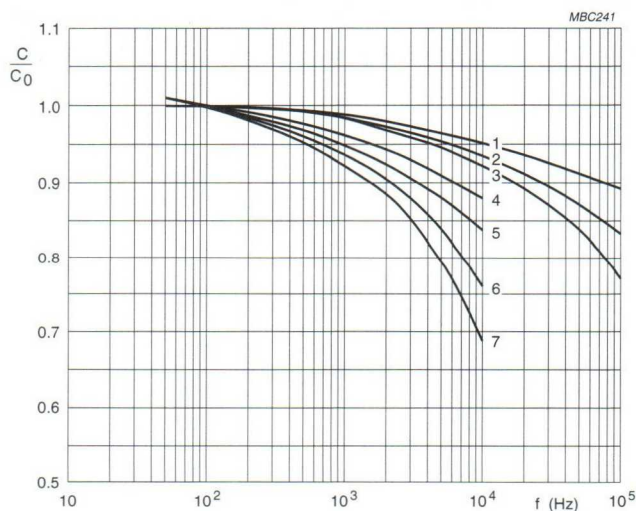
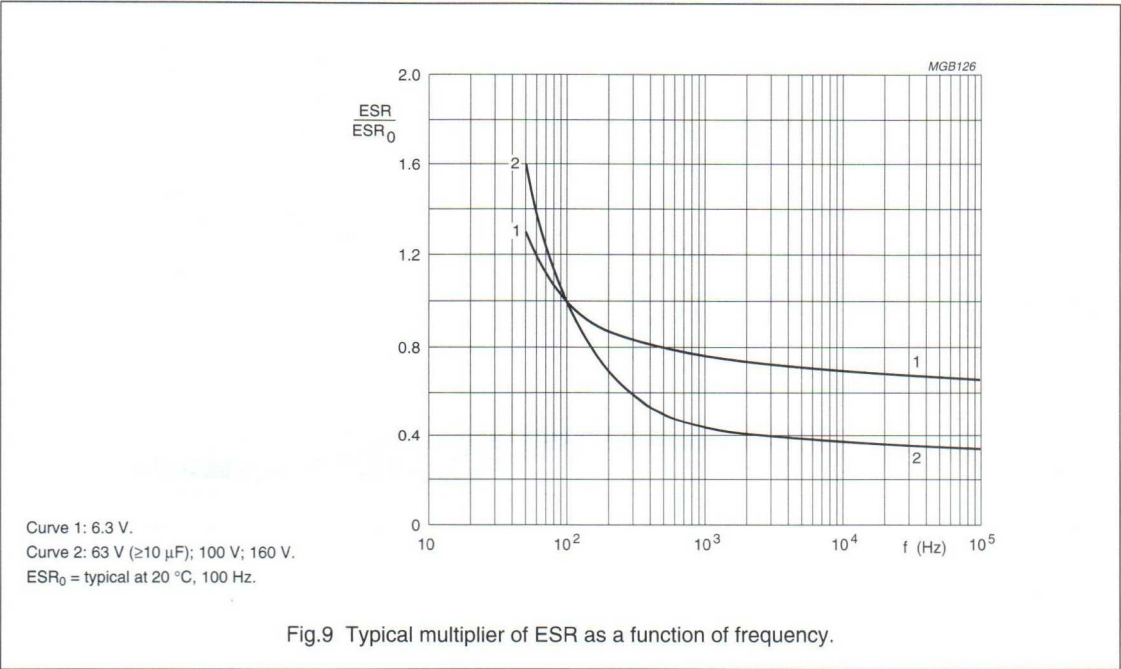
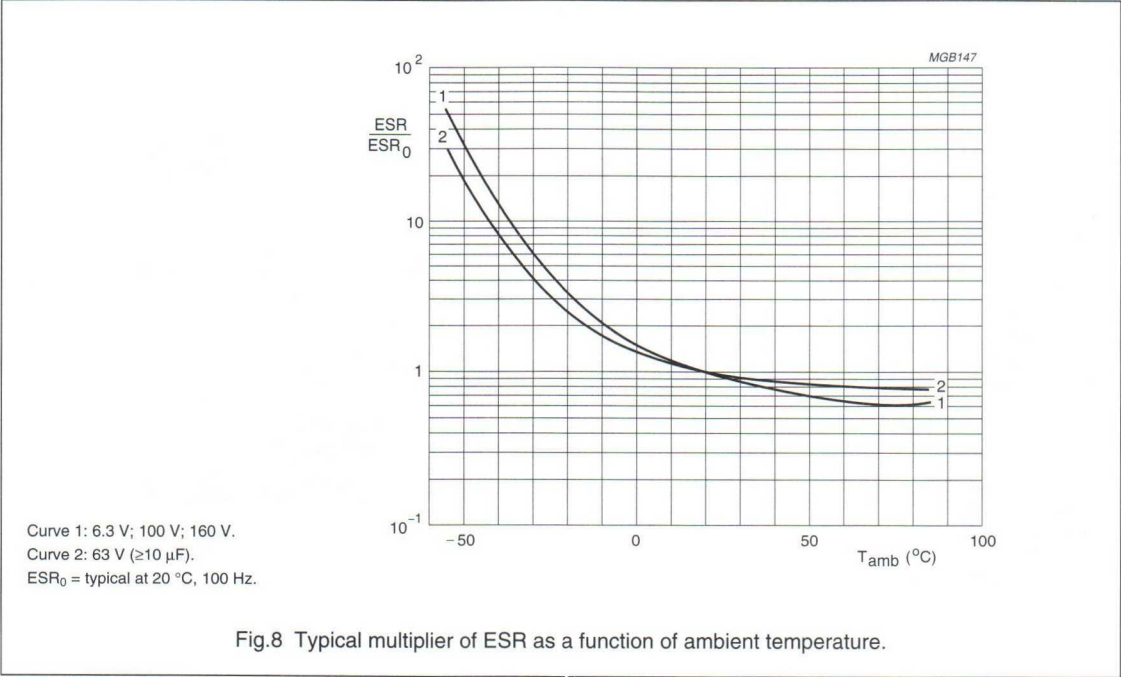


Fig.7 Typical multiplier of capacitance as a function of frequency.

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Equivalent series resistance (ESR)



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Impedance (Z)

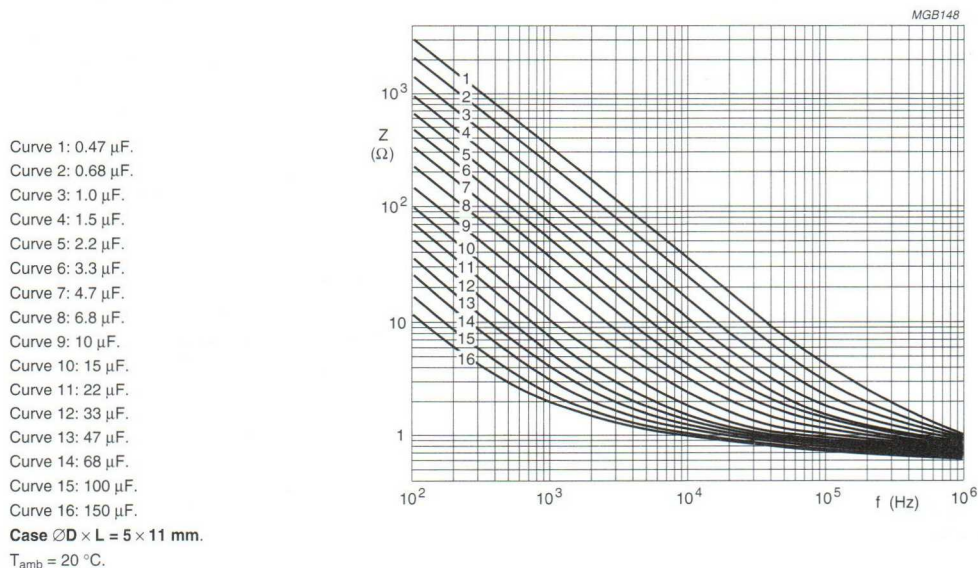


Fig.10 Typical impedance as a function of frequency.

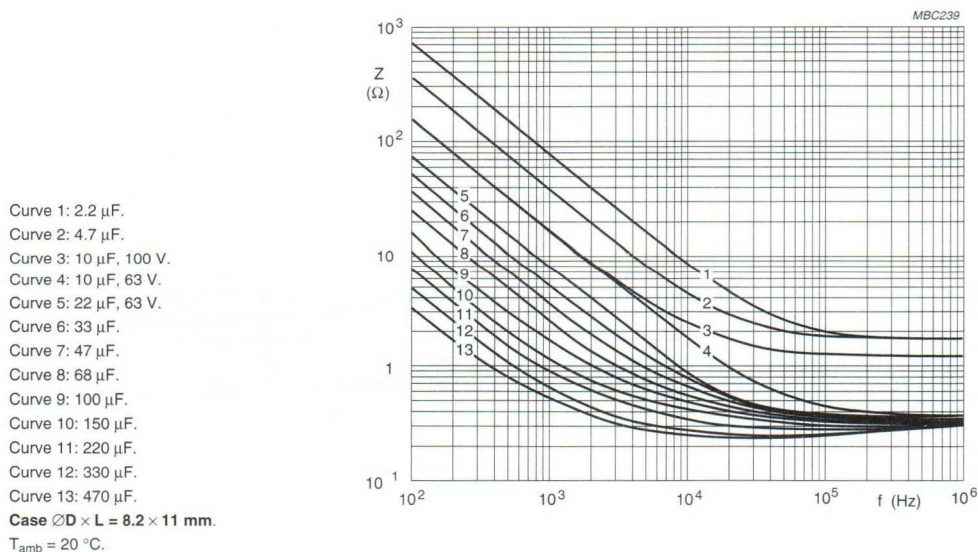


Fig.11 Typical impedance as a function of frequency.

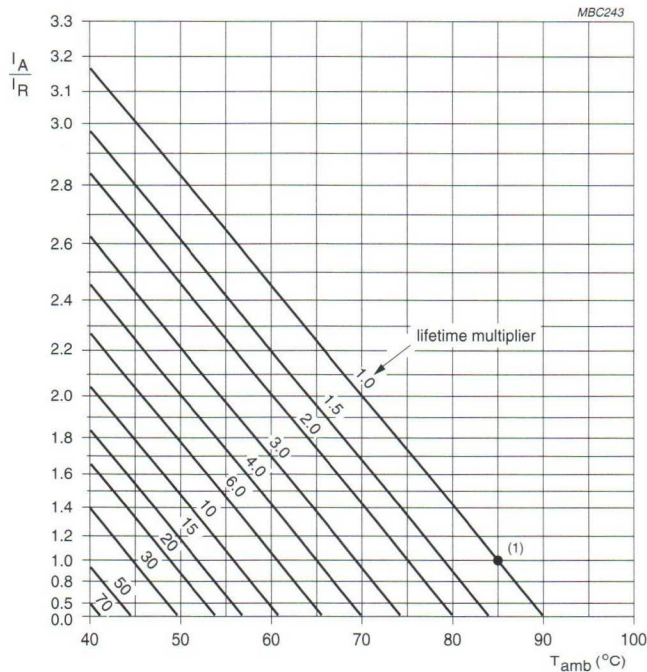
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RIPPLE CURRENT AND USEFUL LIFE

Table 6 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3 \text{ to } 10 \text{ V}$	$U_R = 16 \text{ to } 35 \text{ V}$	$U_R = 40 \text{ to } 160 \text{ V}$
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
≥ 10000	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.12 Multiplier of useful life as a function of ambient temperature and ripple current load.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 7 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: $+15/-30\%$ $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 3000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: $+45/-50\%$ $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq \text{spec. limit}$

Aluminium electrolytic capacitors

Radial Miniature Semi-Professional

047 RMS

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 CV-product per unit volume.

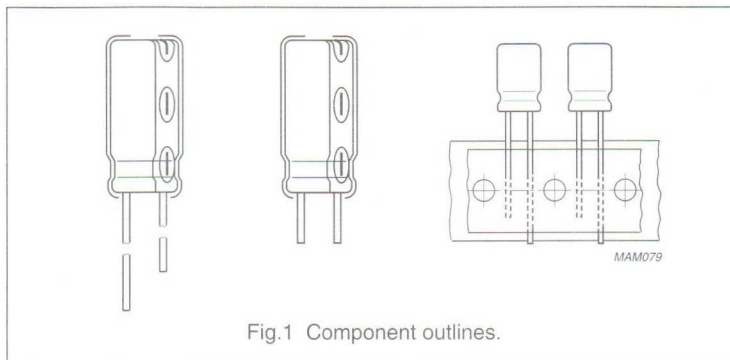
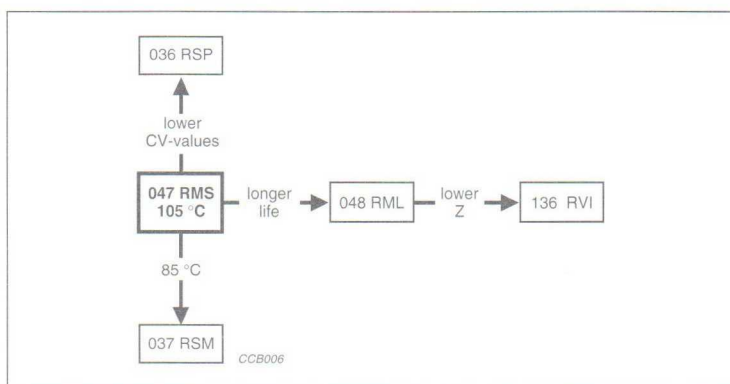


Fig.1 Component outlines.

APPLICATIONS

- EDB, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass).



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	10 × 12 to 18 × 35
Rated capacitance range, C_R	100 to 10000 μF
Tolerance on C_R	±20%
Rated voltage range, U_R	16 to 63 V
Category temperature range	−40 to +105 °C
Endurance test at 105 °C	1000 hours
Useful life at 105 °C	1500 hours
Useful life at 40 °C, $1.3 \times I_R$ applied	150000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/105/56

R

Aluminium electrolytic capacitors

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

C_R (μF)	U_R (V)					
	16	25	35	40	50	63
100 ⁽¹⁾	—	—	—	—	—	10 × 12
220	—	—	10 × 12	—	10 × 16	10 × 20
330	—	—	10 × 16	10 × 20	—	12.5 × 20
470	10 × 12	10 × 16	10 × 20	—	12.5 × 20	12.5 × 25
1000	10 × 20	12.5 × 20	12.5 × 25	—	16 × 25	16 × 31
2200	12.5 × 25	16 × 25	16 × 31	16 × 35	18 × 35	18 × 35
3300	16 × 25	16 × 31	18 × 35	18 × 35	18 × 35	—
4700	16 × 31	18 × 35	18 × 35	—	—	—
6800	16 × 35	18 × 35	—	—	—	—
10000	18 × 35	—	—	—	—	—

Note

- For lower CV-values see data sheet "036 RSP".

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

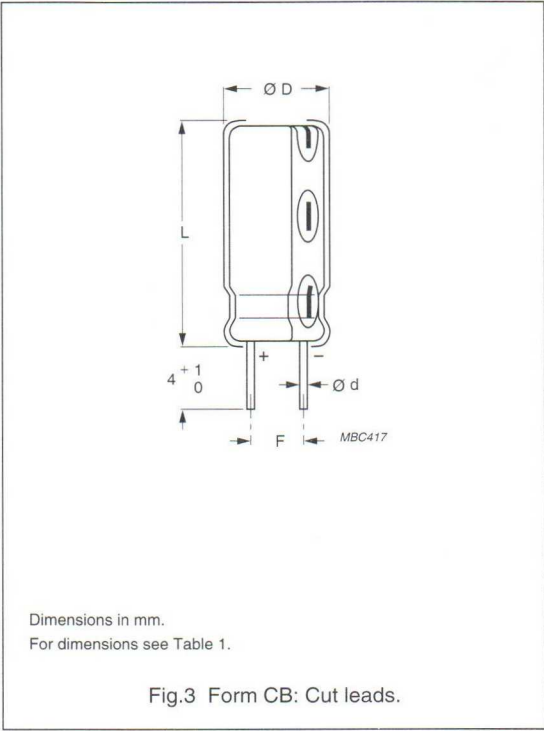
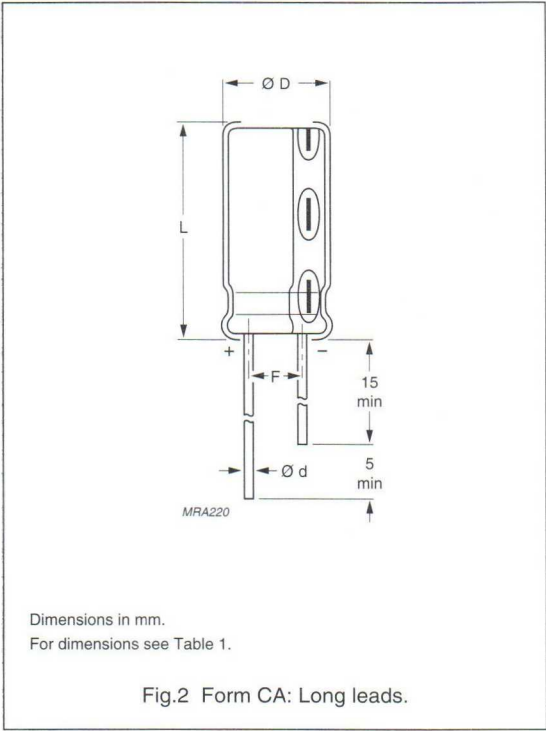


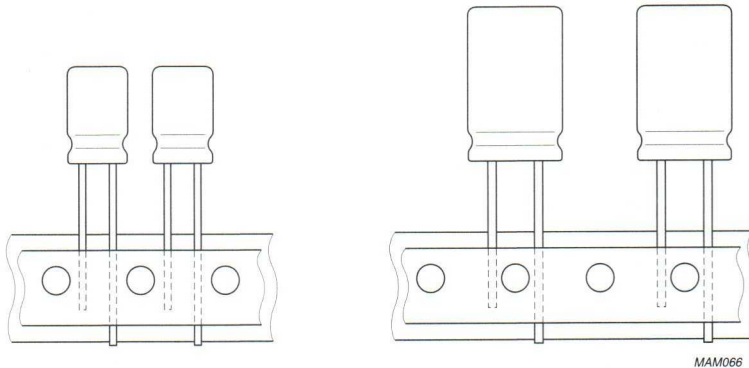
Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA per box	FORM CB per box	FORM TFA per box
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 × 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 × 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 × 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.5	100	100	—
18 × 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	—

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Taped products

**Form TFA:****Case** $\varnothing D \times L \leq 16 \times 31$ mm.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.4 Taped in box (ammopack).

MARKING

The capacitors are marked with the following information:

- Rated capacitance value (in μF)
- Tolerance on rated capacitance, code letter in accordance with "IEC 62" (M for $\pm 20\%$)
- 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.

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Ordering example

Electrolytic capacitor 047 series
1000 µF/35 V; ±20
Nominal case size: Ø12.5 × 25 mm; Form TFA
Catalogue number: 2222 047 30102.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C,
P = 86 to 106 kPa, RH = 45 to 75%.

SYMBOL	DESCRIPTION
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 2 Electrical data and ordering information; preferred types in bold

U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (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)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222		
											BULK PACKAGING		TAPED
											FORM CA	FORM CB	
16	470	10 × 12	14	330	78	18	0.16	0.51	0.45	0.33	047 55471	047 65471	047 35471
	1000	10 × 20	16	540	160	35	0.16	0.24	0.21	0.17	047 55102	047 65102	047 35102
	2200	12.5 × 25	18	830	360	73	0.20	0.14	0.12	0.10	047 55222	047 65222	047 35222
	3300	16 × 25	19	1100	530	110	0.22	0.10	0.09	0.08	047 55332	047 65332	047 35332
	4700	16 × 31	20	1300	760	150	0.24	0.08	0.07	0.07	047 55472	047 65472	047 35472
	6800	16 × 35	21	1600	1100	220	0.28	0.06	0.06	0.06	047 55682	047 65682	—
	10000	18 × 35	22	1800	1600	320	0.36	0.05	0.05	0.05	047 55103	047 65103	—
25	470	10 × 16	15	360	120	27	0.14	0.45	0.38	0.25	047 56471	047 66471	047 36471
	1000	12.5 × 20	17	630	250	53	0.14	0.21	0.18	0.13	047 56102	047 66102	047 36102
	2200	16 × 25	19	990	550	110	0.18	0.12	0.09	0.08	047 56222	047 66222	047 36222
	3300	16 × 31	20	1200	830	170	0.20	0.09	0.07	0.07	047 56332	047 66332	047 36332
	4700	18 × 35	22	1500	1200	240	0.22	0.07	0.05	0.05	047 56472	047 66472	—
	6800	18 × 35	22	1700	1700	340	0.26	0.06	0.04	0.04	047 56682	047 66682	—

Aluminium electrolytic capacitors

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U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE ØD × L (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)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222		
											BULK PACKAGING		TAPED
											FORM CA	FORM CB	FORM TFA
35	220	10 × 12	14	270	80	18	0.12	0.83	0.57	0.38	047 50221	047 60221	047 30221
	330	10 × 16	15	350	120	26	0.12	0.55	0.38	0.28	047 50331	047 60331	047 30331
	470	10 × 20	16	450	170	36	0.12	0.39	0.27	0.22	047 50471	047 60471	047 30471
	1000	12.5 × 25	18	780	350	73	0.12	0.18	0.13	0.12	047 50102	047 60102	047 30102
	2200	16 × 31	20	1200	770	160	0.16	0.11	0.07	0.07	047 50222	047 60222	047 30222
40	3300	18 × 35	22	1500	1200	230	0.18	0.09	0.05	0.05	047 50332	047 60332	—
	4700	18 × 35	22	1800	1600	330	0.20	0.06	0.04	0.04	047 50472	047 60472	—
	330	10 × 20	16	380	140	29	0.12	0.55	0.33	0.26	047 57331	047 67331	047 37331
	2200	16 × 35	21	1200	880	180	0.16	0.11	0.06	0.06	047 57222	047 67222	—
	3300	18 × 35	22	1500	1300	270	0.18	0.08	0.04	0.04	047 57332	047 67332	—
50	220	10 × 16	15	310	110	25	0.10	0.69	0.43	0.33	047 51221	047 61221	047 31221
	470	12.5 × 20	17	540	240	50	0.10	0.32	0.20	0.17	047 51471	047 61471	047 31471
	1000	16 × 25	19	940	500	100	0.10	0.15	0.10	0.09	047 51102	047 61102	047 31102
	2200	18 × 35	22	1400	1100	220	0.14	0.10	0.05	0.05	047 51222	047 61222	—
	3300	18 × 35	22	1600	1700	330	0.16	0.07	0.03	0.04	047 51332	047 61332	—
63	100	10 × 12	14	210	66	16	0.09	1.40	0.75	0.65	047 58101	047 68101	047 38101
	220	10 × 20	16	350	140	31	0.09	0.62	0.34	0.32	047 58221	047 68221	047 38221
	330	12.5 × 20	17	470	210	45	0.09	0.41	0.23	0.22	047 58331	047 68331	047 38331
	470	12.5 × 25	18	620	300	62	0.09	0.29	0.16	0.16	047 58471	047 68471	047 38471
	1000	16 × 31	20	1100	630	130	0.09	0.14	0.08	0.08	047 58102	047 68102	047 38102
2200		18 × 35	22	1500	1400	280	0.13	0.09	0.04	0.04	047 58222	047 68222	—

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Additional electrical data

DESCRIPTION	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 3 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 10 \text{ mm}$	typ. 16 nH
	case $\varnothing D \geq 12.5 \text{ mm}$	typ. 18 nH

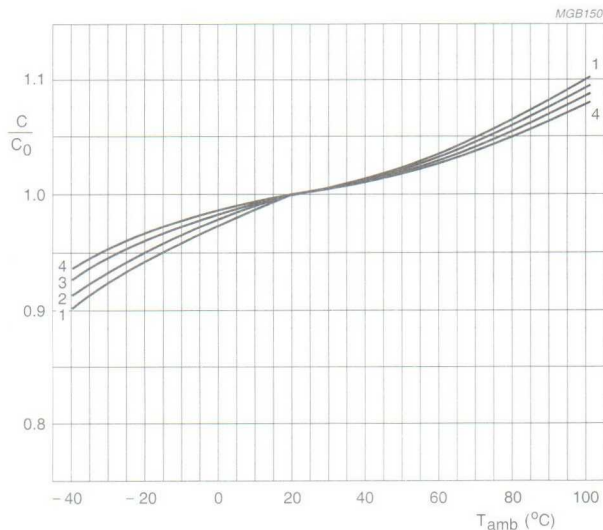
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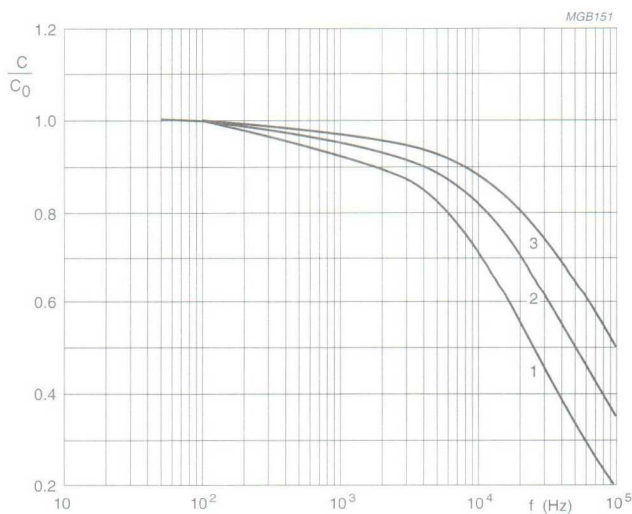
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Capacitance (C)



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 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.

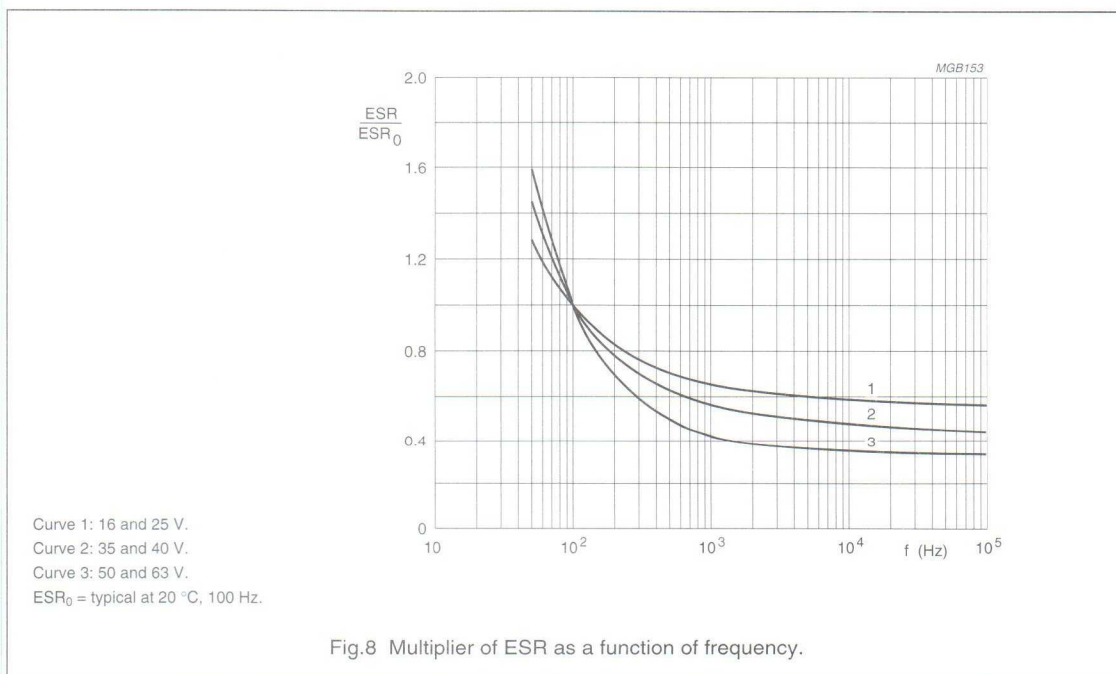
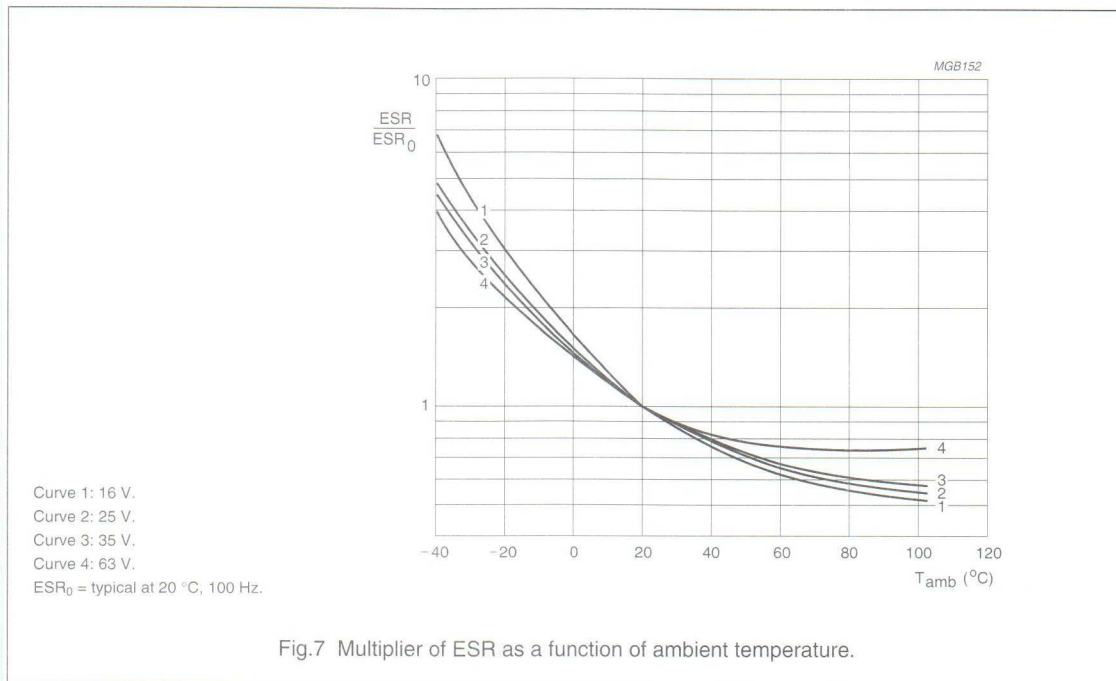
Fig.6 Typical multiplier of capacitance as a function of frequency.

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Equivalent series resistance (ESR)

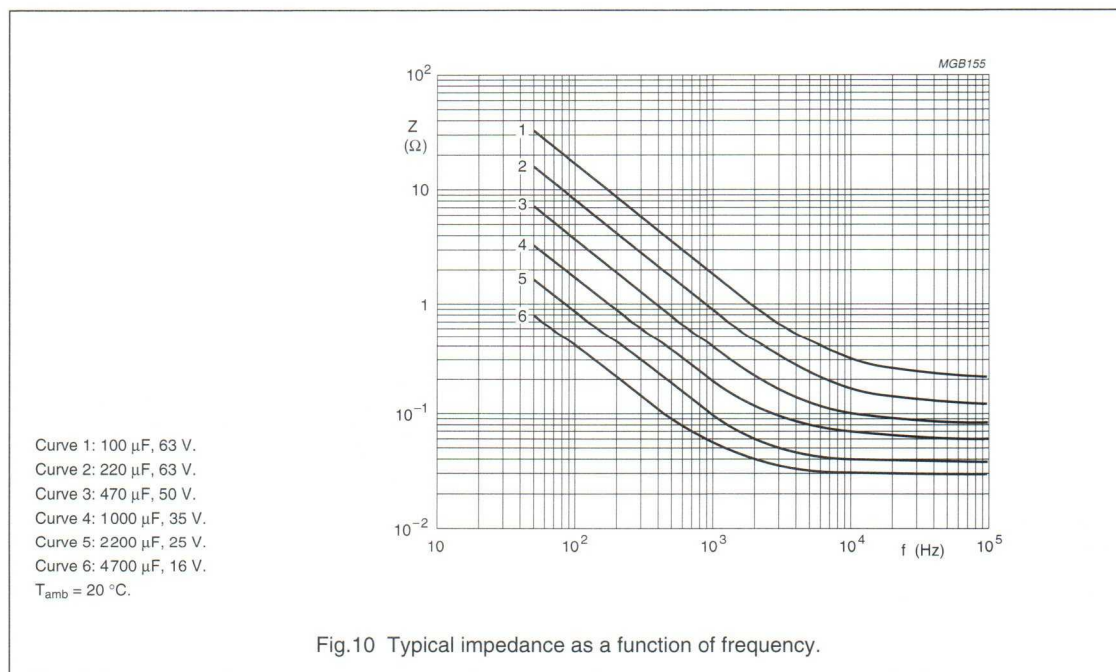
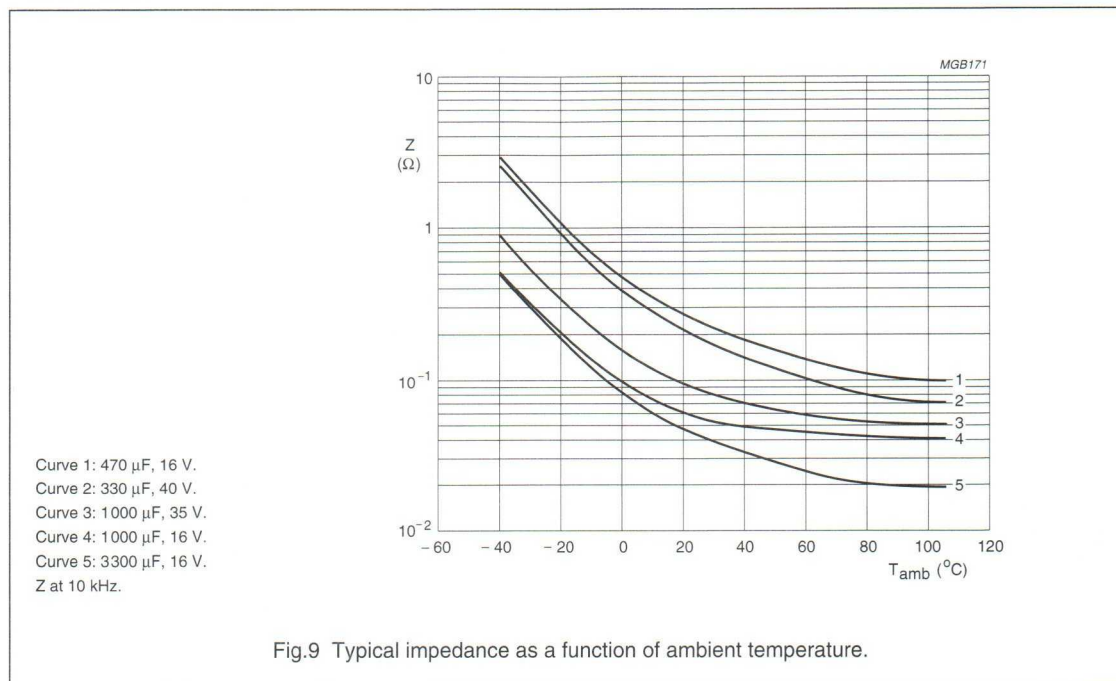


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Impedance (Z)



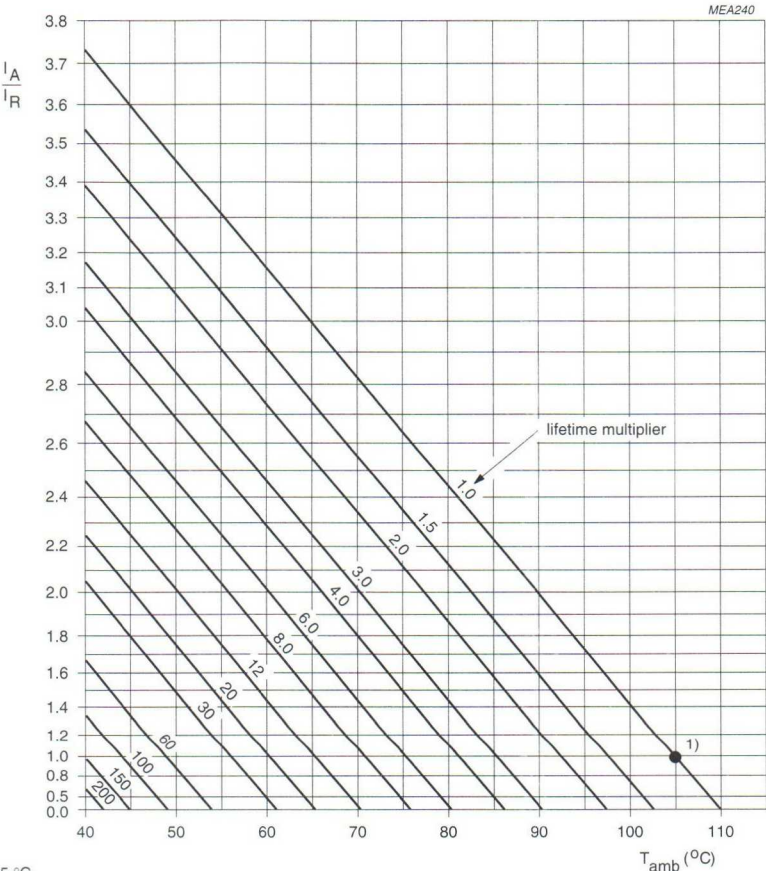
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RIPPLE CURRENT AND USEFUL LIFE

Table 3 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 16 \text{ and } 25 \text{ V}$	$U_R = 35 \text{ and } 40 \text{ V}$	$U_R = 50 \text{ and } 63 \text{ V}$
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: 1500 hours.

Fig.11 Multiplier of useful life as a function of ambient temperature and ripple current load.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 1000 hours	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; 1500 hours	$\Delta C/C: \pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300, subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$

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NOTES

Aluminium electrolytic capacitors

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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 CV-product per unit volume
- Long useful life: 2000 hours at 105 °C, high reliability.

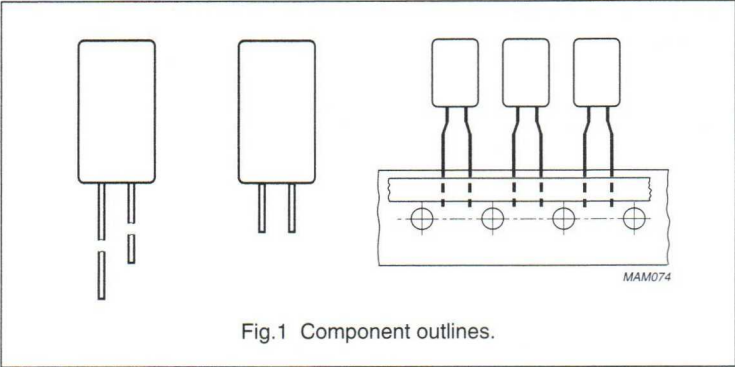
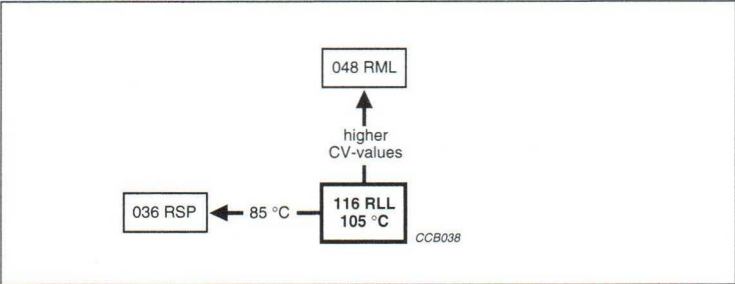


Fig.1 Component outlines.

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).



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	5 × 11 and 8.2 × 11
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, $1.3 \times I_R$ applied	200000 hours
Shelf life at 0 V, 105 °C	1500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	55/105/56

Aluminium electrolytic capacitors

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ 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 × 11	—	—
1.0	—	—	—	—	—	—	5 × 11	—	—
1.5	—	—	—	—	—	—	5 × 11	—	—
2.2	—	—	—	—	—	—	5 × 11	—	8.2 × 11
3.3	—	—	—	—	—	—	5 × 11	—	—
4.7	—	—	—	—	—	—	5 × 11	—	8.2 × 11
6.8	—	—	—	—	—	—	5 × 11	—	—
10	—	—	—	—	—	—	5 × 11	8.2 × 11	8.2 × 11
	—	—	—	—	—	—	8.2 × 11	—	—
15	—	—	—	—	—	—	5 × 11	—	—
22	—	—	—	—	—	—	5 × 11	8.2 × 11	—
	—	—	—	—	—	—	8.2 × 11	—	—
33	—	—	—	—	5 × 11	5 × 11	8.2 × 11	—	—
47	—	—	—	5 × 11	—	—	8.2 × 11	—	—
68	—	—	5 × 11	—	—	—	8.2 × 11	—	—
100	—	5 × 11	—	—	8.2 × 11	8.2 × 11	—	—	—
150	5 × 11	—	—	8.2 × 11	—	—	—	—	—
220	—	—	8.2 × 11	—	—	—	—	—	—
330	—	8.2 × 11	—	—	—	—	—	—	—
470 ⁽¹⁾	8.2 × 11	—	—	—	—	—	—	—	—

Note

- For higher CV-values see data sheet "048 RML".

R

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

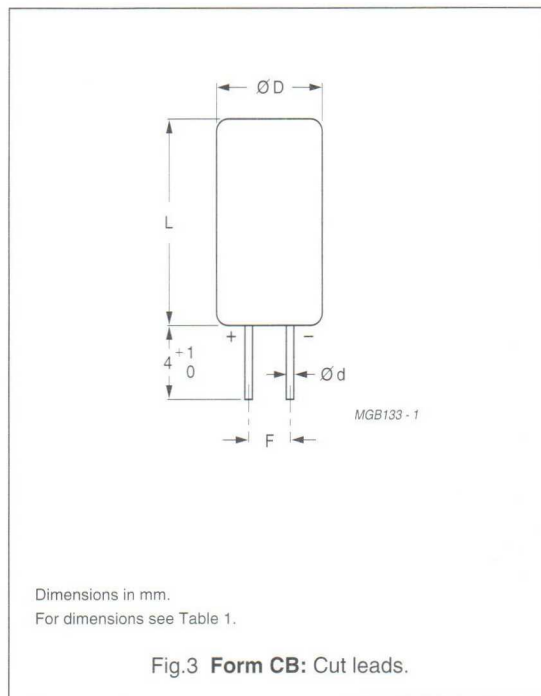
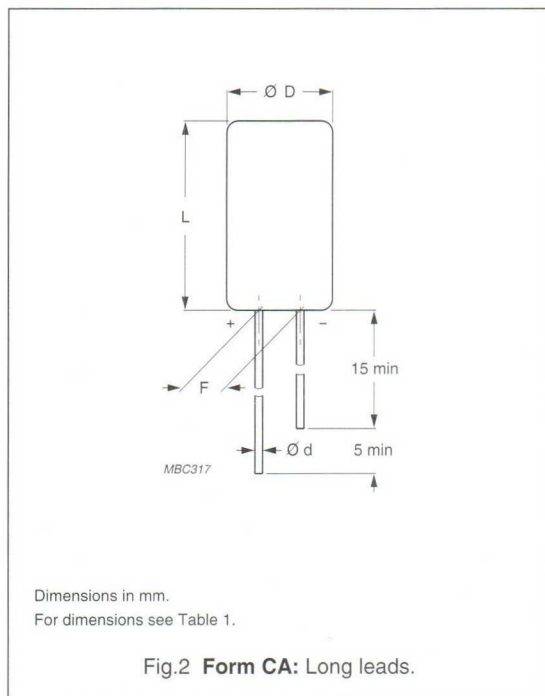


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

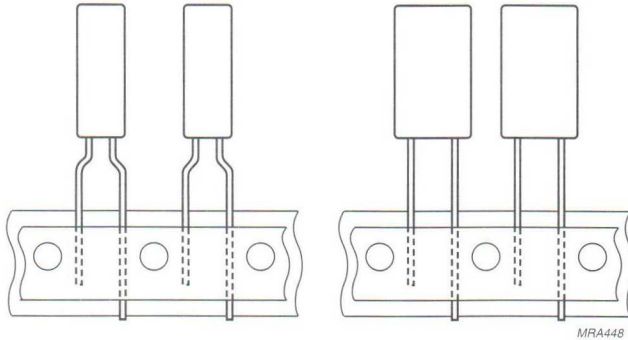
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA, CB	FORM TR+, TN+	FORM TFA, TNA
5 × 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	1000	2000
8.2 × 11	13	0.6	8.7	12	5 ± 0.5	≈ 1.1	1000	500	1000

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Taped products

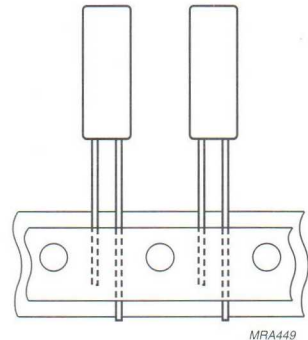


Form TFA:

Pitch $F = 5$ mm.Case $\varnothing D \times L = 5 \times 11$ and 8.2×11 mm.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.4 Taped in box (ammopack).



Form TNA:

Pitch $F = 2.5$ mm.Case $\varnothing D \times L = 5 \times 11$ mm only.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.5 Taped in box (ammopack).

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.

Aluminium electrolytic capacitors

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 2 and 4 apply at $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 kHz, $105\text{ }^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and C_R)
Z_{10}	max. impedance at 10 kHz and 20 or $-40\text{ }^{\circ}\text{C}$
Z_{100}	max. impedance at 100 kHz and $20\text{ }^{\circ}\text{C}$

Table 2 Electrical data; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 kHz $105\text{ }^{\circ}\text{C}$ (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z_{10} 10 kHz $20\text{ }^{\circ}\text{C}$ (Ω)	Z_{100} 100 kHz $20\text{ }^{\circ}\text{C}$ (Ω)	Z_{10} 10 kHz $-40\text{ }^{\circ}\text{C}$ (Ω)
6.3	150	5×11	11	130	8.7	3.9	0.25	2.7	2	1.3	32
	470	8.2×11	13	300	21	6	0.25	0.8	0.64	0.45	10
10	100	5×11	11	130	9	4	0.2	3.2	2	1.4	32
	330	8.2×11	13	280	23	6.3	0.2	1.0	0.61	0.45	9.7
16	68	5×11	11	130	9.5	4.1	0.16	3.7	2.4	1.5	29
	220	8.2×11	13	280	24	6.5	0.16	1.2	0.73	0.5	9.1
25	47	5×11	11	120	10	4.2	0.14	4.7	2.6	1.6	32
	150	8.2×11	13	260	26	6.8	0.14	1.5	0.8	0.5	10
35	33	5×11	11	110	9.9	4.2	0.12	5.8	2.7	1.7	33
	100	8.2×11	13	240	24	6.5	0.12	1.9	0.9	0.55	11
40	33	5×11	11	110	10.9	4.3	0.12	5.8	2.7	1.7	33
	100	8.2×11	13	240	27	7	0.12	1.9	0.9	0.55	11

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ORDERING INFORMATION

Ordering example

Electrolytic capacitor 116 series

220 μ F/16 V; $\pm 20\%$ Nominal case size: $\varnothing 8.2 \times 11$ mm; Form TFA

Catalogue number: 2222 116 35221.

Table 3 Ordering information; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	150	11	116 53151	2.5	—	—	116 33151	5.0	116 73151	2.5
	470	13	116 53471	5.0	116 63471	5.0	116 33471	5.0	—	—
10	100	11	116 54101	2.5	—	—	116 34101	5.0	116 74101	2.5
	330	13	116 54331	5.0	116 64331	5.0	116 34331	5.0	—	—
16	68	11	116 55689	2.5	—	—	116 35689	5.0	116 75689	2.5
	220	13	116 55221	5.0	116 65221	5.0	116 35221	5.0	—	—
25	47	11	116 56479	2.5	—	—	116 36479	5.0	116 76479	2.5
	150	13	116 56151	5.0	116 66151	5.0	116 36151	5.0	—	—
35	33	11	116 50339	2.5	—	—	116 30339	5.0	116 70339	2.5
	100	13	116 50101	5.0	116 60101	5.0	116 30101	5.0	—	—
40	33	11	116 57339	2.5	—	—	116 37339	5.0	116 77339	2.5
	100	13	116 57101	5.0	116 67101	5.0	116 37101	5.0	—	—

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ELECTRICAL DATA (continued)

Table 4 Electrical data continued; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 kHz 105 °C (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z_{10} 10 kHz 20 °C (Ω)	Z_{100} 100 kHz 20 °C (Ω)	Z_{10} 10 kHz -40 °C (Ω)
50	0.47	5 × 11	11	30	3.1	3	0.09	300	150	10	1900
	1.0	5 × 11	11	40	3.3	3.1	0.09	140	70	6	900
	1.5	5 × 11	11	50	3.5	3.1	0.09	95	47	4	600
	2.2	5 × 11	11	60	3.7	3.1	0.09	65	32	3.5	410
	3.3	5 × 11	11	65	4	3.2	0.09	43	21	3.1	270
	4.7	5 × 11	11	70	4.4	3.2	0.09	30	15	2.8	190
	6.8	5 × 11	11	75	5	3.3	0.09	21	10	2.5	130
	10	5 × 11	11	80	6	3.5	0.09	14	7	2.2	90
	10	8.2 × 11	13	160	6	3.5	0.05	8.0	3.6	1.0	40
	15	5 × 11	11	90	7.5	3.8	0.09	9.5	4.7	2.0	60
	22	5 × 11	11	110	9.6	4.1	0.09	6.5	3.2	1.9	41
	22	8.2 × 11	13	190	9.6	4.1	0.06	4.4	2.2	0.9	29
	33	8.2 × 11	13	190	13	4.7	0.09	4.3	2.1	0.77	27
	47	8.2 × 11	13	210	17	5.4	0.09	3.0	1.5	0.65	19
	68	8.2 × 11	13	240	23	6.4	0.09	2.1	1.0	0.55	13
63	10	8.2 × 11	13	160	7	3.6	0.06	9.5	3.5	1.3	45
	22	8.2 × 11	13	190	11	4.4	0.06	4.4	1.8	0.9	23
100	2.2	8.2 × 11	13	60	4.3	3.2	0.06	43	18	4	190
	4.7	8.2 × 11	13	75	5.8	3.5	0.07	24	12	3.5	170
	10	8.2 × 11	13	100	9	4	0.08	13	4.5	3	70

Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.3 U_R$
Reverse voltage		$U_{rev} \leq 1 V$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 3 \mu A$
	after 5 minutes at U_R	$I_{L5} \leq 0.001 C_R \times U_R + 3 \mu A$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D \times L = 5 \times 11$ mm	typ. 13 nH
	case $\varnothing D \times L = 8.2 \times 11$ mm	typ. 16 nH

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ORDERING INFORMATION (continued)**Table 5** Ordering information continued; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
50	0.47	11	116 51477	2.5	—	5.0	116 31477	5.0	116 71477	2.5
	1.0	11	116 51108	2.5	—	5.0	116 31108	5.0	116 71108	2.5
	1.5	11	116 51158	2.5	—	5.0	116 31158	5.0	116 71158	2.5
	2.2	11	116 51228	2.5	—	5.0	116 31228	5.0	116 71228	2.5
	3.3	11	116 51338	2.5	—	5.0	116 31338	5.0	116 71338	2.5
	4.7	11	116 51478	2.5	—	5.0	116 31478	5.0	116 71478	2.5
	6.8	11	116 51688	2.5	—	5.0	116 31688	5.0	116 71688	2.5
	10	11	116 51109	2.5	—	5.0	116 31109	5.0	116 71109	2.5
	10	13	116 90084	5.0	116 90085	5.0	116 90036	5.0	—	—
	15	11	116 51159	2.5	—	5.0	116 31159	5.0	116 71159	2.5
	22	11	116 51229	2.5	—	5.0	116 31229	5.0	116 71229	2.5
	22	13	116 90025	5.0	116 90086	5.0	116 90039	5.0	—	—
	33	13	116 51339	5.0	116 61339	5.0	116 31339	5.0	—	—
	47	13	116 51479	5.0	116 61479	5.0	116 31479	5.0	—	—
	68	13	116 51689	5.0	116 61689	5.0	116 31689	5.0	—	—
63	10	13	116 58109	5.0	116 68109	5.0	116 38109	5.0	—	—
	22	13	116 58229	5.0	116 68229	5.0	116 38229	5.0	—	—
100	2.2	13	116 59228	5.0	116 69228	5.0	116 39228	5.0	—	—
	4.7	13	116 59478	5.0	116 69478	5.0	116 39478	5.0	—	—
	10	13	116 59109	5.0	116 69109	5.0	116 39109	5.0	—	—

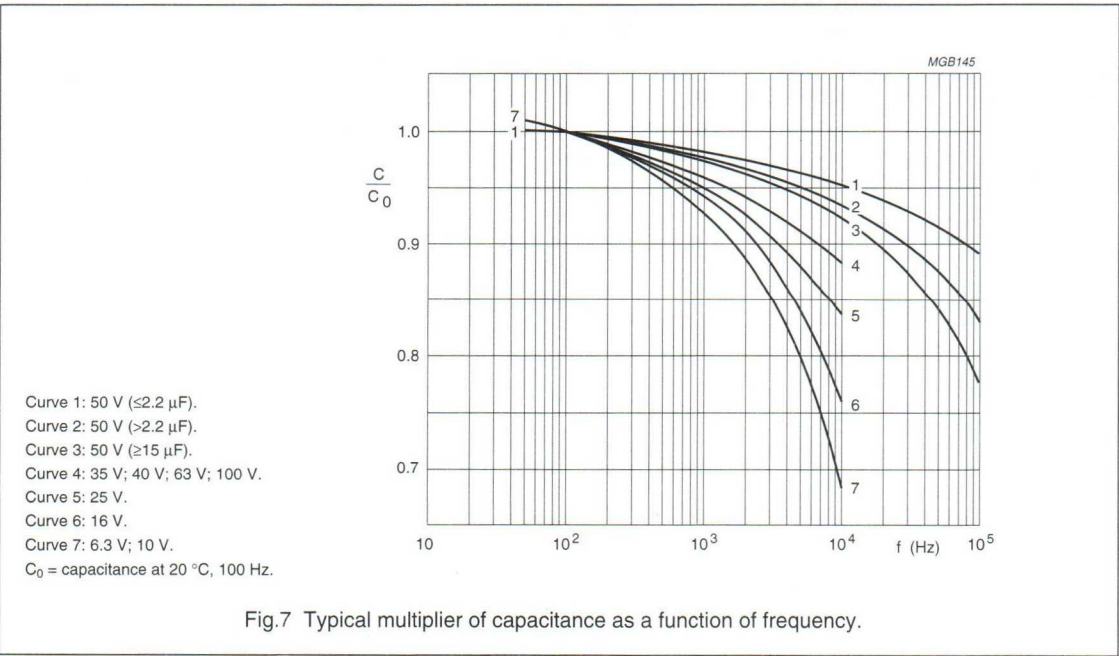
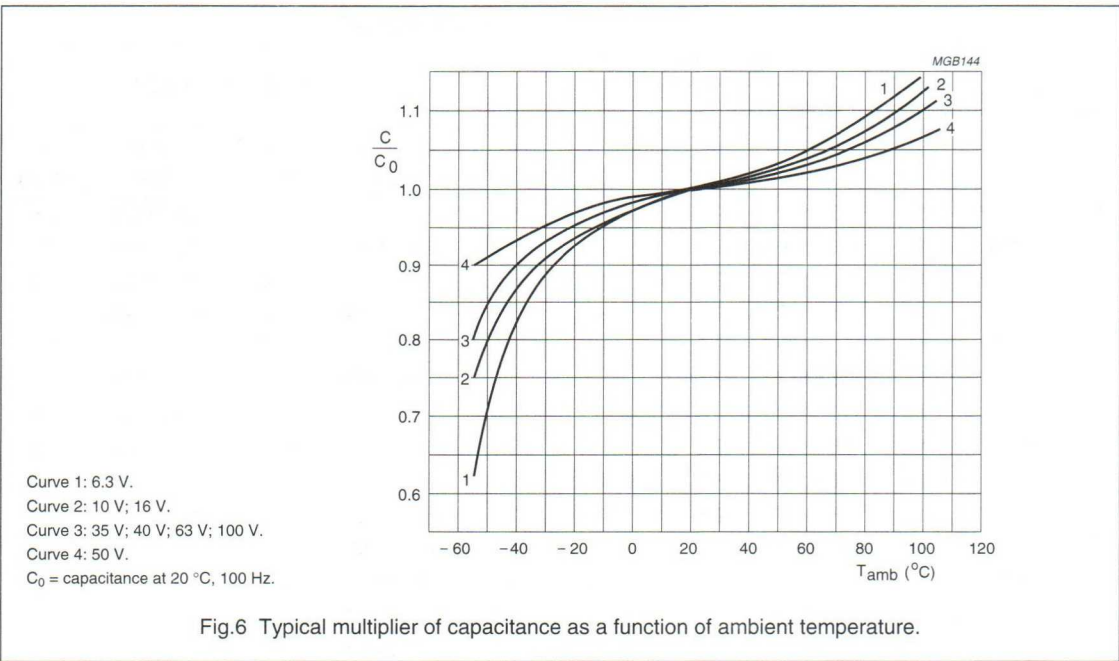
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ELECTRICAL DATA (continued)

Capacitance (C)

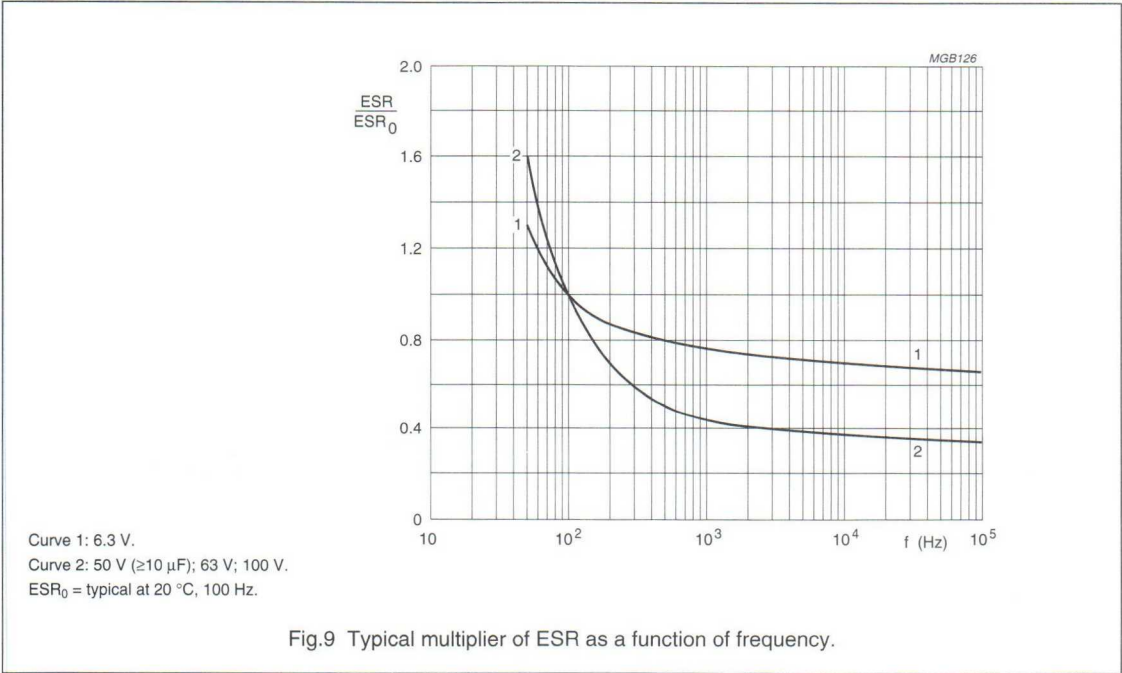
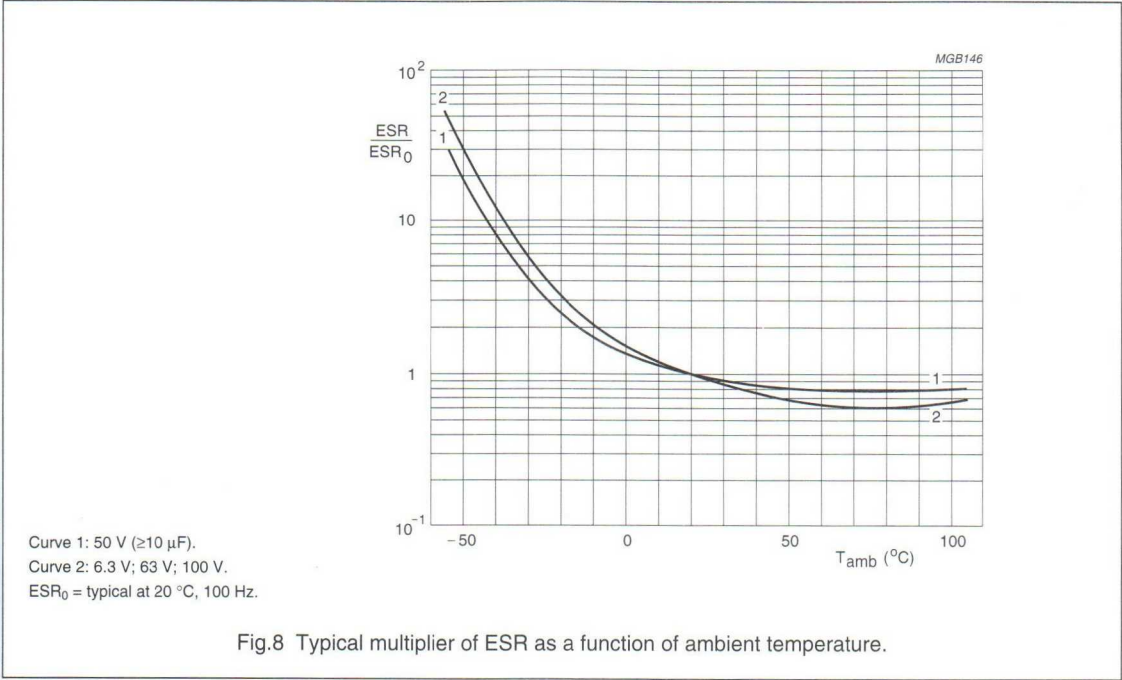


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Equivalent series resistance (ESR)



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Impedance (Z)

Curve 1: 0.47 μF .
 Curve 2: 1.0 μF .
 Curve 3: 1.5 μF .
 Curve 4: 2.2 μF .
 Curve 5: 3.3 μF .
 Curve 6: 4.7 μF .
 Curve 7: 6.8 μF .
 Curve 8: 10 μF .
 Curve 9: 15 μF .
 Curve 10: 22 μF .
 Curve 11: 33 μF .
 Curve 12: 47 μF .
 Curve 13: 68 μF .
 Curve 14: 100 μF .
 Curve 15: 150 μF .

Case $\varnothing D \times L = 5 \times 11 \text{ mm}$.

$T_{\text{amb}} = 20^\circ\text{C}$.

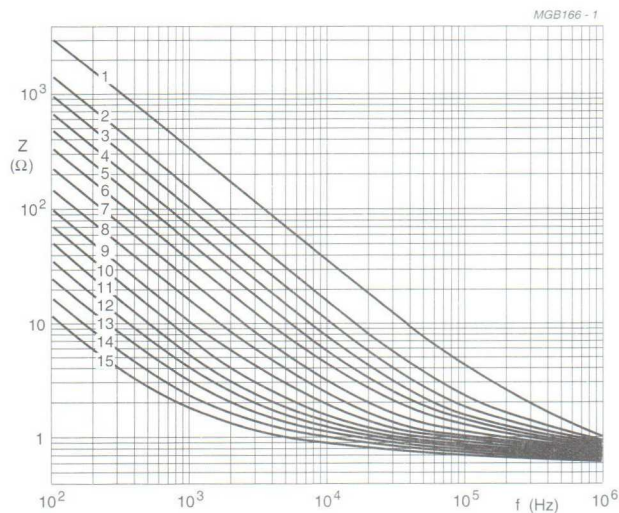


Fig.10 Typical impedance as a function of frequency.

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 .

Case $\varnothing D \times L = 8.2 \times 11 \text{ mm}$.

$T_{\text{amb}} = 20^\circ\text{C}$.

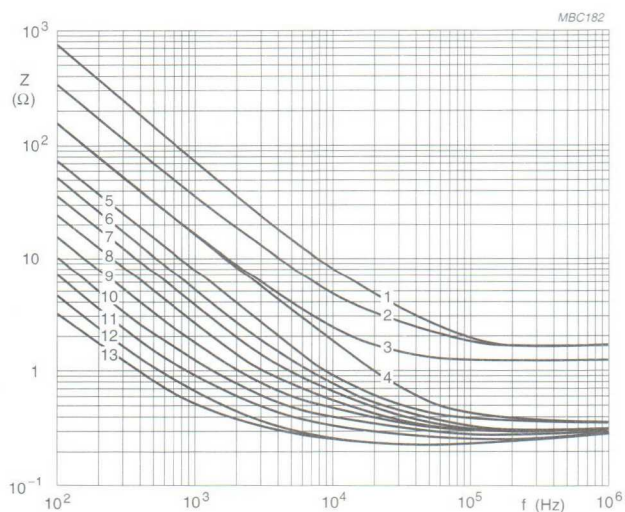


Fig.11 Typical impedance as a function of frequency.

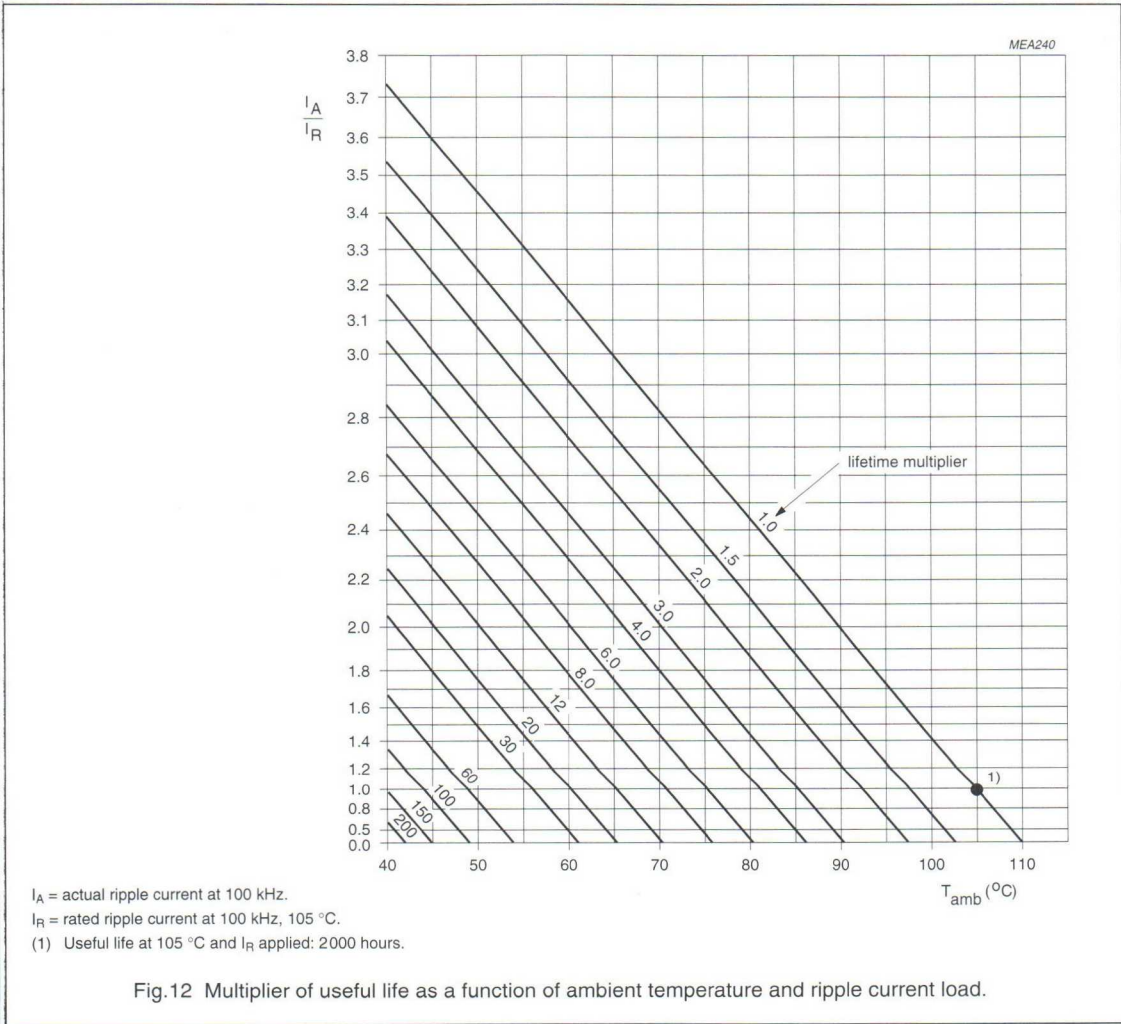
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RIPPLE CURRENT AND USEFUL LIFE

Table 6 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 100 kHz

FREQUENCY (Hz)	I _R MULTIPLIER		
	U _R = 6.3 to 10 V	U _R = 16 to 35 V	U _R = 40 to 100 V (C _R ≥ 10 μF)
50	0.7	0.6	0.5
100	0.77	0.71	0.63
300	0.86	0.85	0.78
1000	0.92	0.93	0.88
3000	0.96	0.96	0.94
10 to 100 k	1.0	1.0	1.0



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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 7 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 1500 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +15/–30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z_{10} \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; 2000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +45/–50% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z_{10} \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 1500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$

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NOTES

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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 to 2500 hours at 105 °C
- Low ESR, low impedance, high ripple current capability.

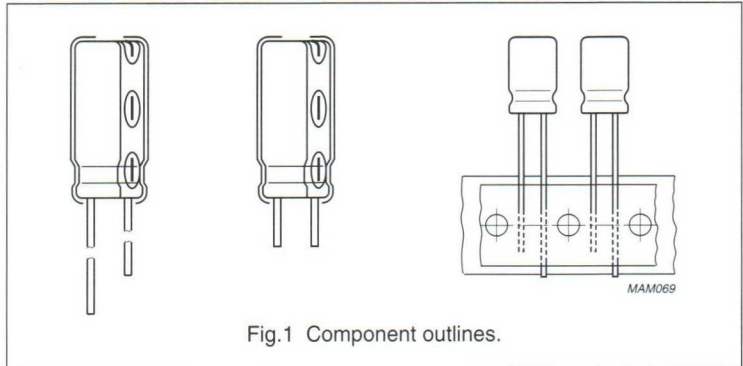
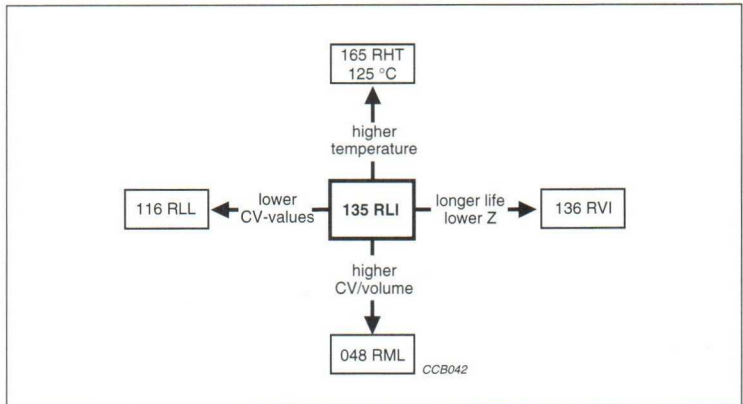


Fig.1 Component outlines.

APPLICATIONS

- General industrial, EDP, telecommunication and audio-video
- Smoothing, filtering, buffering in SMPS and DC/DC converters.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	8 × 12 to 8 × 20	10 × 12 to 18 × 40
Rated capacitance range, C_R	22 to 10000 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, $1.3 \times I_R$ applied	150000 hours	250000 hours
Shelf life at 0 V, 105 °C	1000 hours	1000 hours
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	55/105/56	

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

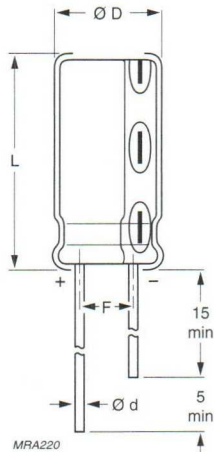
C_R (μF)	U_R (V)							
	6.3	10	16	25	35	50	63	100
22	—	—	—	—	—	—	—	8 × 12
47	—	—	—	—	—	—	8 × 12	—
100	—	—	—	—	8 × 12	10 × 16	—	12.5 × 20
220	—	—	8 × 12	8 × 15	8 × 20	10 × 25	12.5 × 20	16 × 25
330	—	—	8 × 15	—	10 × 20	12.5 × 20	—	16 × 31
	—	—	—	—	—	—	—	18 × 25
470	10 × 12	8 × 15	8 × 20	10 × 20	10 × 30	12.5 × 25	16 × 25	16 × 40
	—	—	—	—	—	18 × 15	—	—
680	10 × 16	—	10 × 20	—	12.5 × 25	—	16 × 31	18 × 40
1000	—	12.5 × 16	10 × 30	12.5 × 25	12.5 × 31	16 × 31	16 × 40	—
	—	—	—	—	16 × 20	—	—	—
1500	—	10 × 30	12.5 × 25	12.5 × 31	12.5 × 40	16 × 40	—	—
2200	12.5 × 20	12.5 × 25	12.5 × 31	12.5 × 40	16 × 35	18 × 40	—	—
	—	18 × 15	16 × 20	18 × 20	18 × 31	—	—	—
3300	—	12.5 × 35	—	16 × 35	18 × 40	—	—	—
	—	16 × 20	—	18 × 31	—	—	—	—
4700	—	16 × 31	16 × 35	18 × 40	—	—	—	—
	—	18 × 25	18 × 31	—	—	—	—	—
6800	16 × 31	16 × 35	18 × 35	—	—	—	—	—
10000	18 × 31	18 × 40	—	—	—	—	—	—

Aluminium electrolytic capacitors

Radial, Low Impedance

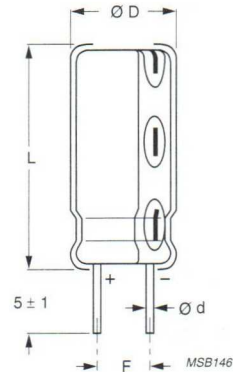
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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.
For dimensions see Table 1.

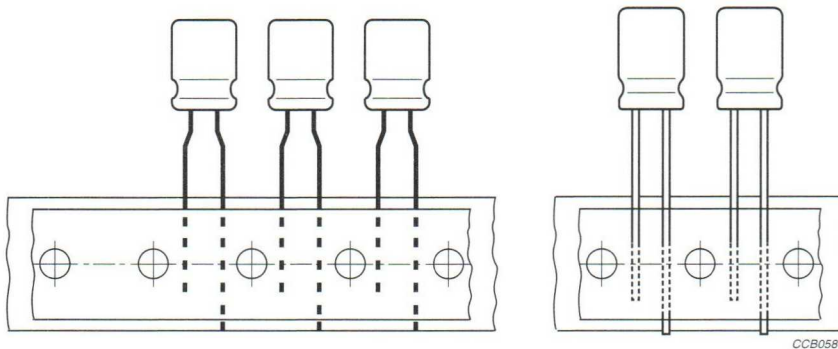
Fig.2 **Form CA:** Long leads.



Dimensions in mm.
For dimensions see Table 1.

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

Taped products



Form TFA:

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.4 Taped in box (ammopack).

Aluminium electrolytic capacitors

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Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
8 × 12	13	0.6	8.5	13	3.5 ± 0.5	≈ 1.1	1000	2000	1000
8 × 15	13L	0.6	8.5	16	3.5 ± 0.5	≈ 1.3	1000	2000	1000
8 × 20	13LL	0.6	8.5	21	3.5 ± 0.5	≈ 1.5	1000	1000	1000
10 × 12	14	0.6	10.5	13.5	5 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22	5 ± 0.5	≈ 2.2	500	500	800
10 × 25	16L	0.6	10.5	27	5 ± 0.5	≈ 3.0	1000	1500	800
10 × 30	16LL	0.6	10.5	32	5 ± 0.5	≈ 3.5	1000	750	—
12.5 × 16	17a	0.6	13	17.5	5 ± 0.5	≈ 2.7	1000	1500	500
12.5 × 20	17	0.6	13	22	5 ± 0.5	≈ 4.0	500	500	500
12.5 × 25	18	0.6	13	27	5 ± 0.5	≈ 5.0	250	250	500
12.5 × 31	18L	0.6	13	33.5	5 ± 0.5	≈ 5.5	1000	750	—
12.5 × 35	18LL	0.6	13	37.5	5 ± 0.5	≈ 6.0	500	750	—
12.5 × 40	1240	0.6	13	42	5 ± 0.5	≈ 7.5	500	750	—
16 × 20	19a	0.8	16.5	23.5	7.5 ± 0.5	≈ 6.0	250	250	250
16 × 25	19	0.8	16.5	27	7.5 ± 0.5	≈ 8.0	250	250	250
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 × 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11	100	100	—
16 × 40	21L	0.8	16.5	42	7.5 ± 0.5	≈ 13	250	500	—
18 × 15	1815	0.8	18.5	17	7.5 ± 0.5	≈ 6.0	500	500	—
18 × 20	1820	0.8	18.5	23.5	7.5 ± 0.5	≈ 8.0	100	100	—
18 × 25	1825	0.8	18.5	27.0	7.5 ± 0.5	≈ 10	100	100	—
18 × 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	—
18 × 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	—
18 × 40	23	0.8	18.5	42	7.5 ± 0.5	≈ 16	250	500	—

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 (135)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with "IEC 62"
- Code indicating factory of origin
- Negative terminal identification.

Aluminium electrolytic capacitors

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 2, 4 and 6 apply at $T_{amb} = 20\text{ °C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 120 Hz, tolerance $\pm 20\%$
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
$\tan \delta$	max. dissipation factor at 120 Hz
ESR	equivalent series resistance at 120 Hz (calculated from $\tan \delta_{max}$ and C_R)
Z	max. impedance at 100 kHz and 20 or -10 °C

Table 2 Electrical data; preferred types in **bold**

U_R (V)	C_R 120 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 120 Hz 105 °C (mA)	I_{RH} 100 kHz 105 °C (mA)	I_{L1} 1 min (μA)	I_{L2} 2 min (μA)	$\tan \delta$ 120 Hz	ESR 120 Hz (Ω)	Z 100 kHz 20 °C (Ω)	Z 100 kHz -10 °C (Ω)
6.3	470	10 × 12	14	410	510	89	30	0.22	0.62	0.28	0.73
	680	10 × 16	15	510	640	129	43	0.22	0.43	0.22	0.57
	2200	12.5 × 20	17	1000	1100	416	140	0.24	0.14	0.089	0.23
	6800	16 × 31	20	1600	1800	1290	430	0.32	0.062	0.055	0.14
	10000	18 × 31	1831	1800	2000	1890	630	0.40	0.053	0.047	0.12
10	470	8 × 15	13L	400	500	141	47	0.19	0.54	0.24	0.62
	1000	12.5 × 16	17a	780	970	300	100	0.19	0.25	0.12	0.31
	1500	10 × 30	16LL	1000	1200	450	150	0.19	0.17	0.093	0.24
	2200	12.5 × 25	18	1200	1300	660	220	0.21	0.13	0.073	0.19
	2200	18 × 15	1815	1200	1300	660	220	0.21	0.13	0.080	0.21
	3300	12.5 × 35	18LL	1600	1800	990	330	0.23	0.092	0.052	0.14
	3300	16 × 20	19a	1200	1400	990	330	0.23	0.092	0.075	0.20
	4700	16 × 31	20	1600	1800	1410	470	0.25	0.071	0.054	0.14
	4700	18 × 25	1825	1700	1800	1410	470	0.25	0.071	0.053	0.14
	6800	16 × 35	21	1800	2000	2040	680	0.29	0.057	0.046	0.12
	10000	18 × 40	23	2200	2500	3000	1000	0.37	0.049	0.037	0.096

Aluminium electrolytic capacitors

Radial, Low Impedance

135 RLI

ORDERING EXAMPLE

Electrolytic capacitor 135 series

1000 $\mu\text{F}/16 \text{ V}; \pm 20\%$ Nominal case size: $\varnothing 10 \times 30 \text{ mm}$; Form CB

Catalogue number: 2222 135 65102.

Table 3 Ordering information; preferred types in **bold**

U _R (V)	C _R 120 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	CATALOGUE NUMBER 2222					
				BULK PACKAGING				TAPED	
				LONG LEADS		CUT LEADS			
				FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)
6.3	470	10 × 12	14	135 53471	5.0	135 63471	5.0	135 33471	5.0
	680	10 × 16	15	135 53681	5.0	135 63681	5.0	135 33681	5.0
	2200	12.5 × 20	17	135 53222	5.0	135 63222	5.0	135 33222	5.0
	6800	16 × 31	20	135 53682	7.5	135 63682	7.5	135 33682	7.5
	10000	18 × 31	1831	135 53103	7.5	135 63103	7.5	—	—
10	470	8 × 15	13L	135 54471	3.5	135 84471	3.5	135 34471	5.0
	1000	12.5 × 16	17a	135 54102	5.0	135 64102	5.0	135 34102	5.0
	1500	10 × 30	16LL	135 54152	5.0	135 64152	5.0	—	—
	2200	12.5 × 25	18	135 54222	5.0	135 64222	5.0	135 34222	5.0
	2200	18 × 15	1815	135 90001	7.5	135 90002	7.5	—	—
	3300	12.5 × 35	18LL	135 54332	5.0	135 64332	5.0	—	—
	3300	16 × 20	19a	135 90025	7.5	135 90026	7.5	135 90042	7.5
	4700	16 × 31	20	135 54472	7.5	135 64472	7.5	135 34472	7.5
	4700	18 × 25	1825	135 90003	7.5	135 90004	7.5	—	—
	6800	16 × 35	21	135 54682	7.5	135 64682	7.5	—	—
	10000	18 × 40	23	135 54103	7.5	135 64103	7.5	—	—

R

Aluminium electrolytic capacitors

Radial, Low Impedance

135 RLI

ELECTRICAL DATA (continued)**Table 4** Electrical data continued; preferred types in **bold**

U_R (V)	C_R 120 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 120 Hz 105 °C (mA)	I_{RH} 100 kHz 105 °C (mA)	I_{L1} 1 min (μ A)	I_{L2} 2 min (μ A)	$\tan \delta$ 120 Hz	ESR 120 Hz (Ω)	Z 100 kHz 20 °C (Ω)	Z 100 kHz -10 °C (Ω)
16	220	8 × 12	13	220	400	106	35	0.16	0.96	0.33	0.86
	330	8 × 15	13L	350	500	158	53	0.16	0.64	0.23	0.60
	470	8 × 20	13LL	520	650	226	75	0.16	0.45	0.18	0.47
	680	10 × 20	16	690	860	326	110	0.16	0.31	0.14	0.36
	1000	10 × 30	16LL	920	1200	480	160	0.16	0.21	0.091	0.24
	1500	12.5 × 25	18	1200	1300	720	240	0.16	0.14	0.072	0.19
	2200	12.5 × 31	18L	1400	1500	1060	350	0.18	0.11	0.063	0.16
	2200	16 × 20	19a	1200	1400	1060	350	0.18	0.11	0.073	0.19
	4700	16 × 35	21	1800	2000	2260	750	0.22	0.062	0.046	0.12
	4700	18 × 31	1831	1800	2000	2260	750	0.22	0.062	0.046	0.12
	6800	18 × 35	22	2000	2200	3260	1100	0.26	0.051	0.040	0.10
25	220	8 × 15	13L	350	500	165	55	0.14	0.84	0.23	0.60
	470	10 × 20	16	690	860	353	120	0.14	0.40	0.14	0.36
	1000	12.5 × 25	18	1100	1300	750	250	0.14	0.19	0.071	0.18
	1500	12.5 × 31	18L	1400	1500	1125	380	0.14	0.12	0.062	0.16
	2200	12.5 × 40	1240	1800	2000	1650	550	0.16	0.10	0.044	0.11
	2200	18 × 20	1820	1400	1600	1650	550	0.16	0.10	0.060	0.16
	3300	16 × 35	21	1800	2000	2475	830	0.18	0.072	0.045	0.12
	3300	18 × 31	1831	1800	2000	2475	830	0.18	0.072	0.045	0.12
	4700	18 × 40	23	2200	2500	3525	1200	0.20	0.056	0.036	0.94
35	100	8 × 12	13	280	400	105	35	0.12	1.59	0.32	0.83
	220	8 × 20	13LL	460	650	231	77	0.12	0.72	0.18	0.47
	330	10 × 20	16	610	860	347	120	0.12	0.48	0.13	0.34
	470	10 × 30	16LL	920	1200	490	160	0.12	0.34	0.089	0.23
	680	12.5 × 25	18	1100	1300	714	240	0.12	0.23	0.070	0.18
	1000	12.5 × 31	18L	1400	1500	1050	350	0.12	0.16	0.061	0.16
	1000	16 × 20	19a	1100	1370	1050	350	0.12	0.16	0.071	0.18
	1500	12.5 × 40	1240	1800	2000	1575	530	0.12	0.11	0.043	0.11
	2200	16 × 35	21	1800	2000	2310	770	0.14	0.084	0.044	0.11
	2200	18 × 31	1831	1800	2000	2310	770	0.14	0.084	0.044	0.11
	3300	18 × 40	23	2200	2500	3465	1200	0.16	0.064	0.035	0.091

Aluminium electrolytic capacitors

Radial, Low Impedance

135 RLI

ORDERING INFORMATION (continued)**Table 5** Ordering information continued; preferred types in **bold**

U _R (V)	C _R 120 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	CATALOGUE NUMBER 2222					
				BULK PACKAGING				TAPED	
				LONG LEADS		CUT LEADS			
				FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)
16	220	8 × 12	13	135 55221	3.5	135 85221	3.5	135 35221	5.0
	330	8 × 15	13L	135 55331	3.5	135 85331	3.5	135 35331	5.0
	470	8 × 20	13LL	135 55471	3.5	135 85471	3.5	135 35471	5.0
	680	10 × 20	16	135 55681	5.0	135 65681	5.0	135 35681	5.0
	1000	10 × 30	16LL	135 55102	5.0	135 65102	5.0	—	—
	1500	12.5 × 25	18	135 55152	5.0	135 65152	5.0	135 35152	5.0
	2200	12.5 × 31	18L	135 55222	5.0	135 65222	5.0	—	—
	2200	16 × 20	19a	135 90007	7.5	135 90008	7.5	135 90043	7.5
	4700	16 × 35	21	135 55472	7.5	135 65472	7.5	—	—
	4700	18 × 31	1831	135 90009	7.5	135 90011	7.5	—	—
6800	18 × 35	22	135 55682	7.5	135 65682	7.5	—	—	
25	220	8 × 15	13L	135 56221	3.5	135 86221	3.5	135 36221	5.0
	470	10 × 20	16	135 56471	5.0	135 66471	5.0	135 36471	5.0
	1000	12.5 × 25	18	135 56102	5.0	135 66102	5.0	135 36102	5.0
	1500	12.5 × 31	18L	135 56152	5.0	135 66152	5.0	—	—
	2200	12.5 × 40	1240	135 56222	5.0	135 66222	5.0	—	—
	2200	18 × 20	1820	135 90012	7.5	135 90013	7.5	—	—
	3300	16 × 35	21	135 56332	7.5	135 66332	7.5	—	—
	3300	18 × 31	1831	135 90014	7.5	135 90015	7.5	—	—
	4700	18 × 40	23	135 56472	7.5	135 66472	7.5	—	—
	35	100	8 × 12	13	135 50101	3.5	135 80101	3.5	135 30101
220		8 × 20	13LL	135 50221	3.5	135 80221	3.5	135 30221	5.0
330		10 × 20	16	135 50331	5.0	135 60331	5.0	135 30331	5.0
470		10 × 30	16LL	135 50471	5.0	135 60471	5.0	—	—
680		12.5 × 25	18	135 50681	5.0	135 60681	5.0	135 30681	5.0
1000		12.5 × 31	18L	135 50102	5.0	135 60102	5.0	—	—
1000		16 × 20	19a	135 90016	7.5	135 90017	7.5	135 90044	7.5
1500		12.5 × 40	1240	135 50152	5.0	135 60152	5.0	—	—
2200		16 × 35	21	135 50222	7.5	135 60222	7.5	—	—
2200		18 × 31	1831	135 90018	7.5	135 90019	7.5	—	—
3300		18 × 40	23	135 50332	7.5	135 60332	7.5	—	—

R

Aluminium electrolytic capacitors

Radial, Low Impedance

135 RLI

ELECTRICAL DATA (continued)**Table 6** Electrical data continued; preferred types in **bold**

U_R (V)	C_R 120 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 120 Hz 105 °C (mA)	I_{RH} 100 kHz 105 °C (mA)	I_{L1} 1 min (μA)	I_{L2} 2 min (μA)	$\tan \delta$ 120 Hz	ESR 120 Hz (Ω)	Z 100 kHz 20 °C (Ω)	Z 100 kHz -10 °C (Ω)
50	100	10 × 16	15	450	640	150	50	0.10	1.33	0.20	0.52
	220	10 × 25	16L	730	1000	330	110	0.10	0.60	0.11	0.29
	330	12.5 × 20	17	790	1100	495	170	0.10	0.40	0.081	0.22
	470	12.5 × 25	18	1100	1300	705	240	0.10	0.28	0.068	0.19
	470	18 × 15	1815	1000	1300	705	240	0.10	0.28	0.074	0.19
	1000	16 × 31	20	1500	1800	1500	500	0.10	0.13	0.050	0.13
	1500	16 × 40	21L	2100	2300	2250	750	0.10	0.088	0.035	0.091
	2200	18 × 40	23	2200	2500	3300	1100	0.12	0.072	0.034	0.091
63	47	8 × 12	13	220	300	89	30	0.08	2.26	0.56	1.5
	220	12.5 × 20	17	630	890	416	140	0.08	0.48	0.16	0.42
	470	16 × 25	19	1200	1400	888	300	0.08	0.23	0.091	0.25
	680	16 × 31	20	1400	1800	1285	430	0.08	0.16	0.065	0.18
	1000	16 × 40	21L	1800	2200	1890	630	0.08	0.11	0.049	0.13
100	22	8 × 12	13	120	310	66	22	0.07	4.22	0.53	1.4
	100	12.5 × 20	17	630	890	300	100	0.07	0.93	0.15	0.40
	220	16 × 25	19	1000	1400	660	220	0.07	0.42	0.086	0.23
	330	16 × 31	20	1300	1800	990	330	0.07	0.28	0.062	0.17
	330	18 × 25	1825	1200	1700	990	330	0.07	0.28	0.074	0.20
	470	16 × 40	21L	1800	2200	1410	470	0.07	0.20	0.047	0.13
	680	18 × 40	23	1900	2400	2040	680	0.07	0.14	0.043	0.12

Aluminium electrolytic capacitors

Radial, Low Impedance

135 RLI

ORDERING INFORMATION (continued)**Table 7** Ordering information continued; preferred types in **bold**

U _R (V)	C _R 120 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	CATALOGUE NUMBER 2222					
				BULK PACKAGING				TAPED	
				LONG LEADS		CUT LEADS			
				FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)
50	100	10 × 16	15	135 51101	5.0	135 61101	5.0	135 31101	5.0
	220	10 × 25	16L	135 51221	5.0	135 61221	5.0	135 31221	5.0
	330	12.5 × 20	17	135 51331	5.0	135 61331	5.0	135 31331	5.0
	470	12.5 × 25	18	135 51471	5.0	135 61471	5.0	135 31471	5.0
	470	18 × 15	1815	135 90021	7.5	135 90022	7.5	—	—
	1000	16 × 31	20	135 51102	7.5	135 61102	7.5	135 31102	7.5
	1500	16 × 40	21L	135 51152	7.5	135 61152	7.5	—	—
	2200	18 × 40	23	135 51222	7.5	135 61222	7.5	—	—
63	47	8 × 12	13	135 58479	3.5	135 88479	3.5	135 38479	5.0
	220	12.5 × 20	17	135 58221	5.0	135 68221	5.0	135 38221	5.0
	470	16 × 25	19	135 58471	7.5	135 68471	7.5	135 38471	7.5
	680	16 × 31	20	135 58681	7.5	135 68681	7.5	135 38681	7.5
	1000	16 × 40	21L	135 58102	7.5	135 68102	7.5	—	—
100	22	8 × 12	13	135 59229	3.5	135 89229	3.5	135 39229	5.0
	100	12.5 × 20	17	135 59101	5.0	135 69101	5.0	135 39101	5.0
	220	16 × 25	19	135 59221	7.5	135 69221	7.5	—	—
	330	16 × 31	20	135 59331	7.5	135 69331	7.5	—	—
	330	18 × 25	1825	135 90023	7.5	135 90024	7.5	—	—
	470	16 × 40	21L	135 59471	7.5	135 69471	7.5	—	—
	680	18 × 40	23	135 59681	7.5	135 69681	7.5	—	—

R

Aluminium electrolytic capacitors

Radial, Low Impedance

135 RLI

Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.03 C_R \times U_R$
	after 2 minutes at U_R	$I_{L2} \leq 0.01 C_R \times U_R$
Capacitance (C)		
Ratio of capacitance at 120 Hz	$U_R = 6.3 \text{ V}$	$C_{-55^\circ\text{C}}/C_{20^\circ\text{C}} \geq 0.7$
	$U_R = 10 \text{ to } 100 \text{ V}$	$C_{-55^\circ\text{C}}/C_{20^\circ\text{C}} \geq 0.8$
Impedance (Z)		
Ratio of impedance at 120 Hz		$Z_{-55^\circ\text{C}}/Z_{20^\circ\text{C}} \leq 3$

Aluminium electrolytic capacitors

Radial, Low Impedance

135 RLI

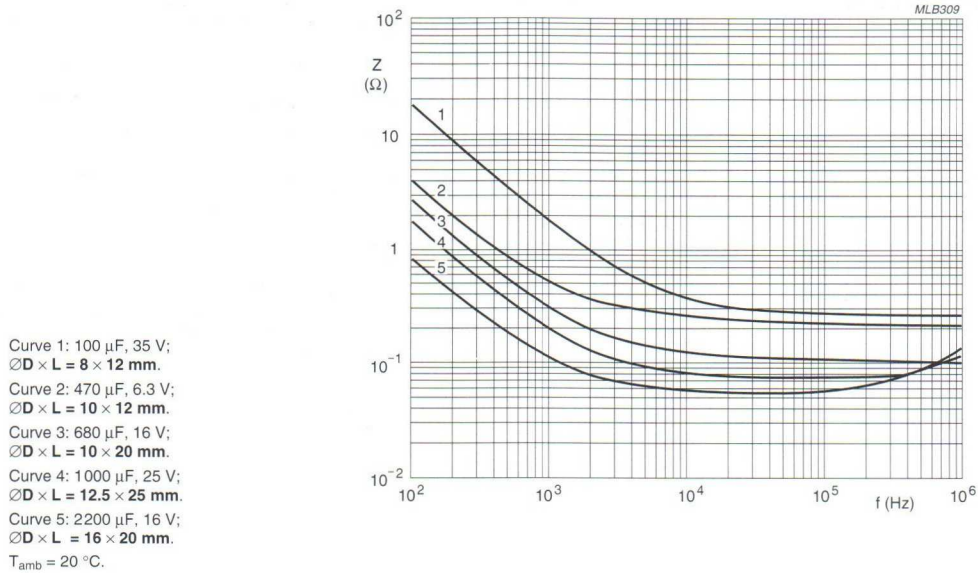


Fig.5 Typical impedance as a function of frequency.

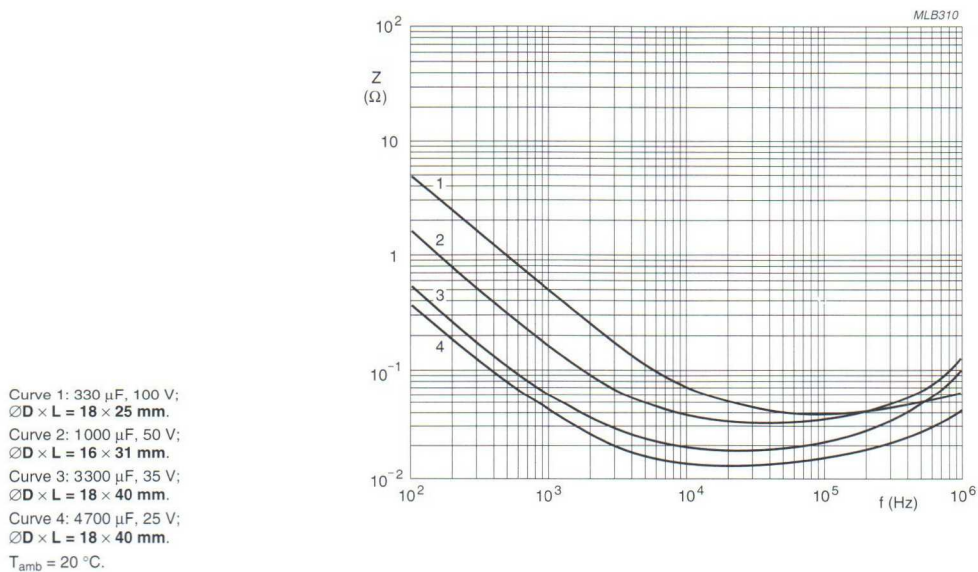


Fig.6 Typical impedance as a function of frequency.

R

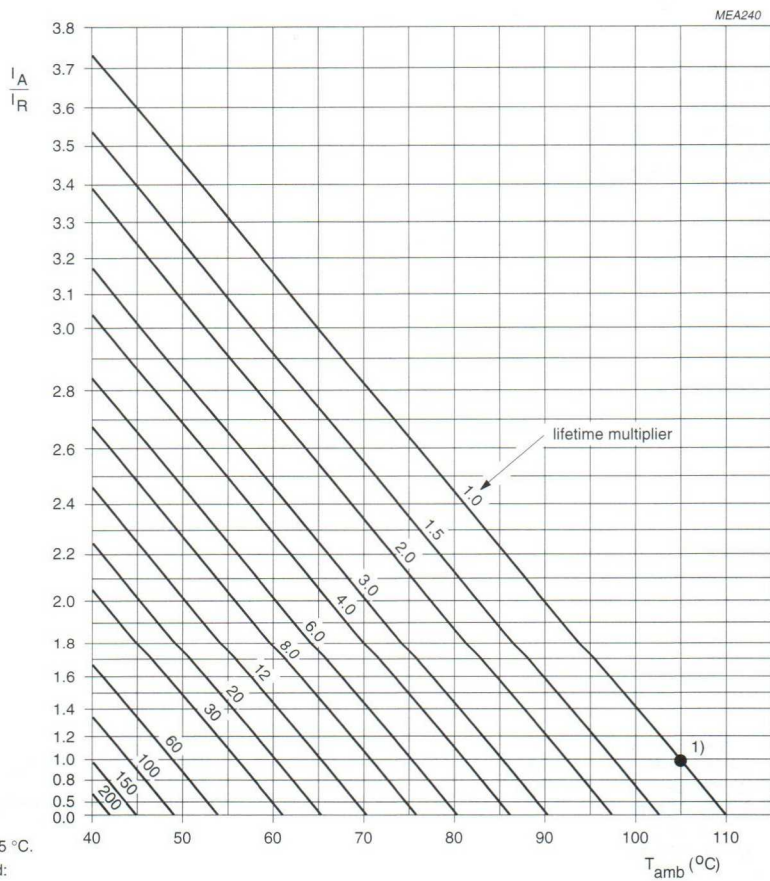
Aluminium electrolytic capacitors
Radial, Low Impedance

135 RLI

RIPPLE CURRENT AND USEFUL LIFE

Table 8 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 100 kHz

FREQUENCY (Hz)	I_R MULTIPLIER			
	22 μ F	33 to 330 μ F	470 to 1 000 μ F	>1 000 μ F
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
1 000	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:
 $\varnothing D = 8$ mm: 1500 hours
 $\varnothing D = 10$ to 18 mm: 2500 hours.

Fig.7 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Radial, Low Impedance

135 RLI

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section “Tests and Requirements”.

Table 9 Test procedures and requirements

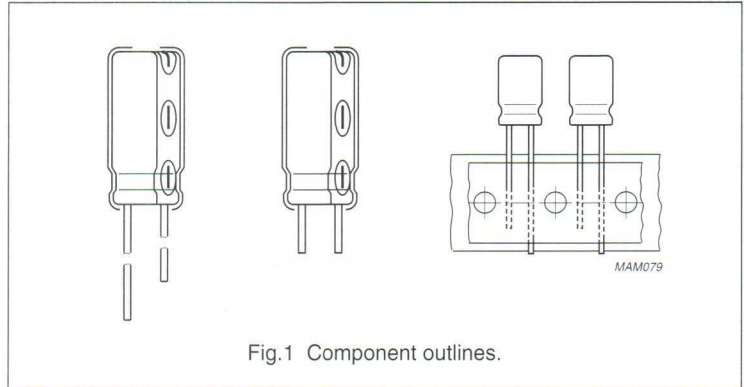
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; $\varnothing D = 8\text{ mm}$: 1 000 hours $\varnothing D = 10\text{ to }18\text{ mm}$: 2 000 hours	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; $\varnothing D = 8\text{ mm}$: 1 500 hours $\varnothing D = 10\text{ to }18\text{ mm}$: 2 500 hours	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30 300, subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 1 000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$

Aluminium electrolytic capacitors

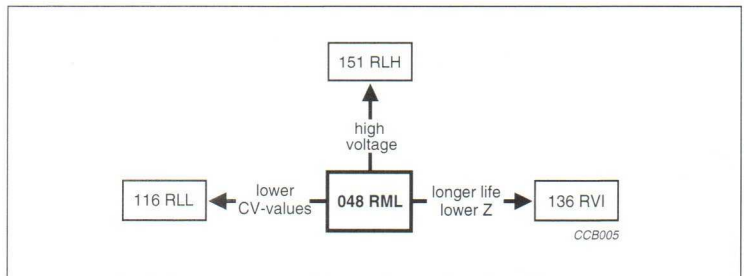
Radial Miniature Long-Life

048 RML**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 CV-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
- Portable and mobile equipment (small size, low mass).

**QUICK REFERENCE DATA**

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	10 × 12 to 18 × 35
Rated capacitance range, C_R	100 to 10000 μF
Tolerance on C_R	±20%
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	−40 to +105 °C
Endurance test at 105 °C	2000 hours
Useful life at 105 °C:	
case $\varnothing D = 10$ and 12.5 mm	3000 hours
case $\varnothing D = 16$ and 18 mm	4000 hours
Useful life at 40 °C, $1.6 \times I_R$ applied:	
case $\varnothing D = 10$ and 12.5 mm	200000 hours
case $\varnothing D = 16$ and 18 mm	260000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/105/56

Aluminium electrolytic capacitors

Radial Miniature Long-Life

048 RML

Selection chart for C_R, U_R and relevant nominal case sizes (∅D × L in mm)

Preferred types in **bold**.

C _R (μF)	U _R (V)							
	6.3	10	16	25	35	40	50	63
100 ⁽¹⁾	—	—	—	—	—	—	—	10 × 12
220	—	—	—	—	10 × 12	—	10 × 16	10 × 20
330	—	—	—	—	—	—	—	12.5 × 20
470	—	—	10 × 12	10 × 16	10 × 20	—	12.5 × 20	12.5 × 25
1000	—	10 × 16	10 × 20	12.5 × 20	12.5 × 25	—	16 × 25	16 × 31
2200	—	12.5 × 20	12.5 × 25	16 × 25	16 × 31	16 × 35	18 × 35	18 × 35
3300	—	12.5 × 25	16 × 25	16 × 31	18 × 35	18 × 35	18 × 35	—
4700	—	16 × 25	16 × 31	18 × 35	18 × 35	—	—	—
6800	16 × 25	16 × 31	16 × 35	—	—	—	—	—
10000	16 × 35	18 × 35	18 × 35	—	—	—	—	—

Note

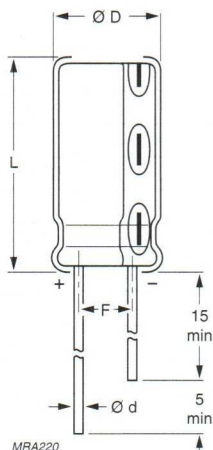
1. For lower CV-values see data sheet "116 RLL".

Aluminium electrolytic capacitors

Radial Miniature Long-Life

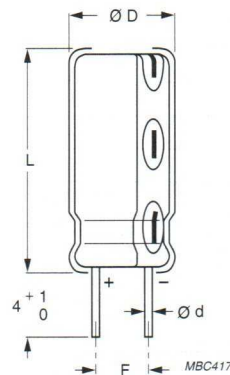
048 RML

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.
For dimensions see Table 1.

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



Dimensions in mm.
For dimensions see Table 1.

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

Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

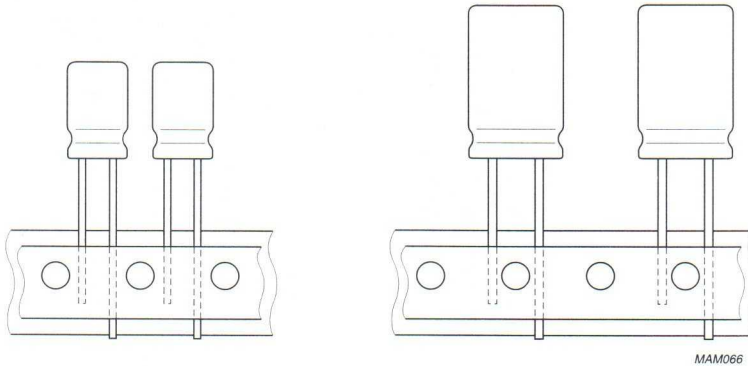
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{\max}$ (mm)	$L_{\max}$ (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES PER BOX		
							FORM CA	FORM CB	FORM TFA
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 × 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 × 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 × 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.5	100	100	—
18 × 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	—

Aluminium electrolytic capacitors

Radial Miniature Long-Life

048 RML

Taped products



Form TFA:

Case $\varnothing D \times L \leq 16 \times 31$ mm.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.4 Taped in box (ammopack).

MARKING

The capacitors are marked with the following information:

- Rated capacitance value (in μF)
- Tolerance on rated capacitance, code letter in accordance with "IEC 62" (M for $\pm 20\%$)
- 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

Aluminium electrolytic capacitors

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Ordering example

Electrolytic capacitor 048 series
2200 $\mu\text{F}/16\text{ V}; \pm 20\%$
Nominal case size: $\varnothing 12.5 \times 25\text{ mm}$; Form TFA
Catalogue number: 2222 048 35222.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{\text{amb}} = 20^\circ\text{C}$,
 $P = 86\text{ to }106\text{ kPa}$, $RH = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
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
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{\text{max}}$ and C_R)
Z	max. impedance at 10 kHz or 100 kHz

Table 2 Electrical data and ordering information; preferred types in **bold**

U_R 100 Hz (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105°C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	Z 100 kHz (m Ω)	CATALOGUE NUMBER 2222		
											BULK PACKAGING		
											FORM CA	FORM CB	FORM TFA
6.3	6800 10000	16×25 16×35	19 21	1350 1700	430 630	89 130	0.32 0.40	75 64	60 46	56 42	048 53682 048 53103	048 63682 048 63103	048 33682 —
10	1000 2200 3300 4700 6800 10000	10×16 12.5×20 12.5×25 16×25 16×31 18×35	15 17 18 19 20 22	470 800 1000 1270 1550 1870	100 220 330 470 680 1000	23 47 69 97 140 200	0.19 0.21 0.23 0.25 0.29 0.37	300 150 110 85 68 59	220 110 76 61 49 40	180 90 68 56 45 36	048 54102 048 54222 048 54332 048 54472 048 54682 048 54103	048 64102 048 64222 048 64332 048 64472 048 64682 048 64103	048 34102 048 34222 048 34332 048 34472 048 34682 —
16	470 1000 2200 3300 4700 6800 10000	10×12 10×20 12.5×25 16×25 16×31 16×35 18×35	14 16 18 19 20 21 22	360 600 1000 1220 1500 1690 1980	78 160 360 530 760 1100 1600	18 35 73 110 150 220 320	0.16 0.16 0.18 0.20 0.22 0.26 0.34	540 250 130 100 75 61 54	340 160 82 61 49 46 38	250 140 70 56 45 42 34	048 55471 048 55102 048 55222 048 55332 048 55472 048 55682 048 55103	048 65471 048 65102 048 65222 048 65332 048 65472 048 65682 048 65103	048 35471 048 35102 048 35222 048 35332 048 35472 — —

Aluminium electrolytic capacitors

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U _R 100 Hz (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (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 (mΩ)	Z 10 kHz (mΩ)	Z 100 kHz (mΩ)	CATALOGUE NUMBER 2222		
											BULK PACKAGING		TAPED
											FORM CA	FORM CB	
25	470	10 × 16	15	440	120	27	0.14	470	240	180	048 56471	048 66471	048 36471
	1000	12.5 × 20	17	720	250	53	0.14	220	120	100	048 56102	048 66102	048 36102
	2200	16 × 25	19	1120	550	110	0.16	120	63	56	048 56222	048 66222	048 36222
	3300	16 × 31	20	1450	830	170	0.18	87	50	45	048 56332	048 66332	048 36332
	4700	18 × 35	22	1720	1200	240	0.20	68	40	36	048 56472	048 66472	—
35	220	10 × 12	14	310	80	18	0.12	870	360	280	048 50221	048 60221	048 30221
	470	10 × 20	16	500	170	36	0.12	410	170	150	048 50471	048 60471	048 30471
	1000	12.5 × 25	18	900	350	73	0.12	190	90	75	048 50102	048 60102	048 30102
	2200	16 × 31	20	1340	770	160	0.14	100	52	45	048 50222	048 60222	048 30222
	3300	18 × 35	22	1600	1200	230	0.16	77	42	36	048 50332	048 60332	—
40	4700	18 × 35	22	1950	1600	330	0.18	61	40	34	048 50472	048 60472	—
	2200	16 × 35	21	1500	880	180	0.13	94	48	45	048 57222	048 67222	—
	3300	18 × 35	22	1600	1300	270	0.15	72	40	36	048 57332	048 67332	—
	220	10 × 16	15	340	110	25	0.10	720	300	250	048 51221	048 61221	048 31221
	470	12.5 × 20	17	620	240	50	0.10	340	130	110	048 51471	048 61471	048 31471
50	1000	16 × 25	19	1030	500	100	0.10	160	70	60	048 51102	048 61102	048 31102
	2200	18 × 35	22	1500	1100	220	0.12	87	50	50	048 51222	048 61222	—
	3300	18 × 35	22	1900	1700	330	0.14	68	40	40	048 51332	048 61332	—
	100	10 × 12	14	240	66	16	0.09	1400	550	310	048 58101	048 68101	048 38101
	220	10 × 20	16	400	140	31	0.09	650	250	200	048 58221	048 68221	048 38221
63	330	12.5 × 20	17	550	210	45	0.09	430	170	120	048 58331	048 68331	048 38331
	470	12.5 × 25	18	700	300	62	0.09	300	110	80	048 58471	048 68471	048 38471
	1000	16 × 31	20	1150	630	130	0.09	140	55	49	048 58102	048 68102	048 38102
	2200	18 × 35	22	1600	1400	280	0.11	80	45	45	048 58222	048 68222	—

R

Aluminium electrolytic capacitors

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Additional electrical data

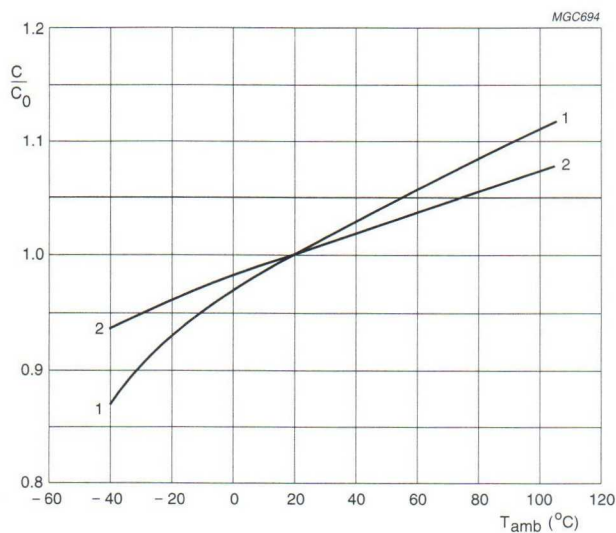
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 3 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 10 \text{ mm}$	typ. 16 nH
	case $\varnothing D \geq 12.5 \text{ mm}$	typ. 18 nH

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Capacitance (C)

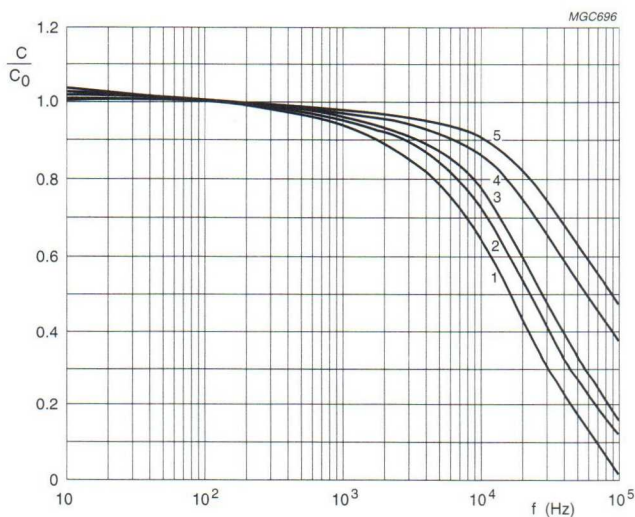


Curve 1: 6.3 V.

Curve 2: 63 V.

 C_0 = capacitance at 20°C , 100 Hz.

Fig.5 Typical multiplier of capacitance as a function of ambient temperature.



Curve 1: 10 V.

Curve 2: 16 V.

Curve 3: 25 V.

Curve 4: 50 V.

Curve 5: 63 V.

 C_0 = capacitance at 20°C , 100 Hz.

Fig.6 Typical multiplier of capacitance as a function of frequency.

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Equivalent series resistance (ESR)

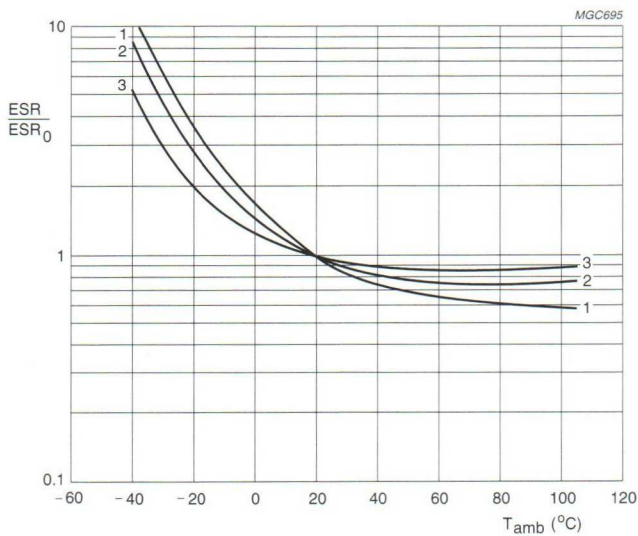


Fig.7 Multiplier of ESR as a function of ambient temperature.

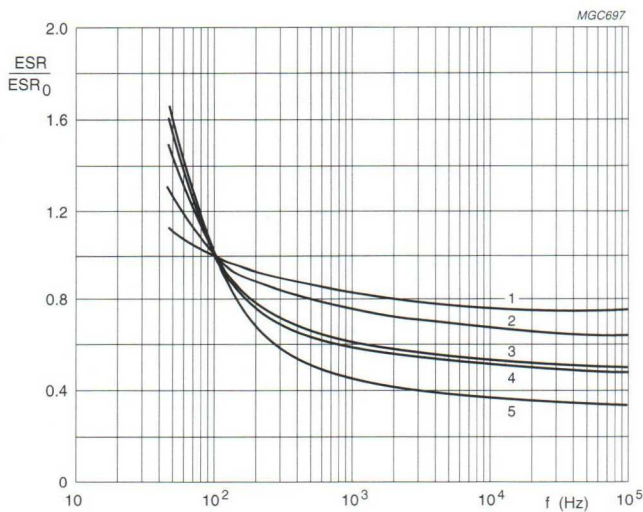


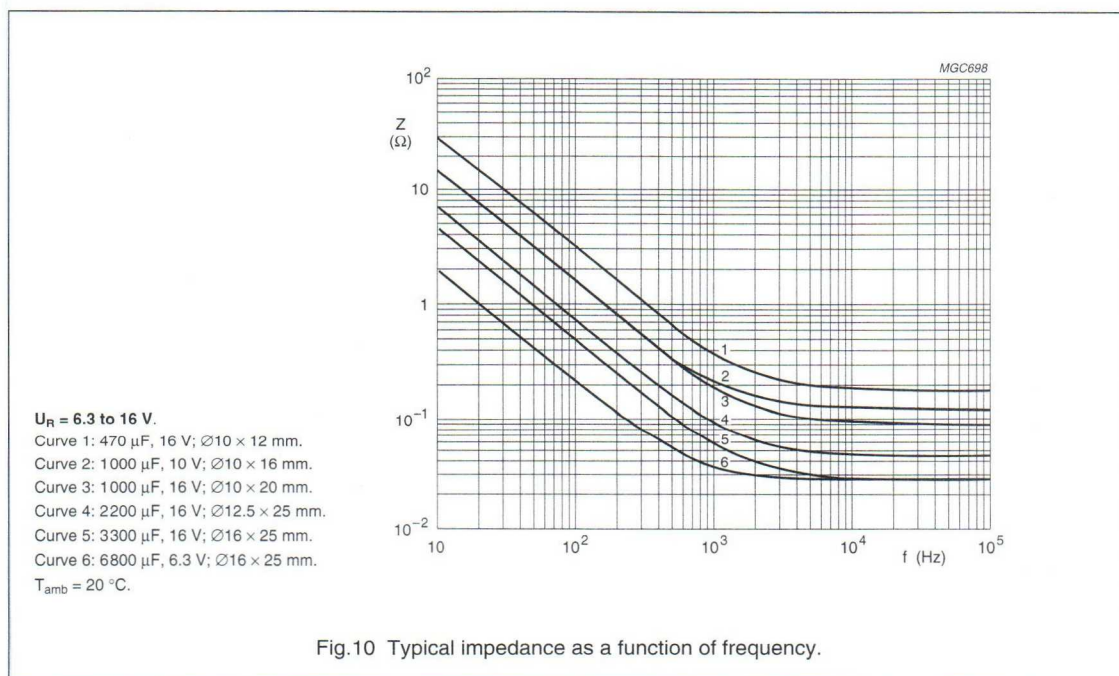
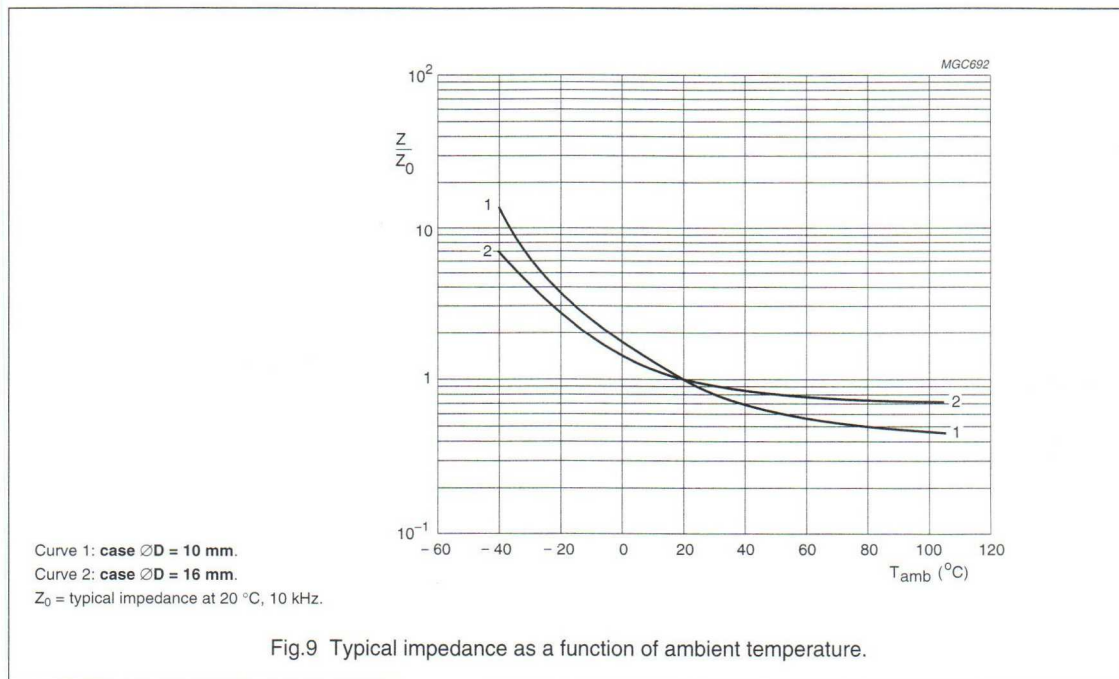
Fig.8 Multiplier of ESR as a function of frequency.

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Impedance (Z)



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$U_R = 25 \text{ to } 35 \text{ V.}$

Curve 1: 220 μF , 35 V; $\varnothing 10 \times 12 \text{ mm}$.

Curve 2: 330 μF , 35 V; $\varnothing 10 \times 16 \text{ mm}$.

Curve 3: 470 μF , 25 V; $\varnothing 10 \times 16 \text{ mm}$.

Curve 4: 470 μF , 35 V; $\varnothing 10 \times 20 \text{ mm}$.

Curve 5: 1000 μF , 25 V; $\varnothing 12.5 \times 20 \text{ mm}$.

Curve 6: 1000 μF , 35 V; $\varnothing 12.5 \times 25 \text{ mm}$.

Curve 7: 3300 μF , 25 V; $\varnothing 16 \times 31 \text{ mm}$.

$T_{\text{amb}} = 20^\circ\text{C}.$

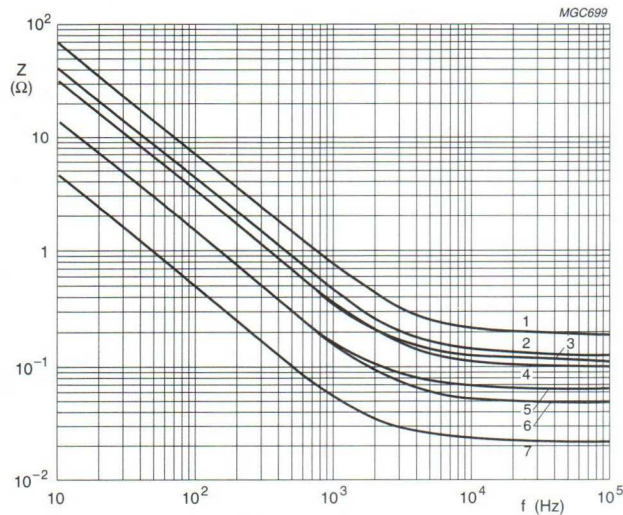


Fig.11 Typical impedance as a function of frequency.

$U_R = 40 \text{ to } 63 \text{ V.}$

Curve 1: 100 μF , 63 V; $\varnothing 10 \times 12 \text{ mm}$.

Curve 2: 220 μF , 50 V; $\varnothing 10 \times 16 \text{ mm}$.

Curve 3: 220 μF , 63 V; $\varnothing 10 \times 20 \text{ mm}$.

Curve 4: 330 μF , 63 V; $\varnothing 12.5 \times 20 \text{ mm}$.

Curve 5: 470 μF , 50 V; $\varnothing 12.5 \times 20 \text{ mm}$.

Curve 6: 470 μF , 63 V; $\varnothing 12.5 \times 25 \text{ mm}$.

Curve 7: 1000 μF , 63 V; $\varnothing 16 \times 31 \text{ mm}$.

Curve 8: 2200 μF , 40 V; $\varnothing 16 \times 35 \text{ mm}$.

$T_{\text{amb}} = 20^\circ\text{C}.$

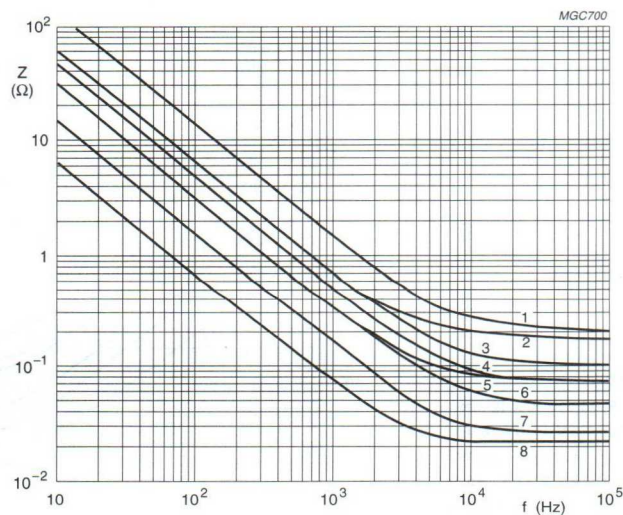


Fig.12 Typical impedance as a function of frequency.

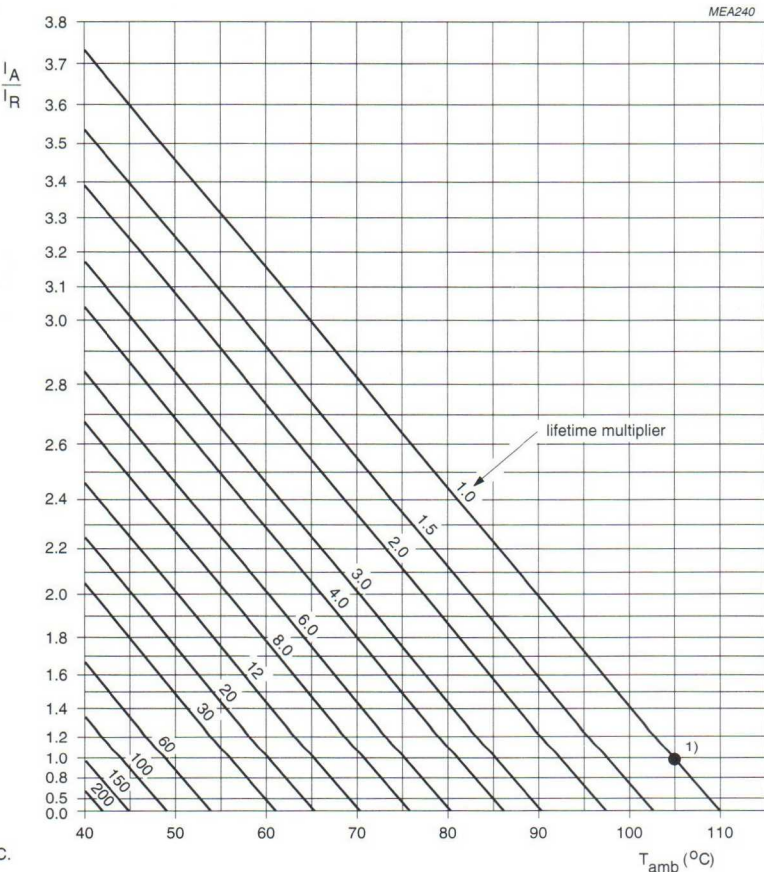
Aluminium electrolytic capacitors Radial Miniature Long-Life

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RIPPLE CURRENT AND USEFUL LIFE

Table 3 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3 \text{ to } 25 \text{ V}$	$U_R = 35 \text{ and } 40 \text{ V}$	$U_R = 50 \text{ and } 63 \text{ V}$
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:
 case $\varnothing D = 10$ and 12.5 mm: 3000 hours
 case $\varnothing D = 16$ and 18 mm: 4000 hours.

Fig.13 Multiplier of useful life as a function of ambient temperature and ripple current load.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

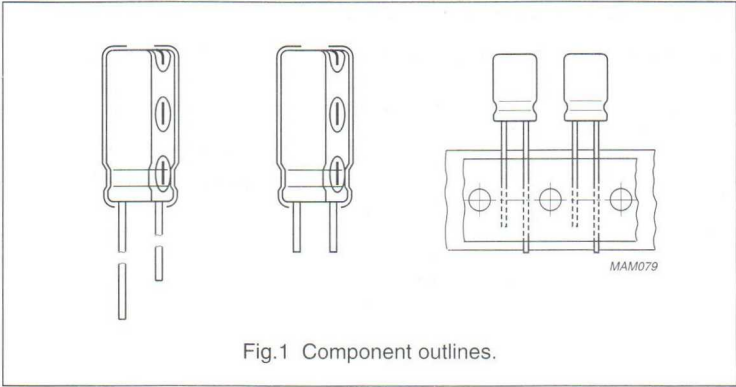
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$U_R = 6.3\text{ V}$; $\Delta C/C$: +15/-30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; case $\varnothing D = 10$ and 12.5 mm : 3000 hours; case $\varnothing D = 16$ and 18 mm : 4000 hours	$U_R = 6.3\text{ V}$; $\Delta C/C$: +45/-50% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$U_R = 6.3\text{ V}$; $\Delta C/C$: +15/-30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$

Aluminium electrolytic capacitors
Radial Long-Life, High voltage

151 RLH

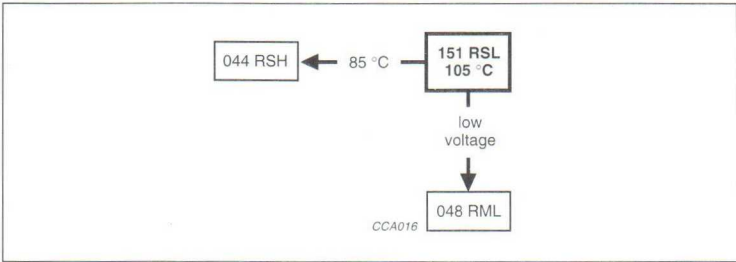
FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, insulated with a blue vinyl sleeve
- Pressure relief
- Charge and discharge proof
- Long useful life:
3000 to 4000 hours at 105 °C,
high reliability
- High rated voltage, up to 450 V.



APPLICATIONS

- High-reliability and professional applications
- Lighting, monitors, consumer electronics, general industrial
- Filtering of high voltages in power supplies.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	10 × 12 to 18 × 35
Rated capacitance range, C_R	1 to 220 μF
Tolerance on C_R	±20%
Rated voltage range, U_R	160 to 450 V
Category temperature range	−40 to +105 °C
Endurance test at 105 °C	2000 hours
Useful life at 105 °C: case $\varnothing D = 10$ and 12.5 mm case $\varnothing D = 16$ and 18 mm	3000 hours 4000 hours
Useful life at 40 °C, $1.6 \times I_R$ applied: case $\varnothing D = 10$ and 12.5 mm case $\varnothing D = 16$ and 18 mm	200000 hours 260000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/105/56

R

Aluminium electrolytic capacitors

Radial Long-Life, High voltage

151 RLH

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

C_R (μF)	U_R (V)					
	160	200	250	350	400	450
1.0	—	—	—	—	—	10 × 12
2.2	—	—	—	—	10 × 12	10 × 16
3.3	—	—	—	10 × 12	10 × 16	10 × 20
4.7	—	10 × 12	10 × 12	10 × 16	10 × 20	12.5 × 20
10	10 × 16	10 × 16	10 × 20	12.5 × 20	12.5 × 20	16 × 20
22	10 × 20	10 × 20	12.5 × 25	12.5 × 25	16 × 25	16 × 31
	—	—	16 × 20	16 × 20	18 × 20	18 × 25
33	12.5 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 31	18 × 35
	—	—	16 × 20	—	18 × 25	—
47	12.5 × 25	12.5 × 25	16 × 25	16 × 35	18 × 31	—
	16 × 20	16 × 20	18 × 20	18 × 31	—	—
100	16 × 25	16 × 31	16 × 31	—	—	—
	18 × 20	18 × 25	18 × 25	—	—	—
220	18 × 35	—	—	—	—	—

Aluminium electrolytic capacitors
Radial Long-Life, High voltage

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

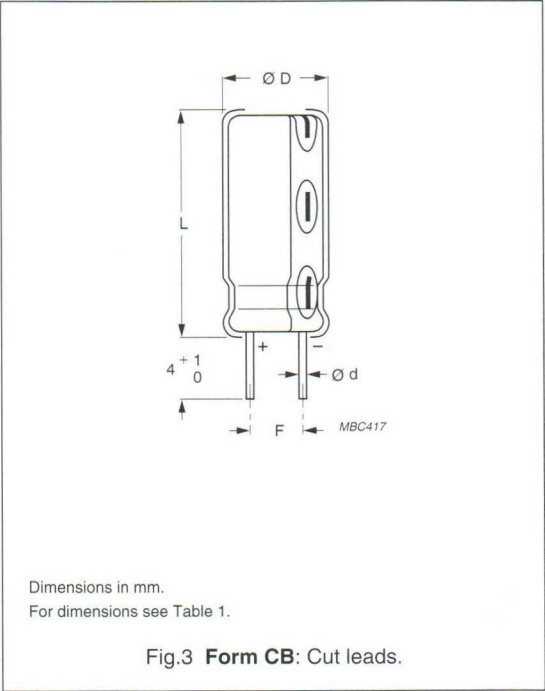
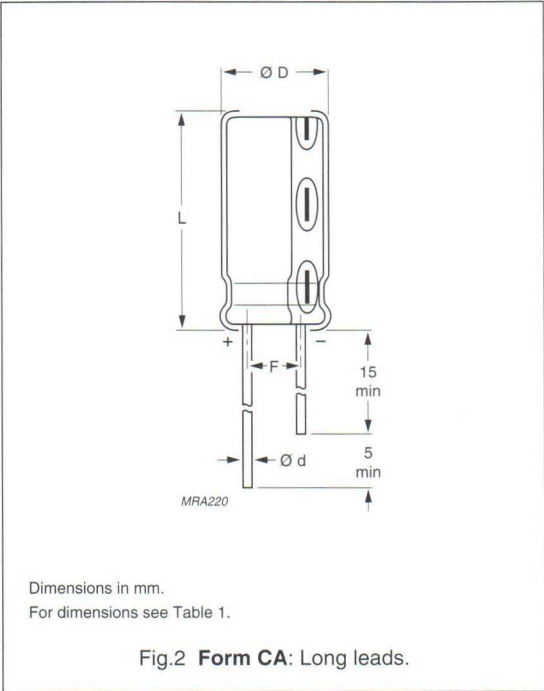


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES PER BOX		
							FORM CA	FORM CB	FORM TFA
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 × 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 × 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 × 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 × 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	100	100	—
18 × 20	1820	0.8	18.5	22.0	7.5 ± 0.5	≈ 8.0	100	100	—
18 × 25	1825	0.8	18.5	27.0	7.5 ± 0.5	≈ 10.0	100	100	—
18 × 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	—
18 × 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	—

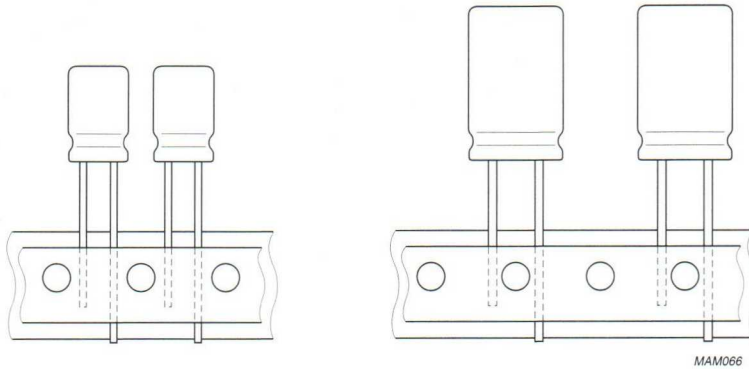
R

Aluminium electrolytic capacitors

Radial Long-Life, High voltage

151 RLH

Taped products



Form TFA.

Case $\varnothing D \times L \leq 16 \times 31$ mm.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.4 Taped in box (ammopack).

MARKING

The capacitors are marked with the following information:

- Rated capacitance value (in μF)
- Tolerance on rated capacitance, code letter in accordance with "IEC 62" (M for $\pm 20\%$)
- Rated voltage (in V)
- Upper category temperature (105 °C)
- Group number (151)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with "IEC 62"
- Negative terminal identification.

Aluminium electrolytic capacitors

Radial Long-Life, High voltage

151 RLH

Ordering example

Electrolytic capacitor 151 series

4.7 μ F/400 V; $\pm 20\%$

Nominal case size: $\varnothing 10 \times 20$ mm; Form TFA

Catalogue number: 2222 151 36478.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{amb} = 20^\circ\text{C}$,
 $P = 86$ to 106 kPa, RH = 45 to 75%.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
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

Table 2 Electrical data and ordering information; preferred types in bold

U_R 100 Hz (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing \times L$ (mm)	CASE CODE	I_R 100 Hz 105°C (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222		
										BULK PACKAGING		TAPED
										FORM CA	FORM CB	FORM TFA
160	10	10×16	15	95	118	54	0.12	19	6.3	151 51109	151 61109	151 31109
	22	10×20	16	145	176	83	0.12	9	3.2	151 51229	151 61229	151 31229
	33	12.5×20	17	190	228	109	0.12	6	2.3	151 51339	151 61339	151 31339
	47	12.5×25	18	280	296	143	0.12	4	1.7	151 51479	151 61479	151 31479
	47	16×20	19a	280	296	143	0.12	4	1.7	151 91475	151 91476	151 91473
	100	16×25	19	380	550	270	0.12	2	1.1	151 51101	151 61101	151 31101
	100	18×20	1820	380	550	270	0.12	2	1.1	151 91105	151 91106	—
	220	18×35	22	630	1126	558	0.12	0.9	0.8	151 51221	151 61221	—
200	4.7	10×12	14	60	96	43	0.12	41	13.0	151 52478	151 62478	151 32478
	10	10×16	15	95	130	60	0.12	19	6.3	151 52109	151 62109	151 32109
	22	10×20	16	145	202	96	0.12	9	3.2	151 52229	151 62229	151 32229
	33	12.5×20	17	190	268	129	0.12	6	2.3	151 52339	151 62339	151 32339
	47	12.5×25	18	280	352	171	0.12	4	1.7	151 52479	151 62479	151 32479
	47	16×20	19a	280	352	171	0.12	4	1.7	151 92475	151 92476	151 92473
	100	16×31	20	410	670	330	0.12	2	1.1	151 52101	151 62101	151 32101
	100	18×25	1825	410	670	330	0.12	2	1.1	151 92105	151 92106	—

R

Aluminium electrolytic capacitors

Radial Long-Life, High voltage

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U_R 100 Hz (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222		
										BULK PACKAGING		TAPED
										FORM CA	FORM CB	FORM TFA
250	4.7	10 × 12	14	60	105	48	0.12	41	13.0	151 53478	151 63478	151 33478
	10	10 × 20	16	105	145	68	0.12	19	6.3	151 53109	151 63109	151 33109
	22	12.5 × 25	18	180	235	113	0.12	9	3.2	151 53229	151 63229	151 33229
	22	16 × 20	19a	180	235	113	0.12	9	3.2	151 93225	151 93226	151 93223
	33	12.5 × 25	18	250	318	154	0.12	6	2.3	151 53339	151 63339	151 33339
	33	16 × 20	19a	250	318	154	0.12	6	2.3	151 93335	151 93336	151 93333
	47	16 × 25	19	300	423	206	0.12	4	1.7	151 53479	151 63479	151 33479
	47	18 × 20	1820	300	423	206	0.12	4	1.7	151 93475	151 93476	—
	100	16 × 31	20	410	820	405	0.12	2	1.1	151 53101	151 63101	151 33101
	100	18 × 25	1825	410	820	405	0.12	2	1.1	151 93105	151 93106	—
350	3.3	10 × 12	14	50	105	47	0.15	72	22.0	151 55338	151 65338	151 35338
	4.7	10 × 16	15	65	119	55	0.15	51	16.0	151 55478	151 65478	151 35478
	10	12.5 × 20	17	120	175	83	0.15	24	7.6	151 55109	151 65109	151 35109
	22	12.5 × 25	18	180	301	146	0.15	11	3.8	151 55229	151 65229	151 35229
	22	16 × 20	19a	180	301	146	0.15	11	3.8	151 95225	151 95226	151 95223
	33	16 × 25	19	210	417	203	0.15	7	2.6	151 55339	151 65339	151 35339
	47	16 × 35	21	300	564	277	0.15	5	2.0	151 55479	151 65479	—
	47	18 × 31	1831	300	564	277	0.15	5	2.0	151 95475	151 95476	—
400	2.2	10 × 12	14	40	93	41	0.15	109	33.0	151 56228	151 66228	151 36228
	3.3	10 × 16	15	50	110	50	0.15	72	22.0	151 56338	151 66338	151 36338
	4.7	10 × 20	16	70	126	58	0.15	51	16.0	151 56478	151 66478	151 36478
	10	12.5 × 20	17	120	190	90	0.15	24	7.6	151 56109	151 66109	151 36109
	22	16 × 25	19	200	334	162	0.15	11	3.8	151 56229	151 66229	151 36229
	22	18 × 20	1820	200	334	162	0.15	11	3.8	151 96225	151 96226	—
	33	16 × 31	20	245	466	228	0.15	7	2.6	151 56339	151 66339	151 36339
	33	18 × 25	1825	245	466	228	0.15	7	2.6	151 96335	151 96336	—
	47	18 × 31	1831	300	634	312	0.15	5	2.0	151 56479	151 66479	—

Aluminium electrolytic capacitors

Radial Long-Life, High voltage

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U_R 100 Hz (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222		
										BULK PACKAGING		TAPED
										FORM CA	FORM CB	FORM TFA
450	1.0	10 × 12	14	30	67	29	0.2	318	94.0	151 57108	151 67108	151 37108
	2.2	10 × 16	15	45	99	45	0.2	145	43.0	151 57228	151 67228	151 37228
	3.3	10 × 20	16	65	115	52	0.2	96	29.0	151 57338	151 67338	151 37338
	4.7	12.5 × 20	17	80	133	62	0.2	68	20.0	151 57478	151 67478	151 37478
	10	16 × 20	19a	140	205	98	0.2	32	10.0	151 57109	151 67109	151 37109
	22	16 × 31	20	220	367	179	0.2	14	4.6	151 57229	151 67229	151 37229
	22	18 × 25	1825	220	367	179	0.2	14	4.6	151 97225	151 97226	—
	33	18 × 35	22	280	516	253	0.2	10	3.4	151 57339	151 67339	—

Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods	IEC 384-4, subclause 4.14: $U_R = 160$ to 250 V $U_R = 350$ to 400 V	$U_s \leq 1.15 \times U_R$ $U_s \leq 1.10 \times U_R$
Reverse voltage	IEC 384-4, subclause 4.15	$U_{rev} \leq 1$ V
Current		
Leakage current	after 1 minute at U_R : $CV \leq 1000 \mu$ C $CV > 1000 \mu$ C after 5 minutes at U_R : $CV \leq 1000 \mu$ C $CV > 1000 \mu$ C	$I_{L1} \leq 0.06 \times C_R \times U_R + 40 \mu$ A $I_{L1} \leq 0.03 \times C_R \times U_R + 70 \mu$ A $I_{L5} \leq 0.03 \times C_R \times U_R + 15 \mu$ A $I_{L5} \leq 0.015 \times C_R \times U_R + 30 \mu$ A
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 10$ mm case $\varnothing D \geq 12.5$ mm	typ. 16 nH typ. 18 nH

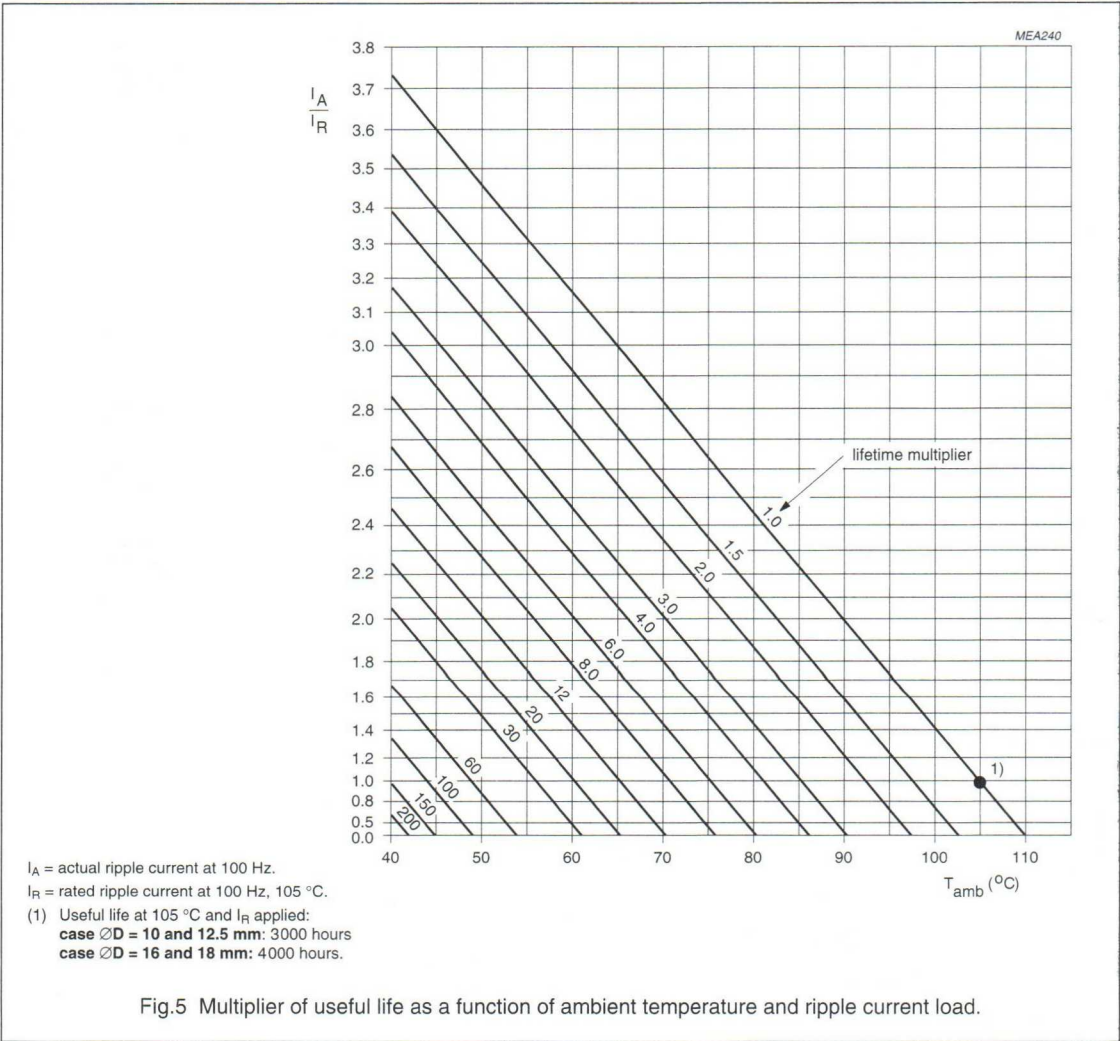
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RIPPLE CURRENT AND USEFUL LIFE

Table 3 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	1.00
300	1.20
1000	1.35
3000	1.45
≥ 10000	1.50



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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.15	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; case $\varnothing D = 10$ and 12.5 mm : 3000 hours; case $\varnothing D = 16$ and 18 mm : 4000 hours	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$

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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 to 4000 hours at 105 °C, high reliability
- High ripple current capability, low impedance, low ESR.

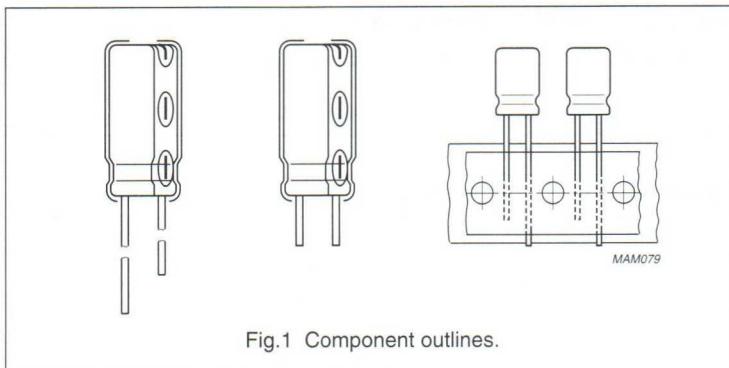
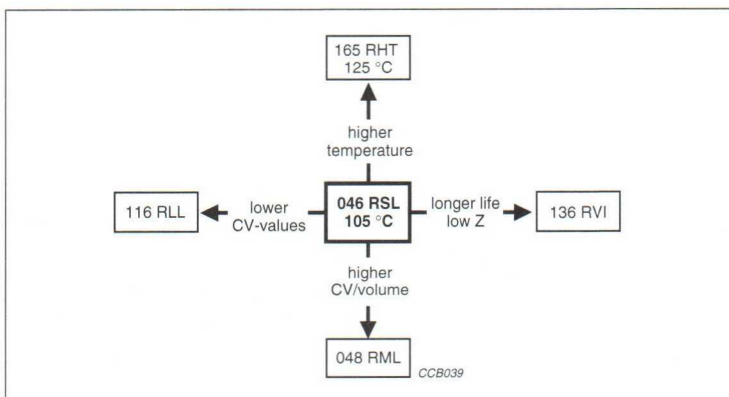


Fig.1 Component outlines.

APPLICATIONS

- Power conversion, EDP, telecommunication, industrial and audio-video
- Smoothing, filtering, buffering in SMPS, timing.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	10 × 12 to 18 × 40
Rated capacitance range, C_R	22 to 10000 μF
Tolerance on C_R	±20%
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	-40 to +105 °C
Endurance test at 105 °C	2000 hours
Useful life at 105 °C:	
case $\varnothing D = 10$ and 12.5 mm	3000 hours
case $\varnothing D = 16$ and 18 mm	4000 hours
Useful life at 40 °C, $1.6 \times I_R$ applied:	
case $\varnothing D = 10$ and 12.5 mm	200000 hours
case $\varnothing D = 16$ and 18 mm	260000 hours
Shelf life at 0 V, 105 °C	1 000 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/105/56

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

C_R (μF)	U_R (V)							
	6.3	10	16	25	35	40	50	63
22 ⁽¹⁾	—	—	—	—	—	—	—	10 × 12
47	—	—	—	—	—	—	—	10 × 12
100	—	—	—	—	—	10 × 12	10 × 16	10 × 20
220	—	—	10 × 12	—	10 × 16	10 × 20	12.5 × 20	12.5 × 25
330	—	10 × 12	10 × 16	—	10 × 20	12.5 × 20	12.5 × 25	16 × 25
470	10 × 12	10 × 16	10 × 20	—	12.5 × 20	12.5 × 25	—	16 × 25
1000	10 × 20	12.5 × 20	12.5 × 25	12.5 × 25	16 × 25	—	16 × 31	18 × 35
2200	12.5 × 25	—	16 × 25	16 × 31	16 × 35	18 × 35	18 × 40	—
3300	16 × 25	—	16 × 31	18 × 35	—	18 × 40	—	—
4700	16 × 31	16 × 35	18 × 35	18 × 40	—	—	—	—
6800	16 × 35	18 × 35	18 × 40	—	—	—	—	—
10 000	18 × 35	18 × 40	—	—	—	—	—	—

Note

1. For lower CV-values see data sheet "116 RLL".

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

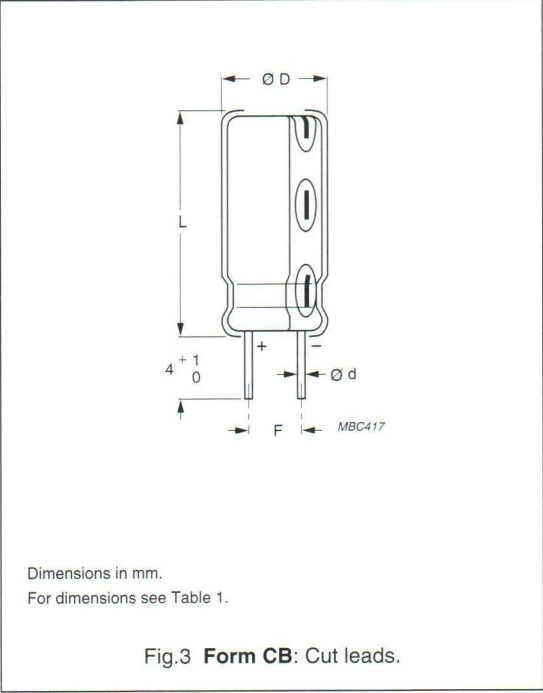
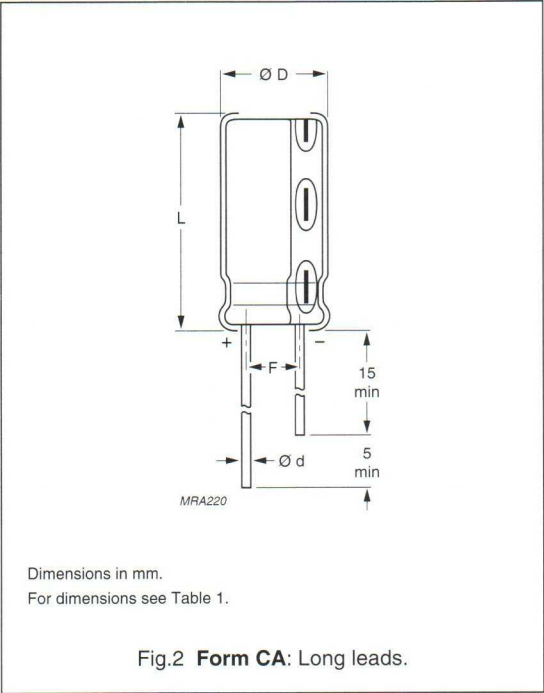


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

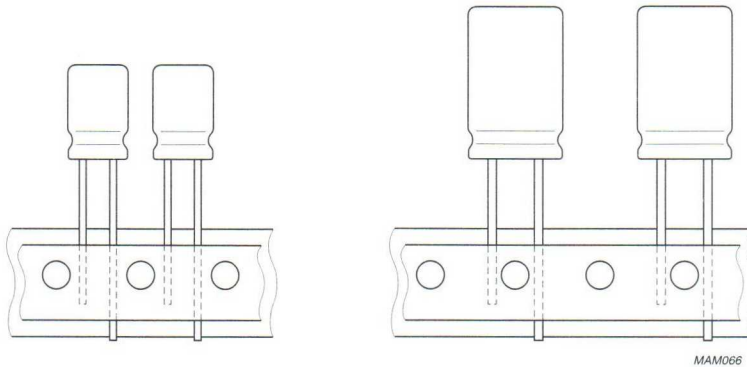
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 × 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 × 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 × 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.5	100	100	—
18 × 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	300	1000	—
18 × 40	23	0.8	18.5	42.0	7.5 ± 0.5	≈ 16.0	300	1000	—

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Taped products



Form TFA:.

Case $\varnothing D \times L \leq 16 \times 31$ mm.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.4 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 $\pm 20\%$)
- 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.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

SYMBOL	DESCRIPTION
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

Ordering example

Electrolytic capacitor 046 series

2200 µF/16 V, ±20%

Nominal case size: Ø16 × 25 mm; Form TFA

Catalogue number: 2222 046 35222.

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Table 2 Electrical data and ordering information; preferred types in **bold**

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE ØD × 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)	CATALOGUE NUMBER 2222		
												BULK PACKAGING		
												FORM CA	FORM CB	FORM TFA
6.3	470	10 × 12	14	360	600	33	9	0.19	0.64	0.32	0.28	046 53471	046 63471	046 33471
	1000	10 × 20	16	600	1000	66	16	0.19	0.30	0.15	0.14	046 53102	046 63102	046 33102
	2200	12.5 × 25	18	950	1500	140	31	0.23	0.17	0.08	0.07	046 53222	046 63222	046 33222
	3300	16 × 25	19	1200	1700	210	45	0.25	0.12	0.06	0.06	046 53332	046 63332	046 33332
	4700	16 × 31	20	1400	2000	300	62	0.27	0.09	0.05	0.05	046 53472	046 63472	046 33472
	6800	16 × 35	21	1600	2100	430	89	0.31	0.07	0.05	0.05	046 53682	046 63682	—
10	10000	18 × 35	22	1800	2300	630	130	0.39	0.06	0.04	0.04	046 53103	046 63103	—
	330	10 × 12	14	370	620	36	10	0.15	0.72	0.38	0.31	046 54331	046 64331	046 34331
	470	10 × 16	15	460	800	50	12	0.15	0.51	0.27	0.22	046 54471	046 64471	046 34471
	1000	12.5 × 20	17	770	1100	100	23	0.15	0.24	0.13	0.12	046 54102	046 64102	046 34102
	4700	16 × 35	21	1600	2300	470	97	0.23	0.08	0.04	0.04	046 54472	046 64472	—
	6800	18 × 35	22	1800	2500	680	140	0.27	0.06	0.03	0.03	046 54682	046 64682	—
	10000	18 × 40	23	2000	2600	1000	200	0.35	0.06	0.03	0.03	046 54103	046 64103	—

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × 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)	CATALOGUE NUMBER 2222		
												BULK PACKAGING		
												FORM CA	FORM CB	FORM TFA
16	220	10 × 12	14	350	620	38	10	0.13	0.94	0.40	0.31	046 55221	046 65221	046 35221
	330	10 × 16	15	430	800	56	14	0.13	0.63	0.30	0.22	046 55331	046 65331	046 35331
	470	10 × 20	16	560	920	78	18	0.13	0.44	0.21	0.18	046 55471	046 65471	046 35471
	1000	12.5 × 25	18	900	1500	160	35	0.13	0.21	0.10	0.10	046 55102	046 65102	046 35102
	2200	16 × 25	19	1300	1800	360	73	0.17	0.12	0.06	0.05	046 55222	046 65222	046 35222
	3300	16 × 31	20	1600	2200	530	110	0.19	0.09	0.04	0.04	046 55332	046 65332	046 35332
25	4700	18 × 35	22	1800	2500	760	150	0.21	0.07	0.03	0.03	046 55472	046 65472	—
	6800	18 × 40	23	2000	2600	1100	220	0.25	0.06	0.03	0.03	046 55682	046 65682	—
	1000	12.5 × 25	18	900	1500	250	53	0.11	0.18	0.09	0.08	046 56102	046 66102	046 36102
	2200	16 × 31	20	1600	2100	550	110	0.15	0.11	0.04	0.04	046 56222	046 66222	046 36222
	3300	18 × 35	22	1900	2500	830	170	0.17	0.08	0.03	0.03	046 56332	046 66332	—
	4700	18 × 40	23	2000	2600	1200	240	0.19	0.06	0.03	0.03	046 56472	046 66472	—
35	220	10 × 16	15	400	740	80	18	0.10	0.72	0.30	0.23	046 50221	046 60221	046 30221
	330	10 × 20	16	510	880	120	26	0.10	0.48	0.26	0.16	046 50331	046 60331	046 30331
	470	12.5 × 20	17	650	1000	170	36	0.10	0.34	0.14	0.11	046 50471	046 60471	046 30471
	1000	16 × 25	19	1200	1600	350	73	0.10	0.16	0.07	0.06	046 50102	046 60102	046 30102
	2200	16 × 35	21	1800	2000	770	160	0.12	0.10	0.04	0.04	046 50222	046 60222	—
	100	10 × 12	14	300	560	43	11	0.09	1.43	0.60	0.35	046 57101	046 67101	046 37101
40	220	10 × 20	16	450	850	91	21	0.09	0.65	0.27	0.17	046 57221	046 67221	046 37221
	330	12.5 × 20	17	590	1000	140	29	0.09	0.43	0.18	0.13	046 57331	046 67331	046 37331
	470	12.5 × 25	18	750	1300	190	41	0.09	0.30	0.13	0.08	046 57471	046 67471	046 37471
	2200	18 × 35	22	1900	2500	880	180	0.11	0.08	0.03	0.03	046 57222	046 67222	—
	3300	18 × 40	23	2100	2600	1300	270	0.12	0.06	0.03	0.03	046 57332	046 67332	—

R

Aluminium electrolytic capacitors

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U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105 °C (mA)	I_{RH} 100 kHz 105 °C (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222		
												BULK PACKAGING		
												FORM CA	FORM CB	FORM TFA
50	100	10 × 16	15	310	610	53	13	0.07	1.11	0.50	0.28	046 51101	046 61101	046 31101
	220	12.5 × 20	17	500	980	110	25	0.07	0.51	0.23	0.13	046 51221	046 61221	046 31221
	330	12.5 × 25	18	680	1200	170	36	0.07	0.34	0.15	0.09	046 51331	046 61331	046 31331
	1000	16 × 31	20	1400	1800	500	100	0.07	0.11	0.05	0.05	046 51102	046 61102	046 31102
	2200	18 × 40	23	2000	2600	1100	220	0.09	0.07	0.03	0.03	046 51222	046 61222	—
63	22	10 × 12	14	170	310	17	9	0.06	4.3	1.6	0.7	046 58229	046 68229	046 38229
	47	10 × 12	14	230	430	33	9	0.06	2.03	0.96	0.40	046 58479	046 68479	046 38479
	100	10 × 20	16	360	710	66	16	0.06	0.95	0.45	0.20	046 58101	046 68101	046 38101
	220	12.5 × 25	18	610	1100	140	31	0.06	0.43	0.20	0.11	046 58221	046 68221	046 38221
	330	16 × 25	19	750	1300	210	45	0.06	0.29	0.14	0.08	046 58331	046 68331	046 38331
	470	16 × 25	19	950	1600	300	62	0.06	0.20	0.10	0.06	046 58471	046 68471	046 38471
	1000	18 × 35	22	1500	2100	630	130	0.06	0.10	0.04	0.04	046 58102	046 68102	—

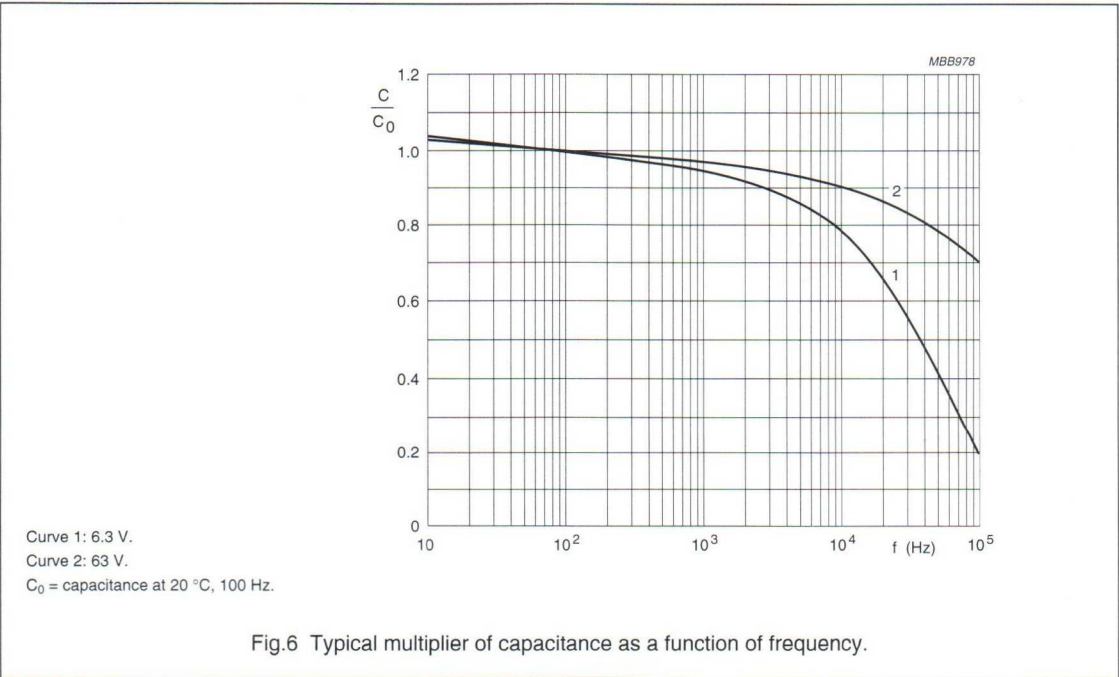
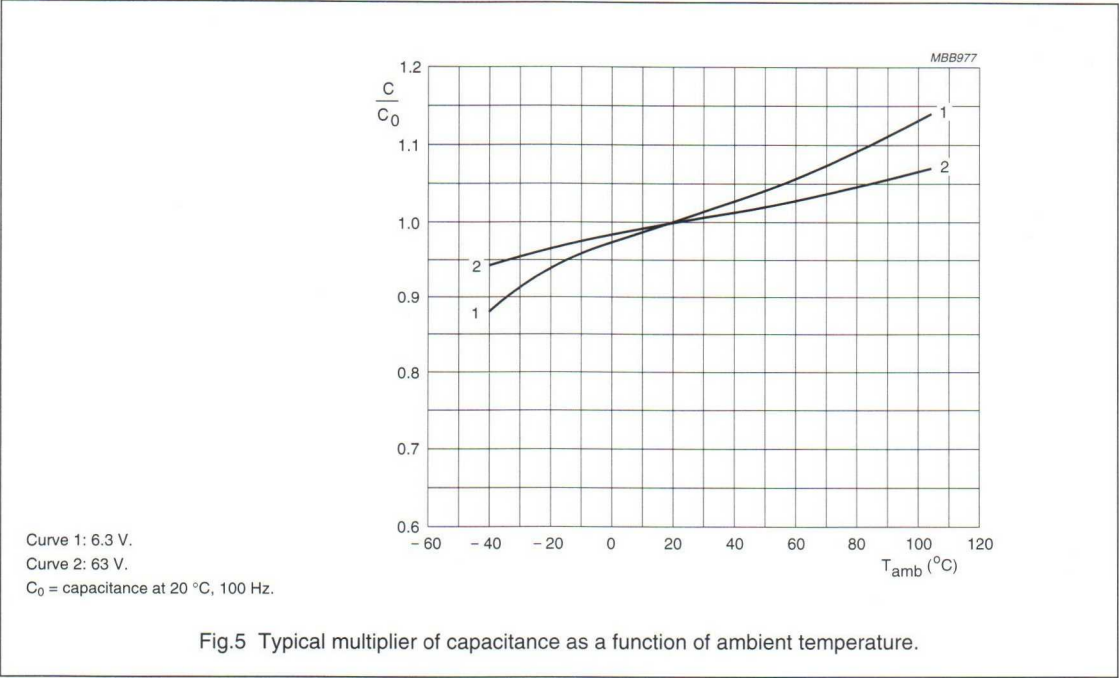
Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 U_R$
Reverse voltage		$U_{rev} \leq 1 V$
Current		
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	$I_{L5} \leq 0.002 C_R \times U_R + 3 \mu A$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 10$ mm	typ. 16 nH
	case $\varnothing D \geq 12.5$ mm	typ. 18 nH

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Capacitance (C)

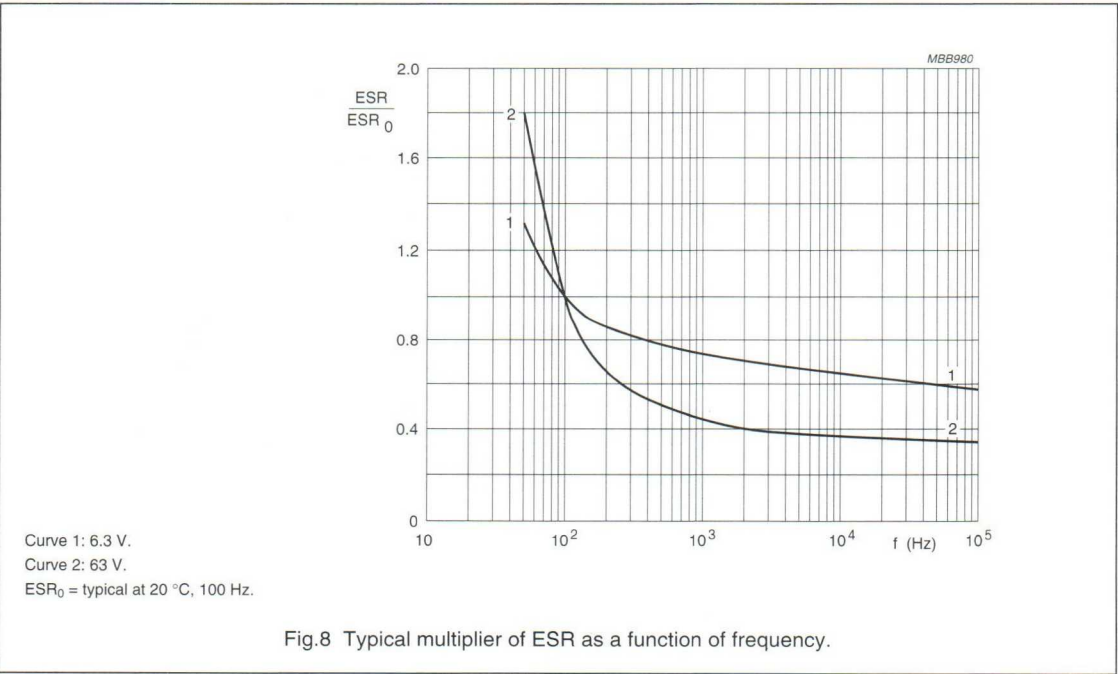
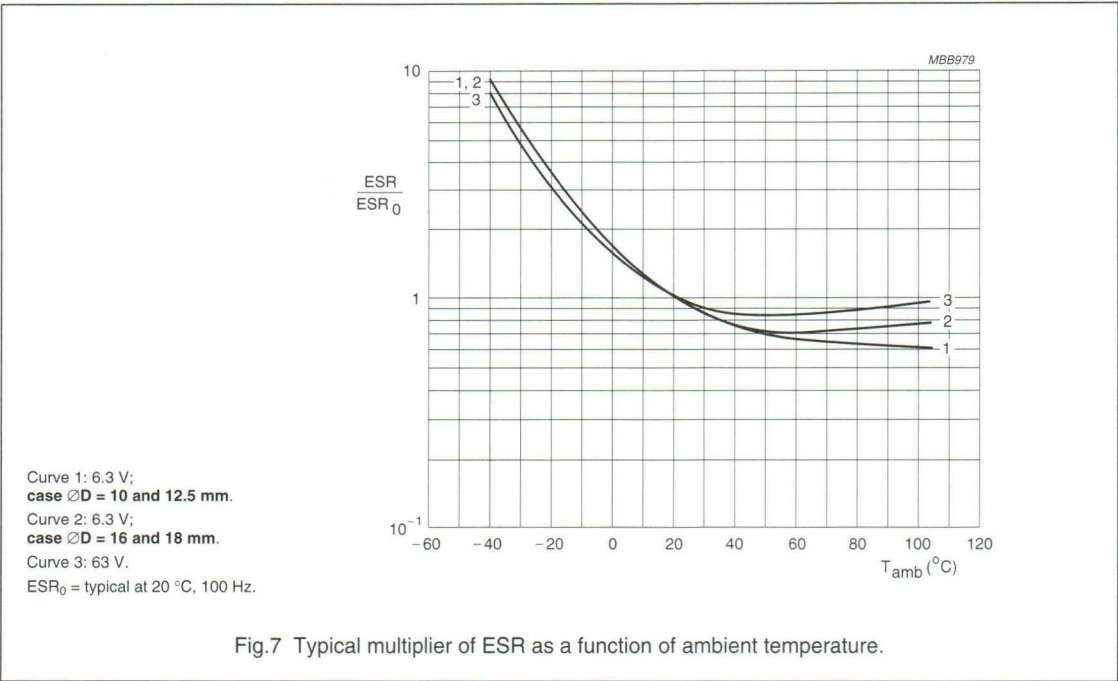


R

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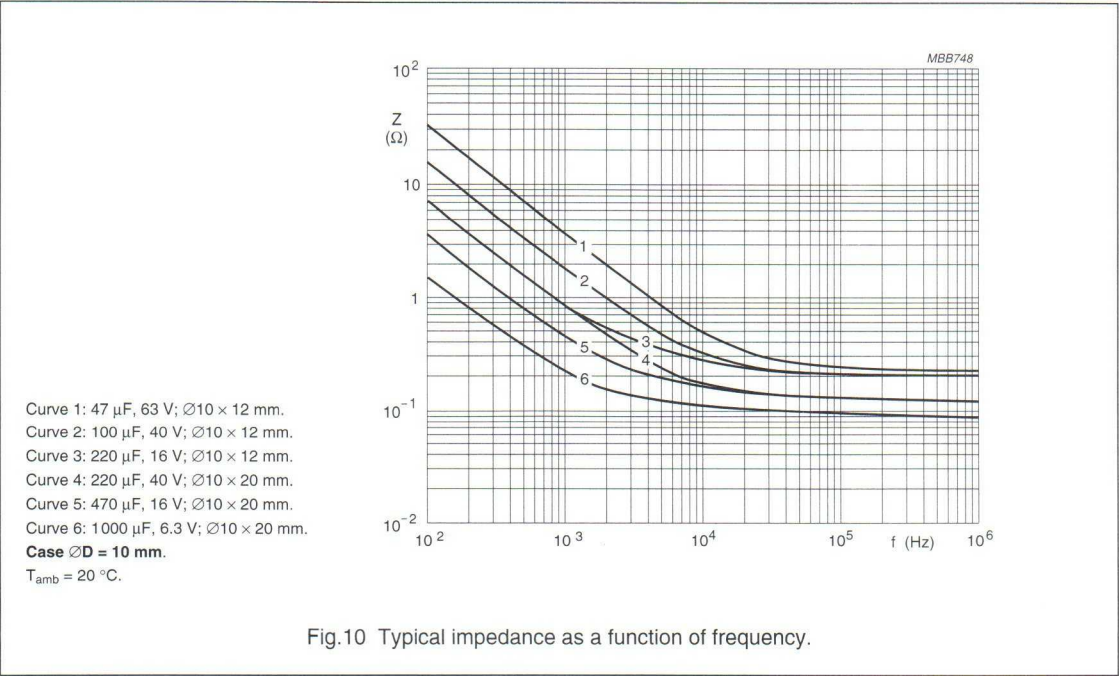
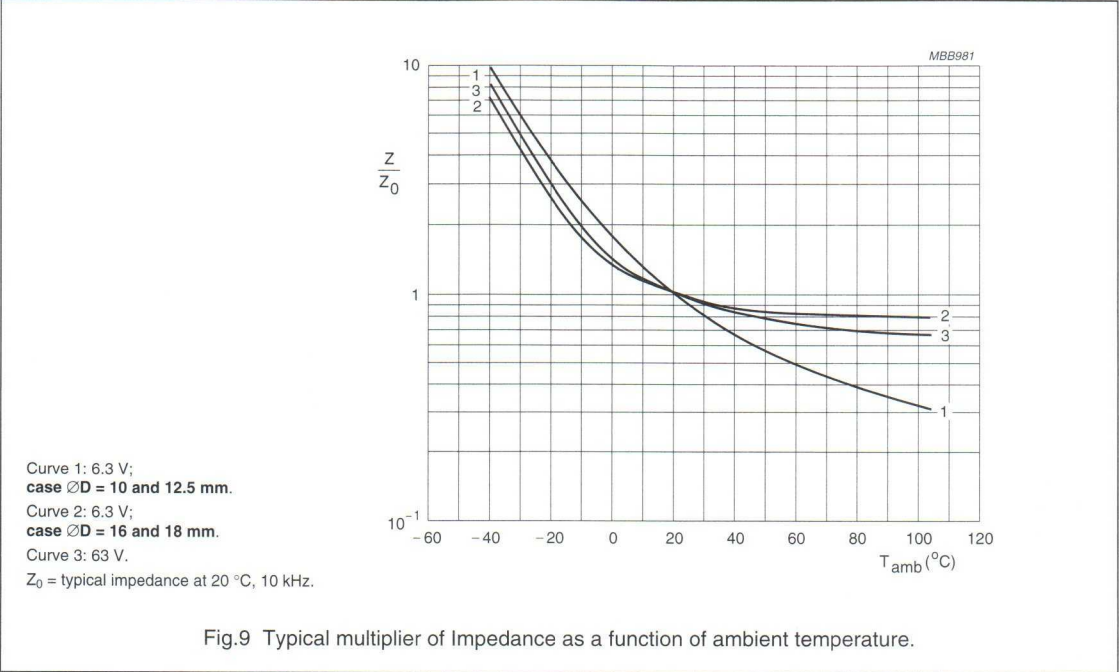
Equivalent series resistance (ESR)



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Impedance (Z)



R

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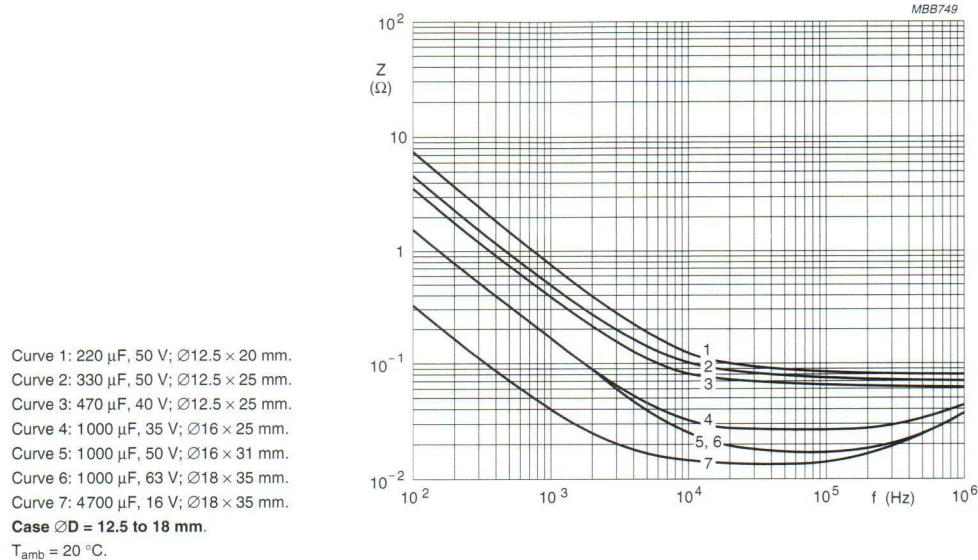


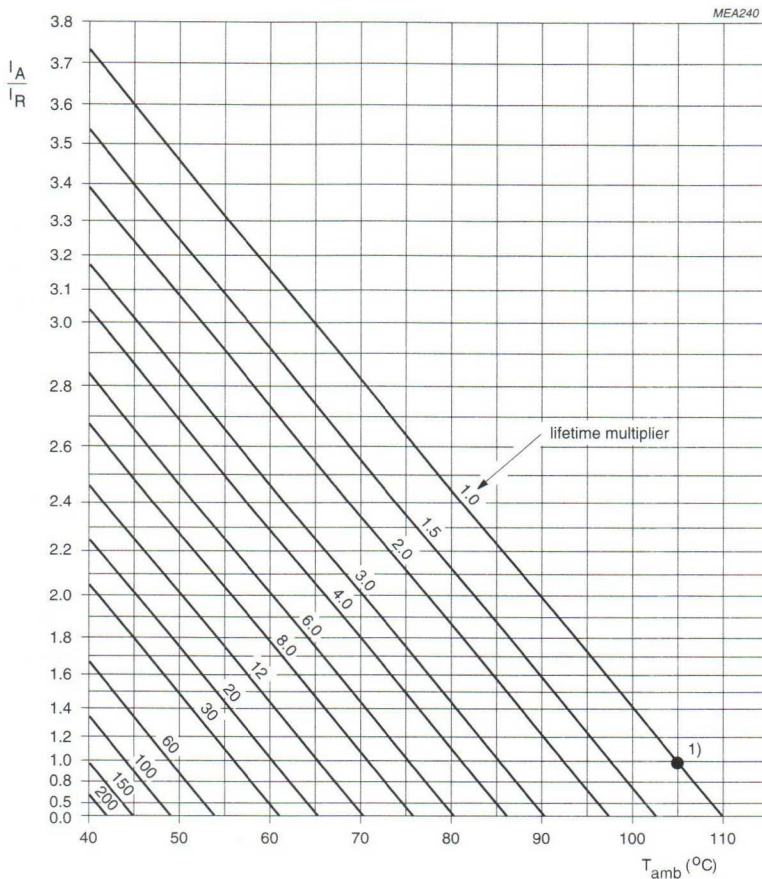
Fig.11 Typical impedance at as a function of frequency.

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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:

case $\varnothing D = 10$ and 12.5 mm; 3000 hours

case $\varnothing D = 16$ and 18 mm; 4000 hours.

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 3 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$U_R = 6.3\text{ V}$; $\Delta C/C$: +15/–30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; 3000 hours, case $\varnothing D = 10$ and 12.5 mm; 4000 hours, case $\varnothing D = 16$ and 18 mm	$U_R = 6.3\text{ V}$; $\Delta C/C$: +45/–50% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$U_R = 6.3\text{ V}$; $\Delta C/C$: +15/–30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$

Aluminium electrolytic capacitors

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- 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: 4000 to 10000 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, automotive and telecommunications
- Smoothing, filtering, buffering.

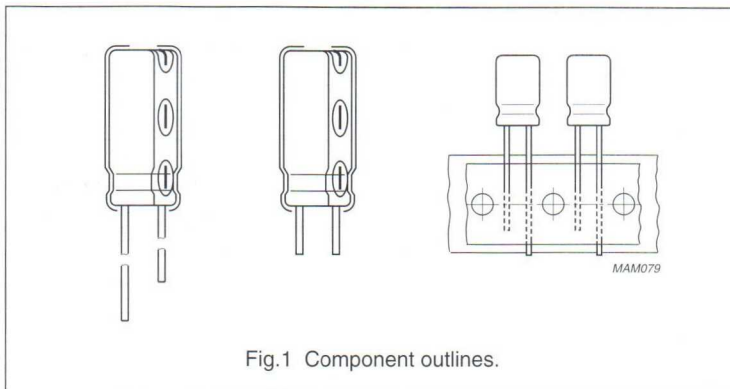
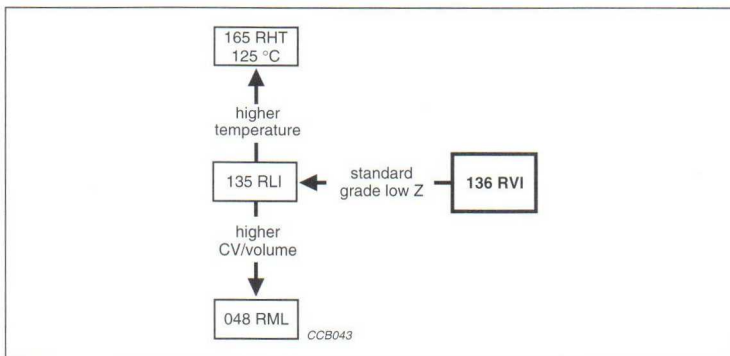


Fig.1 Component outlines.

**QUICK REFERENCE DATA**

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	10 × 12 to 18 × 35
Rated capacitance range, C_R	22 to 10000 μF
Tolerance on C_R	±20%
Rated voltage range, C_R	10 to 100 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 10000 hours (dependent on case size)
Useful life at 40 °C, $1.8 \times I_R$ applied	200000 to 500000 hours (dependent on case size)
Shelf life at 0 V, 105 °C	1 000 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	55/105/56

R

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm). Preferred types in bold.

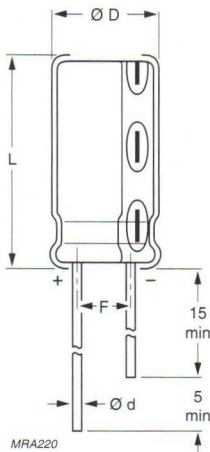
C_R (μF)	U_R (V)						
	10	16	25	35	50	63	100
22	—	—	—	—	—	—	10 × 12
33	—	—	—	—	—	—	10 × 12
47	—	—	—	—	—	10 × 12	10 × 16
56	—	—	—	—	—	10 × 12	—
68	—	—	—	—	—	10 × 16	10 × 20
82	—	—	—	—	10 × 12	—	—
100	—	—	—	—	10 × 12	10 × 16	12.5 × 20
120	—	—	—	10 × 12	10 × 16	10 × 20	—
	—	—	—	—	—	12.5 × 16	—
150	—	—	—	10 × 12	10 × 20	10 × 25	16 × 20
180	—	—	10 × 12	—	10 × 20	10 × 30	—
	—	—	—	—	12.5 × 16	—	—
220	—	—	10 × 12	10 × 16	10 × 25	12.5 × 20	16 × 25
270	—	10 × 12	—	—	—	12.5 × 25	—
330	—	10 × 12	10 × 16	10 × 20	10 × 30	16 × 20	16 × 31
	—	—	—	12.5 × 16	12.5 × 20	—	—
390	10 × 12	—	—	10 × 25	—	12.5 × 31	—
470	10 × 12	10 × 16	10 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 35
	—	—	12.5 × 16	—	—	—	18 × 31
560	—	—	10 × 25	10 × 30	12.5 × 31	—	—
	—	—	—	12.5 × 20	—	—	—
680	10 × 16	10 × 20	—	12.5 × 25	16 × 20	16 × 31	18 × 35
	—	12.5 × 16	—	—	—	18 × 25	—
820	—	10 × 25	10 × 30	—	16 × 25	16 × 35	—
	—	—	12.5 × 20	—	—	—	—
1000	10 × 20	12.5 × 20	12.5 × 25	12.5 × 31	16 × 31	18 × 31	—
	12.5 × 16	—	—	16 × 20	18 × 20	—	—
1200	10 × 25	10 × 30	—	16 × 25	16 × 35	—	—
	—	12.5 × 20	—	—	—	—	—
1500	10 × 30	12.5 × 25	12.5 × 31	16 × 25	18 × 31	18 × 35	—
	12.5 × 20	—	16 × 20	—	—	—	—
1800	12.5 × 20	—	16 × 25	16 × 31	—	—	—
2200	12.5 × 25	12.5 × 31	16 × 31	16 × 35	18 × 35	—	—
	—	16 × 20	18 × 20	18 × 31	—	—	—
2700	12.5 × 31	16 × 25	16 × 31	—	—	—	—
3300	16 × 20	16 × 25	16 × 35	18 × 35	—	—	—
	—	—	18 × 31	—	—	—	—
3900	16 × 25	16 × 31	—	—	—	—	—
4700	16 × 31	16 × 35	18 × 35	—	—	—	—
	—	18 × 31	—	—	—	—	—
5600	16 × 31	—	—	—	—	—	—
	18 × 25	—	—	—	—	—	—
6800	16 × 35	18 × 35	—	—	—	—	—
	18 × 31	—	—	—	—	—	—
10000	18 × 35	—	—	—	—	—	—

Aluminium electrolytic capacitors

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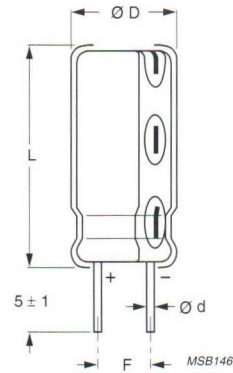
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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



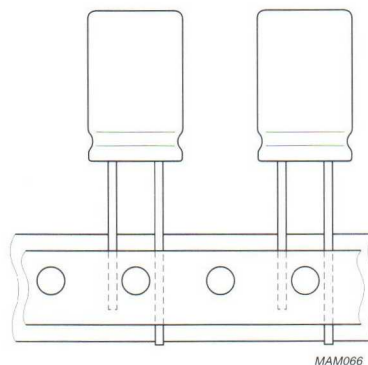
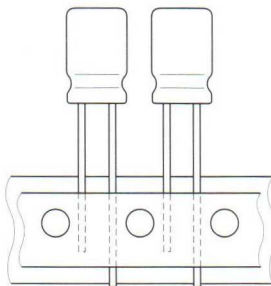
Dimensions in mm.
For dimensions see Table 1.

Fig.2 Form CA: Long Leads.



Dimensions in mm.
For dimensions see Table 1.

Fig.3 Form CB: Cut leads.

**Form TFA:**

Case $\varnothing D \times L \leq 16 \times 31$ mm.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.4 Taped in box (ammopack).

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Table 1 Physical dimensions mass and packaging quantities; see Figs 2, 3 and 4

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
10 × 25	16L	0.6	10.5	27.0	5.0 ± 0.5	≈ 3.0	1000	1500	800
10 × 30	16LL	0.6	10.5	32.0	5.0 ± 0.5	≈ 3.5	1000	750	—
12.5 × 16	17a	0.6	13.0	17.5	5.0 ± 0.5	≈ 2.7	1000	1500	500
12.5 × 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
12.5 × 31	18L	0.6	13.0	33.5	5.0 ± 0.5	≈ 5.5	1000	750	—
16 × 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 × 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 × 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	100	100	—
18 × 20	1820	0.8	18.5	22.0	7.5 ± 0.5	≈ 8.0	100	100	—
18 × 25	1825	0.8	18.5	27.0	7.5 ± 0.5	≈ 10.0	100	100	—
18 × 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	—
18 × 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	—

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 $\pm 20\%$)
- 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.

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Ordering example

Electrolytic capacitor 136 series
1 000 µF/25 V; ±20%

Nominal case size: Ø12.5 × 25 mm; Form TFA
Catalogue number: 2222 136 36102.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C,
P = 86 to 106 kPa, RH = 45 to 75%.

SYMBOL	DESCRIPTION
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 2 Electrical data and ordering information; preferred types in **bold**

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	CATALOGUE NUMBER 2222		
										BULK PACKAGING		TAPED
										FORM CA	FORM CB	FORM TFA
10	390	10 × 12	14	630	39	0.19	780	120	240	136 54391	136 64391	136 34391
	470	10 × 12	14	630	47	0.19	640	120	240	136 54471	136 64471	136 34471
	680	10 × 16	15	830	68	0.19	450	84	170	136 54681	136 64681	136 34681
	1 000	10 × 20	16	1 000	100	0.19	300	62	130	136 54102	136 64102	136 34102
	1 000	12.5 × 16	17a	940	100	0.19	300	76	160	136 94105	136 94106	136 94103
	1 200	10 × 25	16L	1 300	120	0.19	250	52	110	136 54122	136 64122	136 34122
	1 500	10 × 30	16LL	1 400	150	0.19	200	44	88	136 94155	136 94156	–
	1 500	12.5 × 20	17	1 300	150	0.19	200	46	92	136 54152	136 64152	136 34152
	1 800	12.5 × 20	17	1 340	180	0.19	170	46	92	136 54182	136 64182	136 34182
	2 200	12.5 × 25	18	1 700	220	0.21	150	34	68	136 54222	136 64222	136 34222
	2 700	12.5 × 31	18L	2 000	270	0.21	120	30	60	136 54272	136 64272	–
	3 300	16 × 20	19a	1 600	330	0.23	110	38	76	136 54332	136 64332	136 34332
	3 900	16 × 25	19	2 100	390	0.23	94	28	56	136 54392	136 64392	136 34392
	4 700	16 × 31	20	2 400	470	0.25	85	25	50	136 54472	136 64472	136 34472
	5 600	16 × 31	20	2 400	560	0.27	77	25	50	136 54562	136 64562	136 34562
	5 600	18 × 25	1825	2 270	560	0.27	77	25	50	136 94565	136 94566	–

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	CATALOGUE NUMBER		
										2222		
										BULK PACKAGING		
										FORM CA	FORM CB	FORM TFA
10	6800	16 × 35	21	2600	680	0.29	68	22	44	136 54682	136 64682	—
	6800	18 × 31	1831	2760	680	0.29	68	23	46	136 94685	136 94686	—
	10000	18 × 35	22	3180	1000	0.31	49	21	42	136 54103	136 64103	—
16	270	10 × 12	14	630	43	0.16	940	120	240	136 55271	136 65271	136 35271
	330	10 × 12	14	630	53	0.16	770	120	240	136 55331	136 65331	136 35331
	470	10 × 16	15	830	75	0.16	540	84	170	136 55471	136 65471	136 35471
	680	10 × 20	16	1000	110	0.16	380	62	130	136 55681	136 65681	136 35681
	680	12.5 × 16	17a	940	110	0.16	380	76	160	136 95685	136 95686	136 95683
	820	10 × 25	16L	1300	130	0.16	310	52	110	136 55821	136 65821	136 35821
	1000	12.5 × 20	17	1300	160	0.16	260	48	96	136 55102	136 65102	136 35102
	1200	10 × 30	16LL	1400	190	0.16	210	44	88	136 95125	136 95126	—
	1200	12.5 × 20	17	1300	190	0.16	210	46	92	136 55122	136 65122	136 35122
	1500	12.5 × 25	18	1700	240	0.16	170	34	68	136 55152	136 65152	136 35152
	2200	12.5 × 31	18L	2000	350	0.18	130	30	60	136 95225	136 95226	—
	2200	16 × 20	19a	1600	350	0.18	130	38	76	136 55222	136 65222	136 35222
	2700	16 × 25	19	2100	430	0.18	110	28	56	136 55272	136 65272	136 35272
	3300	16 × 25	19	2100	530	0.20	97	28	56	136 55332	136 65332	136 35332
	3900	16 × 31	20	2400	620	0.20	82	25	50	136 55392	136 65392	136 35392
4700	16 × 35	21	2600	750	0.22	75	22	44	136 55472	136 65472	—	
4700	18 × 31	1831	2560	750	0.22	75	23	46	136 95475	136 95476	—	
6800	18 × 35	22	3000	1090	0.24	56	21	42	136 55682	136 65682	—	

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	CATALOGUE NUMBER 2222		
										BULK PACKAGING		TAPED
										FORM CA	FORM CB	FORM TFA
25	180	10 × 12	14	630	45	0.14	1200	120	240	136 56181	136 66181	136 36181
	220	10 × 12	14	630	55	0.14	1000	120	240	136 56221	136 66221	136 36221
	330	10 × 16	15	830	83	0.14	680	84	170	136 56331	136 66331	136 36331
	470	10 × 20	16	1000	120	0.14	470	62	130	136 56471	136 66471	136 36471
	470	12.5 × 16	17a	940	120	0.14	470	76	160	136 96475	136 96476	136 96473
	560	10 × 25	16L	1300	140	0.14	400	52	110	136 56561	136 66561	136 36561
	820	10 × 30	16LL	1400	210	0.14	270	44	88	136 96825	136 96826	—
	820	12.5 × 20	17	1300	210	0.14	270	46	92	136 56821	136 66821	136 36821
	1000	12.5 × 25	18	1700	250	0.14	220	34	68	136 56102	136 66102	136 36102
	1500	12.5 × 31	18L	2000	380	0.14	150	30	60	136 96155	136 96156	—
	1500	16 × 20	19a	1700	380	0.14	150	38	76	136 56152	136 66152	136 36152
	1800	16 × 25	19	2100	450	0.14	120	28	56	136 56182	136 66182	136 36182
	2200	16 × 31	20	2400	550	0.16	120	25	50	136 56222	136 66222	136 36222
	2200	18 × 20	1820	1680	550	0.16	116	28	56	136 96225	136 96226	—
	2700	16 × 31	20	2400	680	0.16	94	25	50	136 56272	136 66272	136 36272
	3300	16 × 35	21	2600	830	0.18	87	22	44	136 56332	136 66332	—
35	3300	18 × 31	1831	2490	830	0.18	87	27	54	136 96335	136 96336	—
	4700	18 × 35	22	3000	1180	0.20	68	21	42	136 56472	136 66472	—
	120	10 × 12	14	630	42	0.12	1600	120	240	136 50121	136 60121	136 30121
	150	10 × 12	14	630	53	0.12	1300	120	240	136 50151	136 60151	136 30151
	220	10 × 16	15	830	77	0.12	870	84	170	136 50221	136 60221	136 30221
	330	10 × 20	16	1000	120	0.12	580	62	130	136 50331	136 60331	136 30331
	330	12.5 × 16	17a	940	120	0.12	580	76	160	136 90335	136 90336	136 90333
	390	10 × 25	16L	1300	140	0.12	490	52	110	136 50391	136 60391	136 30391
	470	12.5 × 20	17	1300	170	0.12	410	48	96	136 50471	136 60471	136 30471
	560	10 × 30	16LL	1400	200	0.12	340	44	88	136 90565	136 90566	—
60	560	12.5 × 20	17	1300	200	0.12	340	46	92	136 50561	136 60561	136 30561
	680	12.5 × 25	18	1700	240	0.12	280	34	68	136 50681	136 60681	136 30681
	1000	12.5 × 31	18L	2000	350	0.12	190	30	60	136 90105	136 90106	—

R

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	CATALOGUE NUMBER		
										2222		TAPED
										BULK PACKAGING		
										FORM CA	FORM CB	FORM TFA
35	1000	16 × 20	19a	1700	350	0.12	190	38	76	136 50102	136 60102	136 30102
	1200	16 × 25	19	2100	420	0.12	160	28	56	136 50122	136 60122	136 30122
	1500	16 × 25	19	2100	530	0.12	130	28	56	136 50152	136 60152	136 30152
	1800	16 × 31	20	2400	630	0.12	110	25	50	136 50182	136 60182	136 30182
	2200	16 × 35	21	2600	770	0.14	100	22	44	136 50222	136 60222	—
	2200	18 × 31	1831	2320	770	0.14	101	27	54	136 90225	136 90226	—
	3300	18 × 35	22	2890	1160	0.16	77	21	42	136 50332	136 60332	—
50	82	10 × 12	14	480	41	0.10	1900	200	400	136 51829	136 61829	136 31829
	100	10 × 12	14	480	50	0.10	1600	200	400	136 51101	136 61101	136 31101
	120	10 × 16	15	760	60	0.10	1300	100	200	136 51121	136 61121	136 31121
	150	10 × 20	16	850	75	0.10	1100	90	180	136 51151	136 61151	136 31151
	180	10 × 20	16	950	90	0.10	880	75	150	136 51181	136 61181	136 31181
	180	12.5 × 16	17a	780	90	0.10	880	110	120	136 91185	136 91186	136 91183
	220	10 × 25	16L	1200	110	0.10	720	63	130	136 51221	136 61221	136 31221
	330	10 × 30	16LL	1300	170	0.10	480	54	110	136 91335	136 91336	—
	330	12.5 × 20	17	1200	170	0.10	480	59	120	136 51331	136 61331	136 31331
	470	12.5 × 25	18	1500	240	0.10	340	44	88	136 51471	136 61471	136 31471
	560	12.5 × 31	18L	1700	280	0.10	280	39	78	136 51561	136 61561	—
	680	16 × 20	19a	1400	340	0.10	230	50	100	136 51681	136 61681	136 31681
	820	16 × 25	19	1900	410	0.10	190	34	68	136 51821	136 61821	136 31821
	1000	16 × 31	20	2200	500	0.10	160	30	60	136 51102	136 61102	136 31102
	1000	18 × 20	1820	1510	500	0.10	159	41	82	136 91105	136 91106	—
	1200	16 × 35	21	2300	600	0.10	130	27	54	136 51122	136 61122	—
	1500	18 × 31	1831	2200	750	0.10	106	31	62	136 51152	136 61152	—
	2200	18 × 35	22	2650	1100	0.12	87	27	54	136 51222	136 61222	—

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	CATALOGUE NUMBER		
										2222		TAPED
										BULK PACKAGING		
										FORM CA	FORM CB	FORM TFA
63	47	10 × 12	14	380	30	0.10	3400	300	750	136 58479	136 68479	136 38479
	56	10 × 12	14	420	35	0.10	2800	270	680	136 58569	136 68569	136 38569
	68	10 × 16	15	520	43	0.10	2300	210	530	136 58689	136 68689	136 38689
	100	10 × 16	15	580	63	0.10	1600	190	480	136 58101	136 68101	136 38101
	120	10 × 20	16	650	76	0.10	1300	160	400	136 58121	136 68121	136 38121
	120	12.5 × 16	17a	610	76	0.10	1300	180	450	136 98125	136 98126	136 98123
	150	10 × 25	16L	780	95	0.10	1100	130	330	136 58151	136 68151	136 38151
	180	10 × 30	16LL	960	110	0.10	880	100	250	136 58181	136 68181	—
	220	12.5 × 20	17	870	140	0.10	720	110	280	136 58221	136 68221	136 38221
	270	12.5 × 25	18	1200	170	0.10	590	74	190	136 58271	136 68271	136 38271
	330	16 × 20	19a	1100	210	0.10	480	85	220	136 58331	136 68331	136 38331
	390	12.5 × 31	18L	1300	250	0.10	410	68	170	136 58391	136 68391	—
	470	16 × 25	19	1500	300	0.10	340	55	140	136 58471	136 68471	136 38471
	680	16 × 31	20	1700	430	0.10	230	46	120	136 58681	136 68681	136 38681
	100	680	18 × 25	1825	1470	430	0.10	234	54	108	136 98685	136 98686
820		16 × 35	21	1900	520	0.10	190	40	100	136 58821	136 68821	—
1000		18 × 31	1831	1950	630	0.10	159	39	78	136 58102	136 68102	—
1500		18 × 35	22	2350	950	0.10	106	33	66	136 58152	136 68152	—
22		10 × 12	14	300	22	0.07	5100	450	2300	136 59229	136 69229	136 39229
33		10 × 12	14	320	33	0.07	3400	390	2000	136 59339	136 69339	136 39339
47		10 × 16	15	450	47	0.07	2400	320	1600	136 59479	136 69479	136 39479
68		10 × 20	16	520	68	0.07	1600	240	1200	136 59689	136 69689	136 39689
100		12.5 × 20	17	800	100	0.07	1100	150	750	136 59101	136 69101	136 39101
150		16 × 20	19a	1000	150	0.07	740	110	550	136 59151	136 69151	136 39151
220		16 × 25	19	1300	220	0.07	510	81	400	136 59221	136 69221	136 39221
330		16 × 31	20	1600	330	0.07	340	58	290	136 59331	136 69331	136 39331
470		16 × 35	21	1800	470	0.07	240	45	230	136 59471	136 69471	—
470		18 × 31	1831	1800	470	0.07	240	45	230	136 99475	136 99476	—
680	18 × 35	22	2000	680	0.07	160	39	200	136 59681	136 69681	—	

R

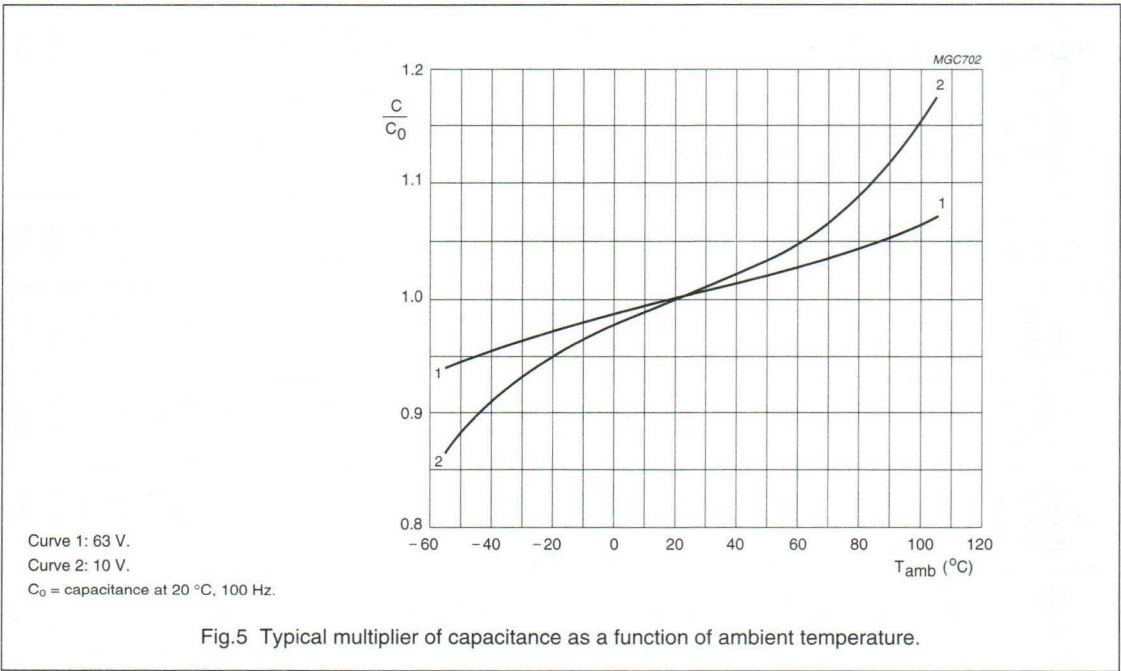
Aluminium electrolytic capacitors Radial, Very Low Impedance

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Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 2 minutes at U_R	$I_{L2} \leq 0.01 C_R \times U_R$ or $3 \mu\text{A}$, whichever is greater
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 10 \text{ mm}$	typ. 16 nH
	case $\varnothing D \geq 12.5 \text{ mm}$	typ. 18 nH

Capacitance (C)



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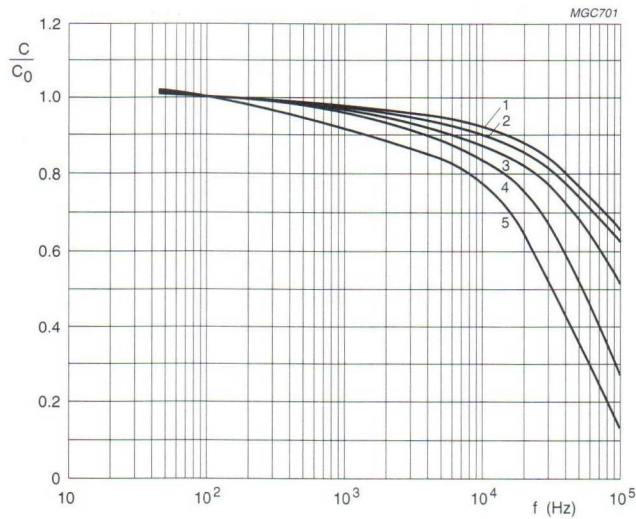


Fig.6 Typical multiplier of capacitance as a function of frequency.

Equivalent series resistance (ESR)

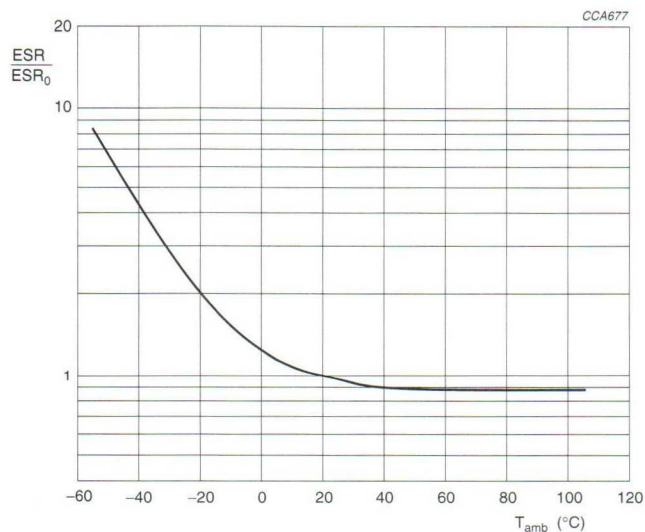
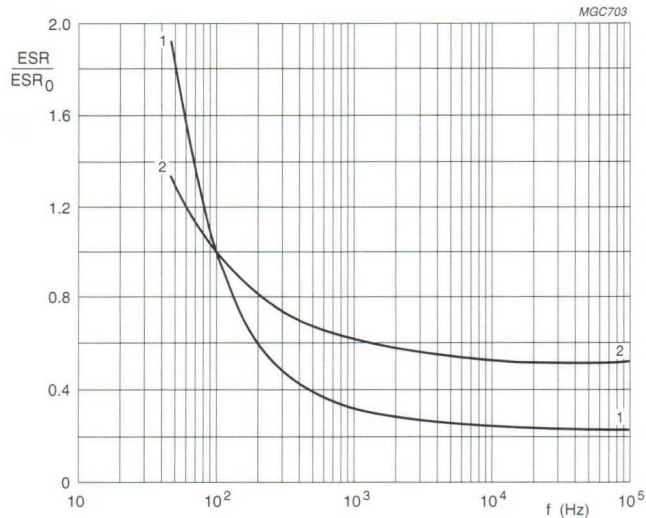
ESR₀ = typical at 20 °C, 100 Hz.

Fig.7 Typical multiplier of ESR as a function of ambient temperature.

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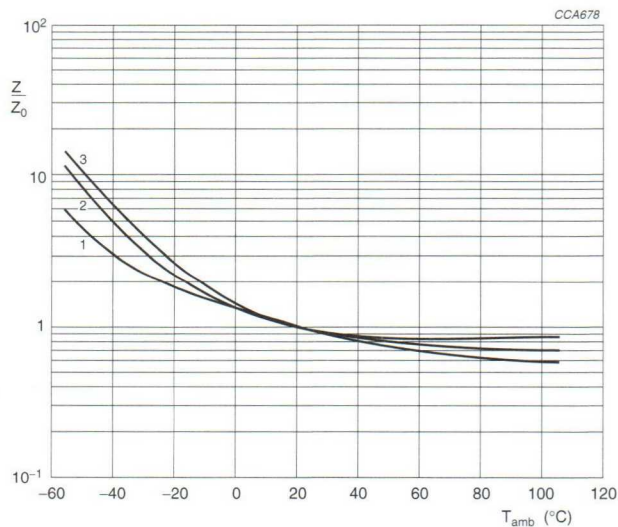
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Curve 1: 63 V.
Curve 2: 10 V.
 ESR_0 = typical at 20 °C, 100 Hz.

Fig.8 Typical multiplier of ESR as a function of frequency.

Impedance (Z)



Curve 1: 10 V.
Curve 2: 50 V.
Curve 3: 63 V.
 Z_0 = typical impedance at 20 °C, 100 kHz.

Fig.9 Typical multiplier of impedance as a function of ambient temperature.

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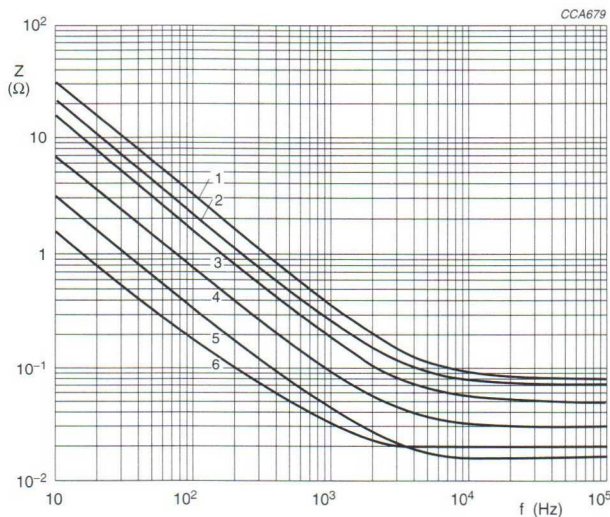
 $U_R = 10$ and 16 V.Curve 1: $470 \mu\text{F}$, 16 V; $\varnothing 10 \times 16$ mm.Curve 2: $680 \mu\text{F}$, 10 V; $\varnothing 10 \times 16$ mm.Curve 3: $1000 \mu\text{F}$, 10 V; $\varnothing 10 \times 20$ mm.Curve 4: $2200 \mu\text{F}$, 10 V; $\varnothing 12.5 \times 25$ mm.Curve 5: $4700 \mu\text{F}$, 16 V; $\varnothing 16 \times 35$ mm.Curve 6: $10000 \mu\text{F}$, 10 V; $\varnothing 18 \times 35$ mm. $T_{\text{amb}} = 20^\circ\text{C}$.

Fig.10 Typical impedance as a function of frequency.

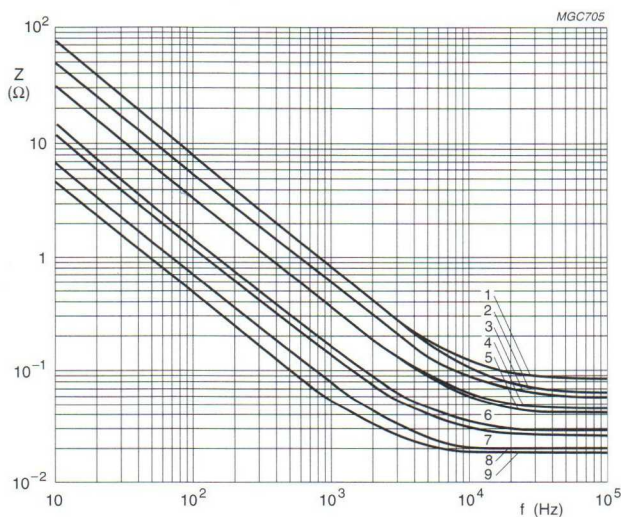
 $U_R = 25$ and 35 V.Curve 1: $220 \mu\text{F}$, 25 V; $\varnothing 10 \times 12$ mm.Curve 2: $220 \mu\text{F}$, 35 V; $\varnothing 10 \times 16$ mm.Curve 3: $330 \mu\text{F}$, 35 V; $\varnothing 10 \times 20$ mm.Curve 4: $470 \mu\text{F}$, 25 V; $\varnothing 10 \times 20$ mm.Curve 5: $470 \mu\text{F}$, 35 V; $\varnothing 12.5 \times 20$ mm.Curve 6: $1000 \mu\text{F}$, 25 V; $\varnothing 12.5 \times 25$ mm.Curve 7: $1200 \mu\text{F}$, 35 V; $\varnothing 16 \times 25$ mm.Curve 8: $2200 \mu\text{F}$, 35 V; $\varnothing 16 \times 35$ mm.Curve 9: $3300 \mu\text{F}$, 25 V; $\varnothing 16 \times 35$ mm. $T_{\text{amb}} = 20^\circ\text{C}$.

Fig.11 Typical impedance as a function of frequency.

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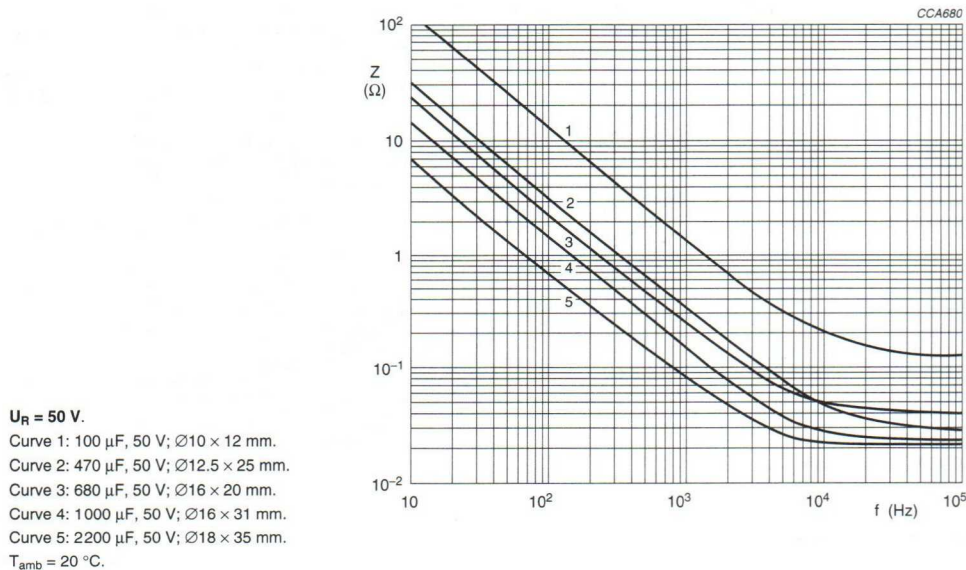


Fig.12 Typical impedance as a function of frequency.

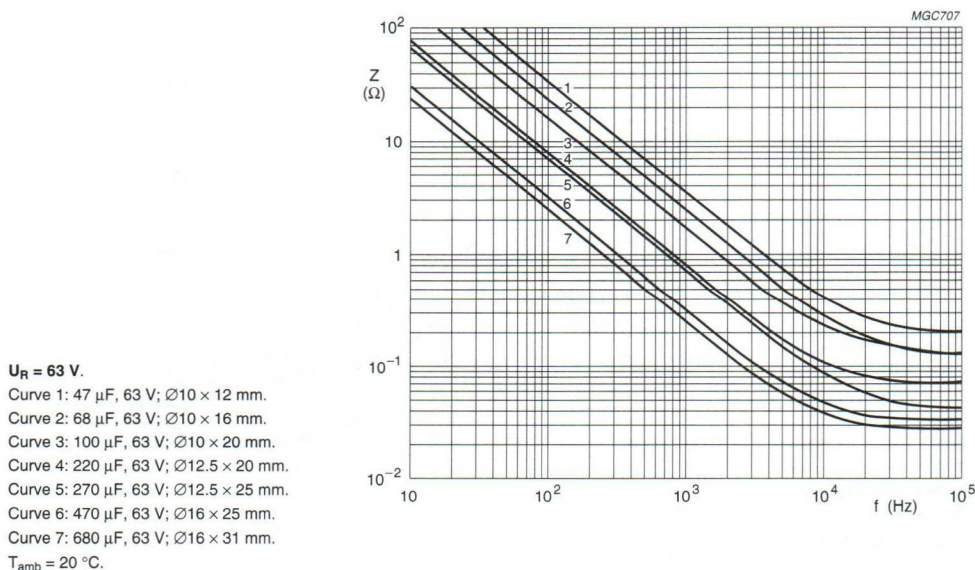


Fig.13 Typical impedance as a function of frequency.

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RIPPLE CURRENT AND USEFUL LIFE

Table 3 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							
	$U_R = 10 \text{ V}$		$U_R = 16 \text{ and } 25 \text{ V}$		$U_R = 35 \text{ and } 50 \text{ V}$		$U_R = 63 \text{ and } 100 \text{ V}$	
	$\varnothing \leq 12.5$	$\varnothing \geq 16$	$\varnothing \leq 12.5$	$\varnothing \geq 16$	$\varnothing \leq 12.5$	$\varnothing \geq 16$	$\varnothing \leq 12.5$	$\varnothing \geq 16$
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
10000	0.96	0.99	0.92	0.96	0.88	0.93	0.85	0.9
30000	0.99	1.0	0.98	0.99	0.94	0.96	0.92	0.95
100000	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 4 Endurance test duration and useful life as a function of case size; see Fig.14

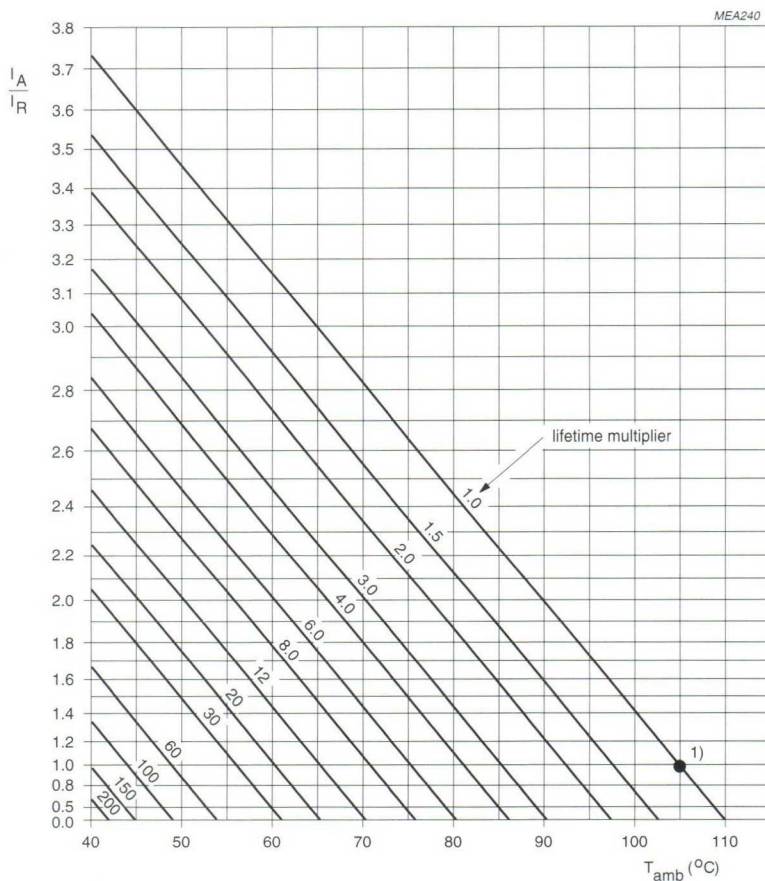
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	ENDURANCE TEST at 105 °C (hours)	USEFUL LIFE at 105 °C (hours)
10 × 12	14	3000	4000
10 × 16	15	3000	6000
10 × 20	16	3000	6000
10 × 25	16L	5000	7000
10 × 30	16LL	5000	7000
12.5 × 16	17a	3000	5000
12.5 × 20	17	3000	7000
12.5 × 25	18	5000	8000
12.5 × 31	18L	5000	8000
16 × 20	19a	3000	7000
16 × 25	19	5000	10000
16 × 31	20	5000	10000
16 × 35	21	5000	10000
18 × 20	1820	3000	7000
18 × 25	1825	5000	10000
18 × 31	1831	5000	10000
18 × 35	22	5000	10000

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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; see Table 4.

Fig.14 Multiplier of useful life as a function of ambient temperature and ripple current load.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 5 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ °C}$; U_R applied; for test duration see Table 4	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ °C}$; U_R and I_R applied; for test duration see Table 4	$\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 105\text{ °C}$; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$

Aluminium electrolytic capacitors

Radial High Temperature

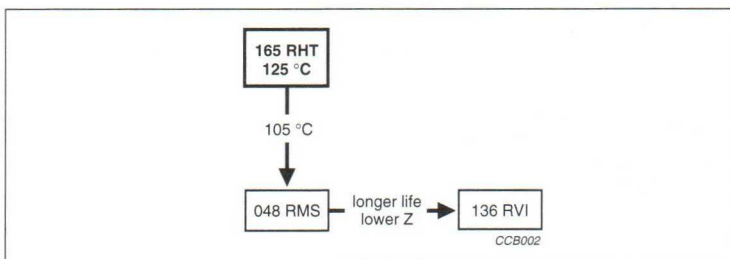
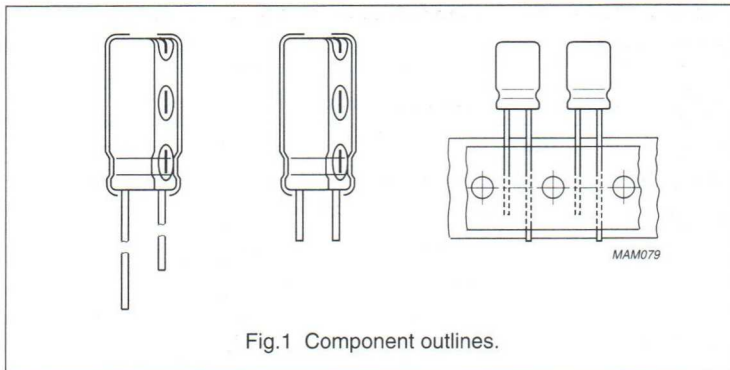
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FEATURES

- 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.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	10 × 12 to 16 × 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	1 000 hours
Useful life at 125 °C	1 500 hours
Useful life at 40 °C, $1.6 \times I_R$ applied	300 000 hours
Shelf life at 0 V, 125 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/125/56

Aluminium electrolytic capacitors

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

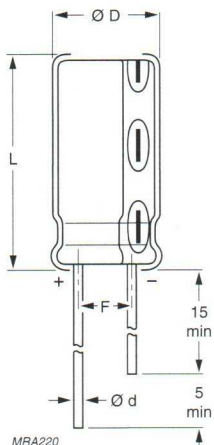
C_R (μF)	U_R (V)					
	10	16	25	35	40	50
22	—	—	—	—	—	10 × 12
47	—	—	—	—	10 × 12	10 × 16
100	—	—	10 × 12	10 × 16	10 × 20	12.5 × 20
220	10 × 12	10 × 16	10 × 20	—	12.5 × 20	16 × 25
470	10 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 31	16 × 35
1000	—	12.5 × 25	16 × 31	—	16 × 35	16 × 35
2200	16 × 31	16 × 35	16 × 35	—	—	—
3300	16 × 35	16 × 35	—	—	—	—
4700	16 × 35	—	—	—	—	—

Aluminium electrolytic capacitors

Radial High Temperature

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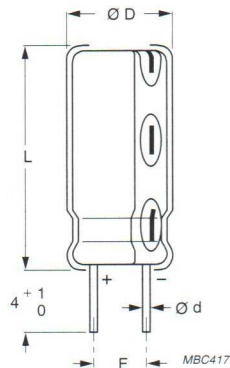
MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

For dimensions see Table 1.

Fig.2 Form CA: Long leads.



Dimensions in mm.

For dimensions see Table 1.

Fig.3 Form CB: Cut leads.

Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

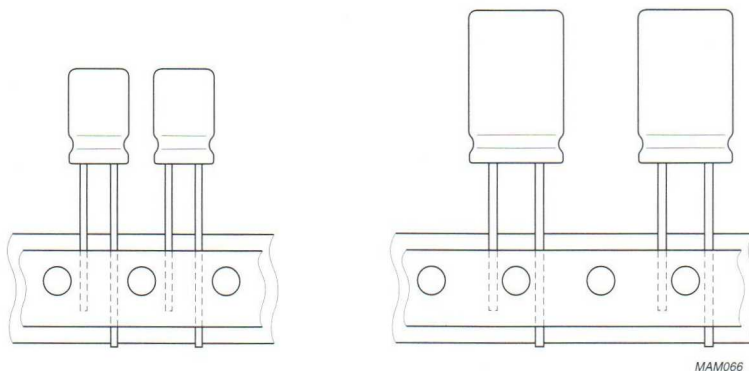
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES PER BOX		
							FORM CA	FORM CB	FORM TFA
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 × 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 × 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 × 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.5	100	100	—

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Taped products

**Form TFA:****Case** $\varnothing D \times L \leq 16 \times 31\text{mm}$.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.4 Taped in box (ammopack).

MARKING

The capacitors are marked with the following information:

- Rated capacitance value (in μF)
- Tolerance on rated capacitance, code letter in accordance with "IEC 62" (M for $\pm 20\%$)
- 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

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

Ordering example

Electrolytic capacitor 165 series
220 µF/25 V; ±20%
Nominal case size: Ø10 × 20 mm; Form TFA
Catalogue number: 2222 165 36221.

SYMBOL	DESCRIPTION
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 2 Electrical data and ordering information; preferred types in bold

U _R 100 Hz (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222		
											BULK PACKAGING		TAPED
											FORM CA	FORM CB	
10	220	10 × 12	14	200	25	7	0.20	1.30	—	0.55	165 54221	165 64221	165 34221
	470	10 × 20	16	340	50	12	0.20	0.61	—	0.26	165 54471	165 64471	165 34471
	2200	16 × 31	20	930	220	47	0.24	0.16	0.07	—	165 54222	165 64222	165 34222
	3300	16 × 35	21	1200	330	69	0.26	0.11	0.05	—	165 54332	165 64332	—
	4700	16 × 35	21	1400	470	97	0.28	0.09	0.04	—	165 90502	165 90507	—
16	220	10 × 16	15	240	38	10	0.16	1.00	—	0.43	165 55221	165 65221	165 35221
	470	12.5 × 20	17	410	78	18	0.16	0.49	—	0.20	165 55471	165 65471	165 35471
	1000	12.5 × 25	18	650	160	35	0.16	0.23	—	0.10	165 55102	165 65102	165 35102
	2200	16 × 35	21	1100	360	73	0.20	0.13	0.05	—	165 55222	165 65222	—
	3300	16 × 35	21	1400	530	110	0.22	0.10	0.04	—	165 90503	165 90508	—
25	100	10 × 12	14	170	28	8	0.14	2.00	—	0.70	165 56101	165 66101	165 36101
	220	10 × 20	16	280	58	14	0.14	0.91	—	0.32	165 56221	165 66221	165 36221
	470	12.5 × 25	18	480	120	27	0.14	0.43	—	0.15	165 56471	165 66471	165 36471
	1000	16 × 31	20	830	250	53	0.14	0.20	—	0.07	165 56102	165 66102	165 36102
	2200	16 × 35	21	1200	550	110	0.18	0.12	0.04	—	165 90504	165 90509	—

Aluminium electrolytic capacitors
Radial High Temperature

165 RHT

Aluminium electrolytic capacitors

Radial High Temperature

165 RHT

CATALOGUE NUMBER 2222															
.															
	U _R 100 Hz (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	Z 100 kHz (Ω)	BULK PACKAGING			TAPED
												FORM CA	FORM CB	FORM TFA	
35	100 470		10 × 16	15	200	38	10	0.12	1.70	—	0.65	165 50101	165 60101	165 30101	
			16 × 25	19	600	170	36	0.12	0.37	—	0.14	165 50471	165 60471	165 30471	
40	47		10 × 12	14	130	22	7	0.12	3.70	—	1.30	165 57479	165 67479	165 37479	
	100		10 × 20	16	210	43	11	0.12	1.70	—	0.60	165 57101	165 67101	165 37101	
	220		12.5 × 20	17	340	91	21	0.12	0.78	—	0.27	165 57221	165 67221	165 37221	
	470		16 × 31	20	650	190	41	0.12	0.37	—	0.13	165 57471	165 67471	165 37471	
	1000		16 × 35	21	1000	400	83	0.12	0.17	—	0.06	165 57102	165 67102	—	
50	22		10 × 12	14	100	14	5	0.10	6.50	—	2.3	165 51229	165 61229	165 31229	
	47		10 × 16	15	150	27	8	0.10	3.00	—	1.10	165 51479	165 61479	165 31479	
	100		12.5 × 20	17	260	53	13	0.10	1.40	—	0.50	165 51101	165 61101	165 31101	
	220		16 × 25	19	450	110	25	0.10	0.65	—	0.23	165 51221	165 61221	165 31221	
	470		16 × 35	21	760	240	50	0.10	0.30	—	0.11	165 51471	165 61471	—	
	1000		16 × 35	21	1200	500	100	0.10	0.14	—	0.05	165 90506	165 90512	—	

Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_S \leq 1.3 U_R$
Reverse voltage		$U_{rev} \leq 1 V$
Current		
Leakage current	after 1 minute at U_R after 5 minutes at U_R	$I_{L1} \leq 0.01 C_R \times U_R + 3 \mu A$ $I_{L5} \leq 0.002 C_R \times U_R + 3 \mu A$
Inductance		
Equivalent series inductance (ESL)	case ØD = 10 mm case ØD ≥ 12.5 mm	typ. 16 nH typ. 18 nH

Aluminium electrolytic capacitors

Radial High Temperature

165 RHT

Capacitance (C)

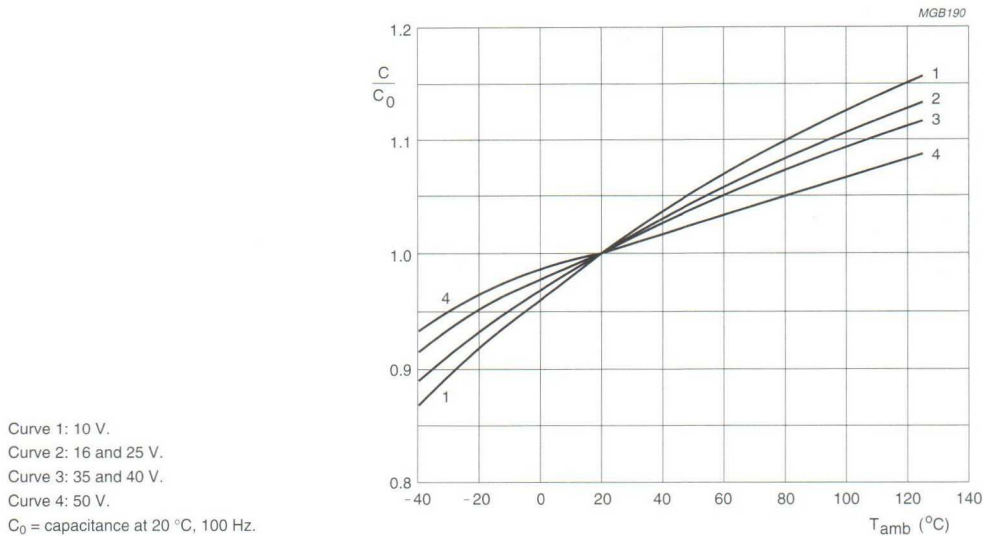


Fig.5 Typical multiplier of capacitance as a function of ambient temperature.

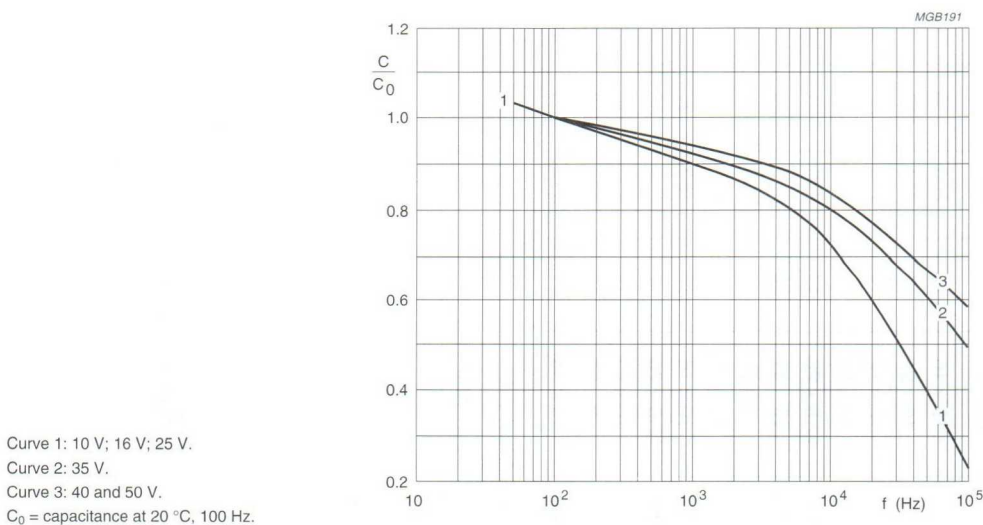
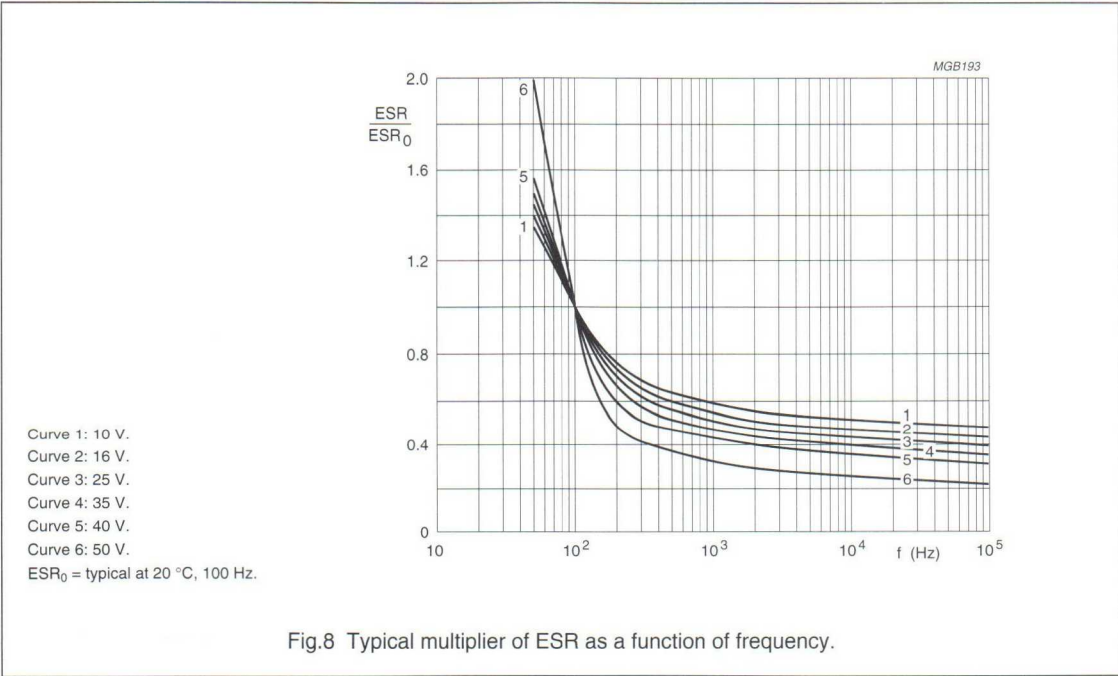
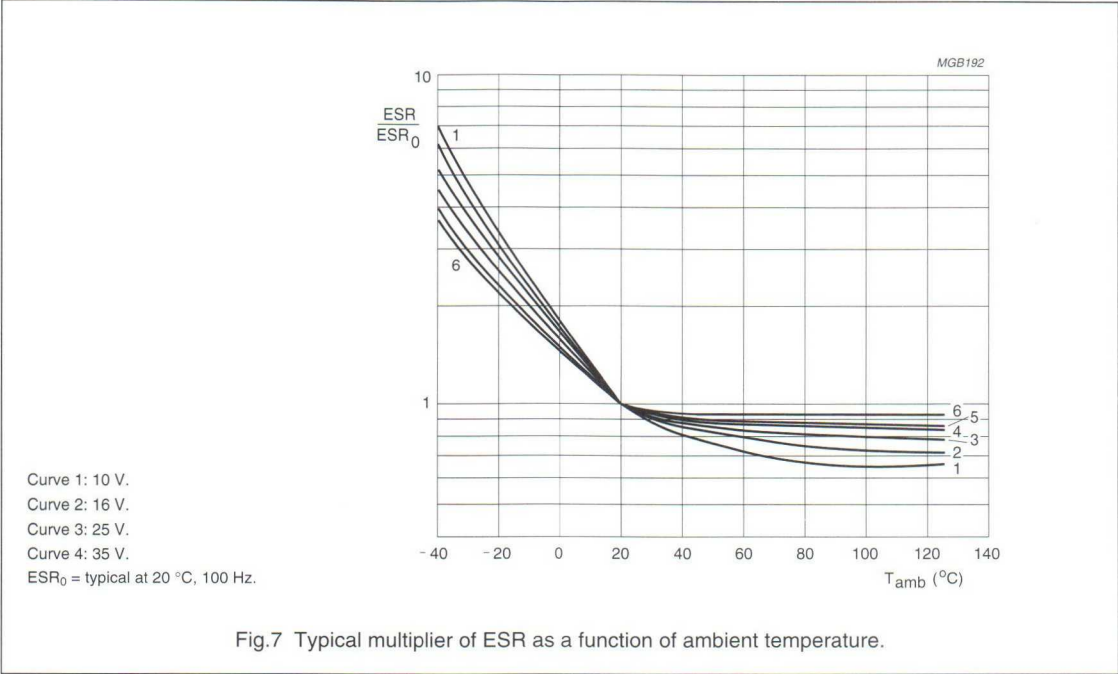


Fig.6 Typical multiplier of capacitance as a function of frequency.

Aluminium electrolytic capacitors
Radial High Temperature

165 RHT

Equivalent series resistance (ESR)

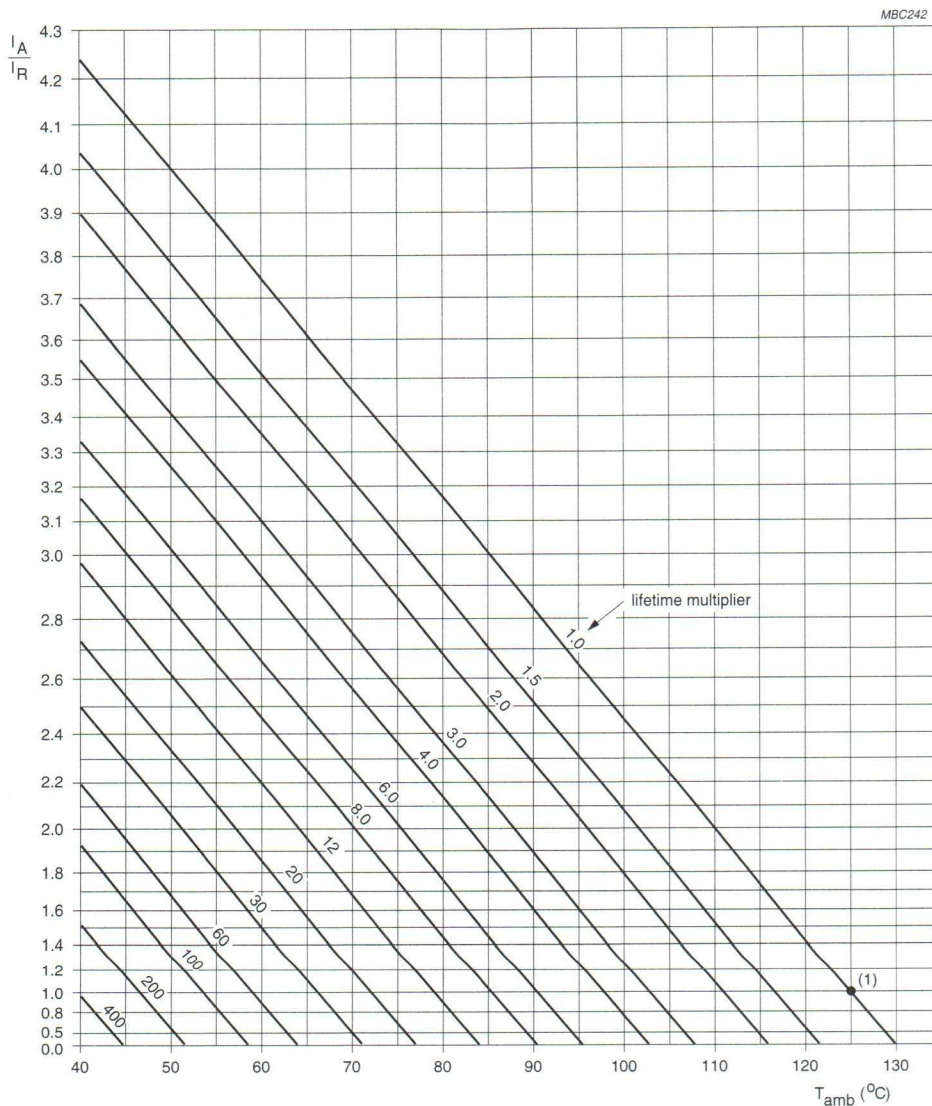


Aluminium electrolytic capacitors

Radial High Temperature

165 RHT

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz.

I_R = rated ripple current at 100 Hz, 125 $^{\circ}\text{C}$.

(1) Useful life at 125 $^{\circ}\text{C}$ and I_R applied: 1500 hours.

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load; see Table 3.

Aluminium electrolytic capacitors

Radial High Temperature

165 RHT

Table 3 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 100 Hz; see Fig.9

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10 \text{ to } 25 \text{ V}$	$U_R = 35 \text{ or } 40 \text{ V}$	$U_R = 50 \text{ V}$
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

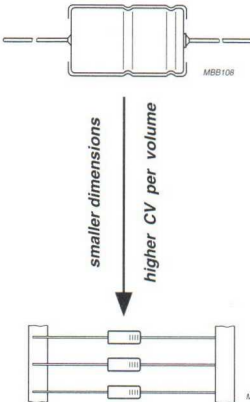
General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 125^\circ\text{C}$; U_R applied; 1000 hours	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 125^\circ\text{C}$; U_R and I_R applied; 1500 hours	$\Delta C/C: \pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 125^\circ\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$

R

AXIAL ALUMINIUM ELECTROLYTIC CAPACITORS

	MINIATURE	STANDARD and SEMI-PROFESSIONAL	LONG-LIFE	EXTRA LONG-LIFE or HIGH TEMPERATURE
	1500 to 2000 hours 85 °C	2500 to 8000 hours 85 °C page 370 137 92 AB bipolar 137 ABA bipolar audio page 372	10000 to 15000 hours 85 °C 2000 to 10000 hours 105 °C 042/043 ASH-ELB 600 V/24 hours page 361	4000 hours 125 °C 119 AHT-DIN page 432
	page 334 030/031 AS ØD = 3.3 mm 117 ASD page 306	page 334 030/031 AS 041 ASH page 347	page 396 132/133 ALL-DIN 042/043 ASH page 347	118 AHT page 414
		021 ASM page 315	138 AML page 374	

CCB099

Aluminium electrolytic capacitors
Axial, Smallest Diameter

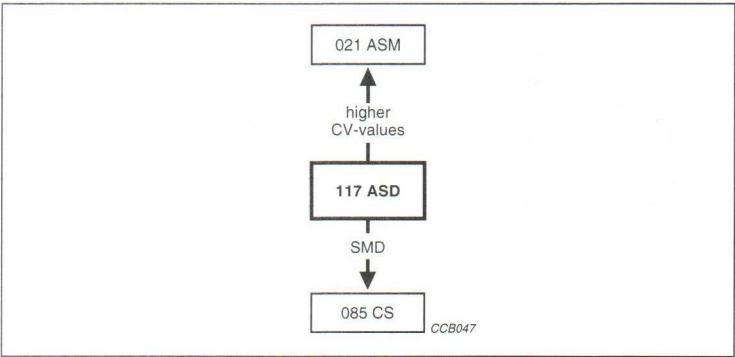
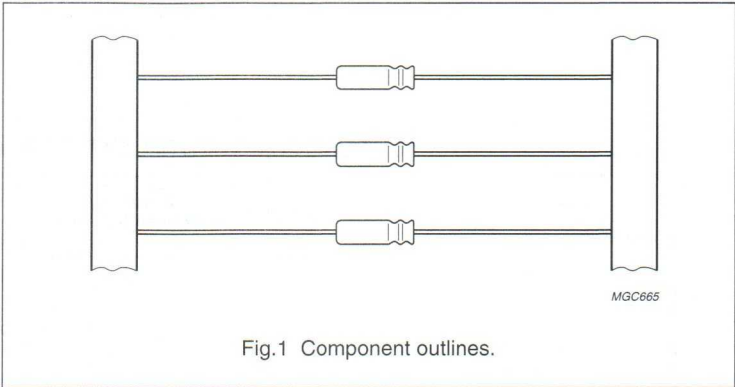
117 ASD

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.

APPLICATIONS

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



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	3.3 × 8 and 3.3 × 11
Rated capacitance range, C_R	0.47 to 22 μF
Tolerance on C_R	-10 to +50% ($\pm 20\%$ 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	60000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/085/56

Aluminium electrolytic capacitors

Axial, Smallest Diameter

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

C_R (μF)	U_R (V)					
	6.3	10	16	25	40	63
0.47	—	—	—	—	—	3.3×8
1.0	—	—	—	—	—	3.3×8
2.2	—	—	—	—	3.3×8	3.3×11
3.3	—	—	—	3.3×8	—	3.3×11
4.7	—	—	3.3×8	—	3.3×11	—
6.8	—	3.3×8	—	3.3×11	—	—
10	3.3×8	—	3.3×11	—	—	—
22	3.3×11	—	—	—	—	—

Aluminium electrolytic capacitors

Axial, Smallest Diameter

117 ASD

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

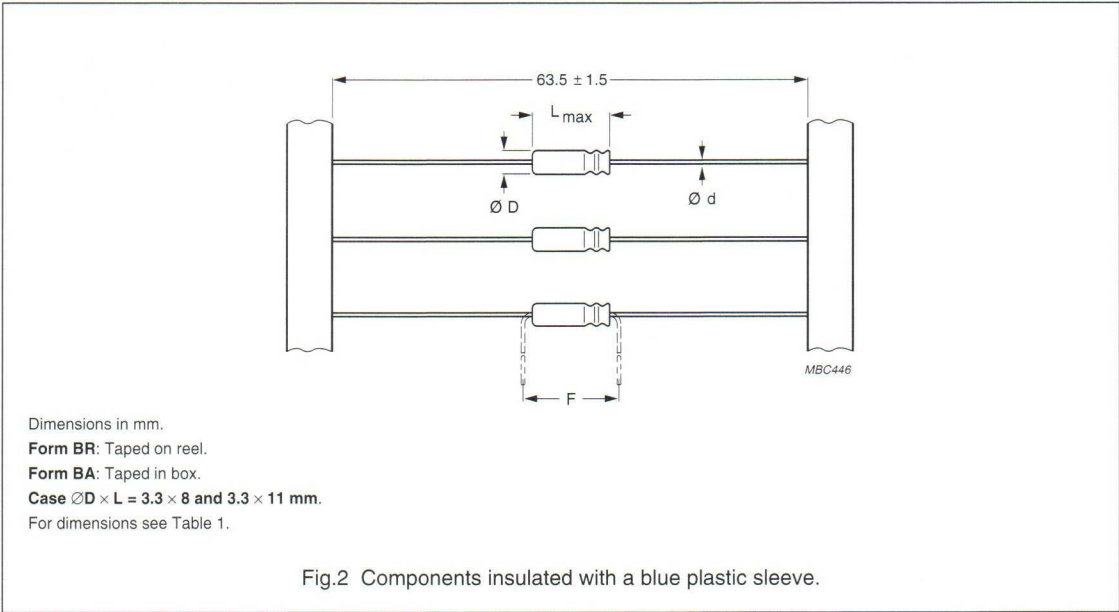


Table 1 Physical dimensions, mass and packaging quantities; see Fig.2

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	AXIAL: FORM BA and BR				MASS (g)	PACKAGING QUANTITIES	
		$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F_{min} (mm)		FORM BA	FORM BR
3.3 × 8	1a	0.6	3.5	9	12.5	≈0.3	1000	4000
3.3 × 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.

Aluminium electrolytic capacitors

Axial, Smallest Diameter

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at
 $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86\text{ to }106\text{ kPa}$, $RH = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $-10\text{ to }+50\%$
I_R	rated RMS ripple current at 100 Hz, $85\text{ }^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and C_R)
Z	max. impedance at 10 kHz

Ordering example

Electrolytic capacitor 117 series

$10\text{ }\mu\text{F}/16\text{ V}$; $-10/+50\%$

Nominal case size: $\varnothing 3.3 \times 11\text{ mm}$;
Form BA

Catalogue number: 2222 117 35109.

Table 2 Electrical data and ordering information

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz $85\text{ }^{\circ}\text{C}$ (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222	
										ON REEL FORM BR	IN BOX FORM BA
6.3	10	3.3×8	1a	11	4	3	0.30	48	20	117 23109	117 33109
	22	3.3×11	1	20	6	3	0.30	22	9	117 23229	117 33229
10	6.8	3.3×8	1a	10	4	3	0.25	59	24	117 24688	117 34688
	4.7	3.3×8	1a	9	5	3	0.20	68	26	117 25478	117 35478
16	10	3.3×11	1	16	6	3	0.20	32	12	117 25109	117 35109
	3.3	3.3×8	1a	8	5	3	0.18	87	27	117 26338	117 36338
25	6.8	3.3×11	1	14	6	3	0.18	42	13	117 26688	117 36688
	2.2	3.3×8	1a	7	5	3	0.16	120	32	117 27228	117 37228
40	4.7	3.3×11	1	13	7	3	0.16	54	15	117 27478	117 37478
	63	3.3×8	1a	4	4	3	0.10	340	120	117 28477	117 38477
	1	3.3×8	1a	6	4	3	0.12	190	55	117 28108	117 38108
	2.2	3.3×11	1	11	6	3	0.14	87	25	117 28228	117 38228
	3.3	3.3×11	1	13	7	3	0.14	68	17	117 28338	117 38338

A

Aluminium electrolytic capacitors

Axial, Smallest Diameter

117 ASD

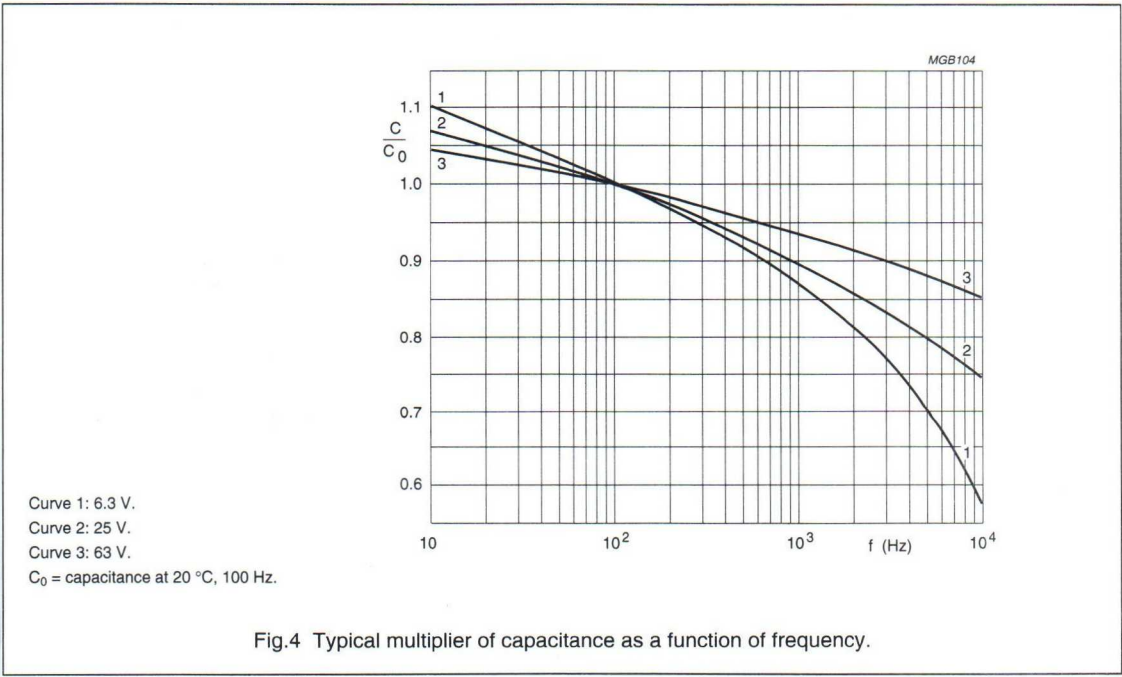
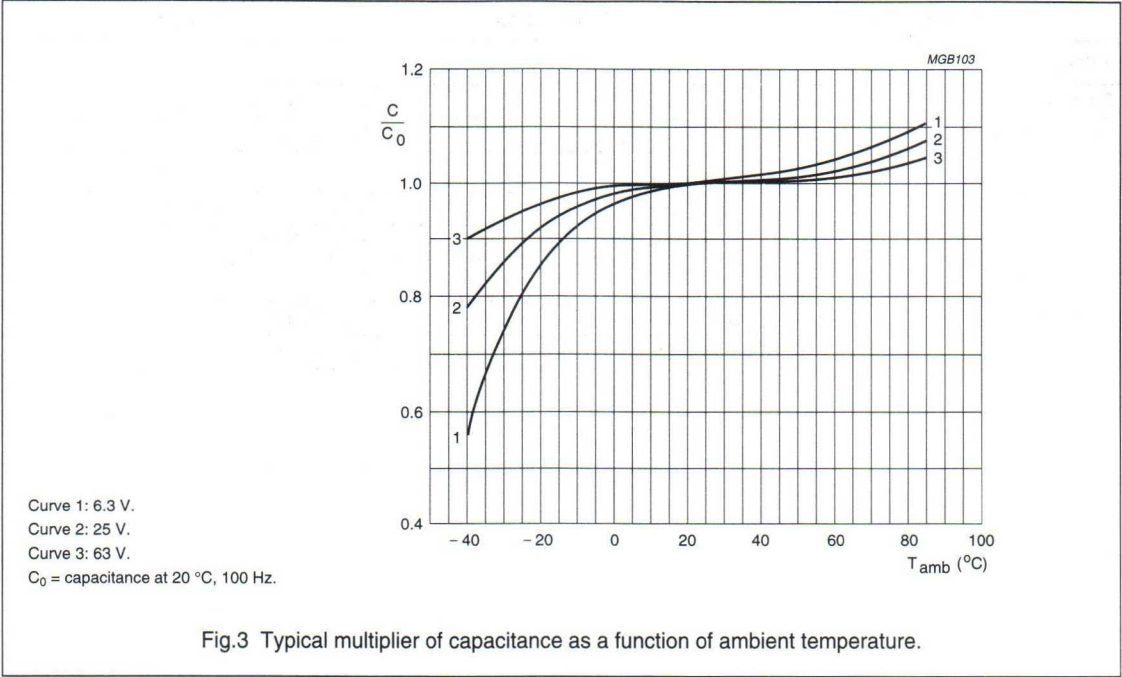
Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.02C_R \times U_R + 3 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 3 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D \times L = 3.3 \times 8 \text{ mm}$	typ. 13 nH
	case $\varnothing D \times L = 3.3 \times 11 \text{ mm}$	typ. 15 nH

Aluminium electrolytic capacitors
Axial, Smallest Diameter

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Capacitance (C)



Aluminium electrolytic capacitors

Axial, Smallest Diameter

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Impedance (Z)

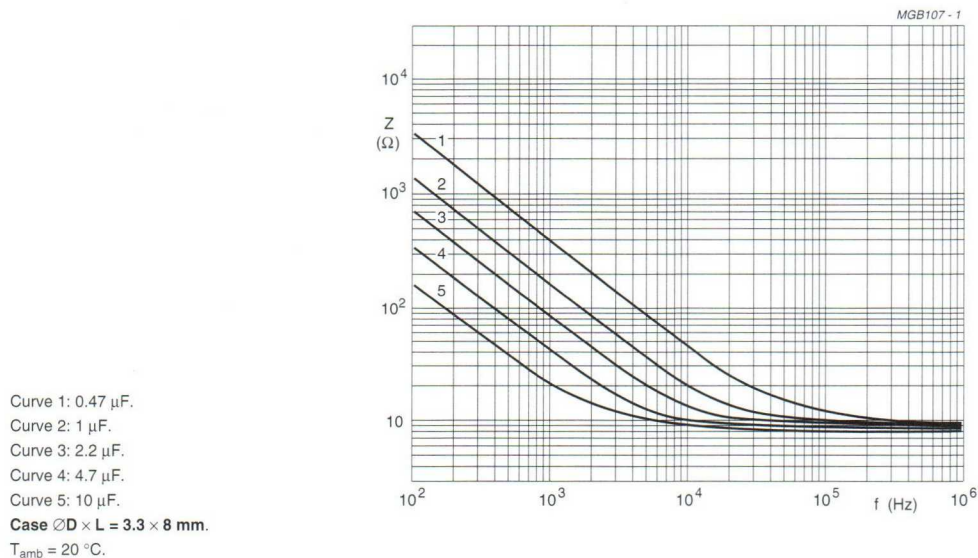


Fig.5 Typical impedance as a function of frequency.

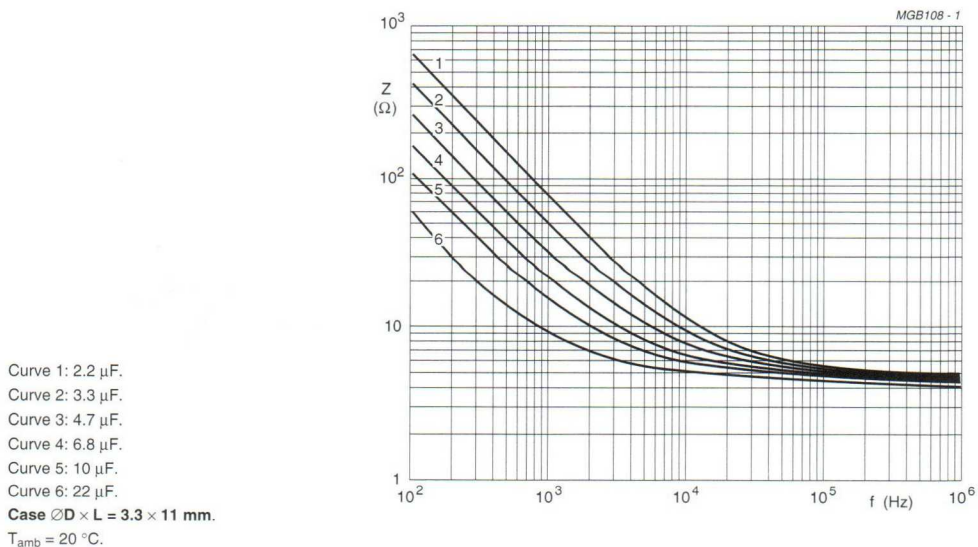


Fig.6 Typical impedance as a function of frequency.

Aluminium electrolytic capacitors

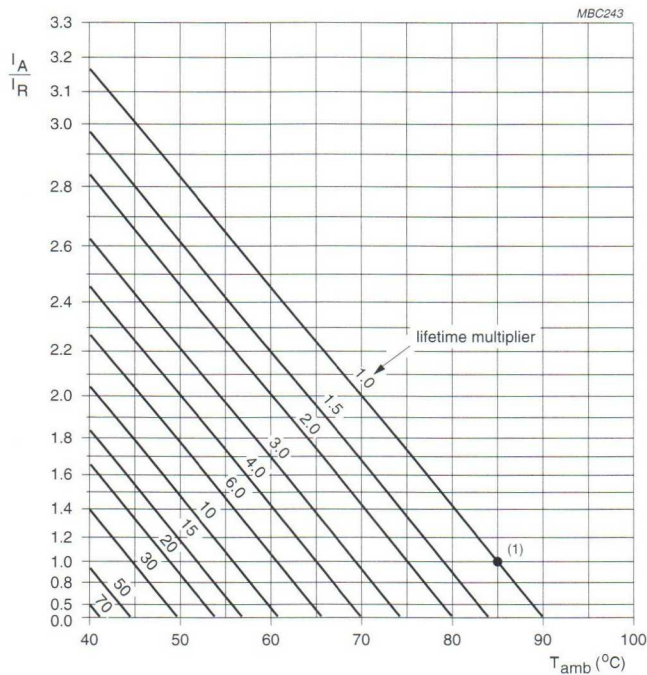
Axial, Smallest Diameter

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RIPPLE CURRENT AND USEFUL LIFE

Table 3 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 85 °C, 100 Hz

FREQUENCY (Hz)	I _R MULTIPLIER		
	U _R = 6.3 to 16 V	U _R = 25 to 40 V	U _R = 63 V
50	0.8	0.75	0.7
100	1.0	1.0	1.0
300	1.2	1.3	1.55
1000	1.35	1.55	1.9
3000	1.45	1.7	2.3
≥10000	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.7 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Axial, Smallest Diameter

117 ASD

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ °C}$; U_R applied; 1500 hours	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ °C}$; U_R and I_R applied; 2000 hours	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ °C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$

Aluminium electrolytic capacitors

Axial Standard Miniature

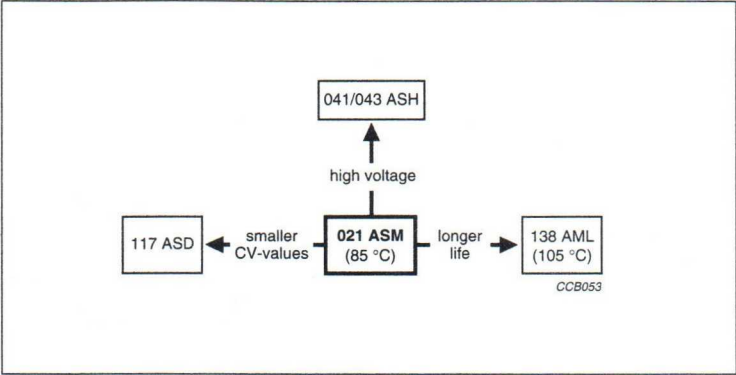
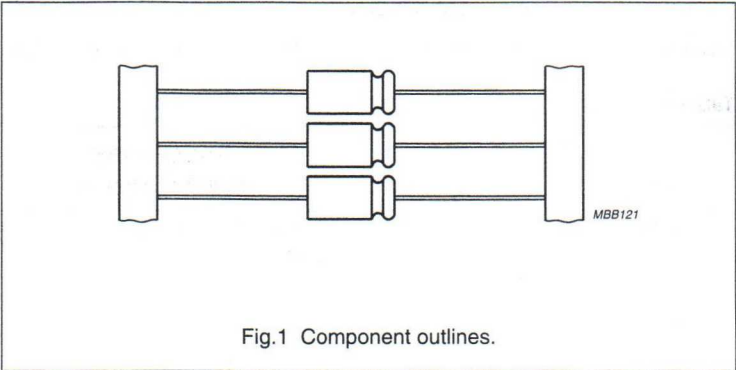
021 ASM

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 $\varnothing 10 \times 30$ to 21×40 mm with pressure relief
- Charge and discharge proof
- Taped versions up to case $\varnothing 15 \times 30$ mm available for automatic insertion
- Miniaturized, high CV-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.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	4.5×10 to 10×25	10×30 to 21×40
Rated capacitance range, C_R	0.47 to 15000 μF	
Tolerance on C_R	$\pm 20\%$	
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	1 000 hours	5 000 hours
$U_R = 40$ to 100 V	2 000 hours	5 000 hours
Useful life at 85 °C	2 500 hours	8 000 hours
Useful life at 40 °C, $1.4 \times I_R$ applied	70 000 hours	200 000 hours
Shelf life at 0 V, 85 °C	500 hours	500 hours
Based on sectional specification	IEC 384-4/CECC 30300	IEC 384-4/CECC 30300
Climatic category IEC 68	40/085/56	

Aluminium electrolytic capacitors

Axial Standard Miniature

021 ASM

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

C_R (μF)	U_R (V)						
	6.3	10	16	25	40	63	100
0.47	—	—	—	—	—	4.5 × 10	—
1	—	—	—	—	—	4.5 × 10	4.5 × 10
2.2	—	—	—	—	—	4.5 × 10	4.5 × 10
3.3	—	—	—	—	—	4.5 × 10	—
4.7	—	—	—	—	—	4.5 × 10	4.5 × 10
10	—	—	—	—	—	4.5 × 10	6 × 10
15	—	—	—	—	—	4.5 × 10	8 × 11
	—	—	—	—	—	—	6.5 × 18
22	—	—	—	—	4.5 × 10	6 × 10	8 × 11
	—	—	—	—	—	—	6.5 × 18
33	—	—	—	—	—	6 × 10	6.5 × 18
47	—	—	—	4.5 × 10	6 × 10	8 × 11	8 × 18
	—	—	—	—	—	6.5 × 18	—
68	—	—	4.5 × 10	—	—	8 × 11	10 × 18
	—	—	—	—	—	6.5 × 18	—
100	—	4.5 × 10	—	6 × 10	8 × 11	8 × 18	10 × 25
	—	—	—	—	6.5 × 18	—	10 × 30
150	—	—	6 × 10	8 × 11	8 × 18	10 × 18	12.5 × 30
	—	—	—	6.5 × 18	—	—	—
220	—	6 × 10	8 × 11	6.5 × 18	10 × 18	10 × 25	12.5 × 30
	—	—	—	—	—	10 × 30	—
330	—	8 × 11	6.5 × 18	8 × 18	10 × 25	12.5 × 30	15 × 30
470	8 × 11	6.5 × 18	8 × 18	10 × 18	10 × 25	12.5 × 30	18 × 30
	—	—	—	—	10 × 30	—	—
680	—	8 × 18	10 × 18	10 × 25	12.5 × 30	15 × 30	18 × 40
	—	—	—	10 × 30	—	—	—
1000	8 × 18	10 × 18	10 × 25	12.5 × 30	12.5 × 30	18 × 30	21 × 40
	—	—	10 × 30	—	—	—	—
1500	—	10 × 25	12.5 × 30	12.5 × 30	15 × 30	18 × 40	—
	—	10 × 30	—	—	—	—	—
2200	10 × 25	12.5 × 30	12.5 × 30	15 × 30	18 × 30	21 × 40	—
3300	—	12.5 × 30	15 × 30	18 × 30	18 × 40	—	—
4700	—	15 × 30	18 × 30	18 × 40	21 × 40	—	—
6800	—	18 × 30	18 × 40	21 × 40	—	—	—
10000	—	18 × 40	21 × 40	—	—	—	—
15000	—	21 × 40	—	—	—	—	—

Aluminium electrolytic capacitors
Axial Standard Miniature

021 ASM

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

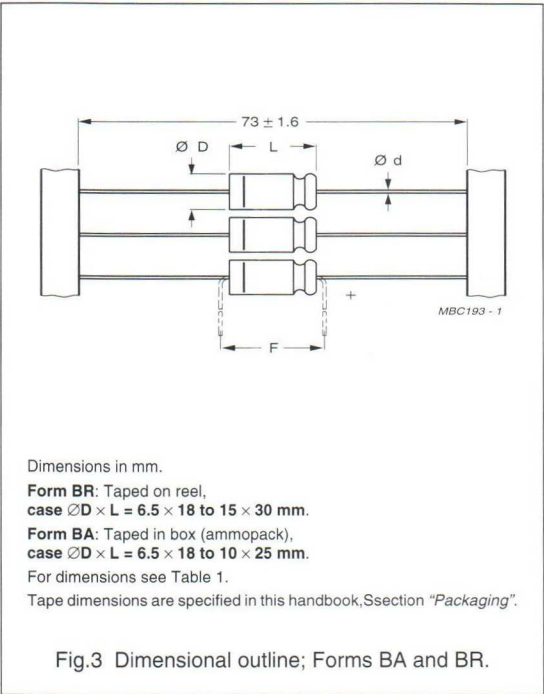
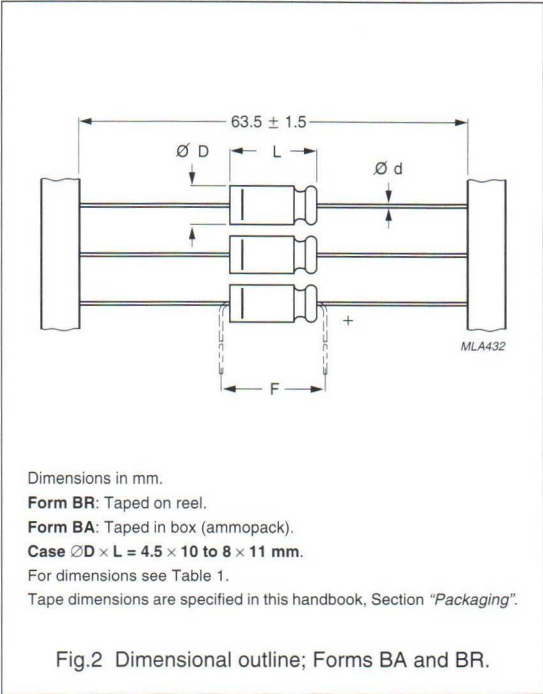
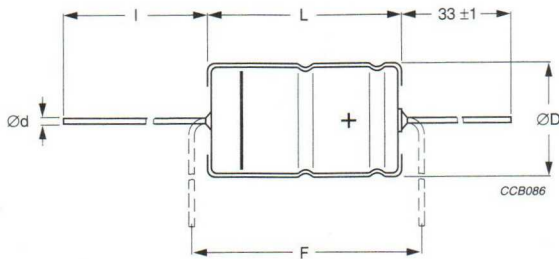


Table 1 Axial; physical dimensions, mass and packaging quantities; see Figs 2, 3 and 4

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	AXIAL: FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		$\varnothing d$	l	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F_{min} (mm)		FORM AA	FORM BA	FORM BR
4.5 × 10	2	0.6	—	5.0	10.5	15	≈0.50	—	1000	3000
6 × 10	3	0.6	—	6.3	10.5	15	≈0.70	—	1000	1000
8 × 11	5a	0.6	—	8.5	11.5	15	≈1.1	—	500	500
6.5 × 18	4	0.8	—	6.9	18.5	25	≈1.3	—	1000	1000
8 × 18	5	0.8	—	8.5	18.5	25	≈1.7	—	500	500
10 × 18	6	0.8	—	10.5	18.5	25	≈2.5	—	500	500
10 × 25	7	0.8	—	10.5	25.0	30	≈3.3	—	500	500
10 × 30	00	0.8	55 ± 1	10.5	30.5	35	≈4.8	200	—	500
12.5 × 30	01	0.8	55 ± 1	13.0	30.5	35	≈7.4	200	—	400
15 × 30	02	0.8	55 ± 1	15.5	30.5	35	≈11.7	200	—	250
18 × 30	03	0.8	55 ± 1	18.5	30.5	35	≈12.9	200	—	—
18 × 40	04	0.8	34 ± 1	18.5	41.5	45	≈19.4	100	—	—
21 × 40	05	0.8	34 ± 1	21.5	41.5	45	≈24.7	100	—	—

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Dimensions in mm.

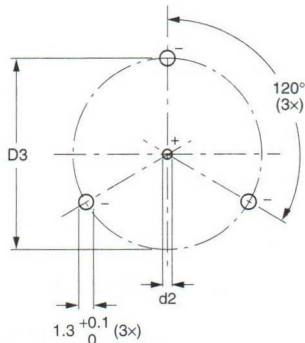
Form AA: Axial in box.

Case $\text{ØD} \times \text{L} = 10 \times 30$ and 21×40 mm.

For case $\text{ØD} \times \text{L} = 18 \times 40$ and 21×40 mm, the stated L may be exceeded by 0.7 mm.

For dimensions see Table 1.

Fig.4 Dimensional outline; Form AA.



mounting holes

Dimensions in mm.

Form MR: case $\text{ØD} \times \text{L} = 15 \times 30$ to 21×40 mm.

Case not insulated (insulation on request).

Especially for applications with severe shocks and vibrations.

For dimensions see Table 2.

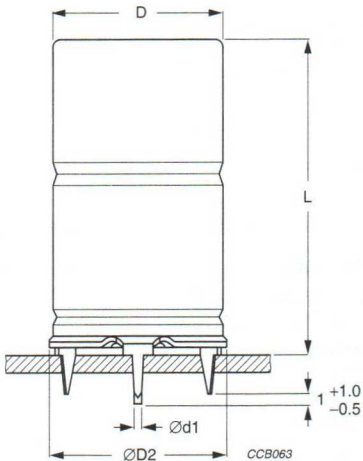
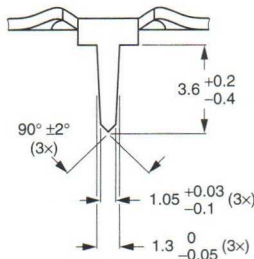


Fig.5 Mounting hole diagram and outline; Form MR; single ended with mounting ring and pins.

Table 2 Single ended; mass and packaging quantities; see Fig.5

NOMINAL CASE SIZE $\text{ØD} \times \text{L}$ (mm)	CASE CODE	SINGLE ENDED WITH MOUNTING RING: FORM MR					MASS (g)	PACKAGING QUANTITIES
		Ød1 (mm)	Ød2 (mm)	ØD2_{max} (mm)	D3 (mm)	L_{max} (mm)		
15 × 30	02	0.8	1.0 +0.4	17.5	16.5 ± 0.2	33	≈ 11.7	200
18 × 30	03	0.8	1.0 +0.4	19.5	18.5 ± 0.2	33	≈ 12.9	200
18 × 40	04	0.8	1.0 +0.4	19.5	18.5 ± 0.2	45	≈ 19.4	100
21 × 40	05	0.8	1.0 +0.4	22.5	21.5 ± 0.2	45	≈ 24.7	100

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ELECTRICAL DATA AND ORDERING INFORMATION

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

Ordering example

Electrolytic capacitor 021 series
1000 $\mu\text{F}/16\text{ V}$; $\pm 20\%$
Nominal case size: $\varnothing 10 \times 25\text{ mm}$; Form BA
Catalogue number: 2222 021 90518.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, $85\text{ }^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta$ max. and C_R)
Z	max. impedance at 10 kHz

Table 3 Electrical data and ordering Information; preferred types in **bold**

CATALOGUE NUMBER 2222													
U _R 100 Hz (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × 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 (Ω)	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 × 11	5a	260	22	10	0.25	0.85	0.64	—	021 23471	021 33471	—
	1000	8 × 18	5	440	42	17	0.25	0.4	0.5	—	021 23102	021 33102	—
	2200	10 × 25	7	710	87	32	0.29	0.21	0.16	—	021 90588	021 90589	—
10	100	4.5 × 10	2	100	10	6	0.20	3.2	2.0	—	021 24101	021 34101	—
	220	6 × 10	3	160	17	8.4	0.20	1.5	0.91	—	021 24221	021 34221	—
	330	8 × 11	5a	230	24	11	0.20	1.0	0.61	—	021 24331	021 34331	—
	470	6.5 × 18	4	310	32	13	0.20	0.68	0.43	—	021 24471	021 34471	—
	680	8 × 18	5	400	45	18	0.20	0.47	0.29	—	021 24681	021 34681	—
	1000	10 × 18	6	550	64	24	0.20	0.32	0.20	—	021 24102	021 34102	—
	1500	10 × 25	7	690	94	34	0.23	0.25	0.18	—	021 90524	021 90525	—
	1500	10 × 30	00	740	94	34	0.23	0.245	0.18	021 14152	021 24152	—	—
	2200	12.5 × 30	01	800	136	48	0.25	0.177	0.095	021 14222	021 24222	—	—
	3300	12.5 × 30	01	1000	202	70	0.27	0.128	0.095	021 14332	021 24332	—	—
	4700	15 × 30	02	1180	286	98	0.29	0.100	0.07	021 14472	021 24472	—	021 44472
	6800	18 × 30	03	1480	412	140	0.34	0.079	0.065	021 14682	—	—	021 44682
	10000	18 × 40	04	1860	604	204	0.40	0.064	0.04	021 14103	—	—	021 44103
	15000	21 × 40	05	2250	904	304	0.50	0.054	0.035	021 14153	—	—	021 44153

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CATALOGUE NUMBER 2222														
U _R 100 Hz (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × 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 (Ω)	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 × 10	2	90	11	6.2	0.16	3.8	2.4	—	021 25689	021 35689	—	
	150	6 × 10	3	140	18	8.8	0.16	1.7	1.1	—	021 25151	021 35151	—	
	220	8 × 11	5a	210	25	11	0.16	1.2	0.73	—	021 25221	021 35221	—	
	330	6.5 × 18	4	290	36	15	0.16	0.77	0.48	—	021 25331	021 35331	—	
	470	8 × 18	5	380	49	19	0.16	0.55	0.34	—	021 25471	021 35471	—	
	680	10 × 18	6	500	69	26	0.16	0.38	0.24	—	021 25681	021 35681	—	
	1000	10 × 25	7	660	100	36	0.16	0.26	0.18	—	021 90517	021 90518	—	
	1000	10 × 30	00	700	100	36	0.16	0.260	0.175	021 15102	021 25102	—		
	1500	12.5 × 30	01	740	148	52	0.19	0.205	0.095	021 15152	021 25152	—		
	2200	12.5 × 30	01	890	216	74	0.21	0.150	0.095	021 15222	021 25222	—		
	3300	15 × 30	02	1130	321	110	0.23	0.111	0.07	021 15332	021 25332	—		
	4700	18 × 30	03	1410	455	154	0.25	0.087	0.065	021 15472	—	—		
	6800	18 × 40	04	1780	656	222	0.30	0.070	0.04	021 15682	—	—		
	10000	21 × 40	05	2170	964	324	0.36	0.058	0.035	021 15103	—	—		
	25	47	4.5 × 10	2	80	11	6.4	0.14	4.8	2.6	—	021 26479	021 36479	—
		100	6 × 10	3	150	19	9	0.14	2.3	1.2	—	021 26101	021 36101	—
150		8 × 11	5a	190	27	12	0.14	1.5	0.80	—	021 90534	021 90535	—	
150		6.5 × 18	4	210	27	12	0.14	1.5	0.80	—	021 26151	021 36151	—	
220		6.5 × 18	4	250	37	15	0.14	1.0	0.55	—	021 26221	021 36221	—	
330		8 × 18	5	340	54	21	0.14	0.68	0.36	—	021 26331	021 36331	—	
470		10 × 18	6	450	75	28	0.14	0.48	0.26	—	021 26471	021 36471	—	
680		10 × 25	7	560	106	38	0.14	0.33	0.18	—	021 90527	021 90528	—	
680		10 × 30	00	640	106	38	0.14	0.323	0.175	021 16681	021 26681	—		
1000		12.5 × 30	01	720	154	54	0.14	0.220	0.095	021 16102	021 26102	—		
1500		12.5 × 30	01	790	229	79	0.17	0.179	0.095	021 16152	021 26152	—		
2200		15 × 30	02	1030	334	114	0.19	0.132	0.07	021 16222	021 26222	—		
3300		18 × 30	03	1310	499	169	0.21	0.099	0.065	021 16332	—	—		
4700		18 × 40	04	1680	709	239	0.23	0.079	0.04	021 16472	—	—		
6800		21 × 40	05	2070	1024	344	0.28	0.064	0.035	021 16682	—	—		

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø × 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 (Ω)	CATALOGUE NUMBER 2222			
										AXIAL			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	
40	22	4.5 × 10	2	60	9	5.8	0.11	8.0	3.2	—	021 27229	021 37229	—
	47	6 × 10	3	110	15	7.8	0.11	3.8	1.5	—	021 27479	021 37479	—
	100	8 × 11	5a	170	28	12	0.11	1.8	0.70	—	021 90537	021 90538	—
	100	6.5 × 18	4	190	28	12	0.11	1.8	0.70	—	021 27101	021 37101	—
	150	8 × 18	5	250	40	16	0.11	1.1	0.47	—	021 27151	021 37151	—
	220	10 × 18	6	330	57	22	0.11	0.8	0.32	—	021 27221	021 37221	—
	330	10 × 25	7	430	83	30	0.11	0.53	0.21	—	021 27331	021 37331	—
	470	10 × 25	7	520	117	42	0.11	0.37	0.18	—	021 90514	021 90515	—
	470	10 × 30	00	570	117	42	0.12	0.404	0.175	021 17471	021 27471	—	
	680	12.5 × 30	01	620	167	58	0.12	0.297	0.095	021 17681	021 27681	—	
	1000	12.5 × 30	01	770	244	84	0.12	0.190	0.095	021 17102	021 27102	—	
	1500	15 × 30	02	930	364	124	0.15	0.159	0.07	021 17152	021 27152	021 47152	
	2200	18 × 30	03	1200	532	180	0.17	0.118	0.065	021 17222	—	021 47222	
	3300	18 × 40	04	1550	796	268	0.19	0.090	0.04	021 17332	—	021 47332	
	4700	21 × 40	05	1880	1132	380	0.21	0.072	0.035	021 17472	—	021 47472	
63	0.47	4.5 × 10	2	8	4.2	4.1	0.09	310	120	—	021 28477	021 38477	—
	1	4.5 × 10	2	12	4.4	4.1	0.09	150	55	—	021 28108	021 38108	—
	2.2	4.5 × 10	2	21	4.8	4.3	0.09	65	25	—	021 28228	021 38228	—
	3.3	4.5 × 10	2	25	5.2	4.4	0.09	44	17	—	021 28338	021 38338	—
	4.7	4.5 × 10	2	31	5.8	4.6	0.09	31	12	—	021 28478	021 38478	—
	10	4.5 × 10	2	50	7.8	5.3	0.08	13	5.5	—	021 28109	021 38109	—
	15	4.5 × 10	2	55	9.5	5.9	0.08	8.5	3.7	—	021 28159	021 38159	—
	22	6 × 10	3	90	12	6.8	0.08	5.8	2.5	—	021 28229	021 38229	—
	33	6 × 10	3	100	16	8.2	0.08	3.9	1.7	—	021 28339	021 38339	—
	47	8 × 11	5a	140	22	10	0.08	2.7	1.2	—	021 90541	021 90542	—
	47	6.5 × 18	4	150	22	10	0.08	0.08	1.2	—	021 28479	021 38479	—
	68	8 × 11	5a	160	30	13	0.08	1.9	0.81	—	021 90544	021 90545	—
	68	6.5 × 18	4	170	30	13	0.08	1.9	0.81	—	021 28689	021 38689	—
	100	8 × 18	5	250	42	17	0.08	1.3	0.55	—	021 28101	021 38101	—

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CATALOGUE NUMBER 2222													
U _R 100 Hz (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × 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 (Ω)	AXIAL			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
63	150	10 × 18	6	320	61	23	0.08	0.85	0.37	—	021 28151	021 38151	—
	220	10 × 25	7	430	88	32	0.08	0.60	0.25	—	021 90511	021 90512	—
	220	10 × 30	00	480	88	32	0.08	0.614	0.20	021 18221	021 28221	—	—
	330	12.5 × 30	01	530	129	46	0.08	0.409	0.14	021 18331	021 28331	—	—
	470	12.5 × 30	01	630	182	63	0.08	0.287	0.10	021 18471	021 28471	—	—
	680	15 × 30	02	830	261	90	0.08	0.199	0.080	021 18681	021 28681	—	021 48681
	1000	18 × 30	03	1120	382	130	0.08	0.135	0.065	021 18102	—	—	021 48102
	1500	18 × 40	04	1350	571	193	0.11	0.122	0.04	021 18152	—	—	021 48152
	2200	21 × 40	05	1780	836	281	0.13	0.099	0.035	021 18222	—	—	021 48222
	100	1	4.5 × 10	2	14	4.6	4.2	0.08	130	90	—	021 29108	021 39108
2.2		4.5 × 10	2	20	5.3	4.4	0.08	58	41	—	021 29228	021 39228	—
4.7		4.5 × 10	2	30	7	4.9	0.08	27	19	—	021 29478	021 39478	—
10		6 × 10	3	65	10	6	0.08	13	9	—	021 29109	021 39109	—
15		8 × 11	5a	77	13	7	0.08	8.5	6	—	021 90547	021 90548	—
15		6.5 × 18	4	85	13	7	0.08	8.5	6	—	021 29159	021 39159	—
22		8 × 11	5a	95	17	8.4	0.08	5.8	4.1	—	021 90551	021 90552	—
22		6.5 × 18	4	100	17	8.4	0.08	5.8	4.1	—	021 29229	021 39229	—
33		6.5 × 18	4	120	24	10.6	0.08	3.9	2.7	—	021 29339	021 39339	—
47		8 × 18	5	160	32	13.4	0.08	2.7	1.9	—	021 29479	021 39479	—
68		10 × 18	6	220	45	17.6	0.08	1.9	1.3	—	021 29689	021 39689	—
100		10 × 25	7	300	64	24	0.08	1.3	0.9	—	021 90531	021 90532	—
100		10 × 30	00	360	64	24	0.07	1.150	1.0	021 19101	021 29101	—	—
150		12.5 × 30	01	420	94	34	0.07	0.645	0.61	021 19151	021 29151	—	—
220		12.5 × 30	01	460	136	48	0.08	0.610	0.56	021 19221	021 29221	—	021 49331
330		15 × 30	02	580	202	70	0.09	0.420	0.40	021 19331	021 29331	—	021 49471
470		18 × 30	03	740	286	98	0.09	0.310	0.29	021 19471	—	—	021 49681
680		18 × 40	04	1050	412	140	0.09	0.195	0.18	021 19681	—	—	021 49812
1000	21 × 40	05	1260	604	204	0.10	0.160	0.15	021 19102	—	—	021 49102	

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Additional electrical data

PARAMETER	CONDITIONS	VALUE	
		AXIAL	SINGLE ENDED
Voltage			
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1 \text{ V}$	
Current			
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$	
	after 5 minutes at U_R : $U_R = 6.3 \text{ V to } 100 \text{ V}$	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$	
Inductance			
Equivalent series inductance (ESL)	case $\varnothing D \times L \text{ mm}$:		
	4.5 × 10	typ. 10 nH	—
	6 × 10	typ. 22 nH	—
	8 × 11	typ. 85 nH	—
	6.5 × 18	typ. 25 nH	—
	8 × 18	typ. 40 nH	—
	10 × 18	typ. 61 nH	—
	10 × 25	typ. 38 nH	—
	10 × 30	typ. 38 nH	—
	12.5 × 30	typ. 46 nH	—
	15 × 30	typ. 48 nH	typ. 39 nH
	18 × 30	typ. 50 nH	typ. 39 nH
	18 × 40	typ. 54 nH	typ. 39 nH
	21 × 40	typ. 59 nH	typ. 39 nH

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Capacitance (C)

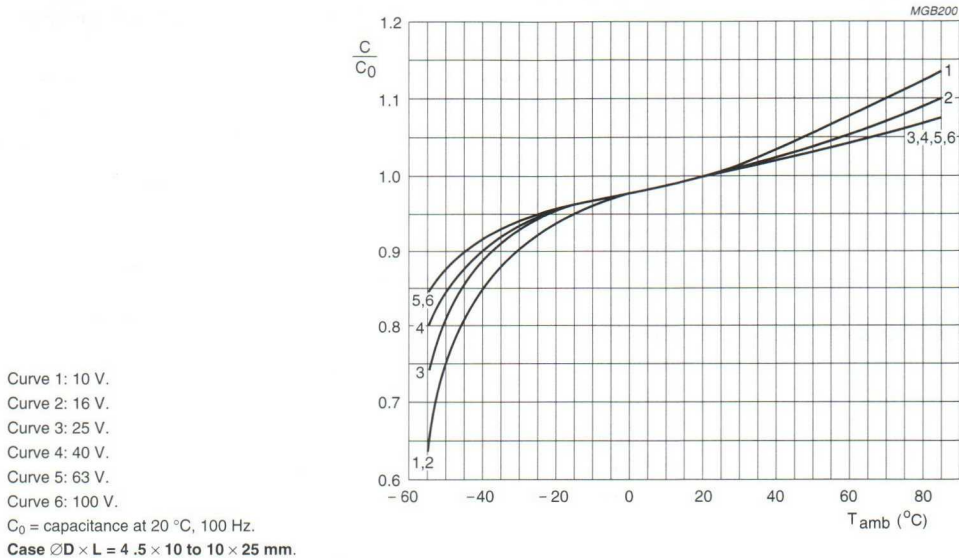


Fig.6 Typical multiplier of capacitance as a function of ambient temperature.

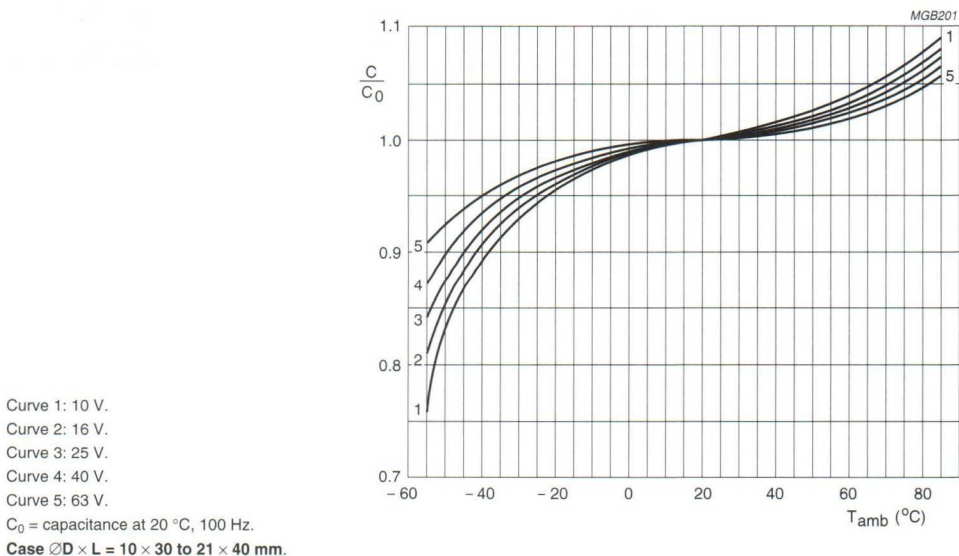
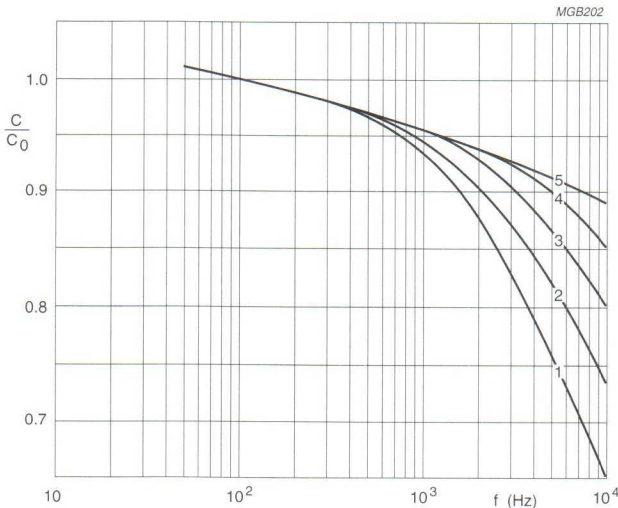


Fig.7 Typical multiplier of capacitance as a function of ambient temperature.

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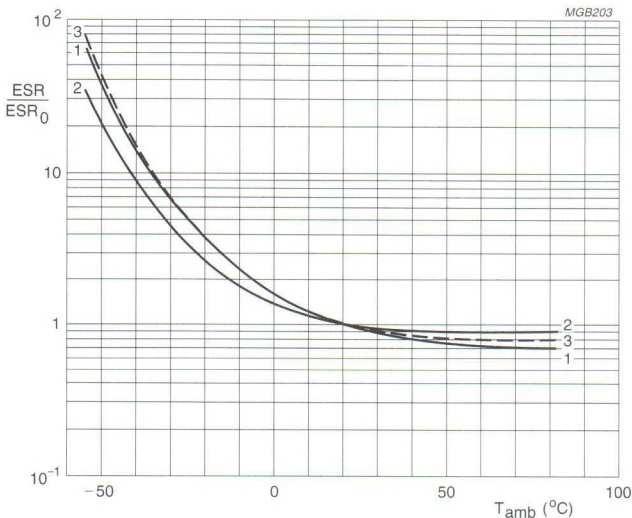
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Curve 1: 10 V.
Curve 2: 16 V.
Curve 3: 25 V.
Curve 4: 40 V.
Curve 5: 63 V.
 C_0 = capacitance at 20 °C; 100 Hz.

Fig.8 Typical multiplier of capacitance as a function of frequency.

Equivalent series resistance (ESR)



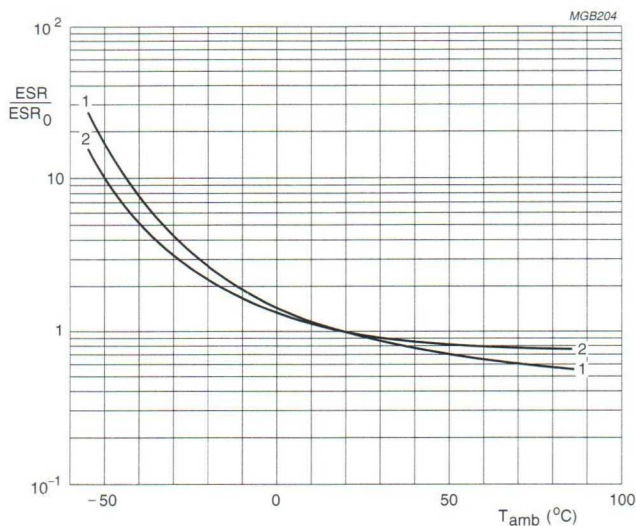
Curve 1: 10 V.
Curve 2: 63 V ($\geq 4.7 \mu F$).
Curve 3: 100 V.
 ESR_0 = typical ESR at 20 °C, 100 Hz.
Case $\varnothing D \times L = 4.5 \times 10$ to 10×25 mm.

Fig.9 Typical multiplier of ESR as a function of ambient temperature.

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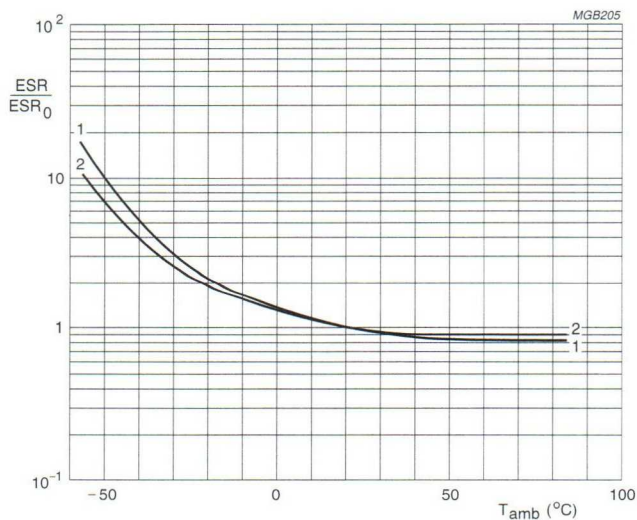


Curve 1: 10 V; 16 V; 25 V.

Curve 2: 40 and 63 V.

ESR₀ = typical ESR at 20 °C, 100 Hz.Case $\varnothing D \times L = 10 \times 30, 12.5 \times 30$ and 15×30 mm.

Fig.10 Typical multiplier of ESR as a function of ambient temperature.



Curve 1: 10 V; 16 V; 25 V.

Curve 2: 40 and 63 V.

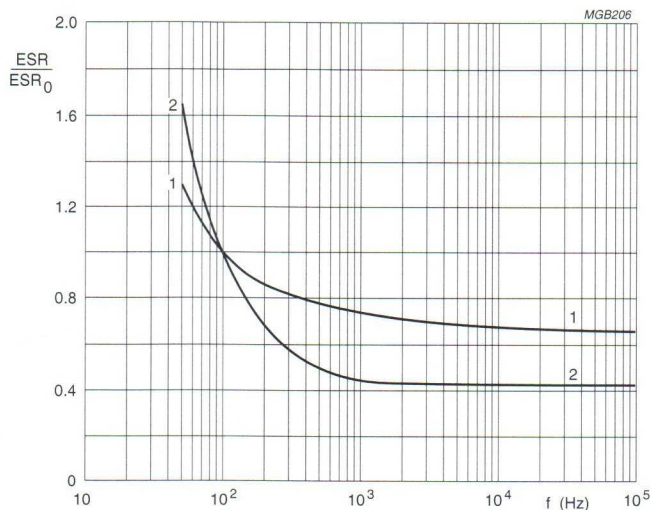
ESR₀ = typical ESR at 20 °C, 100 Hz.Case $\varnothing D \times L = 18 \times 30, 18 \times 40$ and 21×40 mm.

Fig.11 Typical multiplier of ESR as a function of ambient temperature.

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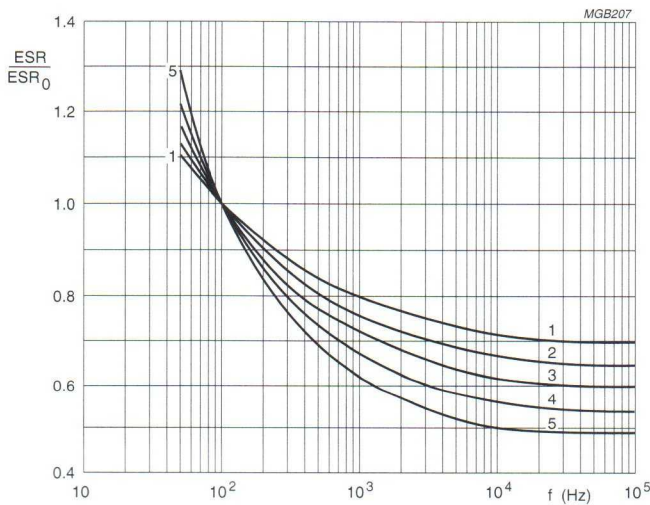
021 ASM



Curve 1: 10 V.

Curve 2: 63 V ($\geq 4.7 \mu F$). ESR_0 = typical ESR at 20 °C, 100 Hz.Case $\varnothing D \times L = 4.5 \times 10$ to 10×25 mm.

Fig.12 Typical multiplier of ESR 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 $\varnothing D \times L = 10 \times 30$ to 21×40 mm.

Fig.13 Typical multiplier of ESR as a function of frequency.

A

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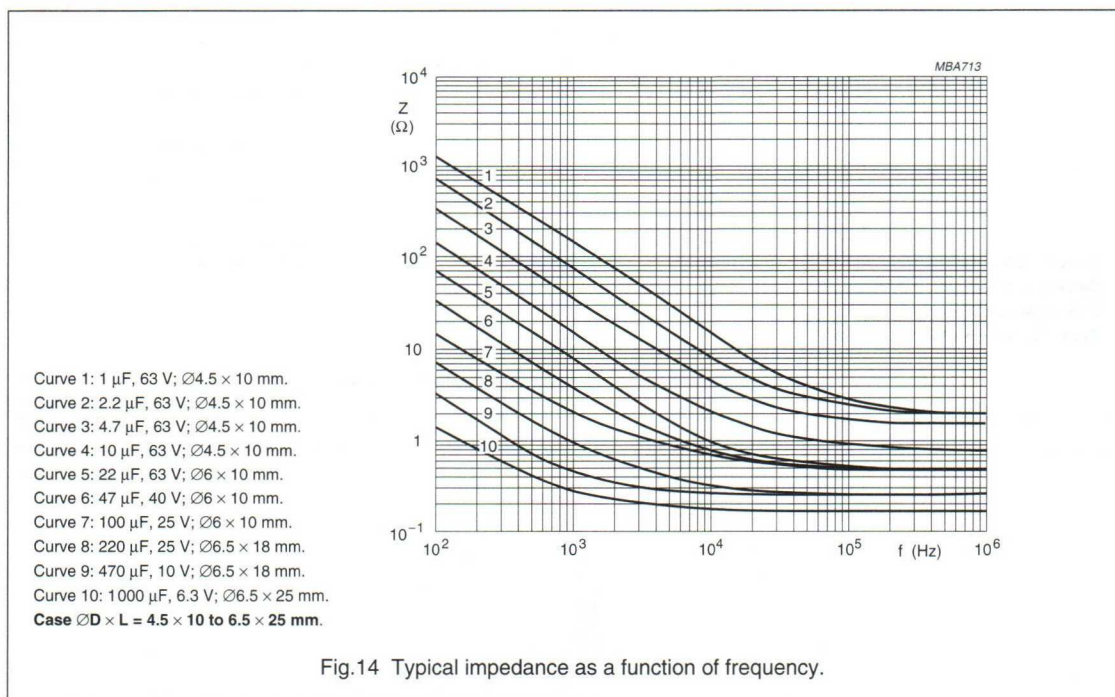
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Impedance (Z)

Table 4 Impedance $\times$ capacitance values (case $\varnothing D \times L = 4.5 \times 10$ to 10×25 mm)

T_{amb}	$Z \times C_R (\Omega \times \mu F) \text{ at } 10 \text{ kHz}$						
	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



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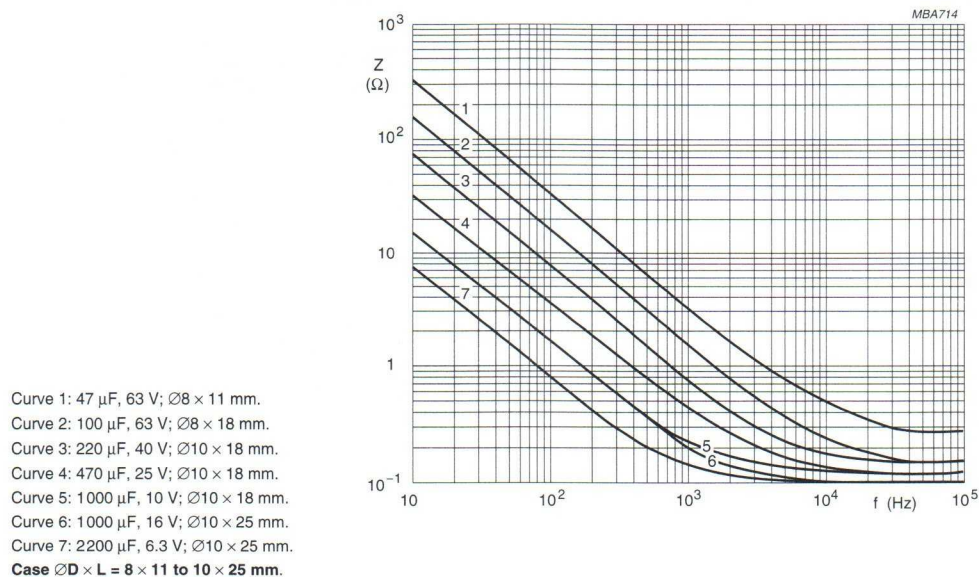


Fig.15 Typical impedance as a function of frequency.

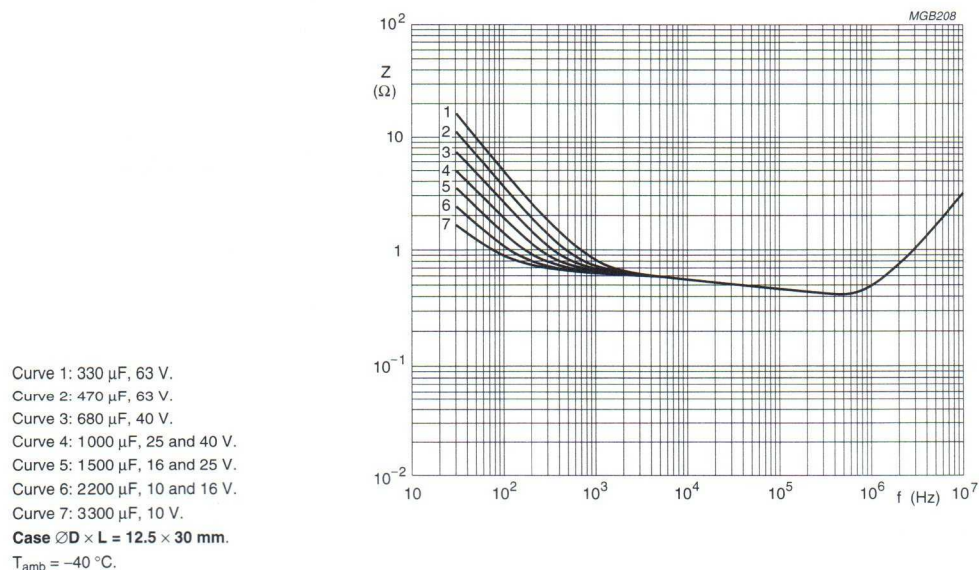


Fig.16 Typical impedance as a function of frequency.

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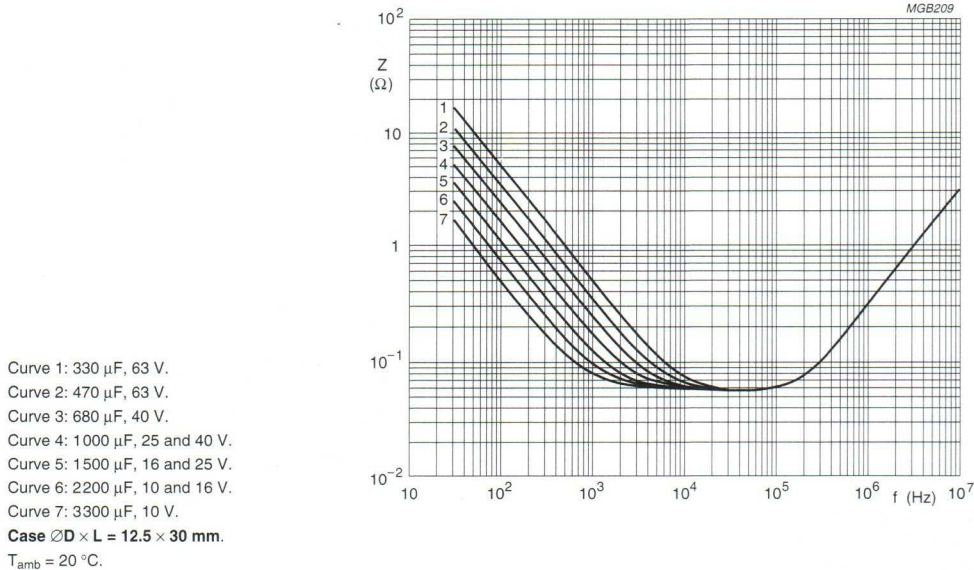


Fig.17 Typical impedance as a function of frequency.

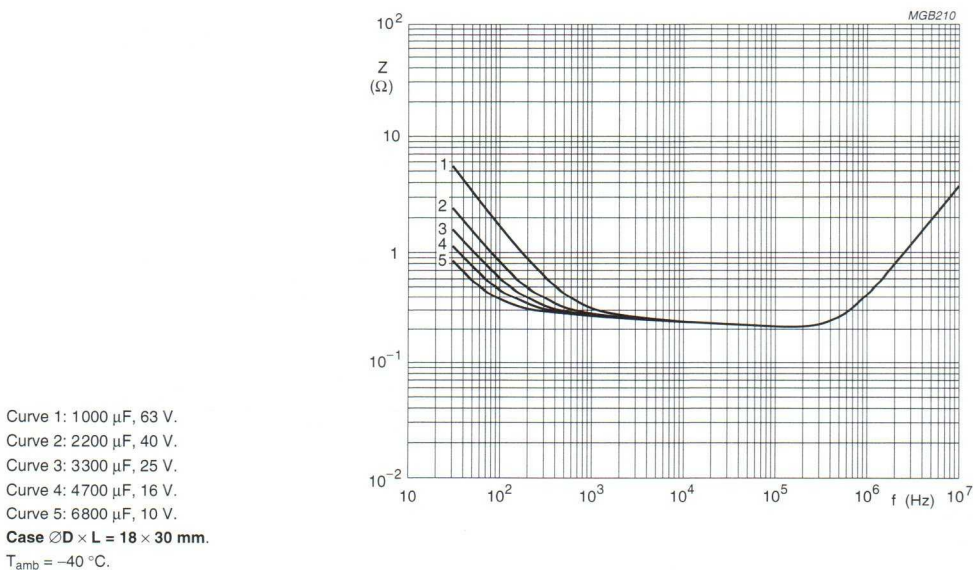


Fig.18 Typical impedance as a function of frequency.

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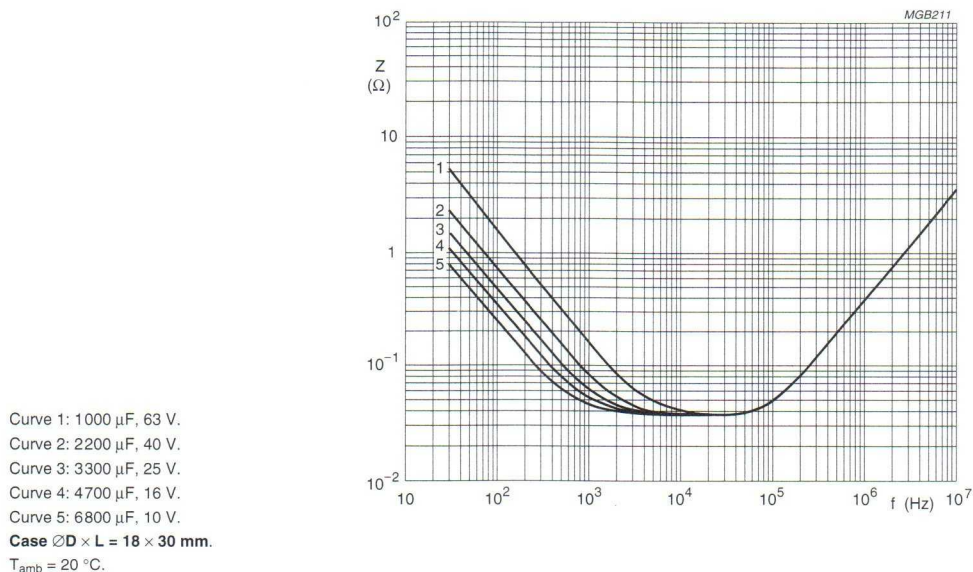


Fig.19 Typical impedance as a function of frequency.

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 indicate the negative terminal
- '+' sign to identify the positive terminal (not for case sizes $L < 18$ mm).

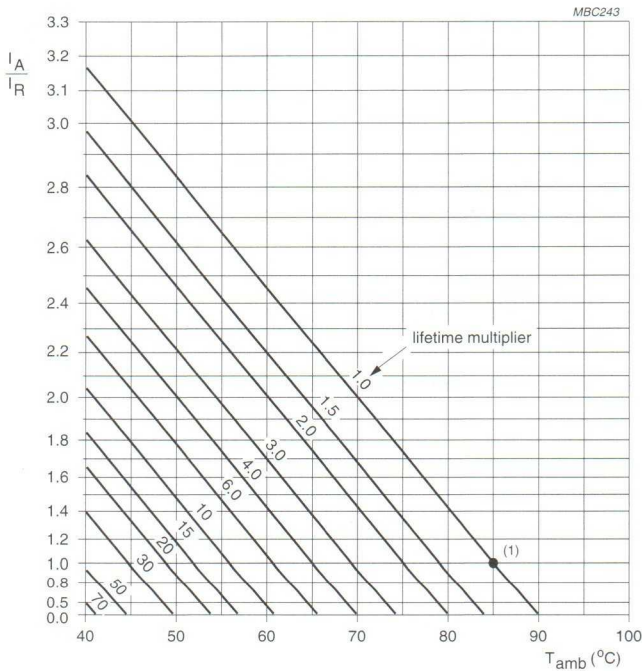
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RIPPLE CURRENT AND USEFUL LIFE

Table 5 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency (I_{R0} = rated ripple current at 100 Hz and 85 °C)

FREQUENCY (Hz)	I _R MULTIPLIER		
	U _R = 6.3 to 16 V	U _R = 25 to 40 V	U _R = 63 to 100 V
50	0.95	0.9	0.85
100	1	1	1
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥10000	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 $\varnothing D \times L = 4.5 \times 10$ to 10×25 mm: 2500 hours
case $\varnothing D \times L = 10 \times 30$ to 21×40 mm: 8000 hours.

Fig.20 Multiplier of useful life as a function of ambient temperature and ripple current load.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 6 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; case $\varnothing D \times L = 4.5 \times 10$ to 10×25 mm: $U_R = 6.3$ to 25 V: 1000 hours; $U_R = 40$ to 100 V: 2000 hours; case $\varnothing D \times L = 10 \times 30$ to 21×40 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; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; case $\varnothing D \times L = 4.5 \times 10$ to 10×25 mm: 2500 hours; case $\varnothing D \times L = 10 \times 30$ to 21×40 mm: 8000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: $+45/-50\%$ $U_R > 6.3$ V; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$

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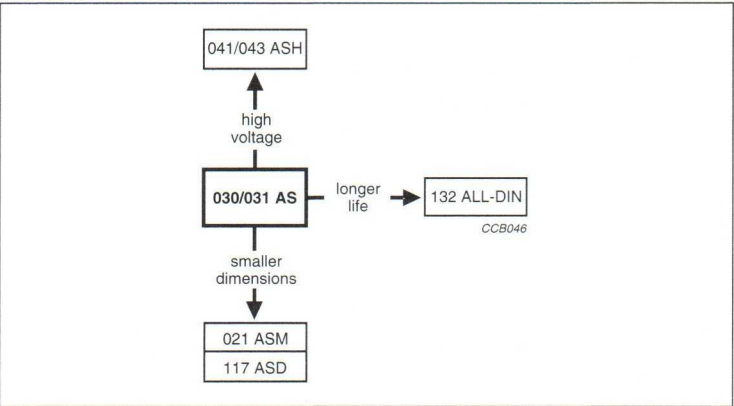
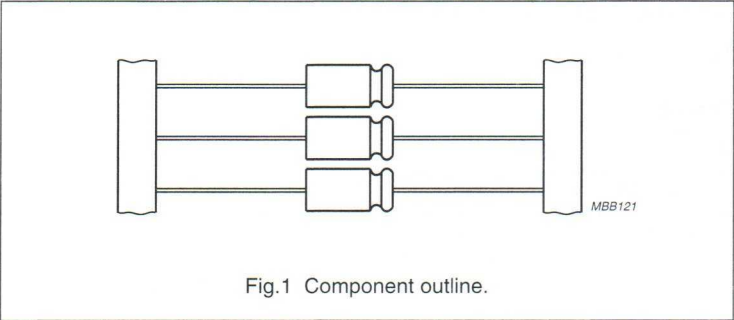
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FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Taped version available for automatic insertion
- Charge and discharge proof
- Useful life: 3000 hours at 85 °C (case $\varnothing D = 3.3$ 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.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	3.3 × 11	4.5 × 10 to 10 × 25
Rated capacitance range, C_R	0.47 to 1000 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
Useful life at 85 °C	1500 hours	3000 hours
Useful life at 40 °C, 1.4 × I_R applied	40000 hours	80000 hours
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	40/085/56	

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

C_R (μF)	U_R (V)						
	6.3	10	16	25	40	63	100
0.47	—	—	—	—	—	—	4.5×10
1.0	—	—	—	—	—	4.5×10	4.5×10
	—	—	—	—	—	3.3×11	—
2.2	—	—	—	—	3.3×11	4.5×10	4.5×10
3.3	—	—	—	—	—	4.5×10	4.5×10
4.7	—	—	3.3×11	—	—	4.5×10	6×10
6.8	—	—	—	—	—	4.5×10	6×10
10	3.3×11	—	—	4.5×10	4.5×10	6×10	8×11
	—	—	—	—	—	—	6.5×18
15	—	—	—	—	4.5×10	6×10	—
22	—	—	—	4.5×10	6×10	8×11	8×18
	—	—	—	—	—	6.5×18	—
33	—	—	4.5×10	—	6×10	—	10×18
47	—	4.5×10	—	6×10	8×11	8×18	10×25
	—	—	—	—	6.5×18	—	—
68	4.5×10	—	6×10	—	—	10×18	—
100	—	6×10	—	8×11	8×18	10×25	—
	—	—	—	6.5×18	—	—	—
150	6×10	—	8×11	8×18	10×18	—	—
	—	—	6.5×18	—	—	—	—
220	—	8×11	8×18	10×18	10×25	—	—
	—	6.5×18	—	—	—	—	—
330	—	8×18	10×18	10×25	—	—	—
470	8×18	10×18	10×25	—	—	—	—
680	10×18	10×25	—	—	—	—	—
1000⁽¹⁾	10×25	—	—	—	—	—	—

Note

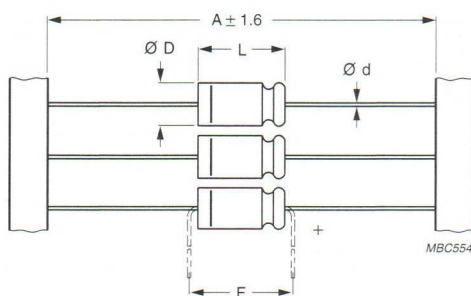
- For larger CV-values see data sheet "021 ASM".

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

Form BR: Taped on reel, **non-preferred**.

Form BA: Taped in box (ammopack), **preferred**.

Case $\varnothing D \times L = 3.3 \times 11$ to 10×25 mm.

For dimensions see Table 1.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.2 Dimensional outline.

Table 1 Axial; Physical dimensions, mass and packaging quantities; see Fig. 2

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	AXIAL FORM BA and BR					MASS (g)	PACKAGING QUANTITIES	
		$\varnothing d$ (mm)	A (mm)	$\varnothing D_{\max}$ (mm)	$L_{\max}$ (mm)	$F_{\min}$ (mm)		FORM BA	FORM BR
3.3×11	1	0.6	63.5 ± 1.5	3.5	12	17.5	≈ 0.35	1000	4000
4.5×10	2	0.6	63.5 ± 1.5	5.0	10.5	15	≈ 0.5	1000	3000
6×10	3	0.6	63.5 ± 1.5	6.3	10.5	15	≈ 0.7	1000	1000
8×11	5a	0.6	63.5 ± 1.5	8.5	11.5	15	≈ 1.1	500	500
6.5×18	4	0.8	73 ± 1.6	6.9	18.5	25	≈ 1.3	1000	1000
8×18	5	0.8	73 ± 1.6	8.5	18.5	25	≈ 1.7	500	500
10×18	6	0.8	73 ± 1.6	10.5	18.5	25	≈ 2.5	500	500
10×25	7	0.8	73 ± 1.6	10.5	25.0	30	≈ 3.3	500	500

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Ordering example

Electrolytic capacitor 031 series.
330 $\mu\text{F}/10\text{ V}$; $-10/+50\%$.
Nominal case size: $\varnothing 8 \times 18\text{ mm}$; Form BA.
Catalogue number: 2222 031 34331.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{\text{amb}} = 20\text{ }^{\circ}\text{C}$,
 $P = 86\text{ to }106\text{ kPa}$, $RH = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $-10\text{ to }+50\%$
I_R	rated RMS ripple current at 100 Hz, $85\text{ }^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\text{Tan } \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\text{tan } \delta_{\text{max}}$ and C_R)
Z	max. impedance at 10 kHz

Table 2 Electrical data and ordering information; preferred types in bold

U_R 100 Hz (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz $85\text{ }^{\circ}\text{C}$ (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\text{Tan } \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222	
										TAPED ON REEL FORM BR	TAPED IN BOX FORM BA
6.3	10	3.3×11	1	15	5	5	0.30	47.8	20	030 23109	030 33109
	68	4.5×10	2	75	22	5.9	0.25	5.86	2.9	030 23689	030 33689
	150	6×10	3	120	10	6.9	0.25	2.66	1.3	030 23151	030 33151
	470	8×18	5	330	22	11	0.25	0.85	0.43	031 23471	031 33471
	680	10×18	6	430	30	14	0.25	0.59	0.29	031 23681	031 33681
	1000	10×25	7	560	42	18	0.25	0.40	0.20	031 23102	031 33102
	47	4.5×10	2	70	24	5.9	0.20	6.78	3.4	030 24479	030 34479
10	100	6×10	3	10	110	7	0.20	3.19	1.6	030 24101	030 34101
	220	8×11	5a	210	18	9.4	0.20	1.45	0.73	030 24221	030 34221
	220	6.5×18	4	210	18	9.4	0.20	1.45	0.73	031 24221	031 34221
	330	8×18	5	310	24	12	0.20	0.97	0.48	031 24331	031 34331
	470	10×18	6	410	33	14	0.20	0.68	0.34	031 24471	031 34471
	680	10×25	7	510	45	19	0.20	0.47	0.24	031 24681	031 34681

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × 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 (Ω)	CATALOGUE NUMBER 2222	
										TAPED ON REEL FORM BR	TAPED IN BOX FORM BA
16	4.7	3.3 × 11	1	15	5	5	0.20	67.8	26	030 25478	030 35478
	33	4.5 × 10	2	65	27	6.1	0.16	7.72	3.6	030 25339	030 35339
	68	6 × 10	3	110	11	7.2	0.16	3.75	1.8	030 25689	030 35689
	150	8 × 11	5a	200	19	9.8	0.16	1.70	0.80	030 25151	030 35151
	150	6.5 × 18	4	200	19	9.8	0.16	1.70	0.80	031 25151	031 35151
	220	8 × 18	5	270	26	12	0.16	1.16	0.55	031 25221	031 35221
	330	10 × 18	6	410	36	16	0.16	0.78	0.36	031 25331	031 35331
	470	10 × 25	7	480	49	20	0.16	0.55	0.26	031 25471	031 35471
	10	4.5 × 10	2	50	13	5.5	0.14	22.3	9	030 26109	030 36109
	22	4.5 × 10	2	60	28	6.1	0.14	10.2	4.1	030 26229	030 36229
25	47	6 × 10	3	100	12	7.4	0.14	4.8	1.9	030 26479	030 36479
	100	8 × 11	5a	160	19	10	0.14	2.23	0.90	030 26101	030 36101
	100	6.5 × 18	4	160	19	10	0.14	2.23	0.90	031 26101	031 36101
	150	8 × 18	5	240	27	13	0.14	1.49	0.60	031 26151	031 36151
	220	10 × 18	6	350	37	16	0.14	1.02	0.41	031 26221	031 36221
	330	10 × 25	7	460	54	22	0.14	0.68	0.27	031 26331	031 36331
	2.2	3.3 × 11	1	15	5	5	0.15	109	32	030 27228	030 37228
	10	4.5 × 10	2	50	20	5.8	0.11	17.6	7	030 27109	030 37109
	15	4.5 × 10	2	55	30	6.2	0.11	11.7	4.7	030 27159	030 37159
	22	6 × 10	3	75	9	6.8	0.11	8.0	3.2	030 27229	030 37229
40	33	6 × 10	3	95	12	7.7	0.11	5.31	2.1	030 27339	030 37339
	47	8 × 11	5a	150	16	8.8	0.11	3.73	1.5	030 27479	030 37479
	47	6.5 × 18	4	150	16	8.8	0.11	3.73	1.5	031 27479	031 37479
	100	8 × 18	5	220	28	13	0.11	1.75	0.70	031 27101	031 37101
	150	10 × 18	6	300	40	17	0.11	1.17	0.47	031 27151	031 37151
	220	10 × 25	7	430	57	23	0.11	0.80	0.32	031 27221	031 37221

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE 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)	CATALOGUE NUMBER 2222	
										TAPED ON REEL FORM BR	TAPED IN BOX FORM BA
63	1.0	3.3 × 11	1	10	5	5	0.12	191	55	030 90067	030 90068
	1.0	4.5 × 10	2	13	5	5	0.09	143	55	030 28108	030 38108
	2.2	4.5 × 10	2	25	7	5.3	0.09	65.2	25	030 28228	030 38228
	3.3	4.5 × 10	2	35	11	5.4	0.09	46.5	17	030 28338	030 38338
	4.7	4.5 × 10	2	40	15	5.6	0.09	30.5	12	030 28478	030 38478
	6.8	4.5 × 10	2	46	22	5.9	0.09	21.1	8.1	030 28688	030 38688
	10	6 × 10	3	70	7	6.3	0.08	12.8	5.5	030 28109	030 38109
	15	6 × 10	3	79	10	6.9	0.08	8.5	3.7	030 28159	030 38159
	22	8 × 11	5a	110	13	7.8	0.08	5.79	2.5	030 28229	030 38229
	22	6.5 × 18	4	110	13	7.8	0.08	5.79	2.5	031 28229	031 38229
	47	8 × 18	5	190	22	11	0.08	2.71	1.2	031 28479	031 38479
	68	10 × 18	6	250	30	14	0.08	1.88	0.81	031 28689	031 38689
	100	10 × 25	7	300	42	18	0.08	1.28	0.55	031 28101	031 38101
	0.47	4.5 × 10	2	9	5	5	0.08	271	96	030 29477	030 39477
100	1.0	4.5 × 10	2	20	5	5	0.08	128	45	030 29108	030 39108
	2.2	4.5 × 10	2	30	11	11	0.08	57.9	21	030 29228	030 39228
	3.3	4.5 × 10	2	40	17	17	0.08	38.6	14	030 29338	030 39338
	4.7	6 × 10	3	50	22	22	0.07	23.7	9.6	030 29478	030 39478
	6.8	6 × 10	3	70	34	34	0.07	16.4	6.6	030 29688	030 39688
	10	8 × 11	5a	90	50	50	0.07	11.2	4.5	030 29109	030 39109
	10	6.5 × 18	4	90	50	50	0.07	11.2	4.5	031 29109	031 39109
	22	8 × 18	5	120	80	80	0.07	5.07	2.1	031 29229	031 39229
	33	10 × 18	6	200	119	119	0.07	3.38	1.4	031 29339	031 39339
	47	10 × 25	7	260	33	33	0.07	2.37	0.96	031 29479	031 39479

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Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R : case $\varnothing D \times L = 3.3 \times 11$ and 4.5×10 mm case $\varnothing D \times L = 6 \times 10$ to 10×25 mm	$I_{L1} \leq 0.05C_R \times U_R$ or $5 \mu\text{A}$, whichever is greater I_{L1} for $CV \leq 1000 \mu\text{C}$: $\leq 0.01C_R \times U_R$ or $1 \mu\text{A}$, whichever is greater I_{L1} for $CV > 1000 \mu\text{C}$: $\leq 0.006C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes: $U_R = 6.3$ to 63 V $U_R = 100 \text{ V}$	$I_{L5} \leq 0.002C_R \times U_R + 5 \mu\text{A}$ $I_{L5} \leq 0.006C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D \times L$ mm: 3.3 × 11 4.5 × 10 6 × 10 8 × 11 6.5 × 18 8 × 18 10 × 18 10 × 25	typ. 11 nH typ. 10 nH typ. 22 nH typ. 85 nH typ. 25 nH typ. 40 nH typ. 61 nH typ. 38 nH

MARKING

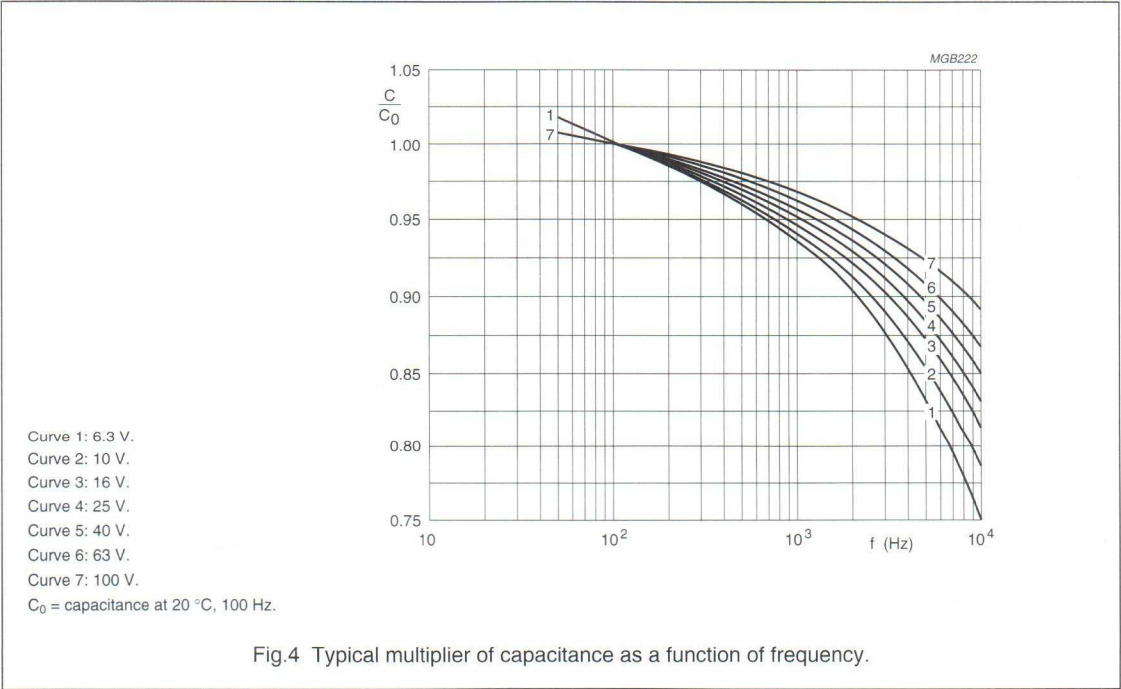
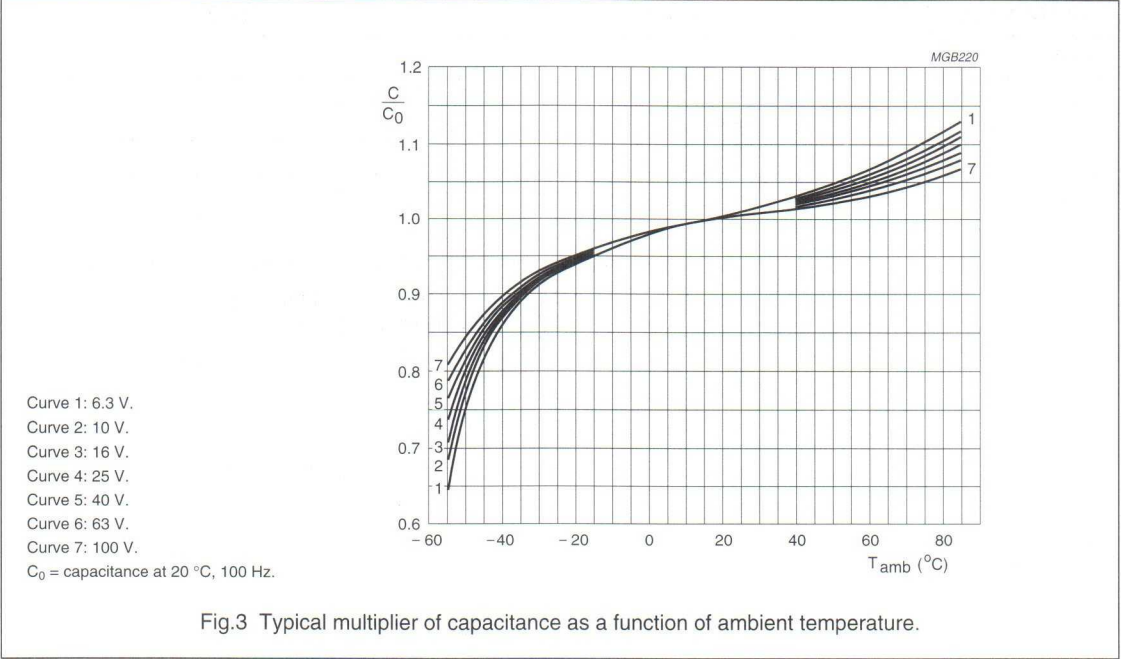
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in μF)
- Tolerance on rated capacitance, code letter in accordance with "IEC 62" (not for case code 1)
- Rated voltage (in V)
- Group number (030 or 031)
- Code indicating factory of origin
- Name of manufacturer (PHILIPS)
- Date code, in accordance with "IEC 62"
- Band to identify the negative terminal
- '+' sign to indicate the positive terminal (not for case sizes $L < 18$ mm).

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Capacitance (C)



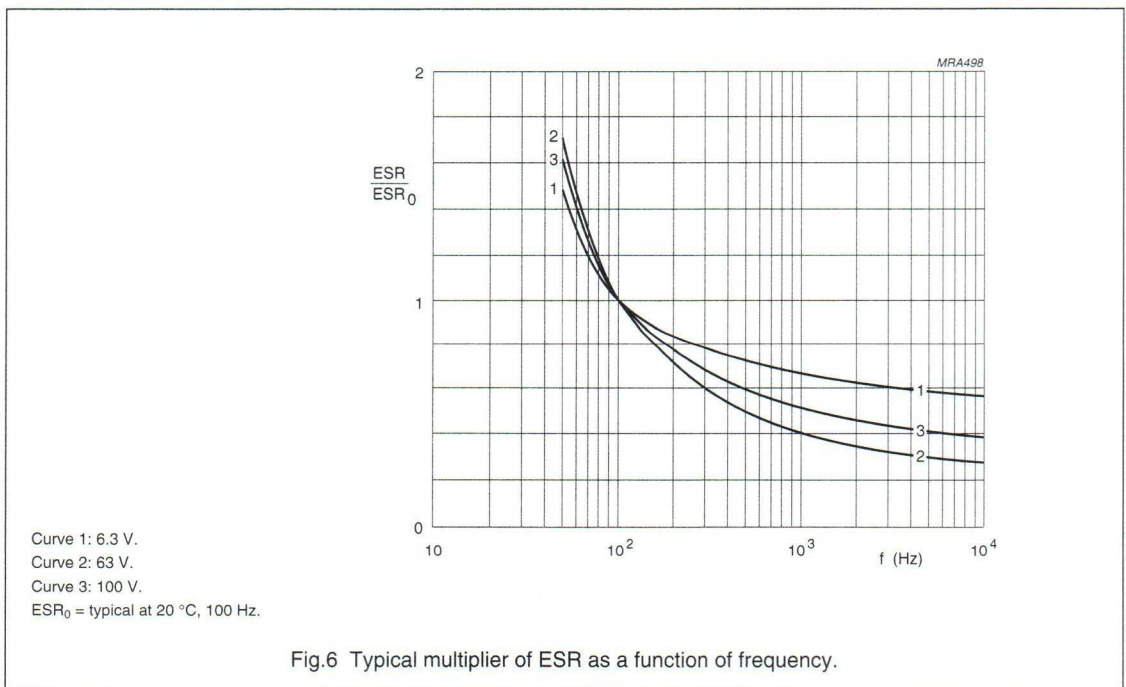
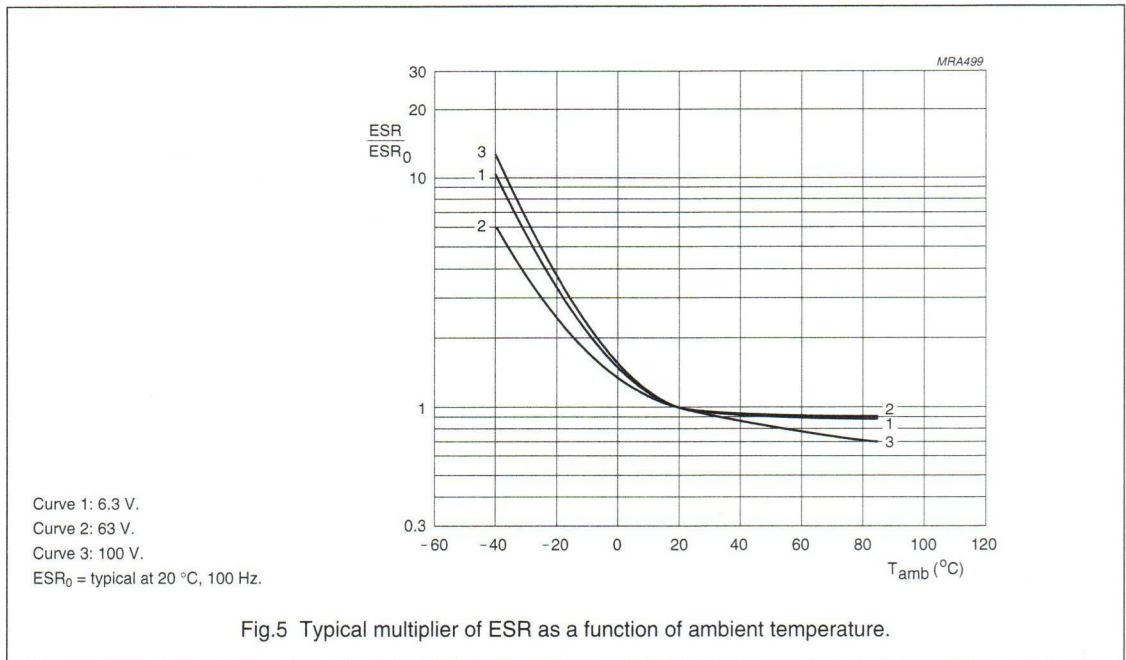
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Equivalent series resistance (ESR)



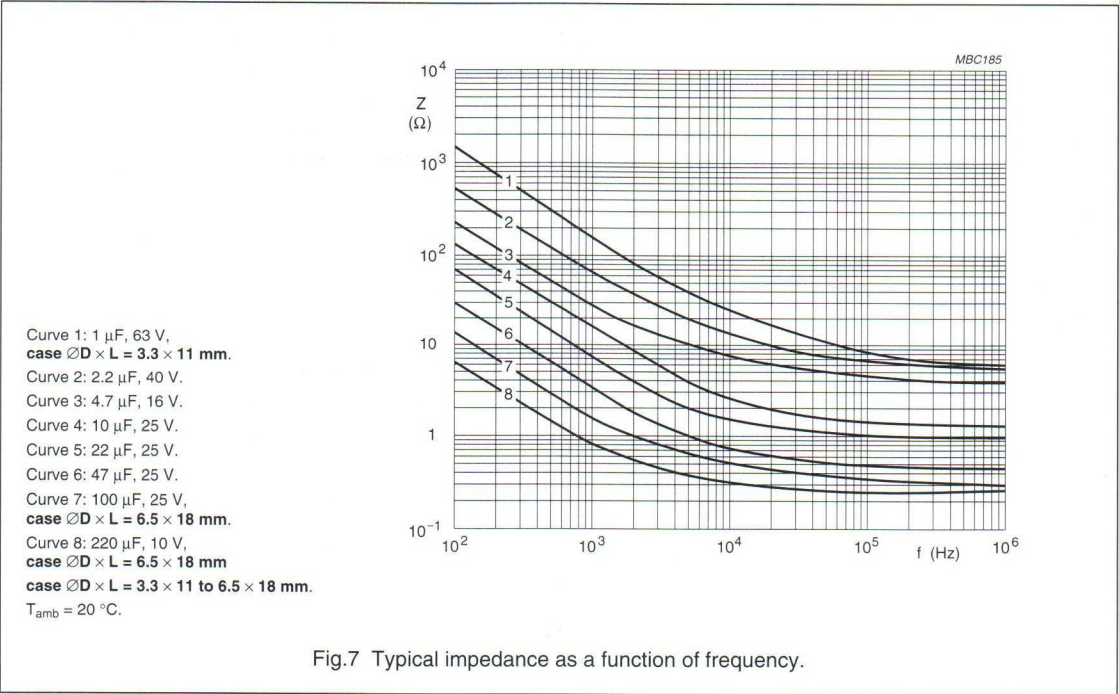
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Impedance (Z)

Table 3 Impedance × capacitance values at 10 kHz

T _{amb}	Z × 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



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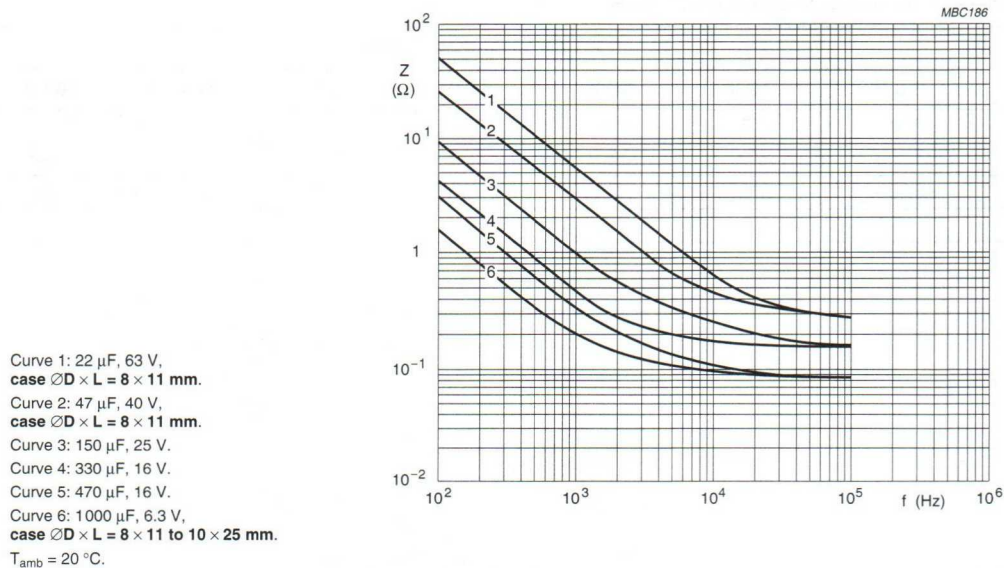


Fig.8 Typical impedance as a function of frequency.

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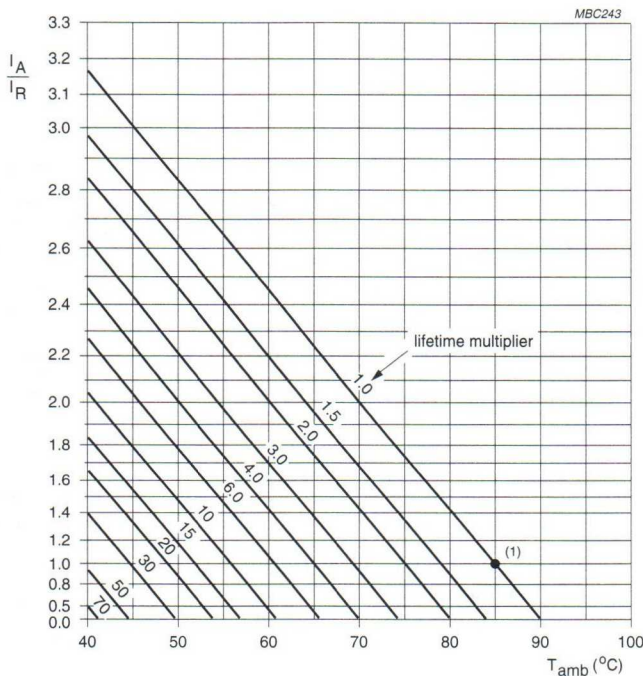
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RIPPLE CURRENT AND USEFUL LIFE

Table 4 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 85 °C, 100 Hz

FREQUENCY (Hz)	I _R MULTIPLIER		
	U _R = 6.3 to 10 V	U _R = 16 to 25 V	U _R = 40 to 100 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥10000	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 $\varnothing D \times L = 3.3 \times 11$ mm: 1500 hours
case $\varnothing D \times L = 4.5 \times 10$ to 10×25 mm: 3000 hours.

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 5 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Case ØD × L = 3.3 × 11 mm			
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	T _{amb} = 85 °C; U _R applied; 1 000 hours	ΔC/C: ±20% tan δ ≤ 2 × spec. limit Z ≤ 3 × spec. limit I _{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T _{amb} = 85 °C; U _R and I _R applied; 1 500 hours	ΔC/C: ±50% tan δ ≤ 3 × spec. limit Z ≤ 3 × spec. limit I _{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤3%
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 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 × spec. limit
Case ØD × L = 4.5 × 10 to 10 × 25 mm			
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	T _{amb} = 85 °C; U _R applied; 2 000 hours	U _R ≤ 6.3 V; ΔC/C: +15/−30% U _R > 6.3 V; ΔC/C: ±15% tan δ ≤ 1.3 × spec. limit Z ≤ 2 × spec. limit I _{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T _{amb} = 85 °C; U _R and I _R applied; 3 000 hours	U _R ≤ 6.3 V; ΔC/C: +45/−50% U _R > 6.3 V; ΔC/C: ±45% tan δ ≤ 3 × spec. limit Z ≤ 3 × spec. limit I _{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 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 × spec. limit

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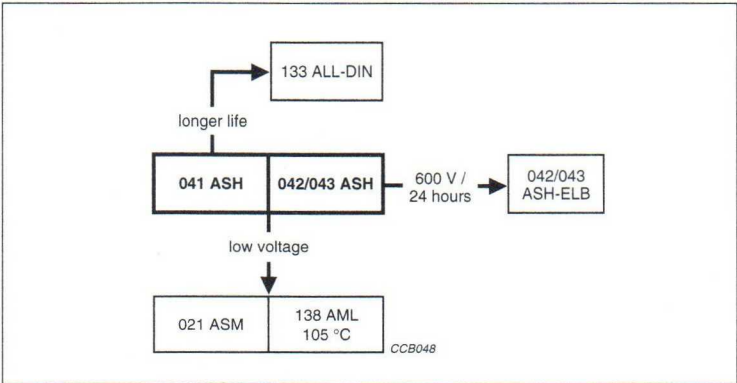
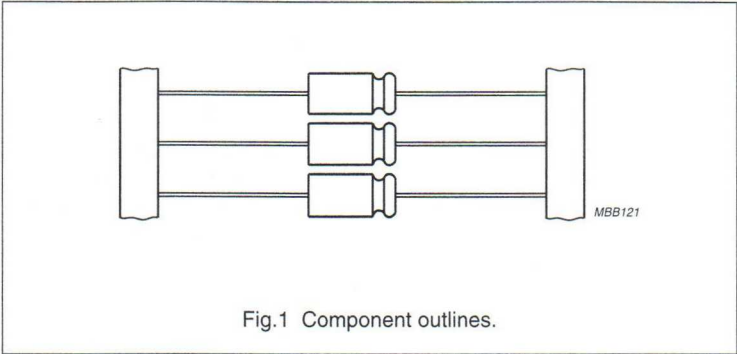
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FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case $\varnothing 10 \times 30$ to 21×40 mm with pressure relief
- Taped versions up to case $\varnothing 15 \times 30$ mm available for automatic insertion
- Charge and discharge proof
- Useful life:
5000 to 15000 hours at 85 °C
- High rated voltage: up to 450 V.

APPLICATIONS

- General purpose, industrial, power supply, audio-video and lighting
- Smoothing, filtering, buffering at high voltages
- Boards with restricted mounting height, vibration and shock resistant.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	6.5 × 18 to 10 × 25	10 × 30 to 21 × 40
Rated capacitance range, C_R	1 to 220 μF	
Tolerance on C_R	−10 to +50%	
Rated voltage range, U_R	160 to 450 V	
Category temperature range	−40 to +85 °C (450 V: −25 to +85 °C)	
Endurance test at 85 °C	2000 hours	8000 hours (450 V: 2000 hours)
Useful life at 85 °C	5000 hours	15000 hours (450 V: 5000 hours)
Useful life at 40 °C	1.4 × I_R applied: 120000 hours	1.8 × I_R applied: 240000 hours (450 V: 120000 hours)
Shelf life at 0 V, 85 °C	500 hours	500 hours
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	40/085/56 (450 V: 25/085/56)	

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

C_R (μF)	U_R (V)					
	160	250	350	385	400	450
1.0	—	—	—	6.5×18	—	—
2.2	—	6.5×18	—	8×18	—	—
4.7	6.5×18	8×18	10×18	10×25	—	—
6.8	—	—	10×30	10×30	10×30	10×30
10	8×18	10×25	12.5×30	12.5×30	12.5×30	12.5×30
	—	10×30	—	—	—	—
15	—	12.5×30	12.5×30	15×30	15×30	12.5×30
22	10×25	12.5×30	15×30	18×30	18×30	15×30
	10×30	—	—	—	—	—
33	12.5×30	15×30	18×30	18×40	18×40	18×30
47	15×30	18×30	18×40	18×40	18×40	18×40
68	15×30	18×40	21×40	21×40	21×40	21×40
100	18×30	21×40	—	—	—	—
150	18×40	—	—	—	—	—
220	21×40	—	—	—	—	—

MARKING

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

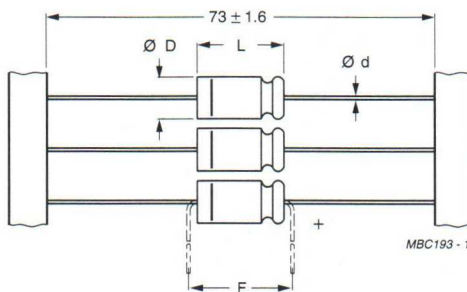
- Rated capacitance (in μF)
- Tolerance on rated capacitance, code letter in accordance with "IEC 62"
- Rated voltage (in V)
- Group number (041, 042 or 043)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with "IEC 62"
- Code indicating factory of origin
- Band to identify the negative terminal
- '+' sign to indicate the positive terminal.

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

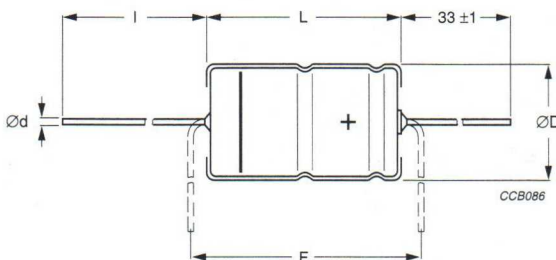
Form BR: Taped on reel,
case $\varnothing D \times L = 6.5 \times 18$ to 15×30 mm.

Form BA: Taped in box (ammopack),
case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm.

For dimensions see Table 1.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.2 Dimensional outline; Forms BA and BR.



Dimensions in mm.

Form AA: Axial in box,
case $\varnothing D \times L = 10 \times 30$ to 21×40 mm

For dimensions see Table 1.

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

Fig.3 Dimensional outline; Form AA.

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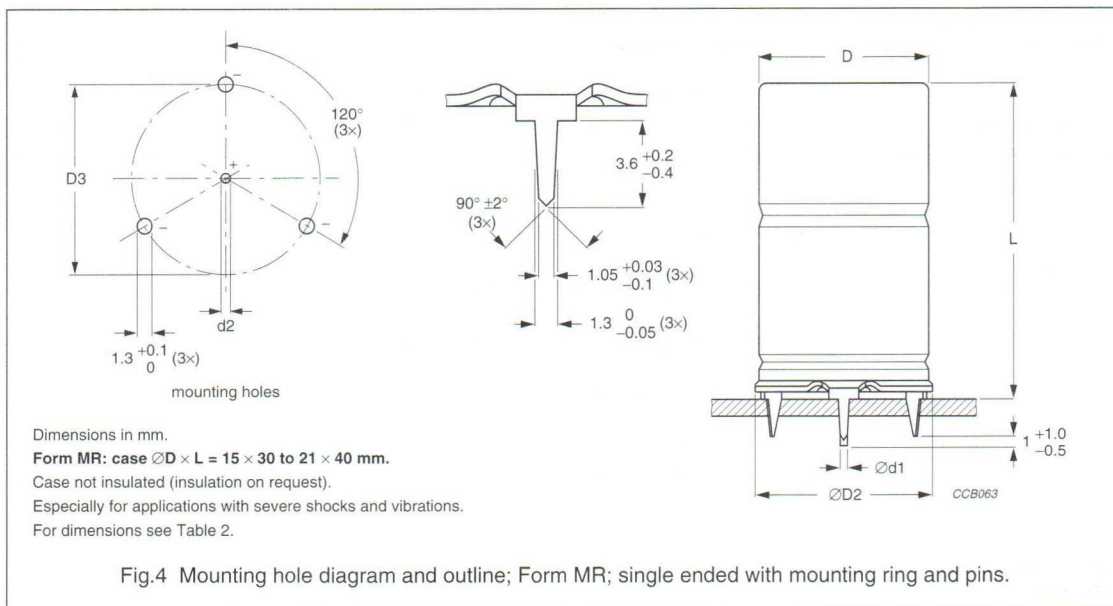
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Table 1 Axial; physical dimensions, mass and packaging information; see Figs 2 and 3

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	AXIAL: FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		$\varnothing d$ (mm)	l (mm)	$\varnothing D_{\max}$ (mm)	$L_{\max}$ (mm)	$F_{\min}$ (mm)		FORM AA	FORM BA	FORM BR
6.5 × 18	4	0.8	—	6.9	18.5	25	≈1.3	—	1000	1000
8 × 18	5	0.8	—	8.5	18.5	25	≈1.7	—	500	500
10 × 18	6	0.8	—	10.5	18.5	25	≈2.5	—	500	500
10 × 25	7	0.8	—	10.5	25.0	30	≈3.3	—	500	500
10 × 30	00	0.8	55 ±1	10.5	30.5	35	≈4.8	200	—	500
12.5 × 30	01	0.8	55 ±1	13.0	30.5	35	≈7.4	200	—	400
15 × 30	02	0.8	55 ±1	15.5	30.5	35	≈11.7	200	—	250
18 × 30	03	0.8	55 ±1	18.5	30.5	35	≈12.9	200	—	—
18 × 40	04	0.8	34 ±1	18.5	41.5	45	≈19.4	100	—	—
21 × 40	05	0.8	34 ±1	21.5	41.5	45	≈24.7	100	—	—

**Table 2** Single ended; physical dimensions, mass and packaging information; see Fig.4

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	SINGLE ENDED WITH MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		$\varnothing d1$ (mm)	$\varnothing d2$ (mm)	$\varnothing D_{\max}$ (mm)	$\varnothing D2_{\max}$ (mm)	$D3$ (mm)	$L_{\max}$ (mm)		
15 × 30	02	0.8	1.0 +0.4	15.5	17.5	16.5 ±0.2	33	≈11.7	200
18 × 30	03	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	33	≈12.9	200
18 × 40	04	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	45	≈19.4	100
21 × 40	05	0.8	1.0 +0.4	21.5	22.5	21.5 ±0.2	45	≈24.7	100

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Ordering example

Electrolytic capacitor 041 series
10 μ F/250 V; $-10/+50\%$
Nominal case size: $\varnothing 10 \times 25$ mm; Form BA
Catalogue number: 2222 041 33109.

ELECTRICAL DATA AND ORDERING INFORMATION

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

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance -10 to $+50\%$
I_R	rated RMS ripple current at 100 Hz, $85\text{ }^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and C_R)
Z	max. impedance at 10 kHz

Table 3 Electrical data and ordering information; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz $85\text{ }^{\circ}\text{C}$ (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222			
										AXIAL		SINGLE ENDED	MOUNTING RING FORM MR
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	
160	4.7	6.5×18	4	50	38	8	0.15	51	26	—	041 21478	041 31478	—
	10	8×18	5	70	68	14	0.15	24	12	—	041 21109	041 31109	—
	22	10×25	7	150	130	25	0.15	11	5.5	—	041 21229	041 31229	—
	22	10×30	00	120	42	25	0.10	6.8	5.5	042 11229	042 21229	—	—
	33	12.5×30	01	150	58	36	0.10	4.5	3.1	042 11339	042 21339	—	—
	47	15×30	02	190	78	49	0.10	3.2	2.1	042 11479	042 21479	—	042 41479
	68	15×30	02	230	110	69	0.10	2.2	1.4	042 11689	042 21689	—	042 41689
	100	18×30	03	350	150	100	0.10	1.5	1.0	042 11101	—	—	042 41101
	150	18×40	04	430	230	150	0.10	1.0	0.7	043 11151	—	—	043 41151
	220	21×40	05	610	330	220	0.10	0.7	0.5	043 11221	—	—	043 41221
250	2.2	6.5×18	4	35	28	6	0.10	72	50	—	041 23228	041 33228	—
	4.7	8×18	5	55	55	11	0.10	34	23	—	041 23478	041 33478	—
	10	10×25	7	90	95	19	0.10	16	11	—	041 23109	041 33109	—
	10	10×30	00	72	33	19	0.10	15	11	042 13109	042 23109	—	—

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	U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222			
											AXIAL			
											IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	SINGLE ENDED MOUNTING RING FORM MR
250	15	12.5 × 30	01	100	44	27	0.10	10	7.4	042 13159	042 23159	—	—	—
	22	12.5 × 30	01	130	60	37	0.10	6.8	5.0	042 13229	042 23229	—	—	—
	33	15 × 30	02	160	84	54	0.10	4.5	3.4	042 13339	042 23339	—	—	042 43339
	47	18 × 30	03	220	120	75	0.10	3.2	2.3	042 13479	—	—	—	042 43479
	68	18 × 40	04	290	160	110	0.10	2.2	1.7	043 13689	—	—	—	043 43689
350	100	21 × 40	05	390	240	150	0.10	1.5	1.1	043 13101	—	—	—	043 43101
	4.7	10 × 18	6	60	69	14	0.10	34	22	—	041 25478	041 35478	—	—
	6.8	10 × 30	00	60	32	18	0.10	22	14	042 15688	042 25688	—	—	—
	10	12.5 × 30	01	90	42	25	0.10	15	10	042 15109	042 25109	—	—	—
	15	12.5 × 30	01	100	57	36	0.10	10	6.7	042 15159	042 25159	—	—	—
385	22	15 × 30	02	140	79	50	0.10	6.8	4.5	042 15229	042 25229	—	—	042 45229
	33	18 × 30	03	160	110	73	0.10	4.5	3.1	042 15339	—	—	—	042 45339
	47	18 × 40	04	270	160	100	0.10	3.2	2.1	043 15479	—	—	—	043 45479
	68	21 × 40	05	320	220	150	0.10	2.2	1.4	043 15689	—	—	—	043 45689
	1	6.5 × 18	4	20	19	4	0.10	160	100	—	041 28108	041 38108	—	—
	2.2	8 × 18	5	40	42	8	0.10	72	45	—	041 28228	041 38228	—	—
	4.7	10 × 25	7	70	71	15	0.10	34	22	—	041 28478	041 38478	—	—
	6.8	10 × 30	00	60	34	20	0.10	22	14	042 18688	042 28688	—	—	—
	10	12.5 × 30	01	90	45	27	0.10	15	10	042 18109	042 28109	—	—	—
	15	15 × 30	02	110	62	39	0.10	10	6.0	042 18159	042 28159	—	—	042 48159
	22	18 × 30	03	150	86	55	0.10	6.8	4.1	042 18229	—	—	—	042 48229
	33	18 × 40	04	200	120	80	0.10	4.5	2.7	043 18339	—	—	—	043 48339
	47	18 × 40	04	270	170	110	0.10	3.2	2.1	043 18479	—	—	—	043 48479
	68	21 × 40	05	320	250	160	0.10	2.2	1.4	043 18689	—	—	—	043 48689

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U _R 100 Hz (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × 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 (Ω)	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 × 30	00	82	220	110	0.055	11.5	7.3	042 16688	042 26688	—	—	
	10	12.5 × 30	01	130	240	110	0.055	7.5	4.6	042 16109	042 26109	—	—	
	15	15 × 30	02	160	250	110	0.055	5.0	3.1	042 16159	042 26159	—	042 46159	
	22	18 × 30	03	210	280	120	0.055	3.5	2.1	042 16229	—	—	042 46229	
	33	18 × 40	04	290	320	130	0.055	2.3	1.4	043 16339	—	—	043 46339	
	47	18 × 40	04	330	370	140	0.055	1.7	1.1	043 16479	—	—	043 46479	
	68	21 × 40	05	430	440	150	0.055	1.2	0.7	043 16689	—	—	043 46689	
	450	6.8	10 × 30	00	60	230	110	0.10	22	14	042 17688	042 27688	—	—
10		12.5 × 30	01	90	240	110	0.10	15	10	042 17109	042 27109	—	—	
15		12.5 × 30	01	100	260	110	0.10	10	6	042 17159	042 27159	—	—	
22		15 × 30	02	140	290	120	0.10	6.8	4.1	042 17229	042 27229	—	042 47229	
33		18 × 30	03	190	330	130	0.10	4.5	2.7	042 17339	—	—	042 47339	
47		18 × 40	04	250	390	140	0.10	3.2	2.1	043 17479	—	—	043 47479	
68		21 × 40	05	330	460	160	0.10	2.2	1.4	043 17689	—	—	043 47689	

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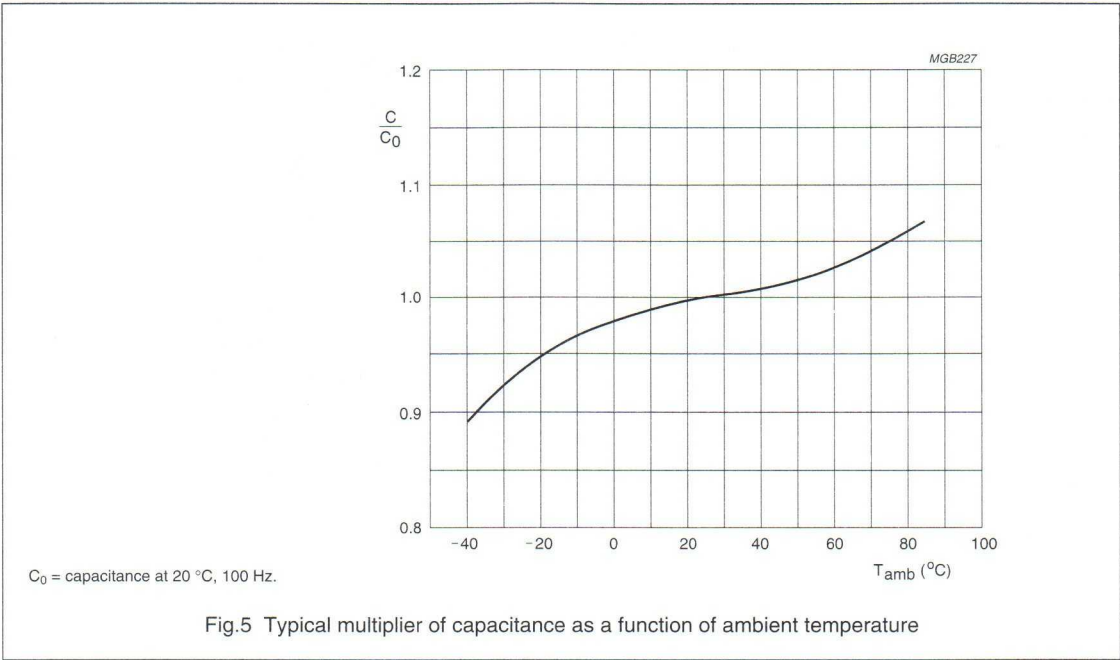
Additional electrical data

PARAMETER	CONDITIONS	VALUE	
		AXIAL	SINGLE ENDED
Voltage			
Surge voltage for short periods	$U_R = 160 \text{ to } 250 \text{ V}$	$U_s \leq 1.15 \times U_R$	
	$U_R = 350 \text{ to } 450 \text{ V}$	$U_s \leq 1.1 \times U_R$	
Reverse voltage		$U_{rev} \leq 1 \text{ V}$	
Current			
Leakage current	after 1 minute:		
	case $\varnothing D \times L = 6.5 \times 18 \text{ to } 10 \times 25 \text{ mm}$:	$I_{L1} \leq 0.05C_R \times U_R \text{ or } 5 \mu\text{A, whichever is greater}$	
	$CV \leq 1000 \mu\text{C}$	$I_{L1} \leq 0.03C_R \times U_R + 20 \mu\text{A}$	
	$CV > 1000 \mu\text{C}$		
	case $\varnothing D \times L = 10 \times 30 \text{ to } 21 \times 40 \text{ mm}$:	$I_{L1} \leq 0.009C_R \times U_R + 10 \mu\text{A}$	
	$U_R = 160 \text{ to } 385 \text{ V}$	$I_{L1} \leq 0.009C_R \times U_R + 200 \mu\text{A}$	
	$U_R = 400 \text{ and } 450 \text{ V}$		
	after 5 minutes:		
	$U_R = 160 \text{ to } 385 \text{ V}$:	$I_{L5} \leq 0.01C_R \times U_R \text{ or } 1 \mu\text{A, whichever is greater}$	
	$CV \leq 1000 \mu\text{C}$	$I_{L5} \leq 0.006C_R \times U_R + 4 \mu\text{A}$	
	$CV > 1000 \mu\text{C}$	$I_{L5} \leq 0.002C_R \times U_R + 100 \mu\text{A}$	
	$U_R = 400 \text{ and } 450 \text{ V}$		
Inductance			
Equivalent series inductance (ESL)	case $\varnothing D \times L \text{ mm}$:		
	6.5×18	typ. 15 nH	—
	8×18	typ. 35 nH	—
	10×18	typ. 69 nH	—
	10×25	typ. 38 nH	—
	10×30	typ. 38 nH	—
	12.5×30	typ. 46 nH	—
	15×30	typ. 48 nH	typ. 39 nH
	18×30	typ. 50 nH	typ. 39 nH
	18×40	typ. 54 nH	typ. 39 nH
	21×40	typ. 59 nH	typ. 39 nH

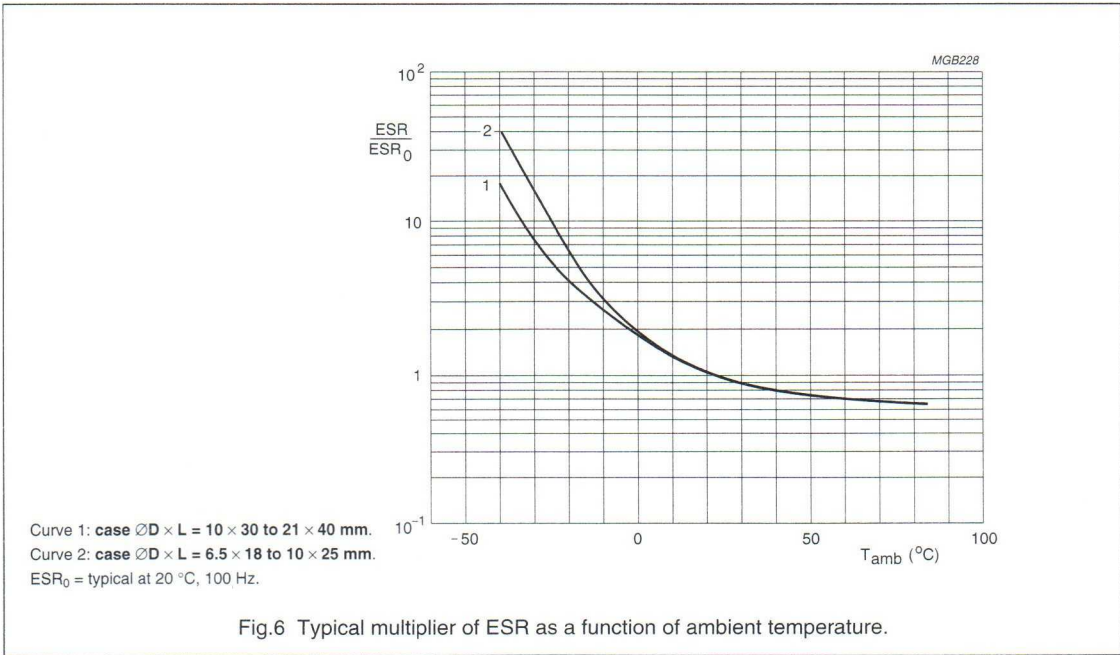
Aluminium electrolytic capacitors
Axial Standard, High Voltage

041-043 ASH

Capacitance (C)



Equivalent series resistance (ESR)



Aluminium electrolytic capacitors

Axial Standard, High Voltage

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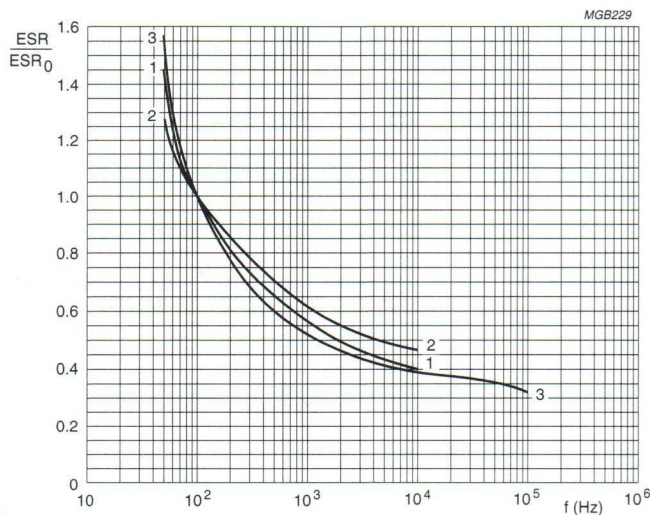


Fig.7 Typical multiplier of ESR as a function of frequency.

Impedance (Z)

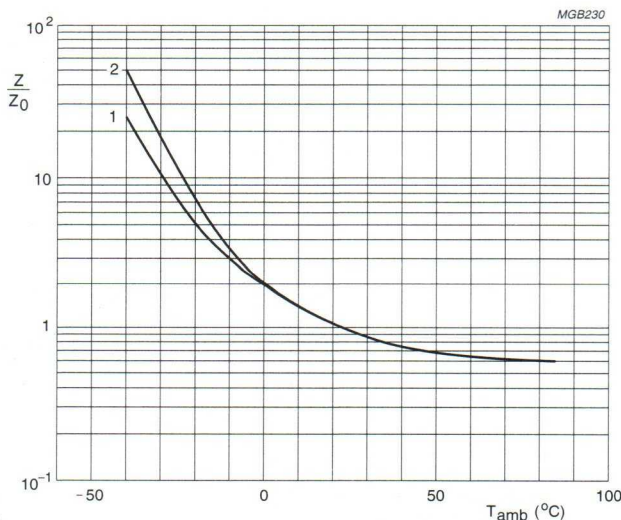


Fig.8 Typical multiplier of impedance as a function of ambient temperature.

Aluminium electrolytic capacitors

Axial Standard, High Voltage

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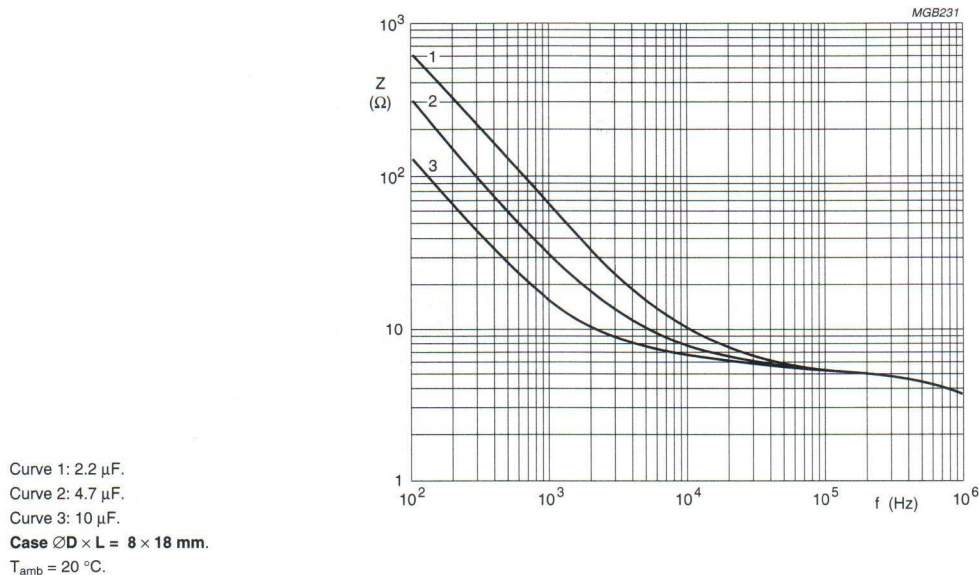


Fig.9 Typical impedance as a function of frequency.

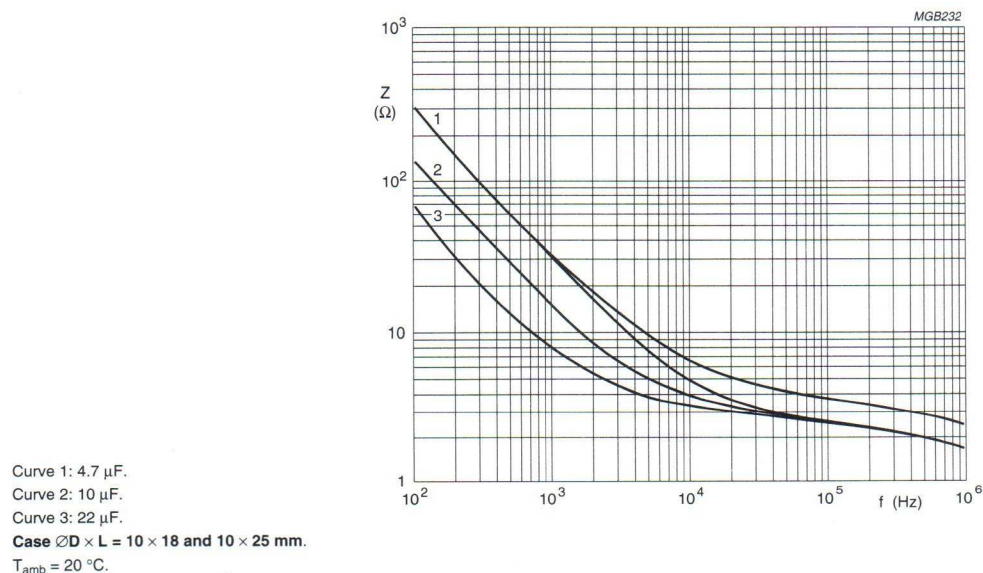


Fig.10 Typical impedance as a function of frequency.

A

Aluminium electrolytic capacitors

Axial Standard, High Voltage

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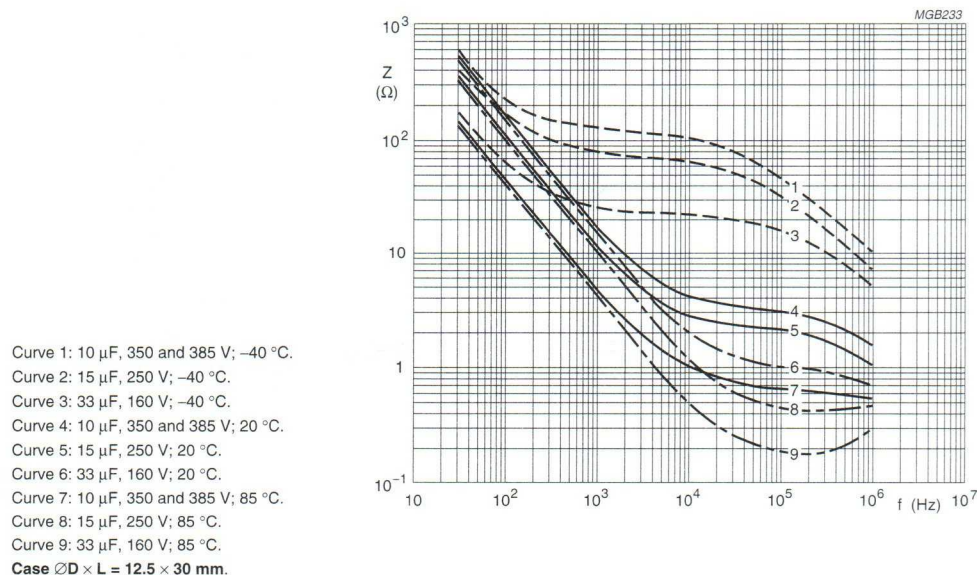


Fig.11 Typical impedance as a function of frequency at different ambient temperatures.

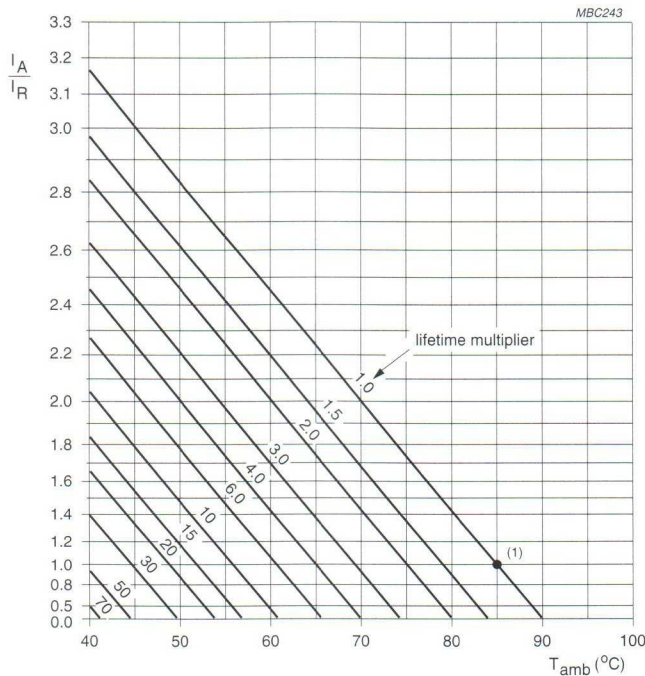
Aluminium electrolytic capacitors
Axial Standard, High Voltage

041-043 ASH

RIPPLE CURRENT AND USEFUL LIFE

Table 4 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = 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
≥ 10000	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 $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm: 5000 hours

case $\varnothing D \times L = 10 \times 30$ to 21×40 mm: 15000 hours (450 V: 5000 hours).

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Axial Standard, High Voltage

041-043 ASH

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 5 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; case $\varnothing D \times L$: 6.5×18 to 10×25 mm: 2000 hours; 10×30 to 21×40 mm: 8000 hours (450 V: 2000 hours)	$U_R = 160\text{ V}$; $\Delta C/C$: $\pm 15\%$ $U_R = 250$ to 450 V ; $\Delta C/C$: $\pm 10\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; case $\varnothing D \times L$: 6.5×18 to 10×25 mm: 5000 hours; 10×30 to 21×40 mm: 15000 hours (450 V: 5000 hours)	$U_R = 160\text{ V}$; $\Delta C/C$: $\pm 45\%$ $U_R = 250$ to 450 V ; $\Delta C/C$: $\pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$

Aluminum electrolytic capacitors
Axial, High Voltage for Electronic Lighting Ballast

042/043 ASH-ELB

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid
 - Axial leads, cylindrical aluminum case, insulated with a blue sleeve
 - Case $\varnothing 12.5 \times 30$ to 21×40 mm with pressure relief
 - Taped versions up to case $\varnothing 15 \times 30$ mm available for automatic insertion
 - Charge and discharge proof
 - Useful life: 15000 hours at 85 °C
 - High voltage: 600 V for 24 hours at 25 °C
 - High ripple current capability.
- APPLICATIONS**
- Electronic lighting ballast, power supply
 - Smoothing, filtering, buffering at high voltages
 - Boards with restricted mounting height, vibration and shock resistant.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	12.5 × 30 to 21 × 40
Rated capacitance range, C_R	6.8 to 33 μF
Tolerance on C_R	-10 to +50%
Rated voltage, U_R	450 V
Category temperature range	-25 to +85 °C
Endurance test at 85 °C	5000 hours
Useful life at 85 °C	15000 hours
Useful life at 70 °C, I_R applied	45000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	25/085/56

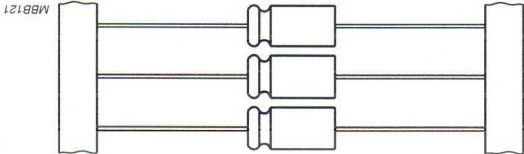
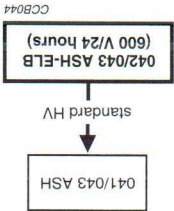


Fig.1 Component outlines.

Aluminium electrolytic capacitors
Axial, High Voltage for Electronic Lighting Ballast

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

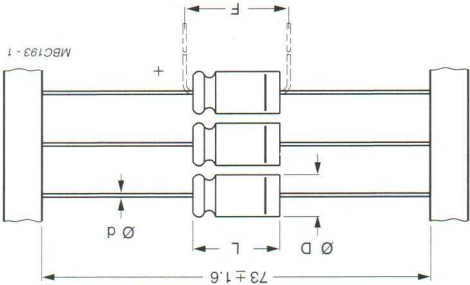


Fig. 2 Dimensional outline: Form BR.

Tape dimensions are specified in this handbook, Section "Packaging".

For dimensions see Table 1.

Case $\varnothing D \times L = 12.5 \times 30$ and 15×30 mm.

Form BR: Taped on reel.

Dimensions in mm.

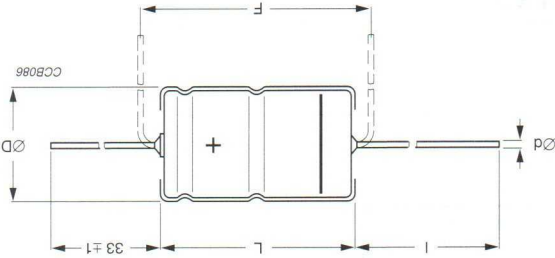


Fig. 3 Dimensional outline: Form AA.

For case $\varnothing D \times L = 18 \times 40$ and 21×40 mm, the stated L may be exceeded by 0.7 mm.

For dimensions see Table 1.

Case $\varnothing D \times L = 12.5 \times 30$ to 21×40 mm.

Form AA: Axial in box.

Dimensions in mm.

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	l (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F_{min} (mm)	MASS (g)	PACKAGING QUANTITIES	
								FORM AA	FORM BR
12.5 × 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	200	400
15 × 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	250
18 × 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	200	—
18 × 40	04	0.8	34 ± 1	18.5	41.5	45	≈ 19.4	100	—
21 × 40	05	0.8	34 ± 1	21.5	41.5	45	≈ 24.7	100	—

Table 1 Axial; physical dimensions, mass and packaging quantities; see Figs 2 and 3

Aluminium electrolytic capacitors

Axial, High Voltage for Electronic Lighting Ballast

042/043 ASH-ELB

Ordering example

Electrolytic capacitor 042 series
10 µF/450 V; -10/+50%

Nominal case size: Ø15 × 30 mm; Form BR
Catalogue number: 2222 042 92109.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C,
P = 86 to 106 kPa, RH = 45 to 75%.

SYMBOL	DESCRIPTION
C _R	rated capacitance at 100 Hz, tolerance -10/+50%
I _R	rated RMS ripple current at 100 Hz, 85 °C or 10 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

Table 2 Electrical data and ordering information; preferred types in bold

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	I _R 100 Hz 85 °C (mA)	I _R 10 kHz 70 °C (mA)	I _{L1} 1 min (µA)	I _{L5} 5 min (µA)	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER	
										2222	AXIAL
										IN BOX FORM AA	TAPED ON REEL FORM BR
450	6.8	12.5 × 30	01	110	630	230	105	7.9	4.4	042 91688	042 92688
	10	15 × 30	02	170	980	240	110	5.3	3.0	042 91109	042 92109
	15	18 × 30	03	250	1400	260	115	3.6	2.0	042 91159	-
	22	18 × 40	04	320	1850	290	120	2.4	1.4	043 91229	-
	33	21 × 40	05	390	2200	330	130	1.7	1.0	043 91339	-

Aluminium electrolytic capacitors

Axial, High Voltage for Electronic Lighting Ballast

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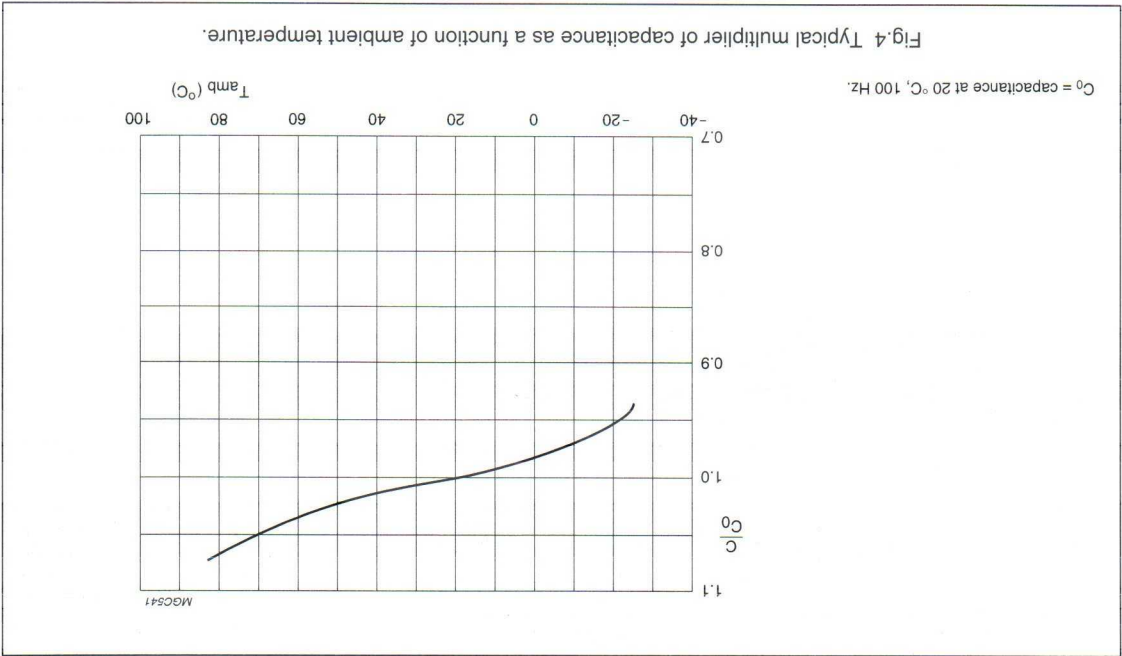
Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods	$U_R = 450\text{ V}$	$U_S \leq 550\text{ V}$
Reverse voltage		$U_{rev} \leq 1\text{ V}$
Current		
Leakage current	after 1 minute: case $\varnothing D \times L = 12.5 \times 30$ to $21 \times 40\text{ mm}$	$I_{L1} \leq 0.009 \times C_R \times U_R + 200\text{ }\mu\text{A}$
	after 5 minutes: $U_R = 450\text{ V}$	$I_{L5} \leq 0.002 \times C_R \times U_R + 100\text{ }\mu\text{A}$
Inductance		
Equivalent series inductance		typ. 46 nH typ. 48 nH typ. 50 nH typ. 54 nH typ. 59 nH
case $\varnothing D \times L$ in mm:		12.5 $\times$ 30 15 $\times$ 30 18 $\times$ 30 18 $\times$ 40 21 $\times$ 40

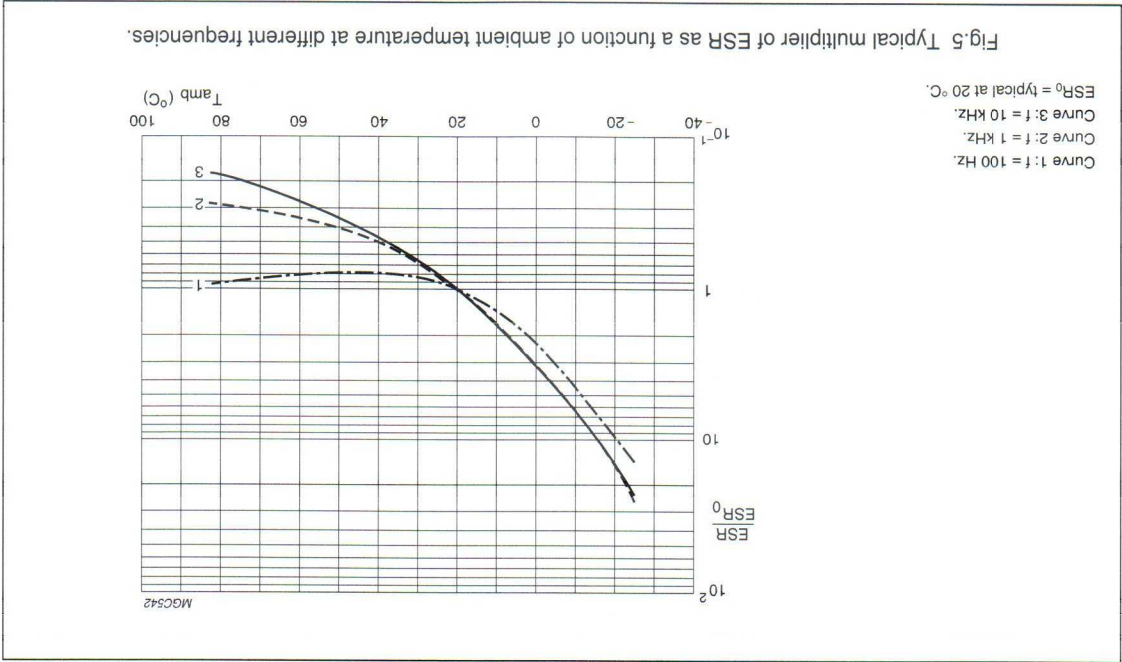
Aluminium electrolytic capacitors
Axial, High Voltage for Electronic Lighting Ballast

042/043 ASH-ELB

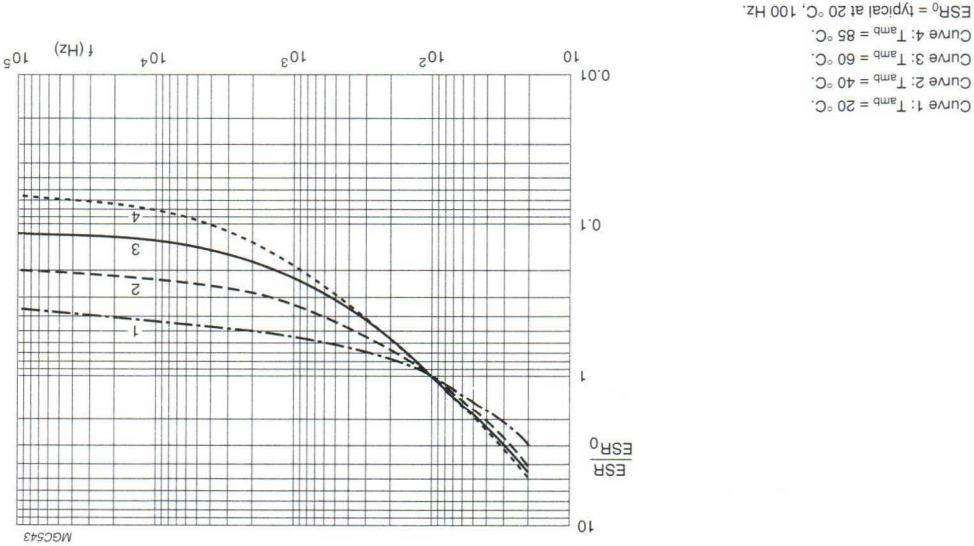
Capacitance (C)



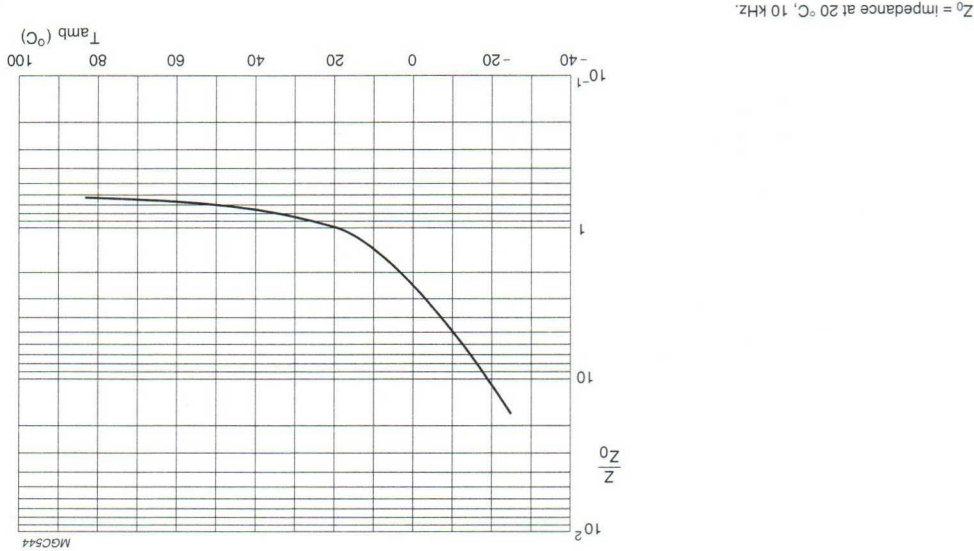
Equivalent series resistance (ESR)



Aluminium electrolytic capacitors
Axial, High Voltage for Electronic Lighting Ballast
042/043 ASH-ELB

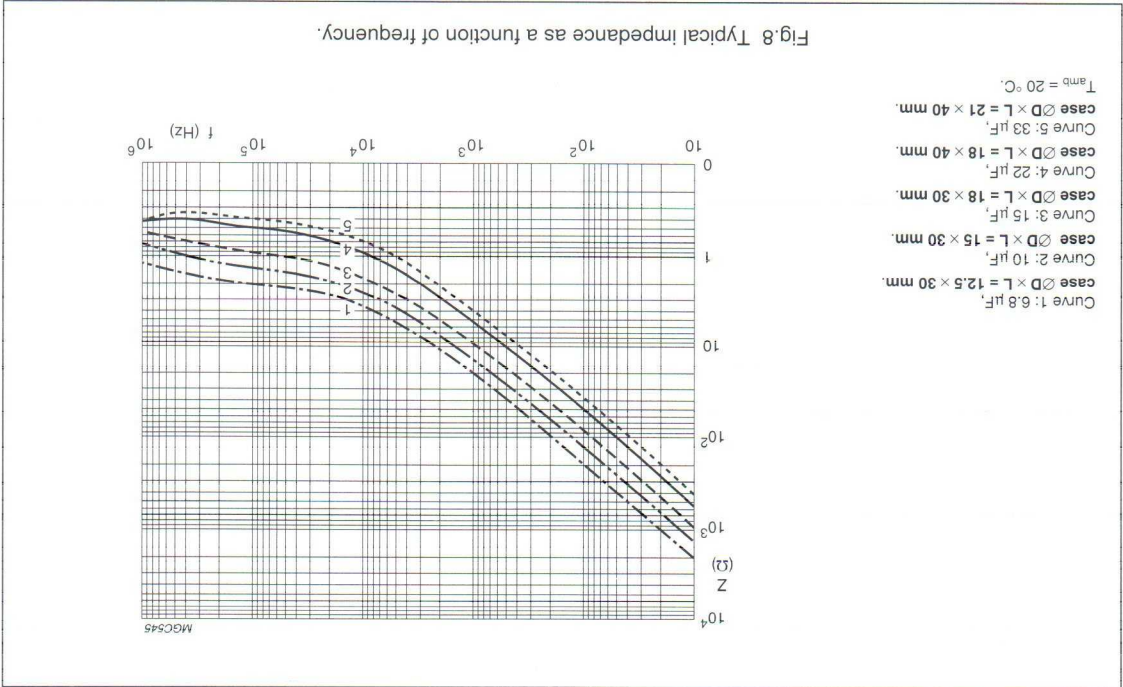


Impedance (Z)



Aluminium electrolytic capacitors Axial, High Voltage for Electronic Lighting Ballast

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MARKING

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

- Rated capacitance (in μ F)
- Tolerance on rated capacitance, code letter in accordance with "IEC 62"
- Rated voltage (in V)
- Catalogue number (last 8 digits)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with "IEC 62"
- Code indicating factory of origin
- Band to identify the negative terminal
- '+' sign to indicate the positive terminal.

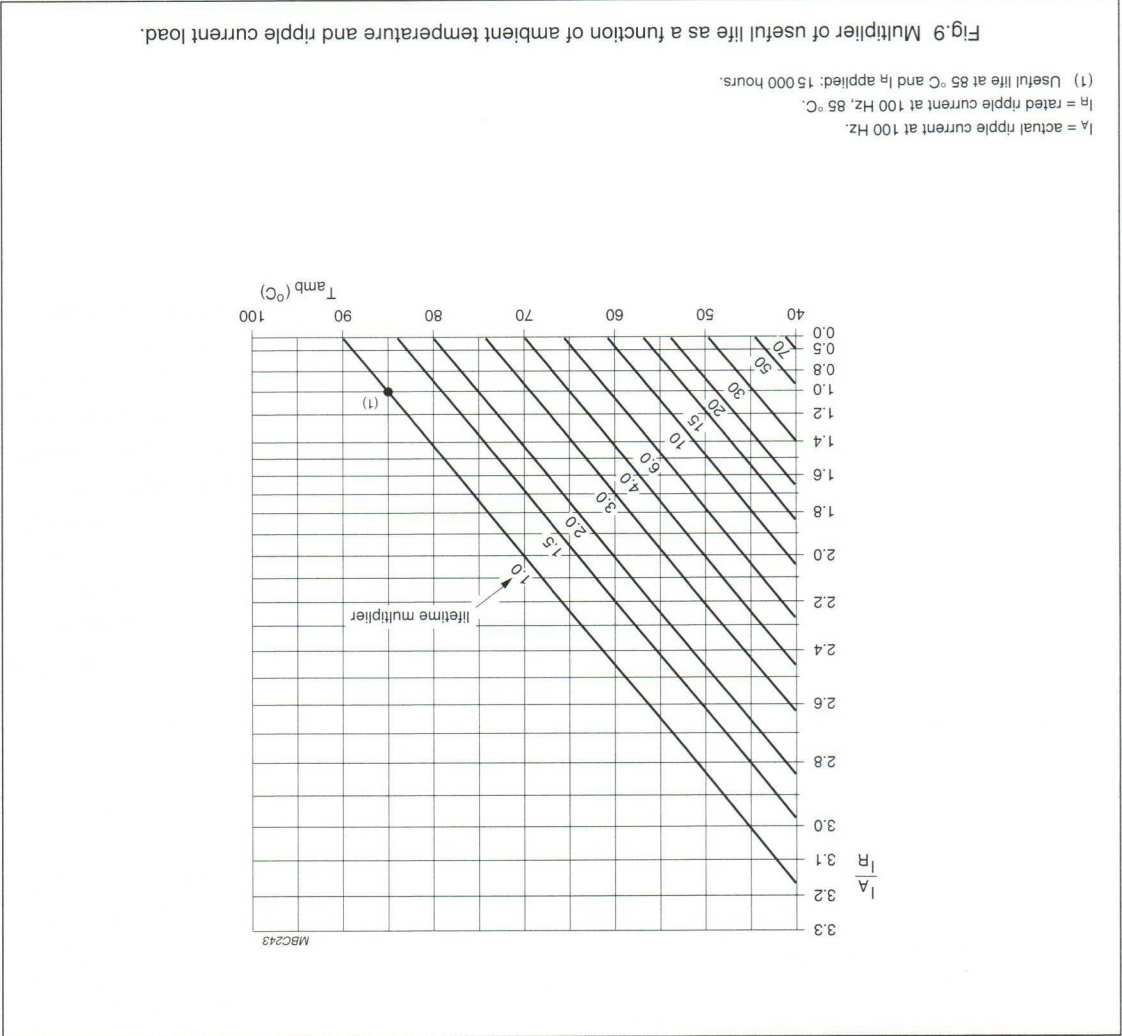
Aluminum electrolytic capacitors
Axial, High Voltage for Electronic Lighting Ballast

042/043 ASH-ELB

Product specification

Table 3 Multiplier of ripple current (I_H/I_{R0}) as a function of frequency; I_{R0} = ripple current at 85 °C, 100 Hz

FREQUENCY (Hz)	I_H MULTIPLIER				
50	0.7	1.0	1.6	2.5	3.2
100	0.7	1.0	1.6	2.5	3.2
300	0.7	1.0	1.6	2.5	3.2
1 000	0.7	1.0	1.6	2.5	3.2
3 000	0.7	1.0	1.6	2.5	3.2
≥10 000	0.7	1.0	1.6	2.5	3.2



Aluminium electrolytic capacitors

Axial, High Voltage for Electronic Lighting Ballast

042/043 ASH-ELB

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85^{\circ}\text{C}$; U_R applied; 5000 hours	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85^{\circ}\text{C}$; U_R and I_R applied; 15000 hours	$\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C, \tan \delta, Z$: for requirements see 'Endurance test' above $I_{LS} \leq 2 \times \text{spec. limit}$

Aluminum electrolytic capacitors

Axial Bipolar

137 92 AB

FEATURES

- Non-polarized aluminum electrolytic capacitors, non-solid case, insulated
- Axial leads, cylindrical aluminum case, insulated
- Taped for automatic insertion
- AC-capability without DC bias
- Charge and discharge proof
- Long useful life: 1 000 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.

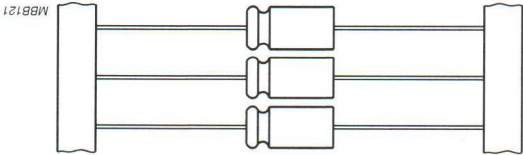
REMARK

Please consult your sales representative for more details.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing_{nom} \times L_{nom}$ in mm)	6×10 to 10×25
Rated capacitance range, C_R	1 to 470 μF
Tolerance on C_R at 100 Hz	-10 to +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	2 000 hours
Useful life at 105 °C	1 000 hours
Useful life at 40 °C, $1.3 \times I_R$ applied	100 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/085/56

Fig.1 Component outlines.



Aluminium electrolytic capacitors

Axial Bipolar

137 92 AB

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing \times L$ in mm)

C_R (μF)	U_R (V)		
	16	25	40
1.0	—	—	—
2.2	—	—	—
3.3	—	—	—
4.7	—	—	—
10	—	—	—
22	—	6 × 10	6.5 × 18
33	6 × 10	—	—
47	—	6.5 × 18	8 × 18
100	8 × 18	10 × 18	10 × 25
220	10 × 18	10 × 25	—
330	10 × 25	—	—
470	10 × 25	—	—

Aluminium electrolytic capacitors
Axial Bipolar Audio-frequency

137 ABA

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

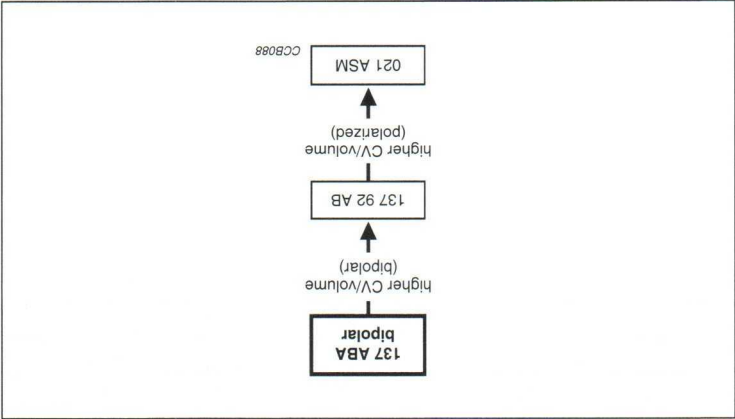
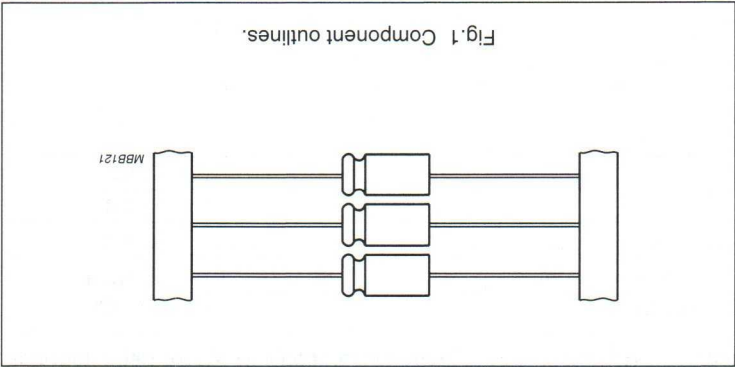
- Speaker crossover networks in audio equipment
- For splitting high, middle and low frequencies
- Axial version allows simple wiring in speaker box
- LD grade types for excellent sound quality.

REMARK

Please consult your sales representative for more details.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	8×18 to 10×25
Rated capacitance range, C_R at 1 kHz	2.2 to 22 μF
Tolerance on C_R at 1 kHz	$\pm 15\%$ or $\pm 10\%$
Rated voltage range DC, U_R	40 to 100 V
Max. RMS voltage range 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, $1.3 \times I_R$ applied	150000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/105/56



Aluminium electrolytic capacitors

Axial Bipolar Audio-frequency

137 ABA

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

C_R at 1 kHz (μF)	U_R (DC); U_{RMS} (AC)	
	40 V; 15 V	63 V; 23 V
2.2	—	8 × 18
3.3	—	10 × 25(1)
	—	10 × 18
4.7	8 × 18	10 × 18
	—	10 × 25(1)
6.8	8 × 18	10 × 25
10	10 × 18	10 × 25
15	10 × 25	—
22	10 × 25	—

Note

1. LD grade types.

Aluminum electrolytic capacitors

Axial Miniature Long-Life

138 AML

FEATURES

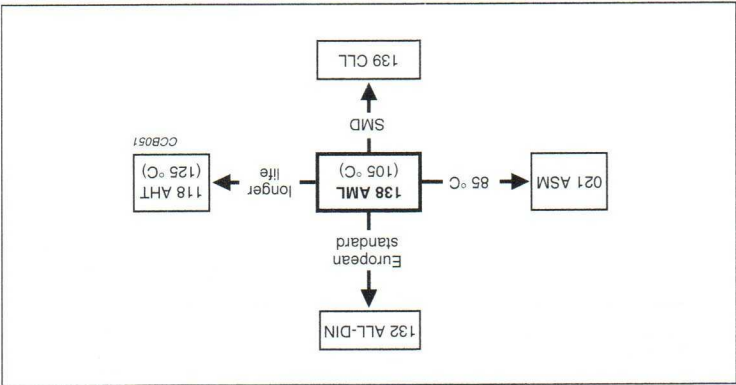
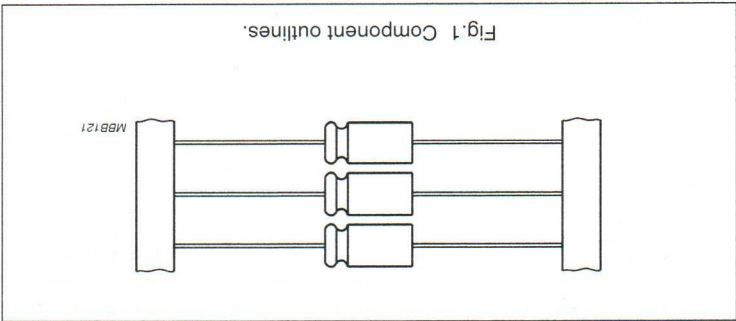
- Polarized aluminum electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve (case $\varnothing 6.3 \times 12.7$ and 7.7×12.7 mm are moulded with flame retardant plastic material)
- Mounting ring version (single ended) not insulated
- Case $\varnothing 10 \times 30$ to 21×40 mm with pressure relief
- Taped versions up to case $\varnothing 15 \times 30$ mm available for automatic insertion
- Charge and discharge proof
- Long useful life: 2000 to 10000 hours at 105°C , high reliability
- High ripple current capability
- Miniaturized, high CV-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)
- Standby applications
- Low mounting height boards
- Vibration and shock resistant.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{\text{nom}} \times L_{\text{nom}}$ in mm)	6.3×2.7 to 10×25 10×30 to 21×40
Rated capacitance range, C_R	1.0 to $15000 \mu\text{F}$
Tolerance on C_R	$\pm 20\%$
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	-40 to $+105^\circ\text{C}$
Endurance test at 105°C	1000 hours
Useful life at 105°C	2000 hours
Useful life at 40°C , I_R applied	$1.3 \times I_R$ applied: 200000 hours $1.8 \times I_R$ applied: 500000 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



Aluminium electrolytic capacitors

Axial Miniature Long-Life

138 AML

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)
Preferred types in bold.

C_R (μF)	U_R (V)									
	6.3	10	16	25	40	50	63	100		
1.0	—	—	—	—	—	—	—	6.3 × 12.7	—	—
2.2	—	—	—	—	—	—	—	6.3 × 12.7	—	—
4.7	—	—	—	—	—	—	6.3 × 12.7	6.3 × 12.7	7.7 × 12.7	7.7 × 12.7
10	—	—	—	6.3 × 12.7	6.3 × 12.7	—	6.3 × 12.7	7.7 × 12.7	7.7 × 12.7	6.5 × 18
22	—	—	6.3 × 12.7	6.3 × 12.7	6.3 × 12.7	—	7.7 × 12.7	6.5 × 18	8 × 18	8 × 18
47	—	—	6.3 × 12.7	7.7 × 12.7	7.7 × 12.7	6.5 × 18	—	—	—	10 × 25
68	—	—	—	—	—	—	—	—	—	10 × 30
100	6.3 × 12.7	—	7.7 × 12.7	6.5 × 18	8 × 18	10 × 18	10 × 25	12.5 × 30	15 × 30	15 × 30
150	—	7.7 × 12.7	—	—	—	—	—	10 × 30	15 × 30	15 × 30
220	7.7 × 12.7	6.5 × 18	8 × 18	10 × 18	10 × 25	—	12.5 × 30	15 × 30	18 × 30	18 × 30
330	—	—	—	—	10 × 30	—	—	12.5 × 30	15 × 30	18 × 30
470	6.5 × 18	8 × 18	10 × 18	10 × 25	12.5 × 30	—	—	15 × 30	18 × 30	21 × 40
680	—	—	—	10 × 30	12.5 × 30	—	—	18 × 30	21 × 40	—
1000	10 × 18	10 × 25	10 × 30	12.5 × 30	15 × 30	—	—	18 × 40	21 × 40	—
1500	—	10 × 30	12.5 × 30	15 × 30	18 × 30	—	—	21 × 40	—	—
2200	10 × 25	12.5 × 30	15 × 30	18 × 30	21 × 40	—	—	—	—	—
3300	—	15 × 30	18 × 30	21 × 40	—	—	—	—	—	—
4700	—	18 × 30	21 × 40	—	—	—	—	—	—	—
6800	—	18 × 40	21 × 40	—	—	—	—	—	—	—
10000	—	18 × 40	21 × 40	—	—	—	—	—	—	—
15000	—	21 × 40	—	—	—	—	—	—	—	—

Aluminium electrolytic capacitors

Axial Miniature Long-Life

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

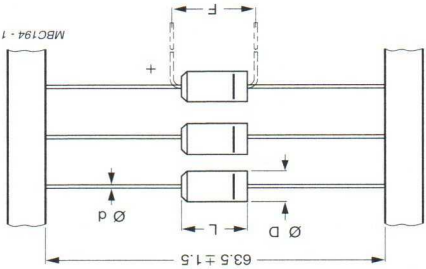


Fig.2 Dimensional outline; Forms BA and BR.

Dimensions in mm.
Form BR: Taped on reel.
Form BA: Taped in box (ammopack).
Case $\varnothing D \times L = 6.3 \times 12.7$ and 7.7×12.7 mm.
For dimensions see Table 1.
Tape dimensions are specified in this handbook, Section "Packaging".

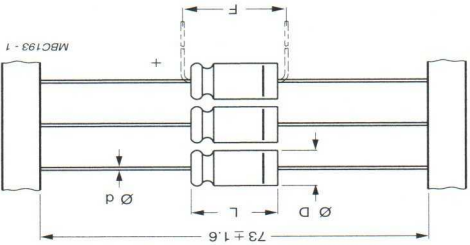


Fig.3 Dimensional outline; Forms BA and BR.

Dimensions in mm.
Form BR: Taped on reel.
Form BA: Taped in box (ammopack).
Case $\varnothing D \times L = 6.5 \times 18$ to 15×30 mm.
Form BA: Taped in box (ammopack).
Case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm.
For dimensions see Table 1.
Tape dimensions are specified in this handbook, Section "Packaging".

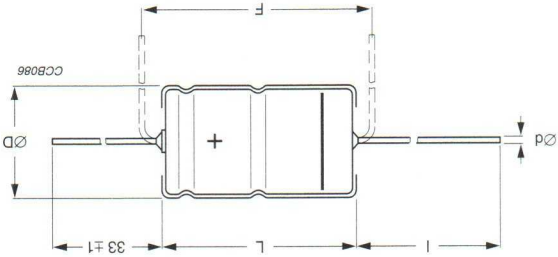


Fig.4 Dimensional outline; Form AA.

Dimensions in mm.
Form AA: Axial in box.
Case $\varnothing D \times L = 10 \times 30$ to 21×40 mm.
For dimensions see Table 1.
For case $\varnothing D \times L = 18 \times 40$ and 21×40 mm, the stated L may be exceeded by 0.7 mm.

Aluminium electrolytic capacitors
Axial Miniature Long-Life

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Table 1 Axial; physical dimensions, mass and packaging quantities; see Figs 2, 3 and 4

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$	$\varnothing d_1$	$\varnothing d_2$	L_{max}	F_{min}	MASS (g)	PACKAGING QUANTITIES		
		(mm)	(mm)	(mm)	(mm)	(mm)		FORM AA	FORM BA	FORM BR
6.3 × 12.7	(2)	0.6	—	6.5	12.9	17.5	≈ 1.1	—	1 000	1 000
7.7 × 12.7	(3)	0.6	—	7.9	12.9	17.5	≈ 1.3	—	500	500
6.5 × 18	4	0.8	—	6.9	18.5	25	≈ 1.3	—	1 000	1 000
8 × 18	5	0.8	—	8.5	18.5	25	≈ 1.7	—	500	500
10 × 18	6	0.8	—	10.5	18.5	25	≈ 2.5	—	500	500
10 × 25	7	0.8	—	10.5	25.0	30	≈ 3.3	—	500	500
10 × 30	00	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	200	—	—
12.5 × 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	200	—	400
15 × 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	—	250
18 × 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	200	—	—
18 × 40	04	0.8	34 ± 1	18.5	41.5	45	≈ 19.4	100	—	—
21 × 40	05	0.8	34 ± 1	21.5	41.5	45	≈ 24.7	100	—	—

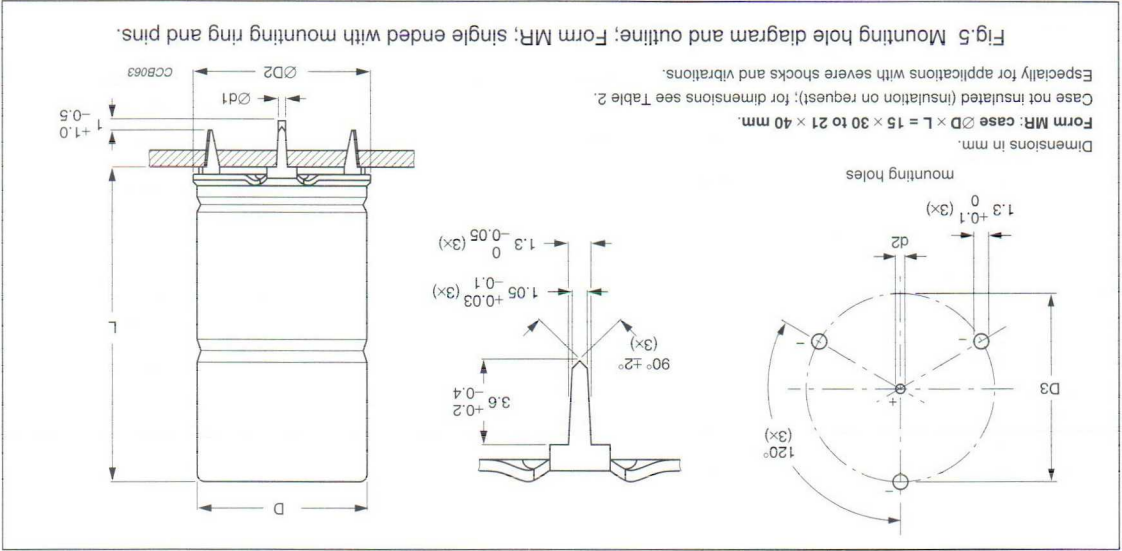


Table 2 Single ended; physical dimensions, mass and packaging quantities; see Fig.5

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d_1$	$\varnothing d_2$	D_{max}	D_{2max}	D_3	L_{max}	MASS (g)	PACKAGING QUANTITIES
		(mm)	(mm)	(mm)	(mm)	(mm)	(mm)		
15 × 30	02	0.8	1.0 ± 0.4	15.5	17.5	16.5 ± 0.2	33	≈ 11.7	200
18 × 30	03	0.8	1.0 ± 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 12.9	200
18 × 40	04	0.8	1.0 ± 0.4	18.5	19.5	18.5 ± 0.2	45	≈ 19.4	100
21 × 40	05	0.8	1.0 ± 0.4	21.5	22.5	21.5 ± 0.2	45	≈ 24.7	100

Aluminium electrolytic capacitors
Axial Miniature Long-Life

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 3, 5 and 7 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

Table 3 Electrical data; preferred types in bold

SYMBOL	DESCRIPTION
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

U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø × 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	100	6.3 × 12.7	99	16	5.3	0.24	3.8	3.0	1.8
	220	7.7 × 12.7	160	31	6.8	0.24	1.7	1.4	0.95
	470	6.5 × 18	250	22	9.9	0.24	0.81	0.64	0.5
	1000	10 × 18	430	42	17	0.24	0.38	0.30	0.24
	2200	10 × 25	640	87	32	0.29	0.21	0.18	0.15
10	150	7.7 × 12.7	140	33	7.0	0.2	2.1	1.3	0.95
	220	6.5 × 18	190	17	8.4	0.2	1.4	0.91	0.5
	470	8 × 18	300	32	13	0.2	0.68	0.43	0.35
	1000	10 × 30	560	94	24	0.2	0.32	0.20	0.16
	1500	12.5 × 30	750	140	34	0.26	0.27	0.20	0.118
	3300	15 × 30	990	200	48	0.27	0.19	0.14	0.13
	4700	18 × 30	1200	290	70	0.28	0.135	0.1	0.1
	6800	18 × 40	1700	410	140	0.32	0.075	0.056	0.069
	10000	21 × 40	2200	600	200	0.37	0.059	0.048	0.065
16	22	6.3 × 12.7	58	10	4.7	0.12	8.7	7.3	2.7
	47	6.3 × 12.7	83	18	5.5	0.16	5.4	3.4	1.9
	100	7.7 × 12.7	130	35	7.2	0.16	2.5	1.6	1.0
	220	8 × 18	230	25	11	0.16	1.2	0.73	0.35
	470	10 × 18	360	49	19	0.16	0.54	0.34	0.25
	1000	10 × 30	530	100	36	0.19	0.29	0.20	0.18
	1500	12.5 × 30	730	150	52	0.19	0.20	0.14	0.13
	2200	15 × 30	950	210	74	0.21	0.15	0.105	0.103
	3300	18 × 30	1200	320	110	0.23	0.11	0.083	0.088

Aluminium electrolytic capacitors
Axial Miniature Long-Life

ORDERING INFORMATION

Ordering example

Electrolytic capacitor 138 series

470 µF/10 V; ±20%

Nominal case size: Ø8 × 18 mm; Form BA

Catalogue number: 2222 138 34471.

Table 4 Ordering information; preferred types in bold

U _r (V)	C _r 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
6.3	100	6.3 × 12.7	(2)	—	138 23101	138 33101	—
	220	7.7 × 12.7	(3)	—	138 23221	138 33221	—
	470	6.5 × 18	4	—	138 23471	138 33471	—
	1000	10 × 18	6	—	138 23102	138 33102	—
10	2200	10 × 25	7	—	138 23222	138 33222	—
	1500	10 × 30	00	138 14152	138 24152	—	—
	2200	12.5 × 30	01	138 14222	138 24222	—	—
	3300	15 × 30	02	138 14332	138 24332	—	—
10	4700	18 × 30	03	138 14472	—	—	—
	6800	18 × 40	04	138 14682	—	—	—
	10000	18 × 40	04	138 14103	—	—	—
	15000	21 × 40	05	138 14153	—	—	—
16	22	6.3 × 12.7	(2)	—	138 25229	138 35229	—
	47	6.3 × 12.7	(2)	—	138 25479	138 35479	—
	100	7.7 × 12.7	(3)	—	138 25101	138 35101	—
	220	8 × 18	5	—	138 25221	138 35221	—
16	470	10 × 18	6	—	138 25471	138 35471	—
	1000	10 × 30	00	138 15102	138 25102	—	—
	1500	12.5 × 30	01	138 15152	138 25152	—	—
	2200	15 × 30	02	138 15222	138 25222	—	—
16	3300	18 × 30	03	138 15332	—	—	—
	4700	18 × 30	02	138 15222	—	—	—
	6300	18 × 30	03	138 15102	—	—	—
	10000	18 × 30	00	138 15152	138 25152	—	—
16	15000	21 × 40	05	138 14153	—	—	—
	22000	21 × 40	04	138 14103	—	—	—
	33000	21 × 40	04	138 14682	—	—	—
	47000	21 × 40	03	138 14472	—	—	—
16	63000	21 × 40	02	138 14332	—	—	—
	100000	21 × 40	01	138 14222	—	—	—
	150000	21 × 40	00	138 14152	—	—	—
	220000	21 × 40	7	—	—	—	—
16	470	8 × 18	5	—	138 24471	138 34471	—
	1000	10 × 25	4	—	138 24221	138 34221	—
	220	6.5 × 18	(3)	—	138 24151	138 34151	—
	150	7.7 × 12.7	(3)	—	138 24102	138 34102	—
16	1500	10 × 30	00	138 14152	138 24152	—	—
	2200	12.5 × 30	01	138 14222	138 24222	—	—
	3300	15 × 30	02	138 14332	138 24332	—	—
	4700	18 × 30	03	138 14472	—	—	—
16	6800	18 × 40	04	138 14682	—	—	—
	10000	18 × 40	04	138 14103	—	—	—
	15000	21 × 40	05	138 14153	—	—	—
	22000	21 × 40	05	138 14153	—	—	—
16	22	6.3 × 12.7	(2)	—	138 25229	138 35229	—
	47	6.3 × 12.7	(2)	—	138 25479	138 35479	—
	100	7.7 × 12.7	(3)	—	138 25101	138 35101	—
	220	8 × 18	5	—	138 25221	138 35221	—
16	470	10 × 18	6	—	138 25471	138 35471	—
	1000	10 × 30	00	138 15102	138 25102	—	—
	1500	12.5 × 30	01	138 15152	138 25152	—	—
	2200	15 × 30	02	138 15222	138 25222	—	—
16	3300	18 × 30	03	138 15332	—	—	—
	4700	18 × 30	02	138 15222	—	—	—
	6300	18 × 30	03	138 15102	—	—	—
	10000	18 × 30	00	138 15152	138 25152	—	—
16	15000	21 × 40	05	138 14153	—	—	—
	22000	21 × 40	04	138 14103	—	—	—
	33000	21 × 40	04	138 14682	—	—	—
	47000	21 × 40	03	138 14472	—	—	—
16	63000	21 × 40	02	138 14332	—	—	—
	100000	21 × 40	01	138 14222	—	—	—
	150000	21 × 40	00	138 14152	—	—	—
	220000	21 × 40	7	—	—	—	—
16	470	8 × 18	5	—	138 24471	138 34471	—
	1000	10 × 25	4	—	138 24221	138 34221	—
	220	6.5 × 18	(3)	—	138 24151	138 34151	—
	150	7.7 × 12.7	(3)	—	138 24102	138 34102	—
16	1500	10 × 30	00	138 14152	138 24152	—	—
	2200	12.5 × 30	01	138 14222	138 24222	—	—
	3300	15 × 30	02	138 14332	138 24332	—	—
	4700	18 × 30	03	138 14472	—	—	—
16	6800	18 × 40	04	138 14682	—	—	—
	10000	18 × 40	04	138 14103	—	—	—
	15000	21 × 40	05	138 14153	—	—	—
	22000	21 × 40	05	138 14153	—	—	—
16	22	6.3 × 12.7	(2)	—	138 25229	138 35229	—
	47	6.3 × 12.7	(2)	—	138 25479	138 35479	—
	100	7.7 × 12.7	(3)	—	138 25101	138 35101	—
	220	8 × 18	5	—	138 25221	138 35221	—
16	470	10 × 18	6	—	138 25471	138 35471	—
	1000	10 × 30	00	138 15102	138 25102	—	—
	1500	12.5 × 30	01	138 15152	138 25152	—	—
	2200	15 × 30	02	138 15222	138 25222	—	—
16	3300	18 × 30	03	138 15332	—	—	—
	4700	18 × 30	02	138 15222	—	—	—
	6300	18 × 30	03	138 15102	—	—	—
	10000	18 × 30	00	138 15152	138 25152	—	—
16	15000	21 × 40	05	138 14153	—	—	—
	22000	21 × 40	04	138 14103	—	—	—
	33000	21 × 40	04	138 14682	—	—	—
	47000	21 × 40	03	138 14472	—	—	—
16	63000	21 × 40	02	138 14332	—	—	—
	100000	21 × 40	01	138 14222	—	—	—
	150000	21 × 40	00	138 14152	—	—	—
	220000	21 × 40	7	—	—	—	—
16	470	8 × 18	5	—	138 24471	138 34471	—
	1000	10 × 25	4	—	138 24221	138 34221	—
	220	6.5 × 18	(3)	—	138 24151	138 34151	—
	150	7.7 × 12.7	(3)	—	138 24102	138 34102	—
16	1500	10 × 30	00	138 14152	138 24152	—	—
	2200	12.5 × 30	01	138 14222	138 24222	—	—
	3300	15 × 30	02	138 14332	138 24332	—	—
	4700	18 × 30	03	138 14472	—	—	—
16	6800	18 × 40	04	138 14682	—	—	—
	10000	18 × 40	04	138 14103	—	—	—
	15000	21 × 40	05	138 14153	—	—	—
	22000	21 × 40	05	138 14153	—	—	—
16	22	6.3 × 12.7	(2)	—	138 25229	138 35229	—
	47	6.3 × 12.7	(2)	—	138 25479	138 35479	—
	100	7.7 × 12.7	(3)	—	138 25101	138 35101	—
	220	8 × 18	5	—	138 25221	138 35221	—
16	470	10 × 18	6	—	138 25471	138 35471	—
	1000	10 × 30	00	138 15102	138 25102	—	—
	1500	12.5 × 30	01	138 15152	138 25152	—	—
	2200	15 × 30	02	138 15222	138 25222	—	—
16	3300	18 × 30	03	138 15332	—	—	—
	4700	18 × 30	02	138 15222	—	—	—
	6300	18 × 30	03	138 15102	—	—	—
	10000	18 × 30	00	138 15152	138 25152	—	—
16	15000	21 × 40	05	138 14153	—	—	—
	22000	21 × 40	04	138 14103	—	—	—
	33000	21 × 40	04	138 14682	—	—	—
	47000	21 × 40	03	138 14472	—	—	—
16	63000	21 × 40	02	138 14332	—	—	—
	100000	21 × 40	01	138 14222	—	—	—
	150000	21 × 40	00	138 14152	—	—	—
	220000	21 × 40	7	—	—	—	—
16	470	8 × 18	5	—	138 24471	138 34471	—
	1000	10 × 25	4	—	138 24221	138 34221	—
	220	6.5 × 18	(3)	—	138 24151	138 34151	—
	150	7.7 × 12.7	(3)	—	138 24102	138 34102	—
16	1500	10 × 30	00	138 14152	138 24152	—	—
	2200	12.5 × 30	01	138 14222	138 24222	—	—
	3300	15 × 30	02	138 14332	138 24332	—	—
	4700	18 × 30	03	138 14472	—	—	—
16	6800	18 × 40	04	138 14682	—	—	—
	10000	18 × 40	04	138 14103	—	—	—
	15000	21 × 40	05	138 14153	—	—	—
	22000	21 × 40	05	138 14153	—	—	—
16	22	6.3 × 12.7	(2)	—	138 25229	138 35229	—
	47	6.3 × 12.7	(2)	—	138 25479	138 35479	—
	100	7.7 × 12.7	(3)	—	138 25101	138 35101	—
	220	8 × 18	5	—	138 25221	138 35221	—
16	470	10 × 18	6	—	138 25471	138 35471	—
	1000	10 × 30	00	138 15102	138 25102	—	—
	1500	12.5 × 30	01	138 15152	138 25152	—	—
	2200	15 × 30	02	138 15222	138 25222	—	—
16	3300	18 × 30	03	138 15332	—	—	—
	4700	18 × 30	02	138 15222	—	—	—
	6300	18 × 30	03	138 15102	—	—	—
	10000	18 × 30	00	138 15152	138 25152	—	—
16	15000	21 × 40	05	138 14153	—	—	—
	22000	21 × 40	04	138 14103	—	—	—
	33000	21 × 40	04	138 14682	—	—	—
	47000	21 × 40	03	138 14472	—	—	—
16	63000	21 × 40	02	138 14332	—	—	—
	100000	21 × 40	01	138 14222	—	—	—
	150000	21 × 40	00	138 14152	—	—	—
	220000	21 × 40	7	—	—	—	—
16	470	8 × 18	5	—	138 24471	138 34471	—
	1000	10 × 25	4	—	138 24221	138 34221	—
	220	6.5 × 18	(3)	—	138 24151	138 34151	—
	150	7.7 × 12.7	(3)	—	138 24102	138 34102	—
16	1500	10 × 30	00	138 14152	138 24152	—	—
	2200	12.5 × 30	01	138 14222	138 24222	—	—
	3300	15 × 30	02	138 14332	138 24332	—	—
	4700	18 × 30	03	138 14472	—	—	—
16	6800	18 × 40	04	138 14682	—	—	—
	10000	18 × 40	04	138 14103	—	—	—
	15000	21 × 40	05	138 14153	—	—	—
	22000	21 × 40	05	138 14153	—	—	—
16	22	6.3 × 12.7	(2)	—	138 25229	138 35229	—
	47	6.3 × 12.7	(2)	—	138 25479	138 35479	—
	100	7.7 × 12.7	(3)	—	138 25101	138 35101	—
	220	8 × 18	5	—	138 25221		

Aluminium electrolytic capacitors
Axial Miniature Long-Life

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ELECTRICAL DATA (continued)

Table 5 Electrical data continued; preferred types in bold

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing \times L$ (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
16	4700	18 × 30	1400	450	150	0.28	0.093	0.073	0.082
	6800	18 × 40	1800	660	220	0.28	0.062	0.048	0.065
	10000	21 × 40	2100	960	320	0.35	0.055	0.044	0.063
25	10	6.3 × 12.7	46	8	4.5	0.09	14	12	2.8
	22	6.3 × 12.7	61	14	5.1	0.14	10	5.5	2.5
	33	6.3 × 12.7	74	20	5.7	0.14	6.8	3.6	1.9
	47	7.7 × 12.7	96	27	6.4	0.14	4.7	2.6	1.0
	100	6.5 × 18	160	19	9.0	0.13	2.1	1.2	0.55
	220	10 × 18	270	37	15	0.13	0.94	0.55	0.27
	470	10 × 25	440	75	28	0.13	0.44	0.26	0.17
	680	10 × 30	500	110	38	0.14	0.32	0.20	0.18
	1000	12.5 × 30	670	150	54	0.14	0.22	0.14	0.13
	1500	15 × 30	890	230	79	0.15	0.16	0.105	0.105
	2200	18 × 30	1200	330	110	0.16	0.12	0.083	0.088
	3300	18 × 40	1600	500	170	0.17	0.08	0.055	0.069
	4700	18 × 40	1800	710	240	0.20	0.067	0.049	0.065
	6800	21 × 40	2100	1000	340	0.26	0.059	0.045	0.064
40	33	7.7 × 12.7	91	29	6.6	0.11	5.3	2.7	1.0
	47	6.5 × 18	120	15	7.8	0.10	3.4	1.9	0.65
	100	8 × 18	180	28	12	0.10	1.6	0.9	0.40
	220	10 × 25	350	57	22	0.10	0.72	0.41	0.20
	330	10 × 30	410	83	30	0.10	0.45	0.25	0.21
	470	12.5 × 30	550	120	42	0.10	0.33	0.18	0.16
	680	12.5 × 30	650	170	58	0.11	0.25	0.145	0.13
	1000	15 × 30	840	240	84	0.11	0.17	0.105	0.097
	1500	18 × 30	1100	360	120	0.12	0.13	0.085	0.087
	2200	18 × 40	1500	530	180	0.13	0.09	0.055	0.070
	3300	21 × 40	1700	800	270	0.15	0.075	0.052	0.069
50	10	6.3 × 12.7	51	13	5.0	0.09	14	7	2.7
	22	7.7 × 12.7	82	25	6.2	0.09	6.5	3.2	1.1
	100	10 × 18	230	34	14	0.08	1.3	0.7	0.30

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ORDERING INFORMATION (continued)

Table 6 Ordering information continued; preferred types in bold

U _R (V)	C _R (µF) 100 Hz	NOMINAL CASE SIZE Ø × L (mm)	CASE CODE	CATALOGUE NUMBER 2222									
				AXIAL					MOUNTING RING FORM MR				
				TAPED ON REEL	TAPED IN BOX	SINGLE ENDED		SINGLE ENDED		SINGLE ENDED		SINGLE ENDED	
16	4700	18 × 30	03	138 15472	138 15103	05	138 15103	04	138 15682	138 45472	138 45682	138 45103	138 45103
16	10000	21 × 40	05	138 15103	138 15682	04	138 15682	05	138 15103	138 45472	138 45682	138 45103	138 45103
25	10	6.3 × 12.7	(2)	—	—	(2)	—	138 26109	138 36109	138 36229	138 36339	138 36479	138 36101
25	22	6.3 × 12.7	(2)	—	138 26229	(2)	138 26229	138 26339	138 26479	138 36221	138 36221	138 36471	138 36101
25	47	7.7 × 12.7	(3)	—	138 26479	(3)	138 26479	138 26101	138 26221	138 26471	138 26681	138 26102	138 26152
25	100	6.5 × 18	4	—	138 26101	4	138 26101	138 26221	138 26471	138 26681	138 26102	138 26152	138 26101
25	220	10 × 18	6	—	138 26221	6	138 26221	138 26471	138 26681	138 26102	138 26152	138 26101	138 26101
25	470	10 × 25	7	—	138 26471	7	138 26471	138 26681	138 26102	138 26152	138 26101	138 26221	138 26471
25	680	10 × 30	00	138 16681	138 16681	00	138 16681	138 16102	138 16152	138 16332	138 16472	138 16682	138 16682
25	1000	12.5 × 30	01	138 16102	138 16152	02	138 16152	138 16222	138 16332	138 16472	138 16682	138 16682	138 16682
25	1500	15 × 30	02	138 16152	138 16152	03	138 16222	138 16332	138 16472	138 16682	138 16682	138 16682	138 16682
25	2200	18 × 30	03	138 16222	138 16332	04	138 16332	138 16472	138 16682	138 16682	138 16682	138 16682	138 16682
25	3300	18 × 40	04	138 16332	138 16472	05	138 16472	138 16682	138 16682	138 16682	138 16682	138 16682	138 16682
25	4700	18 × 40	04	138 16472	138 16682	05	138 16682	138 16682	138 16682	138 16682	138 16682	138 16682	138 16682
25	6800	21 × 40	05	138 16682	138 16682	06	138 16682	138 16682	138 16682	138 16682	138 16682	138 16682	138 16682
40	33	7.7 × 12.7	(3)	—	138 27339	(3)	—	138 27339	138 37339	138 37339	138 37339	138 37339	138 37339
40	47	6.5 × 18	4	—	138 27479	4	—	138 27479	138 37479	138 37479	138 37479	138 37479	138 37479
40	100	8 × 18	5	—	138 27101	5	—	138 27101	138 37101	138 37101	138 37101	138 37101	138 37101
40	220	10 × 25	7	—	138 27221	7	—	138 27221	138 37221	138 37221	138 37221	138 37221	138 37221
40	330	10 × 30	00	138 17331	138 17331	00	138 17331	138 17681	138 27331	138 27331	138 27331	138 27331	138 27331
40	470	12.5 × 30	01	138 17471	138 17471	01	138 17471	138 27471	138 27471	138 27471	138 27471	138 27471	138 27471
40	680	12.5 × 30	01	138 17681	138 17681	01	138 17681	138 27681	138 27681	138 27681	138 27681	138 27681	138 27681
40	1000	15 × 30	02	138 17102	138 17152	02	138 17152	138 27102	138 27102	138 27102	138 27102	138 27102	138 27102
40	1500	18 × 30	03	138 17152	138 17152	03	138 17152	138 27152	138 27152	138 27152	138 27152	138 27152	138 27152
40	2200	18 × 40	04	138 17222	138 17332	04	138 17332	138 27332	138 27332	138 27332	138 27332	138 27332	138 27332
40	3300	21 × 40	05	138 17332	138 17332	05	138 17332	138 27332	138 27332	138 27332	138 27332	138 27332	138 27332
50	10	6.3 × 12.7	(2)	—	138 21109	(2)	—	138 21109	138 31109	138 31109	138 31109	138 31109	138 31109
50	22	7.7 × 12.7	(3)	—	138 21229	(3)	—	138 21229	138 31229	138 31229	138 31229	138 31229	138 31229
50	100	10 × 18	6	—	138 21101	6	—	138 21101	138 31101	138 31101	138 31101	138 31101	138 31101

Aluminium electrolytic capacitors
Axial Miniature Long-Life

ELECTRICAL DATA (continued)

Table 7 Electrical data continued; preferred types in bold

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
63	4.7	6.3 $\times$ 12.7	35	9	4.6	0.09	30	17	5
	10	7.7 $\times$ 12.7	59	16	5.3	0.08	13	8	1.8
	22	6.5 $\times$ 18	100	12	6.8	0.07	5.1	3.6	0.85
	47	8 $\times$ 18	150	22	9.9	0.07	2.4	1.7	0.50
	100	10 $\times$ 25	280	42	17	0.07	1.1	0.8	0.27
	150	10 $\times$ 30	340	61	23	0.11	0.73	0.41	0.31
	220	12.5 $\times$ 30	470	88	32	0.11	0.50	0.28	0.22
	330	12.5 $\times$ 30	570	130	46	0.12	0.37	0.22	0.18
	470	15 $\times$ 30	730	180	63	0.12	0.26	0.15	0.14
	680	18 $\times$ 30	930	260	90	0.12	0.19	0.12	0.11
	1000	18 $\times$ 40	1300	380	130	0.12	0.13	0.08	0.09
	1500	21 $\times$ 40	1600	570	190	0.13	0.10	0.07	0.08
100	1.0	6.3 $\times$ 12.7	16	5	4.2	0.09	140	55	10
	2.2	6.3 $\times$ 12.7	24	7	4.4	0.09	65	25	8
	4.7	7.7 $\times$ 12.7	40	12	4.9	0.08	27	17	5
	10	6.5 $\times$ 18	67	10	6.0	0.07	11	8	2.4
	22	8 $\times$ 18	100	17	8.4	0.07	5.1	3.6	1.4
	47	10 $\times$ 25	190	32	13	0.07	2.4	1.7	0.67
	68	10 $\times$ 30	220	45	18	0.07	1.7	1.1	0.97
	100	12.5 $\times$ 30	290	64	24	0.07	1.1	0.77	0.67
	150	15 $\times$ 30	390	94	34	0.07	0.78	0.52	0.46
	220	15 $\times$ 30	470	140	48	0.07	0.54	0.37	0.33
	330	18 $\times$ 30	620	200	70	0.08	0.38	0.27	0.24
	470	18 $\times$ 40	840	290	98	0.08	0.27	0.19	0.17
	680	21 $\times$ 40	1100	410	140	0.09	0.21	0.14	0.14

Aluminium electrolytic capacitors
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ORDERING INFORMATION (continued)

Table 8 Ordering information continued; preferred types in bold

U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	AXIAL			MOUNTING RING FORM MR
				TAPED IN BOX FORM BA	TAPED ON REEL FORM BR	IN BOX FORM AA	
				CATALOGUE NUMBER 2222			
63	4.7	6.3 × 12.7	(2)	—	138 28478	138 38478	—
	10	7.7 × 12.7	(3)	—	138 28109	138 38109	—
	22	6.5 × 18	4	—	138 28229	138 38229	—
	47	8 × 18	5	—	138 28479	138 38479	—
	100	10 × 25	7	—	138 28101	138 38101	—
	150	10 × 30	00	138 18151	138 28151	—	—
	220	12.5 × 30	01	138 18221	138 28221	138 28221	—
	330	12.5 × 30	01	138 18331	138 28331	138 28331	—
	470	15 × 30	02	138 18471	138 28471	138 28471	—
	680	18 × 30	03	138 18681	—	—	—
	1000	18 × 40	04	138 18102	—	—	—
	1500	21 × 40	05	138 18152	—	—	—
100	1.0	6.3 × 12.7	(2)	—	138 29108	138 39108	—
	2.2	6.3 × 12.7	(2)	—	138 29228	138 39228	—
	4.7	7.7 × 12.7	(3)	—	138 29478	138 39478	—
	10	6.5 × 18	4	—	138 29109	138 39109	—
	22	8 × 18	5	—	138 29229	138 39229	—
	47	10 × 25	7	—	138 29479	138 39479	—
	68	10 × 30	00	138 19689	138 29689	—	—
	100	12.5 × 30	01	138 19101	138 29101	—	—
	150	15 × 30	02	138 19151	138 29151	—	—
	220	15 × 30	02	138 19221	138 29221	—	—
	330	18 × 30	03	138 19331	—	—	—
	470	18 × 40	04	138 19471	—	—	—
680	21 × 40	05	138 19681	—	—	—	

Aluminium electrolytic capacitors

Axial Miniature Long-Life

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ELECTRICAL DATA (continued)

Additional electrical data

PARAMETER	CONDITIONS	VALUE	
		AXIAL	SINGLE ENDED

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

Current			
Leakage current	after 1 minute at U_R :	$I_L \leq 0.02C_R \times U_R + 3\text{ }\mu\text{A}$	
	after 5 minutes at U_R	$I_L \leq 0.006C_R \times U_R + 4\text{ }\mu\text{A}$	

Inductance			
Equivalent series inductance (ESL)	case $\varnothing D \times L$ mm:		
		typ. 20 nH	typ. 39 nH
		typ. 30 nH	typ. 39 nH
		typ. 15 nH	typ. 39 nH
		typ. 35 nH	typ. 39 nH
		typ. 69 nH	typ. 39 nH
		typ. 38 nH	typ. 39 nH
		typ. 38 nH	typ. 39 nH
		typ. 46 nH	typ. 39 nH
		typ. 48 nH	typ. 39 nH
		typ. 50 nH	typ. 39 nH
		typ. 54 nH	typ. 39 nH
		typ. 59 nH	typ. 39 nH

MARKING

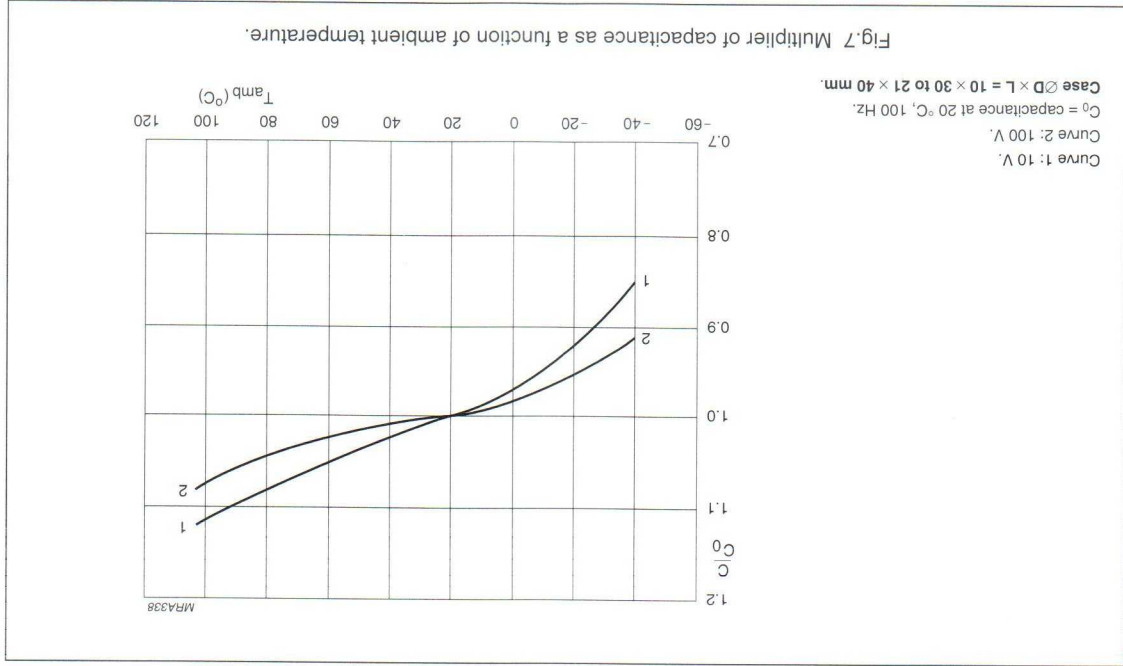
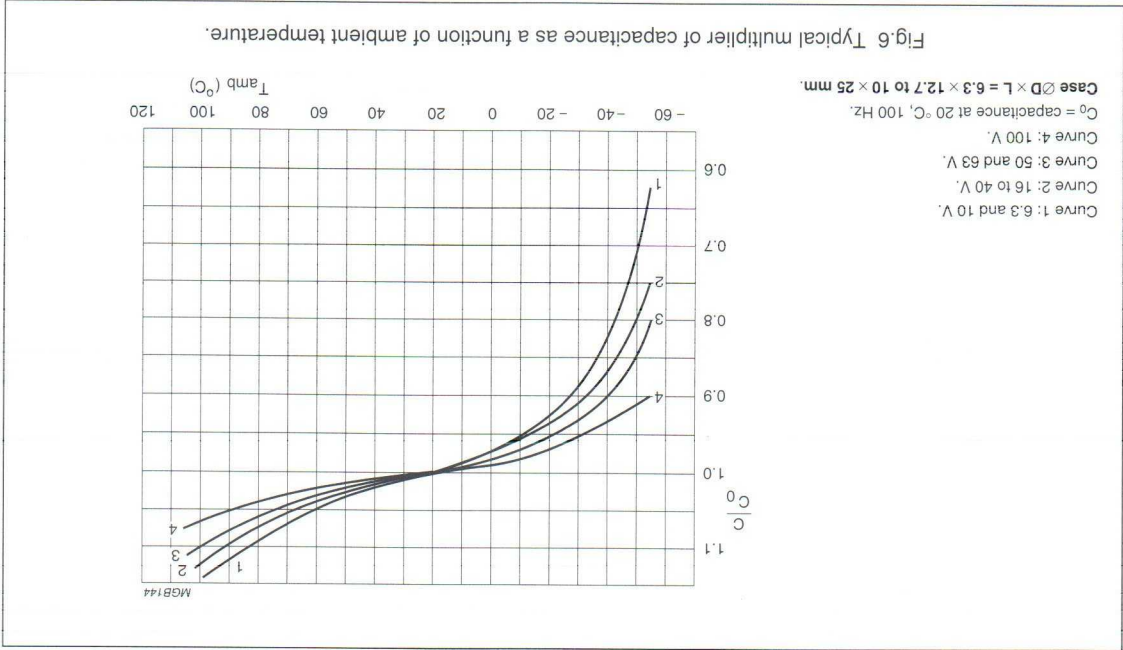
The capacitors are marked (where possible) with the following information:

- 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 indicate the negative terminal
- '+' sign to identify the positive terminal (not for case sizes L < 18 mm).

Aluminium electrolytic capacitors
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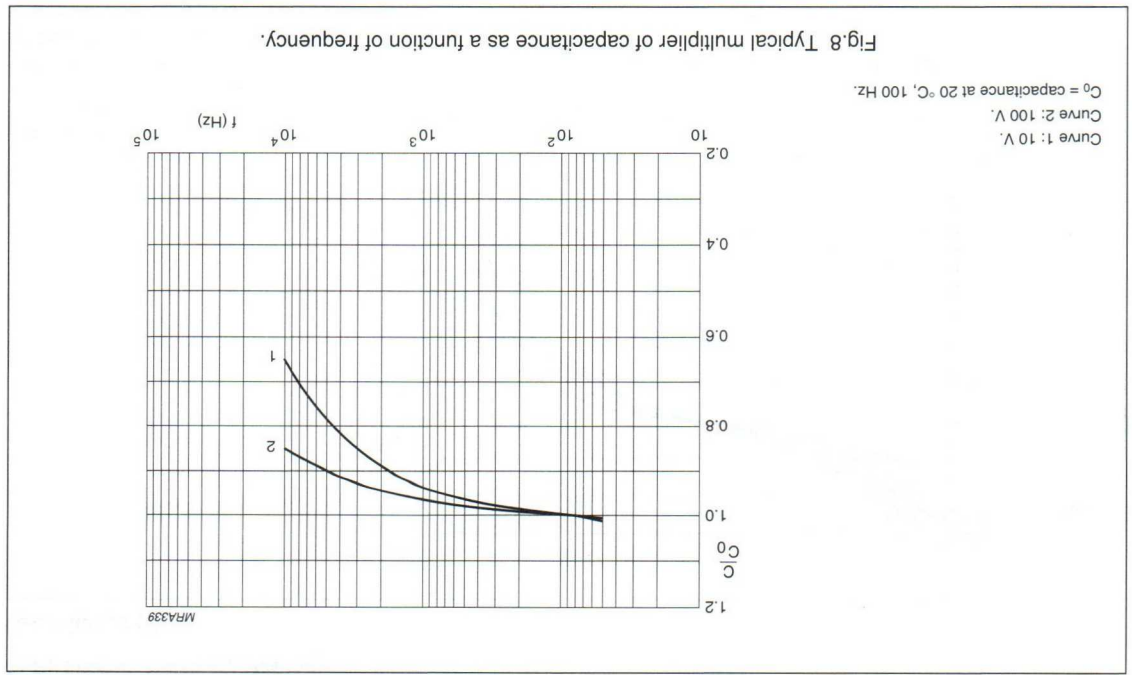
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ELECTRICAL DATA (continued)
Capacitance (C)



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Axial Miniature Long-Life

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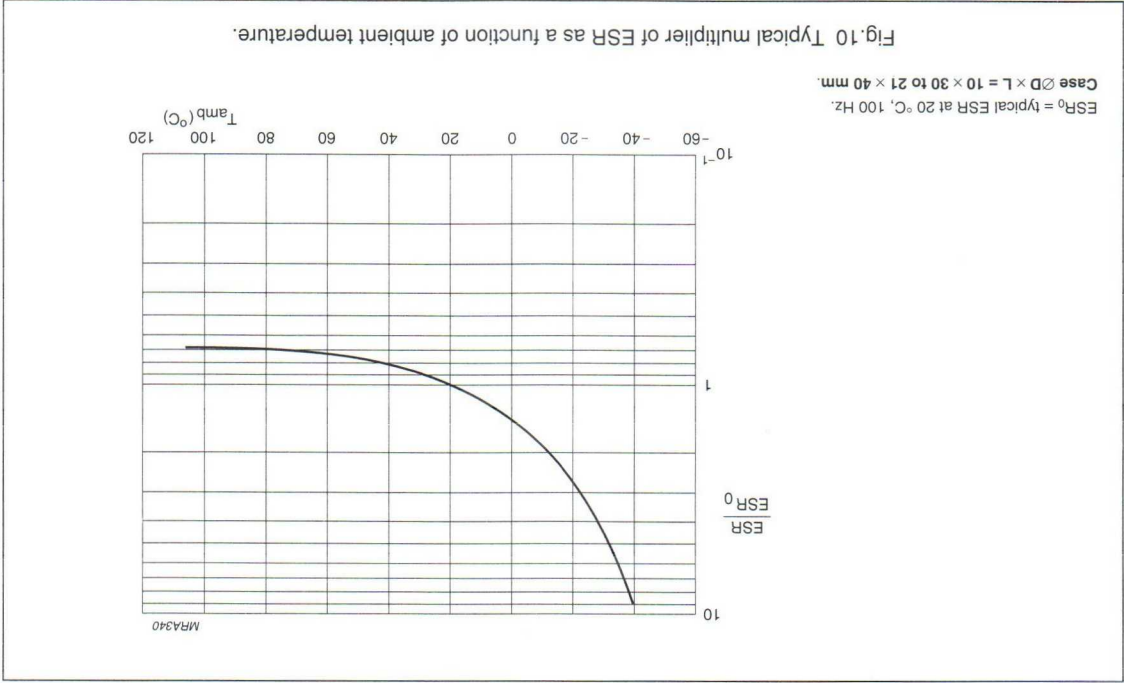
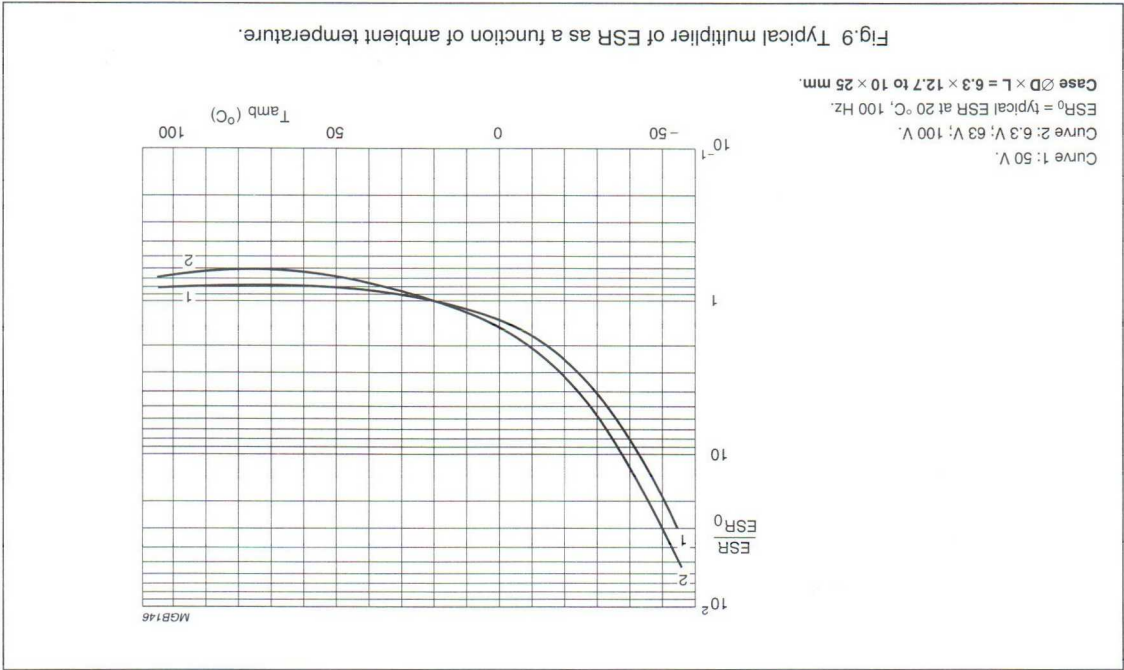


Aluminium electrolytic capacitors

Axial Miniature Long-Life

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Equivalent series resistance (ESR)



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Fig. 11 Typical multiplier of ESR as a function of frequency.

Curve 1: 6.3 V
Curve 2: 100 V.
 ESR_0 = typical ESR at 20 °C, 100 Hz.
Case $\varnothing D \times L = 6.3 \times 12.7$ to 10×25 mm.

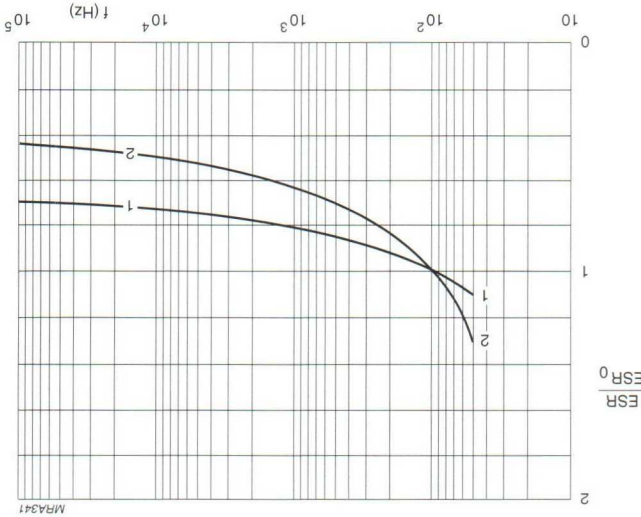


Fig. 12 Typical multiplier of ESR as a function of frequency.

Curve 1: 10 V
Curve 2: 100 V.
 ESR_0 = typical ESR at 20 °C, 100 Hz.
Case $\varnothing D \times L = 10 \times 30$ to 21×40 mm.

Aluminium electrolytic capacitors

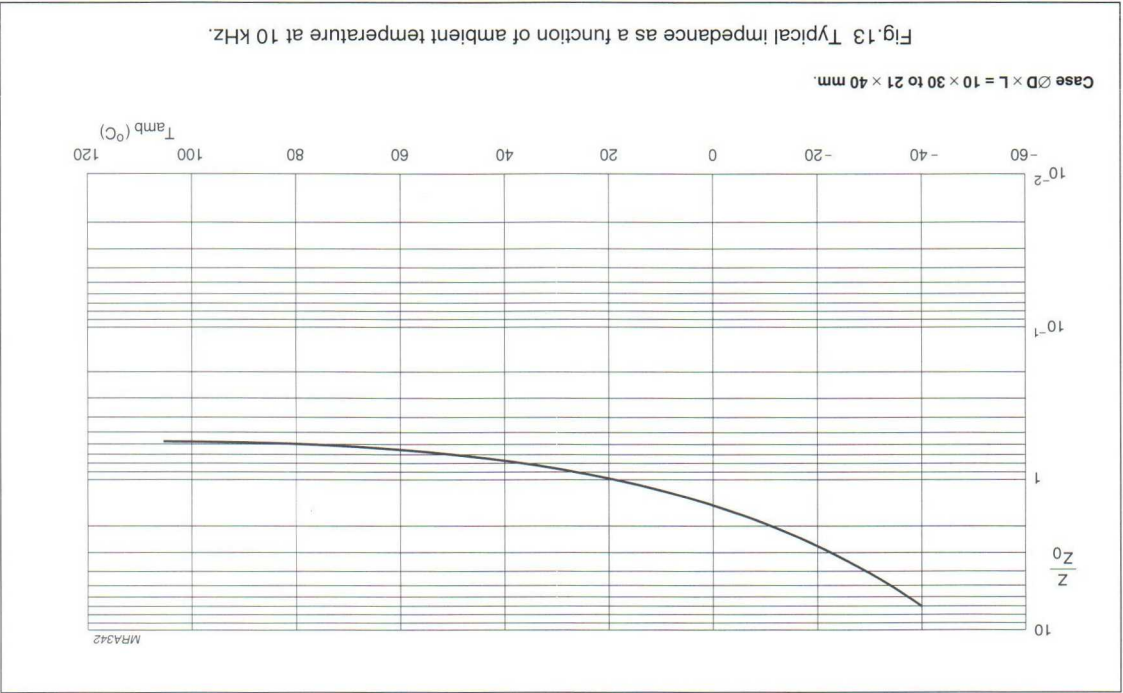
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Impedance (Z)

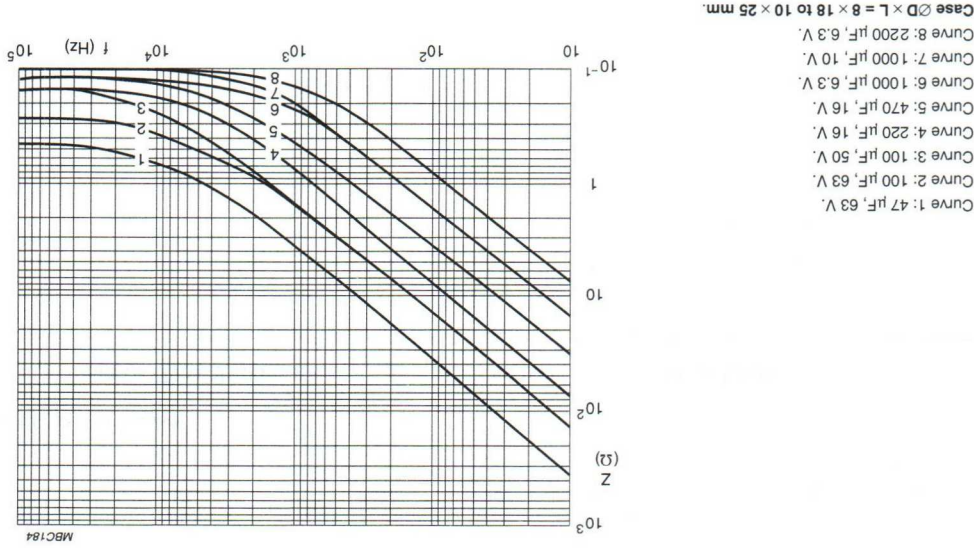
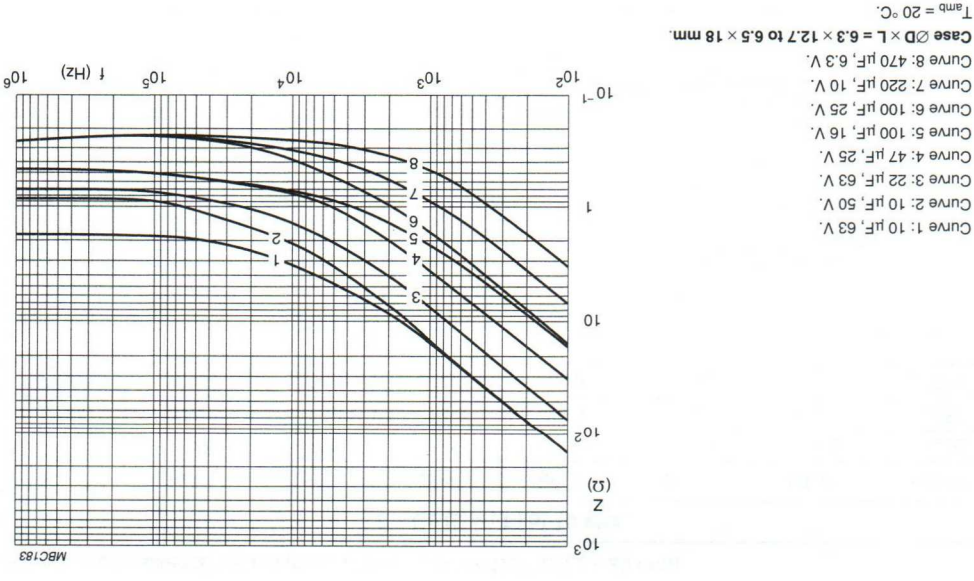
Table 9 Impedance × capacitance values (case Ø × L = 6.3 × 12.7 to 10 × 25 mm)

T _{amb}	Z × 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



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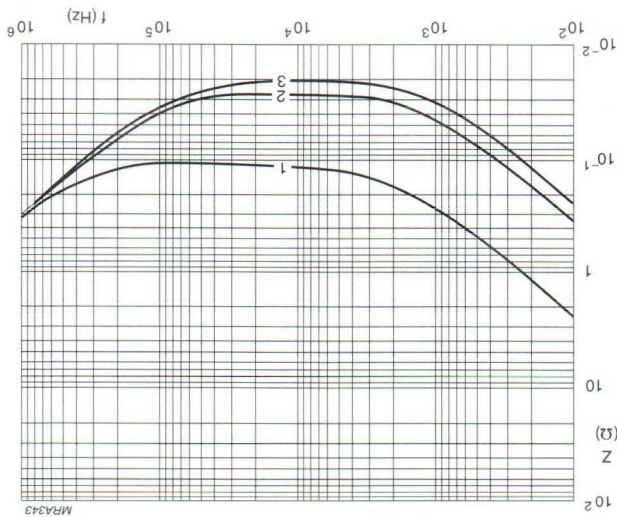


Fig.16 Typical impedance as a function of frequency.

$T_{amb} = 20^{\circ}C$.
Case $\varnothing D \times L = 10 \times 30$ to 21×40 mm.
 Curve 3: 6800 μF , 25 V.
 Curve 2: 4700 μF , 25 V.
 Curve 1: 680 μF , 25 V.

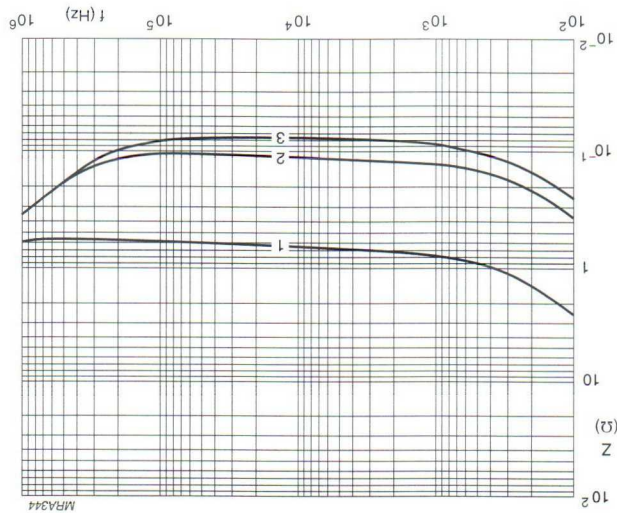


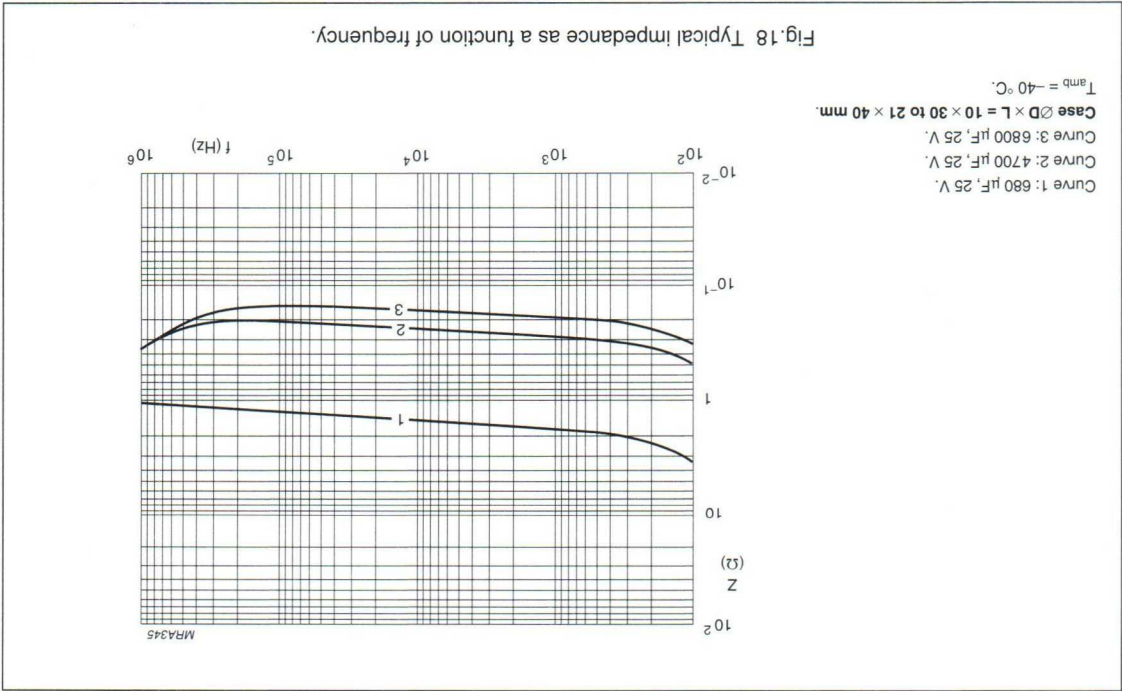
Fig.17 Typical impedance as a function of frequency.

$T_{amb} = -25^{\circ}C$.
Case $\varnothing D \times L = 10 \times 30$ to 21×40 mm.
 Curve 3: 6800 μF , 25 V.
 Curve 2: 4700 μF , 25 V.
 Curve 1: 680 μF , 25 V.

Aluminium electrolytic capacitors

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RIPPLE CURRENT AND USEFUL LIFE

Table 10 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_R = ripple current at $105^{\circ}C$, 100 Hz; see Fig.19

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3$ to 10 V	$U_R = 16$ to 25 V	$U_R = 40$ to 100 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1 000	1.12	1.2	1.3
3 000	1.15	1.25	1.35
$\geq 10 000$	1.2	1.3	1.4

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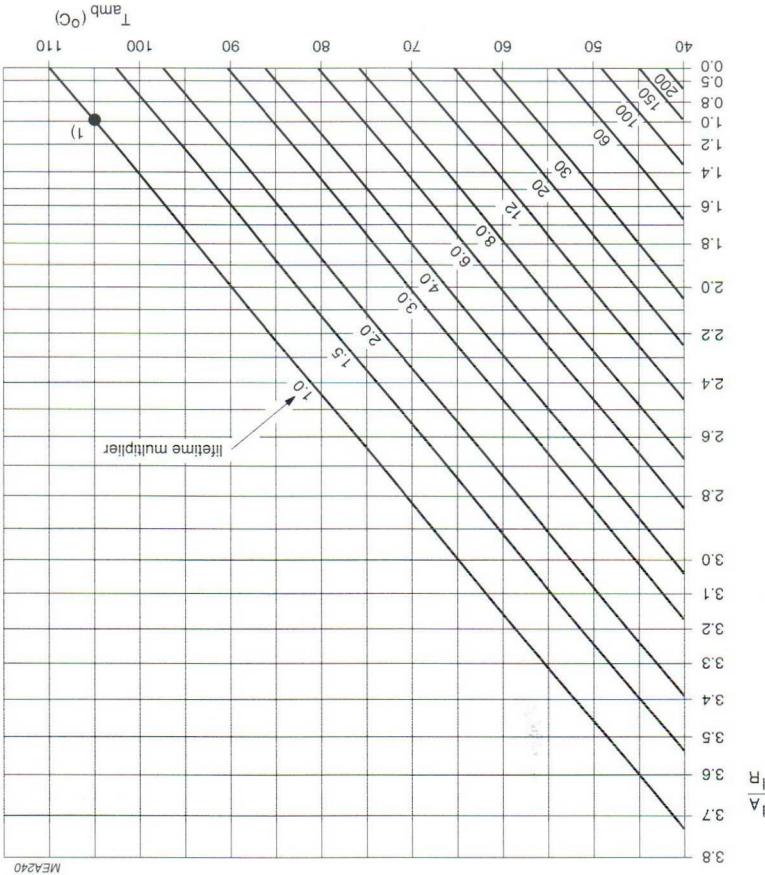


Fig. 19 Multiplier of useful life as a function of ambient temperature and ripple current load; see Table 10.

(1) Useful life at $105^{\circ}C$ and I_R applied:
 $\text{case } \varnothing D \times L = 6.3 \times 12.7 \text{ to } 10 \times 25 \text{ mm: } 2000 \text{ hours}$
 $\text{case } \varnothing D \times L = 10 \times 30 \text{ to } 21 \times 40 \text{ mm: } 1000 \text{ hours}$

I_A = actual ripple current at 100 Hz.
 I_R = rated ripple current at 100 Hz, $105^{\circ}C$.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 11 Test procedures and requirements

TEST	NAME OF TEST		PROCEDURE (quick reference)	REQUIREMENTS
	REFERENCE			
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105^{\circ}\text{C}$; U_R applied; 6.3×12.7 to 10×25 mm: 1 000 hours; 10×30 to 21×40 mm: 5000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +15/-30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$	
	CECC 30301 subclause 1.8.1	$T_{amb} = 105^{\circ}\text{C}$; U_R and I_R applied; 6.3×12.7 to 10×25 mm: 2000 hours; 10×30 to 21×40 mm: 10000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +45/-50% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$	
Useful life				
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300, subclause 4.17	$T_{amb} = 105^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$	

Aluminium electrolytic capacitors
Axial Miniature Long-Life

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NOTES

Aluminum electrolytic capacitors
Axial Long Life, DIN-based

132/133 ALL-DIN

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 $\varnothing 10 \times 30$ to 21×40 mm with pressure relief
- Taped versions up to $\varnothing 15 \times 30$ mm available for automatic insertion
- Charge and discharge proof
- Long useful life: 10000 to 15000 hours at 85 °C, high reliability
- High ripple current capability.

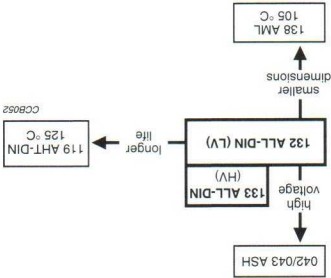
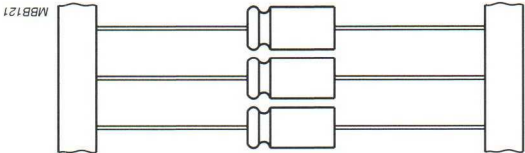
APPLICATIONS

- General industrial, power supplies, telecommunication, EDP
- Coupling, decoupling, timing; smoothing, filtering and buffering in SMPS
- For use where low mounting height is important
- Vibration and shock resistant.

QUICK REFERENCE DATA

DESCRIPTION		VALUE		
Case sizes ($\varnothing^{\text{nom}} \times L^{\text{nom}}$ in mm)		6,5 × 18 and 8 × 18	10 × 18 and 10 × 25	10 × 30 to 21 × 40
Rated capacitance range, C _R		1 to 4700 µF		
Tolerance on C _R		-10 to +50%		
Rated voltage range, U _R		10 to 350 V		
Category temperature range		-40 to +85 °C		
Endurance test at 105 °C	2000 hours	2000 hours	2000 hours	—
Endurance test at 85 °C	6000 hours	8000 hours	8000 hours	8000 hours
Useful life at 105 °C	3000 hours	3000 hours	3000 hours	—
Useful life at 85 °C	10000 hours	15000 hours	15000 hours	15000 hours
Useful life at 40 °C, 1,8 × I _R applied	160000 hours	240000 hours	240000 hours	240000 hours
Shelf life at 0 V, 85 °C		500 hours		
Based on sectional specification		IEC 384-4/CECC 30300		
Detail specification		UTE C031/C033 (without approval)		
Climatic category IEC 68		40/085/56		

Fig.1 Component outlines.



Aluminium electrolytic capacitors

Axial Long Life, DIN-based

132/133 ALL-DIN

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)

Preferred types in bold

C_R (μF)	U_R (V)						
	10	16	25	40	63	100	160
1.0	—	—	—	—	6.5 × 18	—	—
2.2	—	—	—	—	6.5 × 18	6.5 × 18	8 × 18
4.7	—	—	—	—	6.5 × 18	6.5 × 18	8 × 18
10	—	—	—	—	6.5 × 18	8 × 18	10 × 18
	—	—	—	—	—	10 × 18	12.5 × 30 (1)
22	—	—	6.5 × 18	—	8 × 18	10 × 18	12.5 × 30 (1)
	—	—	—	—	—	10 × 30 (1)	—
47	—	6.5 × 18	—	8 × 18	10 × 18	10 × 25	15 × 30 (1)
	—	—	—	—	—	—	—
68	—	—	—	—	10 × 30	12.5 × 30	15 × 30 (1)
100	—	8 × 18	—	10 × 18	10 × 30	15 × 30	18 × 30 (1)
150	—	—	—	12.5 × 30	15 × 30	18 × 30	18 × 40 (1)
220	—	8 × 18	10 × 18	10 × 25	12.5 × 30	15 × 30	21 × 40 (1)
	—	—	—	12.5 × 30	—	—	—
330	—	—	10 × 25	12.5 × 30	15 × 30	18 × 30	—
	—	—	—	—	—	—	—
470	—	12.5 × 30	10 × 25	12.5 × 30	15 × 30	18 × 40	—
	—	—	—	—	—	—	—
680	12.5 × 30	15 × 30	18 × 30	18 × 30	21 × 40	—	—
1 000	15 × 30	18 × 30	18 × 30	18 × 30	21 × 40	—	—
1 500	18 × 30	18 × 30	18 × 30	21 × 40	—	—	—
2 200	18 × 30	18 × 40	21 × 40	—	—	—	—
3 300	18 × 40	21 × 40	—	—	—	—	—
4 700	21 × 40	—	—	—	—	—	—

Note

1. For these CV-values see data sheet "041-043 ASH".

Aluminium electrolytic capacitors
Axial Long Life, DIN-based

132/133 ALL-DIN

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

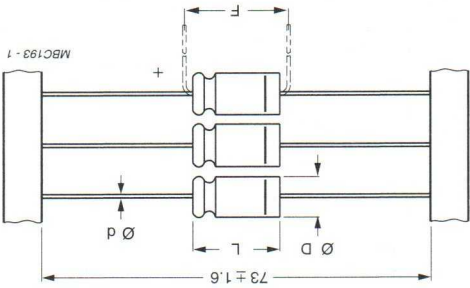


Fig.2 Dimensional outline: Forms BA and BR.
Dimensions in mm.
Form BR: Taped on reel,
case $\varnothing D \times L = 6.5 \times 18$ to 15×30 mm.
Form BA: Taped in box (ammopack),
case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm.
For dimensions see Table 1.
Tape dimensions are specified in this handbook, Section "Packaging".

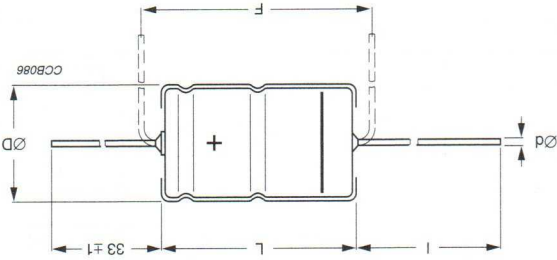


Fig.3 Dimensional outline: Form AA.

Dimensions in mm.
Form AA: Axial in box,
case $\varnothing D \times L = 10 \times 30$ to 21×40 mm.
For case sizes 18×40 mm and 21×40 mm, the stated L may be exceeded by 0.7 mm.
For dimensions see Table 1.

Aluminium electrolytic capacitors

Axial Long Life, DIN-based

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Table 1 Axial; physical dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	AXIAL: FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		$\varnothing d$ (mm)	l (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F_{min} (mm)		FORM AA	FORM BA	FORM BR
6,5 × 18	4	0,8	—	6,9	18,5	25	≈1,3	—	1 000	1 000
8 × 18	5	0,8	—	8,5	18,5	25	≈1,7	—	500	500
10 × 18	6	0,8	—	10,5	18,5	25	≈2,5	—	500	500
10 × 25	7	0,8	—	10,5	25,0	30	≈3,3	—	500	500
10 × 30	00	0,8	55 ±1	10,5	30,5	35	≈4,8	200	—	500
12,5 × 30	01	0,8	55 ±1	13,0	30,5	35	≈7,4	200	—	400
15 × 30	02	0,8	55 ±1	15,5	30,5	35	≈11,7	200	—	250
18 × 30	03	0,8	55 ±1	18,5	30,5	35	≈12,9	200	—	—
18 × 40	04	0,8	34 ±1	18,5	41,5	45	≈19,4	100	—	—
21 × 40	05	0,8	34 ±1	21,5	41,5	45	≈24,7	100	—	—

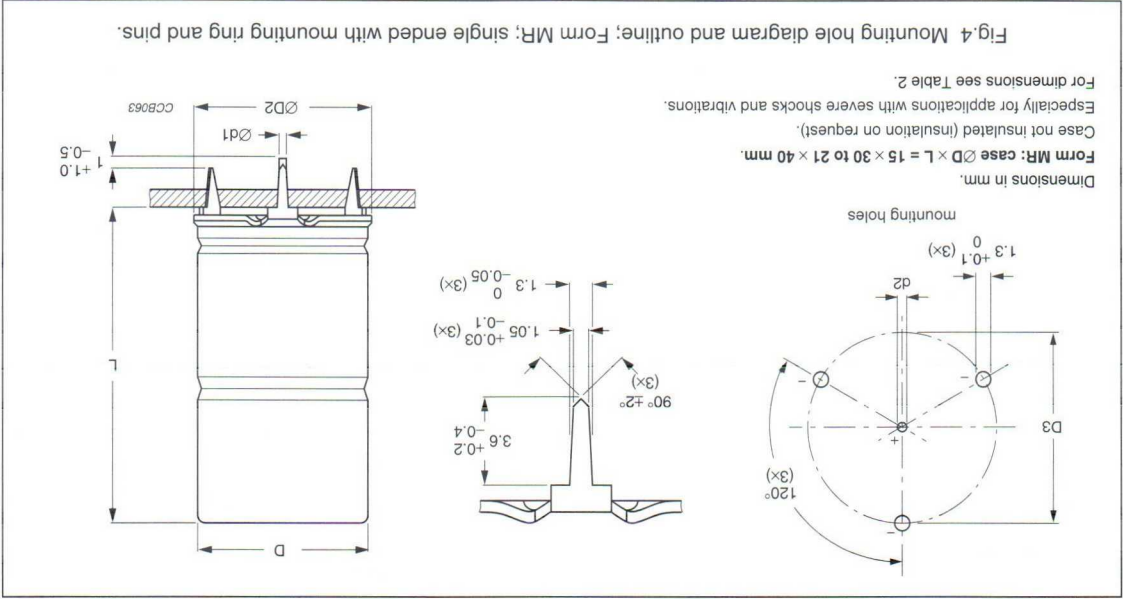


Table 2 Single ended; physical dimensions, mass and packaging quantities; see Fig.4

NOMINAL CASE SIZE Ø D × L (mm)	CASE CODE	Ød1 (mm)	Ød2 (mm)	ØD _{max} (mm)	ØD2 _{max} (mm)	D3 (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES
		SINGLE ENDED WITH MOUNTING RING: FORM MR							
15 × 30	02	0.8	1.0 +0.4	15.5	17.5	16.5 ±0.2	33	≈11.7	200
18 × 30	03	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	33	≈12.9	200
18 × 40	04	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	45	≈19.4	100
21 × 40	05	0.8	1.0 +0.4	21.5	22.5	21.5 ±0.2	45	≈24.7	100

Aluminium electrolytic capacitors
Axial Long Life, DIN-based

132/133 ALL-DIN

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 3, 5, 7 and 9 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

SYMBOL	DESCRIPTION
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 3 Electrical data; preferred types in bold

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE ØD × 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)
16	47	6.5 × 18	95	11	5.5	0.14	4.7	2.6	2.2
	100	8 × 18	150	19	7.2	0.14	2.2	1.2	1.1
	220	10 × 18	250	38	11	0.14	1.0	0.55	0.55
	330	10 × 25	320	56	14.6	0.14	0.67	0.36	0.36
	470	12.5 × 30	450	78	19	0.14	0.47	0.26	0.26
	680	15 × 30	550	69	22	0.14	0.33	0.14	—
	1 000	15 × 30	780	100	32	0.14	0.22	0.10	—
	1 500	18 × 30	950	150	48	0.15	0.16	0.06	—
	2 200	15 × 40	1 300	220	70	0.15	0.11	0.05	—
	3 300	21 × 40	1 600	320	110	0.15	0.07	0.05	—
	4 700	21 × 40	2 300	460	150	0.15	0.05	0.05	—
10	220	8 × 18	190	25	8.4	0.18	1.3	0.73	0.70
	470	12.5 × 30	350	32	9.4	0.18	0.61	0.26	0.60
	680	12.5 × 30	460	45	13.6	0.18	0.42	0.20	0.40
	1 000	15 × 30	640	64	20	0.18	0.28	0.12	—
	1 500	18 × 30	800	94	30	0.22	0.23	0.10	—
	2 200	18 × 30	1 100	140	44	0.22	0.16	0.09	—
	3 300	18 × 40	1 300	200	66	0.27	0.13	0.05	—
	4 700	21 × 40	1 800	290	94	0.27	0.09	0.05	—

Aluminium electrolytic capacitors
Axial Long Life, DIN-based
132/133 ALL-DIN

ORDERING INFORMATION

Ordering example

Electrolytic capacitor 132 series

100 µF/40 V; -10/+50%

Nominal case size: Ø10 × 18 mm; Form BR

Catalogue number: 2222 132 27101.

Table 4 Ordering information; preferred types in bold

Ur (V)	Cr 100 Hz (µF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				AXIAL	SINGLE ENDED	
10	220	8 × 18	5	—	132 24221	132 34221
	470	12.5 × 30	01	132 14471	132 24471	—
	680	12.5 × 30	01	132 14681	132 24681	—
	1000	15 × 30	02	132 14102	132 24102	—
	1500	18 × 30	03	132 14152	—	—
	2200	18 × 30	03	132 14222	—	—
	3300	18 × 40	04	132 14332	—	—
	4700	21 × 40	05	132 14472	—	—
	4700	6.5 × 18	4	—	132 25479	132 35479
	100	8 × 18	5	—	132 25101	132 35101
16	220	10 × 18	6	—	132 25221	132 35221
	330	10 × 25	7	—	132 90508	132 90509
	330	12.5 × 30	01	132 15331	132 25331	—
	470	10 × 25	7	—	132 90507	132 90502
	470	12.5 × 30	01	132 15471	132 25471	—
	680	15 × 30	02	132 15681	132 25681	—
	1000	15 × 30	02	132 15102	132 25102	—
	1500	18 × 30	03	132 15152	—	—
	2200	15 × 40	04	132 15222	—	—
	3300	21 × 40	05	132 15472	—	—
47	100	8 × 18	5	—	132 25101	132 35101
	220	10 × 18	6	—	132 25221	132 35221
	330	10 × 25	7	—	132 90508	132 90509
	330	12.5 × 30	01	132 15331	132 25331	—
	470	10 × 25	7	—	132 90507	132 90502
	470	12.5 × 30	01	132 15471	132 25471	—
	680	15 × 30	02	132 15681	132 25681	—
	1000	15 × 30	02	132 15102	132 25102	—
	1500	18 × 30	03	132 15152	—	—
	2200	15 × 40	04	132 15222	—	—
132 45102	100	8 × 18	5	—	132 25101	132 35101
	220	10 × 18	6	—	132 25221	132 35221
	330	10 × 25	7	—	132 90508	132 90509
	330	12.5 × 30	01	132 15331	132 25331	—
	470	10 × 25	7	—	132 90507	132 90502
	470	12.5 × 30	01	132 15471	132 25471	—
	680	15 × 30	02	132 15681	132 25681	—
	1000	15 × 30	02	132 15102	132 25102	—
	1500	18 × 30	03	132 15152	—	—
	2200	15 × 40	04	132 15222	—	—
132 45102	100	8 × 18	5	—	132 25101	132 35101
	220	10 × 18	6	—	132 25221	132 35221
	330	10 × 25	7	—	132 90508	132 90509
	330	12.5 × 30	01	132 15331	132 25331	—
	470	10 × 25	7	—	132 90507	132 90502
	470	12.5 × 30	01	132 15471	132 25471	—
	680	15 × 30	02	132 15681	132 25681	—
	1000	15 × 30	02	132 15102	132 25102	—
	1500	18 × 30	03	132 15152	—	—
	2200	15 × 40	04	132 15222	—	—
132 45102	100	8 × 18	5	—	132 25101	132 35101
	220	10 × 18	6	—	132 25221	132 35221
	330	10 × 25	7	—	132 90508	132 90509
	330	12.5 × 30	01	132 15331	132 25331	—
	470	10 × 25	7	—	132 90507	132 90502
	470	12.5 × 30	01	132 15471	132 25471	—
	680	15 × 30	02	132 15681	132 25681	—
	1000	15 × 30	02	132 15102	132 25102	—
	1500	18 × 30	03	132 15152	—	—
	2200	15 × 40	04	132 15222	—	—

Aluminium electrolytic capacitors
Axial Long Life, DIN-based

132/133 ALL-DIN

ELECTRICAL DATA (continued)

Table 5 Electrical data continued; preferred types in bold

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
25	22	6.5 × 18	60	8.5	5.1	0.11	8.0	4.1	2.9
	220	10 × 25	340	58	15	0.11	0.8	0.40	0.40
	220	12.5 × 30	340	37	11	0.11	0.8	0.40	0.60
	330	12.5 × 30	410	54	16.5	0.11	0.53	0.30	0.40
	470	12.5 × 30	560	75	24	0.11	0.37	0.20	—
	680	18 × 30	700	106	34	0.11	0.26	0.10	—
	1000	18 × 30	1000	150	50	0.11	0.17	0.10	—
	1500	18 × 40	1100	230	75	0.12	0.13	0.06	—
	2200	21 × 40	1850	330	110	0.13	0.09	0.05	—
40	47	8 × 18	120	22	7.8	0.09	3.0	1.6	1.4
	100	10 × 18	210	43	12	0.09	1.4	0.75	0.75
	150	10 × 25	310	63	16	0.09	0.95	0.50	0.50
	150	12.5 × 30	310	40	12	0.09	0.95	0.50	0.60
	220	12.5 × 30	410	57	17.5	0.09	0.65	0.34	0.40
	330	15 × 30	550	83	26	0.09	0.43	0.20	—
	470	15 × 30	700	120	38	0.09	0.30	0.16	—
	680	18 × 30	900	170	54	0.09	0.21	0.10	—
	1000	18 × 40	1200	240	80	0.09	0.14	0.08	—
	1500	21 × 40	1500	360	120	0.10	0.10	0.06	—
	2200	21 × 40	1900	530	180	0.10	0.07	0.05	—

Aluminium electrolytic capacitors
Axial Long Life, DIN-based
132/133 ALL-DIN

ORDERING INFORMATION (continued)

Table 6 Ordering information continued; preferred types in bold

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			
				IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
25	22	6.5 × 18	4	—	132 26229	132 36229	—
	220	10 × 25	7	—	132 90503	132 90504	—
	220	12.5 × 30	01	132 16221	132 26221	—	—
	330	12.5 × 30	01	132 16331	132 26331	—	—
	470	12.5 × 30	01	132 16471	132 26471	—	—
	680	18 × 30	03	132 16681	—	—	132 46681
	1000	18 × 30	03	132 16102	—	—	132 46102
	1500	18 × 40	04	132 16152	—	—	132 46152
	2200	21 × 40	05	132 16222	—	—	132 46222
40	22	6.5 × 18	5	—	132 27479	132 37479	—
	100	10 × 18	6	—	132 27101	132 37101	—
	150	10 × 25	7	—	132 90511	132 90512	—
	150	12.5 × 30	01	132 17151	132 27151	—	—
	220	12.5 × 30	01	132 17221	132 27221	—	—
	330	15 × 30	02	132 17331	132 27331	—	132 47331
	470	15 × 30	02	132 17471	132 27471	—	132 47471
	680	18 × 30	03	132 17681	—	—	132 47681
	1000	18 × 40	04	132 17102	—	—	132 47102
	1500	21 × 40	05	132 17152	—	—	132 47152
	2200	21 × 40	05	132 17222	—	—	132 47222

Aluminium electrolytic capacitors
Axial Long Life, DIN-based

132/133 ALL-DIN

ELECTRICAL DATA (continued)

Table 7 Electrical data continued: preferred types in bold

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing \times L$ (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
63	4.7	6.5 × 18	38	6.0	4.6	0.07	24	12	5
	10	6.5 × 18	64	9.3	5.3	0.07	11	5.5	3.3
	22	8 × 18	100	17	6.8	0.07	5.1	2.5	2.1
	47	10 × 18	170	33	9.9	0.07	2.4	1.2	1.2
	68	10 × 25	210	46	12.6	0.07	1.6	0.81	0.60
	68	10 × 30	210	30	8.6	0.07	1.6	0.80	0.60
	100	10 × 30	300	42	12.6	0.07	1.1	0.60	0.40
	150	15 × 30	350	61	19	0.07	0.74	0.37	—
	220	15 × 30	520	87	28	0.07	0.50	0.25	—
	330	18 × 30	600	130	42	0.07	0.34	0.15	—
	470	18 × 40	970	180	59	0.07	0.24	0.12	—
	680	21 × 40	1000	260	86	0.07	0.16	0.08	—
1000	1000	21 × 40	1600	380	130	0.07	0.11	0.06	—
1	6.5 × 18	6.5 × 18	20	4.0	4.0	0.06	95	45	6
2.2	6.5 × 18	6.5 × 18	30	5.2	4.4	0.06	43	20	5
4.7	6.5 × 18	6.5 × 18	48	7.7	4.9	0.06	20	9.6	4
10	8 × 18	8 × 18	73	13	6	0.06	9.5	4.5	2.8
22	10 × 18	10 × 18	130	25	8.4	0.06	4.3	2	1.3
47	10 × 25	10 × 25	220	50	13.4	0.06	2.0	1	0.90
47	10 × 30	10 × 30	220	32	9.4	0.06	2.0	1	0.90
68	12.5 × 30	12.5 × 30	250	45	13.5	0.06	1.4	0.80	—
100	15 × 30	15 × 30	380	64	20	0.06	0.95	0.50	—
150	18 × 30	18 × 30	400	94	30	0.06	0.64	0.35	—
220	18 × 40	18 × 40	660	140	44	0.06	0.43	0.20	—
330	18 × 40	18 × 40	700	200	66	0.06	0.29	0.15	—
470	21 × 40	21 × 40	1200	290	94	0.06	0.20	0.10	—

Aluminium electrolytic capacitors
Axial Long Life, DIN-based

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ORDERING INFORMATION (continued)

Table 8 Ordering information continued; preferred types in bold

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE Ø D × L (mm)	CASE CODE	CATALOGUE NUMBER 2222		
				AXIAL		
				TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
63	4.7	6.5 × 18	4	132 28478	132 38478	—
	10	6.5 × 18	4	132 28109	132 38109	—
	22	8 × 18	5	132 28229	132 38229	—
	47	10 × 18	6	132 28479	132 38479	—
	68	10 × 25	7	132 90513	132 90514	—
	68	10 × 30	00	132 28689	—	—
	100	10 × 30	00	132 28101	—	—
	150	15 × 30	02	132 18151	—	—
	220	15 × 30	02	132 18221	132 28151	132 48151
	330	18 × 30	03	132 18331	—	132 48331
	470	18 × 40	04	132 18471	—	132 48471
	680	21 × 40	05	132 18681	—	132 48681
100	1	6.5 × 18	4	—	132 29108	132 39108
	2.2	6.5 × 18	4	—	132 29228	132 39228
	4.7	6.5 × 18	4	—	132 29478	132 39478
	10	8 × 18	5	—	132 29109	132 39109
	22	10 × 18	6	—	132 29229	132 39229
	47	10 × 25	7	—	132 90505	132 90506
	47	10 × 30	00	132 19479	132 29479	—
	68	12.5 × 30	01	132 19689	132 29689	—
	100	15 × 30	02	132 19101	132 29101	132 49101
	150	18 × 30	03	132 19151	—	132 49151
	220	18 × 40	04	132 19221	—	132 49221
	330	18 × 40	04	132 19331	—	132 49331
470	21 × 40	21 × 40	05	132 19471	—	132 49471

Aluminium electrolytic capacitors
Axial Long Life, DIN-based

ELECTRICAL DATA (continued)

Table 9 Electrical data continued; preferred types in bold

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing \times L$ (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
160	2.2	6.5 × 18	22	50	20	0.10	72	55	30
	4.7	8 × 18	37	50	20	0.10	34	26	20
	10	10 × 18	61	50	20	0.10	16	12	10
	22	10 × 25	120	50	20	0.10	7.2	5.5	2.5
250	2.2	8 × 18	25	50	20	0.10	72	50	30
	4.7	10 × 18	37	50	20	0.10	34	23	16
	10	10 × 25	66	50	20	0.10	16	11	9
350	1	6.5 × 18	15	50	20	0.10	160	100	40
	2.2	8 × 18	25	50	20	0.10	72	45	28
	4.7	10 × 18	43	50	20	0.10	34	21	15

Aluminium electrolytic capacitors

Axial Long Life, DIN-based

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ORDERING INFORMATION (continued)

Table 10 Ordering information continued; preferred types in bold

U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
				AXIAL			
				SINGLE ENDED			
CATALOGUE NUMBER 2222							
160	2.2	6.5 × 18	4	—	133 21228	133 31228	—
				—	133 21478	133 31478	—
				—	133 21109	133 31109	—
	10	10 × 18	6	—	133 90502	133 90503	—
				—	133 23228	133 33228	—
				—	133 23109	133 33109	—
250	2.2	8 × 18	5	—	133 25228	133 35228	—
				—	133 25478	133 35478	—
				—	133 25108	133 35108	—
350	1	6.5 × 18	4	—	133 25108	133 35108	—
				—	133 25228	133 35228	—
				—	133 25478	133 35478	—

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.

Aluminium electrolytic capacitors

Axial Long Life, DIN-based

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ELECTRICAL DATA (continued)

Additional electrical data

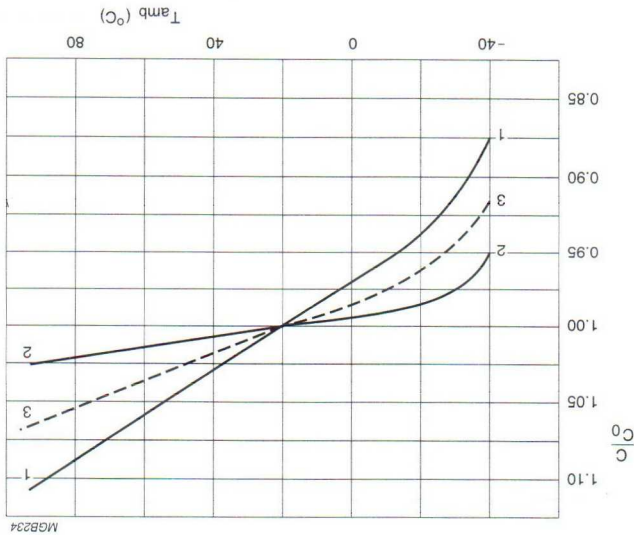
PARAMETER		CONDITIONS		VALUE	
Voltage				SINGLE ENDED	
				AXIAL	
Surge voltage for short periods		$U_R = 10 \text{ to } 250 \text{ V}$		$U_S \leq 1.15 \times U_R$	
Reverse voltage				$U_S \leq 1.1 \times U_R$	
Current				$U_{rev} \leq 1 \text{ V}$	
Leakage current	after 1 minute:	$\text{case } \varnothing \times L = 6.5 \times 18 \text{ to } 10 \times 25 \text{ mm:}$	$U_R = 10 \text{ to } 100 \text{ V}$	$I_{L1} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$	$I_{L1} \leq 50 \mu\text{A}$
	after 5 minutes:	$\text{case } \varnothing \times L = 6.5 \times 18 \text{ to } 10 \times 25 \text{ mm:}$	$U_R = 10 \text{ to } 100 \text{ V}$ $U_R = 160 \text{ to } 350 \text{ V}$ $\text{case } \varnothing \times L = 10 \times 30 \text{ to } 21 \times 40 \text{ mm:}$	$I_{L5} \leq 0.006 C_R \times U_R + 3 \mu\text{A}$	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$
Inductance		$\text{case } \varnothing \times L = 6.5 \times 18 \text{ to } 10 \times 25 \text{ mm:}$	$U_R = 10 \text{ to } 100 \text{ V}$ $U_R = 160 \text{ to } 350 \text{ V}$ $\text{case } \varnothing \times L = 10 \times 30 \text{ to } 21 \times 40 \text{ mm:}$	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$	$I_{L5} \leq 20 \mu\text{A}$
		$\text{case } \varnothing \times L = 6.5 \times 18 \text{ to } 10 \times 25 \text{ mm:}$	$U_R = 10 \text{ to } 100 \text{ V}$ $U_R = 160 \text{ to } 350 \text{ V}$ $\text{case } \varnothing \times L = 10 \times 30 \text{ to } 21 \times 40 \text{ mm:}$	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$	$I_{L5} \leq 20 \mu\text{A}$
Equivalent series inductance (ESL)		$\text{case } \varnothing \times L \text{ mm:}$	6.5×18 8×18 10×18 10×25 10×30 12.5×30 15×30 18×30 18×40 21×40	$\text{typ. } 15 \text{ nH}$ $\text{typ. } 35 \text{ nH}$ $\text{typ. } 69 \text{ nH}$ $\text{typ. } 38 \text{ nH}$ $\text{typ. } 38 \text{ nH}$ $\text{typ. } 46 \text{ nH}$ $\text{typ. } 48 \text{ nH}$ $\text{typ. } 50 \text{ nH}$ $\text{typ. } 54 \text{ nH}$ $\text{typ. } 59 \text{ nH}$	$\text{typ. } 39 \text{ nH}$ $\text{typ. } 39 \text{ nH}$ $\text{typ. } 39 \text{ nH}$ $\text{typ. } 39 \text{ nH}$ $\text{typ. } 39 \text{ nH}$ $\text{typ. } 39 \text{ nH}$ $\text{typ. } 39 \text{ nH}$ $\text{typ. } 39 \text{ nH}$ $\text{typ. } 39 \text{ nH}$ $\text{typ. } 39 \text{ nH}$

Aluminium electrolytic capacitors

Axial Long Life, DIN-based

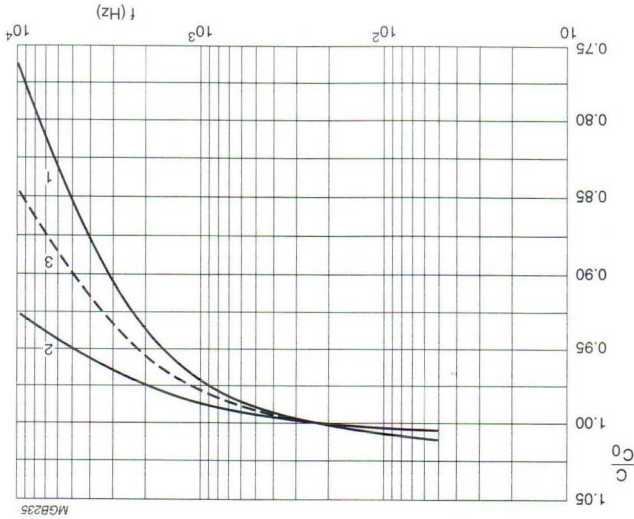
132/133 ALL-DIN

Capacitance (C)



Curve 1: 10 V.
Curve 2: 63 V.
Curve 3: ≥ 100 V.
 C_0 = capacitance at 20 °C, 100 Hz.

Fig.5 Typical multiplier of capacitance as a function of ambient temperature.



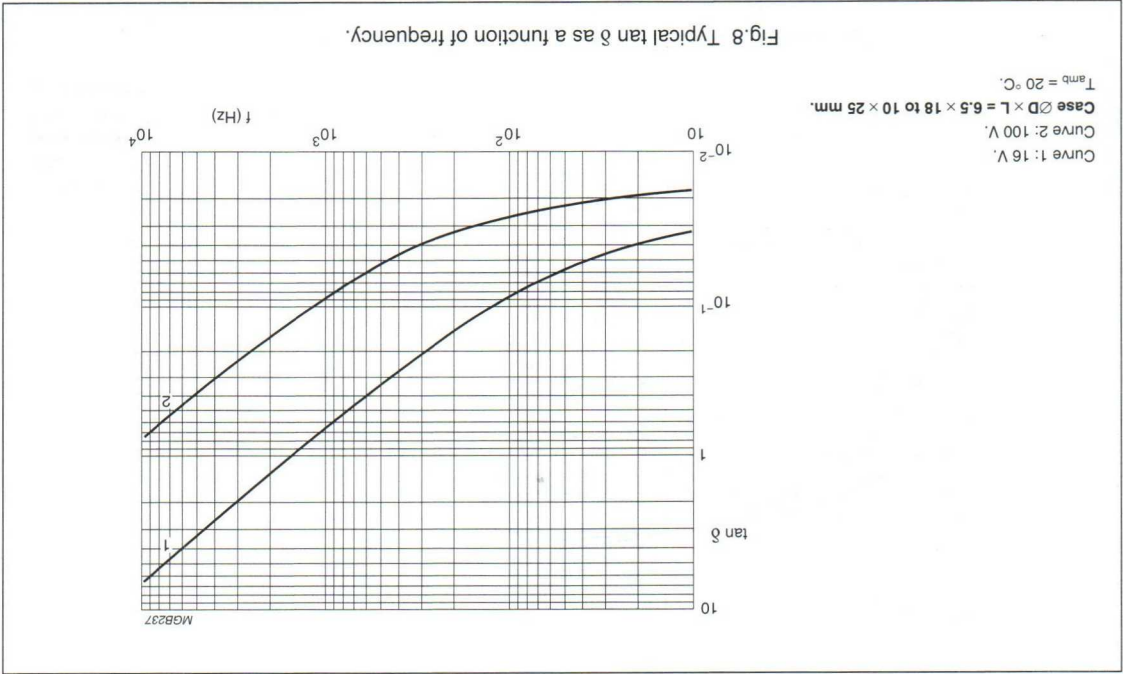
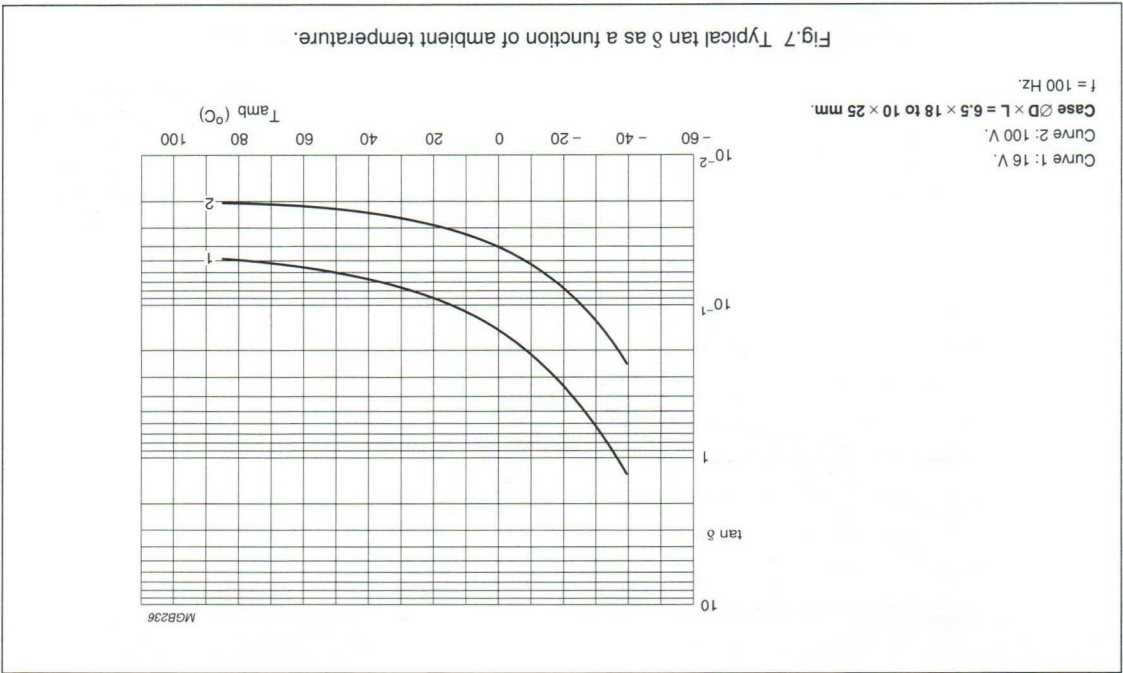
Curve 1: 10 V.
Curve 2: 63 V.
Curve 3: ≥ 100 V.
 C_0 = capacitance at 20 °C, 100 Hz.

Fig.6 Typical multiplier of capacitance as a function of frequency.

Aluminium electrolytic capacitors
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Dissipation factor ($\tan \delta$)

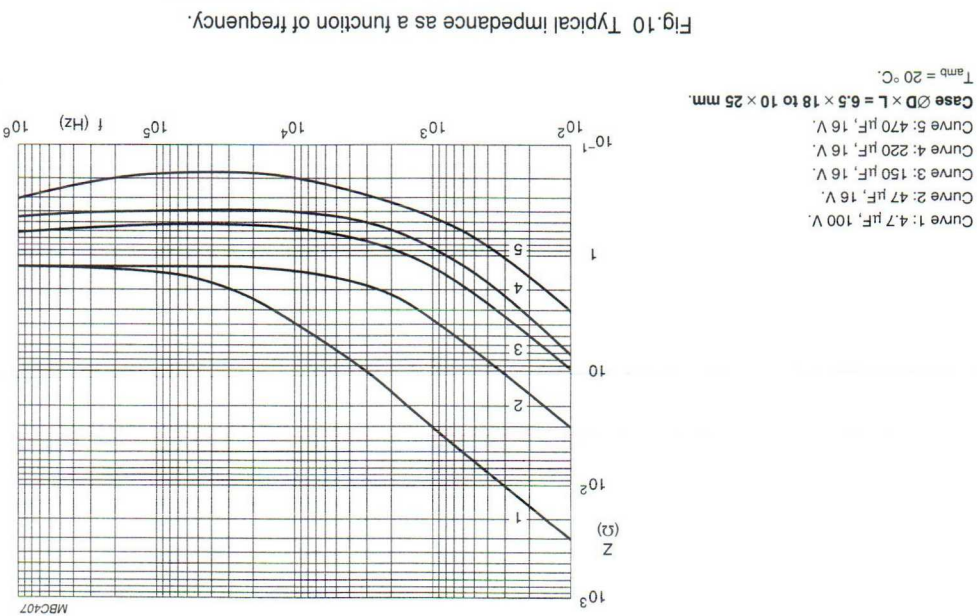
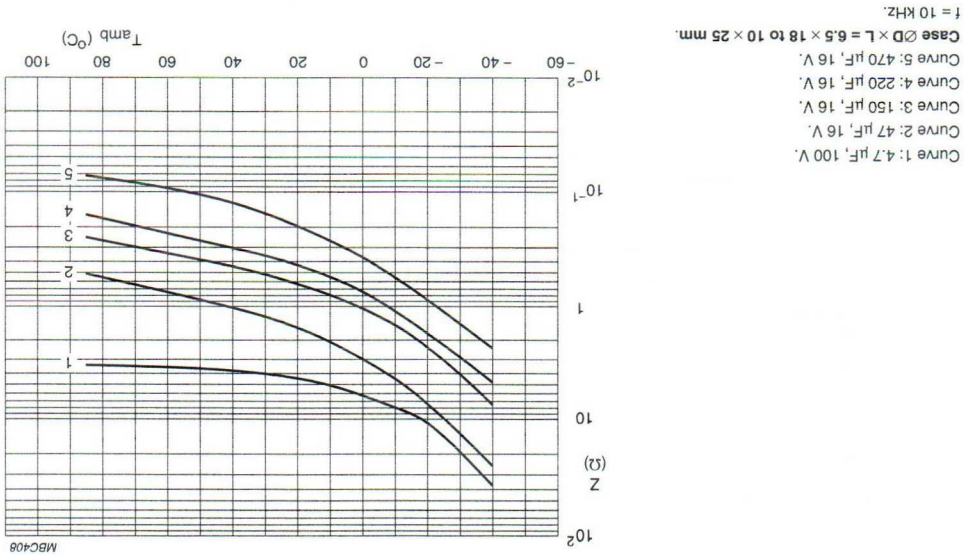


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Impedance (Z)



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RIPPLE CURRENT AND USEFUL LIFE

Table 11 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 85 °C, 100 Hz

FREQUENCY (Hz)	I _R MULTIPLIER		
	U _R = 10 to 16 V	U _R = 25 to 63 V	U _R = 100 to 350 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
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

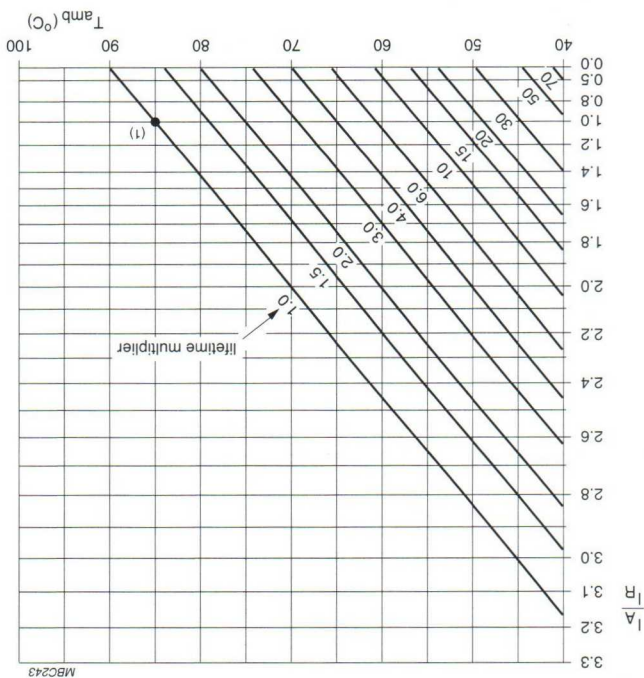


Fig. 11 Multiplier of useful life as a function of ambient temperature and ripple current load.

(1) I_a = actual ripple current at 100 Hz.
 I_a = rated ripple current at 100 Hz, 85 °C.
 Useful life at 85 °C and I_a applied:
 case $\varnothing D \times L = 6.5 \times 18$ and 8×18 mm: 10000 hours
 case $\varnothing D \times L = 10 \times 18$ to 21×40 mm: 15000 hours.

Aluminium electrolytic capacitors
Axial Long Life, DIN-based

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements";

Table 12 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300, subclause 4.13	$T_{amb} = 85^{\circ}\text{C}$; U_R applied; case $\varnothing \times L = 6.5 \times 18$ and 8×18 mm; case $\varnothing \times L = 10 \times 18$ to 21×40 mm; 8000 hours	$U_R = 10$ to 160 V ; $\Delta C/C: \pm 15\%$ $U_R = 250$ to 350 V ; $\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{amb} = 85^{\circ}\text{C}$; U_R and I_R applied; case $\varnothing \times L = 6.5 \times 18$ and 8×18 mm; case $\varnothing \times L = 10 \times 18$ to 21×40 mm; 10000 hours; 15000 hours	$U_R = 10$ to 160 V ; $\Delta C/C: \pm 45\%$ $U_R = 250$ to 350 V ; $\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300, subclause 4.17	$T_{amb} = 85^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{LS} \leq 2 \times \text{spec. limit}$

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Aluminum electrolytic capacitors

Axial High Temperature

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case Ø10 × 30 mm to Ø21 × 40 mm with pressure relief
- Taped versions up to case Ø15 × 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 CV-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.

QUICK REFERENCE DATA

DESCRIPTION		VALUE
Case sizes ($\varnothing_{nom} \times L_{nom}$ in mm)		6.5 × 18 to 10 × 25
Rated capacitance range, C_R		1 to 10000 μF
Tolerance on C_R		±20%
Rated voltage range, U_R		6.3 to 200 V
Category temperature range		-40 to +125 °C
Endurance test at 150 °C (6.3 to 100 V)		500 hours
Endurance test at 125 °C		2000 hours
Useful life at 125 °C		4000 hours
Useful life at 40 °C, $1.8 \times I_R$ applied		500000 hours
Shelf life at 0 V, 125 °C:		
$U_R = 6.3$ to 63 V		500 hours
$U_R = 100$ and 200 V		100 hours
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	40/125/56	55/125/56

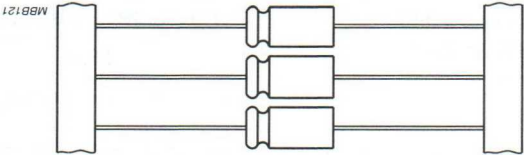
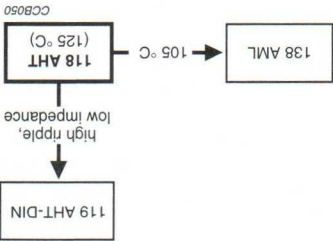


Fig.1 Component outlines: Forms BR and BA.



Aluminium electrolytic capacitors

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Selection chart for C_R, U_R and relevant nominal case sizes (Ø × L in mm)

Preferred types in bold.

C _R (µF)	U _R (V)					
	6.3	10	16	25	40	63
100	—	—	—	—	—	6.5 × 18
2.2	—	—	—	—	—	6.5 × 18
4.7	—	—	—	—	—	6.5 × 18
10	—	—	—	—	—	6.5 × 18
15	—	—	—	—	—	—
22	—	—	—	—	—	8 × 18
33	—	—	—	—	—	10 × 25
47	—	—	—	—	—	10 × 30
68	—	—	—	—	—	12.5 × 30
100	—	—	—	6.5 × 18	8 × 18	10 × 25
150	—	—	—	—	—	10 × 30
220	—	—	—	—	—	—
330	—	—	—	—	—	—
470	—	—	—	—	—	—
680	—	—	—	—	—	—
1000	10 × 18	10 × 25	12.5 × 30	12.5 × 30	18 × 30	21 × 40
1500	10 × 25	12.5 × 30	12.5 × 30	15 × 30	18 × 40	—
2200	—	12.5 × 30	15 × 30	18 × 30	21 × 40	—
3300	—	15 × 30	18 × 30	18 × 40	—	—
4700	—	18 × 30	18 × 40	21 × 40	—	—
6800	—	18 × 40	21 × 40	—	—	—
10000	—	21 × 40	—	—	—	—

Aluminium electrolytic capacitors

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

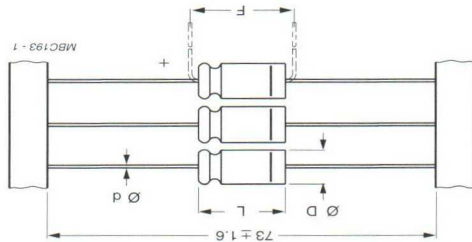


Fig.2 Dimensional outline; Forms BA and BR.

Dimensions in mm.
Form BR: Taped on reel,
case $\varnothing D \times L = 6,5 \times 18$ to 15×30 mm.
Form BA: Taped in box (ammopack),
case $\varnothing D \times L = 6,5 \times 18$ to 10×25 mm.
For dimensions see Table 1.
Tape dimensions are specified in this handbook, Section "Packaging".

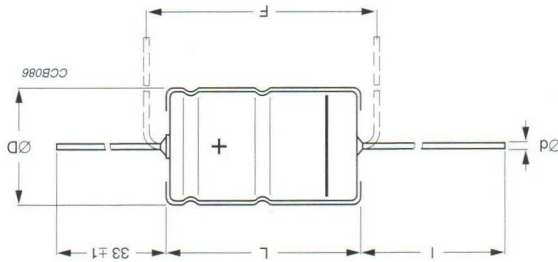


Fig.3 Dimensional outline; Form AA.

Dimensions in mm.
Form AA: Axial in box,
case $\varnothing D \times L = 10 \times 30$ to 21×40 mm.
For case $\varnothing D \times L = 18 \times 40$ and 21×40 mm, the stated limit may be exceeded by 0.7 mm.
For dimensions see Table 1.

Aluminium electrolytic capacitors

Axial High Temperature

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Table 1 Axial: physical dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	AXIAL: FORM AA, BA and BR						MASS (g)	PACKAGING QUANTITIES
		$\varnothing d$ (mm)	l (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F_{min} (mm)	FORM AA		
6.5 × 18	4	0.8	—	6.9	18.5	25	—	1000	1000
8 × 18	5	0.8	—	8.5	18.5	25	—	500	500
10 × 18	6	0.8	—	10.5	18.5	25	—	500	500
10 × 25	7	0.8	—	10.5	25.0	30	—	500	500
10 × 30	00	0.8	55 ± 1	10.5	30.5	35	—	200	200
12.5 × 30	01	0.8	55 ± 1	13.0	30.5	35	—	200	200
15 × 30	02	0.8	55 ± 1	15.5	30.5	35	—	200	250
18 × 30	03	0.8	55 ± 1	18.5	30.5	35	—	200	—
18 × 40	04	0.8	34 ± 1	18.5	41.5	45	—	100	—
21 × 40	05	0.8	34 ± 1	21.5	41.5	45	—	100	—

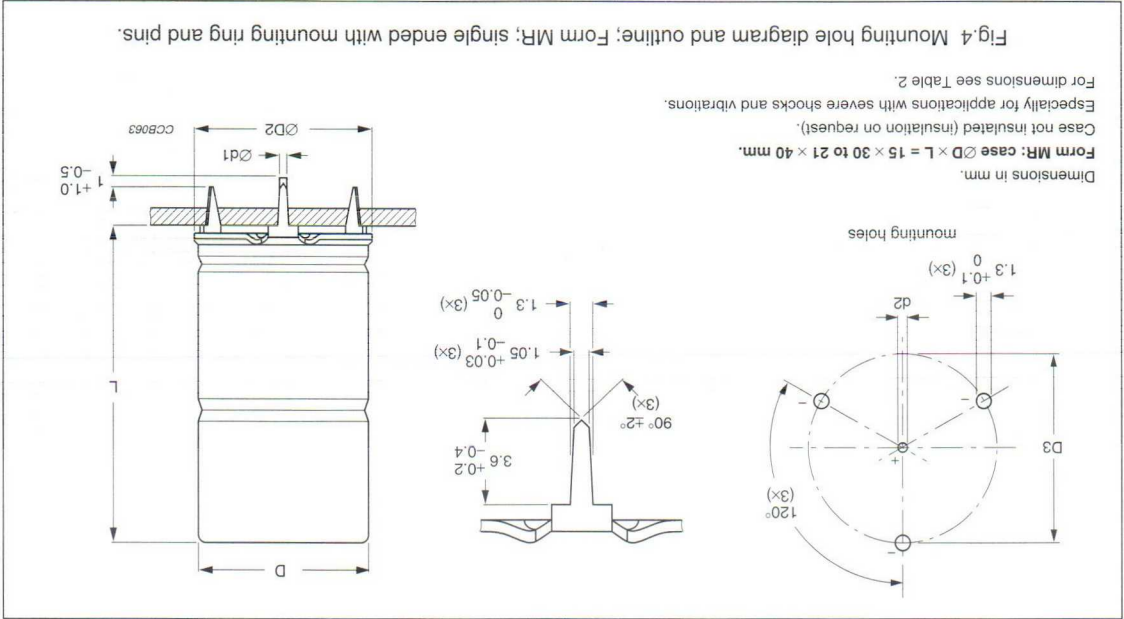


Table 2 Single ended: physical dimensions, mass and packaging quantities; see Fig.4

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	SINGLE ENDED WITH MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		$\varnothing d1$ (mm)	$\varnothing d2$ (mm)	$\varnothing D_{max}$ (mm)	$\varnothing D2_{max}$ (mm)	D3 (mm)	L_{max} (mm)		
15 × 30	02	0.8	1.0 ± 0.4	15.5	17.5	16.5 ± 0.2	33	≈ 8.6	200
18 × 30	03	0.8	1.0 ± 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 11.5	200
18 × 40	04	0.8	1.0 ± 0.4	18.5	19.5	18.5 ± 0.2	45	≈ 14.5	100
21 × 40	05	0.8	1.0 ± 0.4	21.5	22.5	21.5 ± 0.2	45	≈ 19.7	100

Ordering example

Electrolytic capacitor 118 series

1 000 $\mu\text{F}/10\text{ V}$, $\pm 20\%$

Nominal case size: $\varnothing 10 \times 30\text{ mm}$; Form BR

Catalogue number: 2222 118 24102.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 apply at $T_{\text{amb}} = 20\text{ }^{\circ}\text{C}$,
 $P = 86\text{ to }106\text{ KPa}$, $RH = 45\text{ to }75\%$.

C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, $125\text{ }^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{\text{max}}$ and C_R)
Z	max. impedance at 10 kHz

Table 3 Electrical data and ordering information; preferred types in bold

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 125 $^{\circ}\text{C}$ (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222			
										AXIAL			
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	SINGLE ENDED MOUNTING RING FORM MR
6.3	1000 1500	10 $\times$ 18 10 $\times$ 25	6 7	251 352	42 61	17 23	0.50 0.50	0.79 0.53	0.8 0.53	— —	118 23102 118 90502	118 33102 118 90503	— —
10	220 330 470 1000 1500 2200 3300 4700 6800 10000	6.5 $\times$ 18 8 $\times$ 18 8 $\times$ 18 10 $\times$ 25 10 $\times$ 30 12.5 $\times$ 30 15 $\times$ 30 18 $\times$ 30 18 $\times$ 40 21 $\times$ 40	4 5 5 7 00 01 02 03 04 05	109 150 179 343 409 590 826 1035 1395 1674	20 24 32 64 64 94 202 286 412 604	8.4 11 13 24 24 34 70 98 140 200	0.35 0.35 0.35 0.35 0.32 0.32 0.40 0.46 0.53 0.53	2.53 1.69 1.19 0.56 0.505 0.340 0.290 0.190 0.155 0.100 0.084	2.1 1.4 1.0 0.55 0.45 0.28 0.27 0.18 0.15 0.10 0.10	— — — — 118 14102 118 14152 118 14222 118 14332 118 14472 118 14682 118 14103	118 24221 118 24331 118 24471 118 90504 118 24102 118 24152 118 24222 118 24332 — — — —	118 34221 118 34331 118 34471 118 90505 — — — — — —	— — — — — — — — — — — —

Aluminium electrolytic capacitors

Axial High Temperature

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CATALOGUE NUMBER 2222													
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	AXIAL			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	
16	220	8 × 18	5	145	25	11	0.25	1.81	1.5	—	118 25221	118 35221	—
	330	10 × 18	6	204	36	15	0.25	1.21	1.2	—	118 25331	118 35331	—
	470	10 × 18	6	243	49	19	0.25	0.85	0.83	—	118 25471	118 35471	—
	680	10 × 30	00	389	69	30	0.22	0.525	0.45	118 15681	118 25681	—	—
	1000	12.5 × 30	01	557	100	36	0.22	0.345	0.28	118 15102	118 25102	—	—
	1500	12.5 × 30	01	609	148	52	0.29	0.305	0.27	118 15152	118 25152	—	—
	2200	15 × 30	02	790	215	74	0.29	0.205	0.18	118 15222	118 25222	—	118 45222
	3300	18 × 30	03	1008	321	110	0.34	0.165	0.15	118 15332	—	—	118 45332
	4700	18 × 40	04	1363	455	150	0.34	0.105	0.10	118 15472	—	—	118 45472
	6800	21 × 40	05	1627	657	220	0.38	0.088	0.10	118 15682	—	—	118 45682
25	100	6.5 × 18	4	102	20	9	0.18	2.86	2.3	—	118 26101	118 36101	—
	220	10 × 18	6	196	37	15	0.18	1.30	1.25	—	118 26221	118 36221	—
	330	10 × 25	7	274	54	21	0.18	0.87	0.82	—	118 26331	118 36331	—
	470	10 × 25	7	327	75	28	0.18	0.61	0.57	—	118 90508	118 90509	—
	470	10 × 30	00	366	75	28	0.18	0.61	0.50	118 16471	118 26471	—	—
	680	12.5 × 30	01	515	106	38	0.18	0.42	0.30	118 16681	118 26681	—	—
	1000	12.5 × 30	01	531	154	54	0.24	0.375	0.28	118 16102	118 26102	—	—
	1500	15 × 30	02	691	229	79	0.25	0.263	0.22	118 16152	118 26152	—	118 46152
	2200	18 × 30	03	919	334	110	0.26	0.185	0.17	118 16222	—	—	118 46222
	3300	18 × 40	04	1280	499	170	0.26	0.12	0.11	118 16332	—	—	118 46332
4700	21 × 40	05	1464	709	240	0.28	0.095	0.10	118 16472	—	—	118 46472	

Aluminium electrolytic capacitors

Axial High Temperature

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CATALOGUE NUMBER 2222													
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	AXIAL			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
40	47	6.5 × 18	4	89.8	20	7.8	0.11	3.72	2.8	—	118 27479	118 37479	—
	100	8 × 18	5	147	28	12	0.11	1.75	1.3	—	118 27101	118 37101	—
	150	10 × 18	6	207	40	16	0.11	1.17	1.0	—	118 27151	118 37151	—
	220	10 × 25	7	287	57	22	0.11	0.80	0.68	—	118 90511	118 90512	—
	220	10 × 30	00	338	57	22	0.10	0.70	0.55	118 17221	118 27221	—	—
	330	12.5 × 30	01	484	83	30	0.10	0.43	0.33	118 17331	118 27331	—	—
	470	12.5 × 30	01	522	117	42	0.11	0.38	0.30	118 17471	118 27471	—	—
	680	15 × 30	02	695	167	58	0.11	0.255	0.23	118 17681	118 27681	—	118 47681
	1000	18 × 30	03	852	244	84	0.13	0.205	0.18	118 17102	—	—	118 47102
	1500	18 × 40	04	1196	364	120	0.13	0.13	0.11	118 17152	—	—	118 47152
	2200	21 × 40	05	1403	532	180	0.15	0.105	0.10	118 17222	—	—	118 47222
	63	1.0	6.5 × 18	4	16.4	20	4.1	0.07	110	22	—	118 28108	118 38108
2.2		6.5 × 18	4	24.3	20	4.3	0.07	51	15	—	118 28228	118 38228	—
4.7		6.5 × 18	4	35.6	20	4.6	0.07	24	8.9	—	118 28478	118 38478	—
10		6.5 × 18	4	51.9	20	5.3	0.07	11	5.6	—	118 28109	118 38109	—
22		6.5 × 18	4	77.0	20	6.8	0.07	5.1	3.2	—	118 28229	118 38229	—
47		8 × 18	5	126	22	9.9	0.07	2.4	1.5	—	118 28479	118 38479	—
100		10 × 25	7	243	42	17	0.07	1.1	0.7	—	118 90513	118 90514	—
100		10 × 30	00	262	42	17	0.07	1.1	1.0	118 18101	118 28101	—	—
150		12.5 × 30	01	415	61	23	0.07	0.65	0.61	118 18151	118 28151	—	—
220		12.5 × 30	01	454	87	32	0.08	0.61	0.56	118 18221	118 28221	—	—
330		15 × 30	02	544	129	46	0.09	0.42	0.40	118 18331	118 28331	—	118 48331
470		18 × 30	03	695	182	63	0.09	0.31	0.29	118 18471	—	—	118 48471
680	18 × 40	04	971	261	90	0.09	0.2	0.18	118 18681	—	—	118 48681	
1000	21 × 40	05	1161	383	130	0.10	0.16	0.15	118 18102	—	—	118 48102	

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CATALOGUE NUMBER 2222													
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	AXIAL			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	
100	4.7	6.5 × 18	4	36	20	4.9	0.07	24	19	—	118 29478	118 39478	—
	10	6.5 × 18	4	52	20	6.0	0.07	11	9.0	—	118 29109	118 39109	—
	22	8 × 18	5	91	20	8.4	0.07	5.1	4.0	—	118 29229	118 39229	—
	33	10 × 25	7	140	24	11	0.07	3.4	2.7	—	118 29339	118 39339	—
	47	10 × 25	7	170	33	13	0.07	2.6	2.0	—	118 90535	118 90536	—
	47	10 × 30	00	178	33	13	0.08	2.6	2.0	118 19479	118 29479	—	
	68	12.5 × 30	01	278	45	18	0.08	1.8	1.2	118 19689	118 29689	—	
	100	12.5 × 30	01	303	64	24	0.09	1.4	1.15	118 19101	118 29101	—	
	150	15 × 30	02	368	94	34	0.10	0.94	0.78	118 19151	118 29151	118 49151	
	220	18 × 30	03	481	136	48	0.10	0.66	0.55	118 19221	—	—	118 49221
330	18 × 40	04	694	202	70	0.10	0.45	0.37	118 19331	—	—	118 49331	
470	21 × 40	05	833	286	98	0.10	0.33	0.28	118 19471	—	—	118 49471	
200	2.2	6.5 × 18	4	27	20	4.9	0.06	44	23	—	118 90537	118 90538	—
	4.7	8 × 18	5	46	20	5.9	0.06	21	11	—	118 90539	118 90541	—
	10	10 × 25	7	85	20	8.0	0.06	9.4	5.0	—	118 90542	118 90543	—
	15	10 × 30	00	129	22	10	0.046	4.76	3.75	118 92159	118 90012	—	
	22	12.5 × 30	01	198	31	13	0.046	3.17	2.22	118 92229	118 90013	—	
	33	15 × 30	02	242	44	17	0.046	2.11	1.11	118 92339	118 90014	118 90002	
	47	18 × 30	03	317	61	23	0.046	1.48	0.60	118 92479	—	—	118 90003
	68	18 × 40	04	428	86	31	0.046	1.02	0.42	118 92689	—	—	118 90004
100	21 × 40	05	551	124	44	0.046	0.96	0.39	118 92101	—	—	118 90005	

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Additional electrical data

PARAMETER	CONDITIONS	AXIAL	SINGLE ENDED
		VALUE	

Voltage

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

Reverse voltage

Current	
---------	--

Current

Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu A$ or $20 \mu A$ (whichever is greater)
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu A$

Leakage current

Inductance

[illegible]

Equivalent series inductance (ESL)

Equivalent series inductance (ESL)	case ØD × L mm:	6,5 × 18 8 × 18 10 × 18 10 × 25 10 × 30 12,5 × 30 15 × 30 18 × 30 18 × 40 21 × 40	typ. 15 nH typ. 35 nH typ. 69 nH typ. 38 nH typ. 38 nH typ. 30 nH typ. 46 nH typ. 48 nH typ. 50 nH typ. 54 nH typ. 59 nH	- - - - - - -	typ. 39 nH typ. 39 nH typ. 39 nH typ. 39 nH
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Table 4 Operating values at reduced ambient temperature; note 1

SYMBOL	CONDITIONS	VALUES								UNIT
U _R	T ^{amb} > 85 to 125 °C	6.3	10	16	25	40	63	100	125	200
U _{R2}	T ^{amb} ≤ 85 °C	10	16	25	40	63	100	125	250	V

Note

1. For applications at ambient temperatures of $\leq 85^{\circ}\text{C}$, the rated voltage (U_R) may be raised to U_{R2} .

MARKING

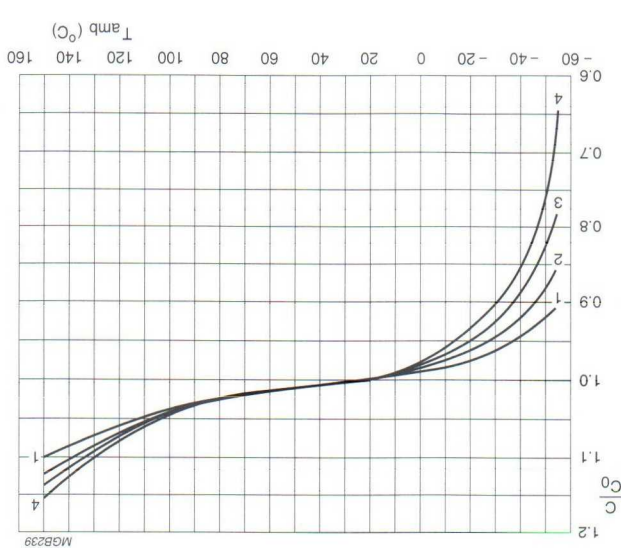
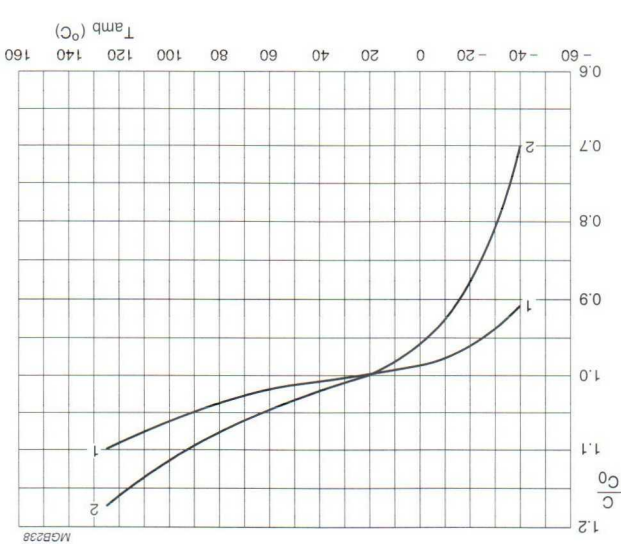
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in μF)
- Tolerance on rated capacitance, code letter in accordance with "IEC 62"
- Rated voltage (in V) at 125 °C and 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
- '+', sign to identify the positive terminal.

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Capacitance (C)



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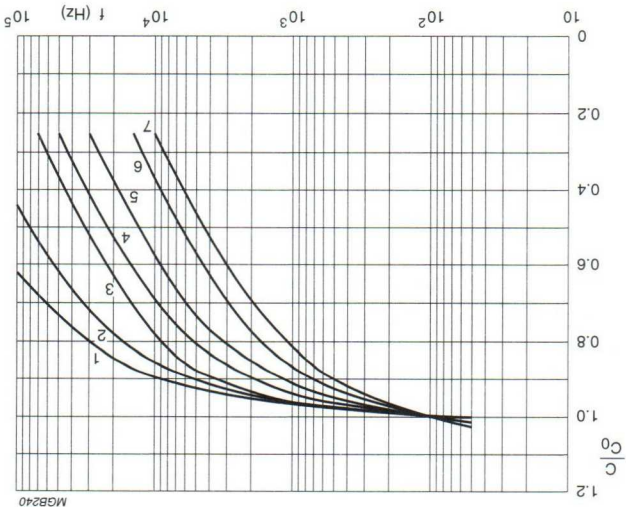


Fig. 7 Typical multiplier of capacitance as a function of frequency.

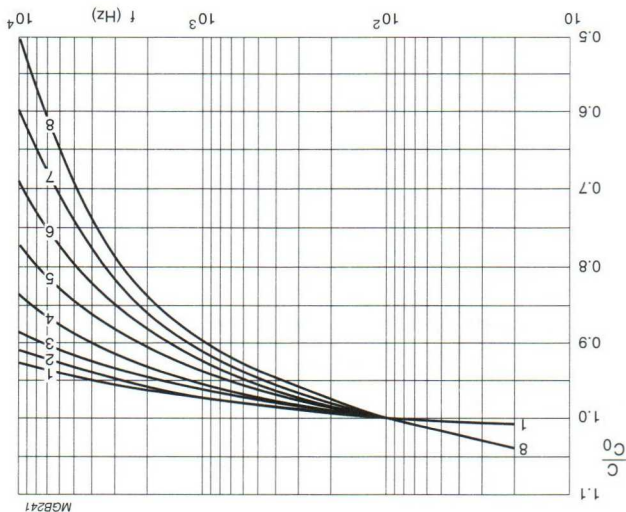


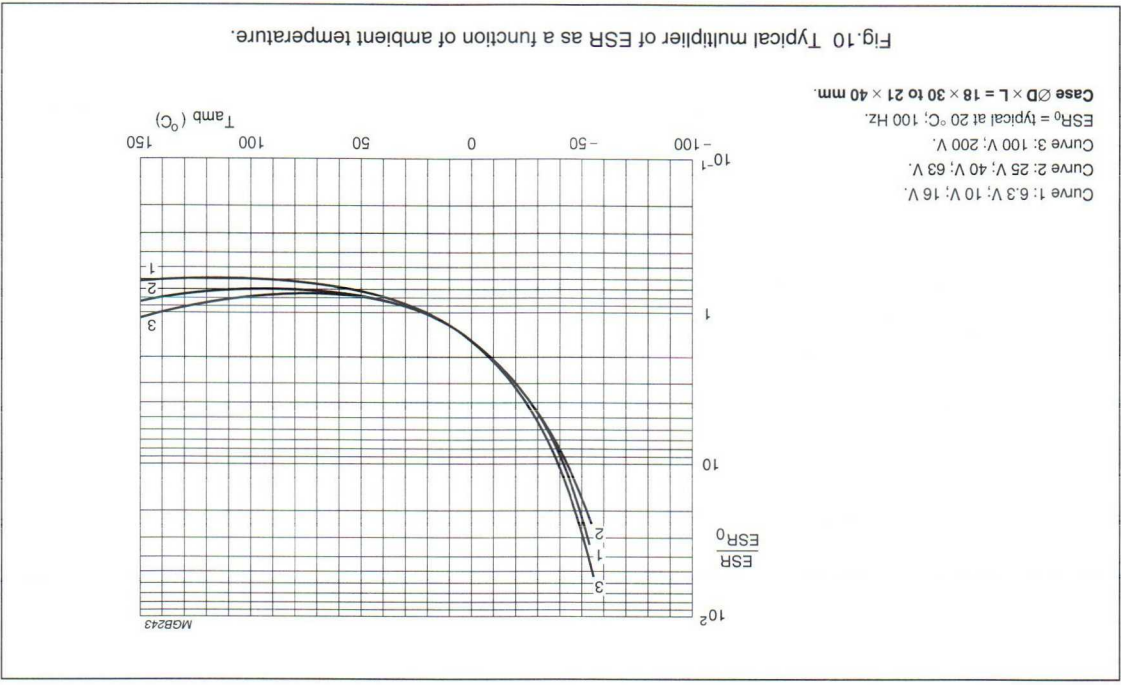
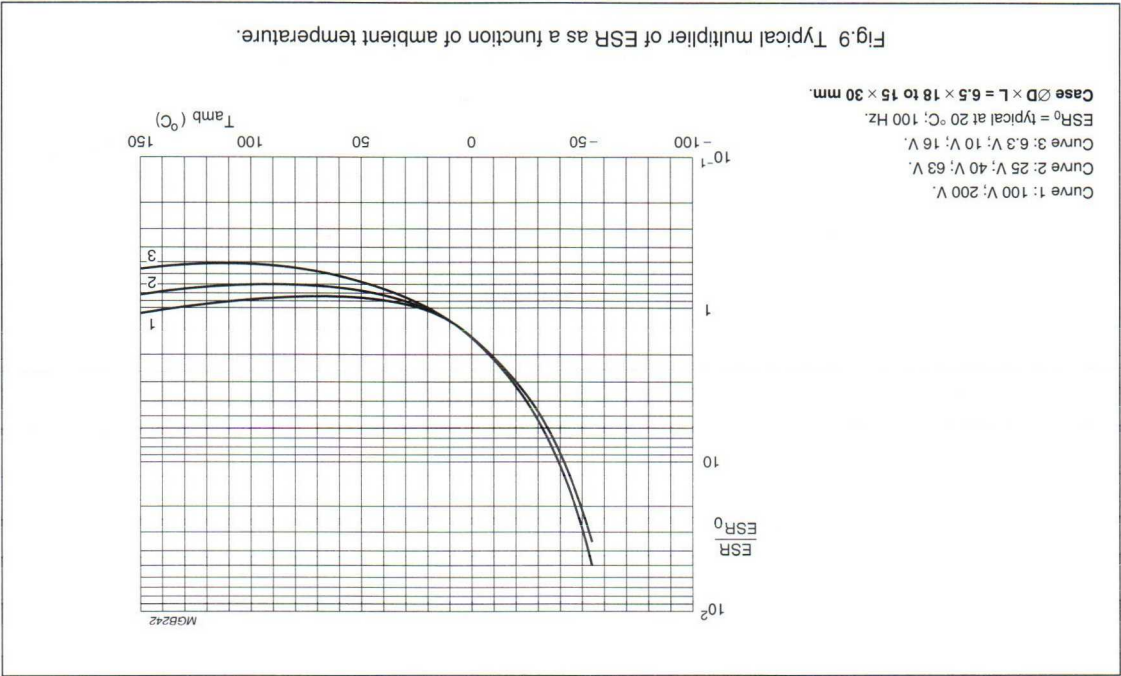
Fig. 8 Typical multiplier of capacitance as a function of frequency.

Case D x L = 10 x 30 to 21 x 40 mm.
 C_0 = capacitance at 20 °C, 100 Hz.

- 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.

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Equivalent series resistance (ESR)



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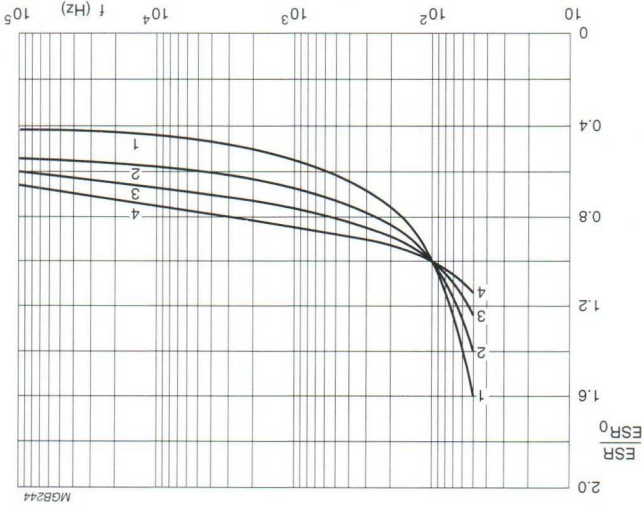


Fig. 11 Typical multiplier of ESR as a function of frequency.

Case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm.
ESR₀ = typical at 20 °C; 100 Hz.
Curve 4: 6.3 V; 10 V; 16 V.
Curve 3: 25 V.
Curve 2: 40 V.
Curve 1: 63 V; 100 V ($\geq 15 \mu F$).

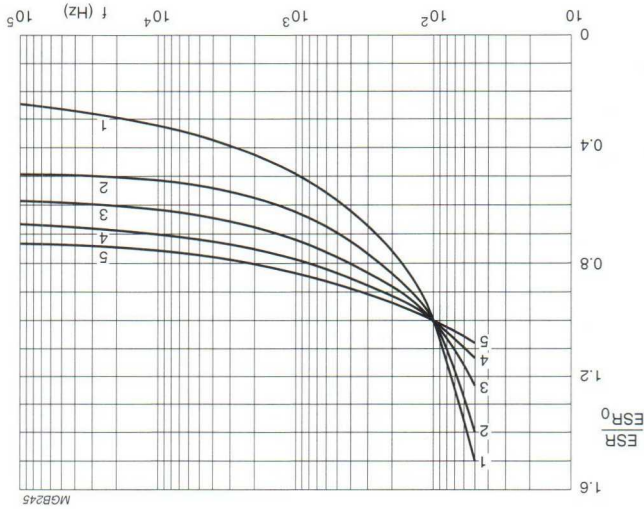


Fig. 12 Typical multiplier of ESR as a function of frequency.

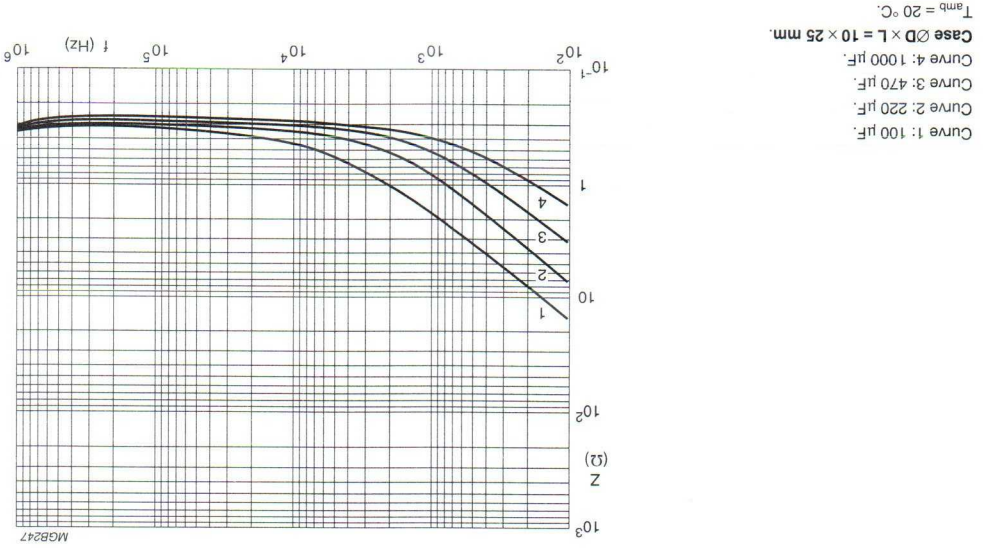
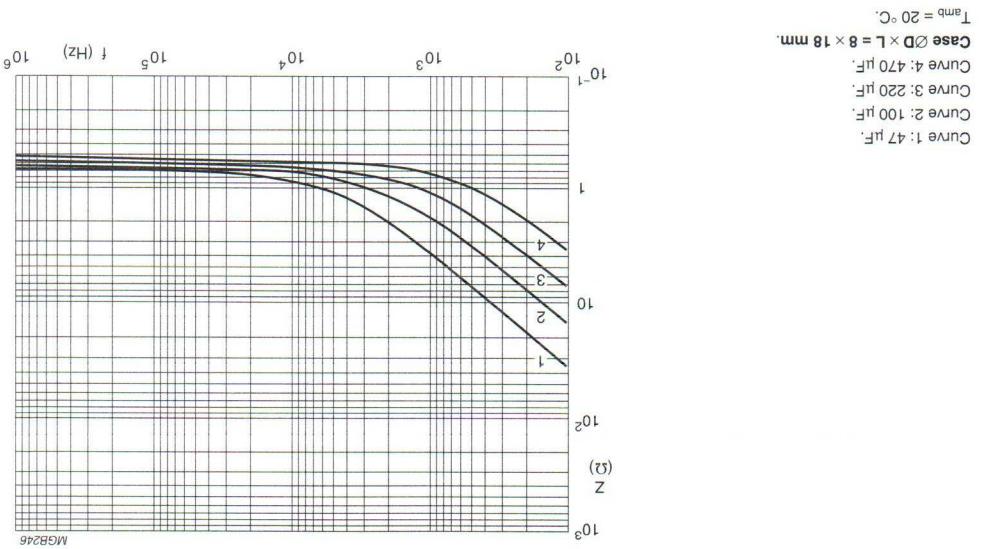
Case $\varnothing D \times L = 10 \times 30$ to 21×40 mm.
ESR₀ = typical at 20 °C; 100 Hz.
Curve 5: 6.3 V; 10 V.
Curve 4: 16 V; 25 V.
Curve 3: 40 V; 63 V.
Curve 2: 100 V.
Curve 1: 200 V.

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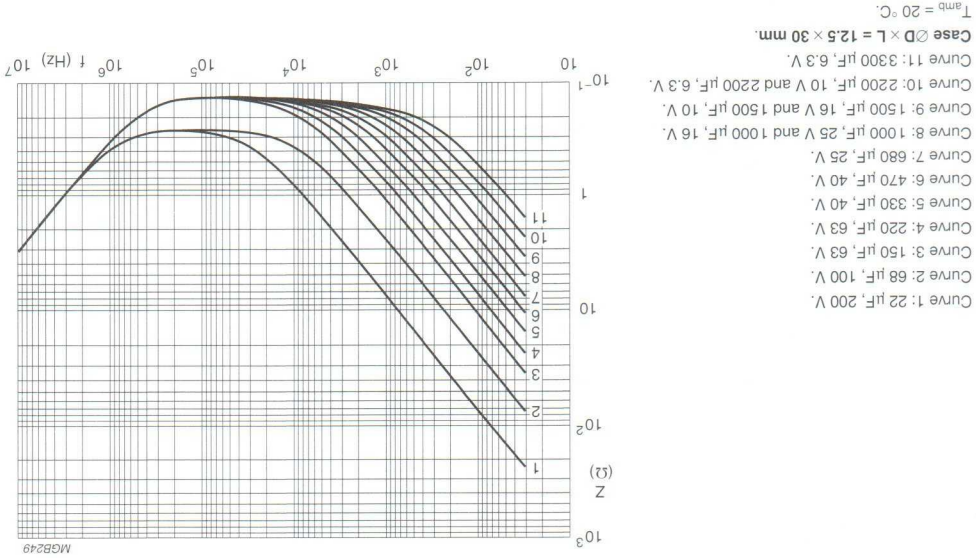
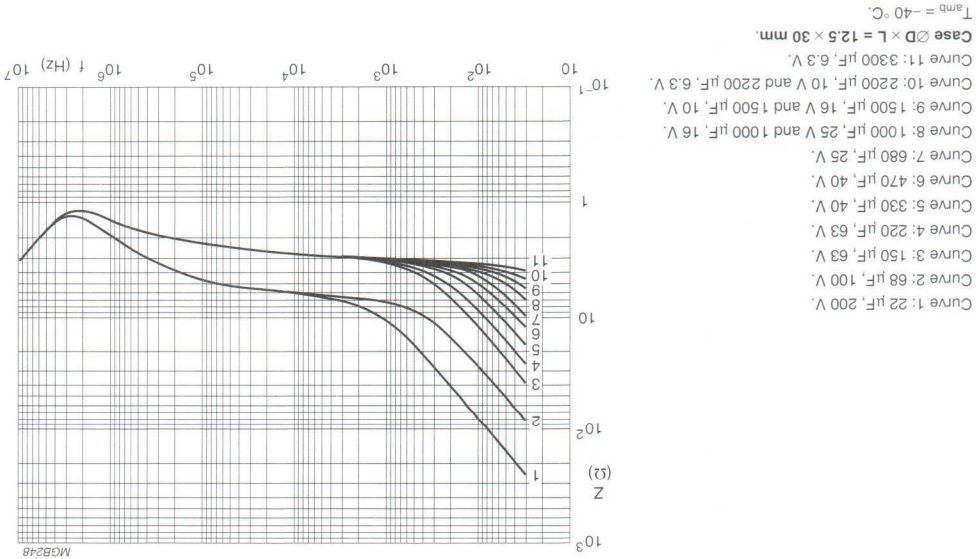
Impedance (Z)



Aluminium electrolytic capacitors

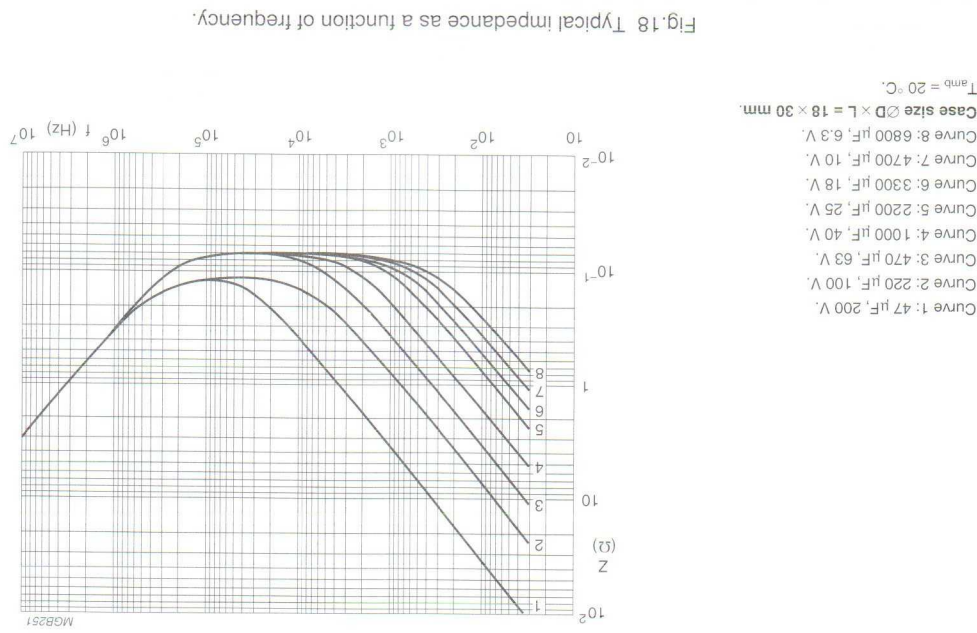
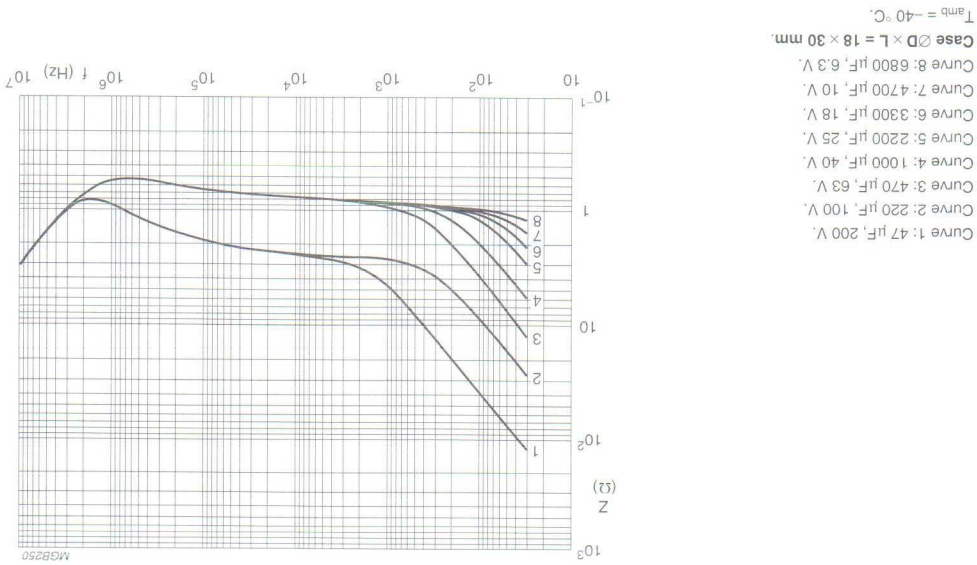
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RIPPLE CURRENT AND USEFUL LIFE

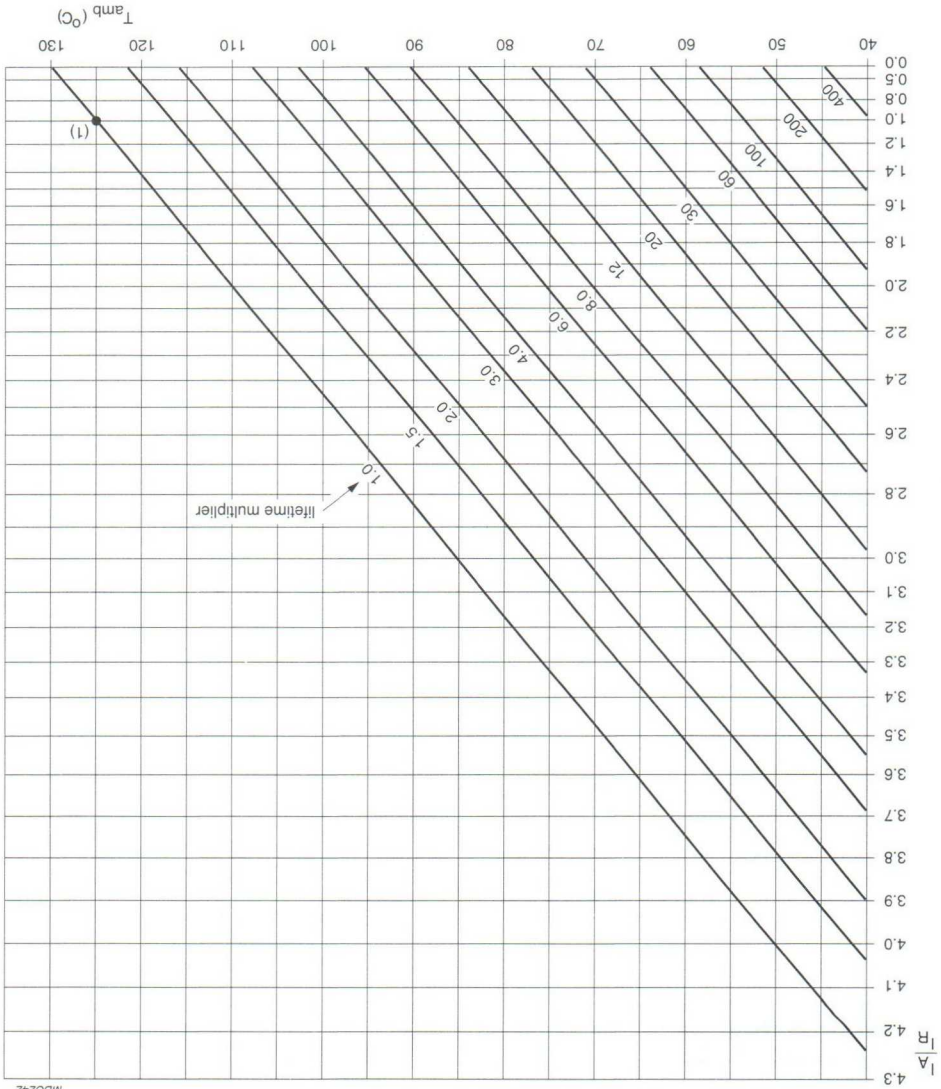


Fig. 19 Multiplier of useful life as a function of ambient temperature and ripple current load; see Table 5.

(1) Useful life at 125 °C and I_R applied: 4 000 hours.

I_R = rated ripple current at 100 Hz, 125 °C.

I_A = actual ripple current at 100 Hz.

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Table 5 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 125 °C, 100 Hz; see Fig.19

FREQUENCY (Hz)	I_R MULTIPLIER	
	$U_R = 6.3$ to 25 V	$U_R = 40$ to 63 V
50	0.95	0.9
100	1.0	1.0
300	1.07	1.12
1000	1.12	1.2
3000	1.15	1.25
≥ 10000	1.2	1.3
		1.4

SPECIFIC TESTS AND REQUIREMENTS

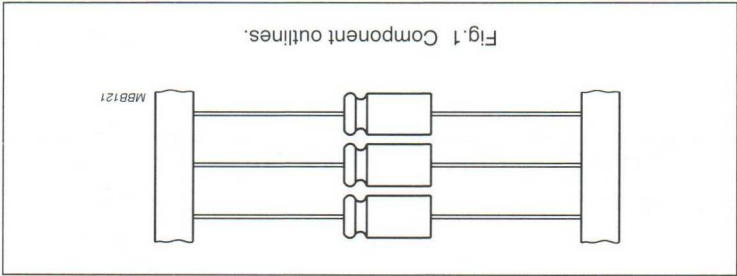
General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 6 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 125^{\circ}\text{C}$; U_R applied; case sizes: 6.5 × 18 to 10 × 25 mm: 2000 hours; 10 × 30 to 21 × 40 mm: 3000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +15/-30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 125^{\circ}\text{C}$; U_R and I_R applied; 4000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +45/-50% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 125^{\circ}\text{C}$; 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	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{LS} \leq 2 \times \text{spec. limit}$
Reverse voltage	IEC 384-4/ CECC 30300 subclause 4.15	$T_{amb} = 125^{\circ}\text{C}$: 125 hours at $U = -1\text{ V}$ followed by 125 hours at U_R	$\Delta C/C$: $\pm 20\%$ $\tan \delta \leq \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$

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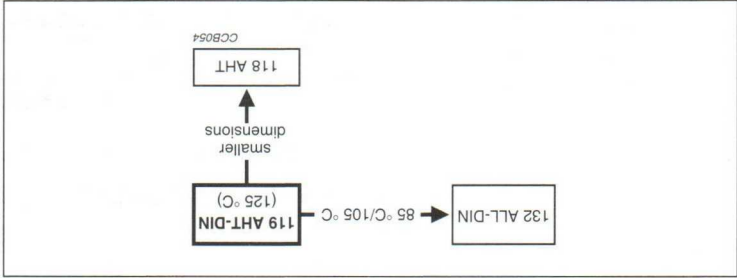


- Polarized aluminum electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case $\varnothing 10 \times 30$ to 21×40 mm with pressure relief
- Taped versions up to case $\varnothing 15 \times 30$ mm available for automatic insertion
- Charge and discharge proof
- Extra long useful life: 4 000 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 without voltage (10 years)
- For use where low mounting height is important; vibration and shock resistant.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing_{nom} \times L_{nom}$ in mm)	6.5×18 to 10×25 10×30 to 21×40
Rated capacitance range, C_R	4.7 to 4 700 μF
Tolerance on C_R	-10/+50%
Rated voltage range, U_R	10 to 200 V
Category temperature range	-55 to +125 °C
Endurance test at 150 °C	500 hours
Endurance test at 125 °C	4 000 hours; 100 V; 3 000 hours 5 000 hours; 100 V; 4 000 hours
Useful life at 125 °C	4 000 hours
Useful life at 40 °C, 1.8 Ir applied	500 000 hours
Shelf life at 0 V, 125 °C:	500 hours 100 hours
$U_R = 10$ to 63 V $U_R = 100$ and 200 V	
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	55/125/56
Approval	UTE CO31/CO33

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing \times L$ in mm)
Preferred types in **bold**.

C_R (μF)	U_R (V)						
	10	16	25	40	63	100	200
4.7	—	—	—	—	—	6.5 × 18	10 × 18
10	—	—	—	—	6.5 × 18	8 × 18	10 × 25
22	—	—	6.5 × 18	—	8 × 18	10 × 18	10 × 25
47	—	—	—	—	—	10 × 30	—
	—	—	—	—	—	10 × 30	—
68	—	—	—	—	—	10 × 30	—
100	6.5 × 18	8 × 18	10 × 18	10 × 25	10 × 30	15 × 30	—
150	—	—	—	12.5 × 30	15 × 30	15 × 30	—
220	10 × 18	10 × 25	10 × 25	12.5 × 30	15 × 30	18 × 30	—
	—	—	12.5 × 30	15 × 30	18 × 30	18 × 40	—
330	—	12.5 × 30	12.5 × 30	15 × 30	18 × 30	18 × 40	—
470	10 × 25	12.5 × 30	12.5 × 30	15 × 30	18 × 30	21 × 40	—
	12.5 × 30	—	—	—	—	—	—
680	12.5 × 30	15 × 30	18 × 30	18 × 30	21 × 40	—	—
1 000	15 × 30	15 × 30	18 × 30	18 × 40	21 × 40	—	—
1 500	18 × 30	18 × 30	18 × 40	21 × 40	—	—	—
2 200	18 × 30	18 × 40	21 × 40	—	—	—	—
3 300	18 × 40	21 × 40	—	—	—	—	—
4 700	21 × 40	—	—	—	—	—	—

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 85 °C
- Group number (19)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with "IEC 62"
- Code indicating factory of origin
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal.

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

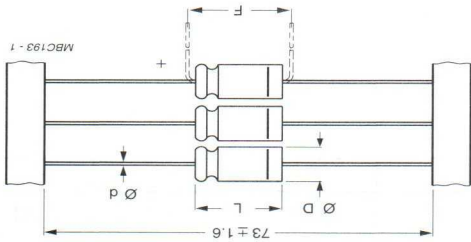


Fig.2 Dimensional outline; Forms BA and BR.

Dimensions in mm.
Form BR: Taped on reel,
case $\varnothing D \times L = 6,5 \times 18$ to 15×30 mm.
Form BA: Taped in box (ammopack),
case $\varnothing D \times L = 6,5 \times 18$ to 10×25 mm.
For dimensions see Table 1.
Tape dimensions are specified in this handbook, Section "Packaging".

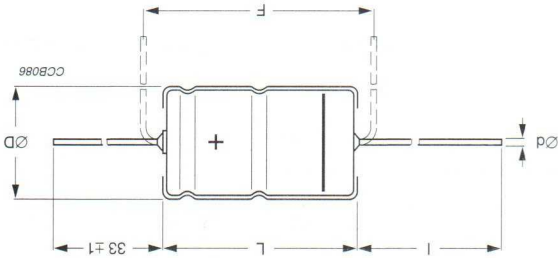


Fig.3 Dimensional outline; Form AA.

Dimensions in mm.
Form AA: Axial in box,
case $\varnothing D \times L = 10 \times 30$ to 21×40 mm.
For case sizes 18×30 and 21×40 mm, the stated L_{max} may be exceeded by 0.7 mm.
For dimensions see Table 1.

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Table 1 Axial; physical dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE Ø D × L (mm)	CASE CODE	AXIAL FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		Ø d	I (mm)	Ø D _{max} (mm)	L _{max} (mm)	F _{min} (mm)		FORM AA	FORM BA	FORM BR
6.5 × 18	4	0.8	—	6.9	18.5	25	≈1.3	—	1000	1000
8 × 18	5	0.8	—	8.5	18.5	25	≈1.7	—	500	500
10 × 18	6	0.8	—	10.5	18.5	25	≈2.5	—	500	500
10 × 25	7	0.8	—	10.5	25.0	30	≈3.3	—	500	500
10 × 30	00	0.8	55 ±1	10.5	30.5	35	≈4.8	200	—	500
12.5 × 30	01	0.8	55 ±1	13.0	30.5	35	≈7.4	200	—	400
15 × 30	02	0.8	55 ±1	15.5	30.5	35	≈11.7	200	—	250
18 × 30	03	0.8	55 ±1	18.5	30.5	35	≈12.9	200	—	—
18 × 40	04	0.8	34 ±1	18.5	41.5	45	≈19.4	100	—	—
21 × 40	05	0.8	34 ±1	21.5	41.5	45	≈24.7	100	—	—

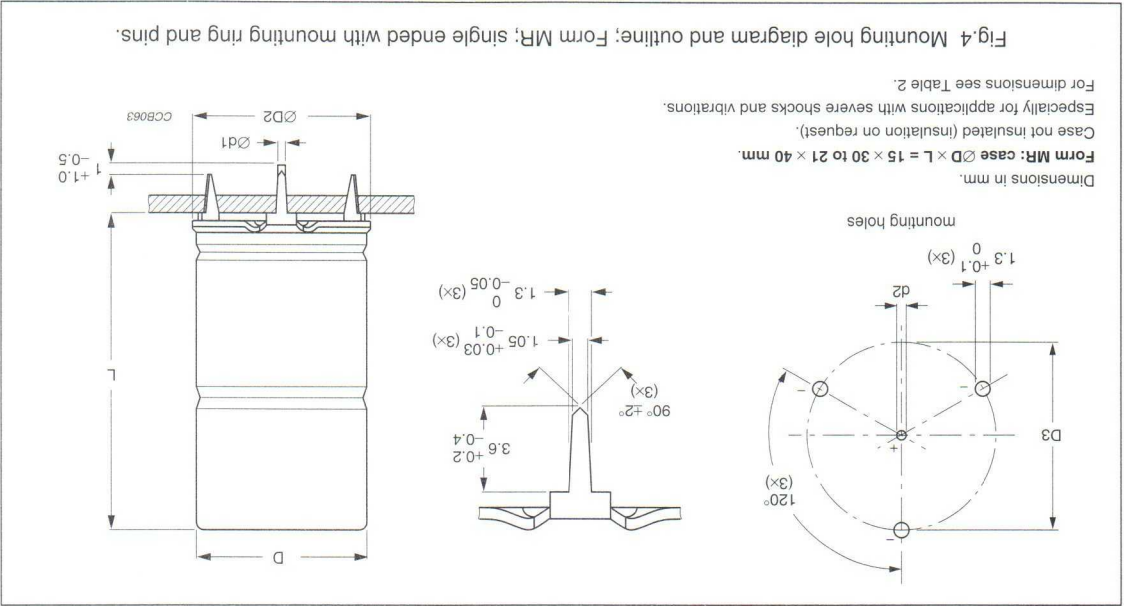


Table 2 Single ended; mass and packaging quantities; see Fig.4

NOMINAL CASE SIZE Ø × L (mm)	CASE CODE	SINGLE ENDED WITH MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		Ød1 (mm)	Ød2 (mm)	ØD _{max} (mm)	ØD2 _{max} (mm)	D3 (mm)	L _{max} (mm)		
15 × 30	02	0.8	1.0 +0.4	15.5	17.5	16.5 ±0.2	33	≈8.6	200
18 × 30	03	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	33	≈11.5	200
18 × 40	04	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	45	≈14.5	100
21 × 40	05	0.8	1.0 +0.4	21.5	22.5	21.5 ±0.2	45	≈19.7	100

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Ordering example

Electrolytic capacitor 119 series

470 µF/16 V; -10/+50%

Nominal case size: Ø12.5 × 30 mm; Form BR

Catalogue number: 2222 119 25471.

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%.

SYMBOL	DESCRIPTION
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 3 Electrical data and ordering Information; preferred types in bold

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	CATALOGUE NUMBER 2222			
										AXIAL			
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	SINGLE ENDED MOUNTING RING FORM MR
10	100	6.5 × 18	4	130	10	6	0.2	3.5	2.2	—	119 24101	119 34101	—
	220	10 × 18	6	240	17	8.4	0.18	1.3	1.0	—	119 24221	119 34221	—
	470	10 × 25	7	380	32	13	0.18	0.61	0.49	—	119 90501	119 90502	—
	470	12.5 × 30	01	550	32	13	0.16	0.54	0.38	119 14471	119 24471	—	—
	680	12.5 × 30	01	590	45	18	0.20	0.47	0.38	119 14681	119 24681	—	—
	1000	15 × 30	02	715	64	24	0.20	0.32	0.24	119 14102	119 24102	—	119 44102
	1500	18 × 30	03	945	94	34	0.22	0.23	0.17	119 14152	—	—	119 44152
	2200	18 × 30	03	1025	136	48	0.26	0.19	0.17	119 14222	—	—	119 44222
	3300	18 × 40	04	1405	202	70	0.27	0.13	0.10	119 14332	—	—	119 44332
	4700	21 × 40	05	1700	286	90	0.30	0.10	0.09	119 14472	—	—	119 44472
16	47	6.5 × 18	4	110	10	5.5	0.13	4.4	2.2	—	119 25479	119 35479	—
	100	8 × 18	5	170	14	7.2	0.13	2.1	1.3	—	119 25101	119 35101	—
	220	10 × 25	7	300	25	11	0.13	0.94	0.55	—	119 25221	119 35221	—
	330	12.5 × 30	01	510	36	15	0.13	0.63	0.38	119 15331	119 25331	—	—
	470	12.5 × 30	01	565	50	19	0.15	0.51	0.38	119 15471	119 25471	—	—

Aluminium electrolytic capacitors Axial High Temperature, DIN-based 119 AHT-DIN

CATALOGUE NUMBER 2222													
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	AXIAL			SINGLE ENDED MOUNTING RING FORM MR
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	
16	680	15 × 30	02	680	69	26	0.15	0.35	0.24	119 15681	119 25681	—	119 45681
	1000	15 × 30	02	735	100	36	0.19	0.30	0.24	119 15102	119 25102	—	119 45102
	1500	18 × 30	03	970	148	52	0.20	0.21	0.17	119 15152	—	—	119 45152
	2200	18 × 40	04	1310	215	74	0.20	0.14	0.10	119 15222	—	—	119 45222
	3300	21 × 40	05	1650	321	110	0.22	0.11	0.09	119 15332	—	—	119 45332
	4700	21 × 40	05	1700	455	154	0.28	0.09	0.09	119 15472	—	—	119 45472
	25	22	6.5 × 18	4	85	10	5.1	0.10	7.2	3.2	—	119 26229	119 36229
100		10 × 18	6	210	19	9	0.10	1.6	1.0	—	119 26101	119 36101	—
220		10 × 25	7	350	37	15	0.10	0.72	0.58	—	119 90503	119 90504	—
220		12.5 × 30	01	500	37	15	0.09	0.65	0.38	119 16221	119 26221	—	—
330		12.5 × 30	01	555	54	21	0.11	0.53	0.38	119 16331	119 26331	—	—
470		12.5 × 30	01	610	75	28	0.13	0.44	0.38	119 16471	119 26471	—	—
680		18 × 30	03	810	106	38	0.13	0.30	0.17	119 16681	—	—	119 46681
40	1000	18 × 30	03	980	154	54	0.13	0.21	0.17	119 16102	—	—	119 46102
	1500	18 × 40	04	1345	229	79	0.13	0.14	0.10	119 16152	—	—	119 46152
	2200	21 × 40	05	1640	334	114	0.13	0.11	0.09	119 16222	—	—	119 46222
	47	8 × 18	5	150	15	7.8	0.08	2.7	1.5	—	119 27479	119 37479	—
	100	10 × 25	7	260	28	12	0.08	1.3	0.7	—	119 27101	119 37101	—
	150	12.5 × 30	01	440	40	16	0.08	0.85	0.51	119 17151	119 27151	—	—
	220	12.5 × 30	01	500	57	22	0.09	0.65	0.48	119 17221	119 27221	—	—
470	330	15 × 30	02	615	83	30	0.09	0.43	0.37	119 17331	119 27331	—	119 47331
	470	15 × 30	02	630	117	42	0.12	0.41	0.37	119 17471	119 27471	—	119 47471
	680	18 × 30	03	845	167	58	0.12	0.28	0.22	119 17681	—	—	119 47681
	1000	18 × 40	04	1140	244	84	0.12	0.19	0.14	119 17102	—	—	119 47102
	1500	21 × 40	05	1400	364	124	0.14	0.15	0.12	119 17152	—	—	119 47152
	2200	21 × 40	05	1490	532	180	0.18	0.13	0.11	119 17222	—	—	119 47222

Aluminium electrolytic capacitors
Axial High Temperature, DIN-based

119 AHT-DIN

CATALOGUE NUMBER 2222													
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	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)	AXIAL			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
63	10	6.5 × 18	4	68	20	5.3	0.07	11	5.6	—	119 28109	119 38109	—
	22	8 × 18	5	110	20	6.7	0.07	5.1	2.8	—	119 28229	119 38229	—
	47	10 × 18	6	180	22	9.9	0.07	2.4	1.3	—	119 28479	119 38479	—
	68	10 × 25	7	230	30	13	0.07	1.6	1.0	—	119 90505	119 90506	—
	68	10 × 30	00	250	30	13	0.07	1.6	0.92	119 18689	119 28689	—	—
	100	10 × 30	00	285	42	17	0.08	1.3	0.75	119 18101	119 28101	—	—
	150	15 × 30	02	440	61	23	0.08	0.85	0.37	119 18151	119 28151	—	119 48151
	220	15 × 30	02	530	87	32	0.08	0.58	0.37	119 18221	119 28221	—	119 48221
	330	18 × 30	03	680	129	46	0.09	0.43	0.23	119 18331	—	—	119 48331
	470	18 × 40	04	905	182	63	0.09	0.30	0.15	119 18471	—	—	119 48471
100	680	21 × 40	05	1175	261	90	0.09	0.21	0.12	119 18681	—	—	119 48681
	1000	21 × 40	05	1385	382	130	0.10	0.16	0.11	119 18102	—	—	119 48102
	4.7	6.5 × 18	4	44	20	10	0.08	27	10	—	119 29478	119 39478	—
	10	8 × 18	5	70	20	10	0.08	13	6.0	—	119 29109	119 39109	—
	22	10 × 18	6	112	20	10	0.08	5.8	3.5	—	119 29229	119 39229	—
	47	10 × 25	7	178	32	13	0.08	2.7	2.0	—	119 90518	119 90519	—
	47	10 × 30	00	178	32	13	0.08	2.7	2.0	119 19479	119 29479	—	—
	68	12.5 × 30	01	278	45	18	0.08	1.9	1.2	119 19689	119 29689	—	—
	100	15 × 30	02	365	64	24	0.09	1.4	0.96	119 19101	119 29101	—	119 49101
	150	15 × 30	02	368	94	34	0.10	1.1	0.78	119 19151	119 29151	—	119 49151
200	220	18 × 30	03	481	136	48	0.10	0.72	0.55	119 19221	—	—	119 49221
	330	18 × 40	04	694	202	70	0.10	0.48	0.37	119 19331	—	—	119 49331
	470	21 × 40	05	833	286	98	0.10	0.34	0.28	119 19471	—	—	119 49471
	4.7	10 × 18	6	52	20	10	0.08	27	10	—	119 90507	119 90508	—
200	10	10 × 25	7	82	20	10	0.08	13	5.0	—	119 90509	119 90511	—

Aluminium electrolytic capacitors
Axial High Temperature, DIN-based
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Additional electrical data

PARAMETER	CONDITIONS	AXIAL	SINGLE ENDED
		VALUE	

Voltage

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

Current

Leakage current	after 1 minute: $U_R = 10\text{ to }40\text{ V}$ $U_R = 63\text{ V to }200\text{ V}$	$I_{L1} \leq 0.006C_R \times U_R + 4\text{ }\mu\text{A}$, or $10\text{ }\mu\text{A}$ (which ever is greater) $I_{L1} \leq 0.006C_R \times U_R + 4\text{ }\mu\text{A}$, or $20\text{ }\mu\text{A}$ (which ever is greater)
	after 5 minutes: $U_R = 10\text{ to }63\text{ V}$ $U_R = 100\text{ and }200\text{ V}$	$I_{L5} \leq 0.002C_R \times U_R + 4\text{ }\mu\text{A}$ $I_{L5} \leq 0.002C_R \times U_R + 4\text{ }\mu\text{A}$ (which ever is greater)

Inductance

Equivalent series inductance (ESL)		case $\varnothing \times L\text{ mm}$: 6.5×18 8×18 10×18 10×25 10×30 12.5×30 15×30 18×30 18×40 21×40	typ. 15 nH typ. 35 nH typ. 69 nH typ. 38 nH typ. 46 nH typ. 48 nH typ. 50 nH typ. 54 nH typ. 59 nH	typ. 39 nH typ. 39 nH typ. 39 nH typ. 39 nH – – – – – –
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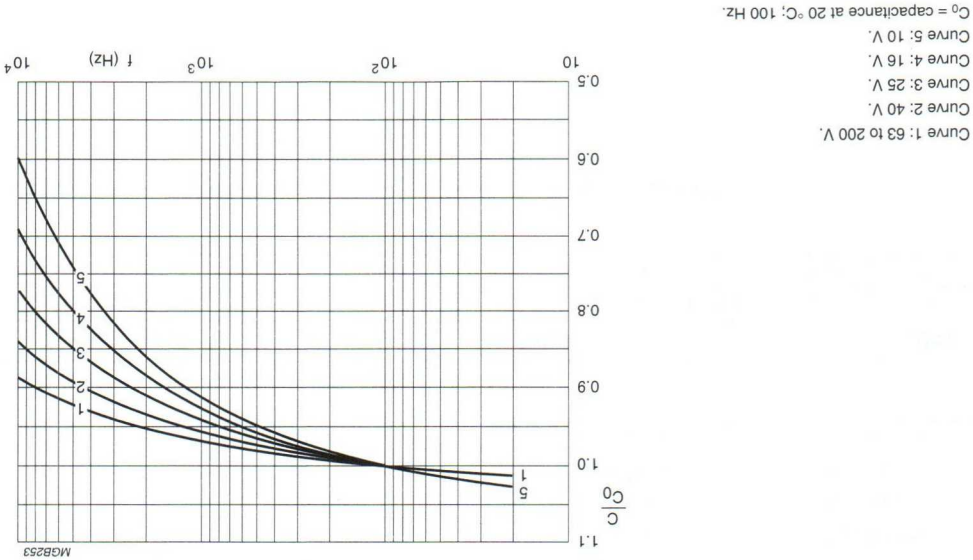
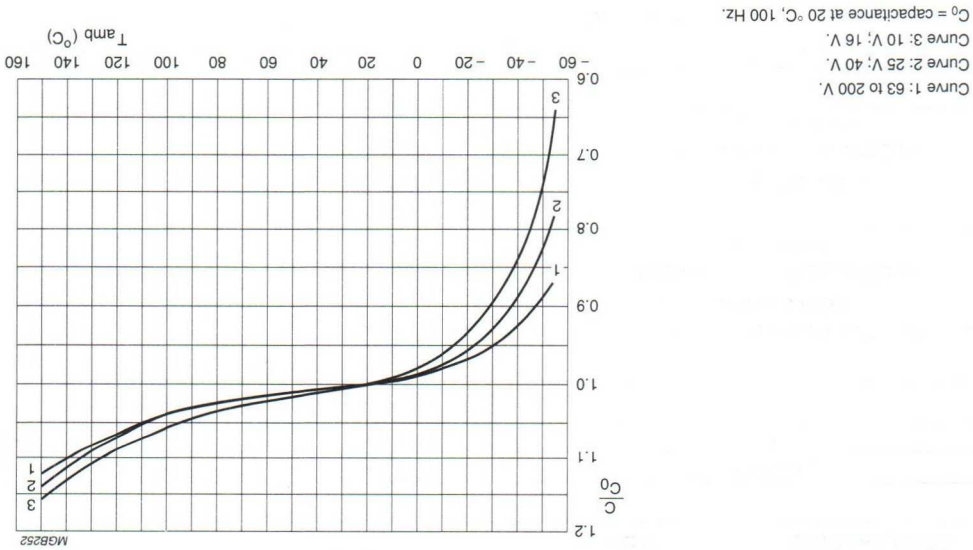
Table 4 Operating values at reduced ambient temperature; note 1

SYMBOL	CONDITIONS	VALUES					UNIT
U_R	$T_{amb} > 85\text{ to }125\text{ }^\circ\text{C}$	10	16	25	40	63	V
U_{R2}	$T_{amb} \leq 85\text{ }^\circ\text{C}$	16	25	40	63	100	V

Note

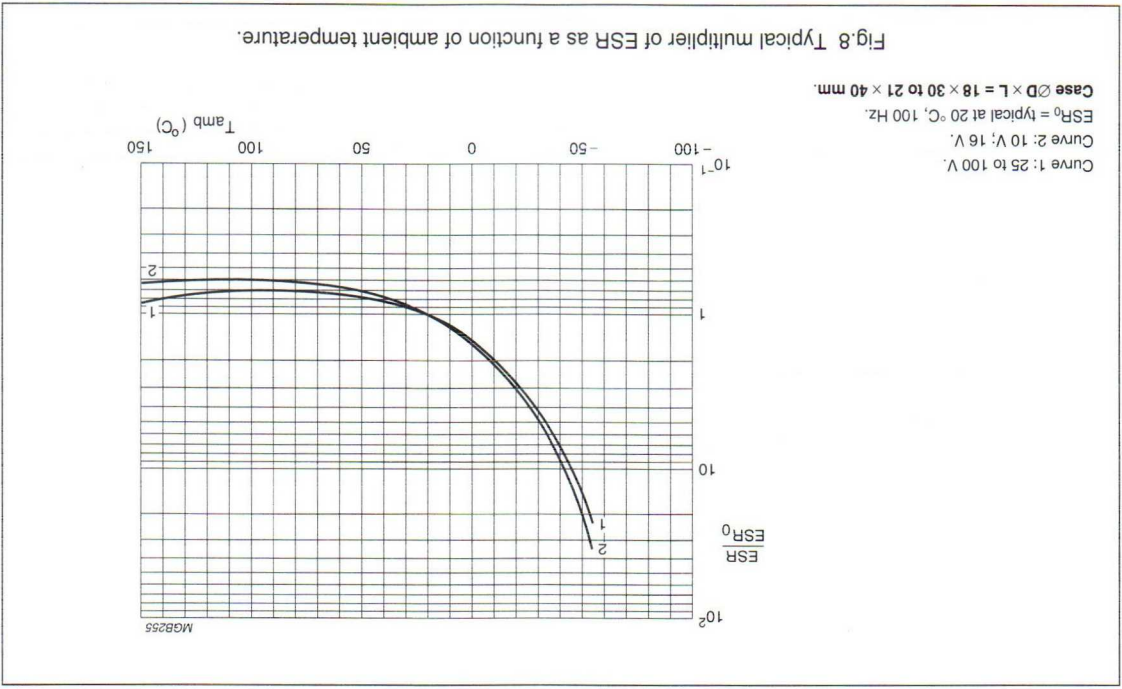
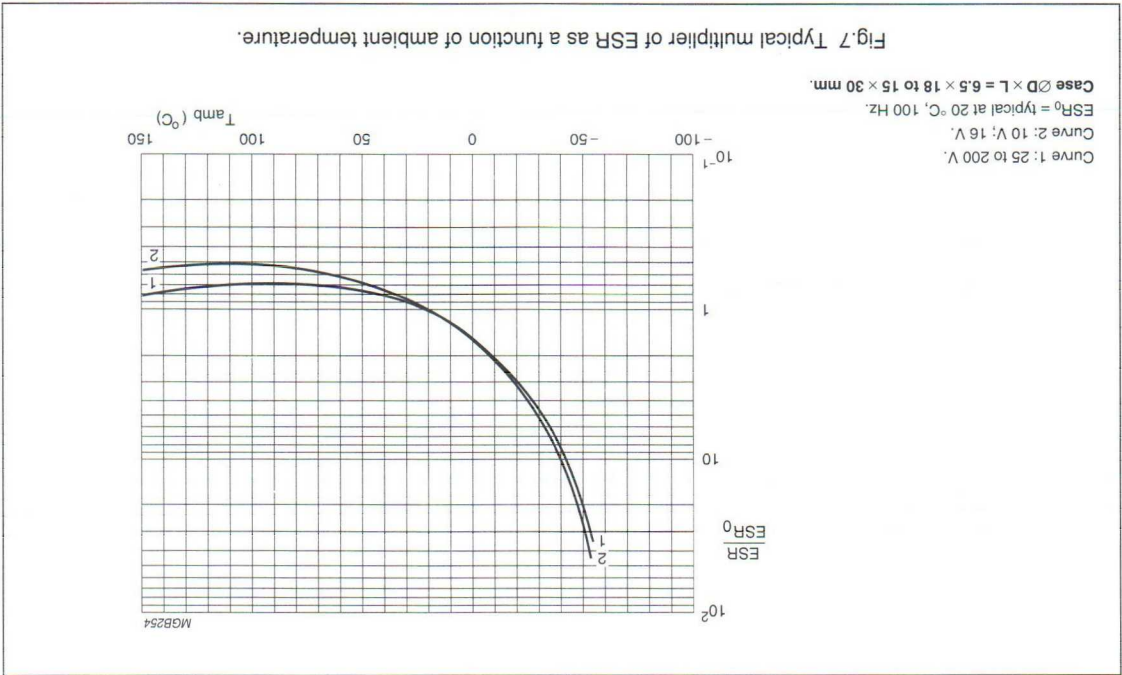
1. For applications at ambient temperatures of $\leq 85\text{ }^\circ\text{C}$, the rated voltage (U_R) may be raised to U_{R2} .

Capacitance (C)



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Equivalent series resistance (ESR)



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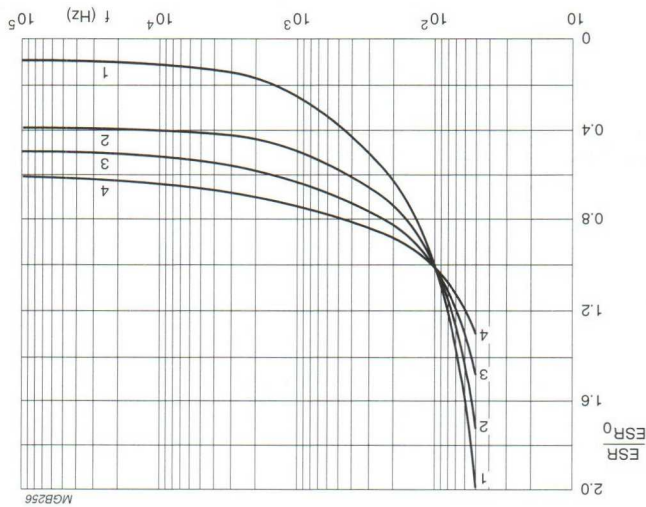


Fig. 9 Typical multiplier of ESR as a function of frequency.

Case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm.
 ESR_0 = typical at 20°C , 100 Hz.
 Curve 4: 10 V; 16 V.
 Curve 3: 25 V; 40 V.
 Curve 2: 63 V ($\geq 10 \mu\text{F}$) and 100 V.
 Curve 1: 63 V ($< 10 \mu\text{F}$) and 200 V.

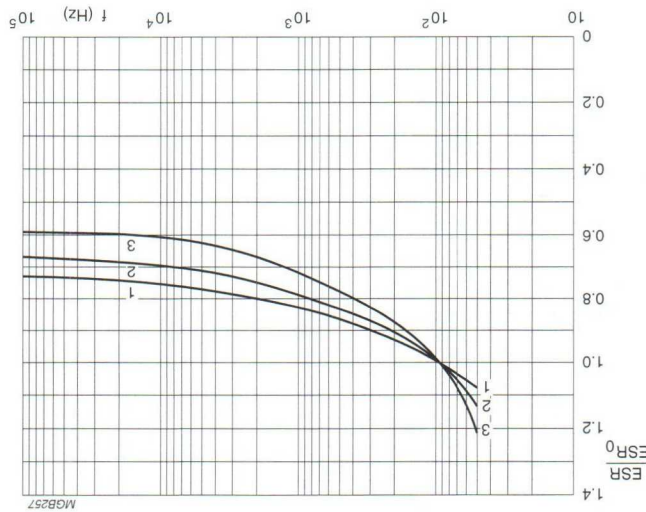
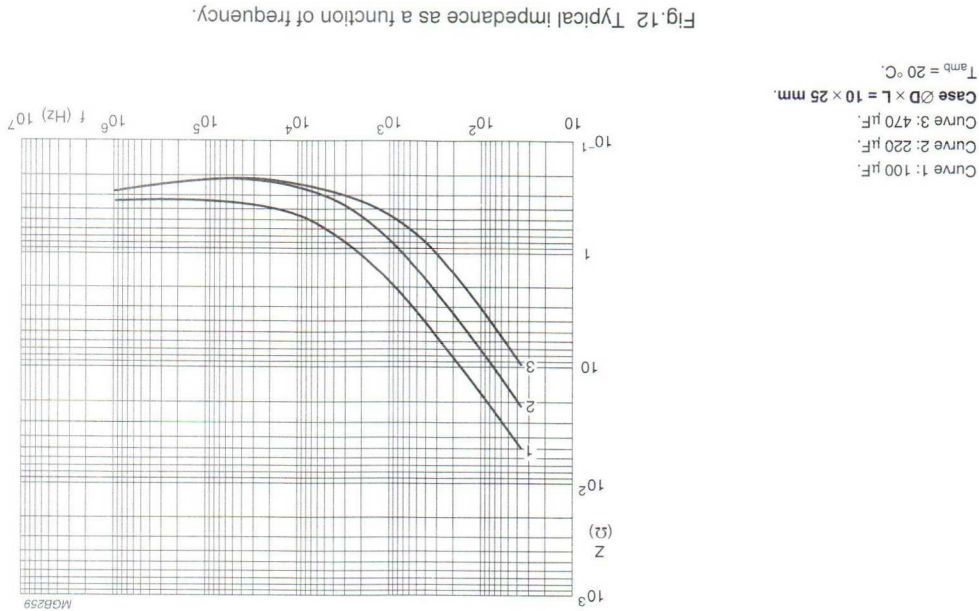
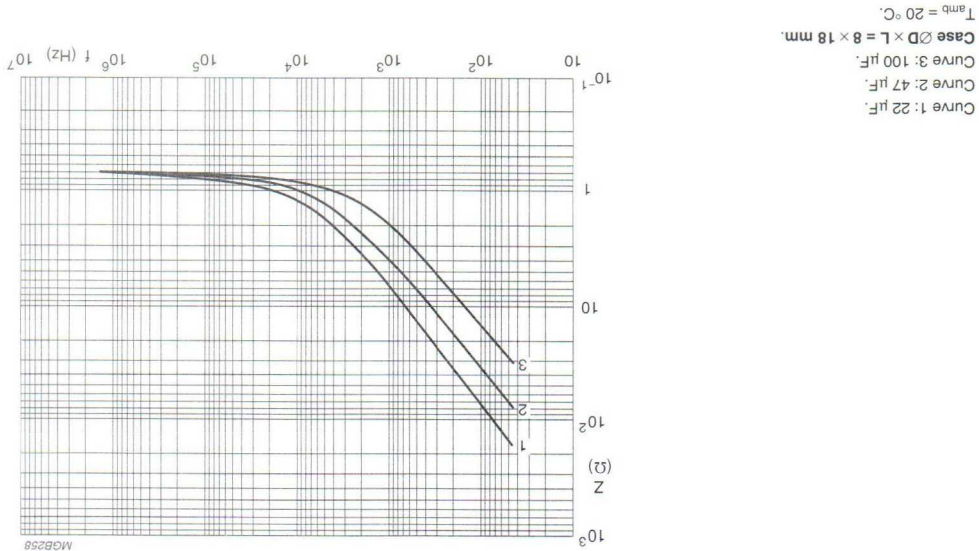


Fig. 10 Typical multiplier of ESR as a function of frequency.

Case $\varnothing D \times L = 10 \times 30$ to 21×40 mm.
 ESR_0 = typical at 20°C , 100 Hz.
 Curve 3: 40 to 100 V.
 Curve 2: 16 V; 25 V.
 Curve 1: 10 V.

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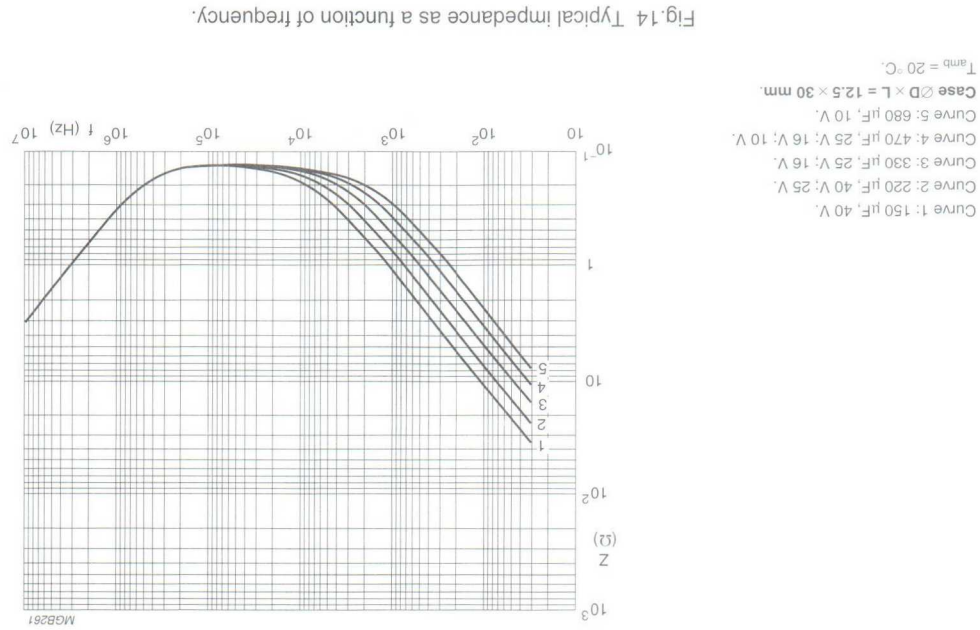
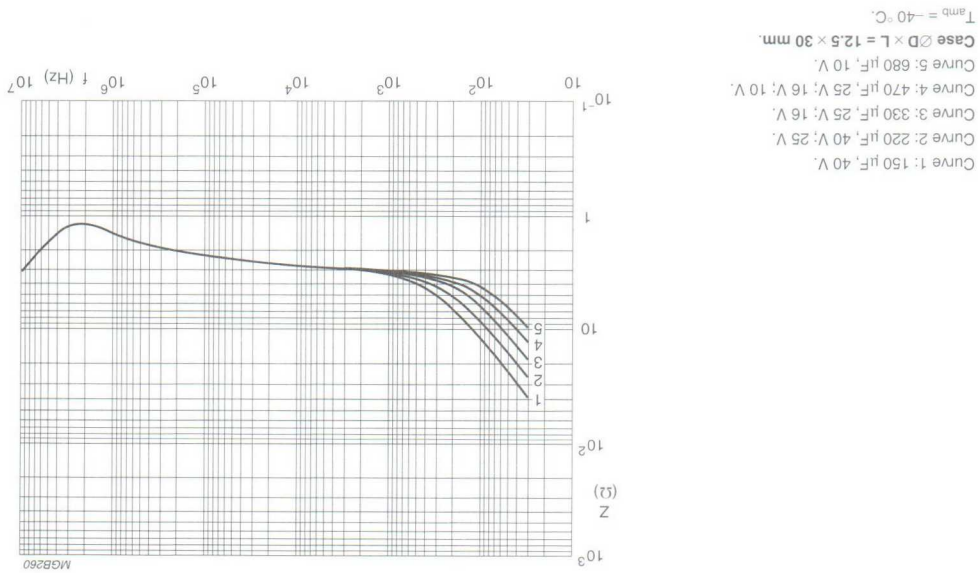
Impedance (Z)



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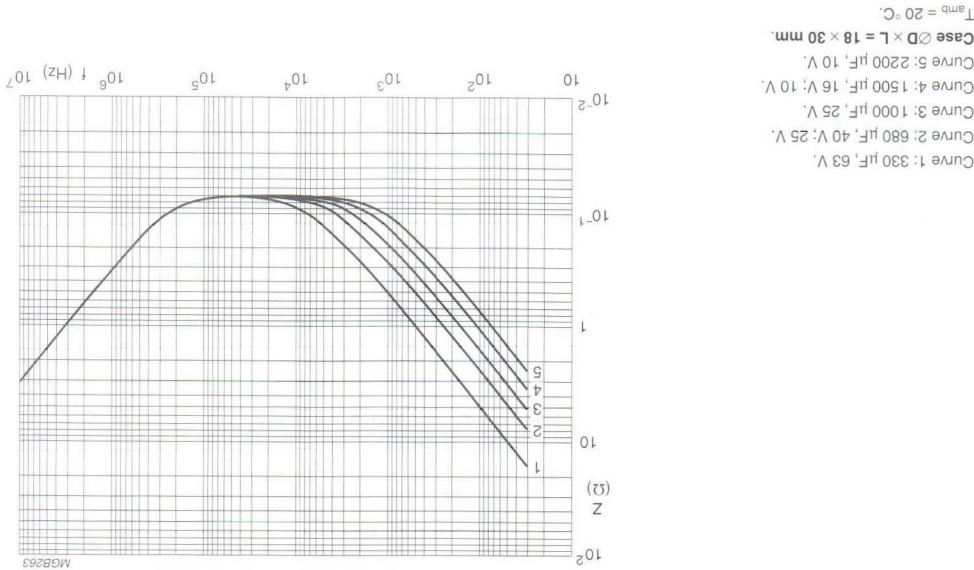
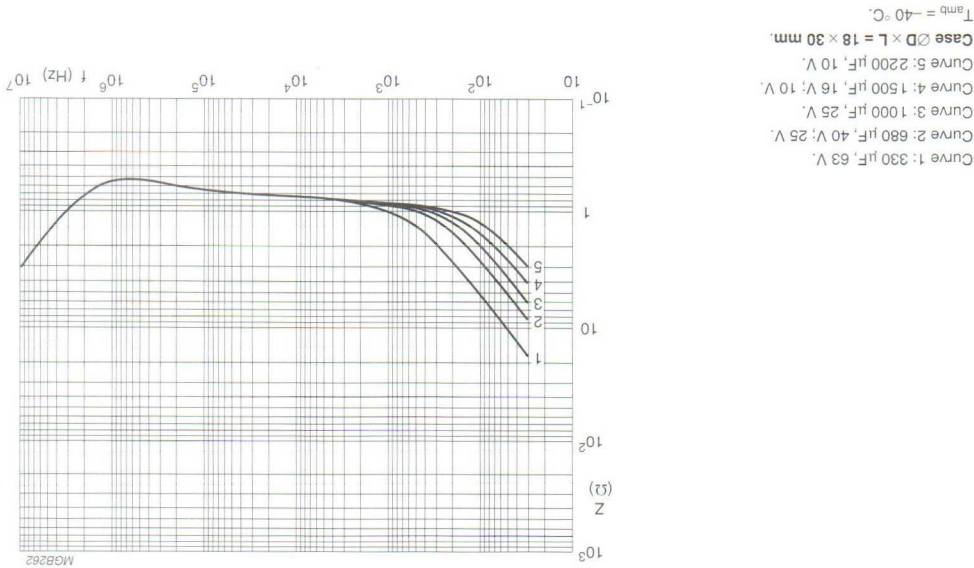
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Product specification



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Axial High Temperature, DIN-based

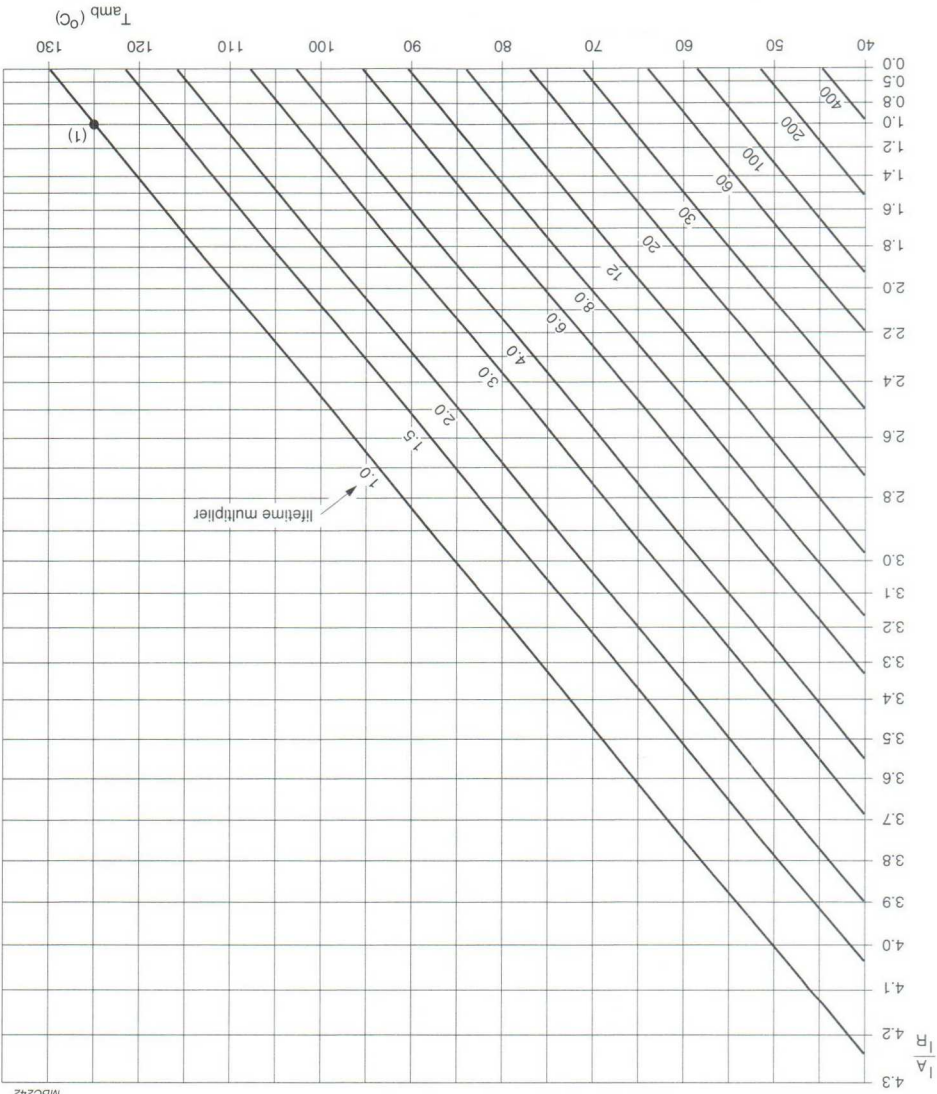
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Aluminium electrolytic capacitors
Axial High Temperature, DIN-based

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RIPPLE CURRENT AND USEFUL LIFE



MBC242

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 $\odot D \times L = 6.5 \times 18$ to 10×25 mm: 4000 hours

case $\odot D \times L = 10 \times 30$ to 21×40 mm: 5000 hours (100 V: 4000 hours).

Fig. 17 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Axial High Temperature, DIN-based

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Table 5 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 125 °C, 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10$ and 16 V	$U_R = 25$ and 40 V	$U_R = 63$ to 200 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1 000	1.12	1.2	1.3
3 000	1.15	1.25	1.35
$\geq 10\,000$	1.2	1.3	1.4

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 6 Test procedures and requirements

TEST		PROCEDURE (quick reference)		REQUIREMENTS	
NAME OF TEST		REFERENCE			
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 125^\circ\text{C}$; U_R applied; case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm; 2 000 hours; case $\varnothing D \times L = 10 \times 30$ to 21×40 mm; 4 000 hours (100 V; 3 000 hours)	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$		
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 125^\circ\text{C}$; U_R and I_R applied; case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm; 4 000 hours; case $\varnothing D \times L = 10 \times 30$ to 21×40 mm; 5 000 hours (100 V; 4 000 hours)	$\Delta C/C: \pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$		
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 125^\circ\text{C}$; 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	$\Delta C/C, \tan \delta, Z$: for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$		
Reverse voltage	IEC 384-4/ CECC 30300 subclause 4.15	$T_{amb} = 125^\circ\text{C}$; 125 hours at $U = -1$ V followed by 125 hours at U_R	$\Delta C/C: \pm 20\%$ $\tan \delta \leq \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$		

SNAP-IN/DIN-PW CAPACITORS

ECONOMY				EURO-DIN				LONG-LIFE			
2500 to 12000 hours				15000 hours				3000 to 10000 hours			
85 °C				85 °C				105 °C			
051-053 PEC-PW page 522				050-052 PED-PW page 540				162/163 PLL-PW page 561			
166/167 PSM-4TSI page 508								168/169 PLL-4TSI page 515			
056/057 PSM-SI page 472								058/059 PLL-SI page 491			
157 PUM-SI page 450								159 PUL-SI page 461			
											
											
											

Aluminium electrolytic capacitors

Power Ultra Miniature Snap-in

157 PUM-SI

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, very small dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Pressure relief on the top of the aluminium case
- Charge and discharge proof
- Useful life: 2 500 hours at 85 °C.

APPLICATIONS

- General purpose, industrial and audio/video systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.

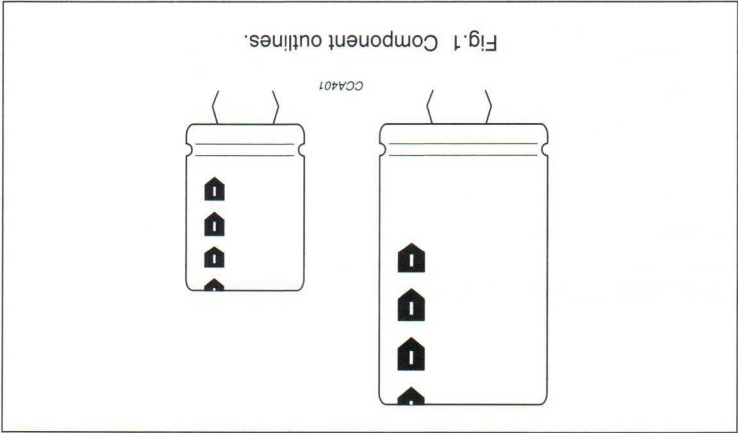
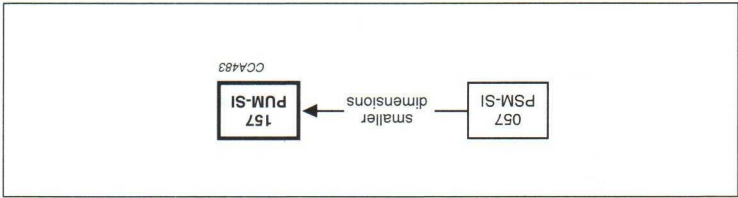


Fig.1 Component outlines.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	22 × 25 to 35 × 50
Rated capacitance range (E6/E12 series), C_R	56 to 2200 μF
Tolerance on C_R	±20%
Rated voltage range, U_R	200 V, 250 V, 400 V, 450 V
Category temperature range	−25 to +85 °C
Endurance test at 85 °C	2000 hours
Load life at 85 °C	2000 hours
Useful life at 85 °C	2500 hours
Useful life at 40 °C and 1.4 × I_R applied	45000 hours
Shelf life at 0 V, 85 °C	1 000 hours
Based on sectional specification	IEC 384-4-1/CECC 30300
Climatic category IEC 68	25/085/56

Aluminium electrolytic capacitors
Power Ultra Miniature Snap-in

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Selection chart for C_R, U_R and relevant nominal case sizes (∅ × L in mm); preferred types in bold

C _R (μF)	U _R (V)		
	200	250	400
56	—	—	22 × 25
68	—	—	22 × 25
82	—	—	22 × 25
100	—	—	22 × 30
	—	—	22 × 35
120	—	—	22 × 30
	—	—	25 × 30
150	—	—	22 × 35
	—	—	25 × 30
	—	—	25 × 40
180	—	—	22 × 40
	—	—	25 × 35
	—	—	30 × 35
220	—	22 × 30	25 × 40
	—	—	30 × 30
	—	—	35 × 25
270	22 × 25	22 × 30	25 × 45
	—	25 × 25	30 × 35
	—	—	35 × 30
330	22 × 30	22 × 35	30 × 40
	—	25 × 30	35 × 30
	—	22 × 40	30 × 45
390	—	30 × 25	35 × 35
470	22 × 35	25 × 35	30 × 50
	25 × 30	30 × 30	35 × 40
560	25 × 35	30 × 30	—
	30 × 25	35 × 25	—
	25 × 40	—	—
680	25 × 40	25 × 45	35 × 50
	30 × 30	30 × 35	—
	35 × 25	—	—
820	25 × 45	30 × 40	—
	30 × 35	35 × 35	—
	35 × 30	—	—
1 000	30 × 40	30 × 45	—
	35 × 30	—	—
1 200	30 × 45	35 × 45	—
	35 × 35	—	—
	—	—	—
1 500	30 × 40	35 × 50	—
	35 × 40	—	—
1 800	35 × 45	—	—
2 200	35 × 50	—	—

Aluminium electrolytic capacitors

Power Ultra Miniature Snap-in

157 PUM-SI

MARKING

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

- Rated capacitance (in μF)
- Tolerance code on rated capacitance (M for $\pm 20\%$)
- Rated voltage (in V)
- 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" and "CECC 30301".

Aluminium electrolytic capacitors

Power Ultra Miniature Snap-in

157 PUM-SI

MECHANICAL DATA AND PACKAGING QUANTITIES

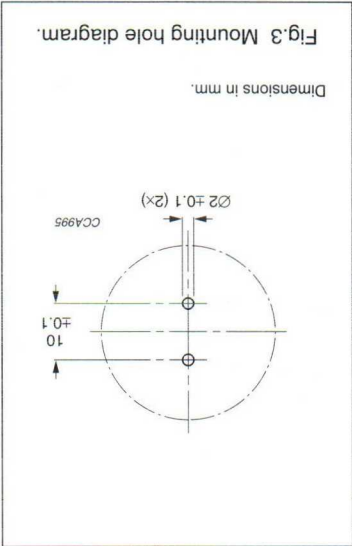
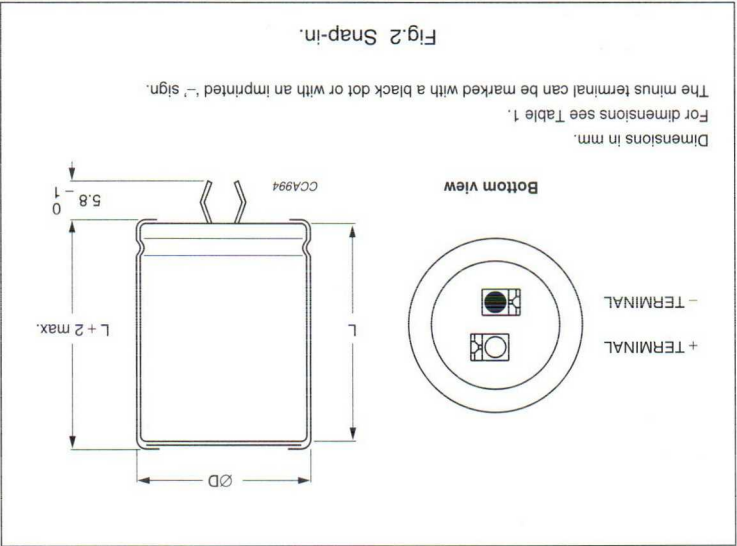


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing D_{max}$ (mm)	L_{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS $l \times w \times h$ (mm)
22 × 25	2225	23	27	≈12	100	260 × 250 × 39
22 × 30	2230	23	32	≈16	100	260 × 250 × 44
22 × 35	2235	23	37	≈20	100	260 × 250 × 49
22 × 40	2240	23	42	≈23	100	260 × 250 × 54
25 × 25	2525	26	27	≈20	100	290 × 280 × 39
25 × 30	2530	26	32	≈22	100	290 × 280 × 44
25 × 35	2535	26	37	≈24	100	290 × 280 × 49
25 × 40	2540	26	42	≈27	100	290 × 280 × 54
25 × 45	2545	26	47	≈32	100	290 × 280 × 59
25 × 50	2550	26	52	≈38	100	290 × 280 × 64
30 × 25	3025	31	27	≈25	100	340 × 330 × 39
30 × 30	3030	31	32	≈30	100	340 × 330 × 44
30 × 35	3035	31	37	≈35	100	340 × 330 × 49
30 × 40	3040	31	42	≈40	100	340 × 330 × 54
30 × 45	3045	31	47	≈45	100	340 × 330 × 59
30 × 50	3050	31	52	≈50	100	340 × 330 × 64
35 × 25	3525	36	27	≈33	50	390 × 198 × 39
35 × 30	3530	36	32	≈40	50	390 × 198 × 44
35 × 35	3535	36	37	≈48	50	390 × 198 × 49
35 × 40	3540	36	42	≈55	50	390 × 198 × 54
35 × 45	3545	36	47	≈63	50	390 × 198 × 59
35 × 50	3550	36	52	≈72	50	390 × 198 × 64

Aluminium electrolytic capacitors
Power Ultra Miniature Snap-in

Ordering example

Electrolytic capacitor 157 series

1 000 µF/200 V; ±20%

Nominal case size: Ø30 × 40 mm

Catalogue number: 2222 157 52102.

SYMBOL	DESCRIPTION
C _R	rated capacitance at 100/120 Hz
I _R	rated RMS ripple current at 120 Hz, 85 °C
I _{LS}	max. leakage current after 5 minutes at U _R
ESR	typ. equivalent series resistance at 100 Hz; note 1
Z	max. impedance at 10 kHz

Note

1. ESR at 120 Hz is approximately 0.95 × ESR 100 Hz.

Table 2 Electrical data and ordering information; preferred types in bold

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	I _R 120 Hz 85 °C (A)	I _{LS} 5 min (mA)	TYP. ESR 100 Hz ⁽¹⁾ (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER
200	270	22 × 25	2225	1.15	0.54	280	700	157 52271
	330	22 × 30	2230	1.36	0.66	260	500	157 52331
	390	22 × 30	2230	1.46	0.78	230	490	157 52391
	470	22 × 35	2235	1.68	0.94	190	400	157 32471
	560	22 × 40	2240	1.91	1.12	190	390	157 42561
		25 × 35	2535	1.91	1.12	160	390	157 32561
		30 × 25	3025	1.89	1.12	160	390	157 52561
680		25 × 40	2540	2.18	1.36	170	340	157 42681
		30 × 30	3030	2.04	1.36	170	340	157 52681
		35 × 25	3525	2.06	1.36	170	340	157 62681
820		25 × 45	2545	2.46	1.64	120	240	157 62821
		30 × 35	3035	2.35	1.64	140	240	157 32821
		35 × 30	3530	2.29	1.64	160	240	157 52821
1 000		30 × 40	3040	2.66	2.00	120	225	157 52102
		35 × 30	3530	2.33	2.00	160	225	157 62102
1 200		30 × 45	3045	2.98	2.40	100	190	157 32122
		35 × 35	3535	2.69	2.40	130	190	157 62122
1 500		30 × 50	3050	3.31	3.00	90	155	157 42152
		35 × 40	3540	3.04	3.00	110	155	157 52152
		35 × 45	3545	3.36	3.60	90	130	157 42182
2 200		35 × 50	3550	3.68	4.40	80	105	157 52222

Aluminium electrolytic capacitors
Power Ultra Miniature Snap-in

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 120 Hz 85 °C (A)	I_S 5 min (mA)	TYP. ESR 100 Hz ⁽¹⁾ (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
250	220	22 × 30	2230	1.23	0.55	340	700	157 53221
	270	22 × 30	2230	1.32	0.67	280	560	157 43271
	330	25 × 25	2525	1.23	0.67	280	560	157 53271
	330	22 × 35	2235	1.53	0.82	230	430	157 33331
	390	22 × 40	2240	1.74	0.97	190	425	157 43391
	470	25 × 35	2535	1.87	1.17	180	320	157 33471
	560	25 × 40	2540	2.12	1.40	160	360	157 43561
	680	25 × 45	2545	2.29	1.70	130	260	157 63681
	820	30 × 40	3040	2.57	2.05	120	210	157 53821
	1 000	30 × 45	3045	2.88	2.50	110	180	157 33102
	1 200	35 × 45	3545	3.17	3.00	100	160	157 43122
	1 500	35 × 50	3550	3.49	3.75	90	140	157 53152

Aluminium electrolytic capacitors

Power Ultra Miniature Snap-in

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 120 Hz 85 °C (A)	I_{LS} 5 min (mA)	TYP. ESR 100 Hz ⁽¹⁾ (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
400	68	22 × 25	2225	0.71	0.27	1180	1950	157 56689
	82	22 × 25	2225	0.77	0.33	990	1620	157 56829
	100	22 × 30	2230	0.94	0.40	930	1220	157 56101
	120	22 × 30	2230	0.97	0.48	870	1140	157 56121
	150	22 × 35	2235	1.13	0.60	700	900	157 36151
		25 × 30	2530	1.16	0.60	680	900	157 56151
	180	22 × 40	2240	1.29	0.72	590	725	157 46181
		25 × 35	2535	1.35	0.72	550	725	157 36181
	220	25 × 40	2540	1.54	0.88	520	590	157 46221
		30 × 30	3030	1.50	0.88	470	590	157 56221
		35 × 25	3525	1.42	0.88	470	590	157 66221
	270	25 × 45	2545	1.72	1.08	400	560	157 66271
		30 × 35	3035	1.74	1.08	380	560	157 36271
		35 × 30	3530	1.71	1.08	400	560	157 56271
	330	30 × 40	3040	1.97	1.32	320	525	157 56331
		35 × 30	3530	1.76	1.32	370	525	157 66331
	390	30 × 45	3045	2.19	1.56	270	420	157 56391
		35 × 35	3535	2.04	1.56	300	420	157 36391
	470	30 × 50	3050	2.40	1.88	240	350	157 46471
		35 × 40	3540	2.30	1.88	250	350	157 56471
		35 × 45	3545	2.55	2.24	210	305	157 46561
	680	35 × 50	3550	2.79	2.72	190	265	157 56681

Aluminium electrolytic capacitors
Power Ultra Miniature Snap-in

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U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 120 Hz 85 °C (A)	I_{LS} 5 min (mA)	TYP. ESR 100 Hz ⁽¹⁾ (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER
450	56	22 × 25	2225	0.68	0.25	1 200	1 880	157 57569
68	22 × 30	2230	2230	0.80	0.30	1 230	1 530	157 57689
82	22 × 30	2230	2230	0.87	0.36	1 030	1 290	157 47829
	25 × 25	2525	2525	0.85	0.36	1 030	1 290	157 57829
100	22 × 35	2235	2235	1.00	0.45	840	1 050	157 37101
	25 × 30	2530	2530	1.02	0.45	860	1 050	157 57101
120	22 × 40	2240	2240	1.15	0.54	710	885	157 47121
	25 × 30	2530	2530	1.09	0.54	710	885	157 57121
150	25 × 40	2540	2540	1.35	0.67	570	705	157 47151
	25 × 35	2535	2535	1.27	0.67	600	705	157 67151
	30 × 30	3030	3030	1.32	0.67	600	705	157 57151
180	25 × 40	2540	2540	1.45	0.81	480	605	157 47181
	30 × 35	3035	3035	1.49	0.81	490	605	157 57181
	35 × 25	3525	3525	1.35	0.81	490	605	157 67181
220	25 × 50	2550	2550	1.73	0.99	400	525	157 47221
	30 × 40	3040	3040	1.72	0.99	410	525	157 57221
	35 × 30	3530	3530	1.61	0.99	440	525	157 67221
270	30 × 45	3045	3045	1.95	1.21	340	450	157 37271
	35 × 35	3535	3535	1.86	1.21	360	450	157 67271
330	30 × 50	3050	3050	2.19	1.48	280	390	157 47331
	35 × 40	3540	3540	2.10	1.48	300	390	157 57331
	35 × 45	3545	3545	2.34	1.75	250	340	157 47391
470	35 × 50	3550	3550	2.60	2.11	210	290	157 57471

Note

1. ESR at 120 Hz is approximately 0.95 × ESR 100 Hz.

Aluminium electrolytic capacitors

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Additional electrical data

PARAMETER	CONDITIONS		VALUE
Voltage			
Surge voltage for short periods	≥400 V versions	$U_s = 1.1 \times U_R$	
	≤250 V versions	$U_s = 1.15 \times U_R$	
Reverse voltage		not allowed	
Current			
Leakage current	after 5 minutes at U_R	$I_{L5} \leq 0.01 C_R \times U_R$	
Inductance			
Equivalent series inductance (ESL)	all case sizes	typ. 19 nH	
		max. 25 nH	
Dissipation factor			
Tangent of loss angle	all types	$\tan \delta \leq 0.15$	

Aluminium electrolytic capacitors

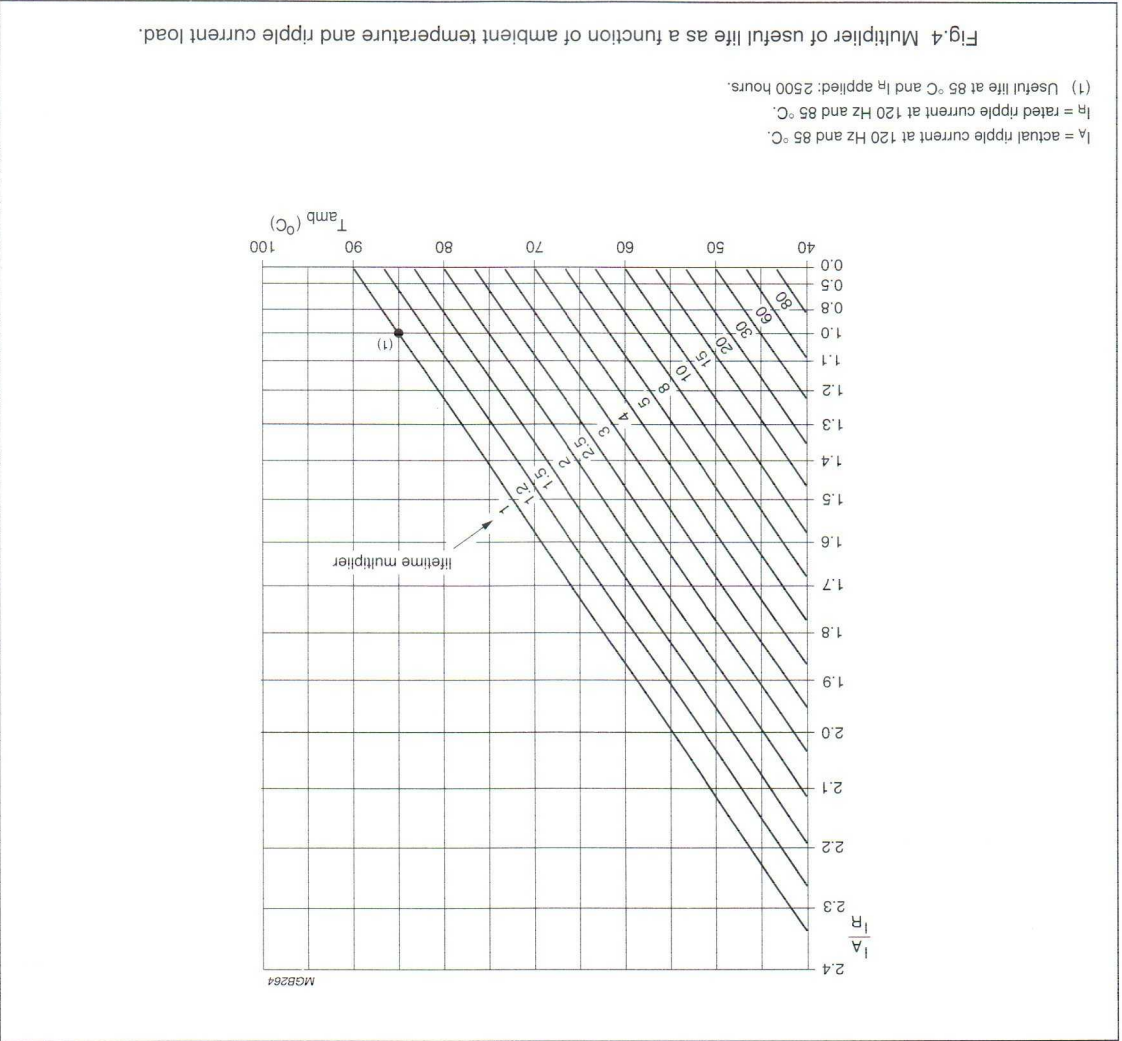
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RIPPLE CURRENT AND USEFUL LIFE

Table 3 Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER
≥10000	1.4
1 000	1.3
200	1.15
120	1.0
100	0.95
50	0.9



Aluminium electrolytic capacitors
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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85^{\circ}\text{C}$; U_R applied; 2000 hours	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{ES} \leq \text{spec. limit}$
Load life		$T_{amb} = 85^{\circ}\text{C}$; U_R and I_R applied; 2000 hours	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{ES} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85^{\circ}\text{C}$; U_R and I_R applied; 2500 hours	$\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{ES} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85^{\circ}\text{C}$; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $I_{ES} \leq 1 \times \text{spec. limit}$

Aluminum electrolytic capacitors

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FEATURES

- Polarized aluminum electrolytic capacitors, non-solid
- Large types, very small dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief on the top of the aluminum case
- Charge and discharge proof
- Low ESR, high ripple current capability
- Useful life: 3 000 hours at 105 °C.

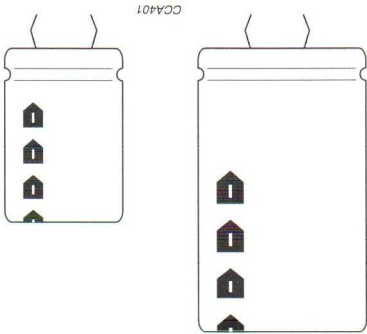
APPLICATIONS

- General purpose, industrial and audio/video systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case size ($\varnothing_{nom} \times L_{nom}$ in mm)	22×25 to 35×50
Rated capacitance range (E6/E12 series), C_R	56 to 1 800 μF
Tolerance on C_R	$\pm 20\%$
Rated voltage range, U_R	200 V, 250 V, 400 V, 450 V
Category temperature range	-25 to +105 °C
Endurance test at 105 °C	2 000 hours
Load life at 105 °C	2 000 hours
Useful life at 105 °C	3 000 hours
Useful life at 40 °C and $1.6 \times I_R$ applied	300 000 hours
Shelf life at 0 V, 105 °C	1 000 hours
Based on sectional specification	IEC 384-4-1/CECC 30300
Climatic category IEC 68	25/105/56

Fig.1 Component outlines.



Aluminium electrolytic capacitors
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Selection chart for C_R, U_R and relevant nominal case sizes (Ø × L in mm); preferred types in bold

C _R (µF)	U _R (V)			C _R (µF)
	200	250	400	
56	—	—	—	22 × 25
68	—	—	22 × 25	22 × 30/25 × 25
82	—	—	22 × 30	22 × 35
100	—	—	22 × 35	22 × 40
	—	—	25 × 30	25 × 30/30 × 25
120	—	—	22 × 35	—
	—	—	25 × 30	25 × 35
	—	—	30 × 25	—
150	—	—	22 × 40	25 × 40
	—	—	25 × 35	30 × 30
	—	—	30 × 30	35 × 25
	—	—	35 × 35	40 × 45
180	—	—	30 × 30	30 × 35
	—	—	35 × 25	—
	—	22 × 30	25 × 45	30 × 40
220	—	22 × 30	30 × 35	35 × 30
	—	25 × 25	35 × 30	—
	—	—	—	30 × 45
270	—	22 × 35	25 × 50	30 × 45
	—	25 × 30	30 × 40	35 × 35
	—	30 × 25	35 × 30	—
330	22 × 30	22 × 40	30 × 45	30 × 50
	—	25 × 30/30 × 25	35 × 35	35 × 40
	22 × 35	25 × 35	30 × 50	35 × 45
390	25 × 30	30 × 30	35 × 40	—
470	22 × 40	25 × 40	35 × 45	35 × 50
	30 × 25	30 × 30/35 × 25	—	—
560	—	25 × 45	35 × 50	—
	25 × 35	30 × 35	—	—
	30 × 30	35 × 30	—	—
680	25 × 45	30 × 40	—	—
	30 × 30	35 × 35	—	—
	35 × 25	—	—	—
820	25 × 50	30 × 45	—	—
	30 × 35	35 × 35	—	—
	35 × 30	35 × 40	—	—
1000	30 × 45	35 × 45	—	—
	35 × 35	35 × 45	—	—
	30 × 50	35 × 45	—	—
1200	35 × 35	35 × 50	—	—
1500	35 × 45	—	—	—
1800	35 × 50	—	—	—

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MARKING

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

- Rated capacitance (in μF)
- Tolerance code on rated capacitance (M for $\pm 20\%$)
- Rated voltage (in V)
- 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" and "CECC 30301".

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MECHANICAL DATA AND PACKAGING QUANTITIES

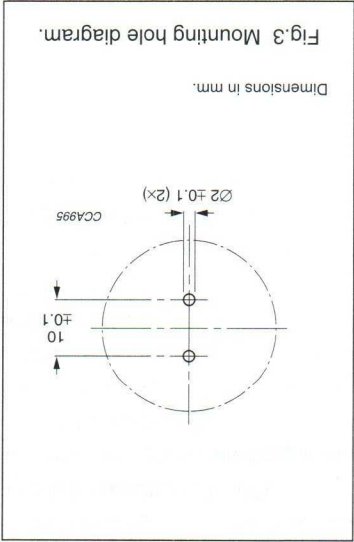
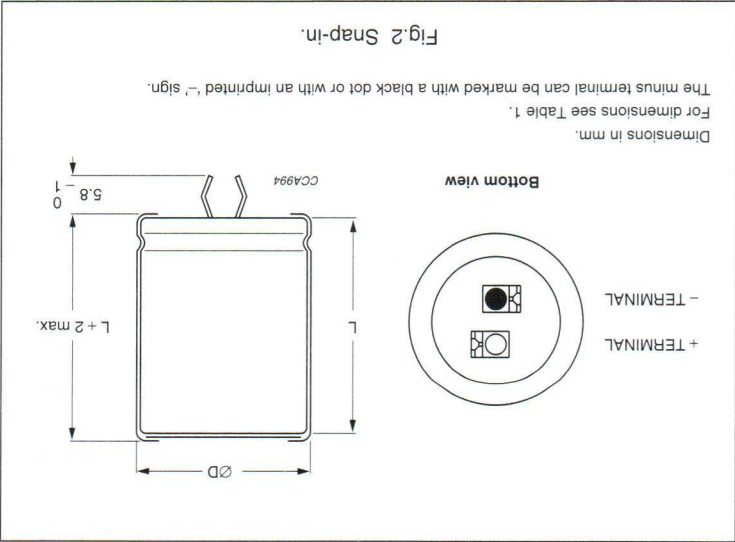


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	ØD _{max} (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
22 × 25	2225	23	27	≈12	100	260 × 250 × 39
22 × 30	2230	23	32	≈16	100	260 × 250 × 44
22 × 35	2235	23	37	≈20	100	260 × 250 × 49
22 × 40	2240	23	42	≈23	100	260 × 250 × 54
25 × 25	2525	26	27	≈20	100	290 × 280 × 39
25 × 30	2530	26	32	≈22	100	290 × 280 × 44
25 × 35	2535	26	37	≈24	100	290 × 280 × 49
25 × 40	2540	26	42	≈27	100	290 × 280 × 54
25 × 45	2545	26	47	≈32	100	290 × 280 × 59
25 × 50	2550	26	52	≈38	100	290 × 280 × 64
30 × 25	3025	31	27	≈25	100	340 × 330 × 39
30 × 30	3030	31	32	≈30	100	340 × 330 × 44
30 × 35	3035	31	37	≈35	100	340 × 330 × 49
30 × 40	3040	31	42	≈40	100	340 × 330 × 54
30 × 45	3045	31	47	≈45	100	340 × 330 × 59
30 × 50	3050	31	52	≈50	100	340 × 330 × 64
35 × 25	3525	36	27	≈33	50	390 × 198 × 39
35 × 30	3530	36	32	≈40	50	390 × 198 × 44
35 × 35	3535	36	37	≈48	50	390 × 198 × 49
35 × 40	3540	36	42	≈55	50	390 × 198 × 54
35 × 45	3545	36	47	≈63	50	390 × 198 × 59
35 × 50	3550	36	52	≈72	50	390 × 198 × 64

Aluminium electrolytic capacitors
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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{amb} = 20^{\circ}C$, $P = 86$ to 106 kPa, RH = 45 to 75%.

Electrolytic capacitor 159 series
1 000 $\mu F/200 V$; $\pm 20\%$

Nominal case size: $\varnothing 30 \times 45$ mm

Catalogue number: 2222 159 42102.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz
I_R	rated RMS ripple current at 120 Hz, 105 °C
I_{LS}	max. leakage current after 5 minutes at U_R
ESR	typ. equivalent series resistance at 100 Hz; note 1
Z	max. impedance at 10 kHz

Note

1. ESR at 120 Hz is approximately $0.95 \times ESR$ 100 Hz.

Table 2 Electrical data and ordering information; preferred types in bold

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 120 Hz 105 °C (A)	I_{LS} 5 min (mA)	TYP. ESR 100 Hz ⁽¹⁾ (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
200	330	22 × 30	2230	1.08	0.66	450	500	159 52331
	390	22 × 35	2235	1.23	0.78	380	470	159 42391
	390	25 × 30	2530	1.23	0.78	390	470	159 52391
470	470	22 × 40	2240	1.37	0.94	320	400	159 32471
470	470	30 × 25	3025	1.27	0.94	370	400	159 52471
560	560	25 × 35	2535	1.50	1.12	280	390	159 42561
560	560	30 × 30	3030	1.52	1.12	290	390	159 52561
680	680	25 × 45	2545	1.82	1.36	230	340	159 42681
680	680	30 × 30	3030	1.59	1.36	260	340	159 52681
680	680	35 × 25	3525	1.44	1.36	300	340	159 62681
820	820	25 × 50	2550	2.04	1.64	190	240	159 32821
820	820	30 × 35	3035	1.83	1.64	210	240	159 42821
820	820	35 × 30	3530	1.77	1.64	230	240	159 52821
1 000	1 000	30 × 45	3045	2.23	2.00	170	225	159 42102
1 000	1 000	35 × 35	3535	2.04	2.00	190	225	159 52102
1 200	1 200	30 × 50	3050	2.47	2.40	140	190	159 42122
1 200	1 200	35 × 35	3535	2.07	2.40	180	190	159 52122
1 500	1 500	35 × 45	3545	2.56	3.00	130	155	159 52152
1 800	1 800	35 × 50	3550	2.80	3.60	120	130	159 52182

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U_R (V)	C_R (μ F) 100 Hz	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 120 Hz 105 °C (A)	I_{L5} 5 min (mA)	TYP. ESR 100 Hz ⁽¹⁾ (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER
250	220	22 × 30	2230	0.90	0.55	540	700	159 43221
	220	25 × 25	2525	0.90	0.55	560	700	159 53221
	270	22 × 35	2235	1.07	0.67	440	560	159 43271
	270	25 × 30	2530	1.08	0.67	450	560	159 53271
	270	30 × 25	3025	1.08	0.67	470	560	159 63271
	330	22 × 40	2240	1.20	0.82	360	430	159 33331
	330	25 × 30	2530	1.21	0.82	380	430	159 43331
	330	30 × 25	3025	1.19	0.82	410	430	159 53331
	390	25 × 35	2535	1.39	0.97	330	410	159 43391
	390	30 × 30	3030	1.41	0.97	330	410	159 53391
	470	25 × 40	2540	1.58	1.17	270	400	159 33471
	470	30 × 30	3030	1.48	1.17	330	400	159 43471
	470	35 × 25	3525	1.37	1.17	330	400	159 53471
	560	25 × 45	2545	1.78	1.40	240	310	159 43561
	560	30 × 35	3035	1.71	1.40	270	310	159 53561
	560	35 × 30	3530	1.67	1.40	260	310	159 63561
	680	30 × 40	3040	1.93	1.70	210	260	159 43681
	680	35 × 35	3535	1.92	1.70	210	260	159 53681
	820	30 × 45	3045	2.16	2.05	180	210	159 43821
	820	35 × 35	3535	1.97	2.05	200	210	159 53821
	820	35 × 40	3540	2.16	2.05	180	210	159 63821
	1000	35 × 40	3540	2.22	2.50	170	180	159 53102
	1000	35 × 45	3545	2.41	2.50	150	180	159 63102
	1200	35 × 45	3545	2.46	3.00	150	160	159 43122
	1200	35 × 50	3550	2.65	3.00	130	160	159 53122

Aluminium electrolytic capacitors

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U _R (V)	400	C _R 100 Hz (µF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	I _R 120 Hz 105 °C (A)	I _{LS} 5 min (mA)	TYP. ESR 100 Hz ⁽¹⁾ (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222
	68	22 × 25	2225	0.51	0.27	1520	1520	1950	159 56689
	82	22 × 30	2230	0.60	0.33	1200	1520	1520	159 46829
	82	25 × 25	2525	0.60	0.33	1220	1520	1520	159 56829
100	100	22 × 35	2235	0.69	0.40	990	1240	1240	159 46101
100	100	25 × 30	2530	0.70	0.40	990	1240	1240	159 56101
120	120	22 × 35	2235	0.76	0.48	840	1100	1100	159 46121
120	120	25 × 30	2530	0.76	0.48	840	1100	1100	159 56121
120	120	30 × 25	3025	0.77	0.48	860	1100	1100	159 66121
150	150	22 × 40	2240	0.86	0.60	820	860	860	159 36151
150	150	25 × 35	2535	0.89	0.60	670	860	860	159 46151
150	150	30 × 30	3030	0.92	0.60	670	860	860	159 56151
180	180	25 × 40	2540	1.01	0.72	560	700	700	159 36181
180	180	30 × 30	3030	0.99	0.72	580	700	700	159 46181
180	180	35 × 25	3525	0.96	0.72	620	700	700	159 56181
220	220	25 × 45	2545	1.15	0.88	460	590	590	159 46221
220	220	30 × 35	3035	1.15	0.88	480	590	590	159 56221
220	220	35 × 30	3530	1.14	0.88	490	590	590	159 66221
270	270	25 × 50	2550	1.31	1.08	380	550	550	159 46271
270	270	30 × 40	3040	1.30	1.08	390	550	550	159 56271
270	270	35 × 30	3530	1.21	1.08	420	550	550	159 66271
330	330	30 × 45	3045	1.47	1.32	320	450	450	159 56331
330	330	35 × 35	3535	1.40	1.32	340	450	450	159 66331
390	390	30 × 50	3050	1.63	1.56	280	410	410	159 46391
390	390	35 × 40	3540	1.57	1.56	290	410	410	159 56391
470	470	35 × 45	3545	1.72	1.88	240	330	330	159 56471
560	560	35 × 50	3550	1.84	2.24	210	280	280	159 56561

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø × L (mm)	CASE CODE	I _R 120 Hz 105 °C (A)	I _{LS} 5 min (mA)	TYP. ESR 100 Hz ⁽¹⁾ (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER 2222
450	56	22 × 25	2225	0.48	0.25	1 630	1 880	159 57569
	68	22 × 30	2230	0.56	0.30	1 280	1 530	159 47689
	68	25 × 25	2525	0.56	0.30	1 290	1 530	159 57689
	82	22 × 35	2235	0.64	0.36	1 060	1 290	159 57829
	100	22 × 40	2240	0.74	0.45	870	1 050	159 37101
	100	25 × 30	2530	0.71	0.45	890	1 050	159 47101
	100	30 × 25	3025	0.73	0.45	910	1 050	159 57101
	120	25 × 35	2535	0.82	0.54	730	885	159 57121
	150	25 × 40	2540	0.95	0.67	590	705	159 47151
	150	30 × 30	3030	0.93	0.67	610	705	159 57151
	150	35 × 25	3525	0.91	0.67	650	705	159 67151
	180	25 × 45	2545	1.07	0.81	490	605	159 47181
	180	30 × 35	3035	1.06	0.81	510	605	159 57181
	220	30 × 40	3040	1.21	0.99	420	525	159 47221
	220	35 × 30	3530	1.14	0.99	450	525	159 57221
	270	30 × 45	3045	1.37	1.21	340	450	159 47271
	270	35 × 35	3535	1.32	1.21	370	450	159 57271
	330	30 × 50	3050	1.54	1.48	290	390	159 47331
	330	35 × 40	3540	1.49	1.48	300	390	159 57331
	390	35 × 45	3545	1.61	1.75	260	340	159 57391
	470	35 × 50	3550	1.72	2.11	220	290	159 57471

Note 1. ESR at 120 Hz is approximately 0.95 × ESR 100 Hz.

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Additional electrical data

PARAMETER	CONDITIONS		VALUE
Voltage			
Surge voltage for short periods	≥400 V versions		$U_s = 1.1 \times U_R$
	≤250 V versions		$U_s = 1.15 \times U_R$
Reverse voltage			not allowed
Current			
Leakage current	after 5 minutes at U_R		$I_{L5} \leq 0.01 C_R \times U_R$
Inductance			
Equivalent series inductance (ESL)	all case sizes		typ. 19 nH
			max. 25 nH
Dissipation factor			
Tangent of loss angle (120 Hz)	all types		$\tan \delta \leq 0.15$

Aluminium electrolytic capacitors

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RIPPLE CURRENT AND USEFUL LIFE

Table 3 Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.9
100	0.95
120	1.0
200	1.15
1 000	1.3
≥ 10000	1.4

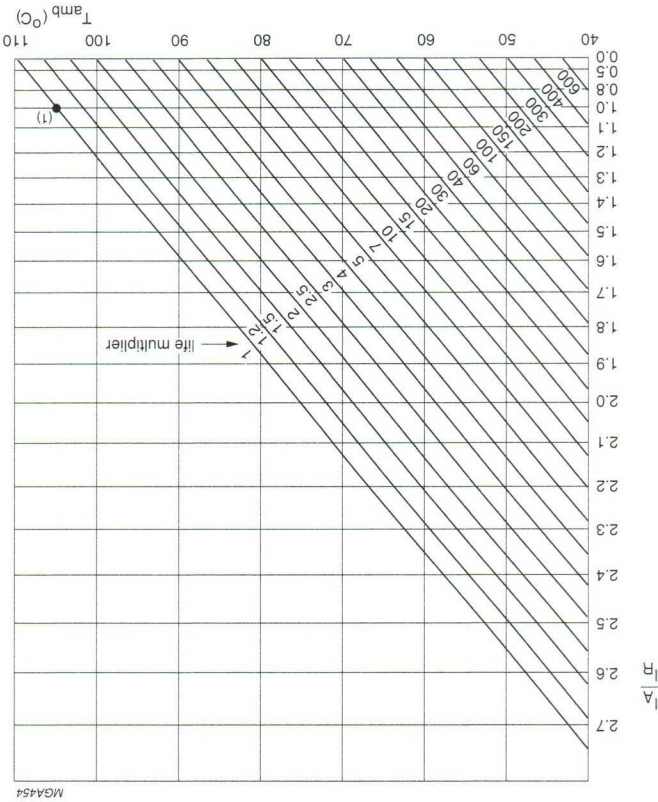


Fig.4 Multiplier of useful life as a function of ambient temperature and ripple current load.

I_A = actual ripple current at 120 Hz and 105 °C.
 I_R = rated ripple current at 120 Hz and 105 °C.
(1) Useful life at 105 °C and I_R applied: 3000 hours.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105^{\circ}\text{C}$; U_R applied; 2000 hours	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$
Load life		$T_{amb} = 105^{\circ}\text{C}$; U_R and I_R applied; 2000 hours	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105^{\circ}\text{C}$; U_R and I_R applied; 3000 hours	$\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$ total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 105^{\circ}\text{C}$; no voltage applied; 1 000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $I_{LS} \leq \text{spec. limit}$

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FEATURES

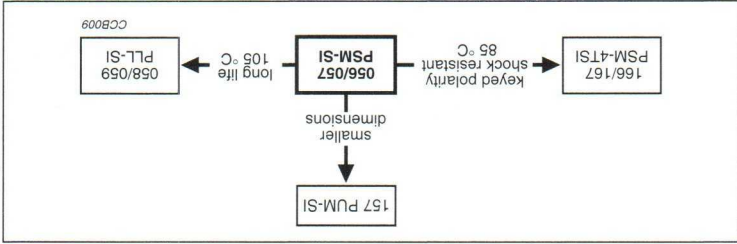
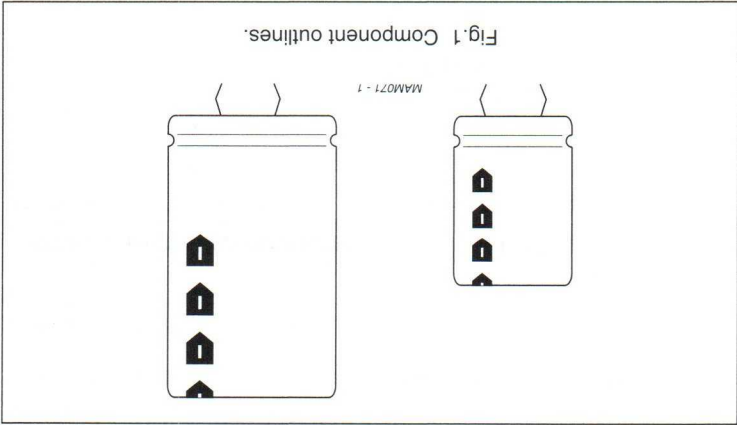
- Polarized aluminum electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief on the top of the aluminum case
- Charge and discharge proof
- Long useful life: 12000 hours at 85 °C
- High ripple current capability; see Table 3 for ripple current optimized types, 385 V and 400 V.

APPLICATIONS

- General purpose, industrial and audio/video systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.

QUICK REFERENCE DATA

DESCRIPTION		VALUE
Case size ($\varnothing_{nom} \times L_{nom}$ in mm)	22 × 25 to 35 × 50	
Rated capacitance range (E6 series), C_R	470 to 68000 μF	47 to 1500 μF
Tolerance on C_R	±20%	
Rated voltage range, U_R	10 to 100 V	200 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	12000 hours (450 V: 5000 hours)	
Useful life at 40 °C and 1.4 × I_R applied	21000 hours (450 V: 90000 hours)	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Detail specification	CECC 30301-806	
Climatic category IEC 68	40/085/56	



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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 056 series
Preferred types in bold

C_R (μF)	U_R (V)					
	10	16	25	40	50	63
470	—	—	—	—	—	22 × 25
680	—	—	—	—	—	22 × 30
1000	—	—	—	—	—	22 × 25
	—	—	—	—	—	22 × 40
1500	—	—	—	—	—	—
	—	—	—	—	—	25 × 40
2200	—	—	—	22 × 25	22 × 30	30 × 40
	—	—	—	—	—	22 × 40
3300	—	—	22 × 25	22 × 30	25 × 30	30 × 30
	—	—	—	—	—	22 × 40
4700	—	—	22 × 25	22 × 30	25 × 30	30 × 40
	—	—	—	—	—	25 × 50
6800	22 × 25	22 × 30	25 × 30	30 × 30	30 × 40	35 × 40
	—	—	22 × 40	25 × 40	25 × 50	30 × 50
10000	22 × 30	25 × 30	30 × 30	30 × 40	35 × 40	35 × 50
	—	22 × 40	25 × 40	25 × 50	30 × 50	—
15000	25 × 30	30 × 30	30 × 40	35 × 40	35 × 50	—
	22 × 40	25 × 40	25 × 50	30 × 50	—	—
22000	30 × 30	30 × 40	35 × 40	35 × 50	—	—
	25 × 40	25 × 50	30 × 50	—	—	—
33000	30 × 40	35 × 40	35 × 50	—	—	—
	25 × 50	30 × 50	—	—	—	—
47000	35 × 40	35 × 50	—	—	—	—
	30 × 50	—	—	—	—	—
68000	35 × 50	—	—	—	—	—

Aluminium electrolytic capacitors
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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 057 series
Preferred types in **bold**.

C_R (μF)	U_R (V)				
		200	250	385	400
47		—	—	22 × 30 ⁽¹⁾	22 × 30 ⁽¹⁾
		—	—	22 × 25	22 × 25
68		—	—	25 × 30 ⁽¹⁾	25 × 30 ⁽¹⁾
		—	—	22 × 40 ⁽¹⁾	22 × 35 ⁽¹⁾
		—	—	22 × 35 ⁽¹⁾	22 × 30
		—	—	22 × 30	22 × 30
88		—	—	22 × 30	22 × 30
		—	—	30 × 30 ⁽¹⁾	30 × 30 ⁽¹⁾
		—	—	25 × 40 ⁽¹⁾	25 × 40 ⁽¹⁾
		—	—	25 × 30	25 × 30
		—	—	22 × 40	22 × 35
100		—	—	22 × 40	22 × 35
		—	—	25 × 30	25 × 30
		—	—	25 × 40 ⁽¹⁾	25 × 40 ⁽¹⁾
		—	—	30 × 30 ⁽¹⁾	30 × 30 ⁽¹⁾
		—	—	22 × 30	22 × 30
150		—	—	30 × 35 ⁽¹⁾	30 × 30
		—	—	30 × 30	25 × 50 ⁽¹⁾
		—	—	25 × 50 ⁽¹⁾	25 × 40
		—	—	25 × 40	25 × 35
		—	—	22 × 40	22 × 35
220		—	—	30 × 40	30 × 35
		—	—	30 × 35	25 × 50
		—	—	25 × 50	—
		22 × 30	25 × 30	35 × 35 ⁽¹⁾	35 × 40 ⁽¹⁾
		22 × 40	22 × 40	30 × 45 ⁽¹⁾	30 × 45
330		—	—	35 × 35	30 × 50
		—	—	30 × 45 ⁽¹⁾	35 × 40
		25 × 30	30 × 30	35 × 50 ⁽¹⁾	35 × 50
		22 × 40	25 × 40	35 × 45 ⁽¹⁾	35 × 45
		—	—	35 × 35	30 × 50
470		30 × 30	30 × 40	35 × 50	35 × 50
		25 × 40	25 × 50	35 × 45	—
		30 × 40	35 × 40	—	—
		25 × 50	30 × 50	—	—
		35 × 40	35 × 50	—	—
1000		30 × 50	—	—	—
		35 × 40	35 × 50	—	—
1500		35 × 50	—	—	—

Note

1. Ripple current optimized types.

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MECHANICAL DATA AND PACKAGING QUANTITIES

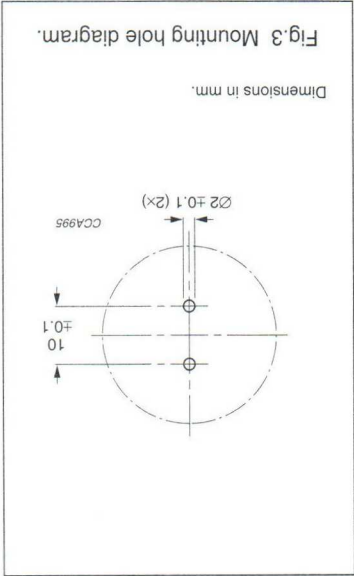
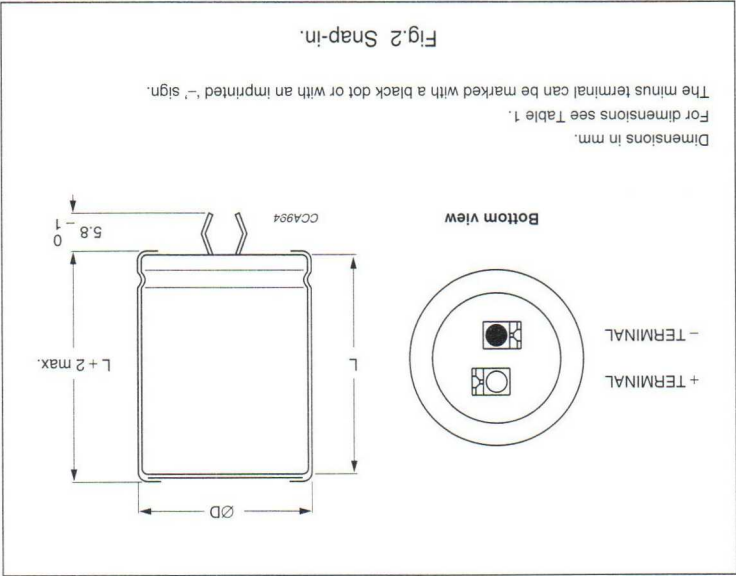


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	ØD _{max} (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
22 × 25	2225	23	27	≈12	100	260 × 250 × 39
22 × 30	2230	23	32	≈16	100	260 × 250 × 44
22 × 35	2235	23	37	≈20	100	260 × 250 × 49
22 × 40	2240	23	42	≈23	100	260 × 250 × 54
25 × 30	2530	26	32	≈22	100	290 × 280 × 44
25 × 35	2535	26	37	≈24	100	290 × 280 × 49
25 × 40	2540	26	42	≈27	100	290 × 280 × 54
25 × 50	2550	26	52	≈38	100	290 × 280 × 64
30 × 30	3030	31	32	≈30	100	340 × 330 × 44
30 × 35	3035	31	37	≈35	100	340 × 330 × 49
30 × 40	3040	31	42	≈40	100	340 × 330 × 54
30 × 45	3045	31	47	≈45	100	340 × 330 × 59
30 × 50	3050	31	52	≈50	100	340 × 330 × 64
35 × 35	3535	36	37	≈48	50	390 × 198 × 49
35 × 40	3540	36	42	≈55	50	390 × 198 × 54
35 × 45	3545	36	47	≈63	50	390 × 198 × 59
35 × 50	3550	36	52	≈72	50	390 × 198 × 64

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 2, 3 and 4 apply at T_{amb} = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

Ordering example

Electrolytic capacitor 056 series

10000 µF/25 V; ±20%

Nominal case size: Ø25 × 40 mm

Catalogue number: 2222 056 46103.

SYMBOL	DESCRIPTION
C _R	rated capacitance at 100 Hz
I _R	rated RMS ripple current at 100 Hz or ≥10 kHz and 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

Table 2 Electrical data and ordering information for **056** series; preferred types in **bold**

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE Ø D × L (mm)	CASE CODE	I _R 100 Hz 85 °C (A)	I _R ≥10 kHz 85 °C (A)	I _{L1} 1 min (µA)	I _{L5} 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER
10	6800	22 × 25	2225	2.04	2.40	412	140	76	62	056 54682
	10000	22 × 30	2230	2.56	3.02	608	205	56	45	056 54103
	15000	25 × 30	2530	3.12	3.68	904	304	44	39	056 54153
	15000	22 × 40	2240	3.39	4.00	904	304	41	34	056 44153
	22000	30 × 30	3030	3.47	4.09	1324	444	44	37	056 54223
	22000	25 × 40	2540	4.12	4.86	1324	444	34	28	056 44223
	33000	30 × 40	3040	4.58	5.40	1984	664	32	28	056 54333
	33000	25 × 50	2550	4.70	5.55	1984	664	30	27	056 44333
	47000	35 × 40	3540	5.10	6.02	2824	944	31	26	056 54473
	47000	30 × 50	3050	5.39	6.36	2824	944	28	24	056 44473
	68000	35 × 50	3550	5.88	6.94	4084	1364	28	23	056 54683
16	4700	22 × 25	2225	2.01	2.37	455	154	79	62	056 55472
	6800	22 × 30	2230	2.54	3.00	657	222	57	45	056 55682
	10000	25 × 30	2530	3.02	3.56	964	324	47	39	056 55103
	10000	22 × 40	2240	3.28	3.87	964	324	44	34	056 45103
	15000	30 × 30	3030	3.36	3.96	1444	484	47	37	056 55153
	15000	25 × 40	2540	4.00	4.72	1444	484	34	28	056 45153
	22000	30 × 40	3040	4.51	5.32	2116	708	33	28	056 55223
	22000	25 × 50	2550	3.97	4.68	2116	708	42	41	056 45223
	33000	35 × 40	3540	5.02	5.92	3172	1060	32	28	056 55333
	33000	30 × 50	3050	4.75	5.61	3172	1060	36	34	056 45333
	47000	35 × 50	3550	5.34	6.30	4516	1508	34	32	056 55473

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø × L (mm)	CASE CODE	I _R 100 Hz 85 °C (A)	I _R ≥10 kHz 85 °C (A)	I _{L1} 1 min (μA)	I _{L5} 5 min (μA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER
25	3300	22 × 25	2225	1.88	2.22	499	169	89	61	056 56332
	4700	22 × 30	2230	2.37	2.80	709	239	65	45	056 56472
	6800	25 × 30	2530	2.81	3.32	1 024	344	54	41	056 56682
	6800	22 × 40	2240	3.16	3.73	1 024	344	47	38	056 46682
	10 000	30 × 30	3030	3.25	3.84	1 504	504	50	38	056 56103
	10 000	25 × 40	2540	3.73	4.40	1 504	504	39	30	056 46103
	15 000	30 × 40	3040	4.73	5.58	2 254	754	30	28	056 56153
	15 000	25 × 50	2550	3.92	4.63	2 254	754	43	39	056 46153
	22 000	35 × 40	3540	4.48	5.29	3 304	1 104	40	28	056 56223
	22 000	30 × 50	3050	4.96	5.85	3 304	1 104	36	23	056 46223
	33 000	35 × 50	3550	4.98	5.88	4 954	1 654	39	33	056 56333
40	2200	22 × 25	2225	1.85	2.26	532	180	92	61	056 57222
	3300	22 × 30	2230	2.09	2.55	796	260	67	45	056 57332
	4700	25 × 30	2530	2.28	2.78	1 132	380	82	70	056 57472
	4700	22 × 40	2240	3.10	3.78	1 132	380	49	38	056 47472
	6800	30 × 30	3030	3.16	3.85	1 636	548	53	38	056 57682
	6800	25 × 40	2540	3.06	3.73	1 636	548	58	50	056 47682
	10 000	30 × 40	3040	4.20	5.12	2 404	804	38	28	056 57103
	10 000	25 × 50	2550	3.88	4.73	2 404	804	44	39	056 47103
	15 000	35 × 40	3540	4.05	4.94	3 604	1 204	49	41	056 57153
	15 000	30 × 50	3050	4.45	5.43	3 604	1 204	41	34	056 47153
	22 000	35 × 50	3550	4.86	5.93	5 284	1 764	40	33	056 57223
50	1500	22 × 25	2225	1.36	1.66	454	154	170	130	056 51152
	2200	22 × 30	2230	1.75	2.14	664	224	120	91	056 51222
	3300	25 × 30	2530	2.17	2.65	994	334	90	72	056 51332
	3300	22 × 40	2240	2.42	2.95	994	334	80	63	056 41332
	4700	30 × 30	3030	2.65	3.23	1 414	474	75	63	056 51472
	4700	25 × 40	2540	2.89	3.53	1 414	474	65	52	056 41472
	6800	30 × 40	3040	3.56	4.34	2 044	684	53	45	056 51682
	6800	25 × 50	2550	3.75	4.58	2 044	684	50	43	056 41682
	10 000	35 × 40	3540	4.05	4.94	3 004	1 004	49	42	056 51103
	10 000	30 × 50	3050	4.50	5.49	3 004	1 004	40	35	056 41103
	15 000	35 × 50	3550	4.98	6.08	4 504	1 504	39	33	056 51153

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_R ≥ 10 kHz 85 °C (A)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
63	1 000	22 × 25	2225	1.46	1.78	382	130	148	104	056 58102
	1 500	22 × 30	2230	1.87	2.28	571	193	105	72	056 58152
	2 200	25 × 30	2530	2.32	2.83	836	281	79	59	056 58222
	2 200	22 × 40	2240	2.54	3.10	836	281	73	53	056 48222
	3 300	30 × 30	3030	2.87	3.50	1 251	420	64	50	056 58332
	3 300	30 × 40	3040	3.14	3.83	1 251	420	64	50	056 58332
	4 700	25 × 50	2550	3.67	4.48	1 780	596	55	44	056 48332
	4 700	30 × 40	3040	3.71	4.53	1 780	596	50	38	056 58472
	4 700	35 × 50	3550	4.33	5.28	2 574	861	43	38	056 58682
	6 800	30 × 50	3050	4.75	5.80	2 574	861	42	37	056 48682
	10 000	35 × 50	3550	5.26	6.42	3 784	1 264	35	30	056 58103
100	1 000	22 × 25	2225	0.77	0.94	286	98	535	470	056 59471
	680	22 × 30	2230	0.99	1.21	412	160	375	328	056 59681
	1 000	25 × 30	2530	1.27	1.55	604	204	265	235	056 59102
	1 000	22 × 40	2240	1.35	1.65	604	204	260	225	056 49102
	1 500	30 × 30	3030	1.67	2.04	904	304	190	170	056 59152
	1 500	25 × 40	2540	1.75	2.14	904	304	180	160	056 49152
	2 200	30 × 40	3040	2.27	2.77	1 324	444	130	120	056 59222
	2 200	25 × 50	2550	2.30	2.80	1 324	444	125	110	056 49222
	3 300	35 × 40	3540	2.84	3.46	1 984	664	100	95	056 59332
	3 300	30 × 50	3050	2.97	3.62	1 984	664	92	85	056 49332
	4 700	35 × 50	3550	3.59	4.38	2 824	677	75	70	056 59472

Aluminium electrolytic capacitors
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Table 3 Electrical data and ordering information for 057 series; preferred types in bold

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE Ø × L (mm)	CASE CODE	I _R 85 °C 100 Hz (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 × 25	2225	0.77	184	64	950	620	057 52151
	220	22 × 30	2230	1.00	268	92	650	435	057 52221
	330	25 × 30	2530	1.36	400	136	430	310	057 52331
	330	22 × 40	2240	1.36	400	136	430	310	057 42331
	470	30 × 30	3030	1.80	568	192	310	230	057 52471
	470	25 × 40	2540	1.80	568	192	310	230	057 42471
	680	30 × 40	3040	2.39	820	276	210	180	057 52681
	680	25 × 50	2550	2.39	820	276	210	180	057 42681
	1000	35 × 40	3540	2.85	1204	404	160	135	057 52102
	1000	30 × 50	3050	2.85	1204	404	160	135	057 42102
250	100	22 × 25	2225	0.63	154	54	1440	770	057 53101
	150	22 × 30	2230	0.83	229	79	960	520	057 53151
	220	25 × 30	2530	1.10	334	114	660	365	057 53221
	220	22 × 40	2240	1.10	334	114	660	365	057 43221
	330	30 × 30	3030	1.49	499	169	440	265	057 53331
	330	25 × 40	2540	1.49	499	169	440	265	057 43331
	470	30 × 40	3040	1.98	709	239	310	185	057 53471
	470	25 × 50	2550	1.98	709	239	310	185	057 43471
	680	35 × 40	3540	2.60	1024	344	240	145	057 53681
	680	30 × 50	3050	2.60	1024	344	240	145	057 43681
385	47	22 × 30	2230	0.59	112	40	3000	1400	057 18479(1)
	47	22 × 25	2225	0.50	112	40	3000	1400	057 58479
	68	25 × 30	2530	0.82	161	56	2100	1100	057 78689(1)
	68	22 × 40	2240	0.81	161	56	2100	1100	057 28689(1)
	68	22 × 35	2235	0.79	161	56	2100	1100	057 18689(1)
	68	22 × 30	2230	0.63	161	56	2100	1000	057 58689
	100	30 × 30	3030	1.13	235	81	1400	750	057 28101(1)
	100	25 × 40	2540	1.13	235	81	1400	750	057 18101(1)
	100	25 × 30	2530	0.86	235	81	1400	780	057 58101
	100	22 × 40	2240	0.86	235	81	1400	780	057 48101
	100	22 × 35	2235	0.84	235	81	1400	780	057 38101
	150	30 × 40	3040	1.54	350	119	1000	500	057 38151(1)
	150	30 × 35	3035	1.41	350	119	1000	500	057 28151(1)
	150	30 × 30	3030	1.16	350	119	950	520	057 58151
	150	25 × 50	2550	1.48	350	119	1000	500	057 18151(1)
L									

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
385	150	25 × 40	2540	1.16	350	119	950	520	057 48151
	220	35 × 35	3535	1.61	512	173	700	460	057 28221(1)
	220	30 × 45	3045	1.63	512	173	700	460	057 18221(1)
	220	30 × 40	3040	1.57	512	173	650	400	057 58221
	220	30 × 35	3035	1.50	512	173	650	400	057 38221
	220	25 × 50	2550	1.57	512	173	650	400	057 48221
	330	35 × 45	3545	2.20	766	258	450	280	057 28331(1)
	330	35 × 35	3535	1.73	766	258	480	280	057 68331
	330	30 × 45	3045	1.75	766	258	480	280	057 38331
	470	35 × 50	3550	2.40	1 089	366	340	220	057 58471
	470	35 × 45	3545	2.29	1 089	366	340	220	057 48471
	470	22 × 30	2230	0.59	117	42	3000	1400	057 16479(1)
400	47	22 × 30	2230	0.59	117	42	3000	1400	057 16479(1)
	47	22 × 25	2225	0.50	117	42	3000	1400	057 56479
	68	25 × 30	2530	0.82	167	58	2100	1100	057 26689(1)
	68	22 × 35	2235	0.79	167	58	2100	1100	057 16689(1)
	68	22 × 30	2230	0.63	167	58	2100	1000	057 56689
	100	30 × 30	3030	1.13	244	84	1400	750	057 26101(1)
	100	25 × 40	2540	1.13	244	84	1400	750	057 16101(1)
	100	25 × 30	2530	0.86	244	84	1400	780	057 56101
	100	22 × 35	2235	0.84	240	84	1400	780	057 36101
	150	30 × 35	3035	1.41	364	124	1000	520	057 26151(1)
	150	30 × 30	3030	1.16	364	124	950	520	057 56151
	150	25 × 50	2550	1.50	364	124	1000	520	057 16151(1)
	150	25 × 40	2540	1.16	364	124	950	520	057 46151
	220	35 × 40	3540	1.74	532	180	700	460	057 26221(1)
	220	30 × 50	3050	1.75	532	180	700	460	057 16221(1)
	220	30 × 35	3035	1.50	532	180	650	400	057 36221
	220	25 × 50	2550	1.57	532	180	650	400	057 46221
	330	35 × 50	3550	2.31	796	268	450	300	057 16331(1)
	330	35 × 40	3540	1.85	796	268	480	280	057 56331
	330	30 × 50	3050	1.85	796	268	480	280	057 46331
	470	35 × 50	3550	2.40	1 132	380	340	220	057 56471
Note									
1. Ripple current optimized types.									

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Table 4 Electrical data and ordering information (continued) for **057** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
450	47	22 × 30	2230	0.26	131	45	5600	4400	057 67479
	68	22 × 30	2230	0.33	188	65	3900	3100	057 57689
	100	30 × 30	3030	0.48	274	94	2600	2100	057 57101
	100	25 × 35	2535	0.46	274	94	2600	2100	057 37101
	150	30 × 35	3035	0.66	409	140	1600	1300	057 37151
	150	25 × 50	2550	0.70	409	140	1600	1300	057 47151
	220	35 × 40	3540	0.92	598	202	1100	900	057 57221
	220	30 × 45	3045	0.73	598	202	1100	900	057 37221
	330	35 × 50	3550	1.26	895	301	700	600	057 57331
	330	35 × 45	3545	1.20	895	301	700	600	057 47331

MARKING

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

- Rated capacitance (in μF)
- Tolerance code on rated capacitance (M for $\pm 20\%$)
- Rated voltage (in V)
- 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" and "CECC 30301".

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ELECTRICAL DATA (continued)

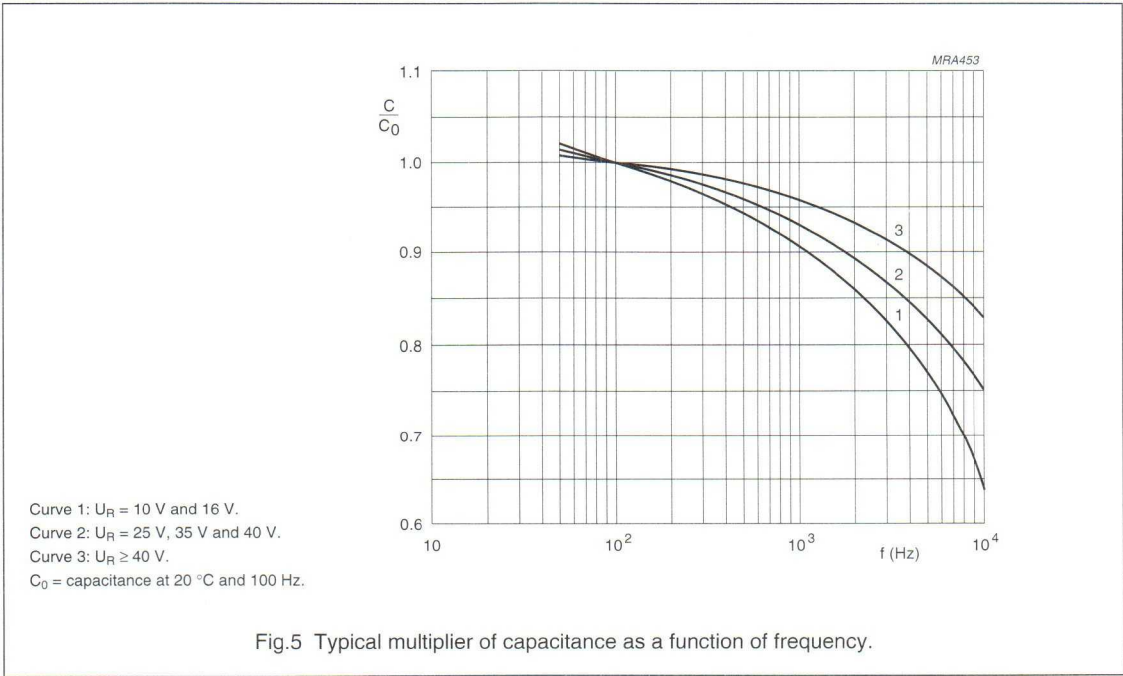
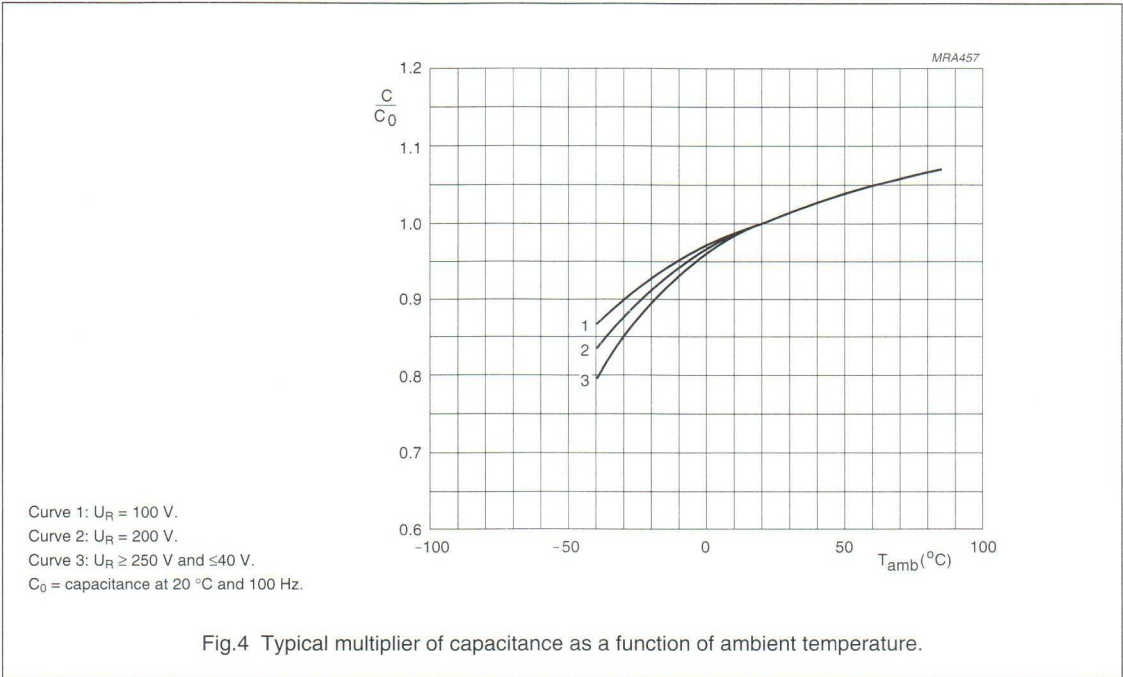
Additional electrical data

PARAMETER	CONDITIONS	VALUE
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		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	all case sizes	typ. 19 nH
		max. 25 nH

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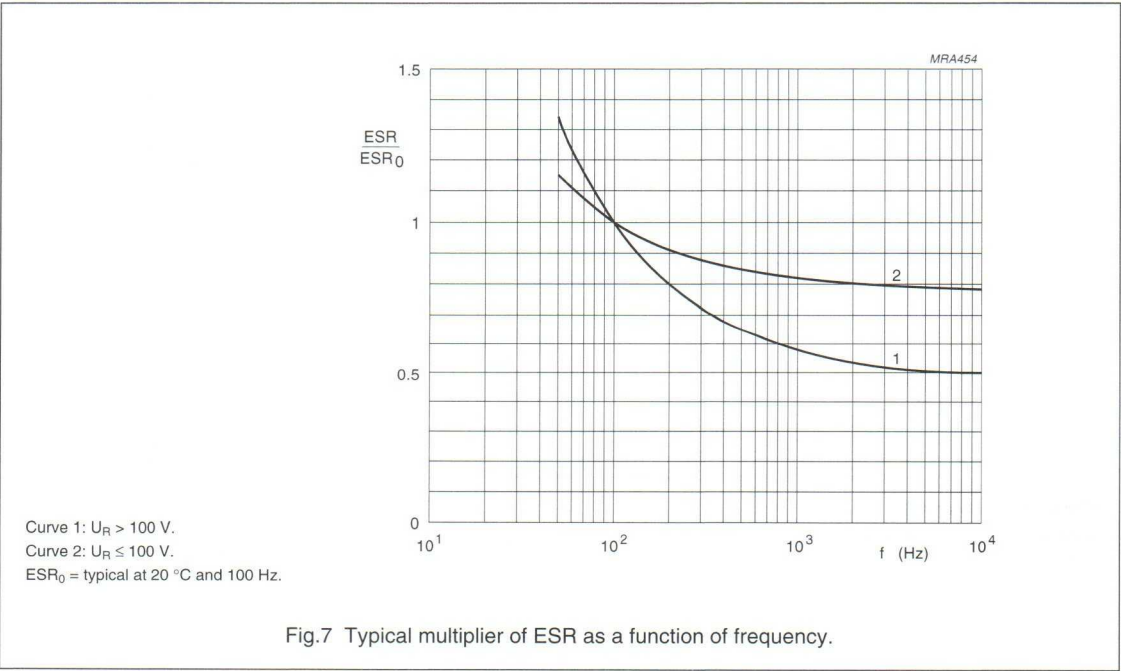
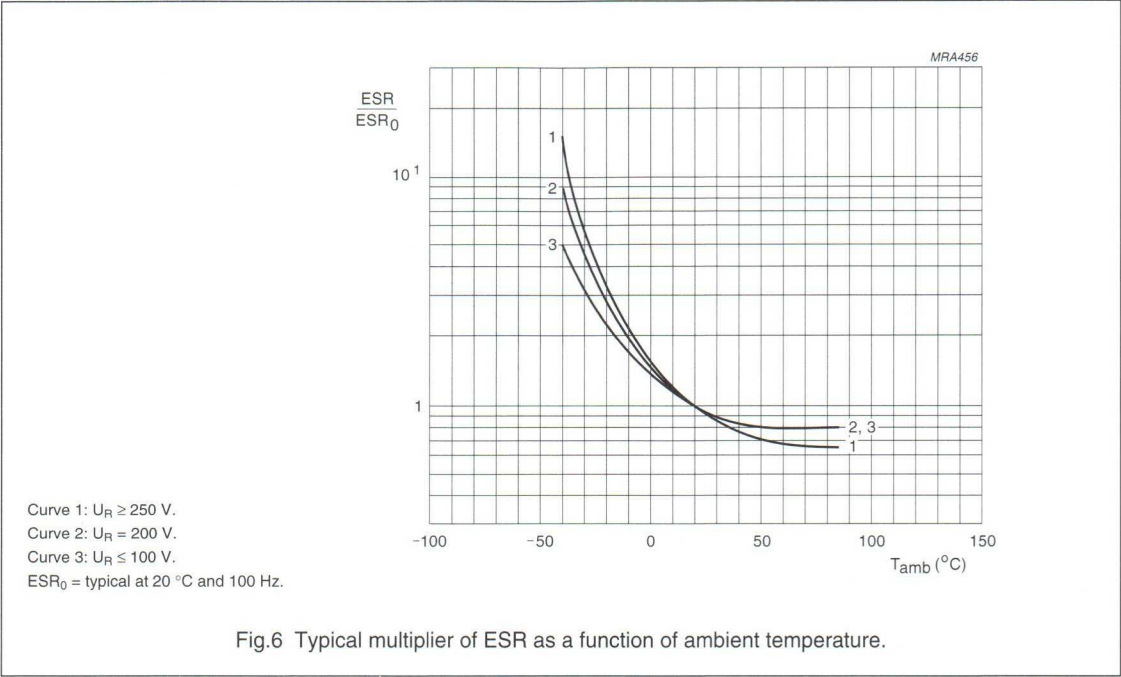
Capacitance (C)



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Equivalent series resistance (ESR)

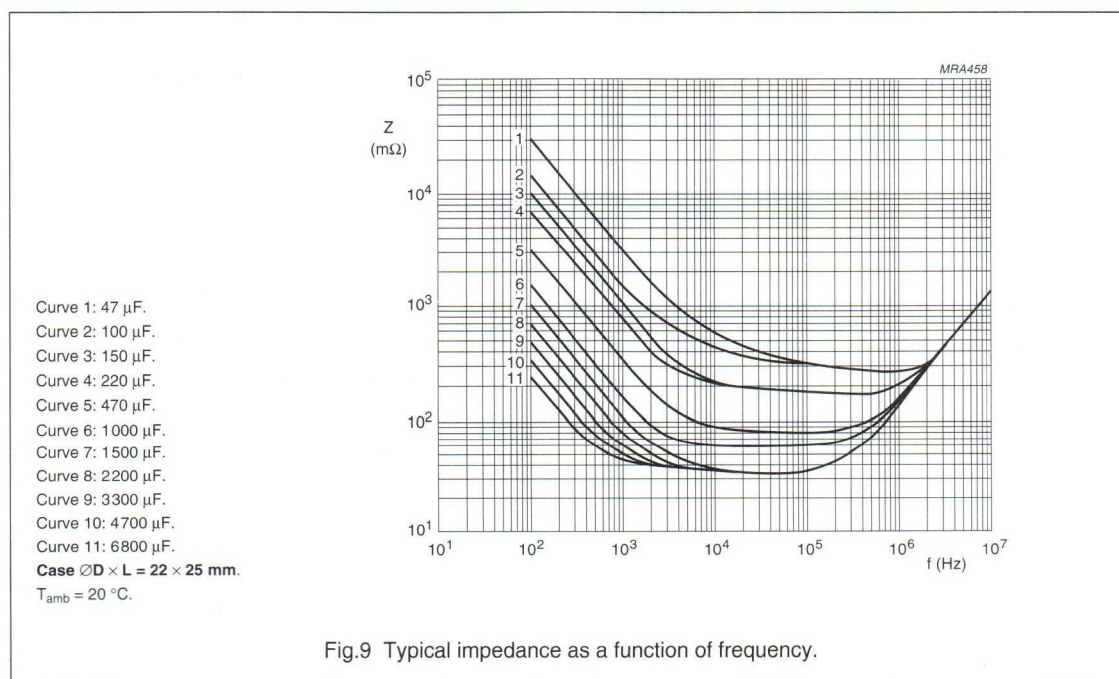
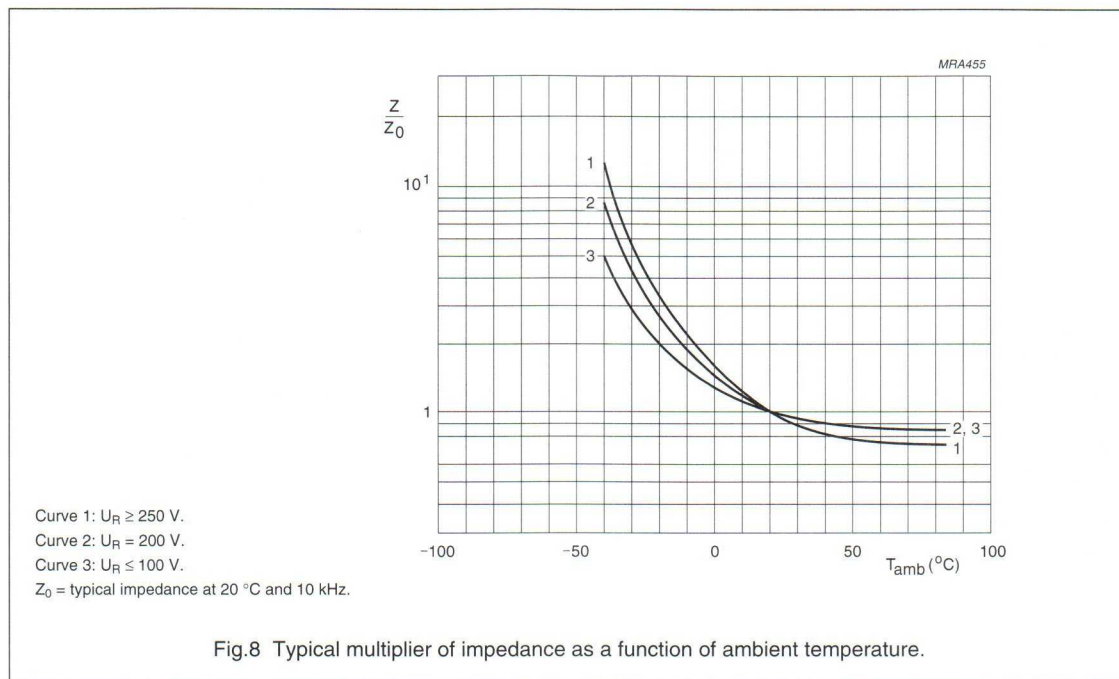


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Impedance (Z)



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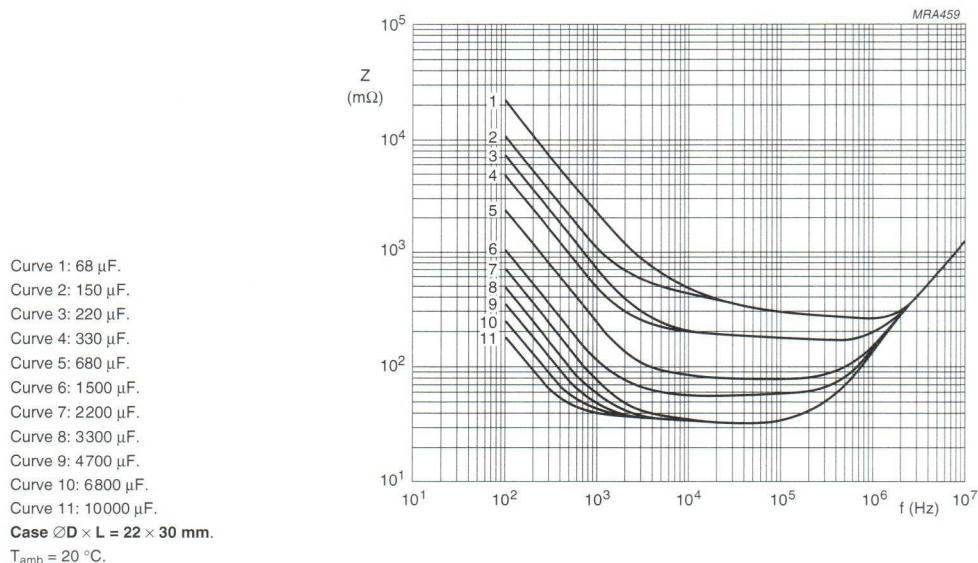


Fig.10 Typical impedance as a function of frequency.

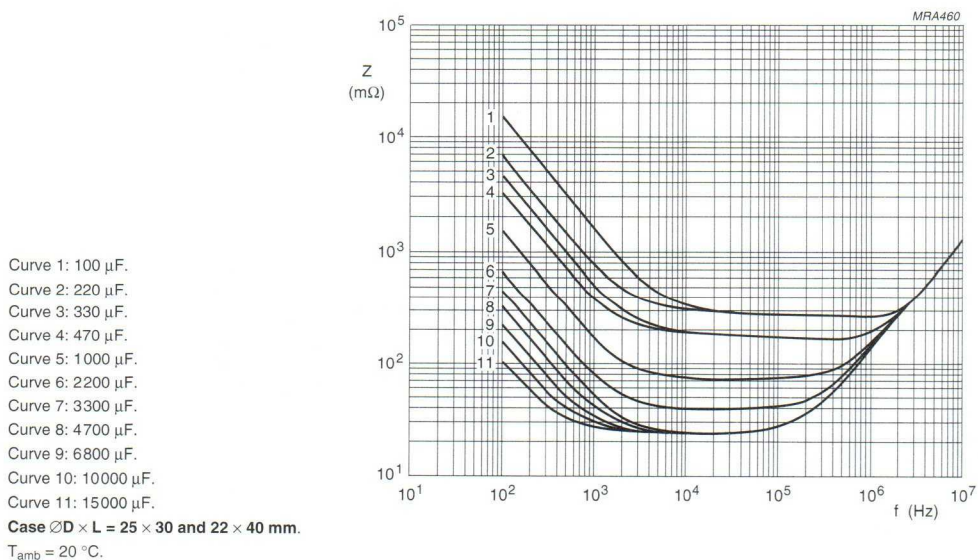


Fig.11 Typical impedance as a function of frequency.

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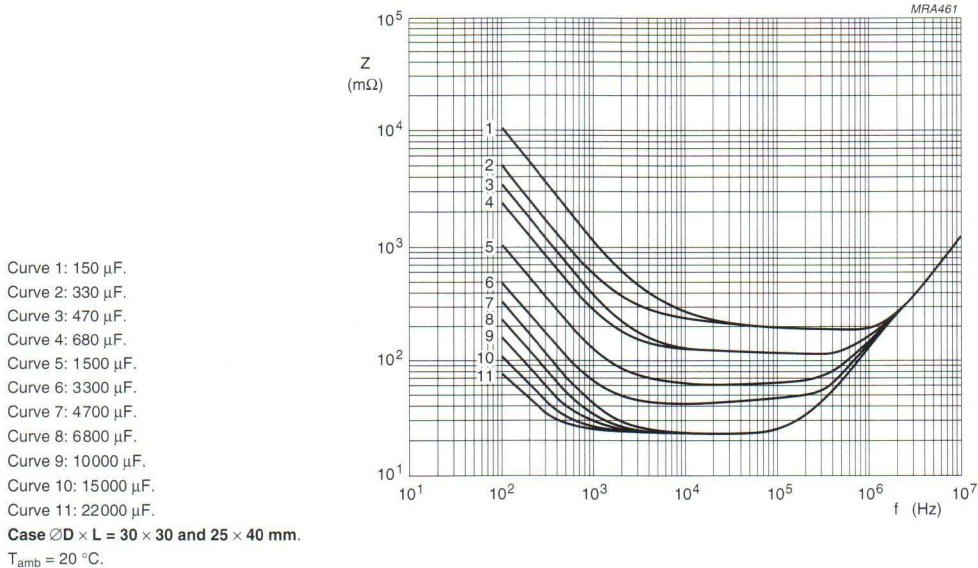


Fig.12 Typical impedance as a function of frequency.

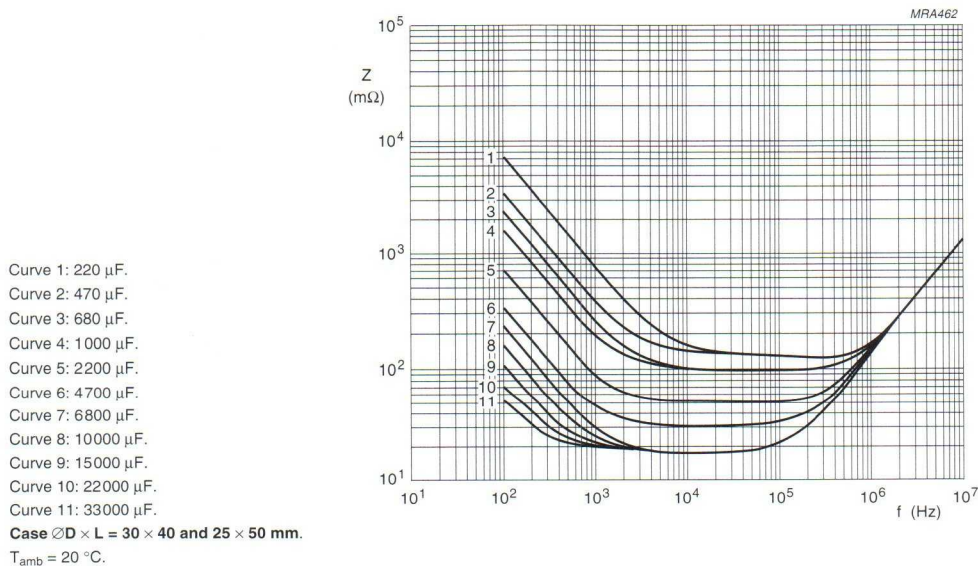


Fig.13 Typical impedance as a function of frequency.

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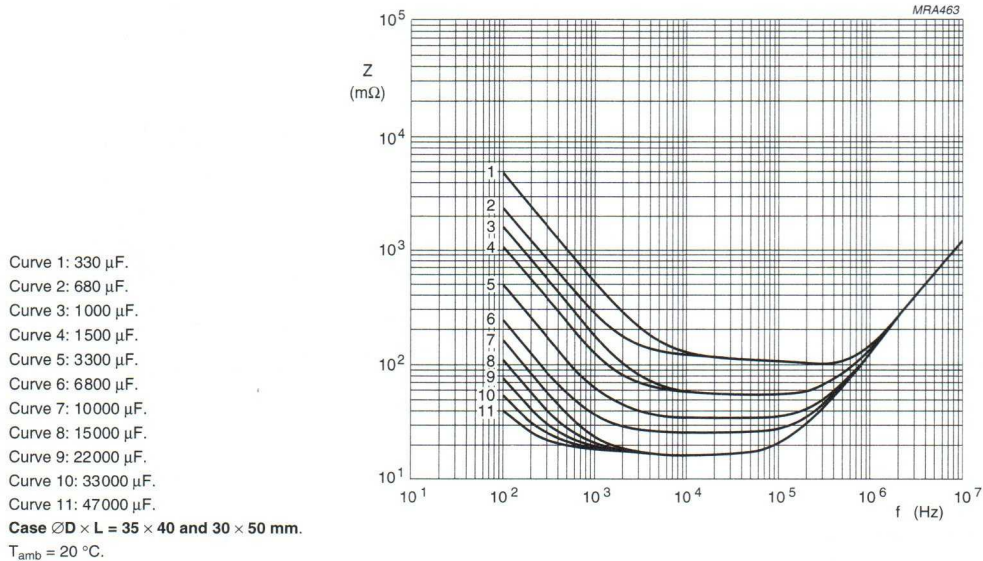


Fig.14 Typical impedance as a function of frequency.

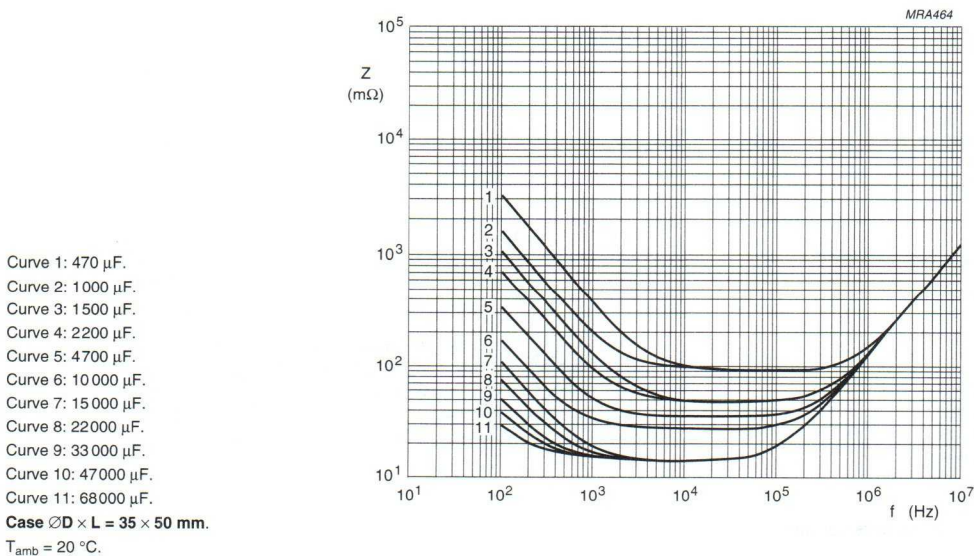


Fig.15 Typical impedance as a function of frequency.

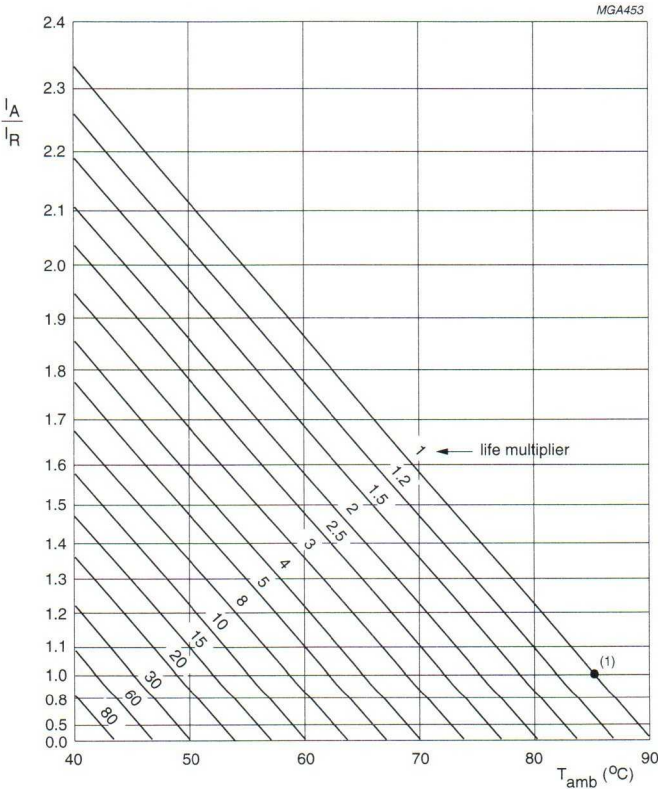
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RIPPLE CURRENT AND USEFUL LIFE

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

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10 \text{ to } 25 \text{ V}$	$U_R = 40 \text{ to } 100 \text{ V}$	$U_R > 100 \text{ V}$
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
≥ 10000	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: 12000 hours (450 V types: 5000 hours).

Fig.16 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 6 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ °C}$; U_R applied; 5000 hours (450 V types: 2000 hours)	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ °C}$; U_R and I_R applied; 12000 hours (450 V types: 5000 hours)	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 30\%$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100\text{ V}$: $\leq 1\%$; $U_R > 100\text{ V}$: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ °C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$: $\pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

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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
- Very long useful life: up to 10000 hours at 105 °C
- Extended temperature range: 105 °C
- Low ESR, high ripple current capability.

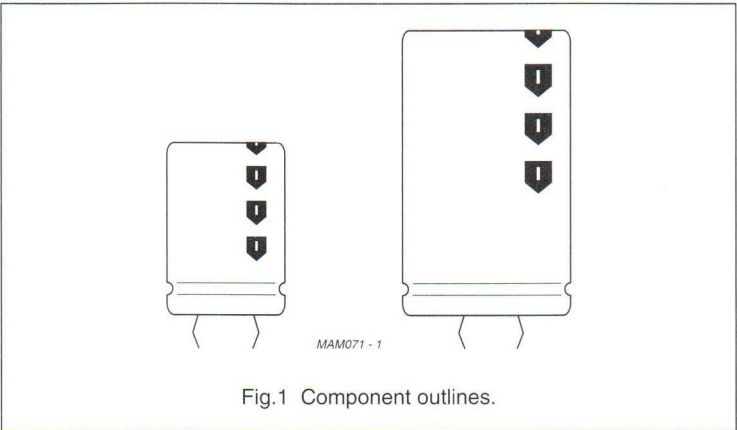
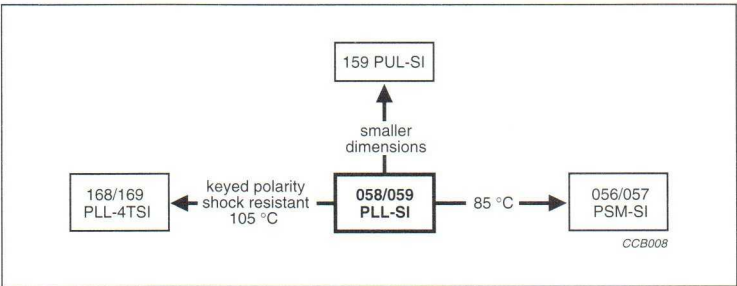


Fig.1 Component outlines.

APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering applications
- Standard and switched mode power supplies
- Energy storage in pulse systems.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	058	059
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	22 × 25 to 35 × 50	
Rated capacitance range (E6 series), C_R	33 to 47000 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: 10000 hours	
Useful life at 40 °C and $1.9 \times I_R$ applied	≤50 V: 125000 hours; ≥63 V: 250000 hours	
Shelf life at 0 V, 105 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Detail specification	CECC 30301-807	
Climatic category IEC 68	40/105/56	

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 058 series

Preferred types in **bold**.

C_R (μF)	U_R (V)						
	10	16	25	40	50	63	100
330	—	—	—	—	—	—	22 × 25
470	—	—	—	—	—	—	22 × 30
680	—	—	—	—	—	22 × 25	25 × 30
	—	—	—	—	—	—	22 × 40
1000	—	—	—	—	22 × 25	22 × 30	30 × 30
	—	—	—	—	—	—	25 × 40
1500	—	—	—	22 × 25	22 × 30	25 × 30	30 × 40
	—	—	—	—	—	22 × 40	25 × 50
2200	—	—	22 × 25	22 × 30	25 × 30	30 × 30	35 × 40
	—	—	—	—	22 × 40	25 × 40	30 × 50
3300	—	22 × 25	22 × 30	25 × 30	30 × 30	30 × 40	35 × 50
	—	—	—	22 × 40	25 × 40	25 × 50	—
4700	22 × 25	22 × 30	25 × 30	30 × 30	30 × 40	35 × 40	—
	—	—	22 × 40	25 × 40	25 × 50	30 × 50	—
6800	22 × 30	25 × 30	30 × 30	30 × 40	35 × 40	35 × 50	—
	—	22 × 40	25 × 40	25 × 50	30 × 50	—	—
10000	25 × 30	30 × 30	30 × 40	35 × 40	35 × 50	—	—
	22 × 40	25 × 40	25 × 50	30 × 50	—	—	—
15000	30 × 30	30 × 40	35 × 40	35 × 50	—	—	—
	25 × 40	25 × 50	30 × 50	—	—	—	—
22000	30 × 40	35 × 40	35 × 50	—	—	—	—
	25 × 50	30 × 50	—	—	—	—	—
33000	35 × 40	35 × 50	—	—	—	—	—
	30 × 50	—	—	—	—	—	—
47000	35 × 50	—	—	—	—	—	—

Aluminium electrolytic capacitors

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 059 series

Preferred types in **bold**.

C_R (μF)	U_R (V)			
	200	250	385	400
33	—	—	22 × 25	—
47	—	—	22 × 30	22 × 30
68	—	22 × 25	22 × 35	22 × 35
	—	—	25 × 30	25 × 30
100	22 × 25	22 × 30	30 × 30	30 × 30
	—	—	25 × 40	25 × 40
150	22 × 30	22 × 35	25 × 50	30 × 35
	—	25 × 30	30 × 40	25 × 50
220	22 × 35	30 × 30	35 × 40	35 × 40
	25 × 30	25 × 35	30 × 50	30 × 50
330	30 × 30	30 × 35	35 × 50	35 × 50
	25 × 40	25 × 50	—	—
470	30 × 35	35 × 35	—	—
	25 × 50	30 × 45	—	—
680	35 × 35	35 × 45	—	—
	30 × 45	—	—	—
1000	35 × 50	—	—	—

MARKING

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

- Rated capacitance (in μF)
- Tolerance code on rated capacitance (M for $\pm 20\%$)
- Rated voltage (in V)
- 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
- Minus-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" and "CECC 30301".

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MECHANICAL DATA AND PACKAGING QUANTITIES

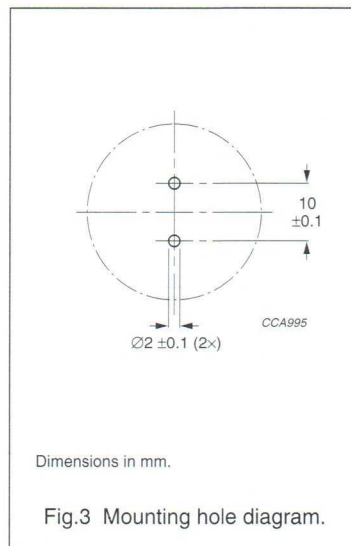
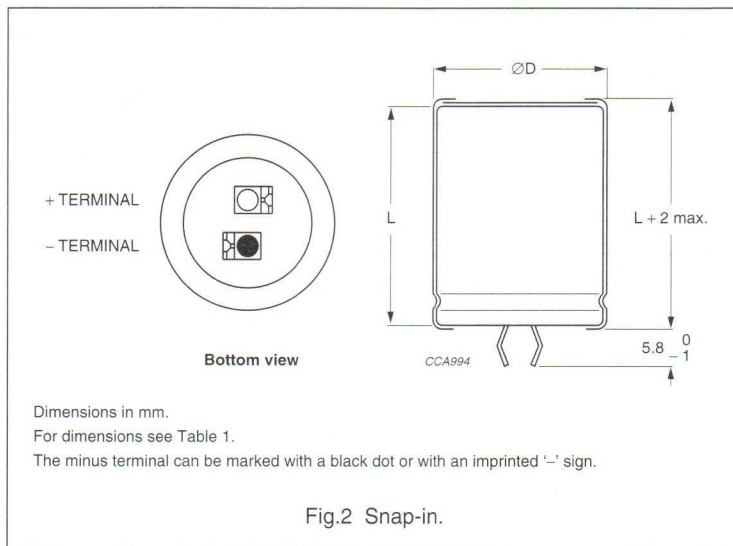


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	ØD _{max} (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
22 × 25	2225	23	27	≈12	100	260 × 250 × 39
22 × 30	2230	23	32	≈16	100	260 × 250 × 44
22 × 35	2235	23	37	≈20	100	260 × 250 × 49
22 × 40	2240	23	42	≈23	100	260 × 250 × 54
25 × 30	2530	26	32	≈22	100	290 × 280 × 44
25 × 35	2535	26	37	≈24	100	290 × 280 × 49
25 × 40	2540	26	42	≈27	100	290 × 280 × 54
25 × 50	2550	26	52	≈38	100	290 × 280 × 64
30 × 30	3030	31	32	≈30	100	340 × 330 × 44
30 × 35	3035	31	37	≈35	100	340 × 330 × 49
30 × 40	3040	31	42	≈40	100	340 × 330 × 54
30 × 45	3045	31	47	≈45	100	340 × 330 × 59
30 × 50	3050	31	52	≈50	100	340 × 330 × 64
35 × 35	3535	36	37	≈48	50	390 × 198 × 49
35 × 40	3540	36	42	≈55	50	390 × 198 × 54
35 × 45	3545	36	47	≈63	50	390 × 198 × 59
35 × 50	3550	36	52	≈72	50	390 × 198 × 64

Aluminium electrolytic capacitors

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 2 and 3 apply at
 $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86\text{ to }106\text{ kPa}$, $RH = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz
I_R	rated RMS ripple current at 100 Hz or $\geq 10\text{ kHz}$ and $105\text{ }^{\circ}\text{C}$
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 058 series

10000 $\mu\text{F}/25\text{ V}$; $\pm 20\%$ Nominal case size: $\varnothing 30 \times 40\text{ mm}$

Catalogue number: 2222 058 56103.

Table 2 Electrical data and ordering information for **058** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105 $^{\circ}\text{C}$ (A)	I_R $\geq 10\text{ kHz}$ 105 $^{\circ}\text{C}$ (A)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
10	4700	22 $\times$ 25	2225	1.95	2.30	286	98	82	57	058 54472
	6800	22 $\times$ 30	2230	2.44	2.88	412	140	61	44	058 54682
	10000	25 $\times$ 30	2530	2.81	3.32	604	204	54	42	058 54103
	10000	22 $\times$ 40	2240	3.29	3.88	604	204	43	32	058 44103
	15000	30 $\times$ 30	3030	3.53	4.17	904	304	42	34	058 54153
	15000	25 $\times$ 40	2540	3.78	4.46	904	304	38	30	058 44153
	22000	30 $\times$ 40	3040	4.62	5.45	1324	444	31	25	058 54223
	22000	25 $\times$ 50	2550	4.68	5.52	1324	444	31	24	058 44223
	33000	35 $\times$ 40	3540	5.15	6.08	1984	664	30	24	058 54333
	33000	30 $\times$ 50	3050	5.70	6.73	1984	664	24	21	058 44333
	47000	35 $\times$ 50	3550	6.23	7.35	2824	944	24	21	058 54473
16	3300	22 $\times$ 25	2225	1.90	2.24	321	110	86	57	058 55332
	4700	22 $\times$ 30	2230	2.36	2.78	455	154	65	44	058 55472
	6800	25 $\times$ 30	2530	2.75	3.25	657	222	56	42	058 55682
	6800	22 $\times$ 40	2240	3.18	3.75	657	222	46	32	058 45682
	10000	30 $\times$ 30	3030	3.44	4.06	964	324	44	34	058 55103
	10000	25 $\times$ 40	2540	3.66	4.32	964	324	40	30	058 45103
	15000	30 $\times$ 40	3040	4.55	5.37	1444	484	32	25	058 55153
	15000	25 $\times$ 50	2550	4.55	5.37	1444	484	32	24	058 45153
	22000	35 $\times$ 40	3540	5.07	5.98	2116	708	31	24	058 55223
	22000	30 $\times$ 50	3050	5.67	6.69	2116	708	25	21	058 45223
	33000	35 $\times$ 50	3550	6.23	7.35	3172	1060	25	21	058 55333

Aluminium electrolytic capacitors

Power Long Life Snap-in

058/059 PLL-SI

U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	I _R 100 Hz 105 °C (A)	I _R ≥10 kHz 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 × 25	2225	1.76	2.08	334	114	100	57	058 56222
	3300	22 × 30	2230	2.23	2.63	499	169	73	44	058 56332
	4700	25 × 30	2530	2.60	3.07	709	239	62	42	058 56472
	4700	22 × 40	2240	3.00	3.54	709	239	52	32	058 46472
	6800	30 × 30	3030	3.26	3.85	1024	344	49	34	058 56682
	6800	25 × 40	2540	3.49	4.12	1024	344	44	30	058 46682
	10000	30 × 40	3040	4.37	5.16	1504	504	35	25	058 56103
	10000	25 × 50	2550	4.37	5.16	1504	504	35	24	058 46103
	15000	35 × 40	3540	4.91	5.79	2254	754	33	24	058 56153
	15000	30 × 50	3050	5.43	6.41	2254	754	27	21	058 46153
	22000	35 × 50	3550	6.07	7.16	3304	1104	27	21	058 56223
40	1500	22 × 25	2225	1.65	2.01	364	124	114	65	058 57152
	2200	22 × 30	2230	2.04	2.49	532	180	87	50	058 57222
	3300	25 × 30	2530	2.43	2.99	796	268	71	45	058 57332
	3300	22 × 40	2240	2.78	3.39	796	268	60	37	058 47332
	4700	30 × 30	3030	2.96	3.61	1132	380	59	40	058 57472
	4700	25 × 40	2540	3.26	3.90	1132	380	51	32	058 47472
	6800	30 × 40	3040	3.94	4.81	1636	548	42	29	058 57682
	6800	25 × 50	2550	4.10	5.00	1636	548	39	26	058 47682
	10000	35 × 40	3540	4.18	5.10	2404	804	46	29	058 57103
	10000	30 × 50	3050	4.98	6.08	2404	804	36	24	058 47103
	15000	35 × 50	3550	5.21	6.36	3604	1204	36	24	058 57153
50	1000	22 × 25	2225	1.50	1.83	304	104	138	69	058 51102
	1500	22 × 30	2230	1.88	2.29	454	154	102	54	058 51152
	2200	25 × 30	2530	2.27	2.77	664	124	82	47	058 51222
	2200	22 × 40	2240	2.55	3.11	664	124	71	38	058 41222
	3300	30 × 30	3030	2.81	3.43	994	334	66	41	058 51332
	3300	25 × 40	2540	3.07	3.75	994	334	57	33	058 41332
	4700	30 × 40	3040	3.77	4.60	1414	474	47	30	058 51472
	4700	25 × 50	2550	3.85	4.70	1414	474	43	27	058 41472
	6800	35 × 40	3540	4.01	4.89	2044	684	49	30	058 51682
	6800	30 × 50	3050	4.74	5.78	2044	684	38	24	058 41682
	10000	35 × 50	3550	5.04	6.15	3004	1004	38	24	058 51103

Aluminium electrolytic capacitors

Power Long Life Snap-in

058/059 PLL-SI

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_R ≥ 10 kHz 105 °C (A)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
63	680	22 × 25	2225	1.17	1.43	261	90	228	150	058 58681
	1000	22 × 30	2230	1.46	1.78	382	130	170	115	058 58102
	1500	25 × 30	2530	1.76	2.15	571	193	137	85	058 58152
	1500	22 × 40	2240	2.00	2.44	571	193	115	85	058 48152
	2200	30 × 30	3030	2.27	2.77	836	281	101	70	058 58222
	2200	25 × 40	2540	2.40	2.93	836	281	94	70	058 48222
	3300	30 × 40	3040	3.07	3.75	1251	420	70	50	058 58332
	3300	25 × 50	2550	3.07	3.75	1251	420	70	50	058 48332
	4700	35 × 40	3540	3.65	4.45	1781	596	60	45	058 58472
	4700	30 × 50	3050	3.88	4.73	1781	596	53	45	058 48472
	6800	35 × 50	3550	4.58	5.59	2574	861	46	35	058 58682
100	330	22 × 25	2225	0.92	1.12	202	70	370	250	058 59331
	470	22 × 30	2230	1.14	1.39	286	98	280	190	058 59471
	680	25 × 30	2530	1.35	1.65	412	140	232	140	058 59681
	680	22 × 40	2240	1.57	1.92	412	140	190	140	058 49681
	1000	30 × 30	3030	1.79	2.40	604	204	163	115	058 59102
	1000	25 × 40	2540	1.85	2.26	604	204	158	115	058 49102
	1500	30 × 40	3040	2.45	2.99	904	304	111	85	058 59152
	1500	25 × 50	2550	2.38	2.90	904	304	116	85	058 49152
	2200	35 × 40	3540	3.05	3.72	1324	444	86	65	058 59222
	2200	30 × 50	3050	3.13	3.82	1324	444	82	65	058 49222
	3300	35 × 50	3550	3.84	4.68	1984	664	64	50	058 59332

Aluminium electrolytic capacitors

Power Long Life Snap-in

058/059 PLL-SI

Table 3 Electrical data and ordering information for **059** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
200	100	22 × 25	2225	0.53	124	44	1280	730	059 52101
	150	22 × 30	2230	0.67	184	64	850	540	059 52151
	220	22 × 35	2235	0.86	268	92	610	430	059 32221
	220	25 × 30	2530	0.87	268	92	610	430	059 52221
	330	30 × 30	3030	1.12	400	136	435	300	059 52331
	330	25 × 40	2540	1.12	400	136	435	300	059 42331
	470	30 × 35	3035	1.46	568	192	335	225	059 32471
	470	25 × 50	2550	1.25	568	192	335	225	059 42471
	680	30 × 45	3045	1.87	820	276	235	155	059 32681
	680	35 × 35	3535	1.85	820	276	235	155	059 62681
	1000	35 × 50	3550	2.45	1204	404	160	125	059 52102
250	68	22 × 25	2225	0.49	106	38	1640	760	059 53689
	100	22 × 30	2230	0.62	154	54	1110	570	059 53101
	150	22 × 35	2235	0.82	229	79	795	440	059 33151
	150	25 × 30	2530	0.82	229	79	795	440	059 53151
	220	25 × 35	2535	1.03	334	114	540	300	059 33221
	220	30 × 30	3030	1.06	334	114	540	300	059 53221
	330	30 × 35	3035	1.43	499	169	385	225	059 33331
	330	25 × 50	2550	1.40	499	169	385	225	059 43331
	470	30 × 45	3045	1.79	709	239	270	155	059 33471
	470	35 × 35	3535	1.79	709	239	270	155	059 63471
	680	35 × 45	3545	2.25	1024	344	190	125	059 43681
385	33	22 × 25	2225	0.32	80	29	3860	3000	059 58339
	47	22 × 30	2230	0.41	113	40	2710	2100	059 58479
	68	22 × 35	2235	0.53	161	56	1870	1460	059 38689
	68	25 × 30	2530	0.52	161	56	1870	1460	059 58689
	100	30 × 30	3030	0.72	235	81	1270	1010	059 58101
	100	25 × 40	2540	0.72	235	81	1270	1010	059 48101
	150	30 × 40	3040	0.99	351	119	850	675	059 58151
	150	25 × 50	2550	0.99	351	119	850	675	059 48151
	220	35 × 40	3540	1.31	512	173	580	465	059 58221
	220	30 × 50	3050	1.31	512	173	580	465	059 48221
	330	35 × 50	3550	1.75	766	258	390	320	059 58331

Aluminium electrolytic capacitors

Power Long Life Snap-in

058/059 PLL-SI

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
400	47	22 × 30	2230	0.30	117	42	4260	3490	059 56479
	68	22 × 35	2235	0.38	167	58	2950	2420	059 36689
	68	25 × 30	2530	0.41	167	58	2950	2420	059 56689
	100	30 × 30	3030	0.55	244	84	2020	1660	059 56101
	100	25 × 40	2540	0.55	244	84	2020	1660	059 46101
	150	30 × 35	3035	0.68	364	124	1350	1110	059 36151
	150	25 × 50	2550	0.78	364	124	1350	1110	059 46151
	220	35 × 40	3540	0.94	532	180	930	760	059 56221
	220	30 × 50	3050	0.94	532	180	930	760	059 46221
	330	35 × 50	3550	1.25	796	260	620	510	059 56331

Additional electrical data

PARAMETER	CONDITIONS	VALUE
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		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	all case sizes	typ. 19 nH
		max. 25 nH

Aluminium electrolytic capacitors

Power Long Life Snap-in

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Capacitance (C)



Fig.4 Typical multiplier of capacitance as a function of ambient temperature.

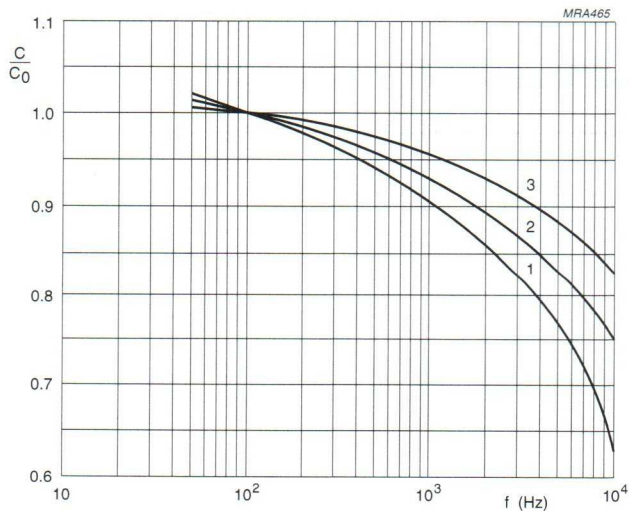
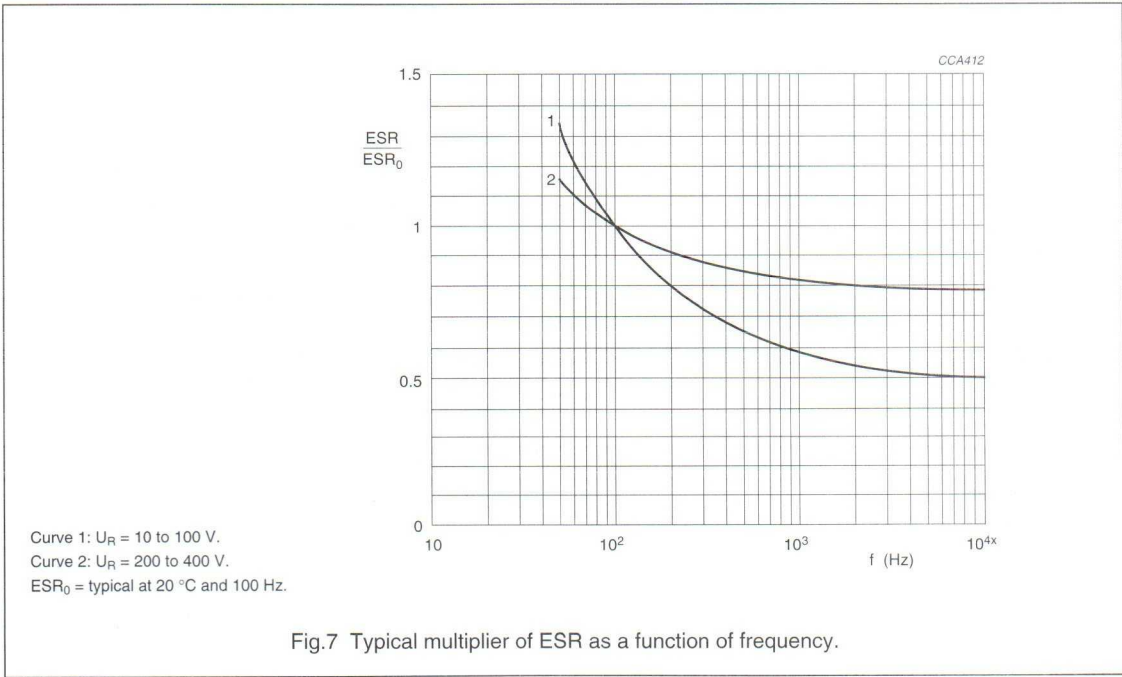
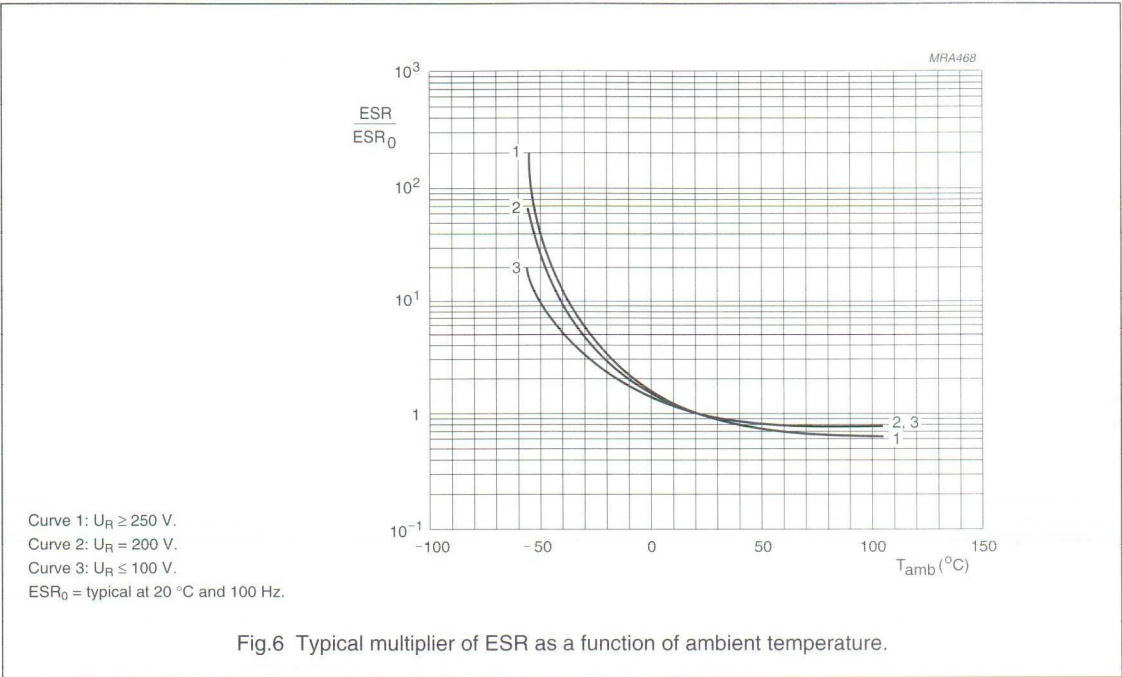


Fig.5 Typical multiplier of capacitance as a function of frequency.

Aluminium electrolytic capacitors
Power Long Life Snap-in

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Equivalent series resistance (ESR)

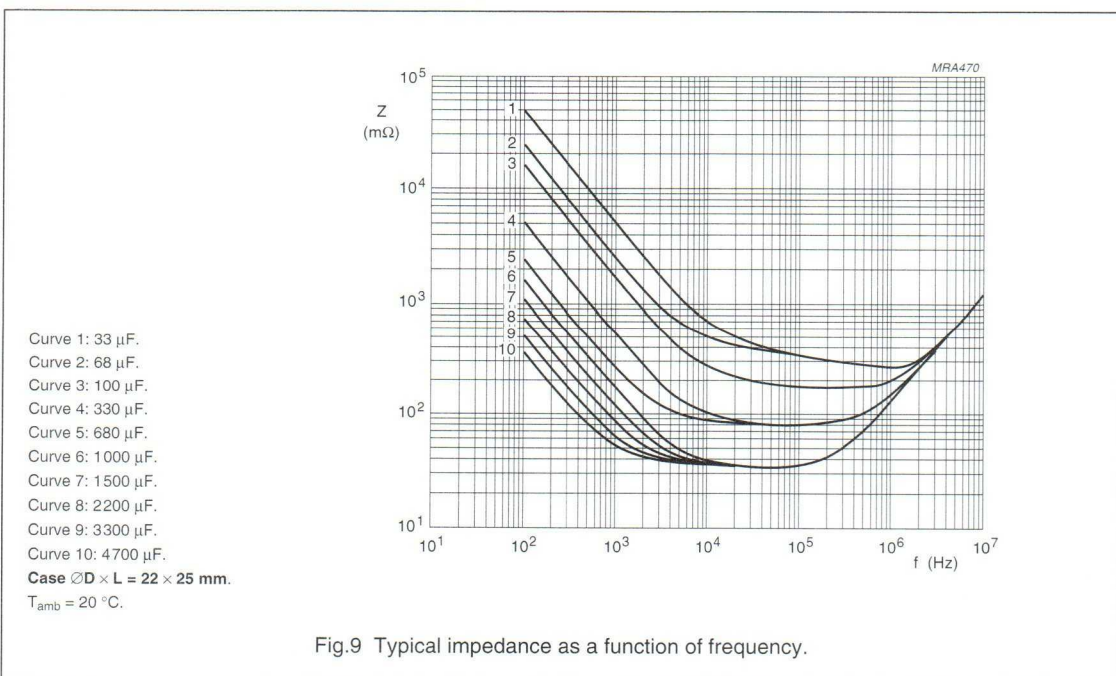
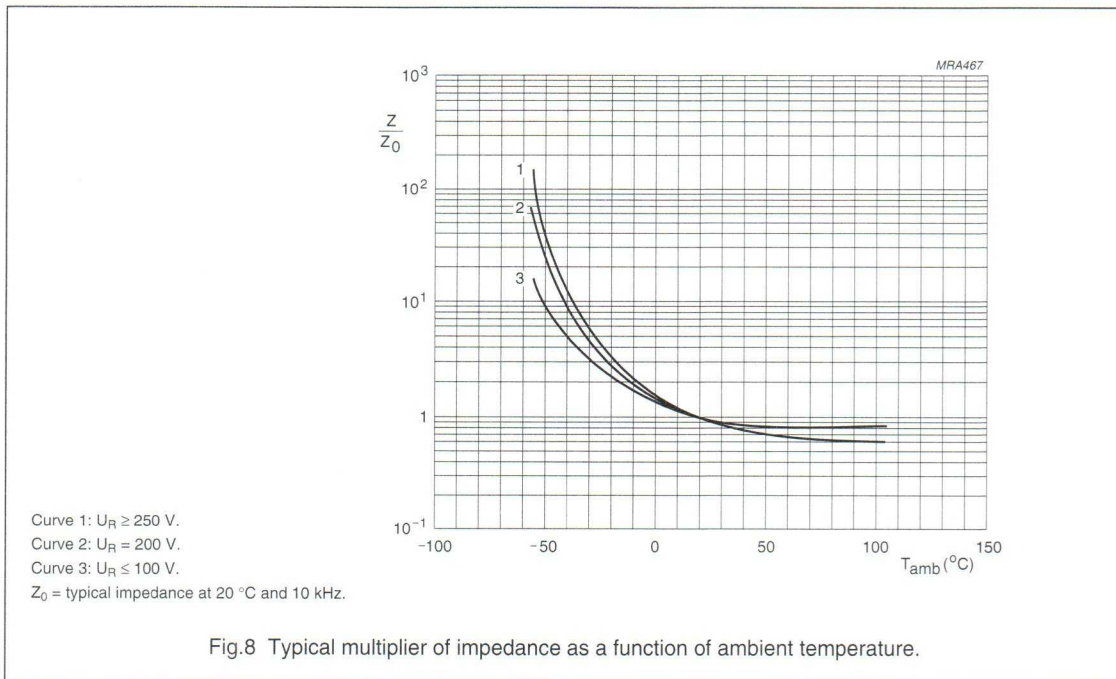


Aluminium electrolytic capacitors

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Impedance (Z)



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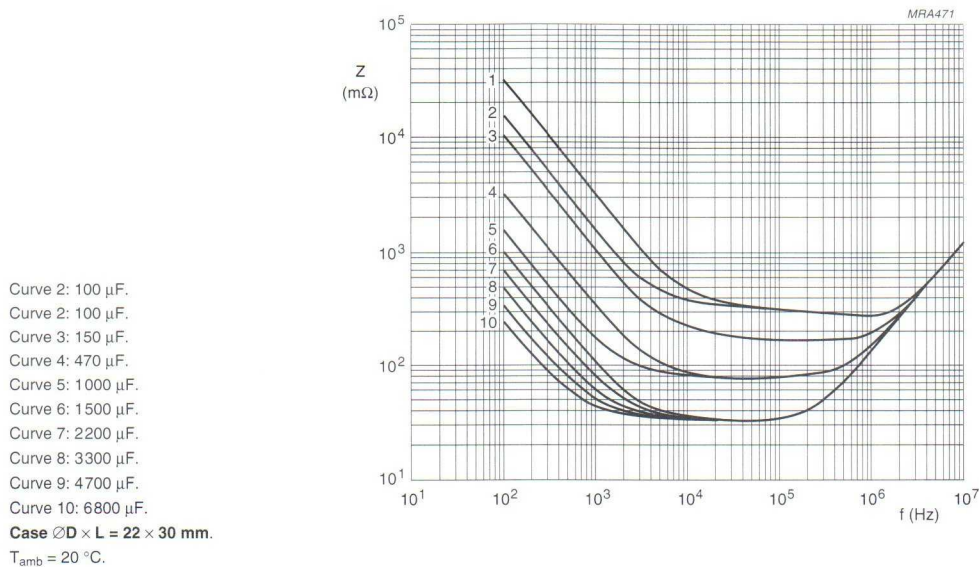


Fig.10 Typical impedance as a function of frequency.

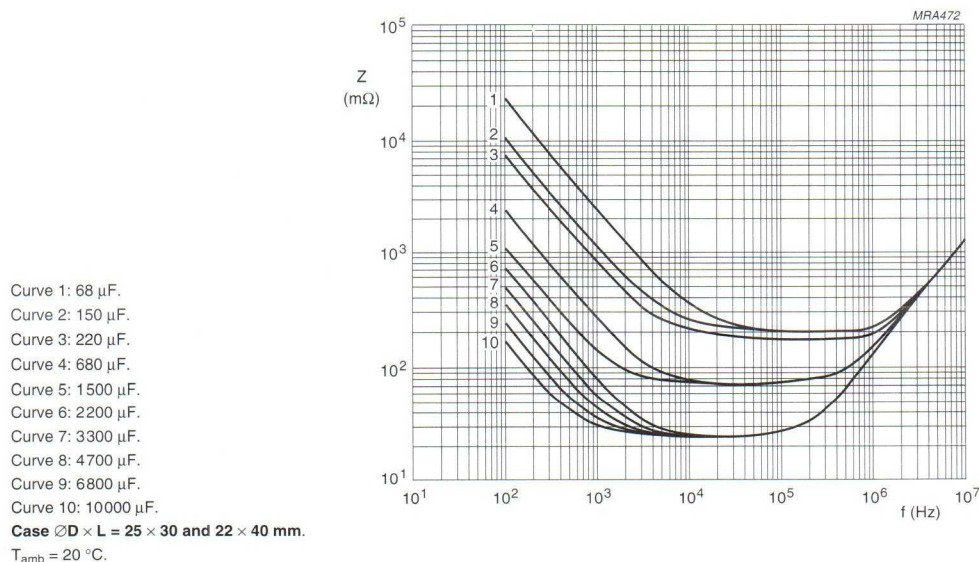
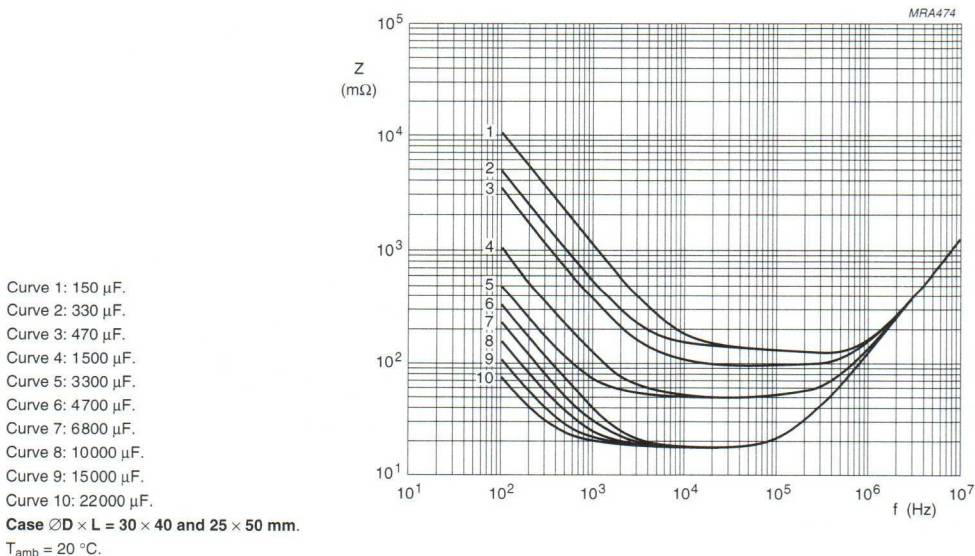
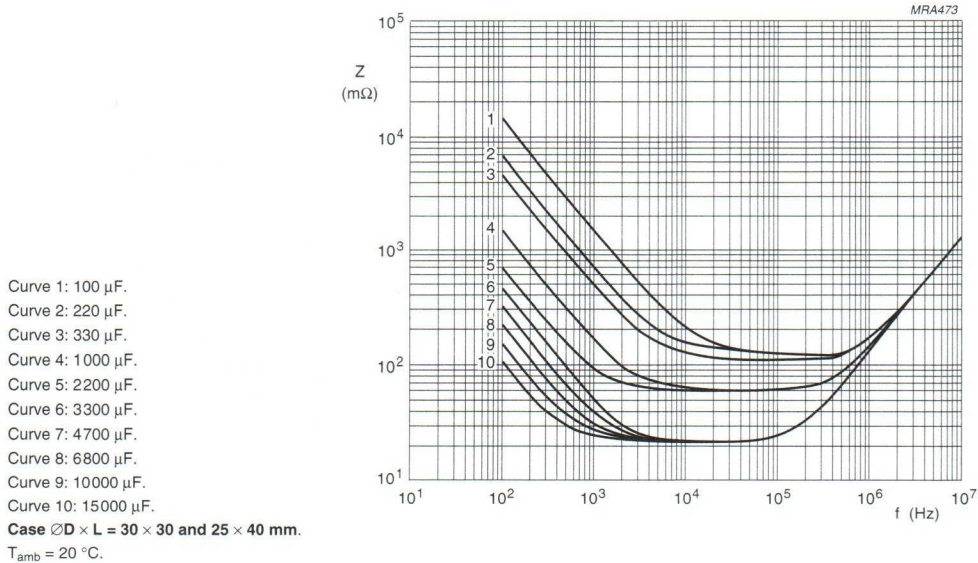


Fig.11 Typical impedance as a function of frequency.

Aluminium electrolytic capacitors

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Aluminium electrolytic capacitors

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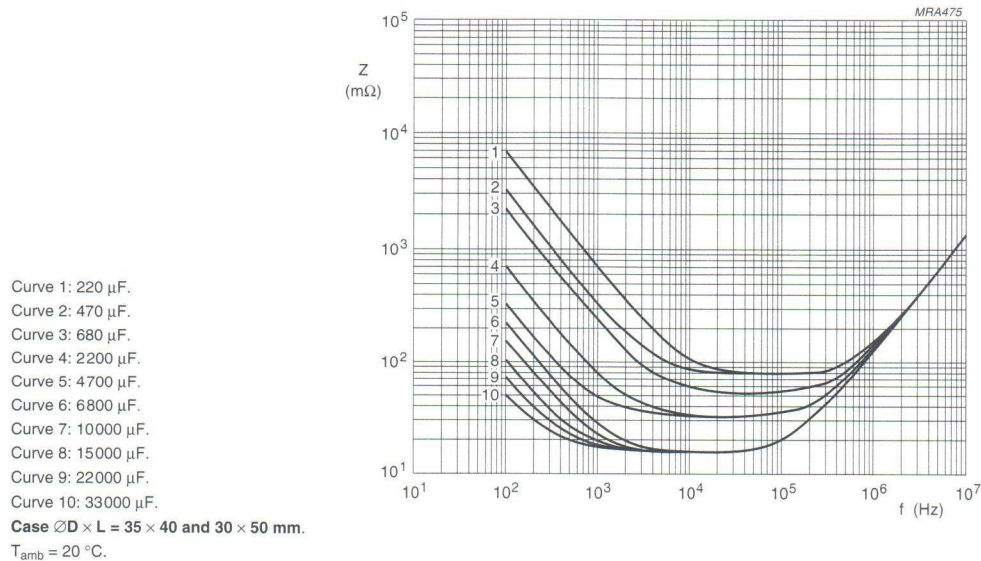


Fig.14 Typical impedance as a function of frequency.

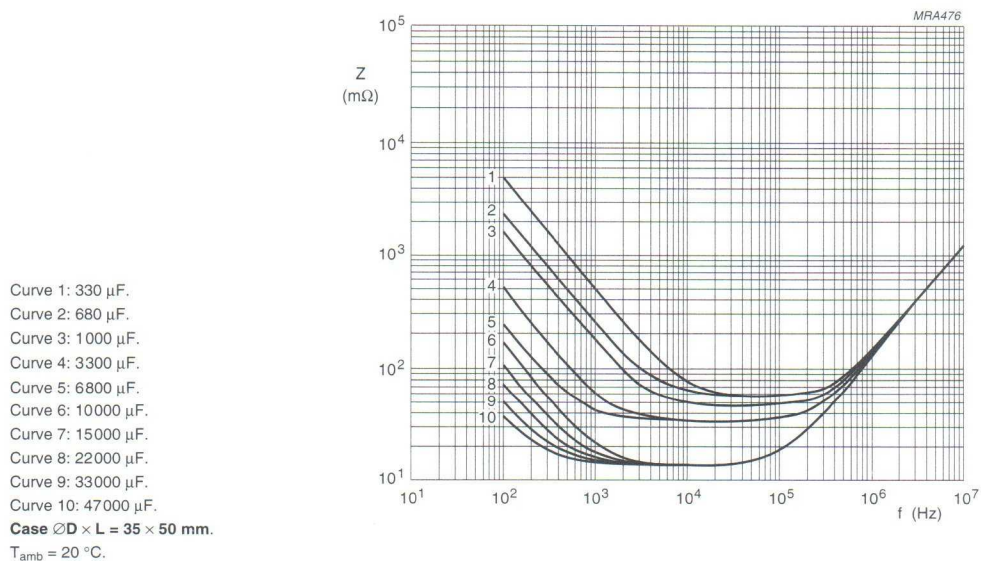


Fig.15 Typical impedance as a function of frequency.

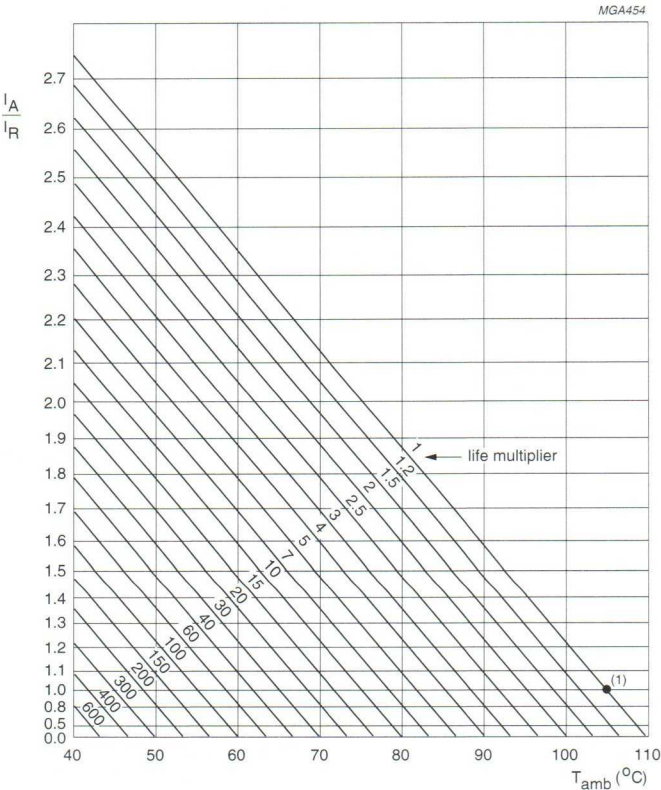
Aluminium electrolytic capacitors Power Long Life Snap-in

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RIPPLE CURRENT AND USEFUL LIFE

Table 4 Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10 \text{ to } 25 \text{ V}$	$U_R = 40 \text{ to } 100 \text{ V}$	$U_R > 100 \text{ V}$
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
≥ 10000	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 $\leq 50 \text{ V}$ types; 10000 hours for $\geq 63 \text{ V}$ types.

Fig.16 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 5 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; $\leq 50\text{ V}$ types: 2000 hours; $\geq 63\text{ V}$ types: 5000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; $\leq 50\text{ V}$ types: 5000 hours; $\geq 63\text{ V}$ types: 10000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 30\%$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100\text{ V}$: $\leq 1\%$; $U_R > 100\text{ V}$: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Aluminium electrolytic capacitors

Power Standard Miniature 4-Terminal Snap-in

166/167 PSM-4TSI

FEATURES

- Keyed polarity obtained by 4 snap-in terminals
- 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: 10000 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.

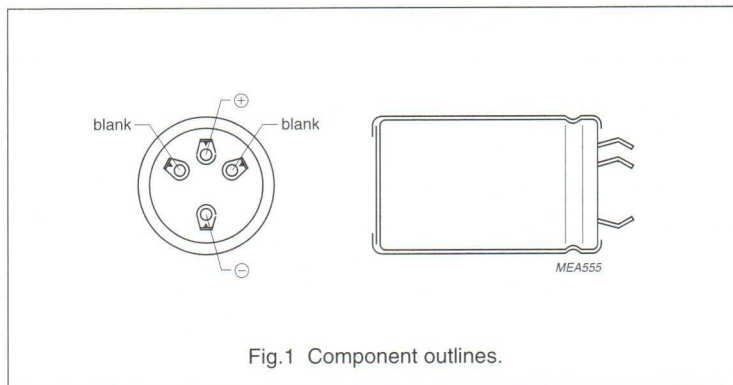
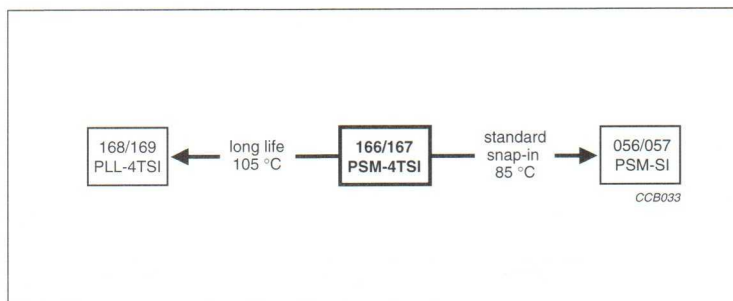


Fig.1 Component outlines.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	166	167
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	35 × 40; 35 × 50	35 × 40; 35 × 45; 35 × 50
Rated capacitance range (E6/E12 series), C_R	3300 to 68000 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	10000 hours	
Useful life at 40 °C and $1.4 \times I_R$ applied	175000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	40/085/56	

Aluminium electrolytic capacitors

Power Standard Miniature 4-Terminal Snap-in

166/167 PSM-4TSI

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 166 seriesPreferred types in **bold**.

C_R (μF)	U_R (V)					
	10	16	25	40	63	100
3300	—	—	—	—	—	35 × 40
4700	—	—	—	—	—	35 × 50
6800	—	—	—	—	35 × 40	—
10000	—	—	—	—	35 × 50	—
15000	—	—	—	35 × 40	—	—
22000	—	—	35 × 40	35 × 50	—	—
33000	—	35 × 40	35 × 50	—	—	—
47000	35 × 40	35 × 50	—	—	—	—
68000	35 × 50	—	—	—	—	—

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 167 seriesPreferred types in **bold**.

C_R (μF)	U_R (V)			
	200	250	385	400
330	—	—	35 × 40	35 × 40
390	—	—	—	35 × 45
470	—	—	35 × 45	35 × 50
	—	—	35 × 50	—
680	—	35 × 40	—	—
820	—	35 × 45	—	—
1000	35 × 40	35 × 50	—	—
1200	35 × 45	—	—	—
1500	35 × 50	—	—	—

Aluminium electrolytic capacitors Power Standard Miniature 4-Terminal Snap-in

166/167 PSM-4TSI

MECHANICAL DATA AND PACKAGING QUANTITIES

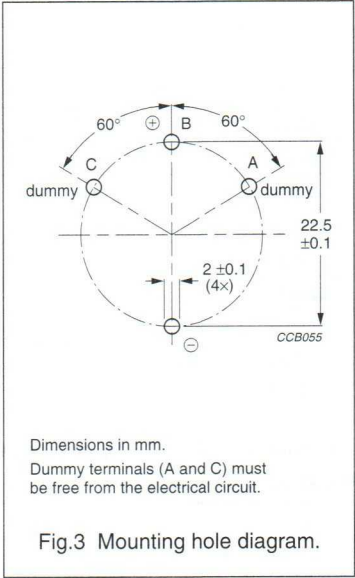
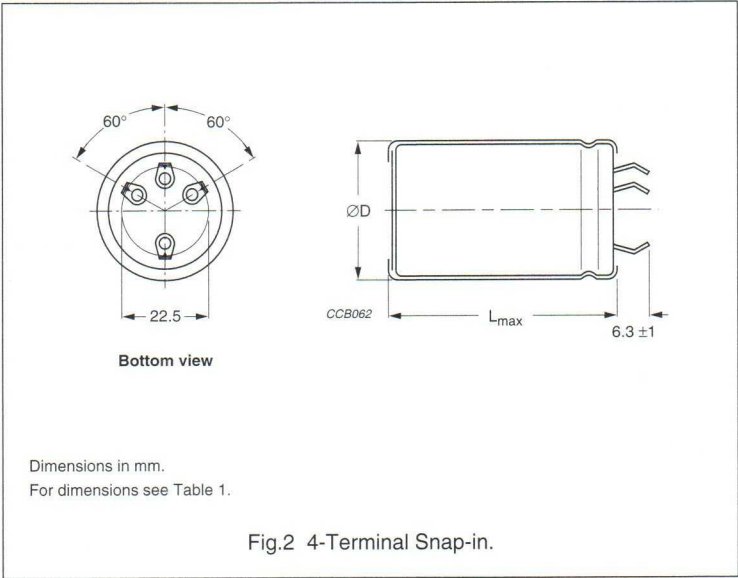


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	ØD _{max} (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
35 × 40	3540	36	42	≈55	50	390 × 198 × 54
35 × 45	3545	36	47	≈63	50	390 × 198 × 59
35 × 50	3550	36	52	≈72	50	390 × 198 × 64

MARKING

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

- Rated capacitance (in µF)
- Tolerance code on rated capacitance (M for ±20%)
- Rated voltage (in V)
- 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" and "CECC 30301".

Aluminium electrolytic capacitors

Power Standard Miniature 4-Terminal Snap-in

166/167 PSM-4TSI

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{amb} = 20^\circ$,
 $P = 86$ to 106 kPa, $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz
I_R	rated RMS ripple current at 100 Hz and 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 166 series

15000 $\mu\text{F}/40$ V; $\pm 20\%$ Nominal case size: $\varnothing 35 \times 40$ mm

Catalogue number: 2222 166 57153.

Table 2 Electrical data and ordering information for **166/167** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85°C (A)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
10	47000	35×40	3540	5.10	2824	944	31	26	166 54473
	68000	35×50	3550	5.88	4084	1364	28	23	166 54683
16	33000	35×40	3540	5.02	3172	1060	32	28	166 55333
	47000	35×50	3550	5.34	4516	1508	34	32	166 55473
25	22000	35×40	3540	4.48	3304	1104	40	28	166 56223
	33000	35×50	3550	4.98	4954	1654	39	33	166 56333
40	15000	35×40	3540	4.05	3604	1204	49	41	166 57153
	22000	35×50	3550	4.86	5284	1764	40	33	166 57223
63	6800	35×40	3540	4.01	2574	861	50	42	166 58682
	10000	35×50	3550	5.00	3784	1264	39	33	166 58103
100	3300	35×40	3540	2.84	1984	664	100	95	166 59332
	4700	35×50	3550	3.59	2824	677	75	70	166 59472
200	1000	35×40	3540	2.85	1204	404	160	135	167 52102
	1200	35×45	3545	2.98	1444	484	150	130	167 42122
	1500	35×50	3550	3.66	1804	604	120	105	167 52152
250	680	35×40	3540	2.60	1024	344	240	145	167 53681
	820	35×45	3545	2.70	1234	414	195	128	167 43821
	1000	35×50	3550	3.12	1504	504	160	105	167 53102
385	330	35×40	3540	2.11	766	258	480	280	167 58331
	470	35×45	3545	2.29	1089	366	340	220	167 48471
	470	35×50	3550	2.76	1089	366	340	220	167 58471
400	330	35×40	3540	1.85	796	268	480	280	167 56331
	390	35×45	3545	2.08	940	316	410	265	167 46391
	470	35×50	3550	2.76	1132	380	340	220	167 56471

Aluminium electrolytic capacitors
Power Standard Miniature 4-Terminal Snap-in

166/167 PSM-4TSI

Additional electrical data

PARAMETER	CONDITIONS	VALUE
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		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	all case sizes	typ. 19 nH
		max. 25 nH

Aluminium electrolytic capacitors

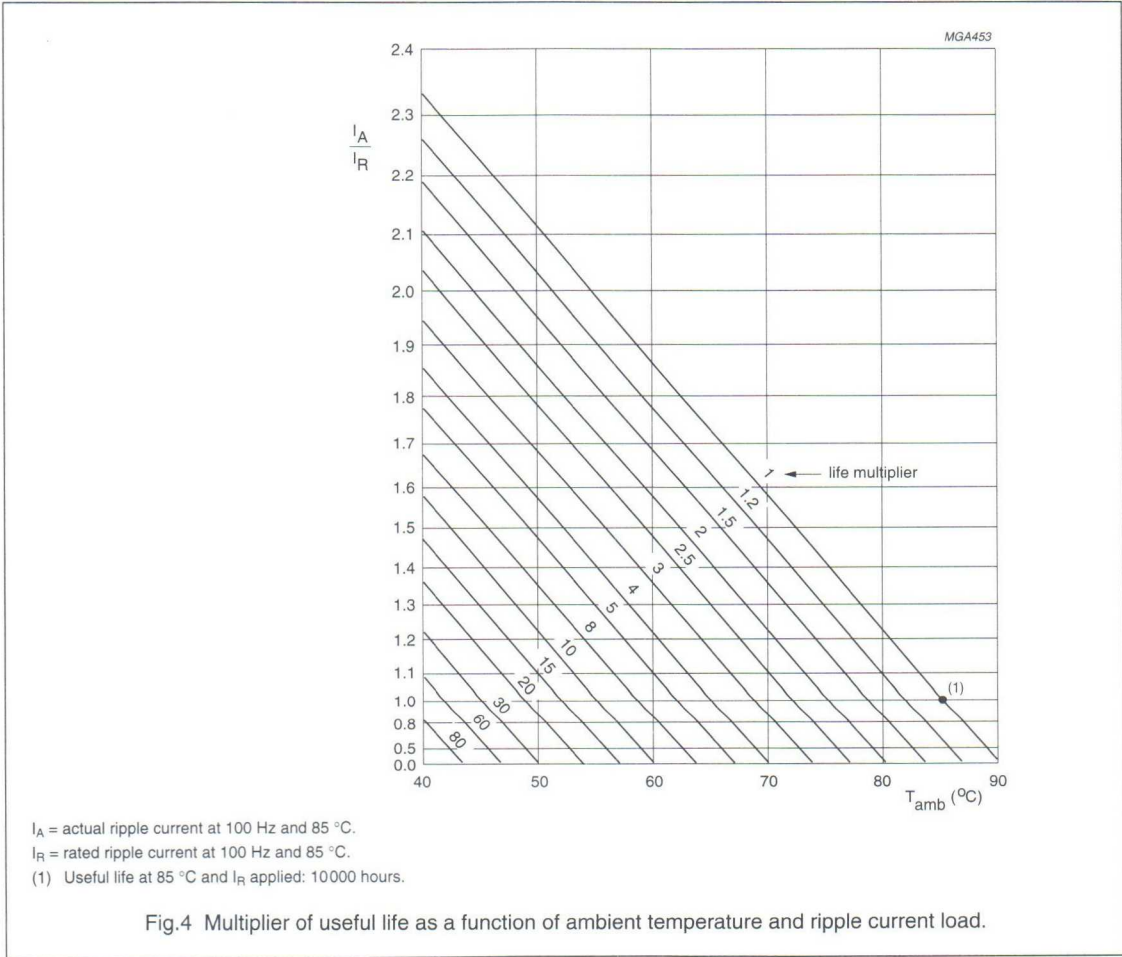
Power Standard Miniature 4-Terminal Snap-in

166/167 PSM-4TSI

RIPPLE CURRENT AND USEFUL LIFE

Table 3 Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10 \text{ to } 25 \text{ V}$	$U_R = 40 \text{ to } 100 \text{ V}$	$U_R > 100 \text{ V}$
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
≥ 10000	1.18	1.22	1.40



Aluminium electrolytic capacitors

Power Standard Miniature 4-Terminal Snap-in

166/167 PSM-4TSI

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 5000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 10000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 30\%$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100\text{ V}$: $\leq 1\%$; $U_R > 100\text{ V}$: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$ no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$: $\pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Aluminium electrolytic capacitors

Power Long Life 4-Terminal Snap-in

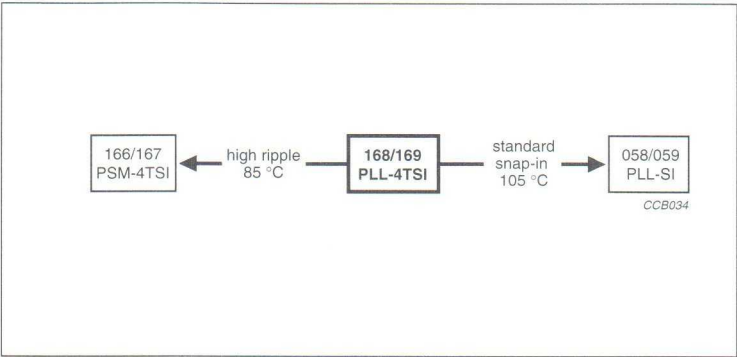
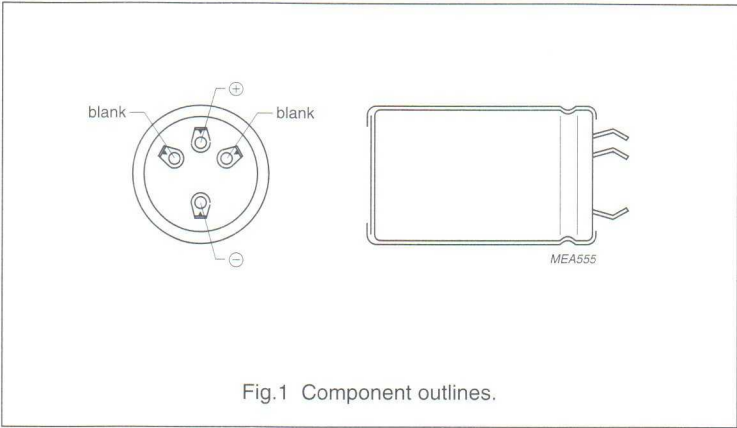
168/169 PLL-4TSI

FEATURES

- Keyed polarity obtained by 4 snap-in terminals
- 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
- Temperature range up to 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.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	168	169
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	35 × 40; 35 × 50	35 × 40; 35 × 45; 35 × 50
Rated capacitance range (E6/E12 series), C_R	2200 to 47000 μF	220 to 1000 μF
Tolerance on C_R	$\pm 20\%$	
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 40 °C and $1.9 \times I_R$ applied	125000 hours	
Shelf life at 0 V, 105 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	40/105/56	

Aluminium electrolytic capacitors

Power Long Life 4-Terminal Snap-in

168/169 PLL-4TSI

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 168 series

Preferred types in **bold**.

C_R (μF)	U_R (V)					
	10	16	25	40	63	100
2200	—	—	—	—	—	35 × 40
3300	—	—	—	—	—	35 × 50
4700	—	—	—	—	35 × 40	—
6800	—	—	—	—	35 × 50	—
10000	—	—	—	35 × 40	—	—
15000	—	—	35 × 40	35 × 50	—	—
22000	—	35 × 40	35 × 50	—	—	—
33000	35 × 40	35 × 50	—	—	—	—
47000	35 × 50	—	—	—	—	—

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 169 series

Preferred types in **bold**.

C_R (μF)	U_R (V)			
	200	250	385	400
220	—	—	35 × 40	35 × 40
270	—	—	35 × 45	35 × 45
330	—	—	35 × 50	35 × 50
470	—	35 × 40	—	—
680	35 × 40	35 × 45	—	—
	—	35 × 50	—	—
820	35 × 45	—	—	—
1000	35 × 50	—	—	—

Aluminium electrolytic capacitors
Power Long Life 4-Terminal Snap-in

168/169 PLL-4TSI

MECHANICAL DATA AND PACKAGING QUANTITIES

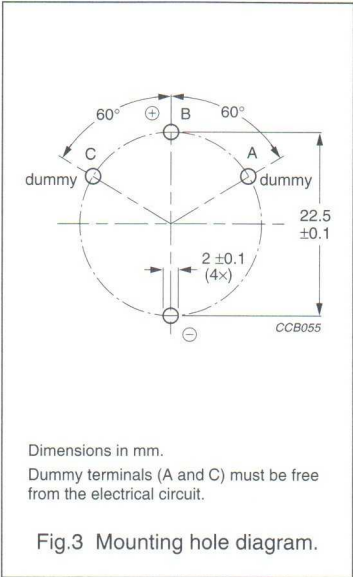
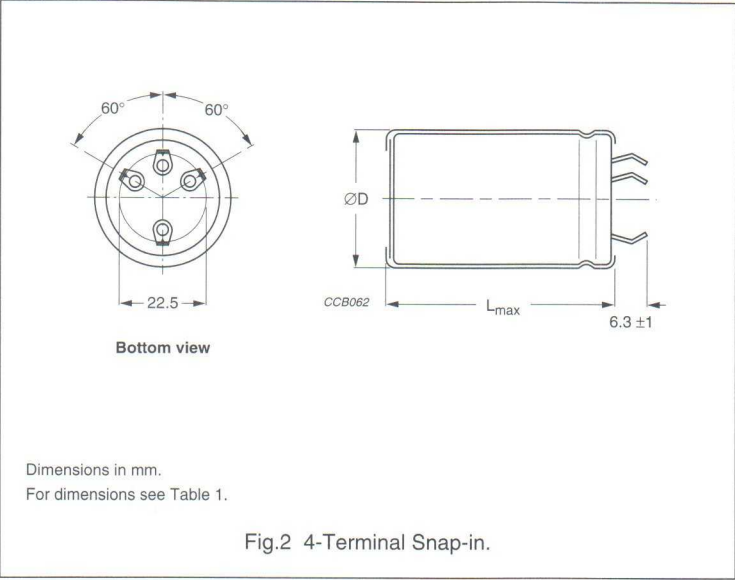


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	ØD _{max} (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
35 × 40	3540	36	42	≈55	50	390 × 198 × 54
35 × 45	3545	36	47	≈63	50	390 × 198 × 59
35 × 50	3550	36	52	≈72	50	390 × 198 × 64

MARKING

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

- Rated capacitance (in µF)
- Tolerance code on rated capacitance (M for ±20%)
- Rated voltage (in V)
- 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" and "CECC 30301".

Aluminium electrolytic capacitors

Power Long Life 4-Terminal Snap-in

168/169 PLL-4TSI

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at
 $T_{amb} = 20\text{ °C}$, $P = 86\text{ to }106\text{ kPa}$, $RH = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz
I_R	rated RMS ripple current at 100 Hz and 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 168 series

15000 $\mu\text{F}/25\text{ V}$; $\pm 20\%$ Nominal case size: $\varnothing 35 \times 40\text{ mm}$

Catalogue number: 2222 168 56153.

Table 2 Electrical data and ordering information for **168/169** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
10	33000 47000	35 × 40 35 × 50	3540 3550	5.15 6.23	1984 2824	664 944	30 24	24 21	168 54333 168 54473
16	22000 33000	35 × 40 35 × 50	3540 3550	5.07 6.23	2116 3172	708 1060	31 25	24 21	168 55223 168 55333
25	15000 22000	35 × 40 35 × 50	3540 3550	4.91 6.07	2254 3304	754 1104	33 27	24 21	168 56153 168 56223
40	10000 15000	35 × 40 35 × 50	3540 3550	4.18 5.21	2404 3604	804 1204	46 36	29 24	168 57103 168 57153
63	4700 6800	35 × 40 35 × 50	3540 3550	3.65 4.58	1781 2574	596 861	60 46	45 35	168 58472 168 58682
100	2200 3300	35 × 40 35 × 50	3540 3550	3.05 3.84	1324 1984	444 664	86 64	65 50	168 59222 168 59332
200	680 820 1000	35 × 40 35 × 45 35 × 50	3540 3545 3550	1.91 2.18 2.45	820 988 1204	276 332 404	235 195 160	155 150 125	169 52681 169 42821 169 52102
250	470 680 680	35 × 40 35 × 45 35 × 50	3540 3545 3550	1.82 2.25 2.30	709 1024 1024	239 344 344	270 190 190	155 125 125	169 53471 169 43681 169 53681
385	220 270 330	35 × 40 35 × 45 35 × 50	3540 3545 3550	1.31 1.52 1.75	512 627 766	173 212 258	580 475 390	465 385 320	169 58221 169 48271 169 58331
400	220 270 330	35 × 40 35 × 45 35 × 50	3540 3545 3550	0.94 1.07 1.25	532 652 796	180 220 260	930 770 620	760 630 510	169 56221 169 46271 169 56331

Aluminium electrolytic capacitors
Power Long Life 4-Terminal Snap-in

168/169 PLL-4TSI

Additional electrical data

PARAMETER	CONDITIONS	VALUE
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		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006C_R \times U_R + 4 \text{ }\mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \text{ }\mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	all case sizes	typ. 19 nH
		max. 25 nH

L

Aluminium electrolytic capacitors

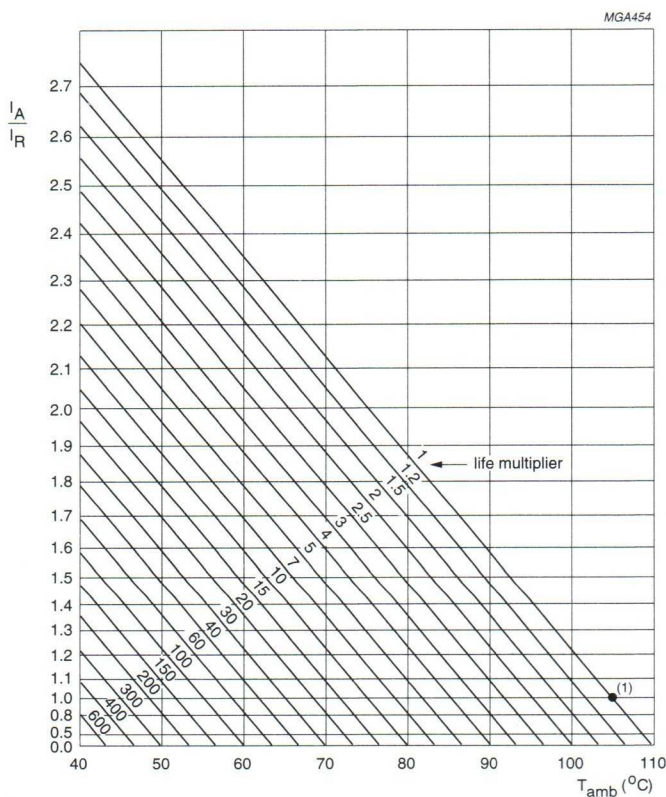
Power Long Life 4-Terminal Snap-in

168/169 PLL-4TSI

RIPPLE CURRENT AND USEFUL LIFE

Table 3 Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10 \text{ to } 25 \text{ V}$	$U_R = 40 \text{ to } 100 \text{ V}$	$U_R > 100 \text{ V}$
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
≥ 10000	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.

Fig.4 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Power Long Life 4-Terminal Snap-in

168/169 PLL-4TSI

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; 5000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 30\%$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100\text{ V}$: $\leq 1\%$; $U_R > 100\text{ V}$: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$: $\pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

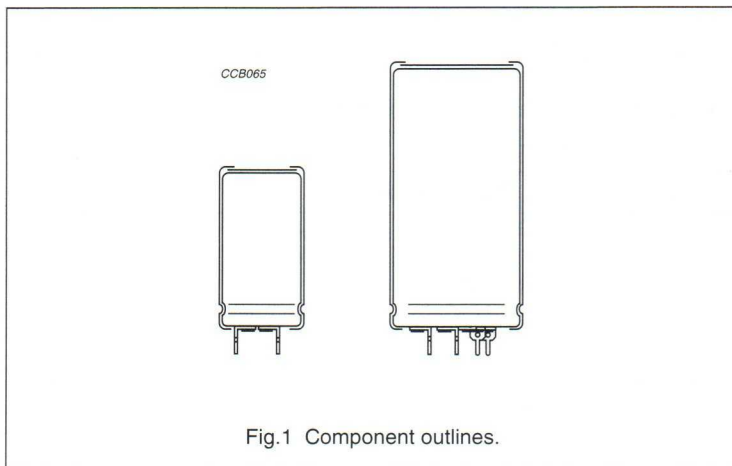
Aluminium electrolytic capacitors

Power Economic Printed Wiring

051/053 PEC-PW

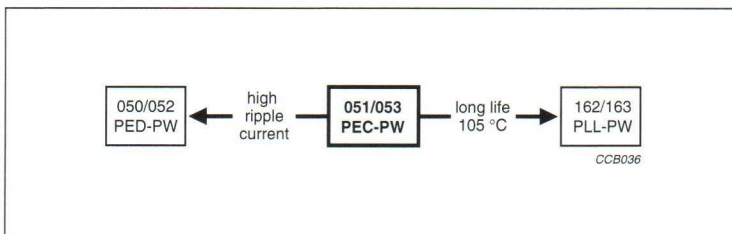
FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types with reduced dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Provided with keyed polarity
- Pressure relief on the top of the aluminium case
- Charge and discharge proof
- Long useful life:
12000 hours at 85 °C
- High ripple current capability
- High resistance to shock and vibration.



APPLICATIONS

- General purpose, industrial and audio/video systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	051	053
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	25 × 30 to 40 × 100	
Rated capacitance range (E6 series), C_R	680 to 150 000 μF	68 to 2200 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	12000 hours	
Useful life at 40 °C, $1.4 \times I_R$ applied	200 000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4, CECC 30300	
Detail specification	DIN 45910-T129, former DIN 41238	
Climatic category IEC 68	40/085/56	

Aluminium electrolytic capacitors

Power Economic Printed Wiring

051/053 PEC-PW

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm)

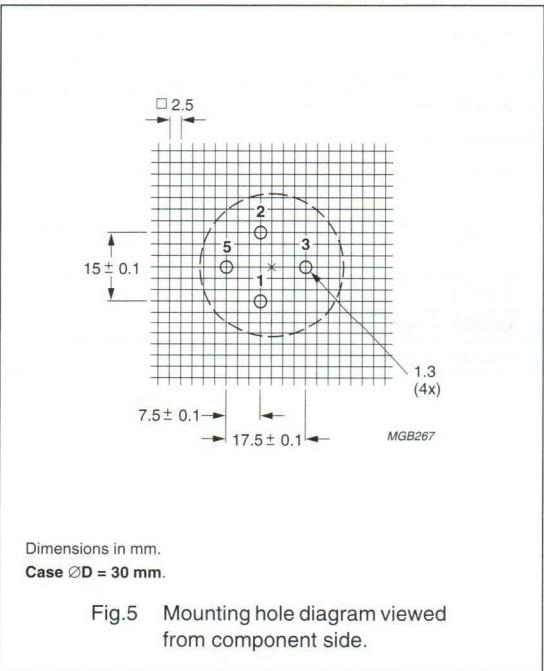
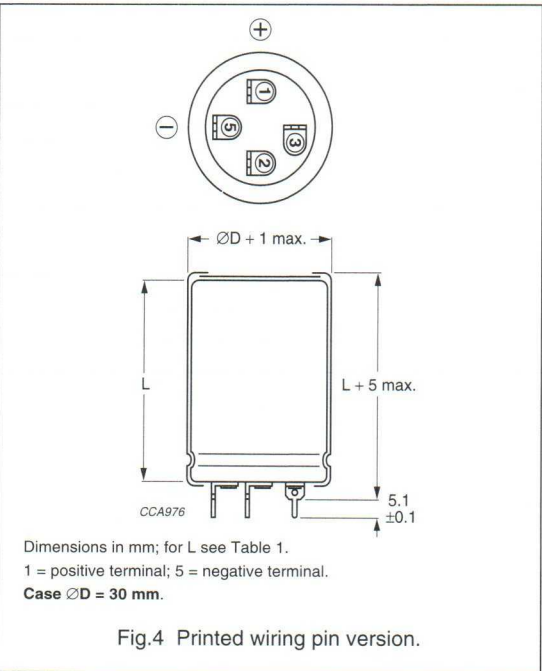
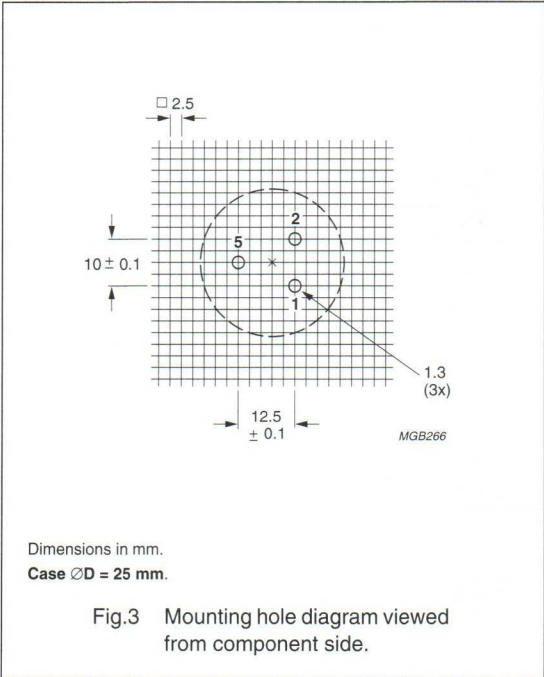
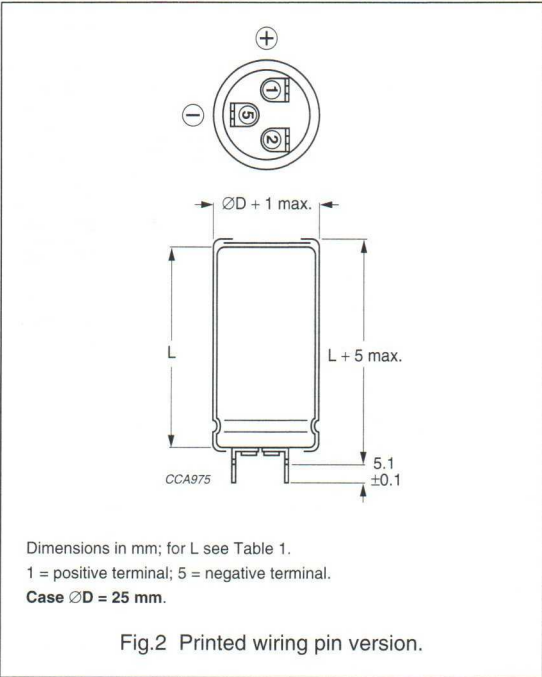
Preferred types in **bold**

C_R (μF)	U_R (V)								
	10	16	25	40	63	100	200	385	400
68	—	—	—	—	—	—	—	25 × 30	25 × 30
100	—	—	—	—	—	—	—	25 × 40	25 × 40
150	—	—	—	—	—	—	25 × 30	30 × 40	30 × 40
220	—	—	—	—	—	—	25 × 40	35 × 40	35 × 40
330	—	—	—	—	—	—	30 × 40	35 × 50	35 × 50
	—	—	—	—	—	—	—	40 × 40	40 × 40
470	—	—	—	—	—	—	35 × 40	40 × 50	40 × 50
680	—	—	—	—	—	25 × 30	35 × 50	40 × 70	40 × 70
	—	—	—	—	—	—	40 × 40	—	—
1000	—	—	—	—	—	25 × 40	40 × 50	40 × 100	40 × 100
1500	—	—	—	—	—	30 × 40	40 × 70	—	—
2200	—	—	—	—	25 × 30	35 × 40	40 × 100	—	—
3300	—	—	—	25 × 30	25 × 40	35 × 50	—	—	—
	—	—	—	—	—	40 × 40	—	—	—
4700	—	—	25 × 30	25 × 40	30 × 40	40 × 50	—	—	—
6800	—	25 × 30	25 × 40	30 × 40	35 × 40	40 × 70	—	—	—
10000	25 × 30	25 × 40	30 × 40	35 × 40	35 × 50	40 × 100	—	—	—
	—	—	—	—	40 × 40	—	—	—	—
15000	25 × 40	30 × 40	35 × 40	35 × 50	40 × 70	—	—	—	—
	—	—	—	40 × 40	—	—	—	—	—
22000	30 × 40	35 × 40	35 × 50	40 × 50	40 × 100	—	—	—	—
	—	—	40 × 40	—	—	—	—	—	—
33000	35 × 40	35 × 50	40 × 50	40 × 70	—	—	—	—	—
	—	40 × 40	—	—	—	—	—	—	—
47000	35 × 50	40 × 50	40 × 70	40 × 100	—	—	—	—	—
	40 × 40	—	—	—	—	—	—	—	—
68000	40 × 50	40 × 70	40 × 100	—	—	—	—	—	—
100000	40 × 70	40 × 100	—	—	—	—	—	—	—
150000	40 × 100	—	—	—	—	—	—	—	—

Aluminium electrolytic capacitors
Power Economic Printed Wiring

051/053 PEC-PW

MECHANICAL DATA AND PACKAGING QUANTITIES



Aluminium electrolytic capacitors
Power Economic Printed Wiring

051/053 PEC-PW

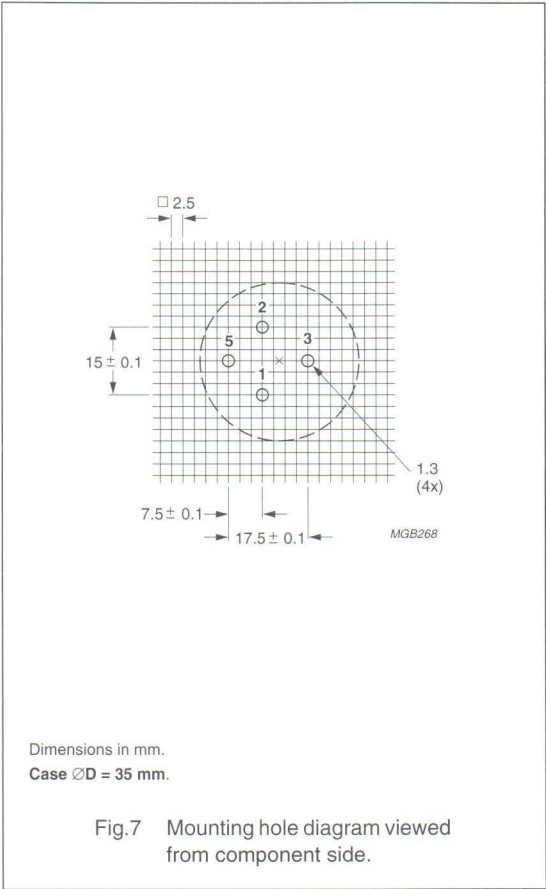
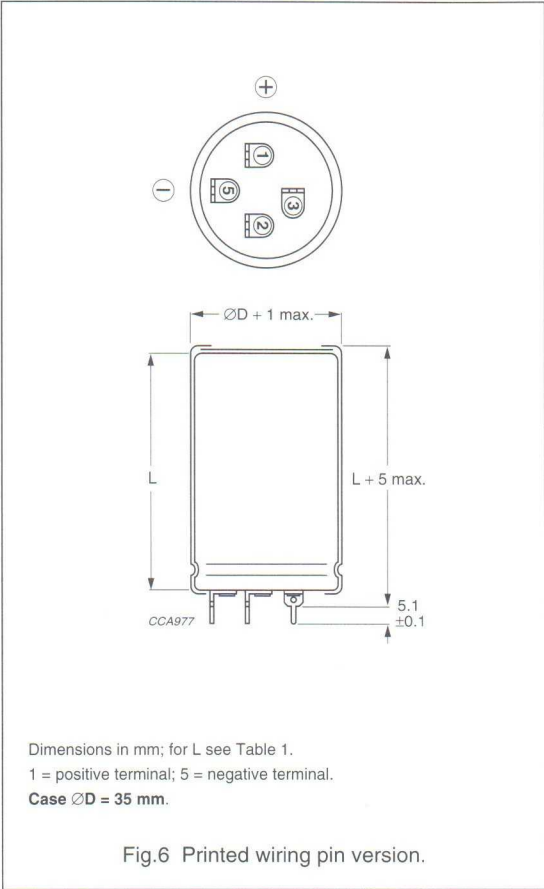
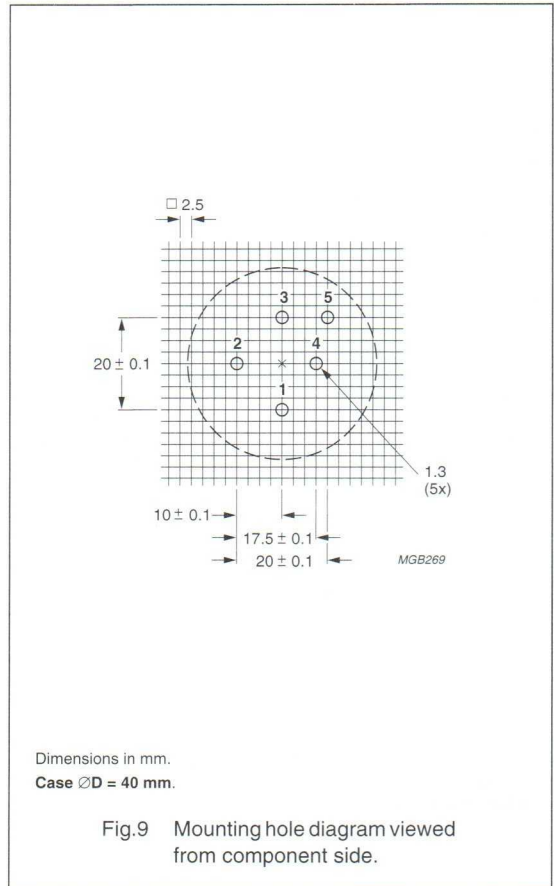
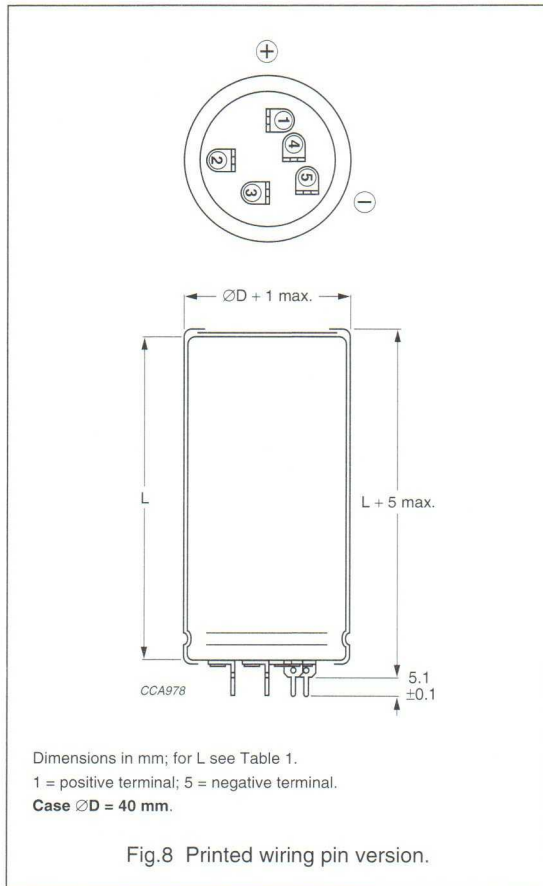


Table 1 Physical dimensions, mass and packaging information; see Figs 2, 4, 6 and 8

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	$\varnothing D_{\text{max}}$ (mm)	L_{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS $l \times w \times h$ (mm)
25 × 30	26	35	≈24	100	290 × 280 × 45
25 × 40	26	45	≈28	100	290 × 280 × 55
30 × 40	31	45	≈38	100	340 × 330 × 55
35 × 40	36	45	≈51	50	390 × 198 × 55
35 × 50	36	55	≈66	50	390 × 198 × 65
40 × 40	41	45	≈78	50	440 × 223 × 55
40 × 50	41	55	≈82	50	440 × 223 × 65
40 × 70	41	75	≈110	50	440 × 223 × 85
40 × 100	41	105	≈176	50	440 × 223 × 115

Aluminium electrolytic capacitors Power Economic Printed Wiring

051/053 PEC-PW



Mounting

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) must be free from the electrical circuit.

MARKING

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

- Rated capacitance (in μF)
- Tolerance on rated capacitance (M for $\pm 20\%$)
- Rated voltage (in V)
- 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" and "CECC 30301".

Aluminium electrolytic capacitors

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 2 and 3 apply at
 $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz
I_R	rated RMS ripple current at 100 Hz, $85\text{ }^{\circ}\text{C}$ or at 20 kHz, $70\text{ }^{\circ}\text{C}$
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 051 series

10 000 $\mu\text{F}/25\text{ V}$; $\pm 20\%$ Nominal case size: $\varnothing 30 \times 40\text{ mm}$

Catalogue number: 2222 051 56103.

Table 2 Electrical data and ordering information for **051** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz $85\text{ }^{\circ}\text{C}$ (A)	I_R 20 kHz $70\text{ }^{\circ}\text{C}$ (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
10	10000	25 × 30	3.1	5.9	0.60	0.20	51	40	051 54103
	15000	25 × 40	4.1	7.8	0.90	0.30	37	30	051 54153
	22000	30 × 40	5.0	9.5	1.32	0.44	30	25	051 54223
	33000	35 × 40	5.5	10.4	1.98	0.66	28	24	051 54333
	47000	35 × 50	6.8	12.9	2.82	0.94	23	20	051 54473
	47000	40 × 40	5.8	10.4	2.82	0.94	29	22	051 44473
	68000	40 × 50	7.1	13.5	4.08	1.36	24	20	051 54683
	100000	40 × 70	9.2	17.4	6.00	2.00	19	16	051 54104
	150000	40 × 100	12.0	22.7	9.00	3.00	16	14	051 54154
16	6800	25 × 30	3.1	5.9	0.65	0.22	53	42	051 55682
	10000	25 × 40	4.0	7.6	0.96	0.32	39	34	051 55103
	15000	30 × 40	5.0	9.5	1.44	0.48	31	27	051 55153
	22000	35 × 40	5.5	10.4	2.12	0.71	29	26	051 55223
	33000	35 × 50	6.7	12.7	3.17	1.06	23	21	051 55333
	33000	40 × 40	5.7	10.8	3.17	1.06	30	24	051 45333
	47000	40 × 50	7.0	13.3	4.52	1.51	24	20	051 55473
	68000	40 × 70	9.2	17.4	6.53	2.18	19	16	051 55683
	100000	40 × 100	12.0	22.7	9.60	3.20	16	14	051 55104
25	4700	25 × 30	2.9	5.5	0.71	0.24	60	42	051 56472
	6800	25 × 40	3.9	7.4	1.02	0.34	42	34	051 56682
	10000	30 × 40	4.8	9.1	1.50	0.50	34	27	051 56103
	15000	35 × 40	5.3	10.0	2.25	0.75	30	26	051 56153
	22000	35 × 50	6.5	12.3	3.30	1.10	24	21	051 56223
	22000	40 × 40	5.7	10.8	3.30	1.10	31	24	051 46223
	33000	40 × 50	7.0	13.3	4.95	1.65	25	20	051 56333
	47000	40 × 70	9.2	17.4	7.05	2.35	19	16	051 56473
	68000	40 × 100	12.0	22.7	10.20	3.40	16	14	051 56683

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U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
40	3300	25 × 30	2.9	5.5	0.80	0.27	87	63	051 57332
	4700	25 × 40	3.8	7.2	1.13	0.38	62	47	051 57472
	6800	30 × 40	4.7	8.9	1.64	0.55	49	38	051 57682
	10000	35 × 40	5.2	9.8	2.40	0.80	48	37	051 57103
	15000	35 × 50	6.3	11.9	3.60	1.20	37	28	051 57153
	15000	40 × 40	5.6	10.6	3.60	1.20	50	35	051 47153
	22000	40 × 50	5.8	11.0	5.28	1.76	39	28	051 57223
	33000	40 × 70	7.8	14.8	7.92	2.64	28	21	051 57333
	47000	40 × 100	10.4	19.7	11.28	3.76	22	17	051 57473
63	2200	25 × 30	2.5	4.7	0.84	0.28	83	62	051 58222
	3300	25 × 40	3.3	6.2	1.25	0.42	58	42	051 58332
	4700	30 × 40	4.1	7.8	1.78	0.60	49	38	051 58472
	6800	35 × 40	4.5	8.5	2.57	0.86	48	37	051 58682
	10000	35 × 50	5.4	10.2	3.78	1.26	37	28	051 58103
	10000	40 × 40	4.6	8.7	3.78	1.26	52	37	051 48103
	15000	40 × 70	7.5	14.2	5.67	1.89	29	24	051 58153
	22000	40 × 100	10.0	19.0	8.32	2.77	22	19	051 58223
100	680	25 × 30	1.74	3.30	0.41	0.14	190	130	051 59681
	1000	25 × 40	2.34	4.44	0.60	0.20	130	90	051 59102
	1500	30 × 40	2.95	5.59	0.90	0.30	95	67	051 59152
	2200	35 × 40	3.69	7.00	1.32	0.44	71	53	051 59222
	3300	35 × 50	4.37	8.29	1.98	0.66	55	41	051 59332
	3300	40 × 40	4.16	7.89	1.98	0.66	64	48	051 49332
	4700	40 × 50	5.21	9.88	2.82	0.94	49	38	051 59472
	6800	40 × 70	6.97	13.22	4.08	1.36	35	28	051 59682
	10000	40 × 100	9.50	18.00	6.00	2.00	26	21	051 59103

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Table 3 Electrical data and ordering information for **053** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
200	150	25 × 30	0.70	1.33	0.18	0.06	1000	770	053 52151
	220	25 × 40	0.94	1.78	0.26	0.09	680	525	053 52221
	330	30 × 40	1.27	2.41	0.40	0.14	460	360	053 52331
	470	35 × 40	1.66	3.15	0.57	0.19	320	250	053 52471
	680	35 × 50	2.19	4.15	0.82	0.28	220	170	053 52681
	680	40 × 40	2.17	4.11	0.82	0.28	220	170	053 42681
	1000	40 × 50	2.86	5.42	1.20	0.40	150	115	053 52102
	1500	40 × 70	3.81	7.22	1.80	0.60	110	85	053 52152
	2200	40 × 100	5.20	9.86	2.64	0.88	80	60	053 52222
385	68	25 × 30	0.47	0.89	0.16	0.06	2200	1480	053 58689
	100	25 × 40	0.64	1.21	0.23	0.08	1500	1020	053 58101
	150	30 × 40	0.90	1.71	0.35	0.12	1000	700	053 58151
	220	35 × 40	1.15	2.18	0.51	0.17	680	480	053 58221
	330	35 × 50	1.53	2.90	0.77	0.26	450	340	053 58331
	330	40 × 40	1.52	2.88	0.77	0.26	450	340	053 48331
	470	40 × 50	1.96	3.72	1.09	0.36	320	260	053 58471
	680	40 × 70	2.70	5.12	1.58	0.53	220	190	053 58681
	1000	40 × 100	3.70	7.02	2.31	0.78	180	140	053 58102
400	68	25 × 30	0.54	1.02	0.16	0.06	2100	1000	053 56689
	100	25 × 40	0.73	1.38	0.24	0.08	1400	780	053 56101
	150	30 × 40	0.98	1.86	0.36	0.12	950	520	053 56151
	220	35 × 40	1.28	2.43	0.52	0.17	650	400	053 56221
	330	35 × 50	1.67	3.17	0.79	0.26	480	280	053 56331
	330	40 × 40	1.67	3.17	0.79	0.26	480	280	053 46331
	470	40 × 50	2.12	4.02	1.12	0.37	340	220	053 56471
	680	40 × 70	2.90	5.50	1.63	0.54	235	155	053 56681
	1000	40 × 100	4.05	7.68	2.40	0.80	160	110	053 56102

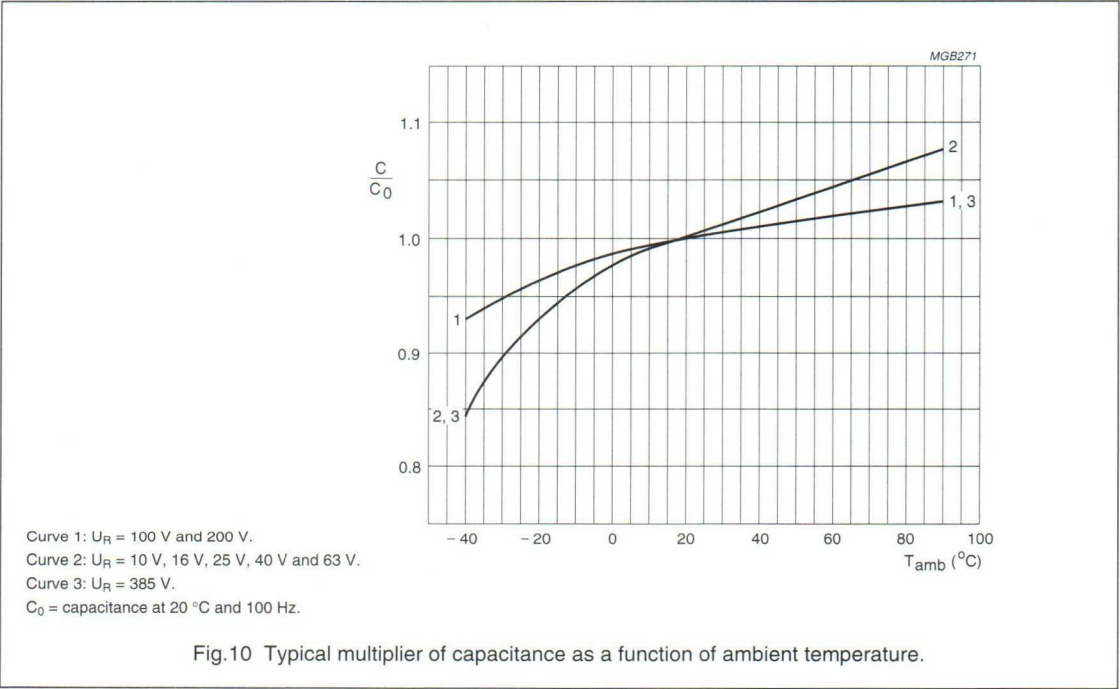
Aluminium electrolytic capacitors
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Additional electrical data

PARAMETER	CONDITIONS	VALUE
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		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case ØD = 25 mm	max. 25 nH
	case ØD = 30 and 35 mm	max. 30 nH
	case ØD = 40 mm	max. 35 nH

Capacitance (C)



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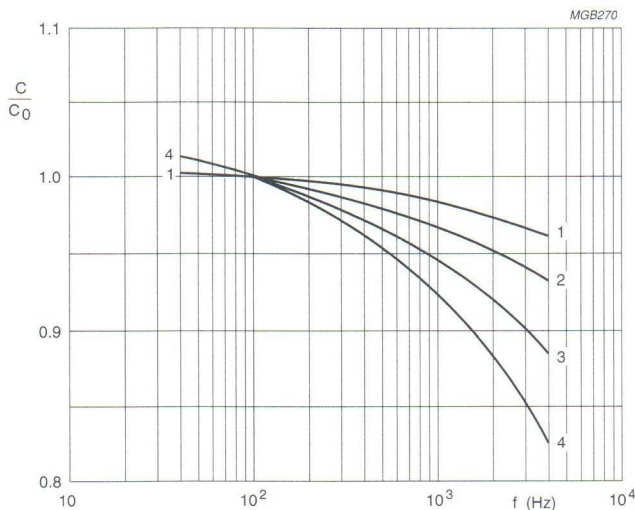
Curve 1: $U_R = 100$ V and 200 V.Curve 2: $U_R = 40$ V and 63 V.Curve 3: $U_R = 25$ V and 385 V.Curve 4: $U_R = 10$ V and 16 V. C_0 = capacitance at 20 °C and 100 Hz.

Fig.11 Typical multiplier of capacitance as a function of frequency.

Equivalent series resistance (ESR)

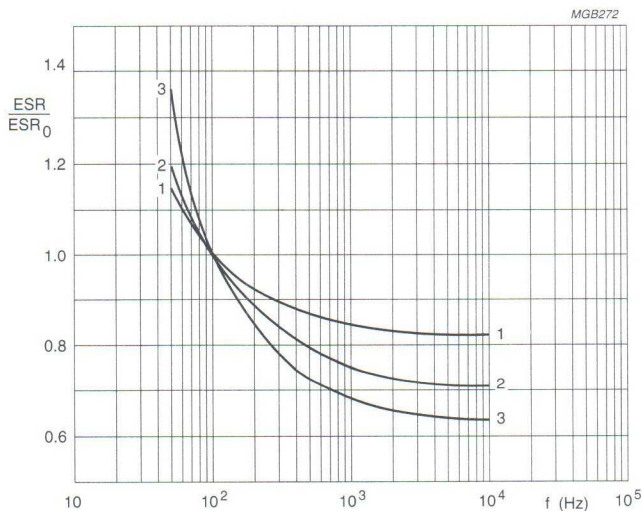
Curve 1: $U_R = 10$ V, 16 V and 25 V.Curve 2: $U_R = 40$ V, 63 V and 385 V.Curve 3: $U_R = 100$ V and 200 V. ESR_0 = typical at 20 °C and 100 Hz.

Fig.12 Typical multiplier of typical ESR as a function of frequency.

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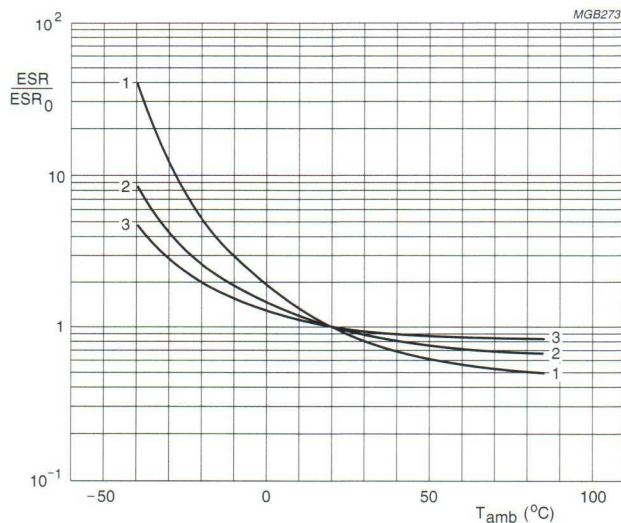
Curve 1: $U_R = 385 \text{ V}$.Curve 2: $U_R = 100 \text{ V}$ and 200 V .Curve 3: $U_R = 10 \text{ V}$ to 63 V . ESR_0 = typical at 20°C and 100 Hz .**Case** $\varnothing D \times L = 25 \times 30, 25 \times 40, 30 \times 40$ and $35 \times 40 \text{ mm}$.

Fig.13 Typical multiplier of ESR as a function of ambient temperature.

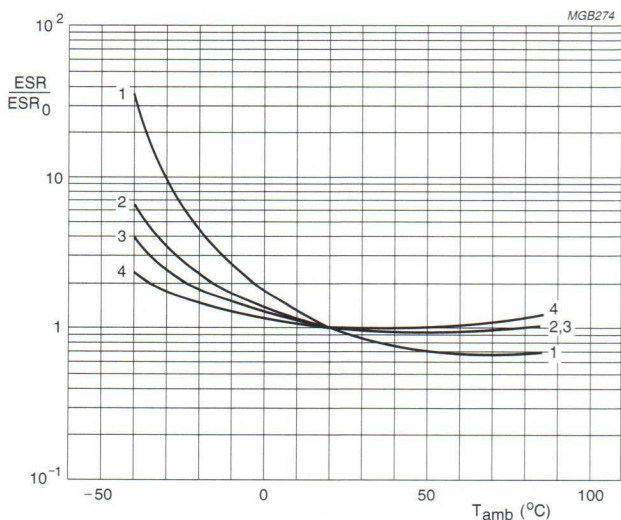
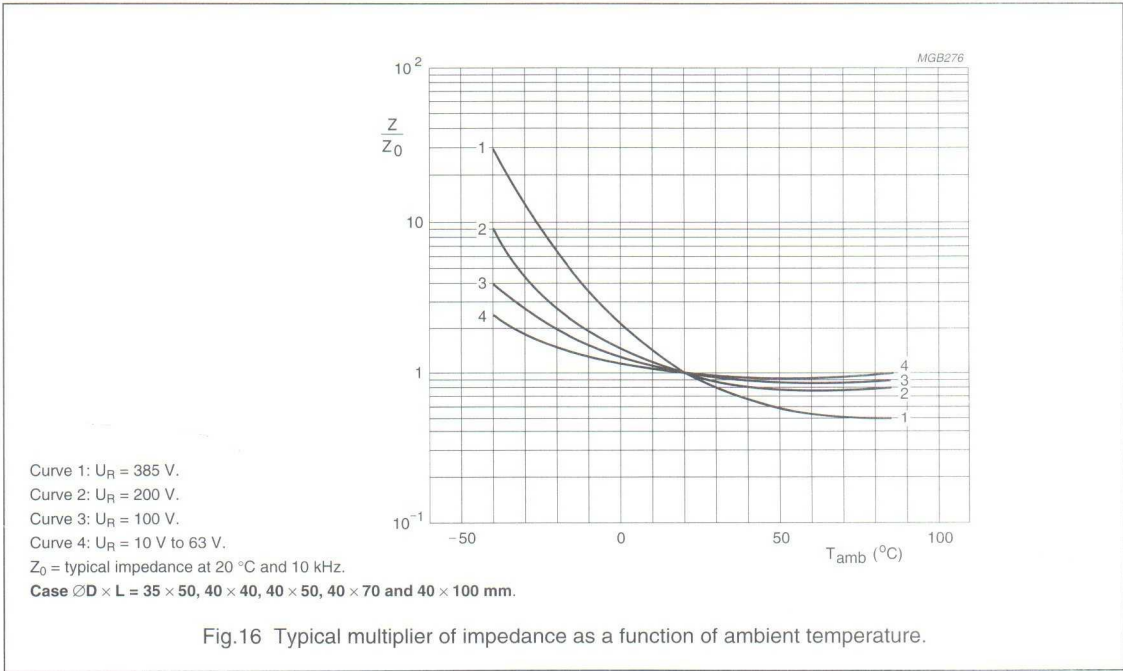
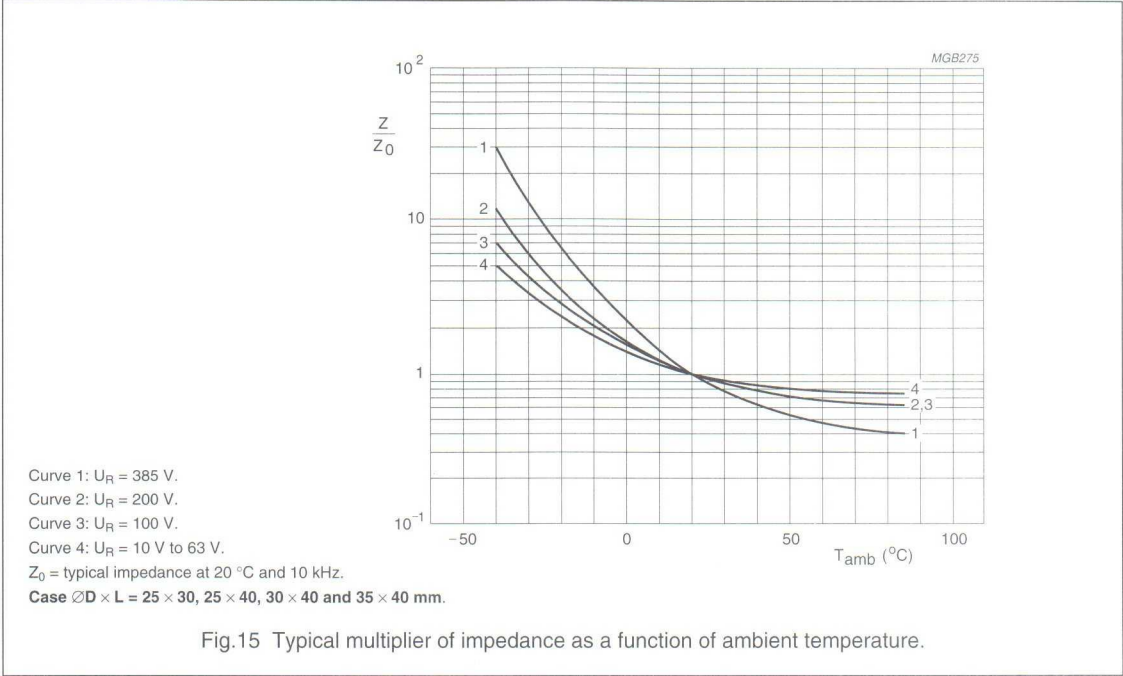
Curve 1: $U_R = 385 \text{ V}$.Curve 2: $U_R = 200 \text{ V}$.Curve 3: $U_R = 100 \text{ V}$.Curve 4: $U_R = 10 \text{ V}$ to 63 V . ESR_0 = typical at 20°C and 100 Hz .**Case** $\varnothing D \times L = 35 \times 50, 40 \times 40, 40 \times 50, 40 \times 70$ and $40 \times 100 \text{ mm}$.

Fig.14 Typical multiplier of ESR as a function of ambient temperature.

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Impedance (Z)



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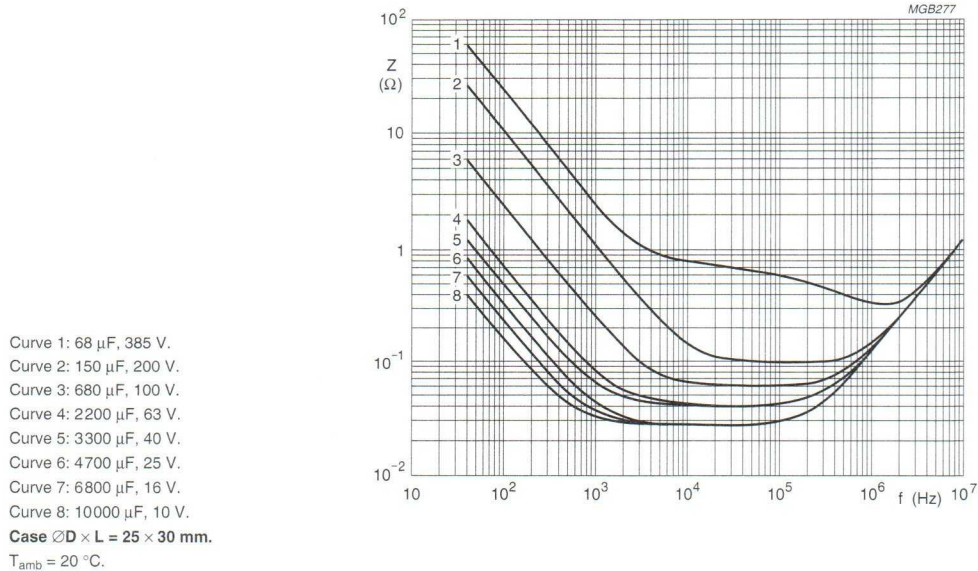


Fig.17 Typical impedance as a function of frequency.

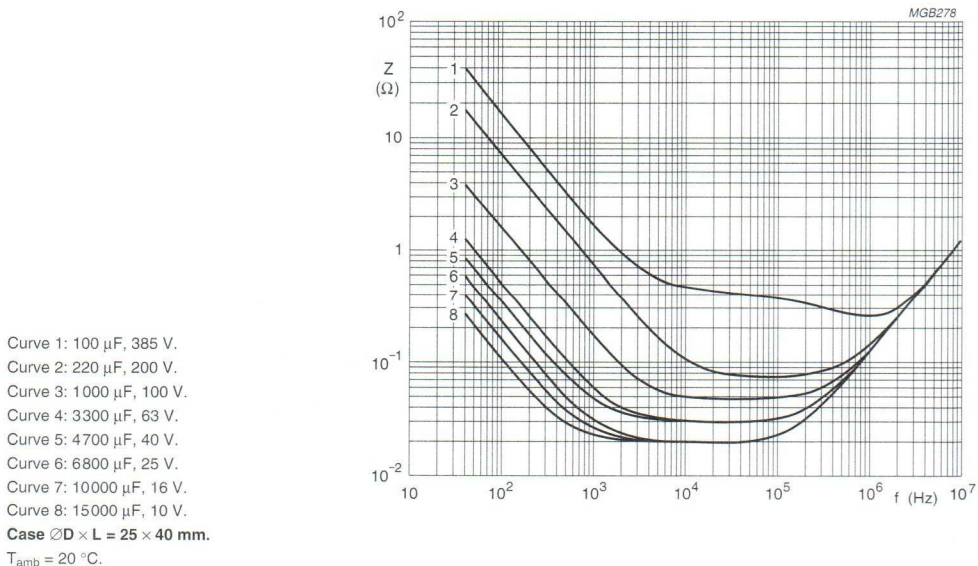


Fig.18 Typical impedance as a function of frequency.

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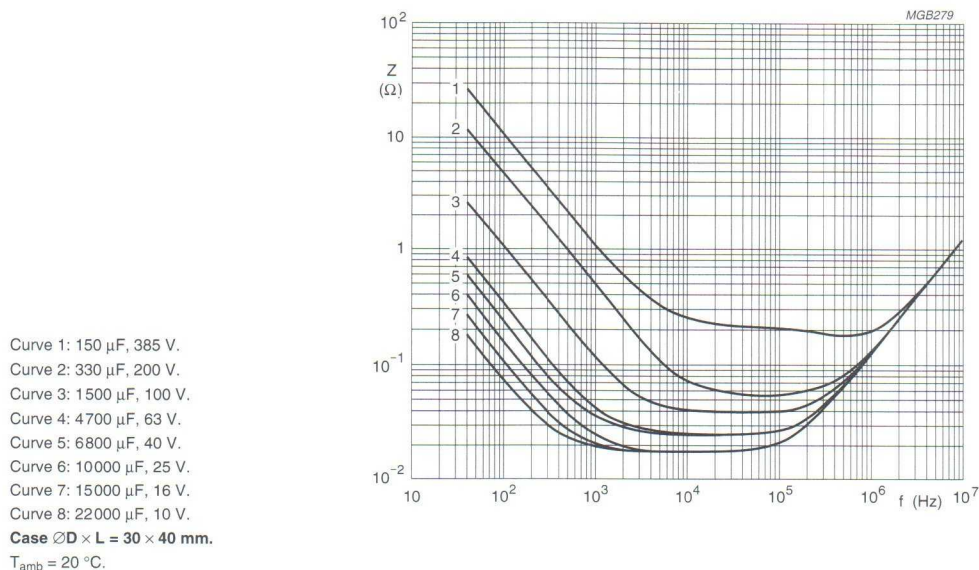


Fig.19 Typical impedance as a function of frequency.

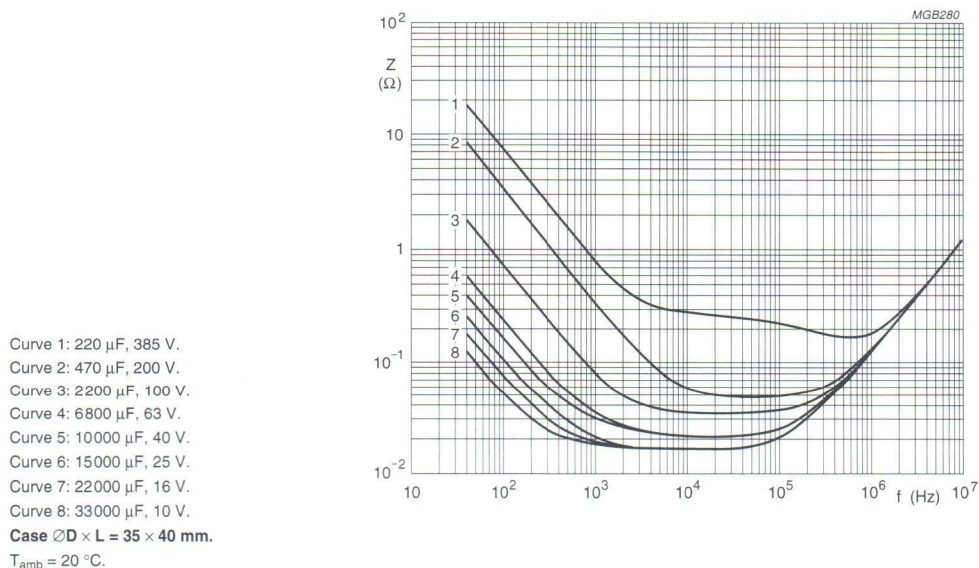


Fig.20 Typical impedance as a function of frequency.

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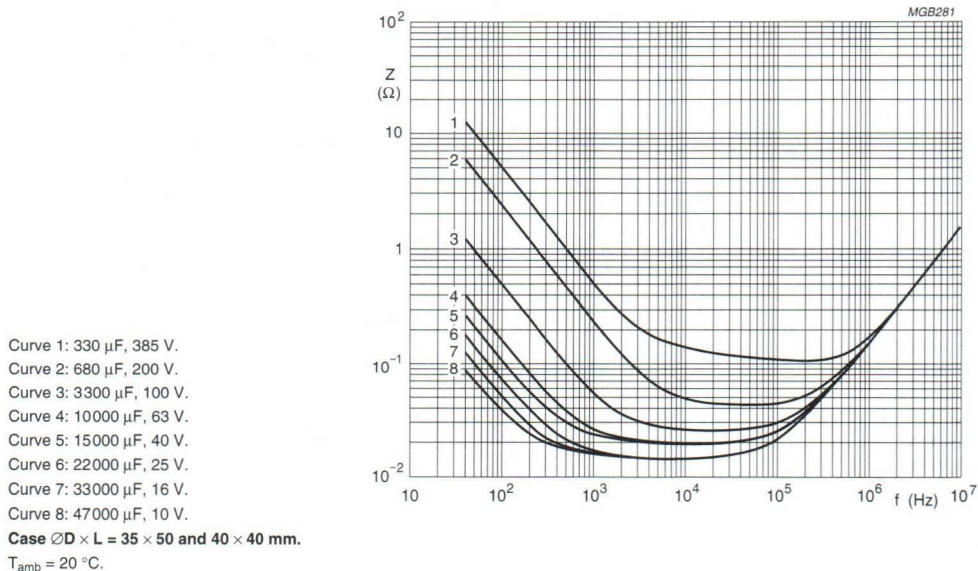


Fig.21 Typical impedance as a function of frequency.

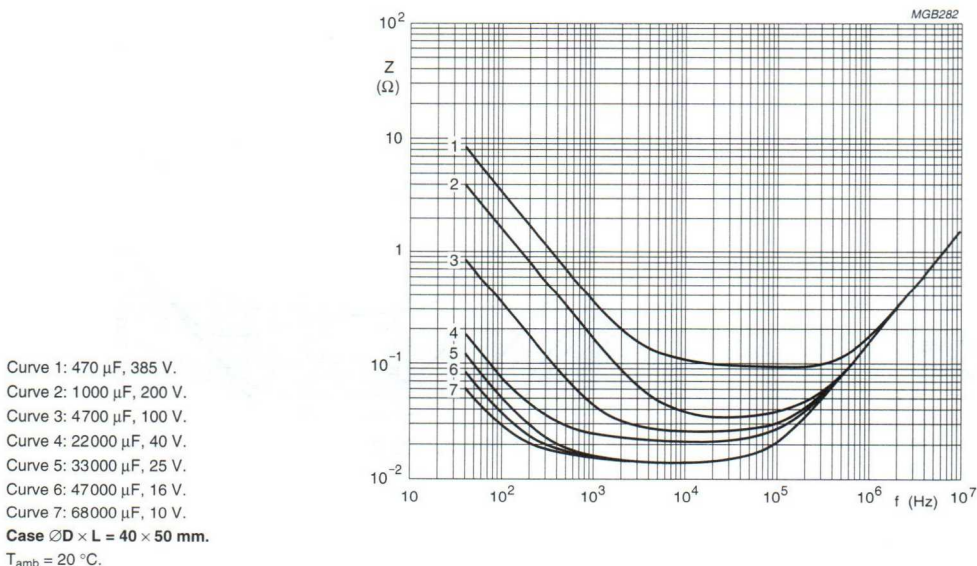


Fig.22 Typical impedance as a function of frequency.

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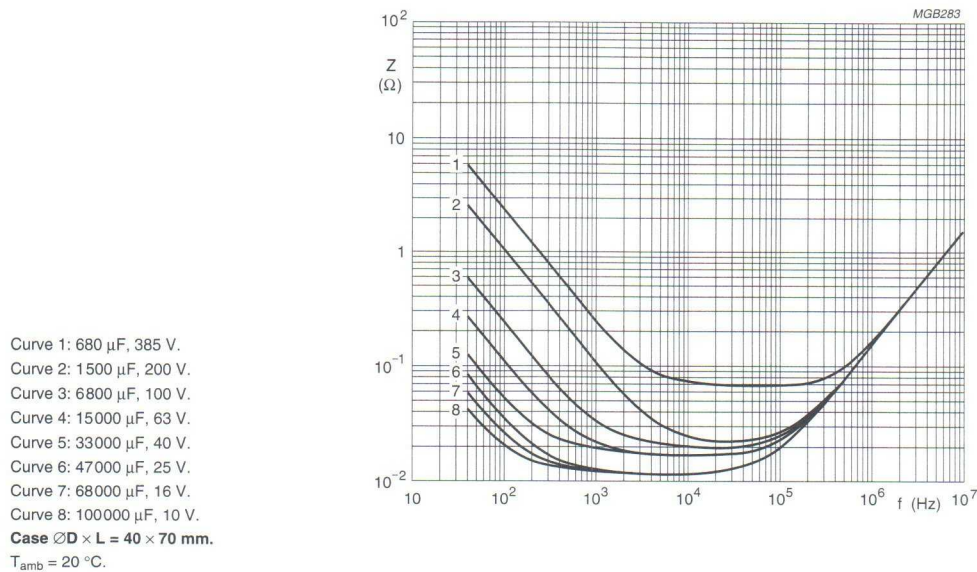


Fig.23 Typical impedance as a function of frequency.

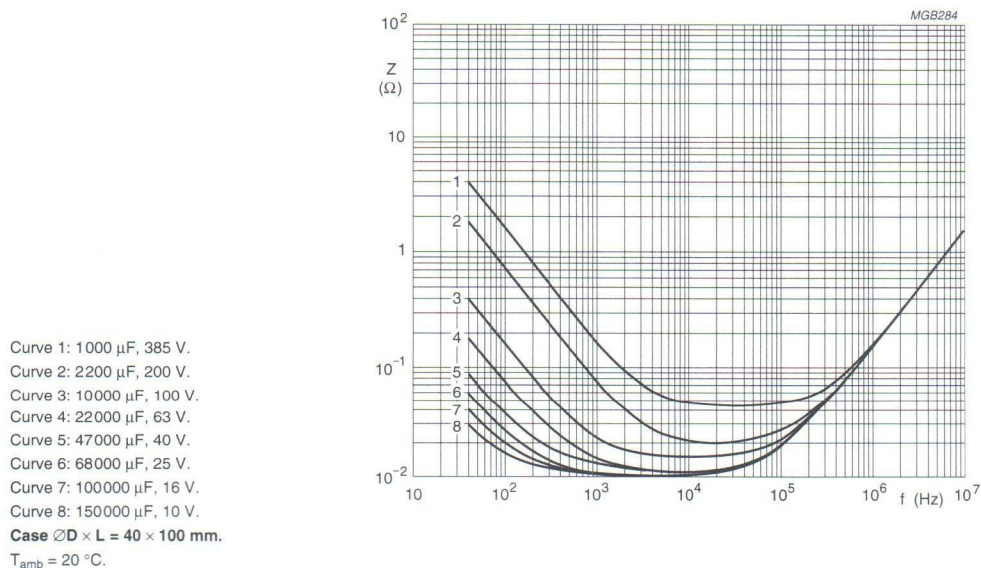


Fig.24 Typical impedance as a function of frequency.

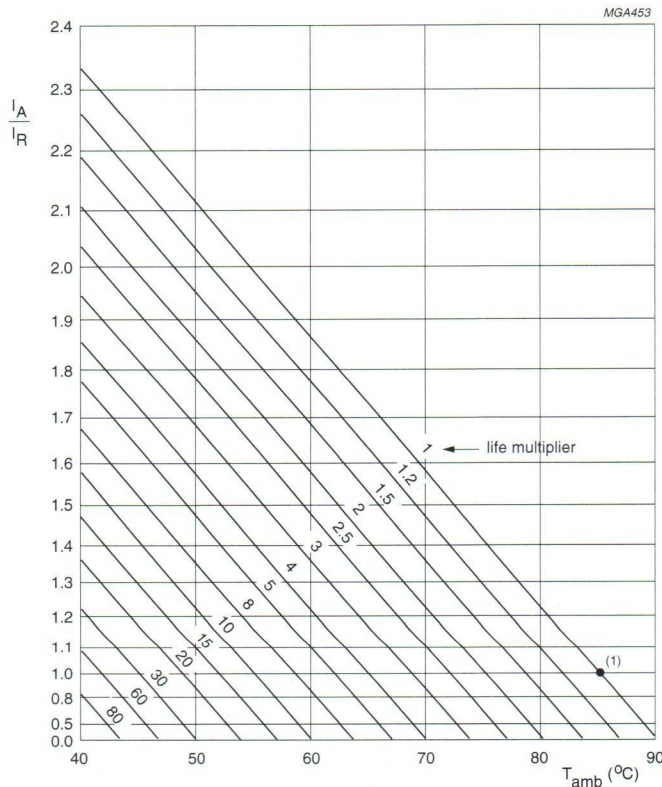
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RIPPLE CURRENT AND USEFUL LIFE

Table 4 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: 12000 hours.

Fig.25 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 5 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 5000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 12000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 30\%$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100\text{ V}$: $\leq 1\%$; $U_R > 100\text{ V}$: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Aluminium electrolytic capacitors Power Eurodin Printed Wiring

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FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, cylindrical aluminium case, insulated with a blue sleeve
- Provided with keyed polarity
- 050 series also available in solder-lug (SL) versions
- Pressure relief on the top of the aluminium case
- Charge and discharge proof
- Very long useful life: 15000 hours at 85 °C
- Low ESR, high ripple current capability
- High resistance to shock and vibration.

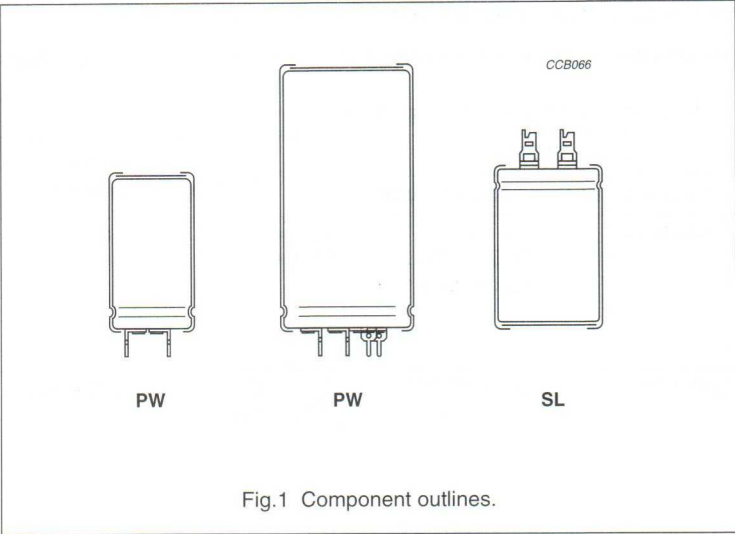
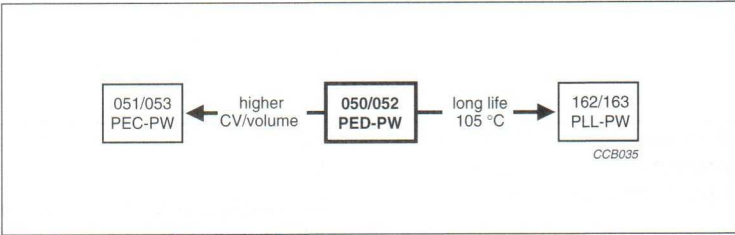


Fig.1 Component outlines.

APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	050	052
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	25 × 30 to 40 × 100	
Rated capacitance range (E6 series), C_R	470 to 68000 μF	47 to 1000 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	15000 hours	
Useful life at 40 °C and $1.4 \times I_R$ applied	250000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Detail specification	DIN 45910-T129, former DIN 41238	
Climatic category IEC 68	40/085/56	

Aluminium electrolytic capacitors

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 050 series

Preferred types in **bold**.

C_R (μF)	U_R (V)					
	10	16	25	40	63	100
470	—	—	—	—	—	25 × 30
680	—	—	—	—	—	25 × 40
1000	—	—	—	—	25 × 30	30 × 40
1500	—	—	—	25 × 30	25 × 40	35 × 40
2200	—	—	25 × 30	25 × 40	30 × 40	35 × 50
	—	—	—	—	—	40 × 40
3300	—	25 × 30	25 × 40	30 × 40	35 × 40	40 × 50
4700	25 × 30	25 × 40	30 × 40	35 × 40	35 × 50	40 × 70
	—	—	—	—	40 × 40	—
6800	25 × 40	30 × 40	35 × 40	35 × 50	40 × 50	40 × 100
	—	—	—	40 × 40	—	—
10000	30 × 40	35 × 40	35 × 50	40 × 50	40 × 70	—
	—	—	40 × 40	—	—	—
15000	35 × 40	35 × 50	40 × 50	40 × 70	40 × 100	—
	—	40 × 40	—	—	—	—
22000	35 × 50	40 × 50	40 × 70	40 × 100	—	—
	40 × 40	—	—	—	—	—
33000	40 × 50	40 × 70	40 × 100	—	—	—
47000	40 × 70	40 × 100	—	—	—	—
68000	40 × 100	—	—	—	—	—

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 052 series

Preferred types in **bold**.

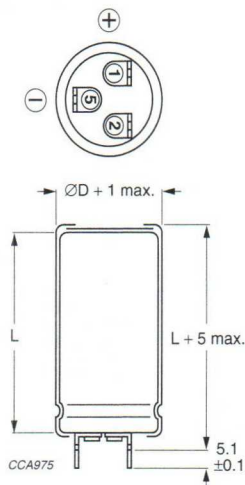
C_R (μF)	U_R (V)		
	250	385	400
47	—	25 × 30	25 × 30
68	—	25 × 40	25 × 40
100	25 × 30	30 × 40	30 × 40
150	25 × 40	35 × 40	35 × 40
220	30 × 40	35 × 50	35 × 50
	—	40 × 40	40 × 40
330	35 × 40	40 × 50	40 × 50
470	35 × 50	40 × 70	40 × 70
	40 × 40	—	—
680	40 × 50	—	40 × 100
1000	40 × 70	—	—

Aluminium electrolytic capacitors

Power Eurodin Printed Wiring

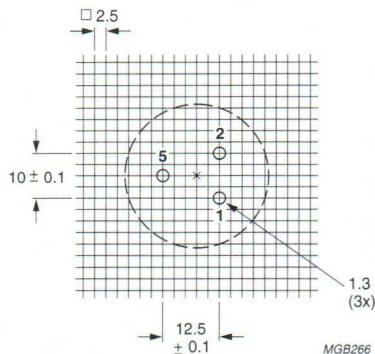
050/052 PED-PW

MECHANICAL DATA AND PACKAGING QUANTITIES



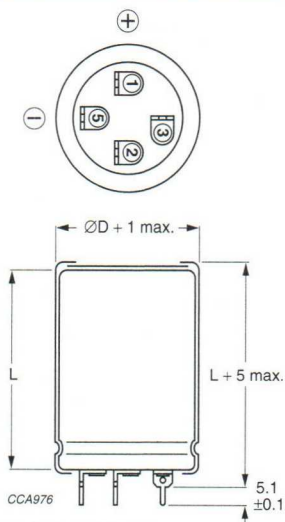
Dimensions in mm; for L see Table 1.
1 = positive terminal; 5 = negative terminal.
Case $\varnothing D = 25 \text{ mm}$.

Fig.2 Printed wiring pin version.



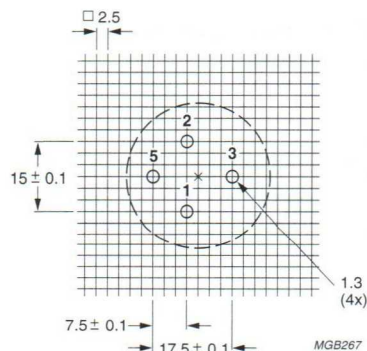
Dimensions in mm.
Case $\varnothing D = 25 \text{ mm}$.

Fig.3 Mounting hole diagram viewed from component side.



Dimensions in mm; for L see Table 1.
1 = positive terminal; 5 = negative terminal.
Case $\varnothing D = 30 \text{ mm}$.

Fig.4 Printed wiring pin version.

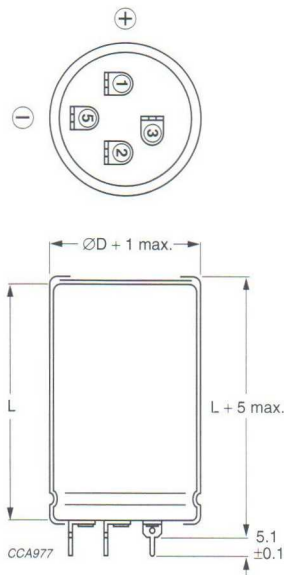


Dimensions in mm.
Case $\varnothing D = 30 \text{ mm}$.

Fig.5 Mounting hole diagram viewed from component side.

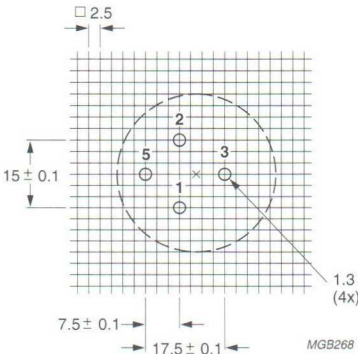
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Dimensions in mm; for L see Table 1.
1 = positive terminal; 5 = negative terminal.
Case $\varnothing D = 35$ mm.

Fig.6 Printed wiring pin version.



Dimensions in mm.
Case $\varnothing D = 35$ mm.

Fig.7 Mounting hole diagram viewed from component side.

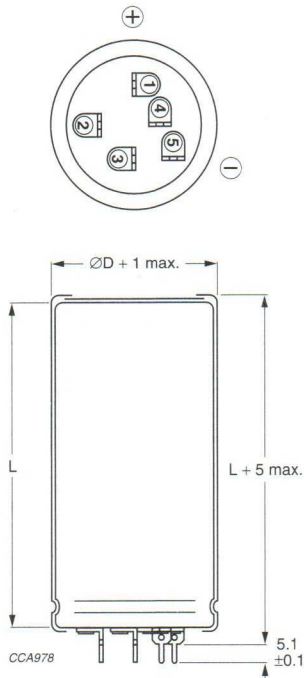
Table 1 PW versions; physical dimensions, mass and packaging information; see Figs 2, 4, 6 and 8

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS $l \times w \times h$ (mm)
25 × 30	26	35	≈24	100	290 × 280 × 45
25 × 40	26	45	≈28	100	290 × 280 × 55
30 × 40	31	45	≈38	100	340 × 330 × 55
35 × 40	36	45	≈51	50	390 × 198 × 55
35 × 50	36	55	≈66	50	390 × 198 × 65
40 × 40	41	45	≈78	50	440 × 223 × 55
40 × 50	41	55	≈82	50	440 × 223 × 65
40 × 70	41	75	≈110	50	440 × 223 × 85
40 × 100	41	105	≈176	50	440 × 223 × 115

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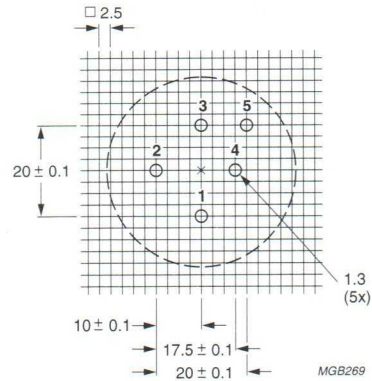


Dimensions in mm; for L see Table 1.

1 = positive terminal; 5 = negative terminal.

Case $\varnothing D = 40$ mm.

Fig.8 Printed wiring pin version.



Dimensions in mm.

Case $\varnothing D = 40$ mm.

Fig.9 Mounting hole diagram viewed from component side.

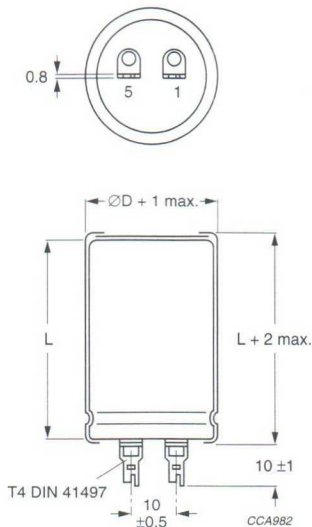
Mounting

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) must be free from the electrical circuit.

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Dimensions in mm; for L see Table 2.
1 = positive terminal; 5 = negative terminal.
See this handbook, Section "Mounting Accessories".

Fig.10 Solder-lug version (SL); only available in 050 series.

Table 2 SL versions (050 series only); physical dimensions, mass and packaging information; see Fig.10

NOMINAL CASE SIZE ØD × L (mm)	ØD _{max} (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
25 × 30	26	32	≈24	100	290 × 280 × 65
25 × 40	26	42	≈28	100	290 × 280 × 75
30 × 40	31	42	≈38	100	340 × 330 × 75
35 × 40	36	42	≈51	50	390 × 198 × 75
35 × 50	36	52	≈66	50	390 × 198 × 85
40 × 50	41	52	≈82	50	440 × 223 × 85
40 × 70	41	72	≈110	50	440 × 223 × 105
40 × 100	41	102	≈176	50	440 × 223 × 135

L

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 3 and 4 apply at
 $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz
I_R	rated RMS ripple current at 100 Hz, $85\text{ }^{\circ}\text{C}$ or at 20 kHz, $70\text{ }^{\circ}\text{C}$
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 050 series

10000 $\mu\text{F}/25\text{ V}$; $-10/+30\%$

Nominal case size: $\varnothing 35 \times 50\text{ mm}$;
 PW version

Catalogue number: 2222 050 56103.

Table 3 Electrical data and ordering information for **050** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz $85\text{ }^{\circ}\text{C}$ (A)	I_R 20 kHz $70\text{ }^{\circ}\text{C}$ (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER (note 1) 2222
10	4700	25 × 30	2.4	4.6	0.28	0.10	74	50	050 54472
	6800	25 × 40	3.2	6.1	0.41	0.14	51	37	050 54682
	10000	30 × 40	3.8	7.2	0.60	0.20	39	29	050 54103
	15000	35 × 40	4.1	7.8	0.90	0.30	35	26	050 54153
	22000	35 × 50	5.0	9.5	1.32	0.44	27	21	050 54223
	22000	40 × 40	4.2	8.0	1.32	0.44	36	27	050 44223
	33000	40 × 50	5.0	9.5	1.98	0.66	29	22	050 54333
	47000	40 × 70	6.8	12.9	2.82	0.94	20	17	050 54473
16	68000	40 × 100	9.2	17.5	4.08	1.36	15	14	050 54683
	3300	25 × 30	2.4	4.6	0.32	0.11	75	50	050 55332
	4700	25 × 40	3.1	5.9	0.45	0.15	52	37	050 55472
	6800	30 × 40	3.7	7.0	0.65	0.22	40	30	050 55682
	10000	35 × 40	4.1	7.8	0.96	0.32	36	27	050 55103
	15000	35 × 50	5.0	9.5	1.44	0.48	28	21	050 55153
	15000	40 × 40	4.2	8.0	1.44	0.48	36	27	050 45153
	22000	40 × 50	5.0	9.5	2.12	0.71	29	22	050 55223
25	33000	40 × 70	6.7	12.7	3.17	1.06	20	17	050 55333
	47000	40 × 100	9.1	17.3	4.51	1.51	15	14	050 55473
	2200	25 × 30	2.3	4.4	0.33	0.11	78	52	050 56222
	3300	25 × 40	3.1	5.9	0.49	0.17	53	38	050 56332
	4700	30 × 40	3.7	7.0	0.70	0.24	42	31	050 56472
	6800	35 × 40	4.1	7.8	1.02	0.34	37	28	050 56682
	10000	35 × 50	5.0	9.5	1.50	0.50	28	21	050 56103
	10000	40 × 40	4.2	8.0	1.50	0.50	36	27	050 46103
	15000	40 × 50	5.0	9.5	2.25	0.75	29	22	050 56153
	22000	40 × 70	6.8	12.9	3.30	1.10	20	17	050 56223
	33000	40 × 100	9.2	17.5	4.95	1.65	15	14	050 56333

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U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER (note 1) 2222
40	1500	25 × 30	2.0	3.8	0.36	0.12	112	68	050 57152
	2200	25 × 40	2.7	5.1	0.53	0.18	76	51	050 57222
	3300	30 × 40	3.3	6.3	0.79	0.27	57	41	050 57332
	4700	35 × 40	3.8	7.2	1.13	0.38	48	35	050 57472
	6800	35 × 50	4.7	8.9	1.64	0.55	36	27	050 57682
	6800	40 × 40	4.1	7.8	1.64	0.55	45	33	050 47682
	10000	40 × 50	4.9	9.3	2.40	0.80	35	27	050 57103
	15000	40 × 70	6.6	12.5	3.60	1.20	25	20	050 57153
	22000	40 × 100	9.0	17.1	5.28	1.76	18	16	050 57223
63	1000	25 × 30	1.8	3.4	0.38	0.13	122	74	050 58102
	1500	25 × 40	2.5	4.7	0.57	0.19	83	54	050 58152
	2200	30 × 40	3.1	5.9	0.83	0.28	57	41	050 58222
	3300	35 × 40	3.6	6.8	1.25	0.42	48	35	050 58332
	4700	35 × 50	4.4	8.3	1.78	0.60	36	27	050 58472
	4700	40 × 40	3.8	7.2	1.78	0.60	45	33	050 48472
	6800	40 × 50	4.7	8.9	2.57	0.86	35	27	050 58682
	10000	40 × 70	6.2	11.8	3.78	1.26	25	20	050 58103
	15000	40 × 100	8.5	16.1	5.67	1.89	18	16	050 58153
100	470	25 × 30	1.4	2.7	0.28	0.10	247	172	050 59471
	680	25 × 40	1.9	3.6	0.41	0.14	170	116	050 59681
	1000	30 × 40	2.5	4.7	0.60	0.20	123	88	050 59102
	1500	35 × 40	3.1	5.8	0.90	0.30	94	71	050 59152
	2200	35 × 50	3.9	7.4	1.32	0.44	69	55	050 59222
	2200	40 × 40	3.6	6.8	1.32	0.44	81	65	050 49222
	3300	40 × 50	4.6	8.7	1.98	0.66	59	48	050 59332
	4700	40 × 70	6.2	11.7	2.82	0.94	42	36	050 59472
	6800	40 × 100	8.2	15.5	4.08	1.36	32	28	050 59682

Note

1. Catalogue number applies to the PW versions; for SL versions (not preferred) available in 050 series only (case size $\varnothing 40 \times 40$ mm not available) replace the 8th digit by '1'; SL versions: 2222 050 1....

L

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Table 4 Electrical data and ordering information for **052** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
250	100	25 × 30	0.6	1.15	0.15	0.05	1800	1300	052 53101
	150	25 × 40	0.8	1.5	0.23	0.08	1100	850	052 53151
	220	30 × 40	1.0	1.9	0.33	0.11	750	550	052 53221
	330	35 × 40	1.4	2.65	0.49	0.17	500	400	052 53331
	470	35 × 50	1.8	3.4	0.70	0.24	360	290	052 53471
	470	40 × 40	1.8	3.4	0.70	0.24	420	350	052 43471
	680	40 × 50	2.3	4.4	1.02	0.34	250	190	052 53681
	1000	40 × 70	3.0	5.7	1.50	0.50	170	140	052 53102
385	47	25 × 30	0.5	0.94	0.11	0.04	2370	1550	052 58479
	68	25 × 40	0.67	1.27	0.16	0.06	1640	1100	052 58689
	100	30 × 40	0.84	1.59	0.23	0.08	1275	950	052 58101
	150	35 × 40	1.13	2.14	0.34	0.11	850	635	052 58151
	220	35 × 50	1.48	2.8	0.50	0.17	580	430	052 58221
	220	40 × 40	1.48	2.8	0.50	0.17	580	430	052 48221
	330	40 × 50	1.97	3.73	0.75	0.25	385	300	052 58331
	470	40 × 70	2.7	5.11	1.06	0.36	270	215	052 58471
400	47	25 × 30	0.47	0.89	0.11	0.04	2700	2125	052 56479
	68	25 × 40	0.63	1.29	0.16	0.06	1875	1470	052 56689
	100	30 × 40	0.84	1.59	0.24	0.08	1275	1000	052 56101
	150	35 × 40	1.13	2.14	0.36	0.12	850	665	052 56151
	220	35 × 50	1.41	2.67	0.52	0.17	650	450	052 56221
	220	40 × 40	1.41	2.67	0.52	0.17	650	450	052 46221
	330	40 × 50	1.86	3.52	0.79	0.26	435	315	052 56331
	470	40 × 70	2.54	4.81	1.12	0.37	305	225	052 56471
	680	40 × 100	3.56	6.75	1.63	0.54	210	155	052 56681

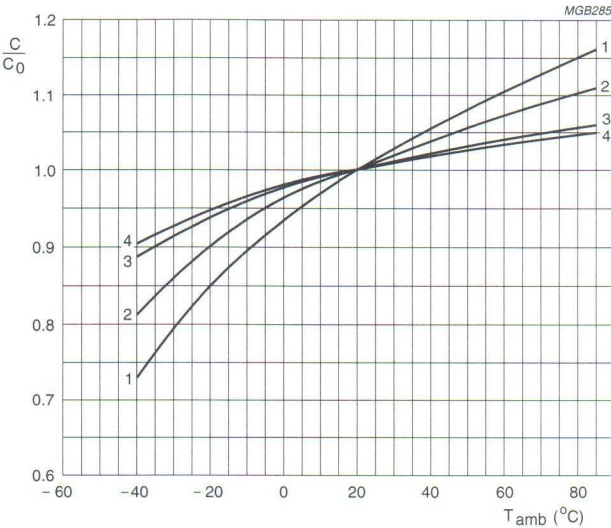
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Additional electrical data

PARAMETER	CONDITIONS	VALUE
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		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 25 \text{ mm}$	max. 25 nH
	case $\varnothing D = 30 \text{ and } 35 \text{ mm}$	max. 30 nH
	case $\varnothing D = 40 \text{ mm}$	max. 35 nH

Capacitance (C)



Curve 1: $U_R = 10 \text{ V}$.
Curve 2: $U_R = 25 \text{ V}$.
Curve 3: $U_R = 63 \text{ V}$.
Curve 4: $U_R = 100 \text{ V}, 250 \text{ V}$ and 385 V .
 C_0 = capacitance at 20°C , 100 Hz .

Fig.11 Typical multiplier of capacitance as a function of ambient temperature.

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Equivalent series resistance (ESR)

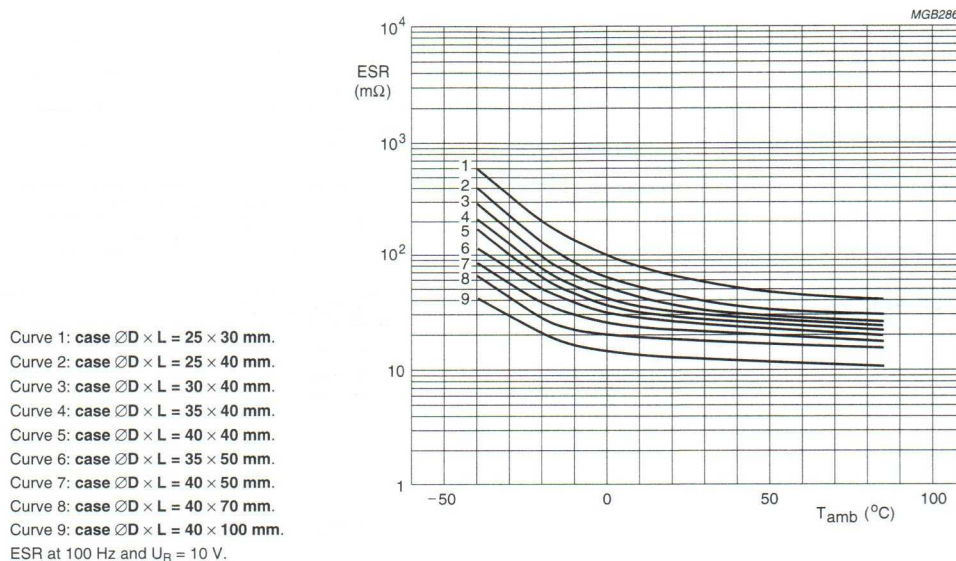


Fig.12 Typical ESR as a function of temperature.

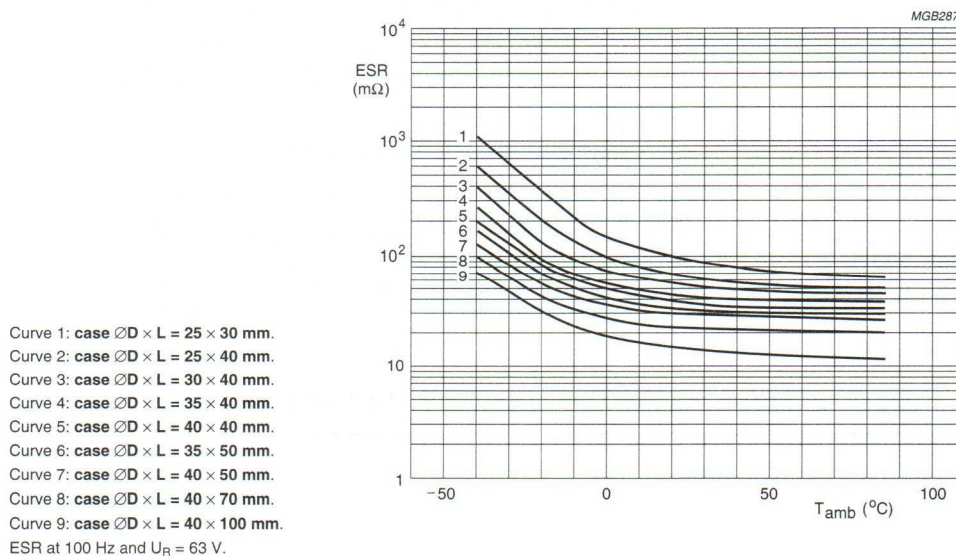


Fig.13 Typical ESR as a function of temperature.

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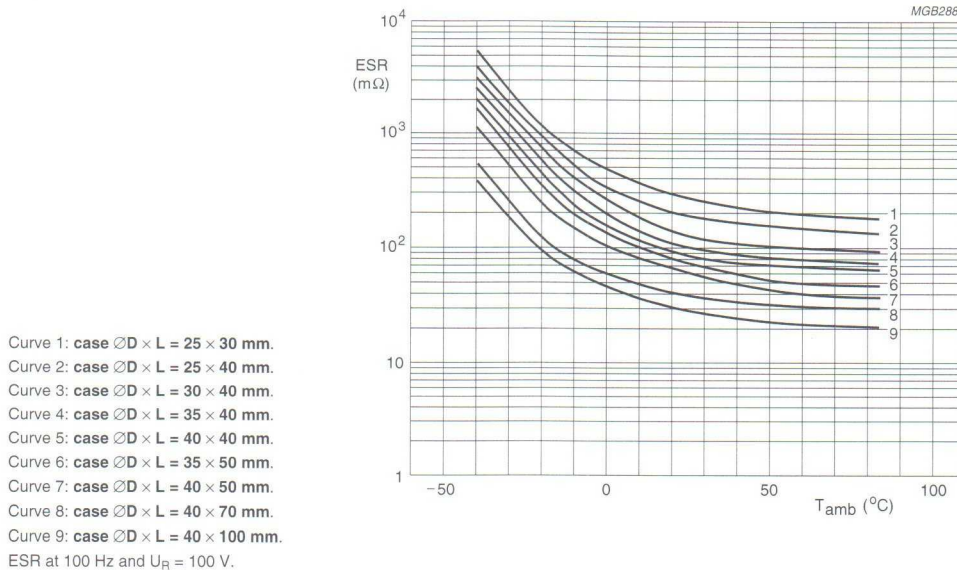


Fig.14 Typical ESR as a function of temperature.

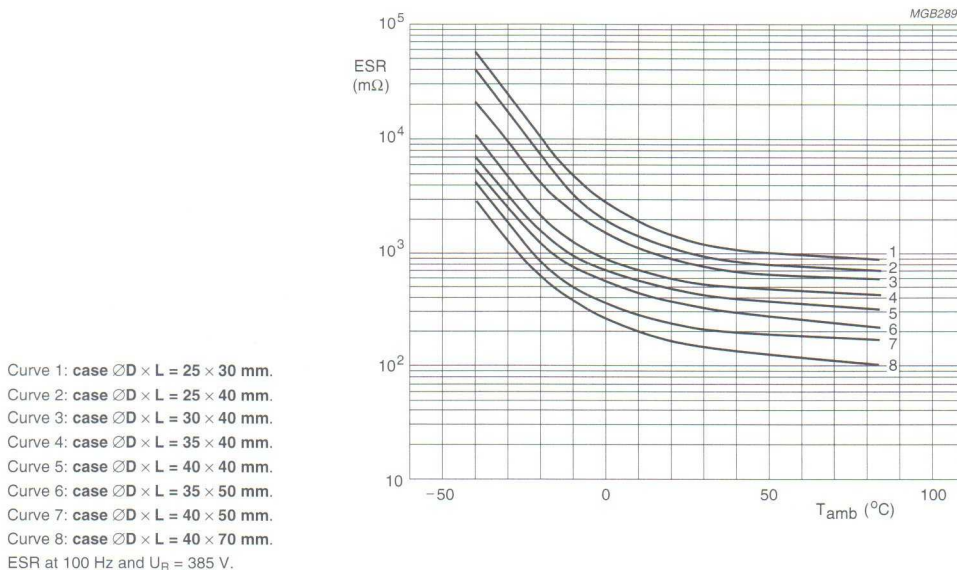


Fig.15 Typical ESR as a function of temperature.

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Impedance (Z)

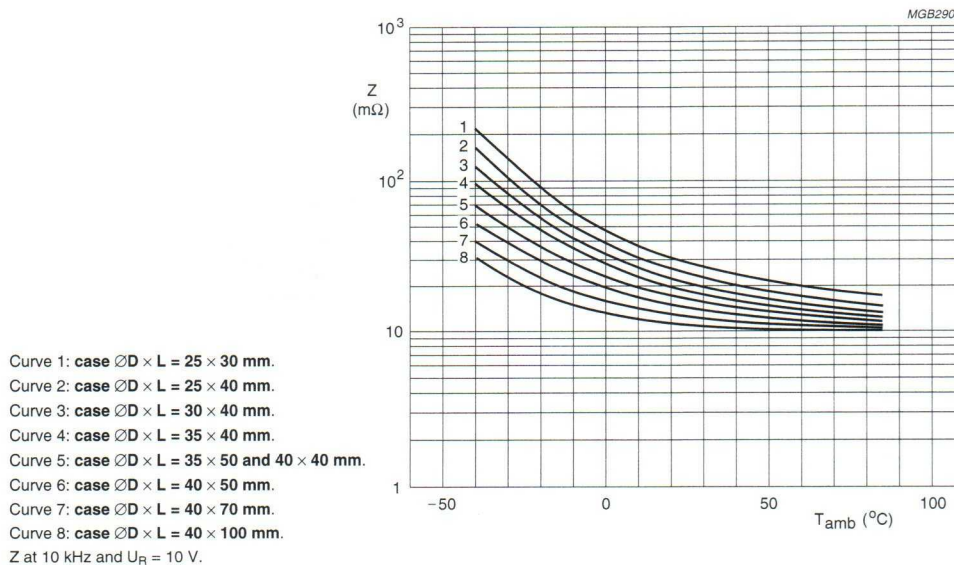


Fig.16 Typical impedance as a function of temperature.

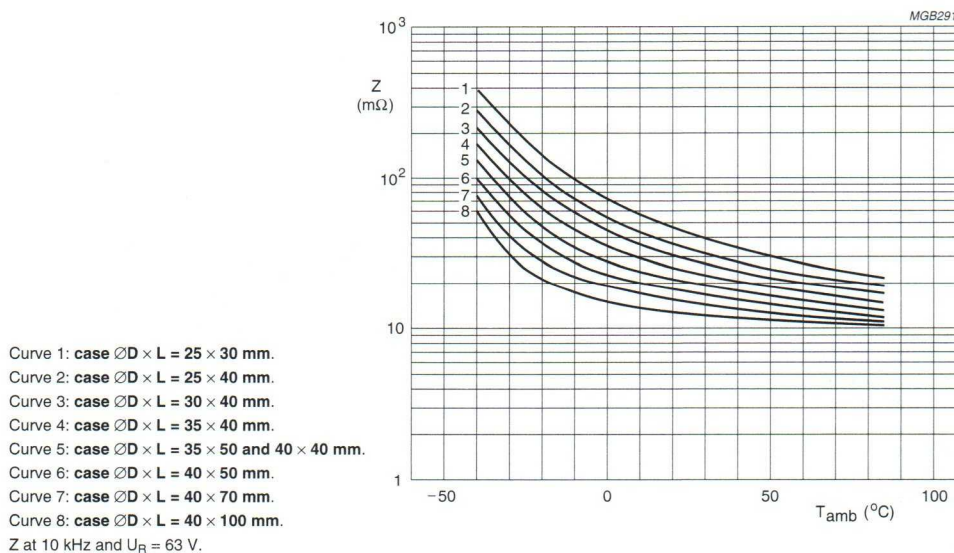


Fig.17 Typical impedance as a function of temperature.

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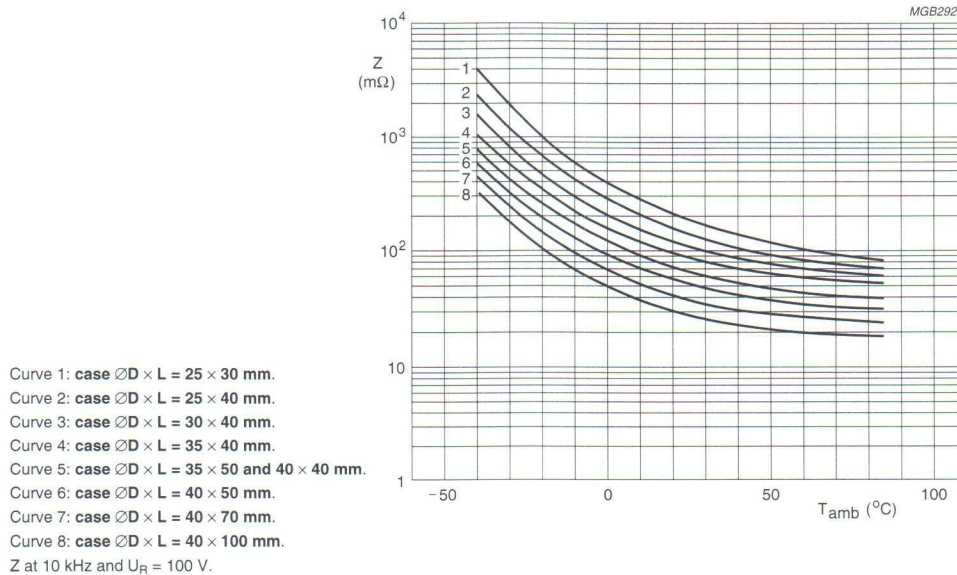


Fig.18 Typical impedance as a function of temperature.

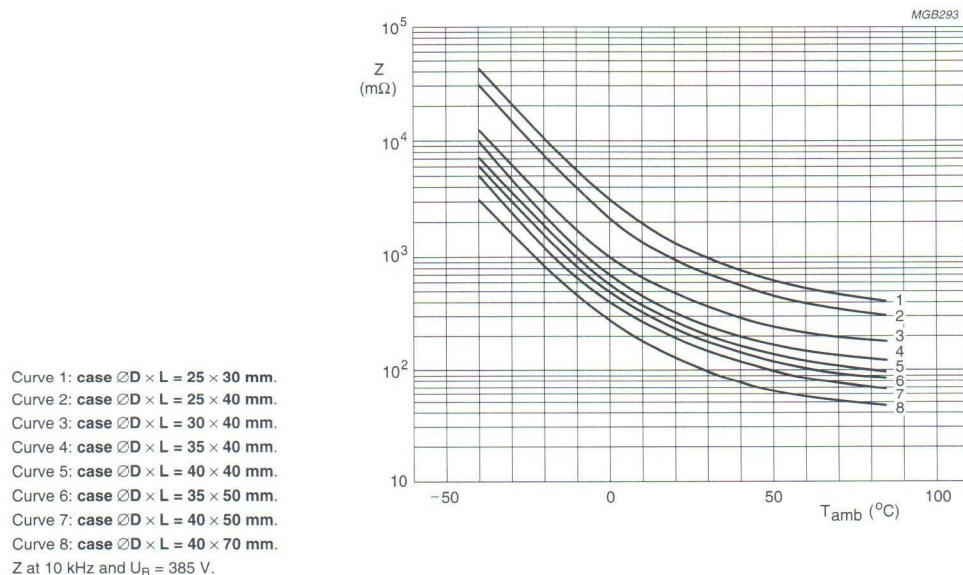


Fig.19 Typical impedance as a function of temperature.

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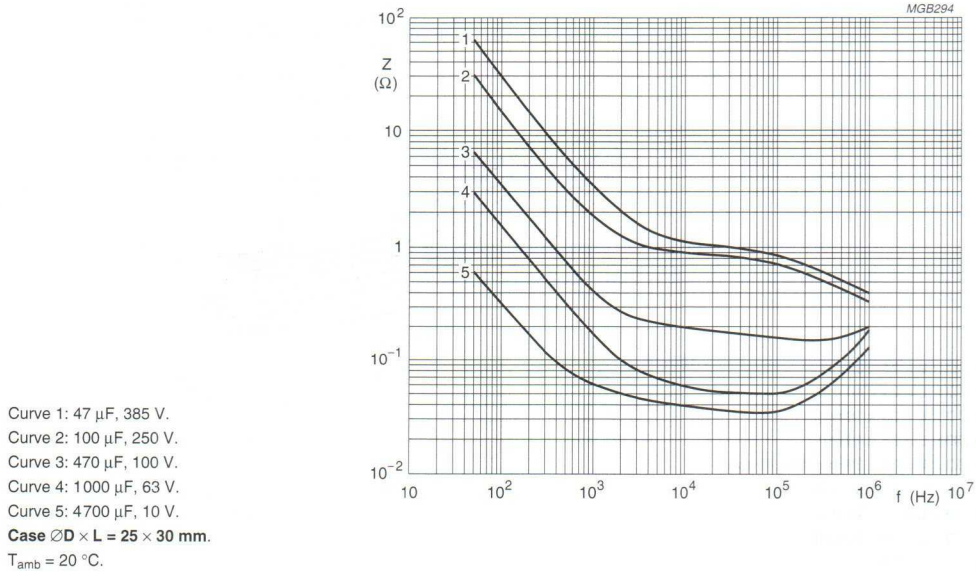


Fig.20 Typical impedance as a function of frequency.

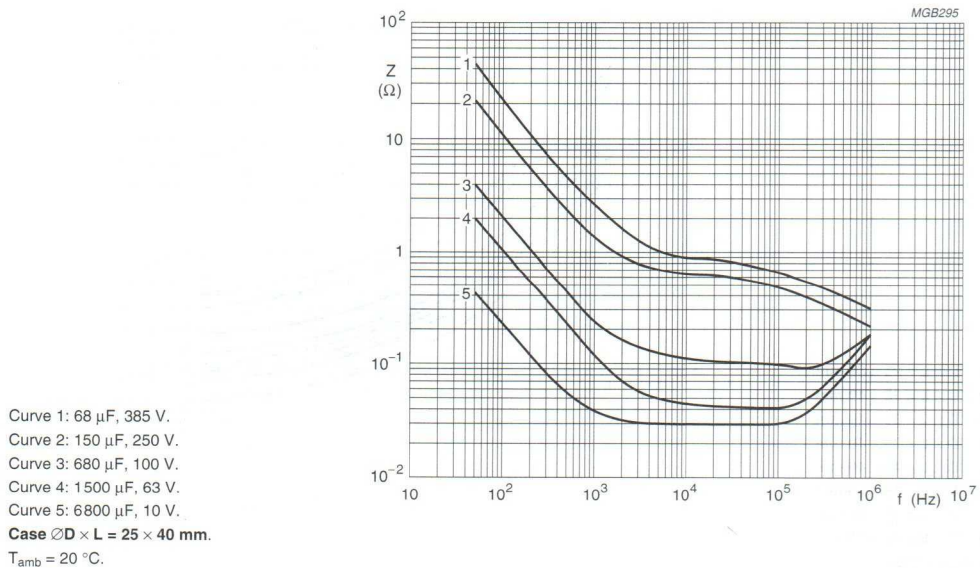


Fig.21 Typical impedance as a function of frequency.

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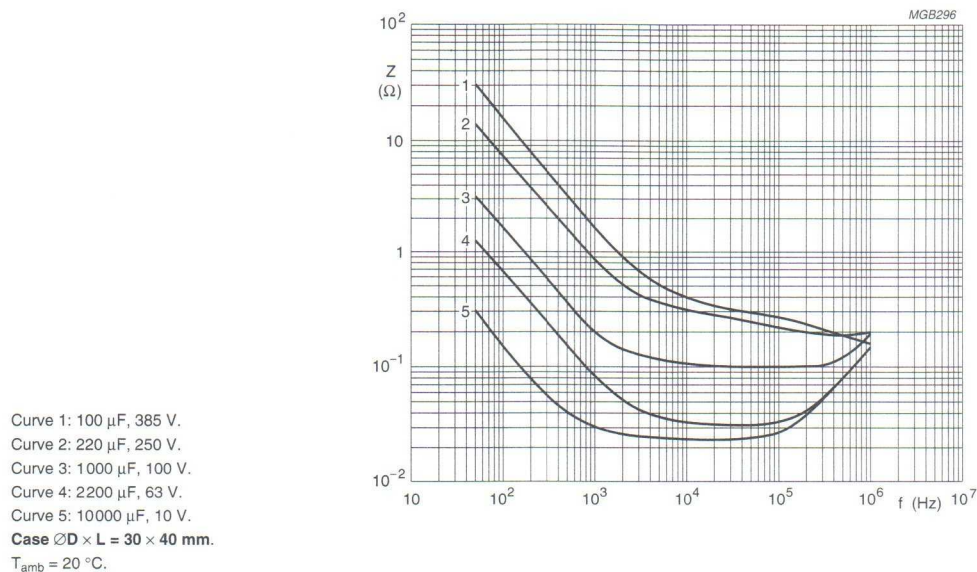


Fig.22 Typical impedance as a function of frequency.

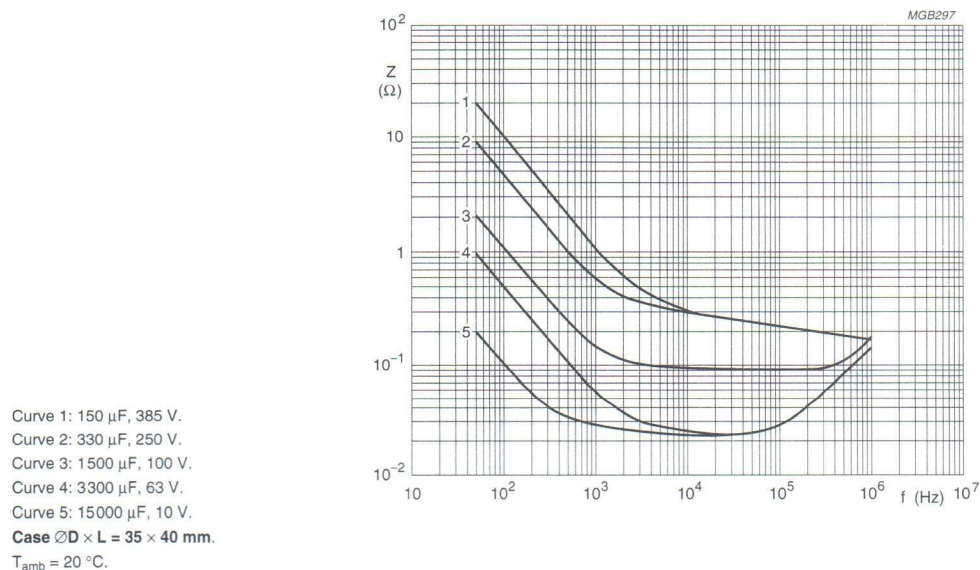


Fig.23 Typical impedance as a function of frequency.

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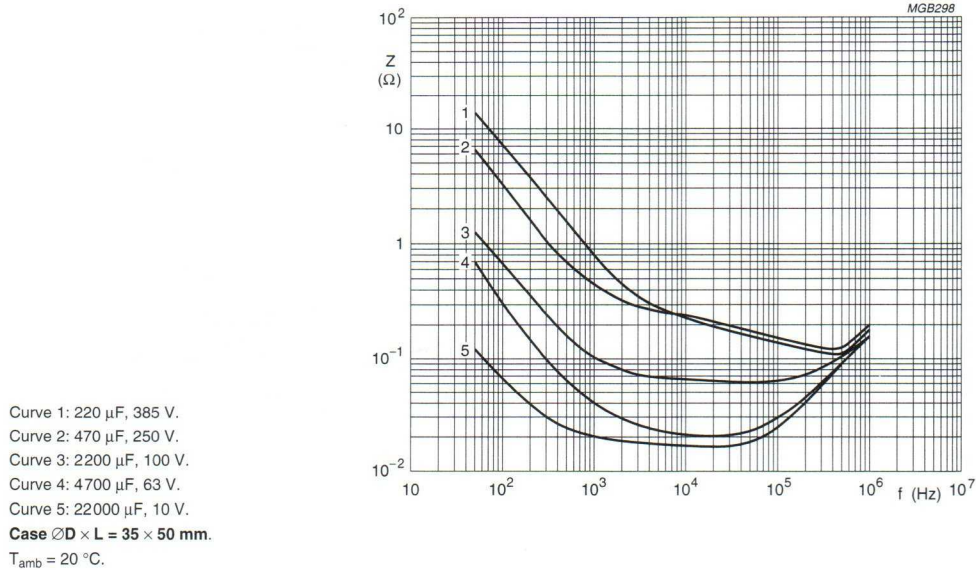


Fig.24 Typical impedance as a function of frequency.

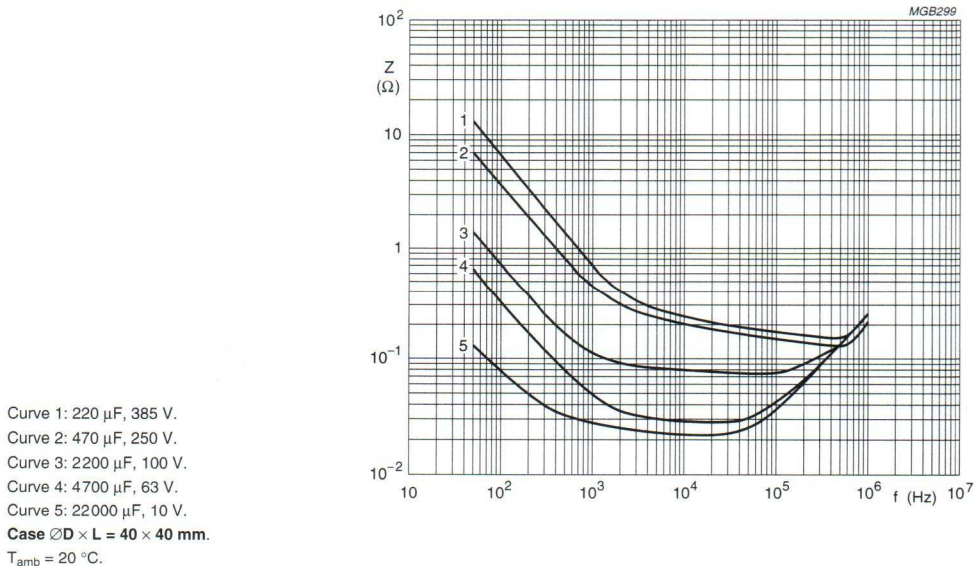


Fig.25 Typical impedance as a function of frequency.

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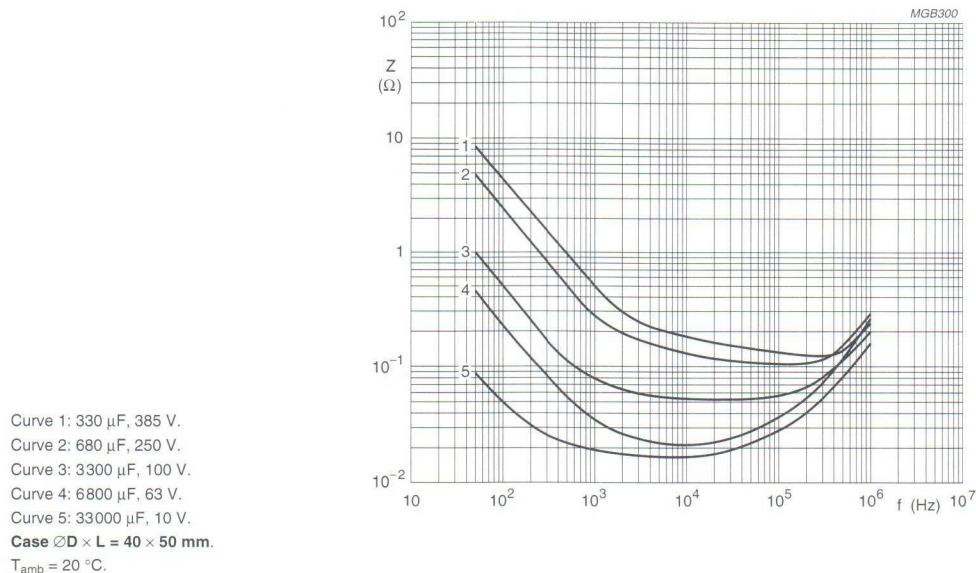


Fig.26 Typical impedance as a function of frequency.

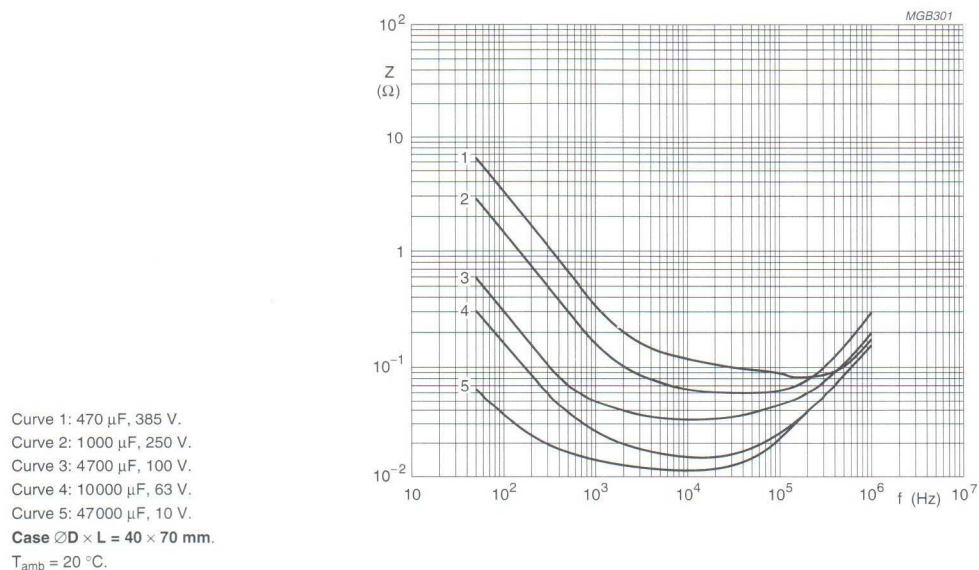
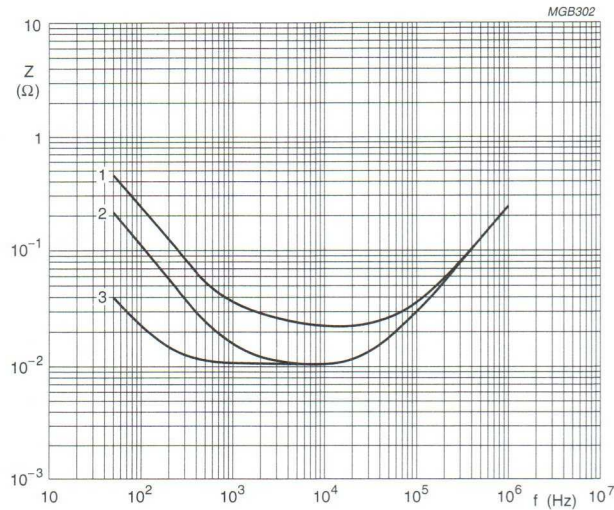


Fig.27 Typical impedance as a function of frequency.

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Curve 1: 6800 μF , 100 V.
 Curve 2: 15000 μF , 63 V.
 Curve 3: 68000 μF , 10 V.
Case $\varnothing D \times L = 40 \times 100 \text{ mm}$.
 $T_{\text{amb}} = 20^\circ\text{C}$.

Fig.28 Typical impedance as a function of frequency.

MARKING

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

- Rated capacitance (in μF)
- Tolerance on rated capacitance (Q for $-10/+30\%$)
- Rated voltage (in V)
- 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" and "CECC 30301".

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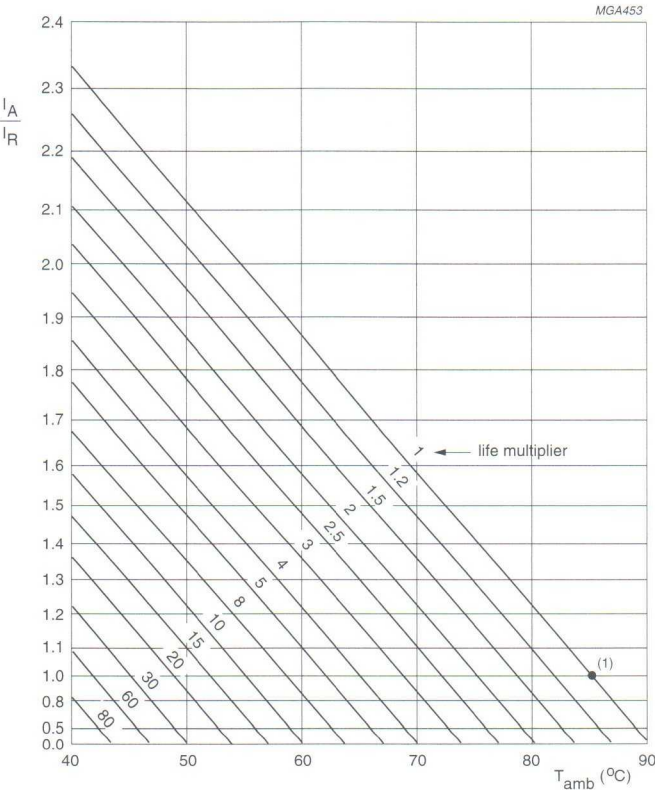
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RIPPLE CURRENT AND USEFUL LIFE

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

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.83
100	1.00
200	1.10
400	1.15
1 000	1.19
≥ 2000	1.20



I_A = actual ripple current at 100 Hz and 85 $^{\circ}C$.
 I_R = rated ripple current at 100 Hz and 85 $^{\circ}C$.
(1) Useful life at 85 $^{\circ}C$ and I_R applied: 15000 hours.

Fig.29 Multiplier of useful life as a function of ambient temperature and ripple current load.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 6 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 5000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 15000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 30\%$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100\text{ V}$: $\leq 1\%$; $U_R > 100\text{ V}$: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$: $\pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

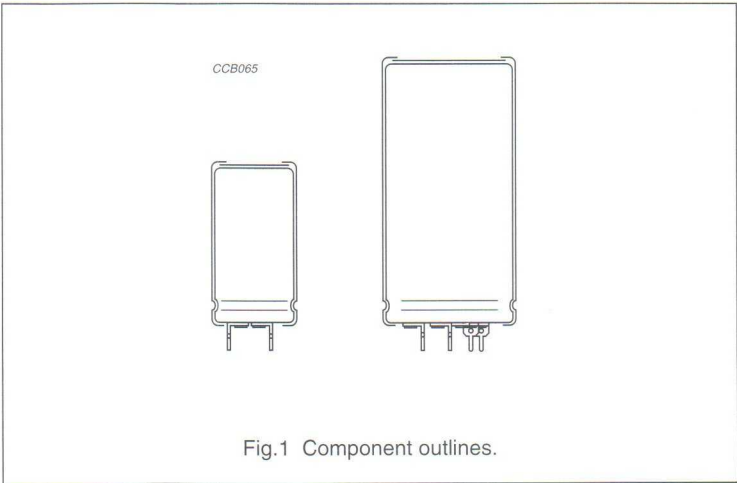
Aluminium electrolytic capacitors

Power Long Life Printed Wiring

162/163 PLL-PW

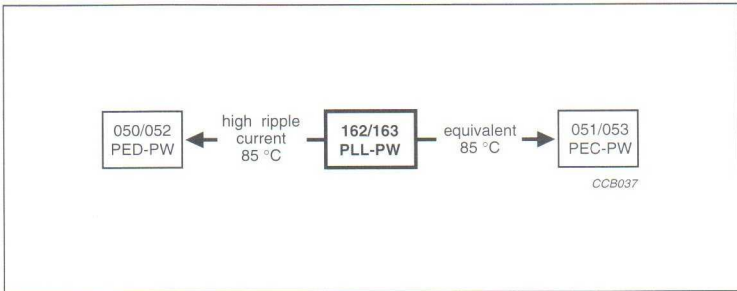
FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Provided with keyed polarity
- Pressure relief on the top of the aluminium case
- Charge and discharge proof
- Very long useful life: 5000 hours at 105 °C
- Low ESR, high ripple current capability
- Temperature range up to 105 °C
- High resistance to shock and vibration.



APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	162	163
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	25 × 30 to 40 × 100	
Rated capacitance range (E6 series), C_R	470 to 150000 μF	68 to 3300 μF
Tolerance on C_R	$\pm 20\%$	
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 40 °C, $1.9 \times I_R$ applied	150000 hours	
Shelf life at 0 V, 105 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Detail specification	similar to DIN 45910-T129, former DIN 41238	
Climatic category IEC 68	40/105/56	

Aluminium electrolytic capacitors

Power Long Life Printed Wiring

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 162 series

Preferred types in **bold**.

C_R (μF)	U_R (V)					
	10	16	25	40	63	100
470	—	—	—	—	—	25 × 30
680	—	—	—	—	—	25 × 40
1000	—	—	—	—	25 × 30	30 × 40
1500	—	—	—	—	25 × 40	35 × 40
2200	—	—	—	25 × 30	30 × 40	35 × 50
	—	—	—	—	—	40 × 40
3300	—	—	—	25 × 40	35 × 40	40 × 50
4700	—	—	25 × 30	30 × 40	35 × 50	40 × 70
	—	—	—	—	40 × 40	—
6800	—	25 × 30	25 × 40	35 × 40	40 × 50	40 × 100
10000	25 × 30	25 × 40	30 × 40	35 × 50	40 × 70	—
	—	—	—	40 × 40	—	—
15000	25 × 40	30 × 40	35 × 40	40 × 50	40 × 100	—
22000	30 × 40	35 × 40	35 × 50	40 × 70	—	—
	—	—	40 × 40	—	—	—
33000	35 × 40	35 × 50	40 × 50	40 × 100	—	—
	—	40 × 40	—	—	—	—
47000	35 × 50	40 × 50	40 × 70	—	—	—
	40 × 40	—	—	—	—	—
68000	40 × 50	40 × 70	40 × 100	—	—	—
100000	40 × 70	40 × 100	—	—	—	—
150000	40 × 100	—	—	—	—	—

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 163 series

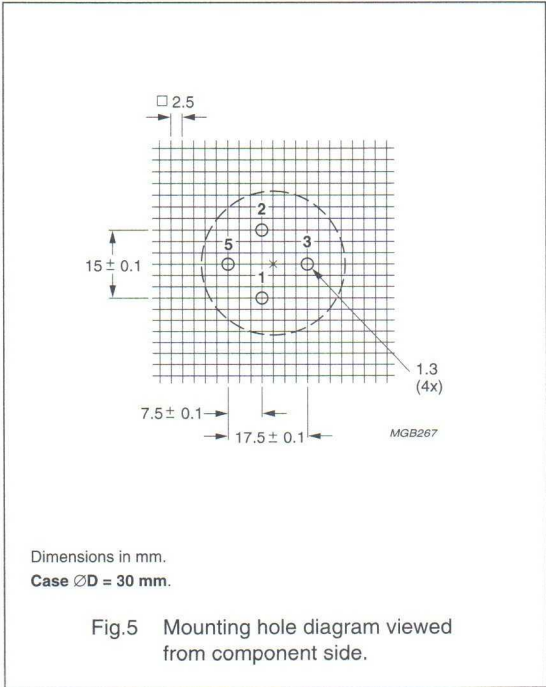
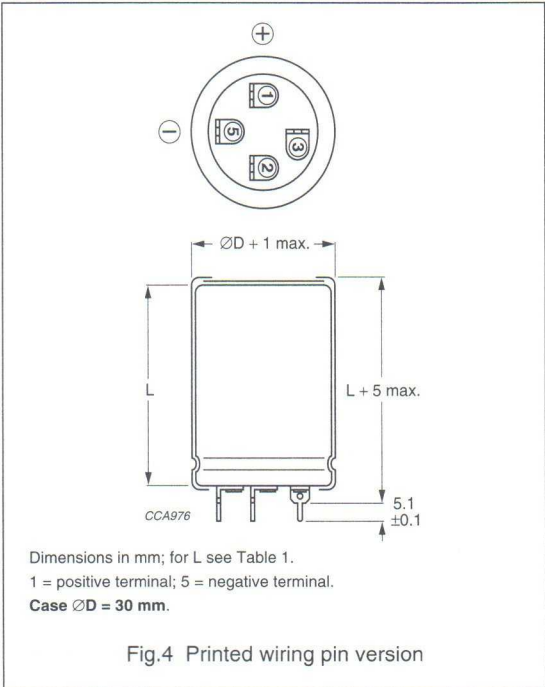
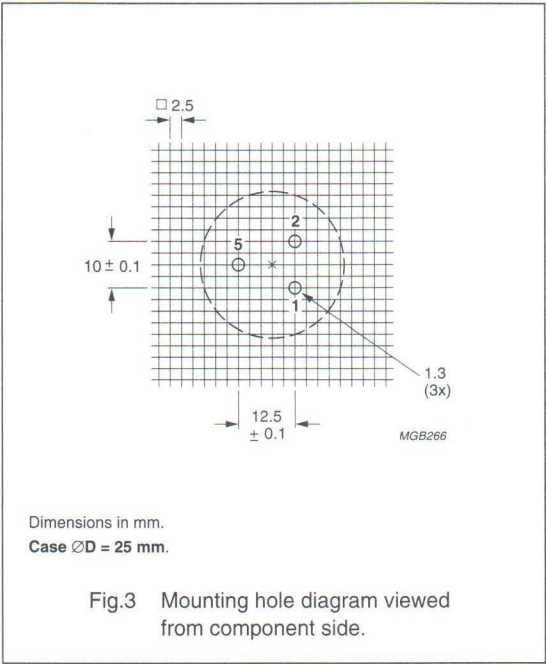
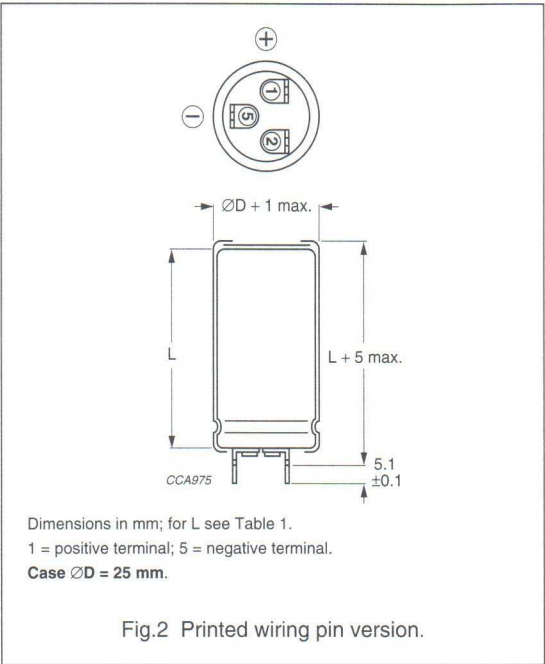
Preferred types in **bold**.

C_R (μF)	U_R (V)			
	200	250	385	400
68	—	—	25 × 30	25 × 30
100	—	25 × 30	25 × 40	25 × 40
150	25 × 30	25 × 40	30 × 40	30 × 40
220	25 × 40	30 × 40	35 × 40	35 × 40
330	30 × 40	35 × 40	35 × 50	35 × 50
	—	—	40 × 40	40 × 40
470	35 × 40	35 × 50	40 × 50	40 × 50
	—	40 × 40	—	—
680	35 × 50	40 × 50	40 × 70	40 × 70
	40 × 50	—	—	—
1000	40 × 50	40 × 70	40 × 100	40 × 100
1500	40 × 70	40 × 100	—	—
2200	40 × 100	—	—	—

Aluminium electrolytic capacitors
Power Long Life Printed Wiring

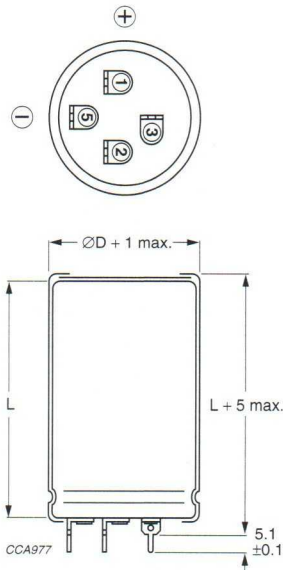
162/163 PLL-PW

MECHANICAL DATA AND PACKAGING QUANTITIES



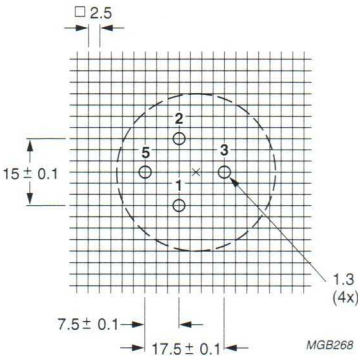
Aluminium electrolytic capacitors
Power Long Life Printed Wiring

162/163 PLL-PW



Dimensions in mm; for L see Table 1.
1 = positive terminal; 5 = negative terminal.
Case ØD = 35 mm.

Fig.6 Printed wiring pin version



Dimensions in mm.
Case ØD = 35 mm.

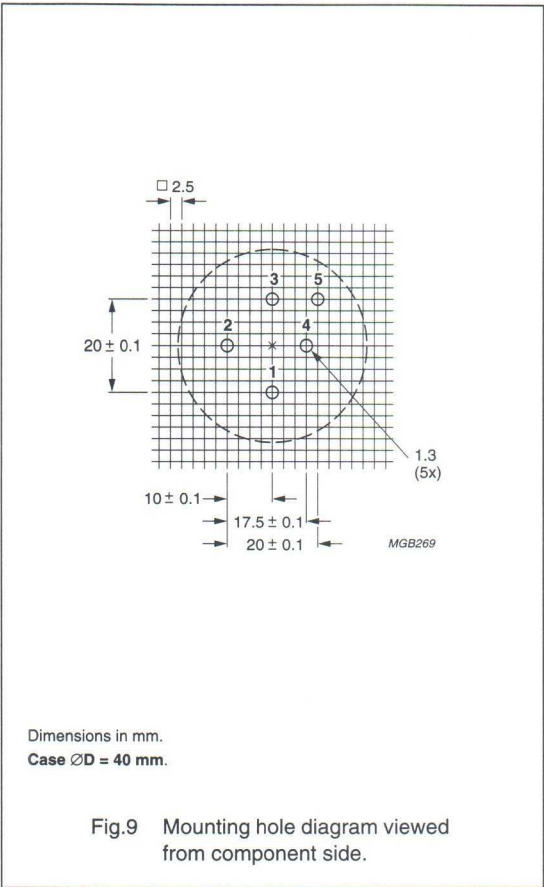
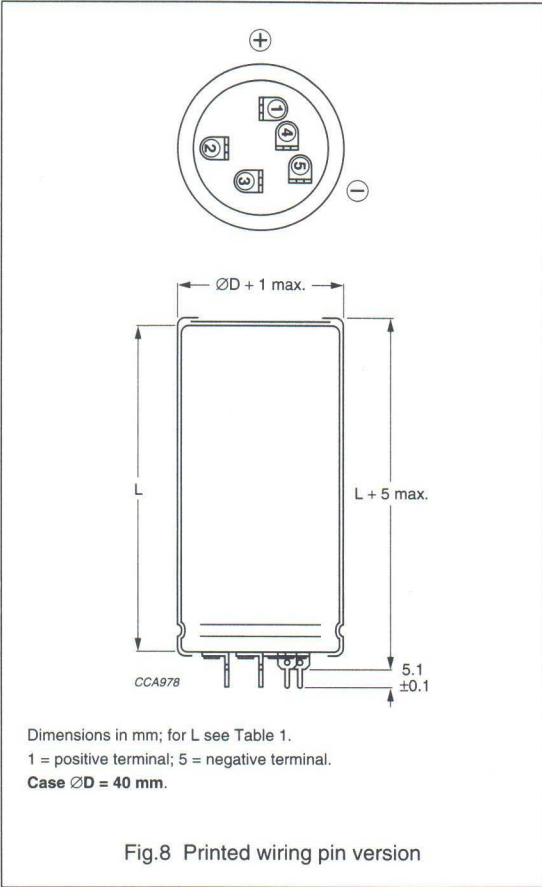
Fig.7 Mounting hole diagram viewed from component side.

Table 1 Physical dimensions, mass and packaging information; see Figs 2, 4, 6 and 8

NOMINAL CASE SIZE ØD × L (mm)	ØD _{max} (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
25 × 30	26	35	≈24	100	290 × 280 × 45
25 × 40	26	45	≈28	100	290 × 280 × 55
30 × 40	31	45	≈38	100	340 × 330 × 55
35 × 40	36	45	≈51	50	390 × 198 × 55
35 × 50	36	55	≈66	50	390 × 198 × 65
40 × 40	41	45	≈78	50	440 × 223 × 55
40 × 50	41	55	≈82	50	440 × 223 × 65
40 × 70	41	75	≈110	50	440 × 223 × 85
40 × 100	41	105	≈176	50	440 × 223 × 115

Aluminium electrolytic capacitors
Power Long Life Printed Wiring

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Mounting

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) must be free from the electrical circuit.

Aluminium electrolytic capacitors

Power Long Life Printed Wiring

162/163 PLL-PW

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 2 and 3 apply at
 $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz
I_R	rated RMS ripple current at 100 Hz and $105\text{ }^{\circ}\text{C}$
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 162 series

10000 $\mu\text{F}/25\text{ V}$; $\pm 20\%$ Nominal case size: $\varnothing 30 \times 40\text{ mm}$

Catalogue number: 2222 162 56103.

Table 2 Electrical data and ordering information for **162** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz $105\text{ }^{\circ}\text{C}$ (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz ($\text{m}\Omega$)	Z 10 kHz ($\text{m}\Omega$)	CATALOGUE NUMBER 2222
10	10000	25×30	3.17	0.60	0.20	48	37	162 54103
	15000	25×40	4.21	0.90	0.30	34	27	162 54153
	22000	30×40	5.05	1.32	0.44	29	23	162 54223
	33000	35×40	5.63	1.98	0.66	27	22	162 54333
	47000	35×50	6.19	2.82	0.94	26	21	162 54473
	47000	40×40	6.19	2.82	0.94	26	21	162 44473
	68000	40×50	7.64	4.08	1.36	21	18	162 54683
	100000	40×70	10.0	6.00	2.00	16	15	162 54104
	150000	40×100	12.9	9.00	3.00	13	12	162 54154
16	6800	25×30	3.11	0.65	0.22	50	37	162 55682
	10000	25×40	4.09	0.96	0.32	36	27	162 55103
	15000	30×40	4.97	1.44	0.48	30	23	162 55153
	22000	35×40	5.53	2.12	0.71	29	22	162 55223
	33000	35×50	6.08	3.17	1.06	28	21	162 55333
	33000	40×40	6.08	3.17	1.06	28	21	162 45333
	47000	40×50	7.46	4.52	1.51	22	18	162 55473
	68000	40×70	9.70	6.53	2.18	17	15	162 55683
	100000	40×100	12.90	9.60	3.20	13	12	162 55104

Aluminium electrolytic capacitors

Power Long Life Printed Wiring

162/163 PLL-PW

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
25	4700	25 × 30	2.94	0.71	0.24	56	37	162 56472
	6800	25 × 40	3.93	1.02	0.34	39	27	162 56682
	10000	30 × 40	4.81	1.50	0.50	32	23	162 56103
	15000	35 × 40	5.43	2.25	0.75	30	22	162 56153
	22000	35 × 50	5.98	3.30	1.10	29	21	162 56223
	22000	40 × 40	5.98	3.30	1.10	29	21	162 46223
	33000	40 × 50	7.30	4.95	1.65	23	18	162 56333
	47000	40 × 70	9.43	7.05	2.35	18	15	162 56473
	68000	40 × 100	12.44	10.20	3.40	14	12	162 56683
40	2200	25 × 30	2.36	0.53	0.18	87	54	162 57222
	3300	25 × 40	3.17	0.79	0.27	60	38	162 57332
	4700	30 × 40	3.93	1.13	0.38	48	33	162 57472
	6800	35 × 40	4.59	1.63	0.55	42	31	162 57682
	10000	35 × 50	5.03	2.40	0.80	41	29	162 57103
	10000	40 × 40	5.03	2.40	0.80	41	29	162 47103
	15000	40 × 50	6.09	3.60	1.20	33	24	162 57153
	22000	40 × 70	8.34	5.28	1.76	23	18	162 57223
	33000	40 × 100	10.97	7.92	2.64	18	15	162 57333
63	1000	25 × 30	1.55	0.38	0.13	202	155	162 58102
	1500	25 × 40	2.10	0.57	0.19	137	109	162 58152
	2200	30 × 40	2.72	0.83	0.28	100	79	162 58222
	3300	35 × 40	3.44	1.25	0.42	75	61	162 58332
	4700	35 × 50	4.09	1.78	0.60	62	53	162 58472
	4700	40 × 40	4.09	1.78	0.60	62	53	162 48472
	6800	40 × 50	5.10	2.57	0.86	47	40	162 58682
	10000	40 × 70	6.86	3.78	1.26	34	29	162 58103
	15000	40 × 100	9.31	5.67	1.89	25	21	162 58153
100	470	25 × 30	1.42	0.28	0.10	240	155	162 59471
	680	25 × 40	1.90	0.41	0.14	167	109	162 59681
	1000	30 × 40	2.48	0.60	0.20	120	79	162 59102
	1500	35 × 40	3.17	0.90	0.30	88	61	162 59152
	2200	35 × 50	3.79	1.32	0.44	72	53	162 59222
	2200	40 × 40	3.79	1.32	0.44	72	53	162 49222
	3300	40 × 50	4.81	1.98	0.66	53	40	162 59332
	4700	40 × 70	6.49	2.82	0.94	38	29	162 59472
	6800	40 × 100	8.80	4.08	1.36	28	21	162 59682

Aluminium electrolytic capacitors

Power Long Life Printed Wiring

162/163 PLL-PW

Table 3 Electrical data and ordering information for **163** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
200	150	25 × 30	0.72	0.18	0.06	950	710	163 52151
	220	25 × 40	0.96	0.26	0.09	650	485	163 52221
	330	30 × 40	1.29	0.40	0.14	442	330	163 52331
	470	35 × 40	1.66	0.57	0.19	321	240	163 52471
	680	35 × 50	2.09	0.82	0.28	237	185	163 52681
	680	40 × 40	2.09	0.82	0.28	237	185	163 42681
	1000	40 × 50	2.71	1.20	0.40	167	133	163 52102
	1500	40 × 70	3.75	1.80	0.60	114	90	163 52152
	2200	40 × 100	5.24	2.64	0.88	79	62	163 52222
250	100	25 × 30	0.67	0.15	0.05	1060	710	163 53101
	150	25 × 40	0.92	0.22	0.08	710	485	163 53151
	220	30 × 40	1.28	0.33	0.11	492	330	163 53221
	330	35 × 40	1.65	0.49	0.17	325	240	163 53331
	470	35 × 50	2.01	0.70	0.24	256	185	163 53471
	470	40 × 40	2.01	0.70	0.24	256	185	163 43471
	680	40 × 50	2.59	1.02	0.34	182	133	163 53681
	1000	40 × 70	3.58	1.50	0.50	125	90	163 53102
	1500	40 × 100	5.05	2.25	0.75	85	62	163 53152
385	68	25 × 30	0.61	0.16	0.06	1650	1260	163 58689
	100	25 × 40	0.82	0.23	0.08	1120	855	163 58101
	150	30 × 40	1.10	0.35	0.12	755	580	163 58151
	220	35 × 40	1.44	0.51	0.17	525	405	163 58221
	330	35 × 50	1.84	0.77	0.26	360	280	163 58331
	330	40 × 40	1.84	0.77	0.26	360	280	163 48331
	470	40 × 50	2.37	1.09	0.36	260	205	163 58471
	680	40 × 70	3.24	1.58	0.53	180	140	163 58681
	1000	40 × 100	4.54	2.31	0.78	125	100	163 58102
400	68	25 × 30	0.39	0.16	0.06	3200	2660	163 56689
	100	25 × 40	0.53	0.24	0.08	2180	1810	163 56101
	150	30 × 40	0.72	0.36	0.12	1460	1210	163 56151
	220	35 × 40	0.94	0.52	0.17	1010	830	163 56221
	330	35 × 50	1.24	0.79	0.26	680	570	163 56331
	330	40 × 40	1.24	0.79	0.26	680	570	163 46331
	470	40 × 50	1.59	1.12	0.37	485	407	163 56471
	680	40 × 70	2.18	1.63	0.54	336	282	163 56681
	1000	40 × 100	3.07	2.40	0.80	230	193	163 56102

Aluminium electrolytic capacitors

Power Long Life Printed Wiring

162/163 PLL-PW

Additional electrical data

PARAMETER	CONDITIONS	VALUE
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		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006C_R \times U_R + 4 \text{ }\mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \text{ }\mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 25 \text{ mm}$	max. 25 nH
	case $\varnothing D = 30 \text{ and } 35 \text{ mm}$	max. 30 nH
	case $\varnothing D = 40 \text{ mm}$	max. 35 nH

MARKING

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

- Rated capacitance (in μF)
- Tolerance on rated capacitance (M for $\pm 20\%$)
- Rated voltage (in V)
- 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" and "CECC 30301".

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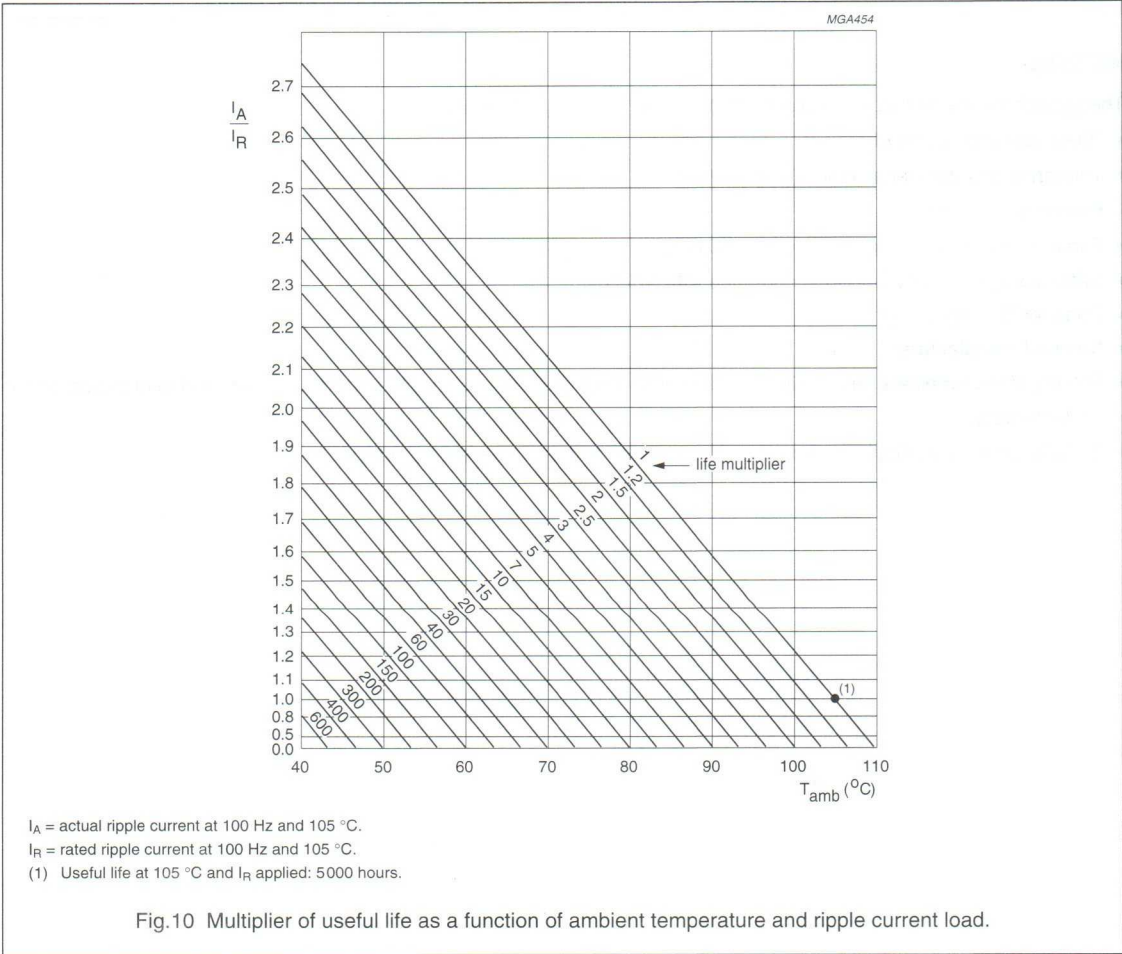
Aluminium electrolytic capacitors
Power Long Life Printed Wiring

162/163 PLL-PW

RIPPLE CURRENT AND USEFUL LIFE

Table 4 Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10 \text{ to } 25 \text{ V}$	$U_R = 40 \text{ to } 100 \text{ V}$	$U_R = 200 \text{ to } 400 \text{ V}$
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
≥ 10000	1.18	1.22	1.40



Aluminium electrolytic capacitors

Power Long Life Printed Wiring

162/163 PLL-PW

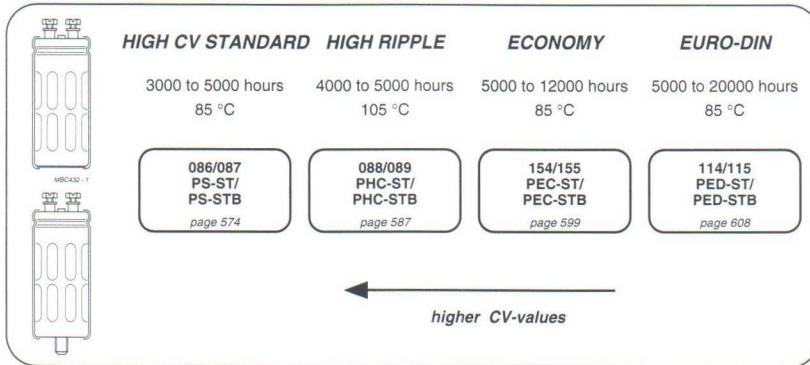
SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 5 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; 5000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 30\%$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100\text{ V}$: $\leq 1\%$; $U_R > 100\text{ V}$: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$: $\pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

SCREW TERMINAL CAPACITORS



CCB098

A supplement for additional screw terminal types and AC motor start capacitors will become available in the second half of 1998.

Aluminium electrolytic capacitors

Power Standard Screw Terminals

086/087 PS-ST

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Also available in bolt version (PS-STB)
- Pressure relief in the sealing
- Charge and discharge proof
- High ripple current capability
- High resistance to shock and vibration.

APPLICATIONS

- General purpose, computer and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Welding
- Energy storage in pulse systems
- Motor control devices
- Uninterruptable power supplies (UPS).

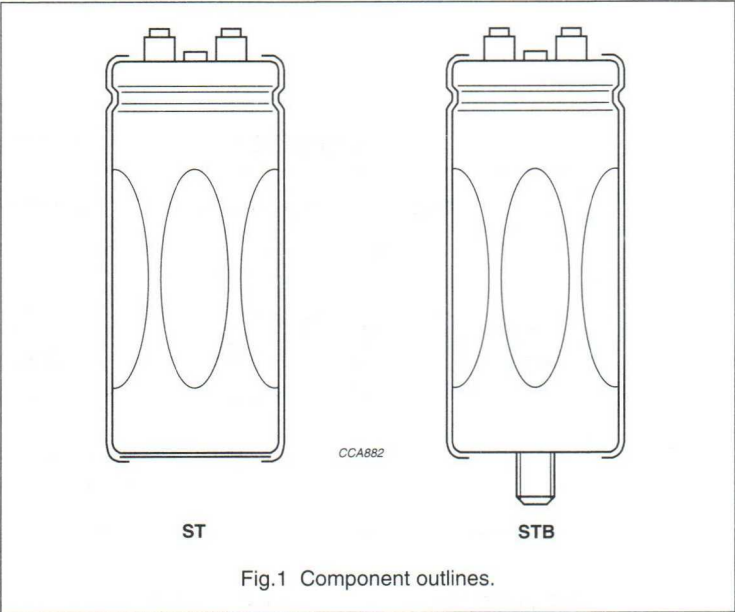
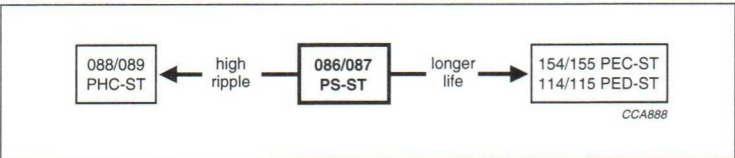


Fig.1 Component outlines.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	086	087
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	35 × 54 to 76 × 220	
Rated capacitance range, C_R	220 to 820000 μF	
Tolerance on C_R	-10 to +30%	
Rated voltage range, U_R	16 to 100 V	200 to 450 V
Category temperature range	-40 to +85 °C	
Endurance test at 85 °C	1000 hours	
Useful life at 85 °C	5000 hours (≥ 100 V: 3000 hours)	
Useful life at 40 °C, $1.1 \times I_R$ applied	120000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	40/085/56	

Aluminium electrolytic capacitors

Power Standard Screw Terminals

086/087 PS-ST

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 086 series

Preferred types in **bold**.

C_R (μF)	U_R (V)						
	16	25	40	50	63	75	100
2700	—	—	—	—	—	—	35 × 54
3300	—	—	—	—	—	—	35 × 80
3900	—	—	—	—	—	35 × 54	—
4700	—	—	—	—	35 × 54	—	—
5600	—	—	—	—	—	—	35 × 105
6800	—	—	—	—	—	35 × 80	—
8200	—	—	—	35 × 54	35 × 80	—	—
10000	—	—	35 × 54	—	—	35 × 105	50 × 80
12000	—	—	—	35 × 80	35 × 105	—	—
15000	—	—	35 × 80	—	—	50 × 80	50 × 105
18000	—	35 × 54	—	35 × 105	50 × 80	—	50 × 130
22000	35 × 54	—	35 × 105	—	—	50 × 105	50 × 143
	—	—	—	—	—	—	63.5 × 105
27000	—	35 × 80	—	50 × 80	50 × 105	50 × 118	63.5 × 130
33000	—	—	—	—	50 × 118	50 × 143	63.5 × 143
	—	—	—	—	—	63.5 × 105	76 × 105
39000	35 × 80	35 × 105	50 × 80	—	50 × 143	63.5 × 118	76 × 118
47000	—	—	—	50 × 105	63.5 × 105	76 × 105	—
56000	35 × 105	—	50 × 105	50 × 118	63.5 × 118	63.5 × 143	76 × 143
	—	—	—	—	—	76 × 118	—
68000	—	50 × 80	50 × 118	50 × 143	63.5 × 143	—	—
	—	—	—	63.5 × 105	76 × 105	—	—
82000	50 × 80	—	50 × 143	63.5 × 118	76 × 118	76 × 143	76 × 220
100000	—	50 × 105	63.5 × 105	63.5 × 143	76 × 143	—	—
	—	—	—	76 × 105	—	—	—
120000	50 × 105	50 × 118	63.5 × 118	76 × 118	—	76 × 220	—
150000	50 × 118	50 × 143	63.5 × 143	76 × 143	76 × 220	—	—
	—	63.5 × 105	76 × 105	—	—	—	—
180000	50 × 143	63.5 × 118	76 × 118	—	—	—	—
220000	63.5 × 105	63.5 × 143	76 × 143	76 × 220	—	—	—
	—	76 × 105	—	—	—	—	—
270000	63.5 × 118	76 × 118	—	—	—	—	—
330000	63.5 × 143	76 × 143	76 × 220	—	—	—	—
	76 × 105	—	—	—	—	—	—
390000	76 × 118	—	—	—	—	—	—
470000	76 × 143	—	—	—	—	—	—
560000	—	76 × 220	—	—	—	—	—
820000	76 × 220	—	—	—	—	—	—

L

Aluminium electrolytic capacitors

Power Standard Screw Terminals

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 087 series

Preferred types in **bold**.

C_R (μF)	U_R (V)				
	200	250	350	400	450
220	—	—	—	—	35 × 54
330	—	—	—	35 × 54	—
390	—	—	35 × 54	—	35 × 80
560	—	—	—	35 × 80	35 × 105
680	—	35 × 54	35 × 80	—	—
820	—	—	—	35 × 105	50 × 80
1000	35 × 54	—	35 × 105	—	—
1200	—	35 × 80	—	50 × 80	50 × 105
1500	35 × 80	—	50 × 80	—	50 × 130
1800	—	35 × 105	—	50 × 105	50 × 143
2200	35 × 105	—	50 × 105	50 × 130	63.5 × 105
2700	—	50 × 80	50 × 130	50 × 143	63.5 × 130
	—	—	63.5 × 105	63.5 × 105	—
3300	—	—	50 × 143	63.5 × 130	63.5 × 143
	—	—	—	—	76 × 105
3900	50 × 80	50 × 105	63.5 × 130	63.5 × 143	76 × 118
	—	—	—	76 × 105	—
4700	—	—	63.5 × 143	76 × 118	76 × 143
	—	50 × 130	76 × 105	—	—
5600	50 × 105	50 × 143	76 × 118	76 × 143	—
6800	50 × 130	63.5 × 105	76 × 143	—	—
8200	50 × 143	63.5 × 130	—	—	76 × 220
10000	63.5 × 105	63.5 × 143	—	76 × 220	—
	—	76 × 105	—	—	—
12000	63.5 × 130	76 × 118	76 × 220	—	—
	76 × 105	—	—	—	—
15000	63.5 × 143	76 × 143	—	—	—
	76 × 118	—	—	—	—
18000	—	—	—	—	—
22000	76 × 143	76 × 220	—	—	—
27000	—	—	—	—	—
33000	76 × 220	—	—	—	—

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MECHANICAL DATA AND PACKAGING QUANTITIES

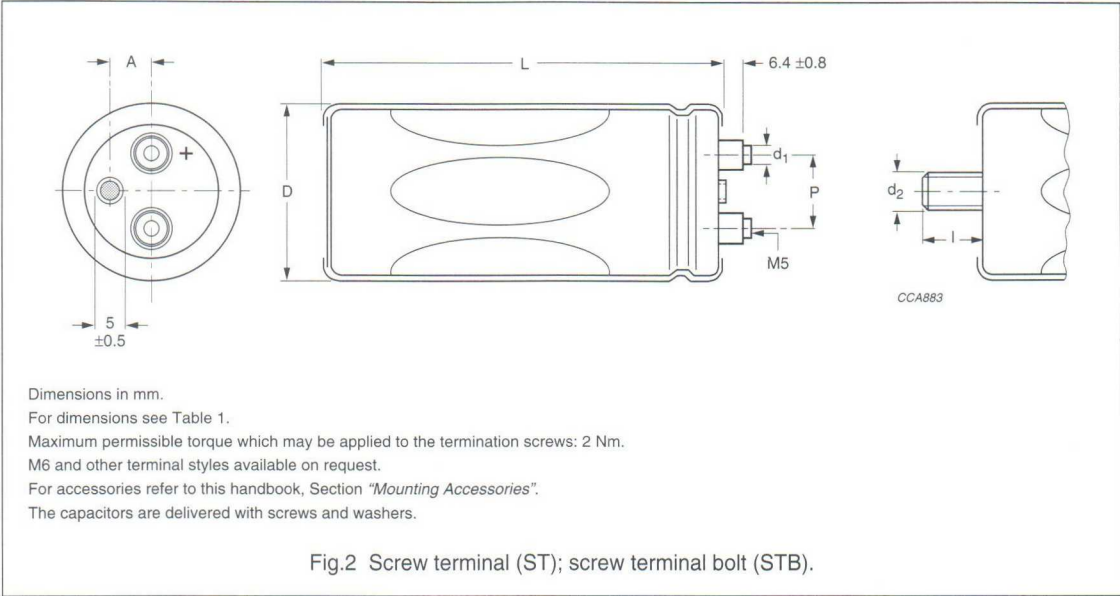


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	ØD _{max} (mm)	L _{max} (mm)	P ±0.4 (mm)	A (mm)	d ₁ ±0.2 (mm)	d ₂ × l	MASS (g)	PACKAGING QUANTITIES (per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
35 × 54	36.3	56.4	12.7	8.0	8.0	M8 × 12	≈72	150	402 × 200 × 258
35 × 80	36.3	81.8	12.7	8.0	8.0	M8 × 12	≈105	150	402 × 200 × 283
35 × 105	36.3	107.2	12.7	8.0	8.0	M8 × 12	≈135	100	402 × 200 × 258
50 × 80	52.9	81.8	22.2	12.7	8.0	M12 × 16	≈190	72	324 × 216 × 278
50 × 105	52.9	107.2	22.2	12.7	8.0	M12 × 16	≈255	48	324 × 216 × 289
50 × 130	52.9	132.6	22.2	12.7	8.0	M12 × 16	≈320	48	324 × 216 × 289
50 × 143	52.9	145.3	22.2	12.7	8.0	M12 × 16	≈350	48	324 × 216 × 315
65 × 105	65.6	107.2	28.5	15.9	8.0	M12 × 16	≈445	40	343 × 275 × 240
65 × 118	65.6	119.9	28.5	15.9	8.0	M12 × 16	≈500	40	343 × 275 × 315
65 × 143	65.6	145.3	28.5	15.9	8.0	M12 × 16	≈600	20	343 × 275 × 240
76 × 105	78.3	107.2	31.8	19.0	8.0	M12 × 16	≈600	20	397 × 320 × 121
76 × 118	78.3	119.9	31.8	19.0	8.0	M12 × 16	≈720	20	397 × 320 × 147
76 × 143	78.3	145.3	31.8	19.0	8.0	M12 × 16	≈970	20	397 × 320 × 178
76 × 220	78.3	221.5	31.8	19.0	8.0	M12 × 16	≈1460	16	426 × 410 × 237

Aluminium electrolytic capacitors

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 2 and 3 apply at
 $T_{amb} = 25\text{ }^{\circ}\text{C}$, $P = 86\text{ to }106\text{ kPa}$, $RH = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz
I_R	rated RMS ripple current at 85 °C
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	max. equivalent series resistance at 100 Hz
Z	impedance at 20 kHz on request
$\tan \delta$	max. dissipation factor at 100 Hz

Ordering example

Electrolytic capacitor 087 series

10000 μF /200 V; $\pm 20\%$

Nominal case size:

 $\varnothing 63.5 \times 105\text{ mm}$, ST version

Catalogue number: 2222 087 12103.

Table 2 Electrical data and ordering information for **086** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	$\tan \delta$ MAX. 100 Hz	CATALOGUE NUMBER (see Table 3, note 1) 2222
16	22000	35 × 54	5.4	3.56	25	0.45	086 15223
	39000	35 × 80	7.6	4.74	18	0.57	086 15393
	56000	35 × 105	9.7	5.68	14	0.64	086 15563
	82000	50 × 80	17	6.87	6	0.40	086 15823
	120000	50 × 105	21	8.31	5	0.49	086 15124
	150000	50 × 118	23	9.30	4	0.49	086 15154
	150000	50 × 143	25	10.18	4	0.59	086 25154
	220000	63.5 × 105	27	11.26	4	0.72	086 15224
	270000	63.5 × 118	29	12.47	4	0.88	086 15274
	330000	63.5 × 143	34	13.79	3	0.81	086 15334
	330000	76 × 105	32	13.79	4	1.08	086 25334
	390000	76 × 118	35	14.99	3	0.96	086 15394
	470000	76 × 143	40	16.45	3	1.15	086 15474
25	820000	76 × 220	50	21.73	3	2.01	086 15824
	18000	35 × 54	5.4	4.02	25	0.37	086 16183
	27000	35 × 80	7.5	4.93	18	0.40	086 16273
	39000	35 × 105	9	5.92	14	0.45	086 16393
	68000	50 × 80	17	7.82	6	0.33	086 16683
	100000	50 × 105	21	9.49	5	0.41	086 16104
	120000	50 × 118	23	10.39	4	0.39	086 16124
	150000	50 × 143	26	11.62	4	0.49	086 16154
	150000	63.5 × 105	27	11.62	4	0.49	086 26154
	180000	63.5 × 118	29	12.73	4	0.59	086 16184
	220000	63.5 × 143	31	14.07	3	0.54	086 16224
	220000	76 × 105	32	14.07	4	0.72	086 26224
	270000	76 × 118	35	15.59	3	0.66	086 16274

Aluminium electrolytic capacitors

Power Standard Screw Terminals

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	CATALOGUE NUMBER (see Table 3, note 1) 2222
25	330000	76 × 143	38	17.23	3	0.81	086 16334
	560000	76 × 220	50	22.45	3	1.37	086 16564
40	10000	35 × 54	4.8	3.79	33	0.27	086 17103
	15000	35 × 80	7.4	4.65	19	0.23	086 17153
	22000	35 × 105	9.4	5.63	14	0.25	086 17223
	39000	50 × 80	15	7.49	7	0.22	086 17393
	56000	50 × 105	19	8.98	6	0.27	086 17563
	68000	50 × 118	21	9.90	5	0.28	086 17683
	82000	50 × 143	23	10.87	5	0.33	086 17823
	100000	63.5 × 105	24	12.00	5	0.41	086 17104
	120000	63.5 × 118	27	13.15	4	0.39	086 17124
	150000	63.5 × 143	31	14.70	4	0.49	086 17154
	150000	76 × 105	29	14.70	4	0.49	086 27154
	180000	76 × 118	35	16.10	4	0.59	086 17184
	220000	76 × 143	37	17.80	3	0.54	086 17224
	330000	76 × 220	50	21.80	3	0.81	086 17334
50	8200	35 × 54	4.2	3.84	41	0.27	086 11822
	12000	35 × 80	6	4.65	28	0.27	086 11123
	18000	35 × 105	7.8	5.69	21	0.31	086 11183
	27000	50 × 80	10	6.97	15	0.33	086 11273
	47000	50 × 105	13	9.20	11	0.42	086 11473
	56000	50 × 118	15	10.04	10	0.46	086 11563
	68000	50 × 143	17	11.06	9	0.50	086 11683
	68000	63.5 × 105	18	11.06	8	0.44	086 21683
	82000	63.5 × 118	20	12.15	7	0.47	086 11823
	100000	63.5 × 143	24	13.42	6	0.49	086 11104
	100000	76 × 105	23	13.42	6	0.49	086 21104
	120000	76 × 118	25	14.70	6	0.59	086 11124
	150000	76 × 143	30	16.43	5	0.61	086 11154
	220000	76 × 220	40	19.90	4	0.72	086 11224
63	4700	35 × 54	4.2	3.26	42	0.16	086 18472
	8200	35 × 80	6	4.31	28	0.19	086 18822
	12000	35 × 105	8	5.22	21	0.21	086 18123
	18000	50 × 80	10	6.39	15	0.22	086 18183
	27000	50 × 105	13	7.83	11	0.24	086 18273
	33000	50 × 118	15	8.65	10	0.27	086 18333
	39000	50 × 143	16	9.40	9	0.29	086 18393
	47000	63.5 × 105	18	10.32	8	0.31	086 18473

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Aluminium electrolytic capacitors

Power Standard Screw Terminals

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	CATALOGUE NUMBER (see Table 3, note 1) 2222
63	56000	63.5 × 118	20	11.27	7	0.32	086 18563
	68000	63.5 × 143	24	12.42	6	0.33	086 18683
	68000	76 × 105	23	12.42	6	0.33	086 28683
	82000	76 × 118	25	13.64	6	0.40	086 18823
	100000	76 × 143	30	15.06	5	0.41	086 18104
	150000	76 × 220	40	16.44	4	0.49	086 18154
75	3900	35 × 54	4.1	3.24	43	0.14	086 12392
	6800	35 × 80	5.9	4.28	29	0.16	086 12682
	10000	35 × 105	7.8	5.20	21	0.17	086 12103
	15000	50 × 80	10	6.36	15	0.18	086 12153
	22000	50 × 105	13	7.71	11	0.20	086 12223
	27000	50 × 118	15	8.54	10	0.22	086 12273
	33000	50 × 143	17	9.44	9	0.24	086 12333
	33000	63.5 × 105	18	9.44	8	0.22	086 22333
	39000	63.5 × 118	20	10.26	7	0.22	086 12393
	56000	63.5 × 143	23	12.30	6	0.27	086 12563
	47000	76 × 105	23	11.26	7	0.27	086 22473
	56000	76 × 118	25	12.30	6	0.27	086 12563
	82000	76 × 143	29	14.88	5	0.33	086 12823
	120000	76 × 220	40	18.00	4	0.39	086 12104
100	2700	35 × 54	3.3	3.12	65	0.14	086 19272
	3900	35 × 80	4.3	3.75	50	0.16	086 19392
	5600	35 × 105	5.9	4.49	32	0.15	086 19562
	10000	50 × 80	5.5	6.00	52	0.42	086 19103
	15000	50 × 105	7.3	7.35	37	0.45	086 19153
	18000	50 × 130	9	8.05	27	0.40	086 19183
	22000	50 × 143	15	8.90	11	0.20	086 19223
	22000	63.5 × 105	11	8.90	19	0.34	086 29223
	27000	63.5 × 118	13	9.86	16	0.35	086 19273
	33000	63.5 × 143	14	10.90	14	0.38	086 19333
	33000	76 × 105	14	10.90	14	0.38	086 29333
	39000	76 × 118	17	11.85	11	0.35	086 19393
	56000	76 × 143	22	14.20	8	0.37	086 19563
	82000	76 × 220	25	17.18	7	0.47	086 19823

Aluminium electrolytic capacitors

Power Standard Screw Terminals

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Table 3 Electrical data and ordering information for **087** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	CATALOGUE NUMBER (note 1) 2222
200	1000	35 × 54	2.6	2.68	109	0.09	087 12102
	1500	35 × 80	3.4	3.29	77	0.09	087 12152
	2200	35 × 105	4.6	3.98	52	0.09	087 12222
	3900	50 × 80	4.8	5.30	73	0.23	087 12392
	5600	50 × 105	8.6	6.35	24	0.11	087 12562
	6800	50 × 130	9.9	7.00	21	0.12	087 12682
	8200	50 × 143	12	7.68	17	0.11	087 12822
	10000	63.5 × 105	11	8.49	22	0.18	087 12103
	12000	63.5 × 130	12	9.30	17	0.17	087 12123
	12000	76 × 105	11	9.30	26	0.25	087 22123
	15000	63.5 × 143	14	10.39	16	0.20	087 12153
	15000	76 × 118	12	10.39	23	0.28	087 22153
	22000	76 × 143	15	12.59	17	0.31	087 12223
	33000	76 × 220	17	15.41	15	0.40	087 12333
250	680	35 × 54	2.6	2.47	120	0.07	087 13681
	1200	35 × 80	3.6	3.29	76	0.07	087 13122
	1800	35 × 105	4.9	4.02	53	0.08	087 13182
	2700	50 × 80	4.4	4.93	67	0.15	087 13272
	3900	50 × 105	7.9	5.92	27	0.09	087 13392
	4700	50 × 130	9	6.50	23	0.09	087 13472
	5600	50 × 143	10	7.10	20	0.09	087 13562
	6800	63.5 × 105	10	7.82	24	0.13	087 13682
	8200	63.5 × 130	11	8.59	19	0.13	087 13822
	10000	63.5 × 143	14	9.49	17	0.14	087 13103
	10000	76 × 105	11	9.49	25	0.20	087 23103
	12000	76 × 118	12	10.39	22	0.22	087 13123
	15000	76 × 143	14	11.62	19	0.23	087 13153
	22000	76 × 220	17	14.07	16	0.29	087 13223

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Aluminium electrolytic capacitors

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U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	CATALOGUE NUMBER (note 1) 2222
350	390	35 × 54	1.3	2.22	270	0.09	087 15391
	680	35 × 80	2.5	2.93	163	0.09	087 15681
	1000	35 × 105	3.3	3.55	112	0.09	087 15102
	1500	50 × 80	3.9	4.35	105	0.13	087 15152
	2200	50 × 105	5.6	5.26	55	0.10	087 15222
	2700	50 × 130	7	5.83	44	0.10	087 15272
	2700	63.5 × 105	6.6	5.83	54	0.12	087 25272
	3300	50 × 143	8	6.45	37	0.10	087 15332
	3900	63.5 × 130	8.7	7.01	37	0.12	087 15392
	4700	63.5 × 143	9.6	7.70	33	0.13	087 15472
	4700	76 × 105	9.6	7.70	33	0.13	087 25472
	5600	76 × 118	10	8.40	33	0.15	087 15562
	6800	76 × 143	11	9.26	28	0.16	087 15682
	12000	76 × 220	18	12.30	18	0.18	087 15123
400	330	35 × 54	1.3	2.18	290	0.08	087 16331
	560	35 × 80	2.1	2.84	190	0.09	087 16561
	820	35 × 105	3	3.44	129	0.09	087 16821
	1200	50 × 80	3.7	4.16	95	0.09	087 16152
	1800	50 × 105	5.5	5.09	59	0.09	087 16182
	2200	50 × 130	6.4	5.63	50	0.09	087 16222
	2700	50 × 143	7.9	6.24	39	0.09	087 16272
	2700	63.5 × 105	7.3	6.24	48	0.11	087 26272
	3300	63.5 × 130	8.5	6.89	39	0.11	087 16332
	3900	63.5 × 143	9.4	7.49	37	0.12	087 16392
	3900	76 × 105	9.4	7.49	37	0.12	087 26392
	4700	76 × 118	10	8.23	34	0.13	087 16472
	5600	76 × 143	11	8.98	28	0.13	087 16562
	10000	76 × 220	18	12.00	18	0.15	087 16103

Aluminium electrolytic capacitors

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	CATALOGUE NUMBER (note 1) 2222
450	220	35 × 54	1	1.89	430	0.08	087 17221
	390	35 × 80	1.8	2.51	310	0.10	087 17391
	560	35 × 105	2.6	3.01	180	0.08	087 17561
	820	50 × 80	3	3.64	145	0.10	087 17821
	1200	50 × 105	4.6	4.41	85	0.08	087 17122
	1500	50 × 130	5.3	4.93	71	0.09	087 17152
	1800	50 × 143	5.9	5.40	60	0.09	087 17182
	2200	63.5 × 105	6.7	5.97	53	0.10	087 17222
	2700	63.5 × 130	7.7	6.61	45	0.10	087 17272
	3300	63.5 × 143	9.5	7.31	35	0.09	087 17332
	3300	76 × 105	9.5	7.31	35	0.09	087 27332
	3900	76 × 118	9.8	7.95	36	0.11	087 17392
	4700	76 × 143	11	8.73	31	0.12	087 17472
	8200	76 × 220	14	11.53	23	0.15	087 17822

Note

- Catalogue number applies to the ST version; for STB version (not preferred) replace 8th digit by '5' if ST version is '1' (2222 086/087 5....) or replace 8th digit by '6' if ST version is '2' (2222 086/087 6....). STB version is not available for case size $\varnothing 76 \times 220$ mm.

MARKING

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

- Rated capacitance (in μF)
- Tolerance on rated capacitance
- Rated voltage (in V)
- Date code (year and week) in accordance with "IEC 62"
- Name of manufacturer
- Code number 17 digits
- Code number 12 digits (12NC).

Aluminium electrolytic capacitors

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ELECTRICAL DATA (continued)**Additional electrical data**

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods	≤250 V versions	$U_s = 1.3 \times U_R$
	≥350 V versions	$U_s = 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 5 minutes at U_R	$I_{L5} \leq 0.006 \times \sqrt{C \times V} \text{ (mA)}$
Inductance		
Equivalent series inductance (ESL)	case ØD = 35 mm	typ. 18 nH
	case ØD = 50 mm	typ. 25 nH
	case ØD = 65 mm	typ. 27 nH
	case ØD = 75 mm	typ. 29 nH

RIPPLE CURRENT AND USEFUL LIFE**Table 4** Multiplier of ripple current (I_R) as a function of frequency

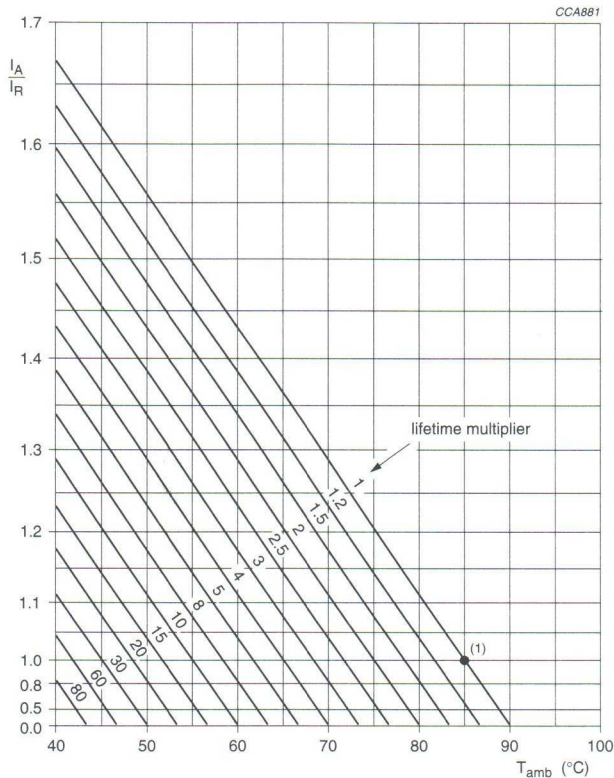
FREQUENCY (Hz)	I_R MULTIPLIER	
	086	087
50	0.9	0.9
100	1.00	1.00
300	1.15	1.25
1000	1.25	1.40
≥10000	1.30	1.50

Aluminium electrolytic capacitors
Power Standard Screw Terminals

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Table 5 Derated voltage life multiplier

RATIO OF APPLIED VOLTAGE TO RATED VOLTAGE					
100%	95%	90%	85%	80%	75%
1.0	1.1	1.2	1.4	1.6	1.8



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 at 85 °C.

(1) Useful life at 85 °C and I_R applied: 5000 hours (3000 hours for ≥ 100 V types).

Fig.3 Multiplier of useful life as a function of ambient temperature and ripple current load.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this data handbook, Section "Tests and Requirements".

Table 6 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ °C}$; U_R applied; 1000 hours	$\Delta C/C: \pm 10\%$ $ESR \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ °C}$; U_R and I_R applied; 5000 hours ($\geq 100\text{ V}$ types: 3000 hours)	$\Delta C/C: \pm 15\%$ $ESR \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ °C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$ $ESR \leq 1.75 \times \text{spec. limit}$

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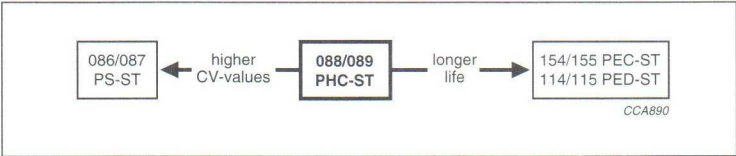
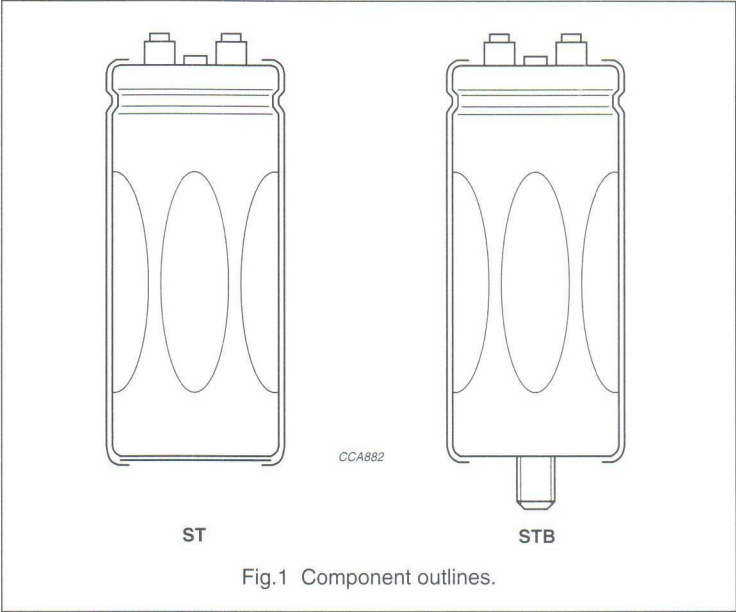
088/089 PHC-ST

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Also available in bolt version (PHC-STB)
- Pressure relief in the sealing disk
- Charge and discharge proof
- High ripple current capability
- High resistance to shock and vibration.

APPLICATIONS

- General purpose, computer and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Welding
- Energy storage in pulse systems
- Motor control devices
- Uninterruptable power supplies (UPS).



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	088	089
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	35 × 54 to 76 × 220	
Rated capacitance range, C_R	270 to 820000 μF	
Tolerance on C_R	-10 to +30%	
Rated voltage range, U_R	16 to 100 V	200 to 400 V
Category temperature range	-40 to +105 °C	
Endurance test at 85 °C	2000 hours	
Useful life at 85 °C	5000 hours (≥ 100 V: 4000 hours)	
Useful life at 40 °C and $1.1 \times I_R$ applied	150000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	40/105/56	

Aluminium electrolytic capacitors

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 088 series

Preferred types in **bold**.

C_R (μF)	U_R (V)						
	16	25	40	50	63	75	100
1800	—	—	—	—	—	—	35 × 54
2700	—	—	—	—	—	35 × 54	35 × 80
3900	—	—	—	—	—	—	35 × 105
4700	—	—	—	—	35 × 54	35 × 80	—
6800	—	—	—	35 × 54	35 × 80	35 × 105	50 × 80
8200	—	—	35 × 54	—	—	—	—
10000	—	—	—	35 × 80	35 × 105	—	50 × 105
12000	—	35 × 54	35 × 80	—	—	50 × 80	50 × 118
15000	—	—	—	35 × 105	—	—	50 × 143
18000	—	—	35 × 105	—	50 × 80	50 × 105	63.5 × 105
22000	35 × 54	35 × 80	—	—	—	50 × 130	63.5 × 130
	—	—	—	—	—	—	76 × 105
27000	—	—	50 × 80	50 × 80	50 × 105	50 × 143	63.5 × 143
	—	—	—	—	—	63.5 × 105	76 × 118
33000	—	35 × 105	—	—	50 × 130	63.5 × 118	—
39000	35 × 80	—	—	50 × 105	50 × 143	63.5 × 143	76 × 143
	—	—	—	—	63.5 × 105	76 × 105	—
47000	—	—	50 × 105	50 × 130	63.5 × 118	76 × 118	—
56000	35 × 105	50 × 80	50 × 130	50 × 143	63.5 × 143	76 × 143	76 × 220
	—	—	—	63.5 × 105	76 × 105	—	—
68000	—	—	50 × 143	63.5 × 118	76 × 118	—	—
	—	—	63.5 × 105	—	—	—	—
82000	50 × 80	50 × 105	63.5 × 118	63.5 × 143	76 × 143	—	—
	—	—	—	76 × 105	—	—	—
100000	—	50 × 130	63.5 × 143	76 × 118	—	76 × 220	—
	—	—	76 × 105	—	—	—	—
120000	50 × 105	50 × 143	76 × 118	76 × 143	—	—	—
	—	63.5 × 105	—	—	—	—	—
150000	50 × 130	63.5 × 118	76 × 143	—	76 × 220	—	—
	50 × 143	—	—	—	—	—	—
180000	—	63.5 × 143	—	—	—	—	—
	—	76 × 105	—	—	—	—	—
220000	63.5 × 105	76 × 118	—	76 × 220	—	—	—
270000	63.5 × 118	76 × 143	76 × 220	—	—	—	—
330000	63.5 × 143	—	—	—	—	—	—
	76 × 105	—	—	—	—	—	—
390000	76 × 118	—	—	—	—	—	—
470000	76 × 143	76 × 220	—	—	—	—	—
820000	76 × 220	—	—	—	—	—	—

Aluminium electrolytic capacitors

Power High Current Screw Terminals

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 089 series

Preferred types in **bold**.

C_R (μF)	U_R (V)			
	200	250	350	400
270	—	—	—	35 × 54
330	—	—	35 × 54	—
390	—	—	—	—
470	—	35 × 54	—	35 × 80
560	—	—	35 × 80	—
680	35 × 54	—	—	35 × 105
820	—	35 × 80	35 × 105	—
1000	—	—	—	50 × 80
1200	35 × 80	35 × 105	50 × 80	—
1500	—	—	—	50 × 105
1800	35 × 105	50 × 80	50 × 105	50 × 118
2200	—	—	50 × 118	50 × 143
	—	—	—	63.5 × 105
2700	50 × 80	50 × 105	50 × 143	63.5 × 130
	—	—	63.5 × 105	—
3300	—	50 × 118	63.5 × 130	63.5 × 143
	—	—	—	76 × 105
3900	50 × 105	50 × 143	63.5 × 143	76 × 118
	—	—	76 × 105	—
4700	50 × 118	63.5 × 105	76 × 118	76 × 143
5600	50 × 143	63.5 × 130	76 × 143	—
6800	63.5 × 105	63.5 × 143	—	—
	—	76 × 105	—	—
8200	63.5 × 130	76 × 118	—	76 × 220
10000	63.5 × 143	76 × 143	76 × 220	—
	76 × 105	—	—	—
12000	76 × 118	—	—	—
	—	76 × 220	—	—
15000	76 × 143	—	—	—
22000	76 × 220	—	—	—

Aluminium electrolytic capacitors Power High Current Screw Terminals

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MECHANICAL DATA AND PACKAGING QUANTITIES

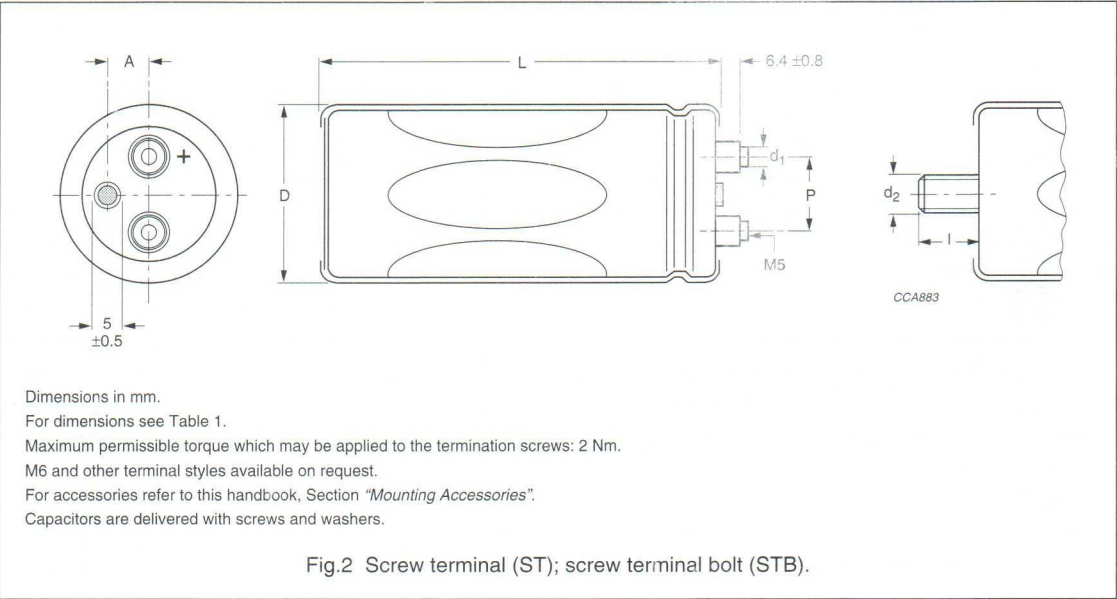


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	ØD _{max} (mm)	L _{max} (mm)	P ±0.4 (mm)	A (mm)	d ₁ ±0.2 (mm)	d ₂ × l	MASS (g)	PACKAGING QUANTITIES (per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
35 × 54	36.3	56.4	12.7	8.0	8.0	M8 × 12	≈72	150	402 × 200 × 258
35 × 80	36.3	81.8	12.7	8.0	8.0	M8 × 12	≈105	150	402 × 200 × 283
35 × 105	36.3	107.2	12.7	8.0	8.0	M8 × 12	≈135	100	402 × 200 × 258
50 × 80	52.9	81.8	22.2	12.7	8.0	M12 × 16	≈190	72	324 × 216 × 278
50 × 105	52.9	107.2	22.2	12.7	8.0	M12 × 16	≈255	48	324 × 216 × 289
50 × 130	52.9	132.6	22.2	12.7	8.0	M12 × 16	≈320	48	324 × 216 × 289
50 × 143	52.9	145.3	22.2	12.7	8.0	M12 × 16	≈350	48	324 × 216 × 315
65 × 105	65.6	107.2	28.5	15.9	8.0	M12 × 16	≈445	40	343 × 275 × 240
65 × 118	65.6	119.9	28.5	15.9	8.0	M12 × 16	≈500	40	343 × 275 × 315
65 × 143	65.6	145.3	28.5	15.9	8.0	M12 × 16	≈600	20	343 × 275 × 240
76 × 105	78.3	107.2	31.8	19.0	8.0	M12 × 16	≈600	20	397 × 320 × 121
76 × 118	78.3	119.9	31.8	19.0	8.0	M12 × 16	≈720	20	397 × 320 × 147
76 × 143	78.3	145.3	31.8	19.0	8.0	M12 × 16	≈970	20	397 × 320 × 178
76 × 220	78.3	221.5	31.8	19.0	8.0	M12 × 16	≈1460	16	426 × 410 × 237

Aluminium electrolytic capacitors

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 2 and 3 apply at
 $T_{amb} = 25\text{ }^{\circ}\text{C}$, $P = 86\text{ to }106\text{ kPa}$, $RH = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz
$I_{R\ 85}$	rated RMS ripple current at 85 °C
$I_{R\ 105}$	rated RMS ripple current at 105 °C = $0.25 \times I_{R\ 85}$
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	max. equivalent series resistance at 100 Hz
Z	impedance at 20 kHz on request
$\tan \delta$	max. dissipation factor at 100 Hz

Ordering example

Electrolytic capacitor 089 series

10000 μF /200 V; $\pm 20\%$

Nominal case size:

 $\varnothing 63.5 \times 143\text{ mm}$, ST version

Catalogue number: 2222 089 12103.

Table 2 Electrical data and ordering information for **088** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	$\tan \delta$ MAX. 100 Hz	CATALOGUE NUMBER (see Table 3, note 1) 2222
16	22000	35 × 54	12	1.78	10	0.18	088 15223
	39000	35 × 80	17	2.37	7	0.22	088 15393
	56000	35 × 105	21	2.84	6	0.27	088 15563
	82000	50 × 80	24	3.44	6	0.40	088 15823
	120000	50 × 105	30	4.16	6	0.49	088 15124
	150000	50 × 130	30	4.65	4	0.49	088 15154
	150000	50 × 143	30	4.65	4	0.49	088 25154
	220000	63.5 × 105	44	5.63	3	0.54	088 15224
	270000	63.5 × 118	48	6.24	3	0.66	088 15274
	330000	63.5 × 143	50	6.89	3	0.81	088 15334
	330000	76 × 105	50	6.89	3	0.81	088 25334
	390000	76 × 118	50	7.49	3	0.96	088 15394
	470000	76 × 143	50	8.23	2	0.77	088 15474
	820000	76 × 220	50	10.87	2	1.34	088 15824
25	12000	35 × 54	6.8	1.64	32	0.31	088 16123
	22000	35 × 80	9.6	2.22	22	0.40	088 16223
	33000	35 × 105	12	2.72	17	0.46	088 16333
	56000	50 × 80	21	3.55	7	0.32	088 16563
	82000	50 × 105	28	4.30	5	0.33	088 16823
	100000	50 × 130	30	4.74	5	0.41	088 16104
	120000	50 × 143	30	5.20	4	0.39	088 16124
	120000	63.5 × 105	35	5.20	5	0.49	088 26124
	150000	63.5 × 118	38	5.81	4	0.49	088 16154
	180000	63.5 × 143	41	6.36	4	0.59	088 16184
	180000	76 × 105	42	6.36	4	0.59	088 26184

Aluminium electrolytic capacitors

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U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	CATALOGUE NUMBER (see Table 3, note 1) 2222
25	220000	76 × 118	46	7.04	4	0.72	088 16224
	270000	76 × 143	49	7.79	4	0.88	088 16274
	470000	76 × 220	50	10.28	3	1.15	088 16474
40	8200	35 × 54	6.1	1.72	39	0.26	088 17822
	12000	35 × 80	8.7	2.08	27	0.26	088 17123
	18000	35 × 105	11	2.55	20	0.29	088 17183
	27000	50 × 80	19	3.12	9	0.20	088 17273
	47000	50 × 105	25	4.11	6	0.23	088 17473
	56000	50 × 130	30	4.49	5	0.23	088 17563
	68000	50 × 143	30	4.95	5	0.28	088 17683
	68000	63.5 × 105	32	4.95	5	0.28	088 27683
	82000	63.5 × 118	35	5.43	5	0.33	088 17823
	100000	63.5 × 143	38	6.00	5	0.41	088 17104
	100000	76 × 105	38	6.00	5	0.41	088 27104
	120000	76 × 118	42	6.57	4	0.39	088 17124
	150000	76 × 143	46	7.35	4	0.49	088 17154
	270000	76 × 220	50	9.86	3	0.66	088 17274
50	6800	35 × 54	5.9	1.75	42	0.23	088 11682
	10000	35 × 80	8.4	2.12	28	0.23	088 11103
	15000	35 × 105	11	2.60	21	0.26	088 11153
	27000	50 × 80	14	3.49	15	0.33	088 11273
	39000	50 × 105	19	4.19	11	0.35	088 11393
	47000	50 × 130	21	4.60	10	0.38	088 11473
	56000	50 × 143	24	5.02	9	0.41	088 11563
	56000	63.5 × 105	26	5.02	8	0.37	088 21563
	68000	63.5 × 118	29	5.53	7	0.39	088 11683
	82000	63.5 × 143	34	6.07	6	0.40	088 11823
	82000	76 × 105	32	6.07	6	0.40	088 21823
	100000	76 × 118	36	6.71	6	0.49	088 11104
	120000	76 × 143	39	7.35	5	0.49	088 11124
	220000	76 × 220	50	9.95	4	0.72	088 11224
63	4700	35 × 54	5.9	1.63	42	0.16	088 18472
	6800	35 × 80	8.4	1.96	29	0.16	088 18682
	10000	35 × 105	11	2.38	21	0.17	088 18103
	18000	50 × 80	14	3.19	15	0.22	088 18183
	27000	50 × 105	19	3.91	11	0.24	088 18273
	33000	50 × 130	23	4.33	9	0.24	088 18333
	39000	50 × 143	25	4.70	9	0.29	088 18393

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U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	CATALOGUE NUMBER (see Table 3, note 1) 2222
63	39000	63.5 × 105	26	4.70	8	0.25	088 28393
	47000	63.5 × 118	28	5.16	7	0.27	088 18473
	56000	63.5 × 143	31	5.63	7	0.32	088 18563
	56000	76 × 105	32	5.63	7	0.32	088 28563
	68000	76 × 118	36	6.21	6	0.33	088 18683
	82000	76 × 143	39	6.82	5	0.33	088 18823
	150000	76 × 220	50	9.22	4	0.49	088 18154
75	2700	35 × 54	5.7	1.35	46	0.10	088 12272
	4700	35 × 80	8.2	1.78	30	0.12	088 12472
	6800	35 × 105	10	2.14	22	0.12	088 12682
	12000	50 × 80	14	2.85	16	0.16	088 12123
	18000	50 × 105	18	3.49	12	0.18	088 12183
	22000	50 × 130	22	3.85	10	0.18	088 12223
	27000	50 × 143	24	4.27	9	0.20	088 12273
	27000	63.5 × 105	25	4.27	8	0.18	088 22273
	33000	63.5 × 118	28	4.72	7	0.19	088 12333
	39000	63.5 × 143	33	5.13	6	0.19	088 12393
	39000	76 × 105	33	5.13	6	0.19	088 22393
	47000	76 × 118	35	5.63	6	0.23	088 12473
	56000	76 × 143	41	6.15	5	0.23	088 12563
	100000	76 × 220	50	8.22	4	0.33	088 12104
100	1800	35 × 54	4	1.27	79	0.12	088 19182
	2700	35 × 80	5.9	1.56	51	0.11	088 19272
	4700	35 × 105	8.9	2.06	32	0.12	088 19472
	6800	50 × 80	6.8	2.47	64	0.36	088 19682
	10000	50 × 105	10	3.00	38	0.31	088 19103
	12000	50 × 130	11	3.29	34	0.33	088 19123
	15000	50 × 143	13	3.67	28	0.34	088 19153
	18000	63.5 × 105	17	4.02	18	0.26	088 19183
	22000	63.5 × 118	20	4.45	14	0.26	088 19223
	22000	63.5 × 143	15	4.45	25	0.45	088 29223
	27000	76 × 105	22	4.93	13	0.29	088 19273
	27000	76 × 118	18	4.93	20	0.44	088 29273
	39000	76 × 143	21	5.92	16	0.51	088 19393
	56000	76 × 220	25	7.10	14	0.64	088 19563

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Aluminium electrolytic capacitors

Power High Current Screw Terminals

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Table 3 Electrical data and ordering information for **089** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	CATALOGUE NUMBER (note 1) 2222
200	680	35 × 54	2.9	1.11	130	0.07	089 12681
	1200	35 × 80	4.1	1.47	76	0.07	089 12122
	1800	35 × 105	6.9	1.80	53	0.08	089 12182
	2700	50 × 80	6.2	2.20	76	0.17	089 12272
	3900	50 × 105	8.5	2.65	51	0.16	089 12392
	4700	50 × 130	11	2.91	36	0.14	089 12472
	5600	50 × 143	15	3.17	20	0.09	089 12562
	6800	63.5 × 105	14	3.50	24	0.13	089 12682
	8200	63.5 × 118	16	3.64	21	0.14	089 12822
	10000	63.5 × 143	20	4.24	17	0.14	089 12103
	10000	76 × 105	16	4.24	25	0.20	089 22103
	12000	76 × 118	18	4.65	22	0.22	089 12123
	15000	76 × 143	21	6.20	19	0.23	089 12153
	22000	76 × 220	25	6.29	15	0.27	089 12223
250	470	35 × 54	2.9	1.03	130	0.05	089 13471
	820	35 × 80	4.7	1.36	86	0.06	089 13821
	1200	35 × 105	6.8	1.64	54	0.05	089 13122
	1800	50 × 80	6.9	2.01	76	0.11	089 13182
	2700	50 × 105	8.4	2.46	52	0.11	089 13272
	3300	50 × 130	14	2.72	22	0.06	089 13332
	3900	50 × 143	16	2.96	19	0.06	089 13392
	4700	63.5 × 105	14	3.25	25	0.10	089 13472
	5600	63.5 × 118	16	3.55	20	0.09	089 13562
	6800	63.5 × 143	18	3.91	17	0.09	089 13682
	6800	76 × 105	18	3.91	17	0.09	089 23682
	8200	76 × 118	16	4.30	24	0.16	089 13822
	10000	76 × 143	21	4.74	18	0.15	089 13103
	12000	76 × 220	25	5.20	16	0.16	089 13123

Aluminium electrolytic capacitors

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_{L5} 5 min (mA)	ESR MAX. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	CATALOGUE NUMBER (note 1) 2222
350	330	35 × 54	1.9	1.02	290	0.08	089 15331
	560	35 × 80	2.9	1.33	191	0.09	089 15561
	820	35 × 105	4.2	1.61	129	0.09	089 15821
	1200	50 × 80	5	1.94	122	0.12	089 15122
	1800	50 × 105	7.3	2.38	74	0.11	089 15182
	2200	50 × 130	9.1	2.63	49	0.09	089 15222
	2700	50 × 143	10	2.92	39	0.09	089 15272
	2700	63.5 × 105	10	2.92	47	0.10	089 25272
	3300	63.5 × 118	12	3.22	39	0.11	089 15332
	3900	63.5 × 143	13	3.50	34	0.11	089 15392
	3900	76 × 105	13	3.50	34	0.11	089 25392
	4700	76 × 118	14	3.85	34	0.13	089 15472
	5600	76 × 143	16	4.20	28	0.13	089 15562
	10000	76 × 220	25	5.61	18	0.15	089 15103
400	270	35 × 54	1.7	0.99	333	0.07	089 16271
	470	35 × 80	2.9	1.30	224	0.09	089 16471
	680	35 × 105	4.1	1.56	134	0.07	089 16681
	1000	50 × 80	4.8	1.90	127	0.10	089 16102
	1500	50 × 105	7.8	2.32	63	0.08	089 16152
	1800	50 × 130	8.8	2.55	53	0.08	089 16182
	2200	50 × 143	9.8	2.81	45	0.08	089 16222
	2200	63.5 × 105	9.8	2.81	45	0.08	089 26222
	2700	63.5 × 118	10.7	3.12	47	0.10	089 16272
	3300	63.5 × 143	13	3.45	35	0.09	089 16332
	3300	76 × 105	13	3.45	35	0.09	089 26332
	3900	76 × 118	13	3.75	37	0.12	089 16392
	4700	76 × 143	15	4.11	31	0.12	089 16472
	8200	76 × 220	22	5.43	24	0.16	089 16822

Note

1. Catalogue number applies to the ST version; for STB version (not preferred) replace 8th digit by '5' if ST version is '1' (2222 088/089 5....) or replace 8th digit by '6' if ST version is '2' (2222 088/089 6....). STB version is not available for case size $\varnothing 76 \times 220$ mm.

L

Aluminium electrolytic capacitors

Power High Current Screw Terminals

088/089 PHC-ST

ELECTRICAL DATA (continued)**Additional electrical data**

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods	≤250 V versions	$U_s = 1.3 \times U_R$
	≥350 V versions	$U_s = 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 5 minutes at U_R	$I_{L5} \leq 0.003 \times \sqrt{C \times V} \text{ (mA)}$
Inductance		
Equivalent series inductance (ESL)	case ØD = 35 mm	typ. 18 nH
	case ØD = 50 mm	typ. 25 nH
	case ØD = 65 mm	typ. 27 nH
	case ØD = 75 mm	typ. 29 nH

MARKING

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

- Rated capacitance (in μF)
- Tolerance on rated capacitance
- Rated voltage (in V)
- Date code (year and week) in accordance with "IEC 62"
- Name of manufacturer
- Code number 17 digits
- Code number 12 digits (12NC).

RIPPLE CURRENT AND USEFUL LIFE**Table 4** Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER	
	088	089
50	0.9	0.9
100	1.00	1.00
300	1.15	1.25
1000	1.25	1.40
≥10000	1.30	1.50

Aluminium electrolytic capacitors

Power High Current Screw Terminals

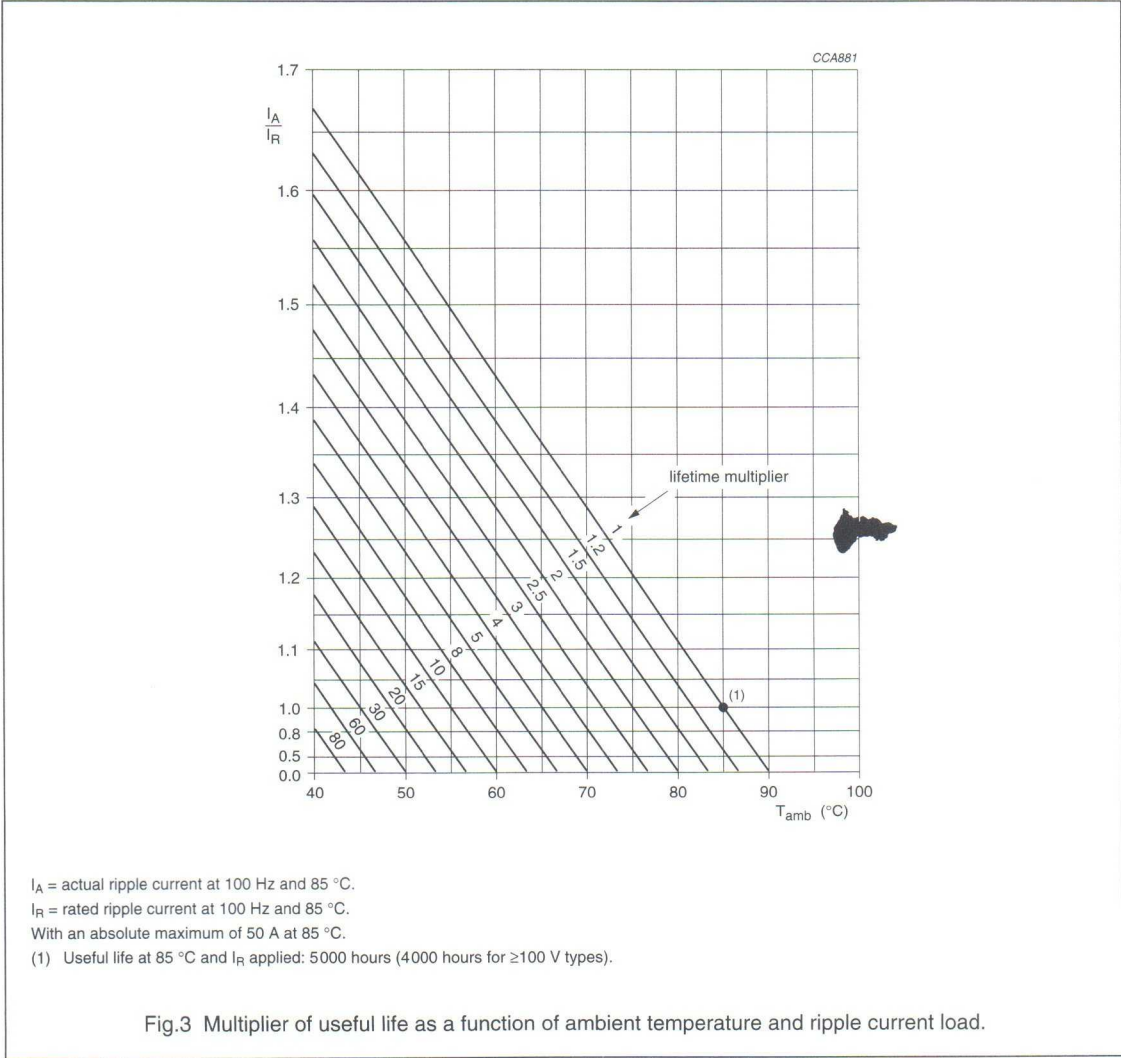
088/089 PHC-ST

Table 5 Derated voltage life multiplier

RATIO OF APPLIED VOLTAGE TO RATED VOLTAGE					
100%	95%	90%	85%	80%	75%
1.0	1.1	1.2	1.4	1.6	1.8

Table 6 Ripple current multiplier for elevated temperatures

RIPPLE CURRENT MULTIPLIER FOR ELEVATED TEMPERATURES				
85 °C	90 °C	95 °C	100 °C	105 °C
1.0	0.85	0.7	0.5	0.25



Aluminium electrolytic capacitors

Power High Current Screw Terminals

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this data handbook, Section "Tests and Requirements".

Table 7 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$\Delta C/C: \pm 10\%$ $ESR \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 5000 hours ($\geq 100\text{ V}$ types: 4000 hours)	$\Delta C/C: \pm 15\%$ $ESR \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$ $ESR \leq 1.75 \times \text{spec. limit}$

Aluminium electrolytic capacitors

Power Economic Screw Terminals

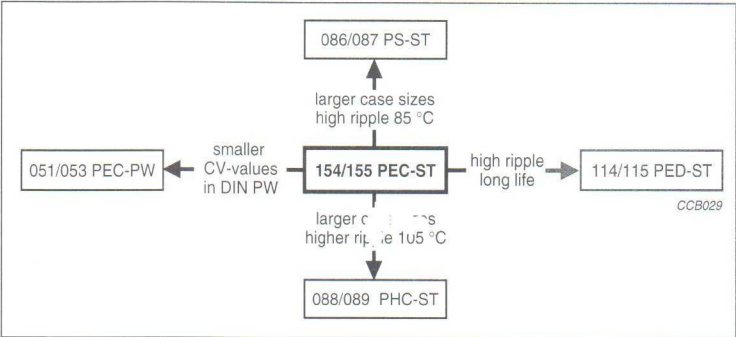
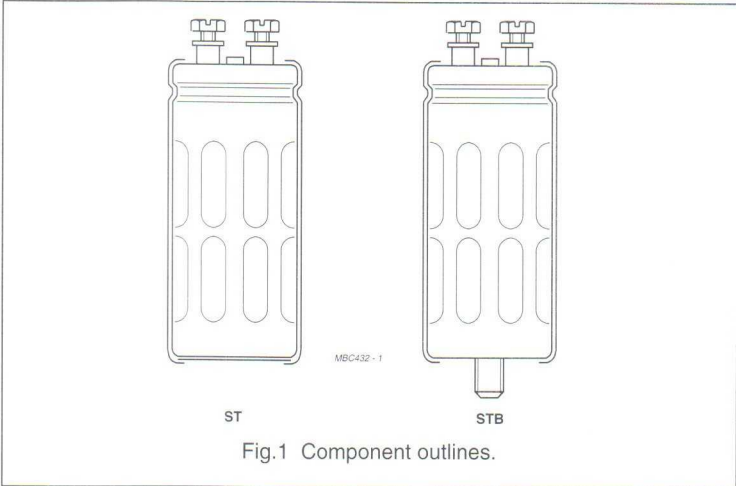
154/155 PEC-ST

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: 12000 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.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	154	155
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	35 × 60 to 75 × 105	
Rated capacitance range (E6 series), C_R	220 to 470000 μF	
Tolerance on C_R	±20%	
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 (400 V: 2000 hours)	
Useful life at 85 °C	12000 hours (400 V: 5000 hours)	
Useful life at 40 °C, $1.4 \times I_R$ applied	200000 hours (400 V: 90000 hours)	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	40/085/56	

Aluminium electrolytic capacitors

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 154 series

Preferred types in **bold**.

C_R (μF)	U_R (V)					
	10	16	25	40	63	100
3300	—	—	—	—	—	35 × 60
4700	—	—	—	—	—	35 × 80
6800	—	—	—	—	35 × 60	35 × 105
10000	—	—	—	—	35 × 80	50 × 80
15000	—	—	—	35 × 60	35 × 105	50 × 105
22000	—	—	35 × 60	35 × 80	50 × 80	65 × 105
33000	—	35 × 60	35 × 80	50 × 80	50 × 105	75 × 105
47000	35 × 60	35 × 80	35 × 105	50 × 80	65 × 105	—
68000	35 × 80	35 × 105	50 × 80	50 × 105	75 × 105	—
100000	35 × 105	50 × 80	50 × 105	65 × 105	—	—
150000	50 × 80	50 × 105	65 × 105	75 × 105	—	—
220000	50 × 105	65 × 105	75 × 105	—	—	—
330000	65 × 105	75 × 105	—	—	—	—
470000	75 × 105	—	—	—	—	—

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 155 series

Preferred types in **bold**.

C_R (μF)	U_R (V)			
	250	350	385	400
220	—	—	35 × 60	35 × 60
330	—	35 × 60	35 × 80	35 × 80
470	35 × 60	35 × 80	35 × 80	35 × 80
680	35 × 80	35 × 105	35 × 105	35 × 105
1000	35 × 105	50 × 80	50 × 80	50 × 80
1500	50 × 80	50 × 105	50 × 105	50 × 105
2200	50 × 105	65 × 105	65 × 105	65 × 105
3300	65 × 105	65 × 105	75 × 105	75 × 105
4700	65 × 105	—	—	—
6800	75 × 105	—	—	—

Aluminium electrolytic capacitors
Power Economic Screw Terminals

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MECHANICAL DATA AND PACKAGING QUANTITIES

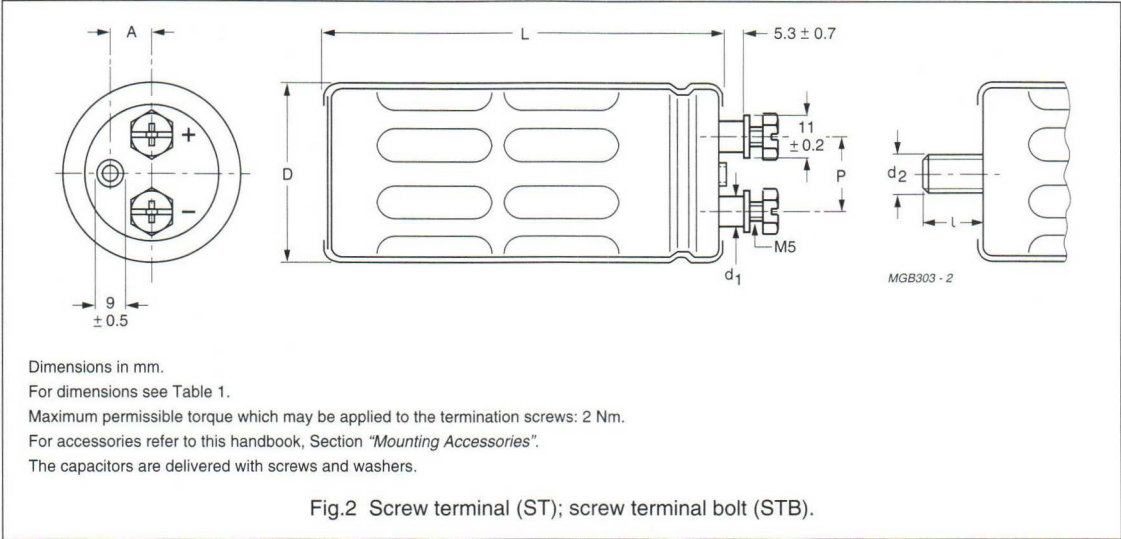


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	ØD _{max} (mm)	L _{max} (mm)	P ±0.1 (mm)	A (mm)	d ₁ ±0.2 (mm)	d ₂ × l	MASS (g)	PACKAGING QUANTITIES (per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
35 × 60	36.5	63	13.0	8.4	8.0	M8 × 12	≈55	25	196 × 192 × 110
35 × 80	36.5	83	13.0	8.4	8.0	M8 × 12	≈80	25	196 × 192 × 115
35 × 105	36.5	108	13.0	8.4	8.0	M8 × 12	≈110	25	196 × 192 × 140
50 × 80	51.5	83	22.0	14.3	8.0	M12 × 16	≈160	25	293 × 273 × 115
50 × 105	51.5	108	22.0	14.3	8.0	M12 × 16	≈210	25	293 × 273 × 140
65 × 105	66.5	108	28.5	19.0	9.6	M12 × 16	≈370	10	368 × 151 × 140
75 × 105	76.5	108	32.0	21.0	9.6	M12 × 16	≈535	10	418 × 173 × 140

MARKING

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

- Rated capacitance (in µF)
- Tolerance code on rated capacitance (M for ±20%)
- Rated voltage (in V)
- 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 (last 8 digits)
- Code for basic specification in accordance with "IEC 384-4-1" and "CECC 30301".

L

Aluminium electrolytic capacitors

Power Economic Screw Terminals

154/155 PEC-ST

Ordering Example

Electrolytic capacitor 154 series

10000 µF/63 V; ±20%

Nominal case size: Ø35 × 80 mm; ST version

Catalogue number: 2222 154 18103.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 2 and 3 apply at $T_{amb} = 20\text{ °C}$, $P = 86$ to 106 kPa, $RH = 45$ to 75%.

SYMBOL	DESCRIPTION
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
Tan δ	max. dissipation factor at 100 Hz

Table 2 Electrical data and ordering information for **154** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD × 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 TYP. 100 Hz (mΩ)	Tan δ MAX. 100 Hz	Z TYP. 20 kHz (mΩ)	Z MAX. 20 kHz (mΩ)	CATALOGUE NUMBER (see Table 3, note 1) 2222
10	47000	35 × 60	8.4	15.9	2.82	0.94	14	0.48	11	16.5	154 14473
	68000	35 × 80	8.7	16.5	4.08	1.36	11	0.88	9	13.5	154 14683
	100000	35 × 105	10.7	20.3	6.00	2.00	10.5	0.92	8	12	154 14104
	150000	50 × 80	13.2	25.0	9.00	3.00	8	1.03	8	12	154 14154
	220000	50 × 105	16.5	31.4	13.20	4.40	6.5	1.26	7	10.5	154 14224
	330000	65 × 105	20.8	39.5	19.80	6.60	5.5	1.59	7	10.5	154 14334
	470000	75 × 105	22.6	42.9	28.20	9.40	5.5	2.21	7	10.5	154 14474
16	33000	35 × 60	8.4	15.9	3.17	1.06	14	0.32	10	15	154 15333
	47000	35 × 80	8.7	16.5	4.51	1.51	11	0.32	9	13.5	154 15473
	68000	35 × 105	12.2	23.2	6.53	2.18	8	0.45	8	12	154 15683
	100000	50 × 80	13.2	25.0	9.60	3.20	8	0.70	8	12	154 15104
	150000	50 × 105	14.9	28.3	14.40	4.80	8	0.88	7	10.5	154 15154
	220000	65 × 105	20.8	39.5	21.10	7.04	5.5	1.07	7	10.5	154 15224
	330000	75 × 105	22.6	42.9	31.70	10.60	5.5	1.58	7	10.5	154 15334

Aluminium electrolytic capacitors

Power Economic Screw Terminals

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 TYP. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	Z TYP. 20 kHz (m Ω)	Z MAX. 20 kHz (m Ω)	CATALOGUE NUMBER (see Table 3, note 1) 2222
25	22000	35 × 60	8.1	15.4	3.30	1.10	12	0.23	10	15	154 16223
	33000	35 × 80	9.6	18.2	4.95	1.65	10	0.28	9	13.5	154 16333
	47000	35 × 105	12.2	23.2	7.05	2.35	8	0.33	8	12	154 16473
	68000	50 × 80	13.2	25.0	10.20	3.40	8	0.49	8	12	154 16683
	100000	50 × 105	15.9	30.2	15.00	5.00	7	0.60	8	12	154 16104
	150000	65 × 105	19.7	37.4	22.50	7.50	7	0.93	8	12	154 16154
	220000	75 × 105	22.6	42.9	33.00	11.00	5.5	1.07	7	10.5	154 16224
	15000	35 × 60	7.7	14.6	3.60	1.20	13	0.17	10	15	154 17153
	22000	35 × 80	9.8	18.6	5.28	1.76	11	0.20	9	13.5	154 17223
	33000	50 × 80	11.8	22.4	7.92	2.64	10	0.29	9	13.5	154 17333
40	47000	50 × 80	11.8	22.4	11.30	3.76	10	0.42	9	13.5	154 17473
	68000	50 × 105	14.1	26.8	16.30	5.44	9	0.45	8	12	154 17683
	100000	65 × 105	17.3	32.9	24.00	8.00	9	0.80	8	12	154 17104
	150000	75 × 105	20.8	39.5	36.00	12.00	6.5	0.83	7	10.5	154 17154
	6800	35 × 60	6.6	12.5	2.57	0.86	17	0.10	13	19	154 18682
	10000	35 × 80	8.6	16.3	3.78	1.26	12.5	0.11	10	15	154 18103
	15000	35 × 105	10.9	20.7	5.67	1.89	10	0.13	9	13.5	154 18153
	22000	50 × 80	11.8	22.4	8.32	2.77	10	0.20	9	13.5	154 18223
	33000	50 × 105	14.1	26.8	12.50	4.16	9	0.24	8	12	154 18333
	47000	65 × 105	17.3	32.9	17.80	5.92	9	0.36	8	12	154 18473
100	68000	75 × 105	17.7	33.6	25.70	8.57	9	0.58	8	12	154 18683
	3300	35 × 60	3.8	7.2	1.98	0.66	50	0.13	35	55	154 19332
	4700	35 × 80	5.3	10.0	2.82	0.94	35	0.13	25	40	154 19472
	6800	35 × 105	7.1	13.5	4.08	1.36	25	0.14	18	28	154 19682
	10000	50 × 80	8.9	16.9	6.00	2.00	18	0.14	13	20	154 19103
	15000	50 × 105	11.5	21.8	9.00	3.00	14	0.16	10	16	154 19153
	22000	65 × 105	18.2	34.5	13.20	4.40	7.5	0.13	6	9	154 19223
	33000	75 × 105	24.1	45.7	19.80	6.60	5.0	0.13	4	6	154 19333

Aluminium electrolytic capacitors

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Table 3 Electrical data and ordering information for 155 series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 TYP. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	Z TYP. 20 kHz (m Ω)	Z MAX. 20 kHz (m Ω)	CATALOGUE NUMBER (note 1) 2222
250	470	35 × 60	1.6	3.0	0.70	0.24	360	0.16	300	450	155 13471
	680	35 × 80	2.2	4.2	1.02	0.34	250	0.16	216	325	155 13681
	1000	35 × 105	2.9	5.5	1.50	0.50	175	0.16	140	210	155 13102
	1500	50 × 80	3.9	7.4	2.25	0.75	115	0.16	100	150	155 13152
	2200	50 × 105	5.3	10.1	3.30	1.10	80	0.17	70	105	155 13222
	3300	65 × 105	7.7	14.6	4.95	1.65	50	0.17	43	65	155 13332
	4700	65 × 105	8.2	15.6	7.05	2.35	44	0.19	40	60	155 13472
	6800	75 × 105	10	19	10.20	3.40	35	0.22	33	50	155 13682
350	330	35 × 60	1.5	2.9	0.69	0.23	370	0.12	313	470	155 15331
	470	35 × 80	2.1	4.0	0.99	0.33	260	0.12	223	335	155 15471
	680	35 × 105	2.9	5.5	1.43	0.48	180	0.12	146	220	155 15681
	1000	50 × 80	3.7	7.0	2.10	0.70	125	0.12	113	170	155 15102
	1500	50 × 105	4.3	8.2	3.15	1.05	120	0.18	106	160	155 15152
	2200	65 × 105	6.5	12.6	4.62	1.54	70	0.18	63	95	155 15222
	3300	65 × 105	7.1	13.5	6.93	2.31	60	0.19	63	95	155 15332
	220	35 × 60	1.0	2.0	0.51	0.17	650	0.15	475	955	155 18221
385	330	35 × 80	1.5	2.9	0.76	0.25	430	0.15	326	635	155 18331
	470	35 × 80	1.8	3.4	1.08	0.36	300	0.15	220	445	155 18471
	680	35 × 105	2.4	4.6	1.57	0.52	210	0.15	150	310	155 18681
	1000	50 × 80	3.4	6.5	2.31	0.77	125	0.15	90	210	155 18102
	1500	50 × 105	4.7	8.9	3.46	1.15	85	0.15	60	140	155 18152
	2200	65 × 105	6.5	12.4	5.08	1.69	58	0.15	40	95	155 18222
	3300	75 × 105	7.6	14.5	7.62	2.54	50	0.15	35	70	155 18332

Aluminium electrolytic capacitors

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 TYP. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	Z TYP. 20 kHz (m Ω)	Z MAX. 20 kHz (m Ω)	CATALOGUE NUMBER (note 1) 2222
400	220	35 × 60	1.0	2.0	0.53	0.18	650	0.15	475	955	155 16221
	330	35 × 80	1.5	2.9	0.79	0.27	430	0.15	320	635	155 16331
	470	35 × 80	1.8	3.4	1.13	0.38	300	0.15	220	445	155 16471
	680	35 × 105	2.4	4.6	1.63	0.54	210	0.15	150	310	155 16681
	1000	50 × 80	3.4	6.5	2.40	0.80	125	0.15	90	210	155 16102
	1500	50 × 105	4.7	8.9	3.60	1.20	85	0.15	60	140	155 16152
	2200	65 × 105	6.5	12.4	5.28	1.76	58	0.15	40	95	155 16222
	3300	75 × 105	7.6	14.5	7.92	2.64	50	0.15	35	70	155 16332

Note

1. Catalogue number applies to the ST version; for STB version (not preferred) replace 8th digit by '5' (2222 154/155 5....).

Additional electrical data

PARAMETER	CONDITIONS	VALUE
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		$U_{rev} \leq 1 V$
Current		
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	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu A$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 35$ mm	typ. 18 nH
	case $\varnothing D = 50$ mm	typ. 25 nH
	case $\varnothing D = 65$ mm	typ. 27 nH
	case $\varnothing D = 75$ mm	typ. 29 nH

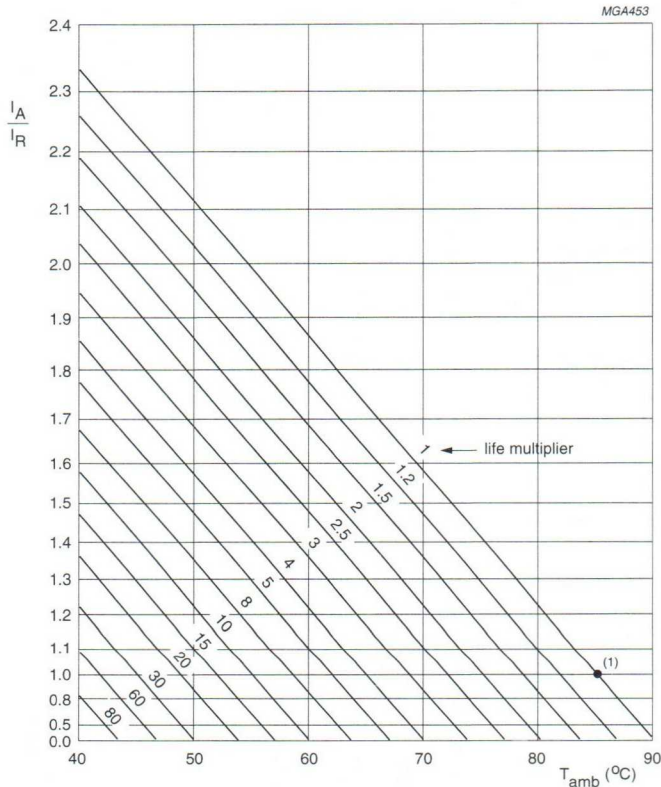
Aluminium electrolytic capacitors
Power Economic Screw Terminals

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RIPPLE CURRENT AND USEFUL LIFE

Table 4 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 $^{\circ}\text{C}$.
 I_R = rated ripple current at 100 Hz and 85 $^{\circ}\text{C}$.
With an absolute maximum of 50 A at 85 $^{\circ}\text{C}$.

(1) Useful life at 85 $^{\circ}\text{C}$ and I_R applied: 12000 hours; (5000 hours for 400 V types).

Fig.3 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Power Economic Screw Terminals

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 5 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 5000 hours (400 V types: 2000 hours)	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 12000 hours (400 V types: 5000 hours)	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 30\%$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100\text{ V}$: $\leq 1\%$; $U_R > 100\text{ V}$: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Aluminium electrolytic capacitors

Power Eurodin Screw Terminals

114/115 PED-ST

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: 20000 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.

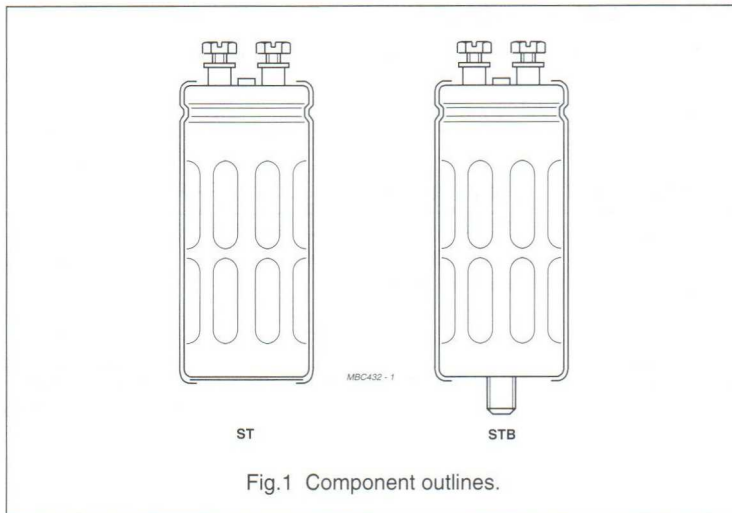
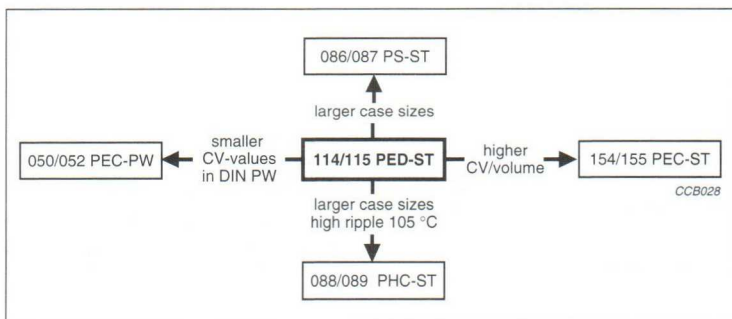


Fig.1 Component outlines.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	114	115
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	35 × 60 to 75 × 105	
Rated capacitance range (E6 series), C_R	150 to 220000 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	20000 hours (400 V: 5000 hours)	
Useful life at 40 °C, $1.4 \times I_R$ applied	350000 hours (400 V: 90000 hours)	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	40/085/56	

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 114 series

Preferred types in **bold**.

C_R (μF)	U_R (V)					
	10	16	25	40	63	100
1000	—	—	—	—	—	35 × 60
1500	—	—	—	—	—	35 × 60
2200	—	—	—	—	35 × 60	35 × 80
3300	—	—	—	35 × 60	35 × 60	35 × 105
4700	—	—	35 × 60	35 × 60	35 × 80	50 × 80
6800	—	—	35 × 60	35 × 80	35 × 105	50 × 105
10000	—	35 × 60	35 × 80	35 × 105	50 × 80	65 × 105
15000	35 × 60	35 × 80	35 × 105	50 × 80	50 × 105	65 × 105
22000	35 × 80	35 × 105	50 × 80	50 × 105	65 × 105	75 × 105
33000	35 × 105	50 × 80	50 × 105	65 × 105	65 × 105	—
47000	50 × 80	50 × 105	65 × 105	65 × 105	75 × 105	—
68000	50 × 105	65 × 105	65 × 105	75 × 105	—	—
100000	65 × 105	65 × 105	75 × 105	—	—	—
150000	65 × 105	75 × 105	—	—	—	—
220000	75 × 105	—	—	—	—	—

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 115 series

Preferred types in **bold**.

C_R (μF)	U_R (V)			
	250	350	385	400
150	—	—	35 × 60	35 × 60
220	—	—	35 × 80	35 × 80
330	35 × 60	—	35 × 105	35 × 105
470	35 × 80	—	50 × 80	50 × 80
680	35 × 105	50 × 80	50 × 105	50 × 105
1000	50 × 80	50 × 105	65 × 105	65 × 105
1500	50 × 105	—	65 × 105	65 × 105
2200	65 × 105	—	75 × 105	75 × 105
3300	65 × 105	75 × 105	—	—
4700	75 × 105	—	—	—

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MECHANICAL DATA AND PACKAGING QUANTITIES

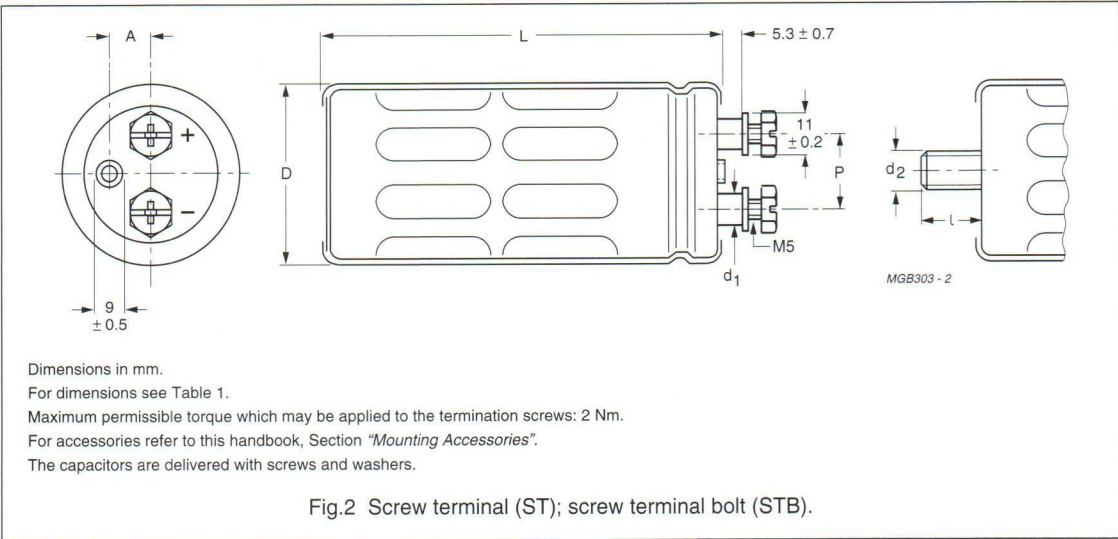


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	ØD _{max} (mm)	L _{max} (mm)	P ±0.1 (mm)	A (mm)	d ₁ ±0.2 (mm)	d ₂ × l	MASS (g)	PACKAGING QUANTITIES (per box)	CARDBOARD BOX DIMENSIONS l × w × h (mm)
35 × 60	36.5	63	13.0	8.4	8.0	M8 × 12	≈55	25	196 × 192 × 110
35 × 80	36.5	83	13.0	8.4	8.0	M8 × 12	≈80	25	196 × 192 × 115
35 × 105	36.5	108	13.0	8.4	8.0	M8 × 12	≈110	25	196 × 192 × 140
50 × 80	51.5	83	22.0	14.3	8.0	M12 × 16	≈160	25	293 × 273 × 115
50 × 105	51.5	108	22.0	14.3	8.0	M12 × 16	≈210	25	293 × 273 × 140
65 × 105	66.5	108	28.5	19.0	9.6	M12 × 16	≈370	10	368 × 151 × 140
75 × 105	76.5	108	32.0	21.0	9.6	M12 × 16	≈535	10	418 × 173 × 140

MARKING

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

- Rated capacitance (in µF)
- Tolerance code on rated capacitance (M for ±20%)
- Rated voltage (in V)
- 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 (last 8 digits)
- Code for basic specification in accordance with "IEC 384-4-1" and "CECC 30301".

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Ordering example

Electrolytic capacitor 114 series

10000 µF/25 V; -10/+30%

Nominal case size: Ø35 × 80 mm; ST version

Catalogue number: 2222 114 16103.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 2 and 3 apply at $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86\text{ to }106\text{ kPa}$, $RH = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
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
Tan δ	max. dissipation factor at 100 Hz

Table 2 Electrical data and ordering information for the **114** series; preferred types in **bold**

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ØD × 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 TYP. 100 Hz (mΩ)	Tan δ MAX. 100 Hz	Z TYP. 20 kHz (mΩ)	Z MAX. 20 kHz (mΩ)	CATALOGUE NUMBER (see Table 3, note 1) 2222
10	15000	35 × 60	6	11.4	0.90	0.30	20	0.32	13	20	114 14153
	22000	35 × 80	7.5	14.2	1.32	0.43	14	0.33	9.5	14	114 14223
	33000	35 × 105	10	19	1.98	0.66	10	0.35	7.5	10	114 14333
	47000	50 × 80	14	26.5	2.82	0.94	7.5	0.36	5.0	9.5	114 14473
	68000	50 × 105	18	34	4.08	1.36	5.5	0.38	4.0	8.0	114 14683
	100000	65 × 105	30	50	6.00	2.00	3.5	0.34	3.0	5.0	114 14104
	150000	65 × 105	30	50	9.00	3.00	3.0	0.45	3.0	5.0	114 14154
	220000	75 × 105	37	50	13.20	4.40	2.0	0.45	2.5	4.0	114 14224
	16	35 × 60	6	11.4	0.96	0.32	22	0.22	13	20	114 15103
		35 × 80	7.5	14.2	1.44	0.40	15	0.23	9.5	14	114 15153
		35 × 105	10	19	2.12	0.71	11	0.25	7.0	10	114 15223
		50 × 80	13	24.6	3.17	1.06	7.5	0.26	5.0	9.5	114 15333
		50 × 105	18	34	4.52	1.51	5.5	0.27	4.0	8.0	114 15473
		65 × 105	28	50	6.53	2.18	3.5	0.24	3.0	5.0	114 15683
		65 × 105	28	50	9.60	3.20	3.0	0.31	3.0	5.0	114 15104
		75 × 105	37	50	14.40	4.80	2.0	0.31	2.5	4.0	114 15154

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 TYP. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	Z TYP. 20 kHz (m Ω)	Z MAX. 20 kHz (m Ω)	CATALOGUE NUMBER (see Table 3, note 1) 2222
25	4700	35 × 60	5.2	10	0.71	0.24	30	0.14	15	23	114 16472
	6800	35 × 60	5.2	10	1.02	0.34	25	0.18	14	21	114 16682
	10000	35 × 80	6.7	12.7	1.50	0.50	18	0.18	10	15	114 16103
	15000	35 × 105	9.7	18.4	2.25	0.75	12	0.19	7.5	11	114 16153
	22000	50 × 80	12.5	23.7	3.30	1.10	8.5	0.19	5.5	9.5	114 16223
	33000	50 × 105	18	34	4.95	1.65	6.0	0.21	4.0	8.0	114 16333
	47000	65 × 105	27	50	7.05	2.35	4.0	0.18	3.0	5.0	114 16473
	68000	65 × 105	27	50	10.20	3.40	3.5	0.23	3.0	5.0	114 16683
	100000	75 × 105	37	50	15.00	5.0	2.5	0.23	2.5	4.0	114 16104
	3300	35 × 60	4.5	8.5	0.80	0.27	37	0.13	21	32	114 17332
40	4700	35 × 60	4.5	8.5	1.13	0.38	35	0.17	22	33	114 17472
	6800	35 × 80	6	11.4	1.64	0.55	25	0.17	15	23	114 17682
	10000	35 × 105	7.5	14.2	2.40	0.80	17	0.18	11	17	114 17103
	15000	50 × 80	10	19	3.60	1.20	11	0.17	7.5	13	114 17153
	22000	50 × 105	15	28.5	5.28	1.76	8.0	0.18	5.5	10.5	114 17223
	33000	65 × 105	21	40	7.92	2.64	5.0	0.16	3.5	6.0	114 17333
	47000	65 × 105	22	42	11.28	3.76	4.5	0.21	3.5	6.0	114 17473
	68000	75 × 105	30	50	16.32	5.44	3.0	0.21	3.0	4.5	114 17683
	2200	35 × 60	3.7	7	0.84	0.28	39	0.09	22	33	114 18222
	3300	35 × 60	3.7	7	1.25	0.42	32	0.11	20	30	114 18332
63	4700	35 × 80	5.2	10	1.78	0.66	23	0.11	14	21	114 18472
	6800	35 × 105	7.5	14.2	2.57	0.86	17	0.11	10	15	114 18682
	10000	50 × 80	9.5	18	3.78	1.26	12	0.12	7.5	14	114 18103
	15000	50 × 105	13.5	25.6	5.67	1.89	8.5	0.13	5.5	10.5	114 18153
	22000	65 × 105	21	40	8.32	2.77	5.0	0.11	3.5	6.0	114 18223
	33000	65 × 105	22	42	12.48	4.16	4.5	0.14	3.5	6.0	114 18333
	47000	75 × 105	30	50	17.77	5.92	3.0	0.14	3.0	4.5	114 18473
	2200	35 × 60	3.7	7	0.84	0.28	39	0.09	22	33	114 18222
	3300	35 × 60	3.7	7	1.25	0.42	32	0.11	20	30	114 18332
	4700	35 × 80	5.2	10	1.78	0.66	23	0.11	14	21	114 18472

Aluminium electrolytic capacitors

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 TYP. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	Z TYP. 20 kHz (m Ω)	Z MAX. 20 kHz (m Ω)	CATALOGUE NUMBER (see Table 3, note 1) 2222
100	1000	35 × 60	3.0	5.7	0.60	0.20	85	0.09	45	67	114 19102
	1500	35 × 60	3.3	6.3	0.90	0.30	65	0.10	40	60	114 19152
	2200	35 × 80	4.6	8.7	1.32	0.41	45	0.10	28	42	114 19222
	3300	35 × 105	6.5	12.3	1.98	0.66	30	0.10	19	28	114 19332
	4700	50 × 80	7.4	14.0	2.82	0.94	27	0.11	17	25	114 19472
	6800	50 × 105	9.9	18.8	4.08	1.36	19	0.11	12	18	114 19682
	10000	65 × 105	15.0	28.5	6.00	2.00	11	0.11	7	11	114 19103
	15000	65 × 105	15.8	30.0	9.00	3.00	10	0.12	6	10	114 19153
	22000	75 × 105	20.5	38.9	13.20	4.40	7	0.12	5	8	114 19223

Table 3 Electrical data and ordering information for the 115 series; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 TYP. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	Z TYP. 20 kHz (m Ω)	Z MAX. 20 kHz (m Ω)	CATALOGUE NUMBER (see note 1) 2222
250	330	35 × 60	1.8	3.4	0.50	0.17	300	0.15	275	500	115 13331
	470	35 × 80	2.5	4.7	0.71	0.24	250	0.15	140	375	115 13471
	680	35 × 105	3.5	6.6	1.02	0.34	180	0.15	125	300	115 13681
	1000	50 × 80	4.2	8	1.50	0.50	110	0.15	60	130	115 13102
	1500	50 × 105	6.3	12	2.25	0.75	60	0.15	40	100	115 13152
	2200	65 × 105	8.8	16.7	3.30	1.10	45	0.15	30	60	115 13222
	3300	65 × 105	10.5	20	4.95	1.65	30	0.15	25	50	115 13332
	4700	75 × 105	14	26.5	7.05	2.35	25	0.15	20	40	115 13472
	680	50 × 80	3.9	7.0	1.47	0.48	140	0.10	60	130	115 15681
	1000	50 × 105	5.4	9.7	2.14	0.71	65	0.10	50	100	115 15102
350	3300	75 × 105	10.8	19.4	6.93	2.31	30	0.12	20	45	115 15332

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U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (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 TYP. 100 Hz (m Ω)	Tan δ MAX. 100 Hz	Z TYP. 20 kHz (m Ω)	Z MAX. 20 kHz (m Ω)	CATALOGUE NUMBER (see note 1) 2222
385	150	35 × 60	1.0	1.8	0.34	0.12	730	0.12	450	935	115 18151
	220	35 × 80	1.4	2.6	0.50	0.17	520	0.12	310	630	115 18221
	330	35 × 105	1.9	3.6	0.75	0.25	340	0.12	210	425	115 18331
	470	50 × 80	2.7	5.1	1.06	0.36	200	0.12	140	300	115 18471
	680	50 × 105	3.6	6.9	1.53	0.51	140	0.12	100	205	115 18681
	1000	65 × 105	5.1	9.7	2.25	0.75	95	0.12	65	125	115 18102
	1500	65 × 105	5.7	10.6	3.38	1.13	80	0.12	45	95	115 18152
	2200	75 × 105	7.3	13.8	4.95	1.65	55	0.12	40	75	115 18222
	150	35 × 60	1.0	1.8	0.36	0.12	730	0.12	450	935	115 16151
	220	35 × 80	1.4	2.6	0.53	0.18	520	0.12	310	630	115 16221
400	330	35 × 105	1.9	3.6	0.79	0.26	340	0.12	210	425	115 16331
	470	50 × 80	2.7	5.1	1.13	0.38	200	0.12	140	300	115 16471
	680	50 × 105	3.6	6.9	1.63	0.54	140	0.12	100	205	115 16681
	1000	65 × 105	5.1	9.7	2.40	0.80	95	0.12	65	125	115 16102
	1500	65 × 105	5.7	10.6	3.60	1.20	80	0.12	45	95	115 16152
	2200	75 × 105	7.3	13.8	5.28	1.76	55	0.12	40	75	115 16222

Note

1. Catalogue number applies to the ST version; for STB version (not preferred) replace 8th digit by '5' (2222 114/115 5....).

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Additional electrical data

PARAMETER	CONDITIONS	VALUE
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		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006C_R \times U_R + 4 \text{ }\mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \text{ }\mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case ØD = 35 mm	typ. 13 nH
	case ØD = 50 mm	typ. 16 nH
	case ØD = 65 mm	typ. 19 nH
	case ØD = 75 mm	typ. 20 nH

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Equivalent series resistance (ESR)

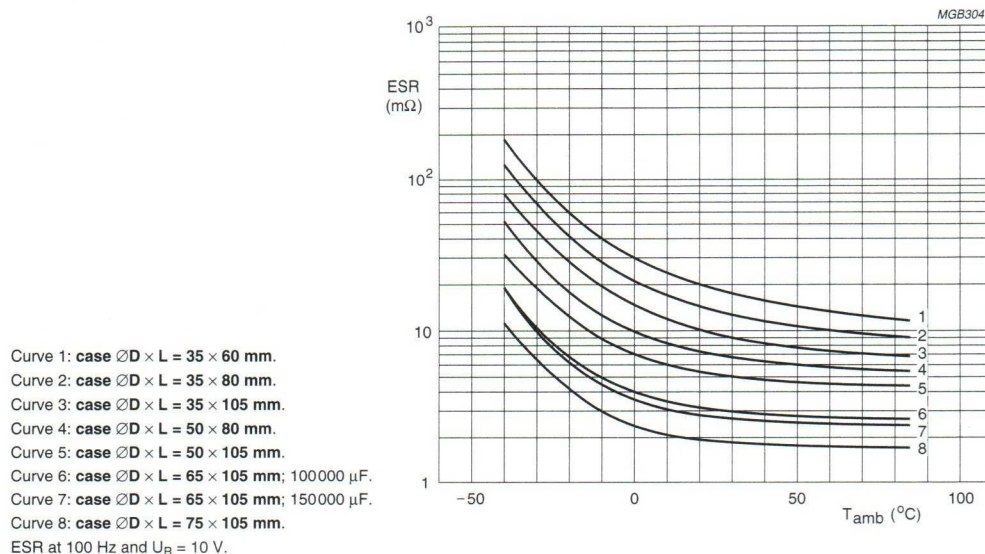


Fig.3 Typical ESR as a function of temperature.

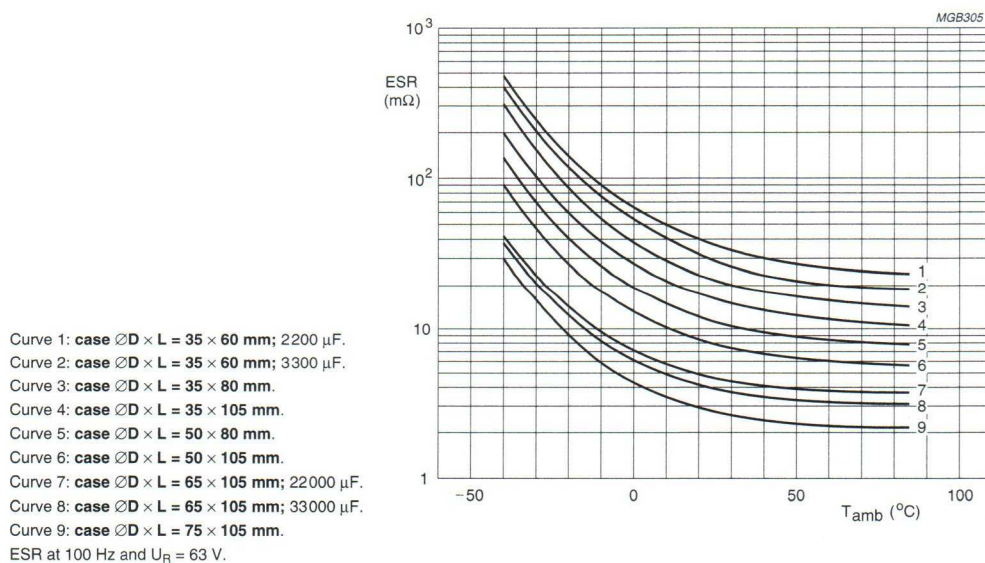
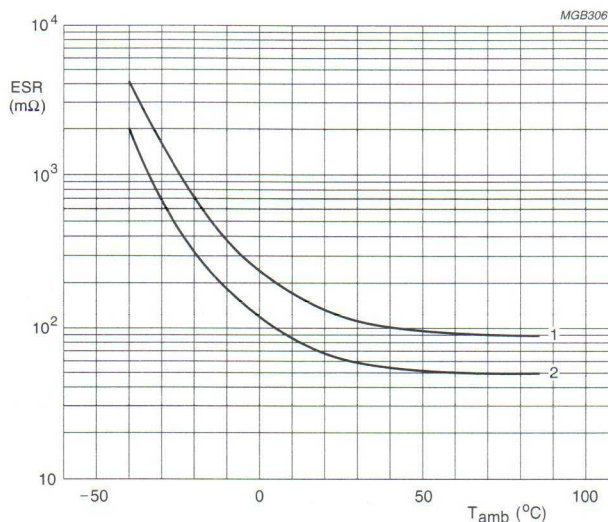


Fig.4 Typical ESR as a function of temperature.

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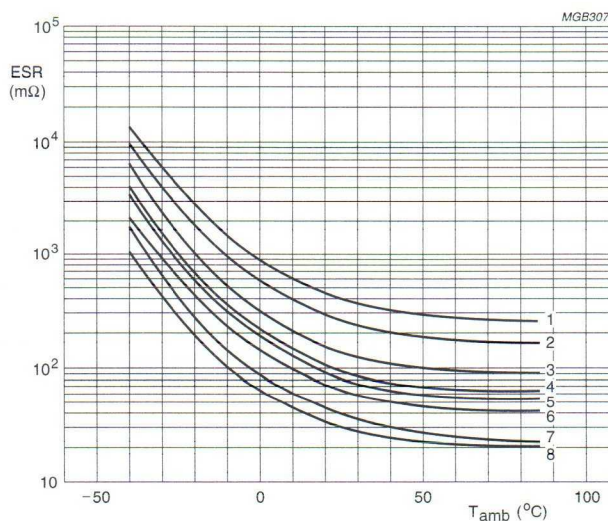
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Curve 1: case $\varnothing D \times L = 50 \times 80$ mm.
 Curve 2: case $\varnothing D \times L = 50 \times 105$ mm.
 ESR at 100 Hz and $U_R = 250$ V.

Fig.5 Typical ESR as a function of temperature.



Curve 1: case $\varnothing D \times L = 35 \times 60$ mm.
 Curve 2: case $\varnothing D \times L = 35 \times 80$ mm.
 Curve 3: case $\varnothing D \times L = 35 \times 105$ mm.
 Curve 4: case $\varnothing D \times L = 50 \times 80$ mm.
 Curve 5: case $\varnothing D \times L = 50 \times 105$ mm.
 Curve 6: case $\varnothing D \times L = 65 \times 105$ mm; 1000 μ F.
 Curve 7: case $\varnothing D \times L = 65 \times 105$ mm; 1500 μ F.
 Curve 8: case $\varnothing D \times L = 75 \times 105$ mm.
 ESR at 100 Hz and $U_R = 385$ V.

Fig.6 Typical ESR as a function of temperature.

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Impedance (Z)

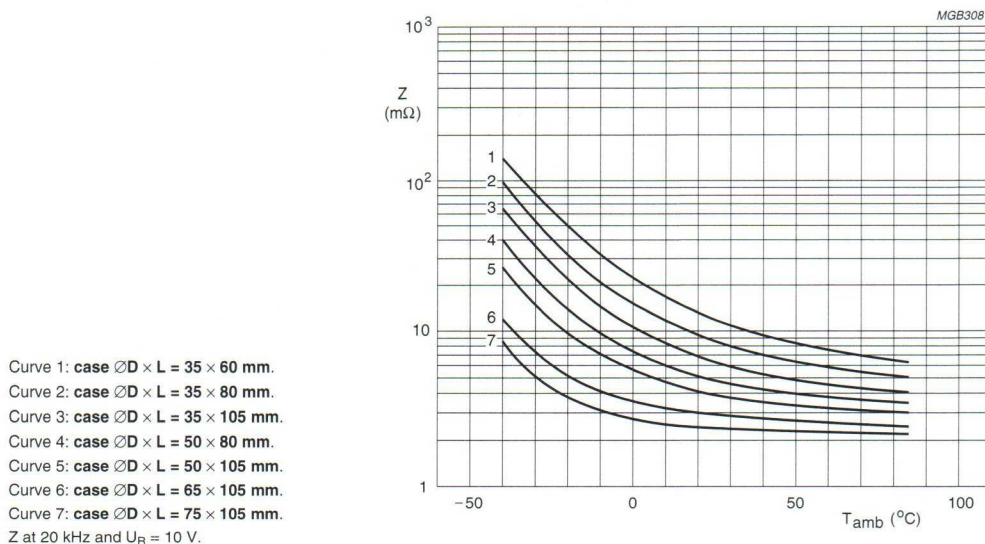


Fig.7 Typical impedance as a function of temperature.

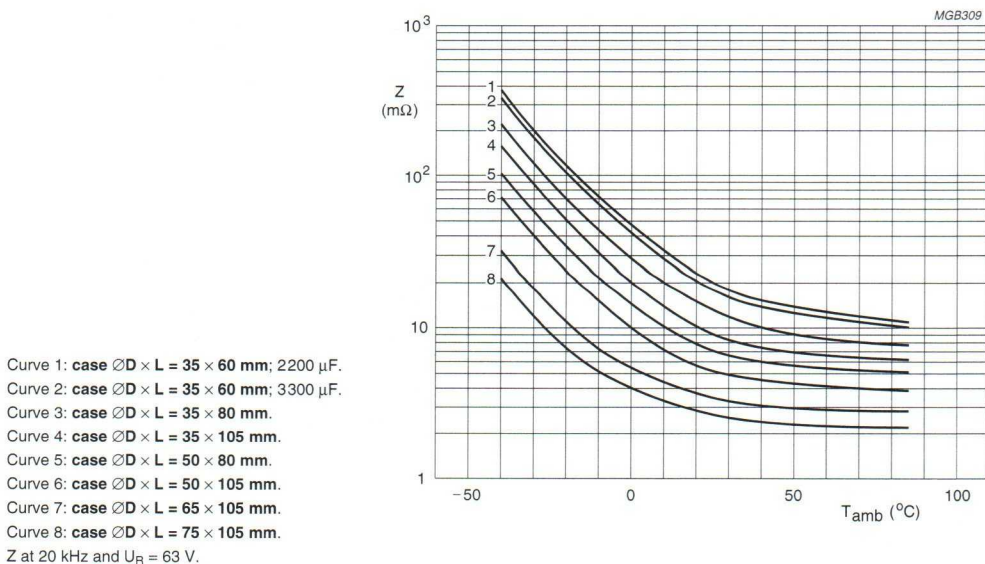


Fig.8 Typical impedance as a function of temperature.

Aluminium electrolytic capacitors

Power Eurodin Screw Terminals

114/115 PED-ST

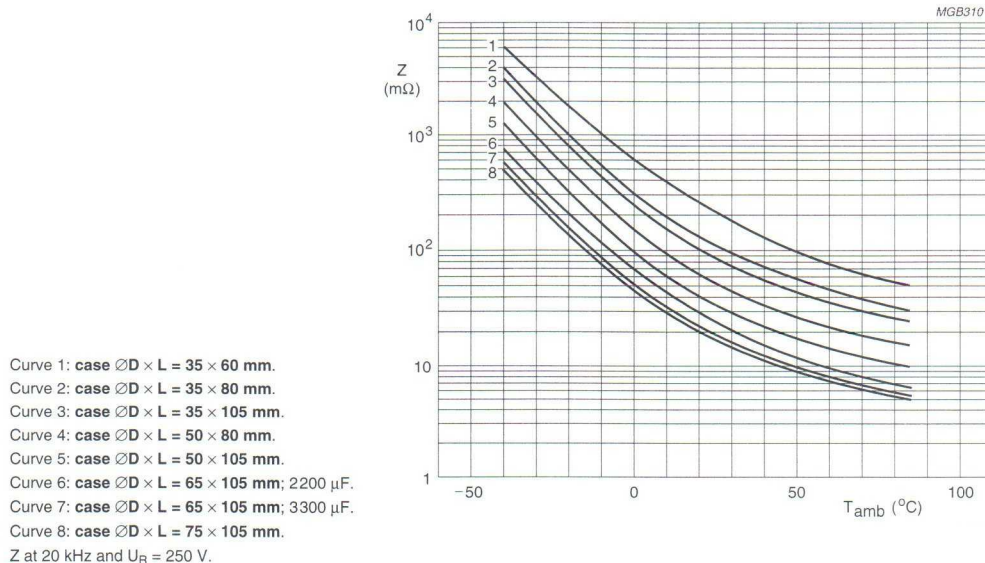


Fig.9 Typical impedance as a function of temperature.

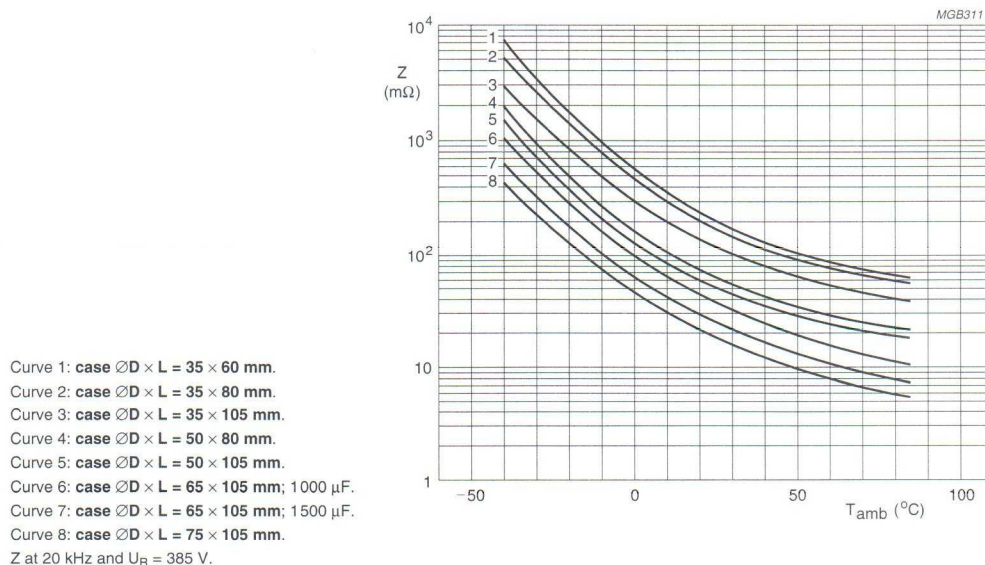
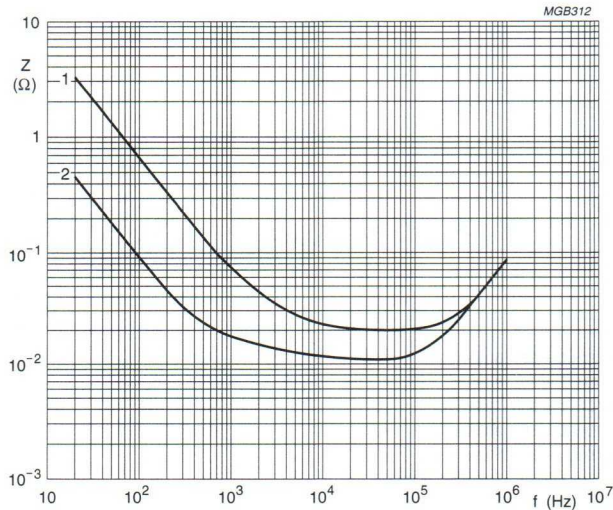


Fig.10 Typical impedance as a function of temperature.

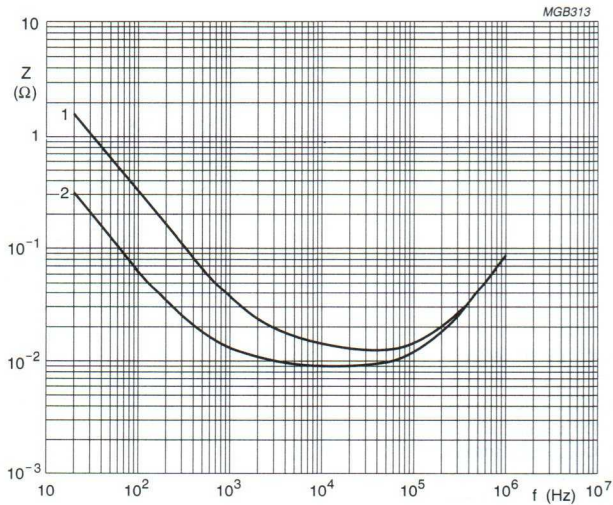
Aluminium electrolytic capacitors
Power Eurodin Screw Terminals

114/115 PED-ST



Curve 1: 2200 μF , 63 V.
Curve 2: 15000 μF , 10 V.
Case $\varnothing D \times L = 35 \times 60 \text{ mm}$.
 $T_{\text{amb}} = 20^\circ\text{C}$.

Fig.11 Typical impedance as a function of frequency.

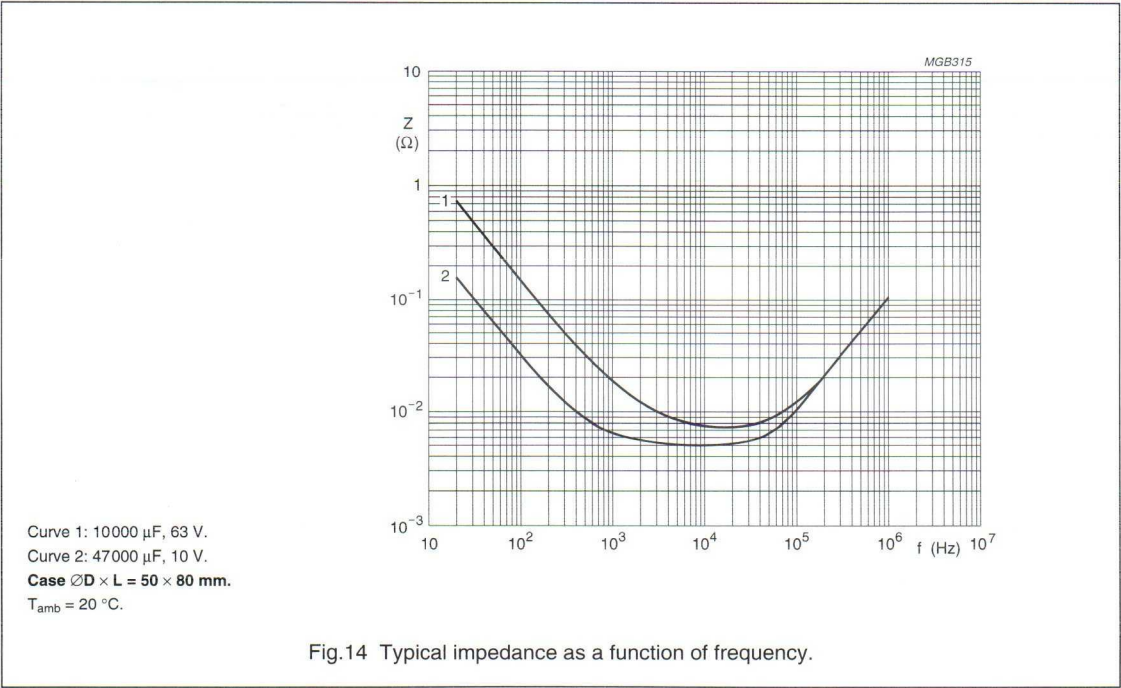
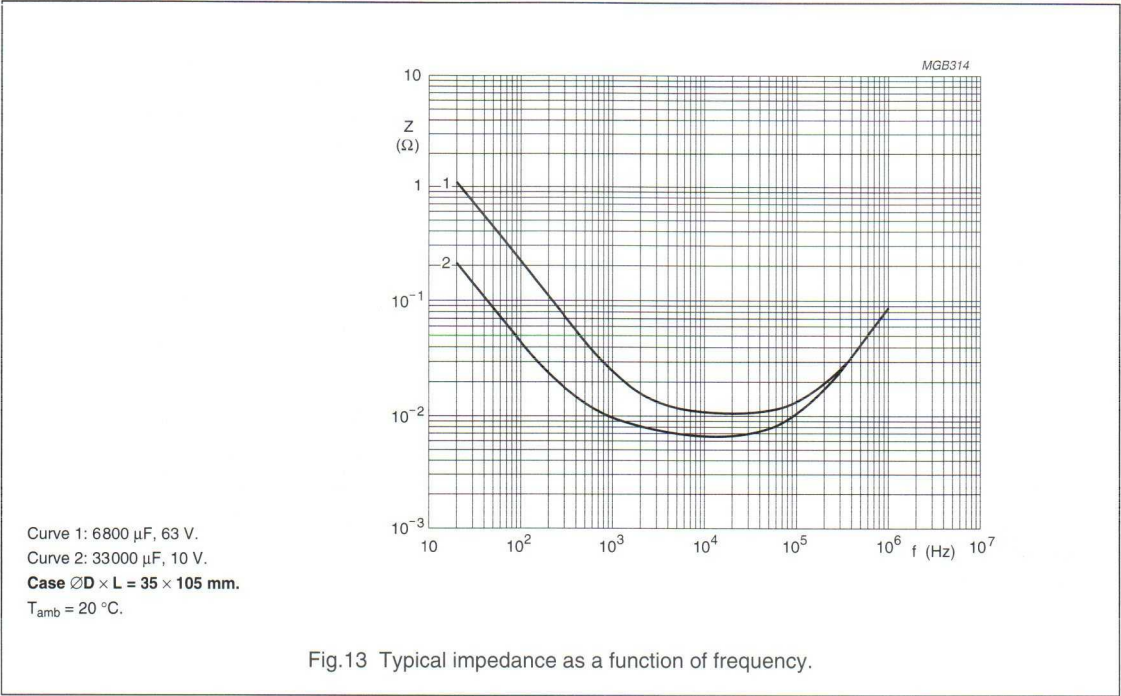


Curve 1: 4700 μF , 63 V.
Curve 2: 22000 μF , 10 V.
Case $\varnothing D \times L = 35 \times 80 \text{ mm}$.
 $T_{\text{amb}} = 20^\circ\text{C}$.

Fig.12 Typical impedance as a function of frequency.

Aluminium electrolytic capacitors
Power Eurodin Screw Terminals

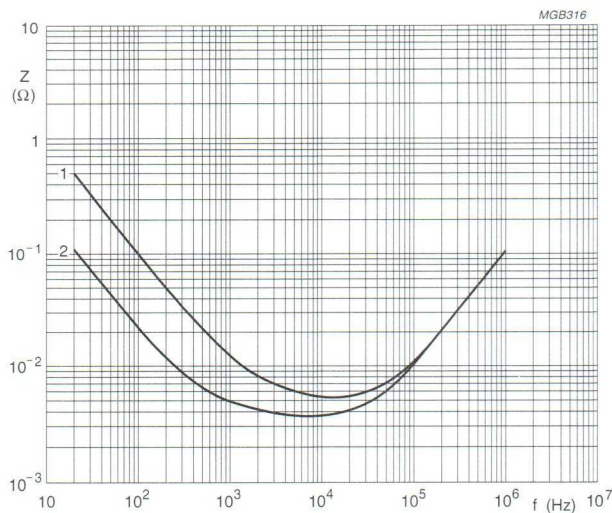
114/115 PED-ST



Aluminium electrolytic capacitors

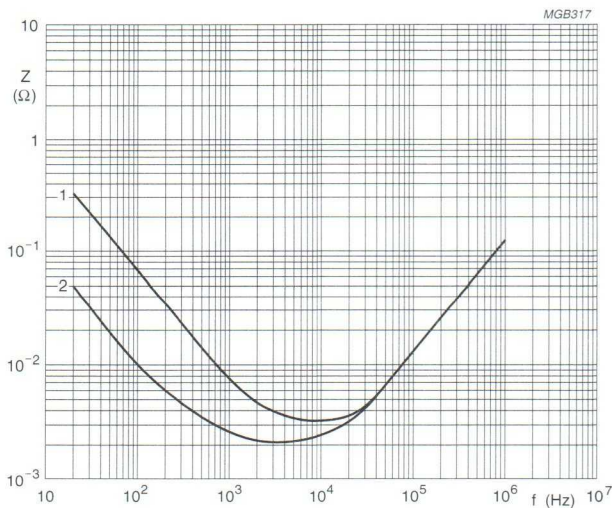
Power Eurodin Screw Terminals

114/115 PED-ST



Curve 1: 15000 μ F, 63 V.
 Curve 2: 68000 μ F, 10 V.
Case $\varnothing D \times L = 50 \times 105$ mm.
 $T_{amb} = 20$ °C.

Fig.15 Typical impedance as a function of frequency.



Curve 1: 22000 μ F, 63 V.
 Curve 2: 150000 μ F, 10 V.
Case $\varnothing D \times L = 65 \times 105$ mm.
 $T_{amb} = 20$ °C.

Fig.16 Typical impedance as a function of frequency.

Aluminium electrolytic capacitors

Power Eurodin Screw Terminals

114/115 PED-ST

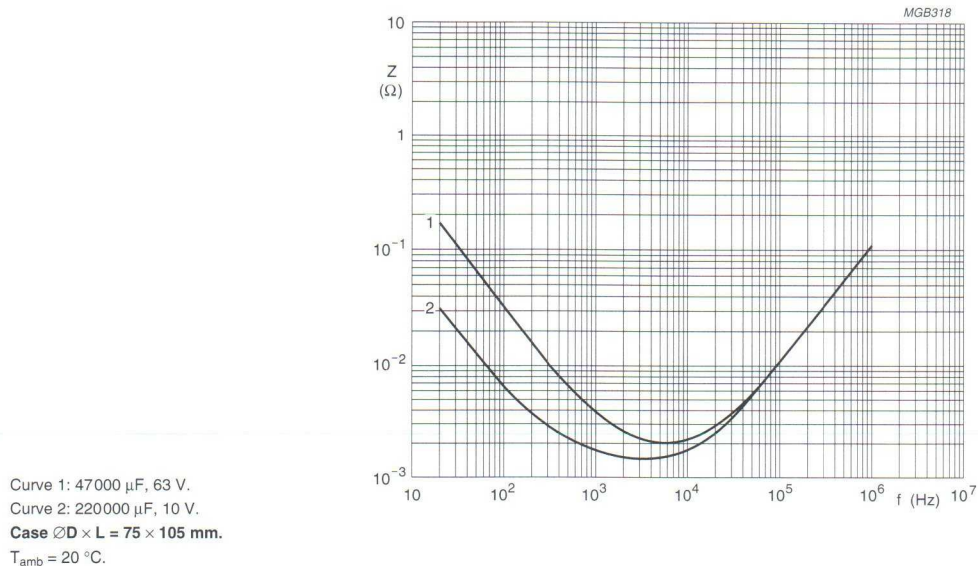


Fig.17 Typical impedance as a function of frequency.

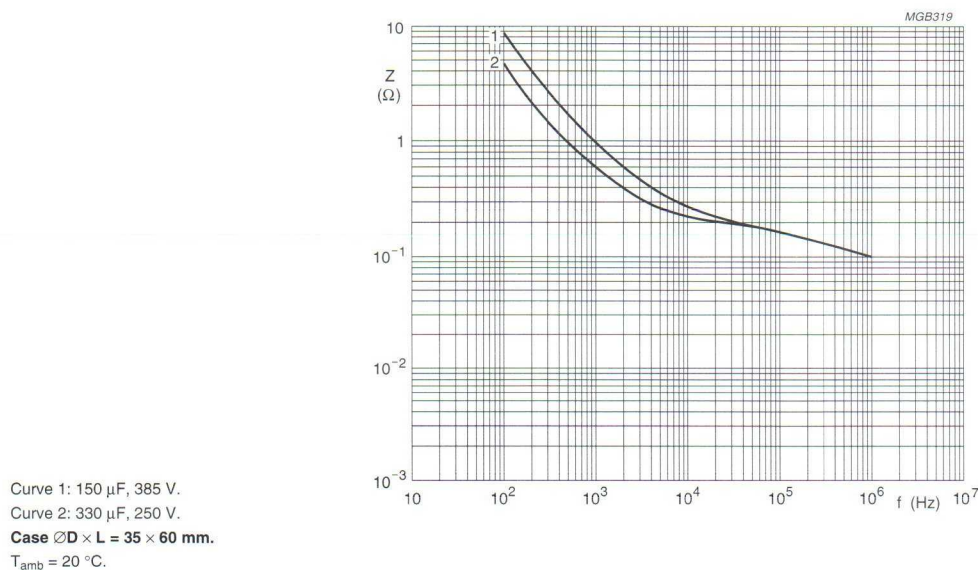
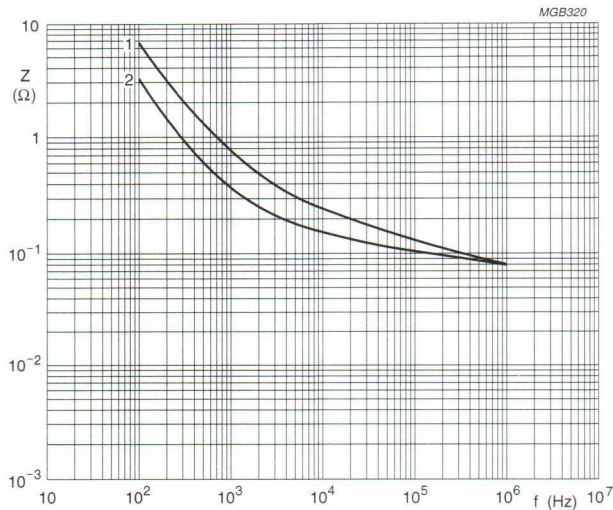


Fig.18 Typical impedance as a function of frequency.

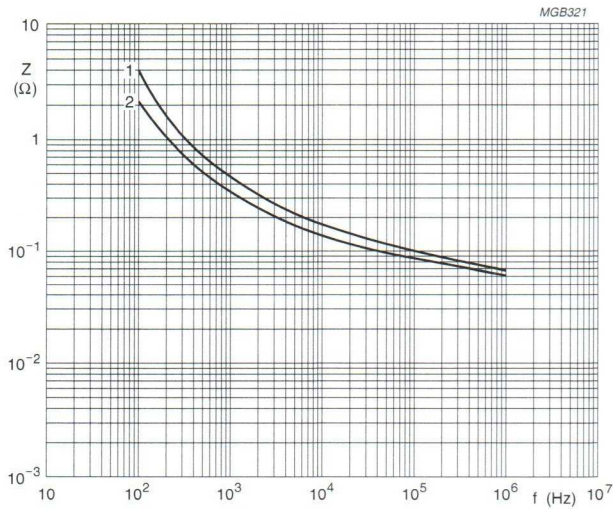
Aluminium electrolytic capacitors Power Eurodin Screw Terminals

114/115 PED-ST



Curve 1: 220 μ F, 385 V.
Curve 2: 470 μ F, 250 V.
Case $\varnothing D \times L = 35 \times 80$ mm.
 $T_{amb} = 20$ °C.

Fig.19 Typical impedance as a function of frequency.



Curve 1: 330 μ F, 385 V.
Curve 2: 680 μ F, 250 V.
Case $\varnothing D \times L = 35 \times 105$ mm.
 $T_{amb} = 20$ °C.

Fig.20 Typical impedance as a function of frequency.

Aluminium electrolytic capacitors

Power Eurodin Screw Terminals

114/115 PED-ST

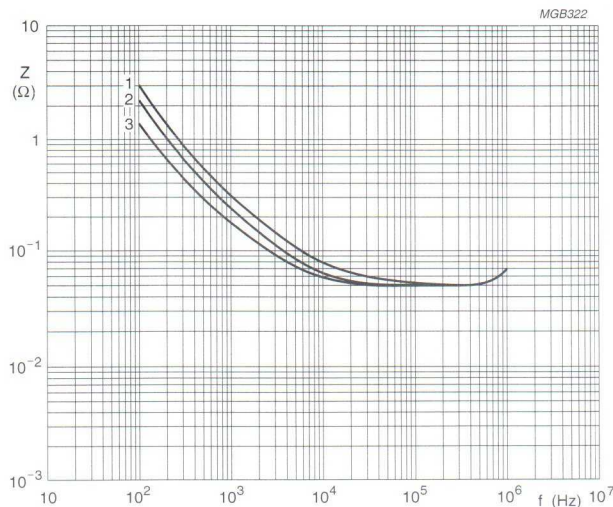
Curve 1: 470 μ F, 385 V.Curve 2: 1000 μ F, 250 V.Curve 3: 680 μ F, 350 V.**Case** $\varnothing D \times L = 50 \times 80$ mm. $T_{amb} = 20$ °C.

Fig.21 Typical impedance as a function of frequency.

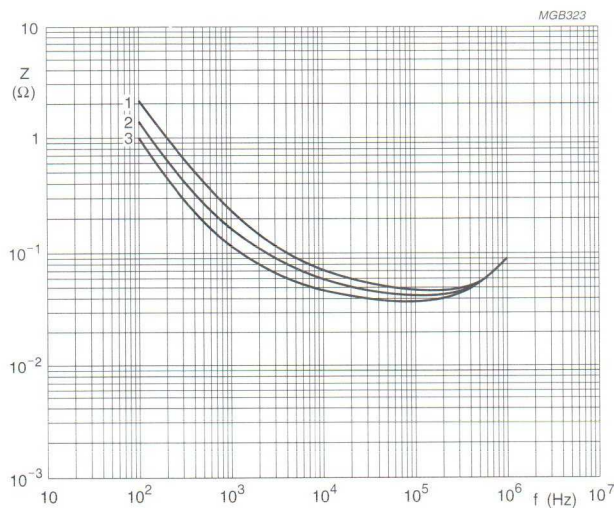
Curve 1: 680 μ F, 385 V.Curve 2: 1000 μ F, 350 V.Curve 3: 1500 μ F, 250 V.**Case** $\varnothing D \times L = 50 \times 105$ mm. $T_{amb} = 20$ °C.

Fig.22 Typical impedance as a function of frequency.

Aluminium electrolytic capacitors

Power Eurodin Screw Terminals

114/115 PED-ST

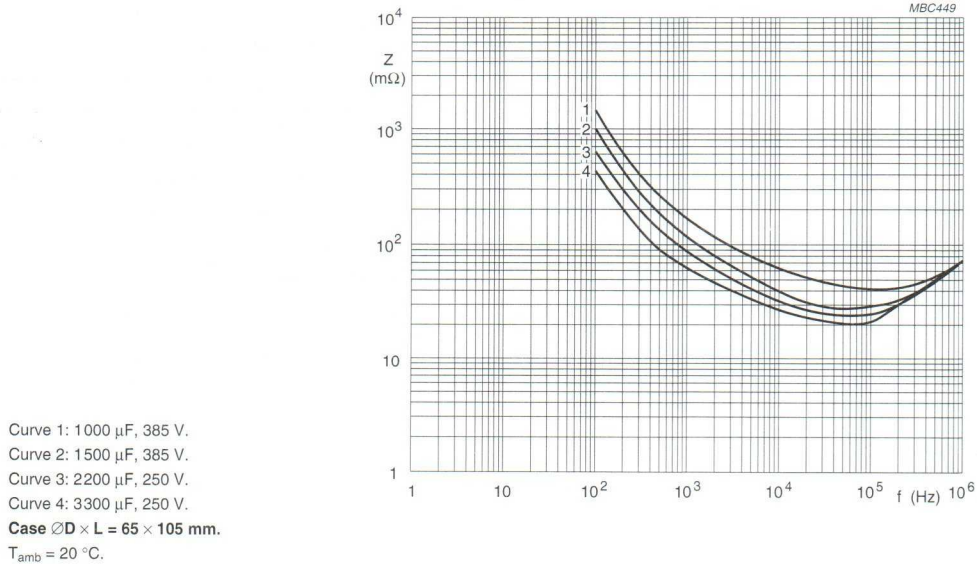


Fig.23 Typical impedance as a function of frequency.

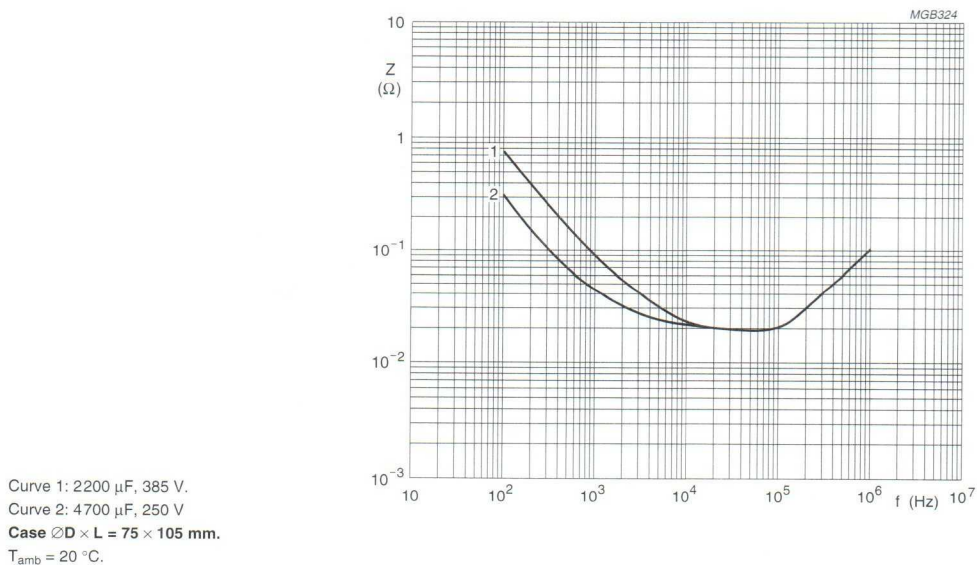


Fig.24 Typical impedance as a function of frequency.

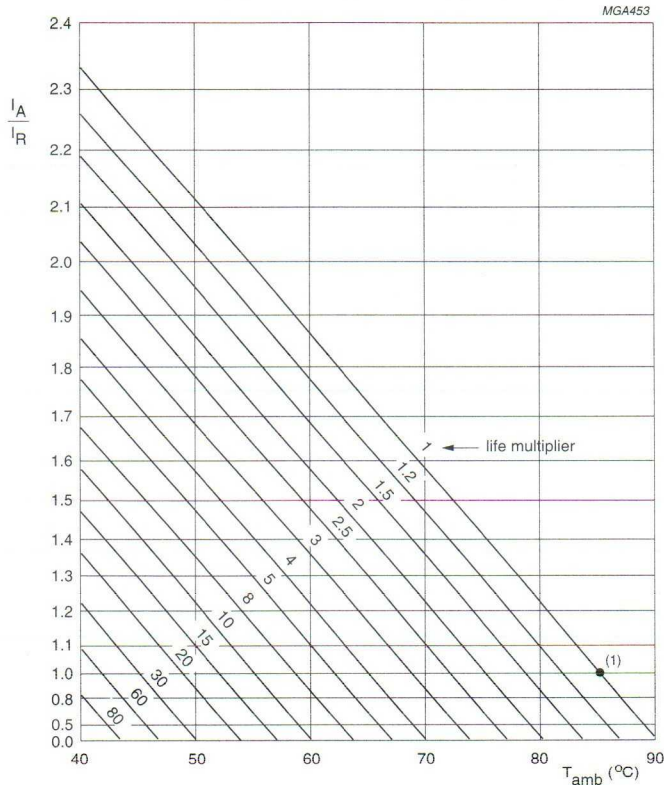
Aluminium electrolytic capacitors
Power Eurodin Screw Terminals

114/115 PED-ST

RIPPLE CURRENT AND USEFUL LIFE

Table 4 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
1 000	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 at 85 °C

(1) Useful life at 85 °C and I_R applied: 20000 hours (5000 hours for 400 V types).

Fig.25 Multiplier of useful life as a function of ambient temperature and ripple current load.

Aluminium electrolytic capacitors

Power Eurodin Screw Terminals

114/115 PED-ST

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 5 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 8000 hours (400 V types: 2000 hours)	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 20000 hours (400 V types: 5000 hours)	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 30\%$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100\text{ V}$: $\leq 1\%$; $U_R > 100\text{ V}$: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$: $\pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Electrolytic capacitors

Mounting accessories

MECHANICAL DATA

Clamps for ST-types:

086/087 PS-ST; 088/089 PHC-ST

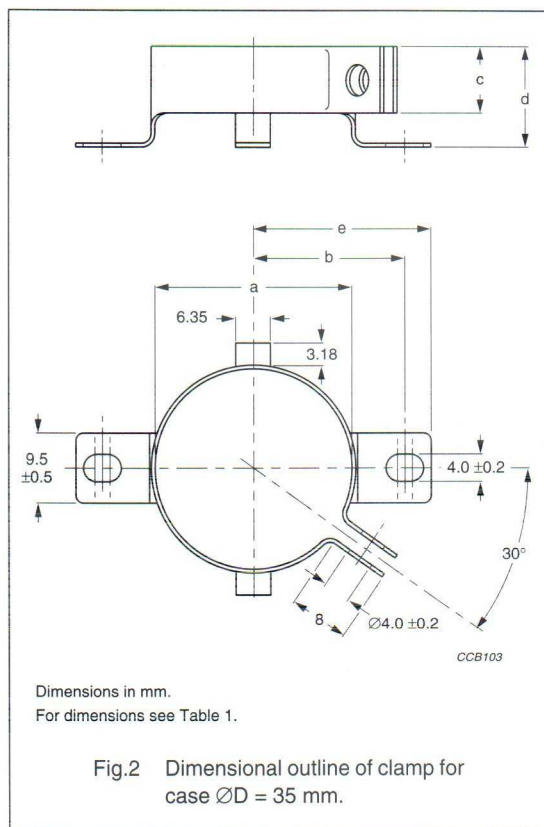
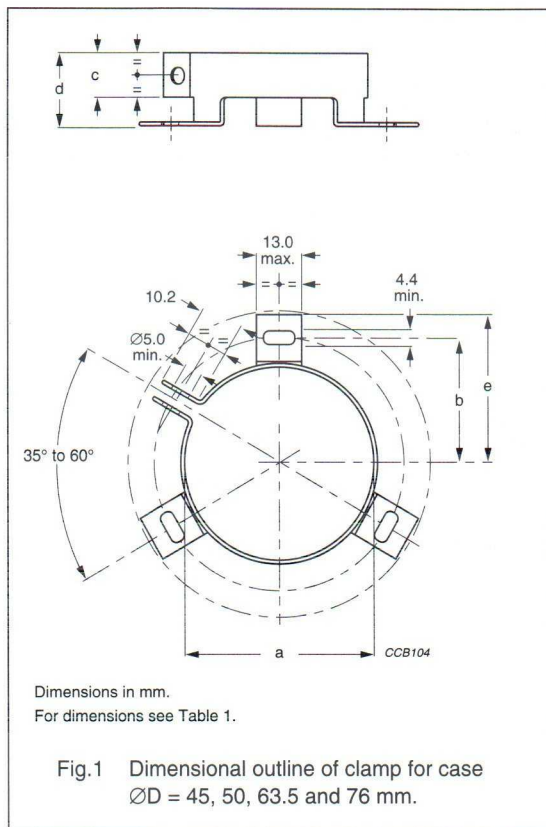
To facilitate vertical mounting, a series of rigid clamps made of zinc plated steel are available.

The clamps have either two or three mounting lugs, may be easily slipped over the capacitor and then clamped with

a nut and bolt. Five types of clamps are available, one for each case diameter.

They are delivered without nuts or bolts.

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

**Table 1** Clamp dimensions; see Figs 1 and 2

CASE DIAMETER (mm)	a (mm)	b (mm)	c (mm)	d (mm)	e (mm)	CATALOGUE NUMBER
35	34.92 ±0.13	23.01 ±0.79	14.25 ±0.40	19.05 ±0.79	29.36 ±0.79	4322 043 17521
45	44.45 ±0.13	28.57 ±0.79	19.05 ±0.40	28.57 ±0.79	33.35 ±0.79	4322 043 17481
50	50.80 ±0.13	31.75 ±0.79	19.05 ±0.40	28.57 ±0.79	36.51 ±0.79	4322 043 17491
63.5	63.50 ±0.13	38.10 ±0.79	19.05 ±0.40	28.57 ±0.79	42.87 ±0.79	4322 043 17501
76	76.20 ±0.13	44.45 ±0.79	19.05 ±0.40	28.57 ±0.79	49.22 ±0.79	4322 043 17511

Electrolytic capacitors

Mounting accessories

Clamps for ST types:**154/155 PEC-ST; 114/115 PED-ST**

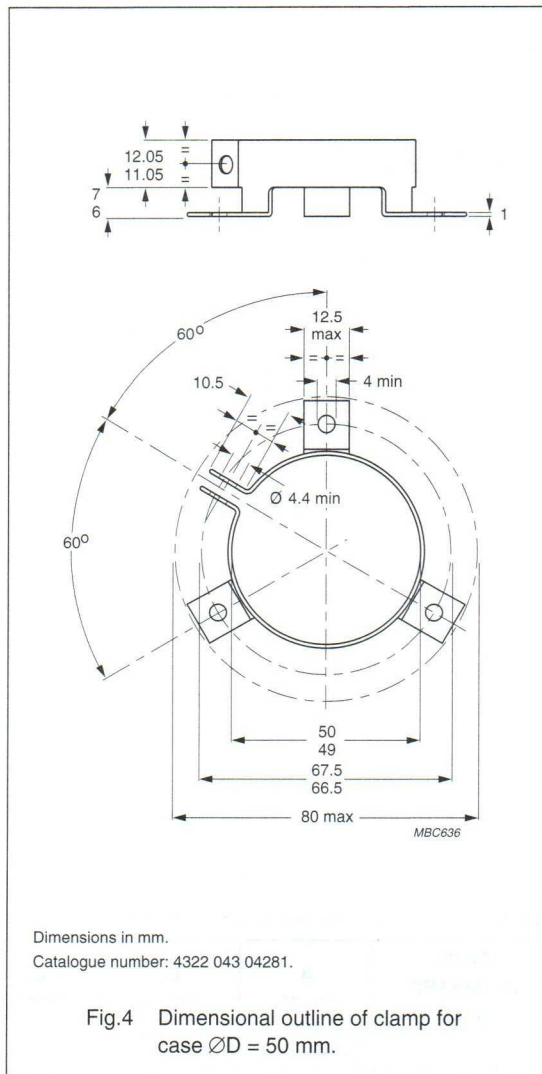
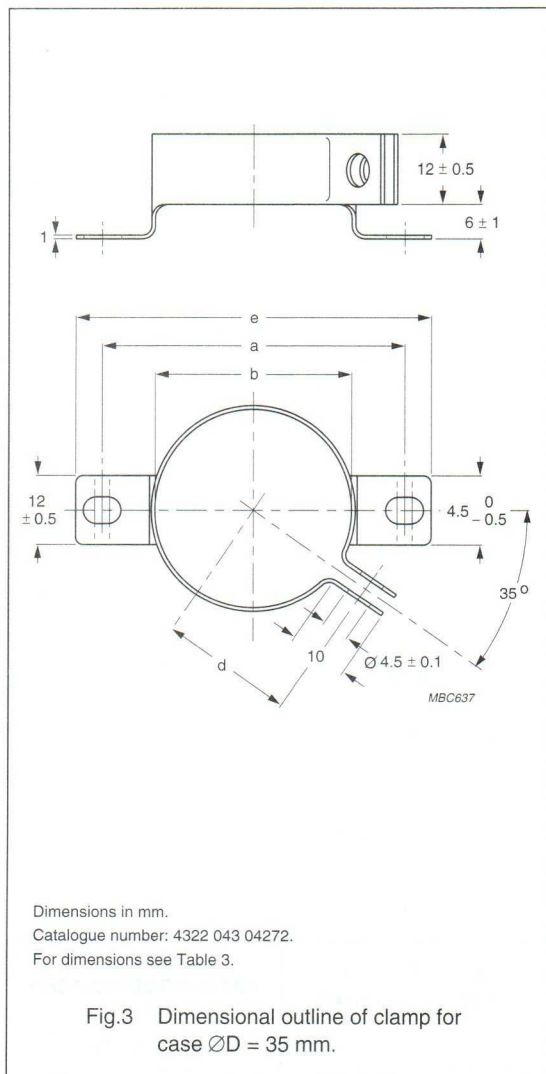
To facilitate vertical mounting, a series of rigid clamps made of zinc plated steel are available.

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.

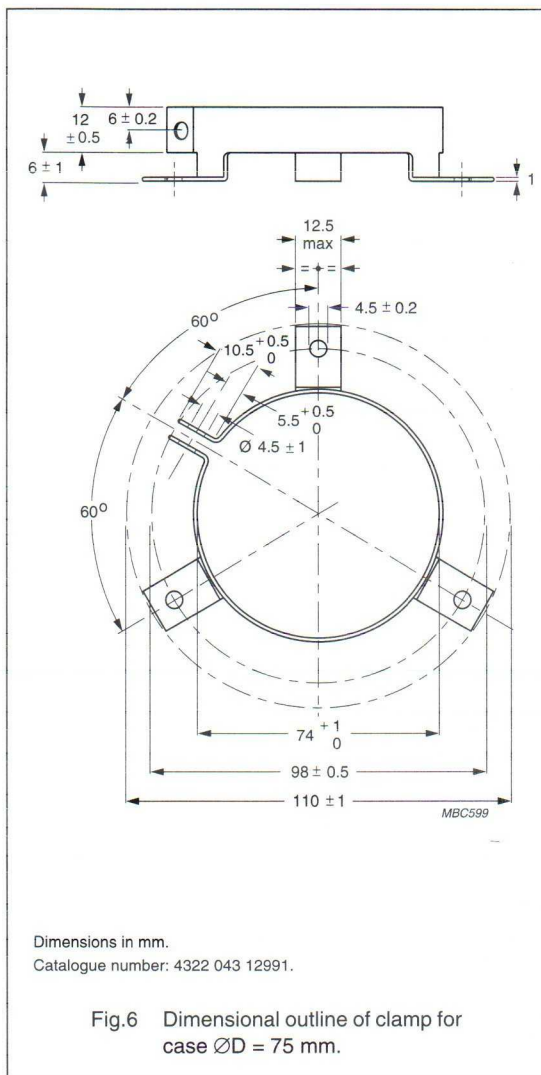
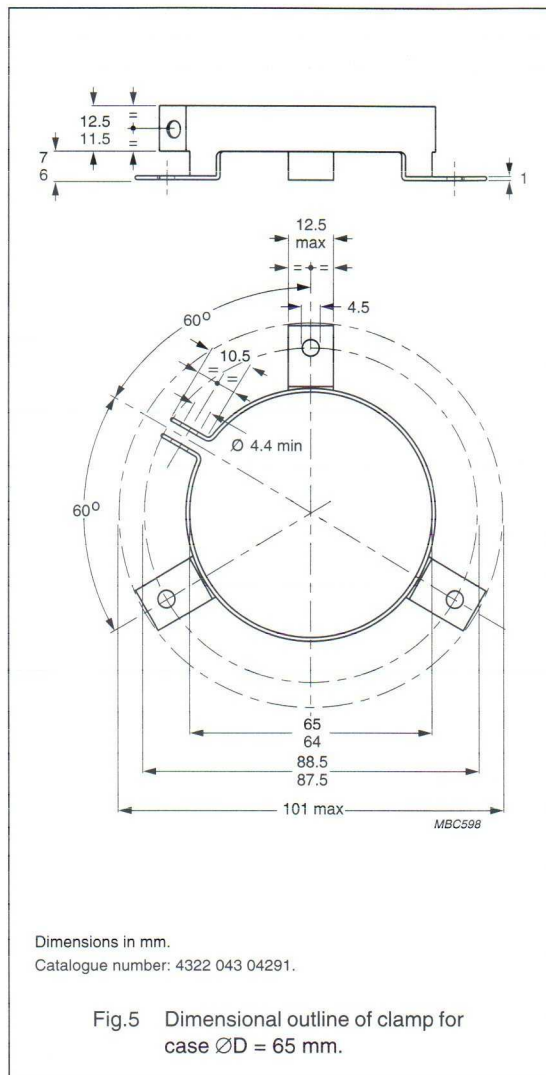
They are delivered without nuts or bolts.

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



Electrolytic capacitors

Mounting accessories



Electrolytic capacitors

Mounting accessories

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 4 Nm for M8 nuts and 10 Nm for M12 nuts.

If insulated mounting is required, synthetic nuts and rubber washers are available; for these nuts the maximum permissible torque is 2 Nm (M8) and 4 Nm (M12).

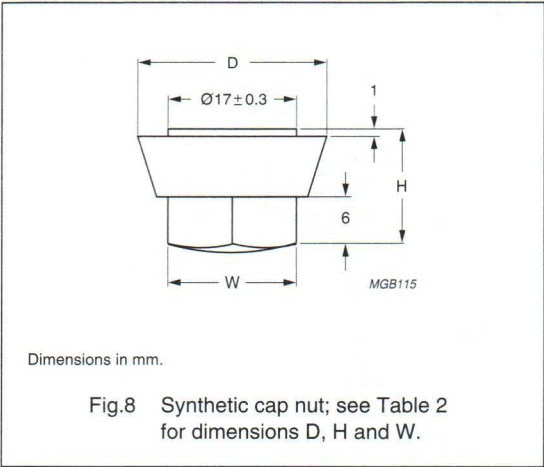
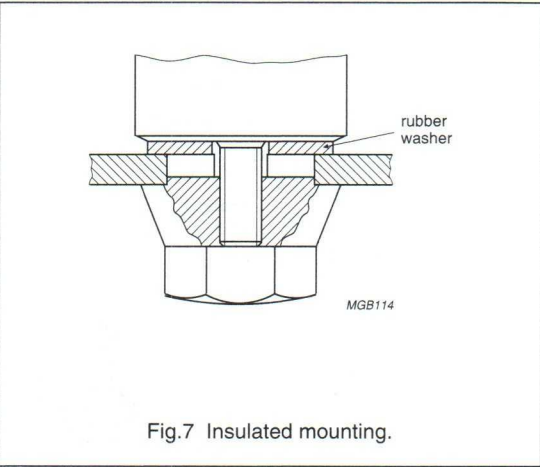
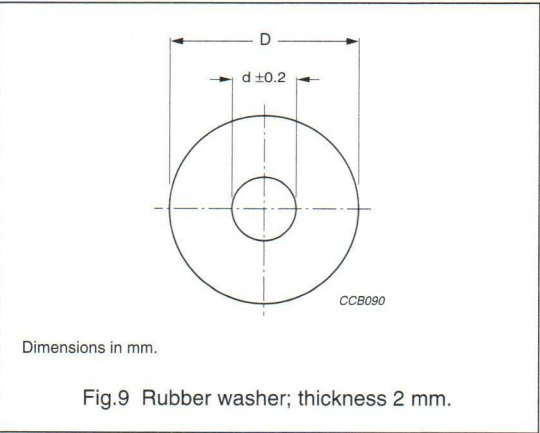


Table 2 Dimensions of synthetic cap nut; see Fig.8

CASE DIAMETER (mm)	THREAD	D (mm)	H (mm)	W ⁽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.



Rubber washer ordering codes

D (mm)	d (mm)	CATALOGUE NUMBER
34	8.4	4322 043 05591
49	13.0	4322 043 05531
64	13.0	4322 043 05521
74	13.0	4322 043 13001

Electrolytic capacitors

Mounting accessories

Clamps for SL-versions, ØD = 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.

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

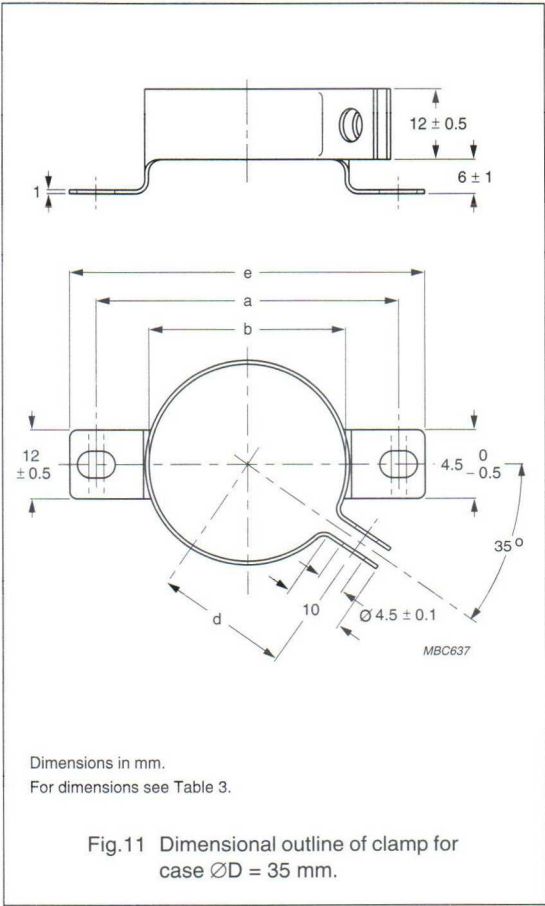
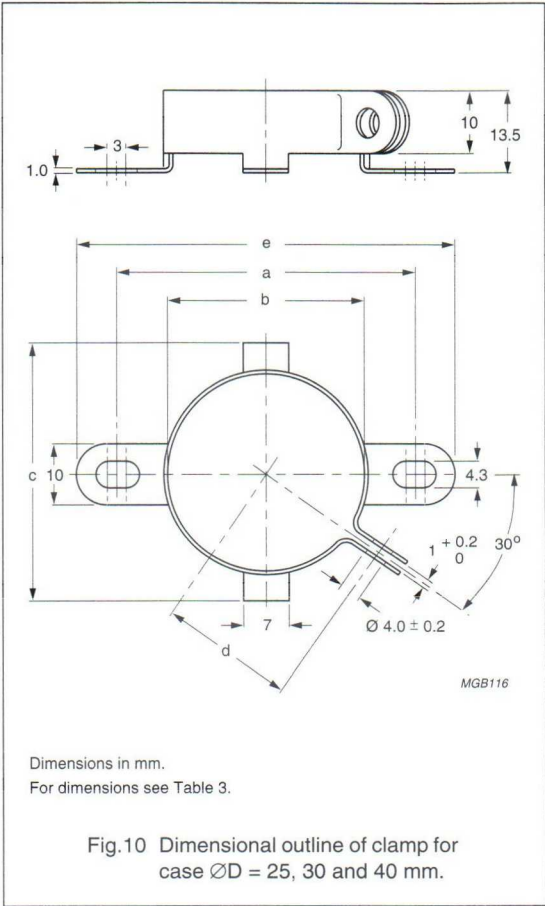
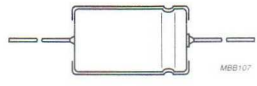


Table 3 Clamp dimensions; see Figs 3, 10 and 11

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

SOLID ALUMINIUM (SAL) ELECTROLYTIC CAPACITORS

		PROFESSIONAL 20 000 hours / 125 °C	
RADIAL (pearl)		SAL- RPM128 H: 9 mm page 560	SAL- RP122 H: 12 mm page 579
AXIAL		SAL- A123 page 597	

MBB742 - 2

Solid Aluminium electrolytic capacitors

Solid Al, Radial Pearl Miniature

128 SAL-RPM

FEATURES

- Polarized aluminium electrolytic capacitors, solid electrolyte MnO_2
- Radial leads, max. height 9.5 mm, resin dipped, orange coloured
- Extremely long useful life, 20000 hours/125 °C
- Extended usable temperature range up to 175 °C
- Excellent low temperature, impedance and ESR behaviour
- Charge and discharge proof, application with 0 Ω resistance allowed
- Reverse DC voltage up to $0.3 \times U_R$ allowed
- AC voltage up to $0.8 \times U_R$ allowed
- Advanced technology to achieve high reliability and high stability.

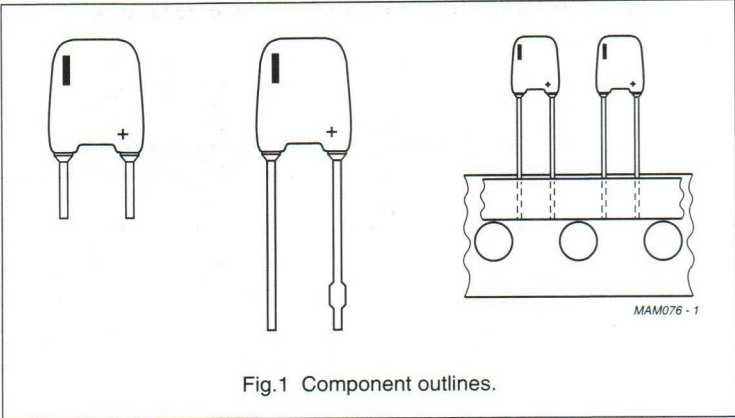
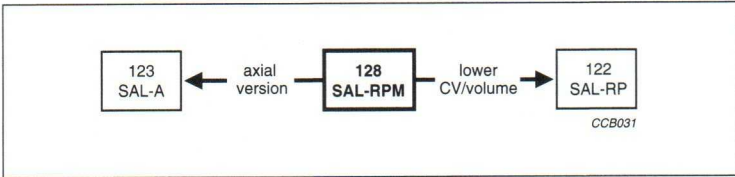


Fig.1 Component outlines.



APPLICATIONS

- EDP, telecommunication, general industrial, automotive and audio-video
- Smoothing, filtering and buffering
- For small power supplies, DC/DC converters.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($H_{\max} \times W_{\max} \times T_{\max}$ in mm)	$9.5 \times 7 \times 3$ to $9.5 \times 8 \times 6$
Rated capacitance range (E6 series), C_R	0.1 to 68 μF
Tolerance on C_R	$\pm 20\%$
Rated voltage range, U_R	6.3 to 40 V
Category temperature range: $U_R = 6.3$ to 40 V $U_C = 6.3$ to 25 V	-55 to $+85$ °C -55 to $+125$ °C
Endurance test at 125 °C	10000 hours
Useful life at 125 °C	20000 hours
Useful life at 175 °C	2000 hours
Useful life at 40 °C, I_R applied	>300000 hours
Shelf life at 0 V, 125 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Detail specification	IEC 384-4-2, CECC 30302
Climatic category IEC 68	55/125/56

Solid Aluminium electrolytic capacitors

Solid Al, Radial Pearl Miniature

128 SAL-RPM

Selection chart for C_R , U_R , U_C and relevant maximum case sizes ($H \times W \times T$ in mm)

Preferred types in **bold**.

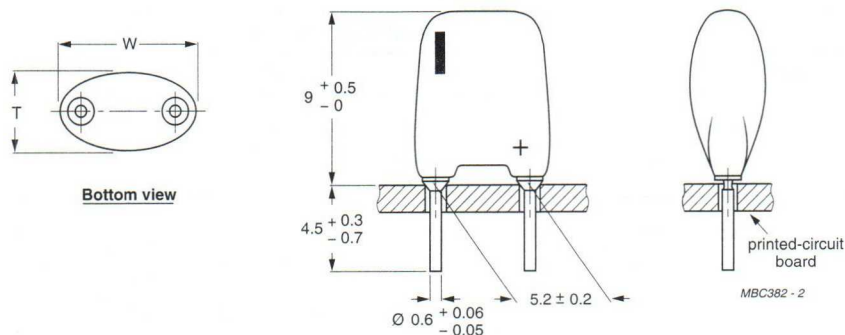
C_R (μF)	U_R (V) at $T_{amb} = 85^\circ C$					
	6.3	10	16	25	35	40
	U_C (V) at $T_{amb} = 125^\circ C$					
	6.3	10	16	25	25	25
0.1	—	—	—	—	—	$9.5 \times 7 \times 3$
0.15	—	—	—	—	—	$9.5 \times 7 \times 3$
0.22	—	—	—	—	—	$9.5 \times 7 \times 3.5$
0.33	—	—	—	—	$9.5 \times 7 \times 3.5$	$9.5 \times 7 \times 4$
0.47	—	—	—	—	$9.5 \times 7 \times 4$	$9.5 \times 7 \times 5$
0.68	—	—	—	$9.5 \times 7 \times 3.5$	$9.5 \times 7 \times 4$	$9.5 \times 7 \times 5$
1	—	—	—	$9.5 \times 7 \times 3.5$	$9.5 \times 7 \times 5$	$9.5 \times 8 \times 5$
1.5	—	—	—	$9.5 \times 7 \times 3.5$	$9.5 \times 8 \times 5$	$9.5 \times 8 \times 6$
2.2	—	—	$9.5 \times 7 \times 3.5$	$9.5 \times 7 \times 4$	$9.5 \times 8 \times 6$	$9.5 \times 8 \times 6$
3.3	—	—	$9.5 \times 7 \times 3.5$	$9.5 \times 7 \times 5$	$9.5 \times 8 \times 6$	—
4.7	—	$9.5 \times 7 \times 3.5$	$9.5 \times 7 \times 4$	$9.5 \times 8 \times 5$	—	—
6.8	—	$9.5 \times 7 \times 3.5$	$9.5 \times 7 \times 4$	$9.5 \times 8 \times 6$	—	—
10	$9.5 \times 7 \times 3.5$	$9.5 \times 7 \times 4$	$9.5 \times 7 \times 5$	$9.5 \times 8 \times 6$	—	—
15	—	$9.5 \times 7 \times 4$	$9.5 \times 8 \times 5$	—	—	—
22	$9.5 \times 7 \times 4$	$9.5 \times 7 \times 5$	$9.5 \times 8 \times 6$	—	—	—
33	$9.5 \times 7 \times 5$	$9.5 \times 8 \times 5$	—	—	—	—
47	$9.5 \times 8 \times 5$	$9.5 \times 8 \times 6$	—	—	—	—
68	$9.5 \times 8 \times 6$	—	—	—	—	—

Solid Aluminium electrolytic capacitors

Solid Al, Radial Pearl Miniature

128 SAL-RPM

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



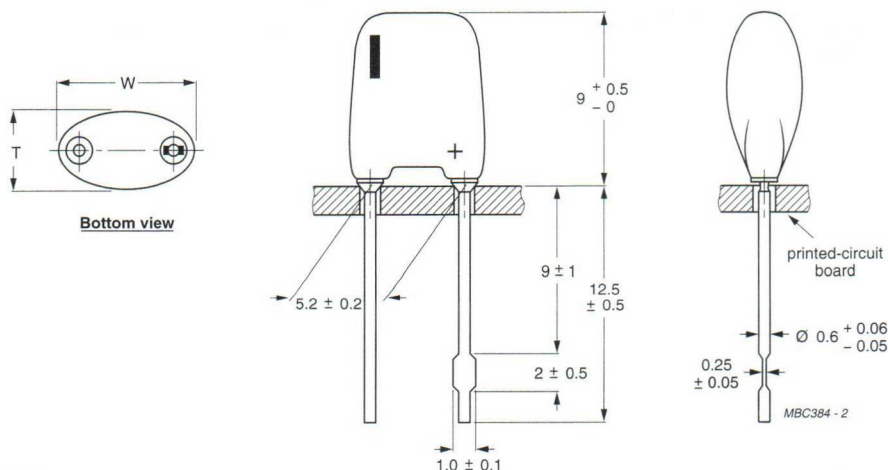
Dimensions in mm.

For dimensions see Table 1.

The diameter of the mounting holes in the printed-circuit board is 0.8 ± 0.1 mm.

Flanges are provided with degassing grooves.

Fig.2 Form CB: Short leads, in boxes.



Dimensions in mm.

For dimensions see Table 1.

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.

Solid Aluminium electrolytic capacitors

Solid Al, Radial Pearl Miniature

128 SAL-RPM

Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

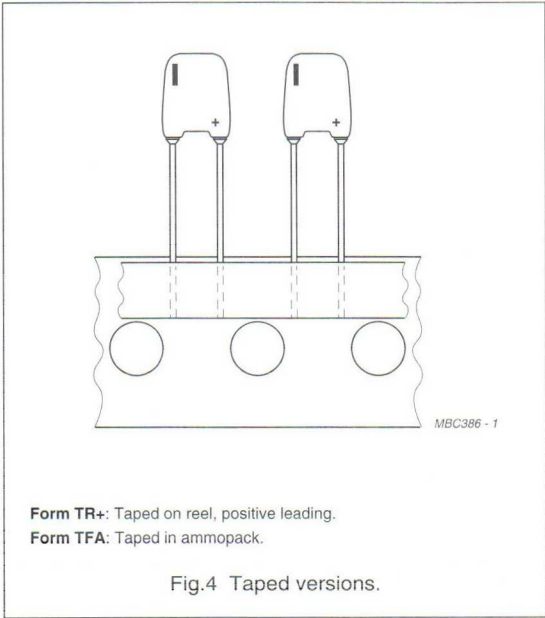
MAXIMUM CASE SIZE H × W × T (mm)	CASE CODE	MASS (g)	PACKAGING QUANTITIES			
			FORM CA (note 1)	FORM CB (note 1)	FORM TR+	FORM TFA
9.5 × 7 × 3	10	≈0.22	1000	1000	2000	2000
9.5 × 7 × 3.5	20	≈0.25	1000	1000	2000	2000
9.5 × 7 × 4	30	≈0.30	1000	1000	2000	2000
9.5 × 7 × 5	40	≈0.35	1000	1000	1000	1000
9.5 × 8 × 5	50	≈0.50	1000	1000	1000	1000
9.5 × 8 × 6	60	≈0.60	1000	1000	1000	1000

Note

1. In plastic bags of 200 units each.

TAPED PRODUCTS

Tape dimensions are specified in this handbook, Section "Packaging".



MARKING

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

- Rated capacitance (in μF)
- Tolerance code on rated capacitance (M for $\pm 20\%$)
- Rated voltage (in V) and category voltage if applicable
- Date code in accordance with "IEC 62"
- Name of manufacturer
- '+' sign to indicate the anode terminal
- 'I' sign to indicate 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.

Solid Aluminium electrolytic capacitors

Solid Al, Radial Pearl Miniature

128 SAL-RPM

Ordering example

Electrolytic capacitors 128 series

10 $\mu\text{F}/16 \text{ V}$; $\pm 20\%$ Maximum case size: $9.5 \times 7 \times 5 \text{ mm}$; Form CB

Catalogue number: 2222 128 55109.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{\text{amb}} = 20 \text{ to } 25^\circ\text{C}$,
 $P = 86 \text{ to } 106 \text{ kPa}$, $RH = 45 \text{ to } 75\%$.

C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	max. RMS ripple current no necessary DC applied
I_{L5}	max. leakage current after 5 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	max. equivalent series resistance at 100 Hz
Z	max. impedance at 100 kHz

Table 2 Electrical data and ordering information **128** series; preferred types in **bold**

U_C (V)	U_R (V)	C_R 100 Hz (μF)	MAXIMUM CASE SIZE $H \times W \times T$ (mm)	CASE CODE	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)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222 128.....			
												FORM CB	FORM CA	FORM TR+ REEL	FORM TFA AMMO
6.3	6.3	10	$9.5 \times 7 \times 3.5$	20	22.4	320	595	2	0.10	20	2.0	53109	73109	23109	33109
		22	$9.5 \times 7 \times 4$	30	32.9	470	870	4	0.10	9	1.0	53229	73229	23229	33229
		33	$9.5 \times 7 \times 5$	40	65.4	595	1100	5	0.10	6.1	0.70	53339	73339	23339	33339
		47	$9.5 \times 8 \times 5$	50	118.4	740	1360	7	0.10	4.3	0.50	53479	73479	23479	33479
		68	$9.5 \times 8 \times 6$	60	153.0	800	1650	11	0.10	3.0	0.40	53689	73689	23689	33689
10	10	4.7	$9.5 \times 7 \times 3.5$	20	16.1	230	425	2	0.10	43	3.00	54478	74478	24478	34478
		6.8	$9.5 \times 7 \times 3.5$	20	18.9	270	500	2	0.10	30	2.20	54688	74688	24688	34688
		10	$9.5 \times 7 \times 4$	30	21.7	310	573	3	0.10	20	1.70	54109	74109	24109	34109
		15	$9.5 \times 7 \times 4$	30	27.3	390	720	4	0.10	14	1.20	54159	74159	24159	34159
		22	$9.5 \times 7 \times 5$	40	51.7	470	870	6	0.10	9	0.90	54229	74229	24229	34229
		33	$9.5 \times 8 \times 5$	50	81.6	510	940	8	0.10	6.1	0.60	54339	74339	24339	34339
		47	$9.5 \times 8 \times 6$	60	105.4	620	1140	12	0.10	4.3	0.40	54479	74479	24479	34479
16	16	2.2	$9.5 \times 7 \times 3.5$	20	14.0	200	370	2	0.10	91	4.50	55228	75228	25228	35228
		3.3	$9.5 \times 7 \times 3.5$	20	16.1	230	425	2	0.10	61	3.30	55338	75338	25338	35338
		4.7	$9.5 \times 7 \times 4$	30	18.9	270	500	2	0.10	43	2.30	55478	75478	25478	35478
		6.8	$9.5 \times 7 \times 4$	30	22.4	320	590	3	0.10	30	1.65	55688	75688	25688	35688
		10	$9.5 \times 7 \times 5$	40	42.9	390	720	4	0.10	20	1.10	55109	75109	25109	35109
		15	$9.5 \times 8 \times 5$	50	71.2	445	820	6	0.10	14	0.85	55159	75159	25159	35159
		22	$9.5 \times 8 \times 6$	60	86.7	510	940	9	0.10	9	0.65	55229	75229	25229	35229

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CATALOGUE NUMBER 2222 128.....															
U _C (V)	U _R (V)	C _R 100 Hz (μF)	MAXIMUM CASE SIZE H × W × T (mm)	CASE CODE	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)	FORM	FORM	FORM	FORM
												CB	CA	TR+ REEL	TFA AMMO
25	25	0.68	9.5 × 7 × 3.5	20	7.7	110	200	2	0.10	295	17.00	56687	76687	26687	36687
		1	9.5 × 7 × 3.5	20	9.1	130	240	2	0.10	200	12.50	56108	76108	26108	36108
		1.5	9.5 × 7 × 3.5	20	10.8	155	285	2	0.10	135	9.50	56158	76158	26158	36158
		2.2	9.5 × 7 × 4	30	13.6	195	360	2	0.10	91	7.00	56228	76228	26228	36228
		3.3	9.5 × 7 × 5	40	16.1	230	425	2	0.10	61	5.20	56338	76338	26338	36338
		4.7	9.5 × 8 × 5	50	25.3	270	500	3	0.10	43	3.50	56478	76478	26478	36478
		6.8	9.5 × 8 × 6	60	52.7	310	570	4	0.10	30	2.70	56688	76688	26688	36688
		10	9.5 × 8 × 6	60	64.8	360	660	6	0.10	20	2.00	56109	76109	26109	36109
		0.33	9.5 × 7 × 3.5	20	5.6	80	145	2	0.10	610	27.00	50337	70337	20337	30337
35	35	0.47	9.5 × 7 × 4	30	6.3	90	165	2	0.10	430	20.00	50477	70477	20477	30477
		0.68	9.5 × 7 × 4	30	7.7	110	205	2	0.10	295	15.00	50687	70687	20687	30687
		1	9.5 × 7 × 5	40	13.7	125	230	2	0.10	200	10.00	50108	70108	20108	30108
		1.5	9.5 × 8 × 5	50	24.8	155	285	2	0.10	135	7.00	50158	70158	20158	30158
		2.2	9.5 × 8 × 6	60	33.1	195	360	2	0.10	91	4.50	50228	70228	20228	30228
		3.3	9.5 × 8 × 6	60	39.9	235	435	3	0.10	61	3.50	50338	70338	20338	30338
		0.1	9.5 × 7 × 3	10	2.0	40	75	2	0.10	1990	45.00	57107	77107	27107	37107
		0.15	9.5 × 7 × 3	10	2.5	50	95	2	0.10	1330	35.00	57157	77157	27157	37157
		0.22	9.5 × 7 × 3.5	20	4.2	60	115	2	0.10	910	27.00	57227	77227	27227	37227
40	40	0.33	9.5 × 7 × 4	30	5.3	75	140	2	0.10	610	20.00	57337	77337	27337	37337
		0.47	9.5 × 7 × 5	40	10.4	95	175	2	0.10	430	15.00	57477	77477	27477	37477
		0.68	9.5 × 7 × 5	40	12.1	110	205	2	0.10	295	10.00	57687	77687	27687	37687
		1	9.5 × 8 × 5	50	20.0	125	230	2	0.10	200	7.00	57108	77108	27108	37108
		1.5	9.5 × 8 × 6	60	25.5	150	280	2	0.10	135	5.50	57158	77158	27158	37158
		2.2	9.5 × 8 × 6	60	33.1	195	360	2	0.10	91	4.20	57228	77228	27228	37228

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Additional electrical data

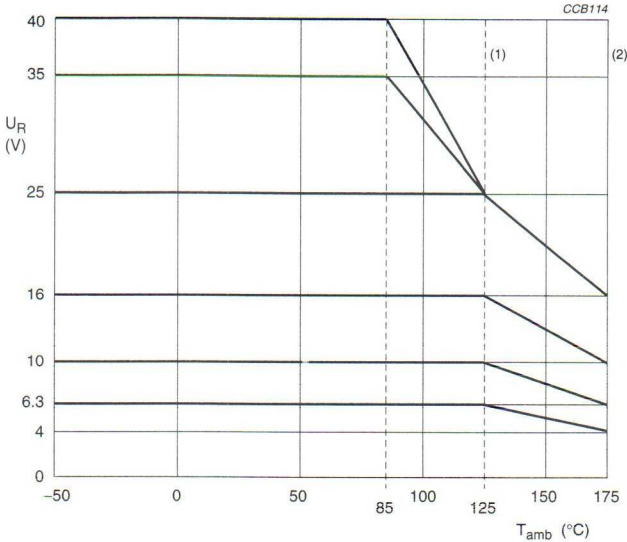
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} < 0.3 \times U_R$
Maximum peak AC voltage	reverse voltage applied	$\leq 2 \text{ V}$
Maximum peak AC voltage, without reverse voltage applied	$T_{amb} \leq 85 \text{ }^\circ\text{C}$: at $f \leq 0.1 \text{ Hz}$ at $0.1 \text{ Hz} < f \leq 1 \text{ Hz}$ at $1 \text{ Hz} < f \leq 10 \text{ Hz}$ at $10 \text{ Hz} < f \leq 50 \text{ Hz}$ at $f > 50 \text{ Hz}$ $85 \text{ }^\circ\text{C} < T_{amb} \leq 125 \text{ }^\circ\text{C}$: at $f \leq 0.1 \text{ Hz}$ at $0.1 \text{ Hz} < f \leq 1 \text{ Hz}$ at $1 \text{ Hz} < f \leq 10 \text{ Hz}$ at $10 \text{ Hz} < f \leq 50 \text{ Hz}$ at $f > 50 \text{ Hz}$	$0.30 \times U_R$ $0.45 \times U_R$ $0.60 \times U_R$ $0.65 \times U_R$ $0.80 \times U_R$ $0.15 \times U_R$ $0.22 \times U_R$ $0.30 \times U_R$ $0.32 \times U_R$ $0.40 \times U_R$
Inductance		
Equivalent series inductance (ESL)	case sizes $9.5 \times 7 \times 3$ to $9.5 \times 7 \times 5 \text{ mm}$	typ. 9 to 14 nH
	case sizes $9.5 \times 8 \times 5$ and $9.5 \times 8 \times 6 \text{ mm}$	typ. 11 to 16 nH
	all case sizes	max. 20 nH
Dissipation		
Maximum power dissipation	case sizes $9.5 \times 7 \times 3$ to $9.5 \times 7 \times 5 \text{ mm}$	$P_{125} = 88 \text{ mW}$
	case sizes $9.5 \times 8 \times 5$ and $9.5 \times 8 \times 6 \text{ mm}$	$P_{125} = 104 \text{ mW}$
Current		
Maximum leakage current	after 5 minutes at U_R and $T_{amb} = 25 \text{ }^\circ\text{C}$	$I_{L5} \leq 0.025 C_R \times U_R$ or $2 \text{ } \mu\text{A}$ whichever is greater; see Table 2
Typical leakage current	15 s at U_R and $T_{amb} = 25 \text{ }^\circ\text{C}$: $U_R = 6.3$ to 16 V $U_R = 25$ to 40 V	$\approx 0.2 \times$ value stated in Table 2 $\approx 0.1 \times$ value stated in Table 2

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Voltage



- (1) $U_C = 125$ °C.
(2) $U_C = 175$ °C.

Fig.5 Maximum permissible voltage up to $T_{amb} = 175$ °C.

Ripple current (I_R)

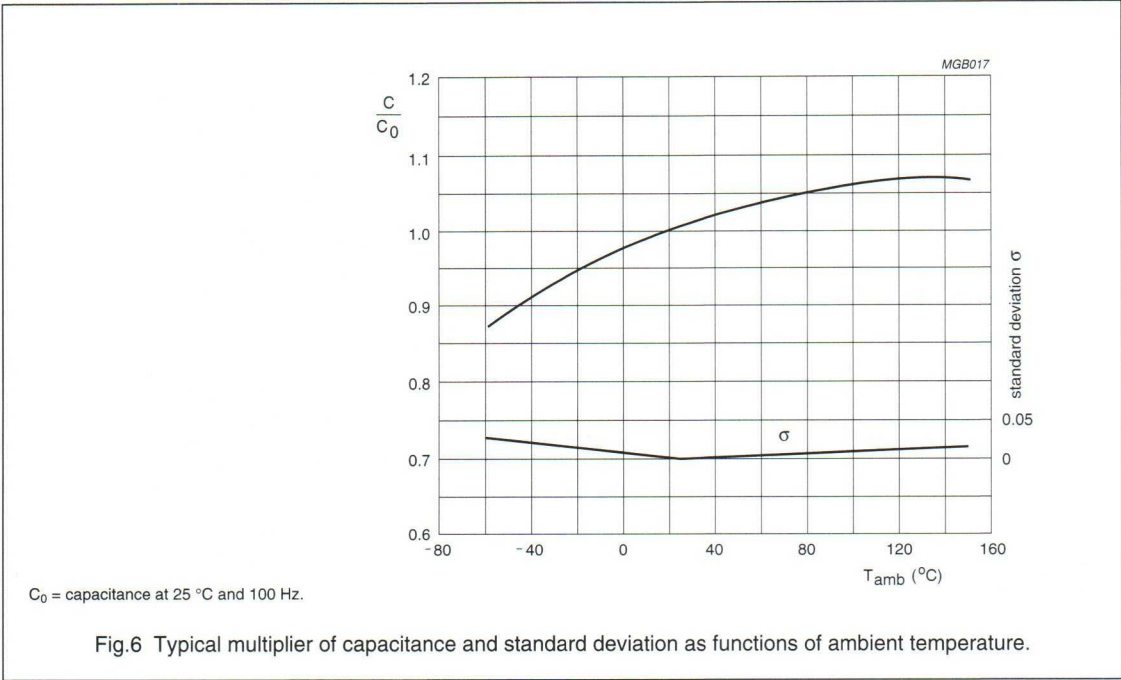
Applying the maximum RMS ripple current given in Table 2 will cause a device temperature of 138 °C. The 100 kHz values in Table 2 for other temperatures are to be calculated with the following I_R multipliers:

PARAMETER	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

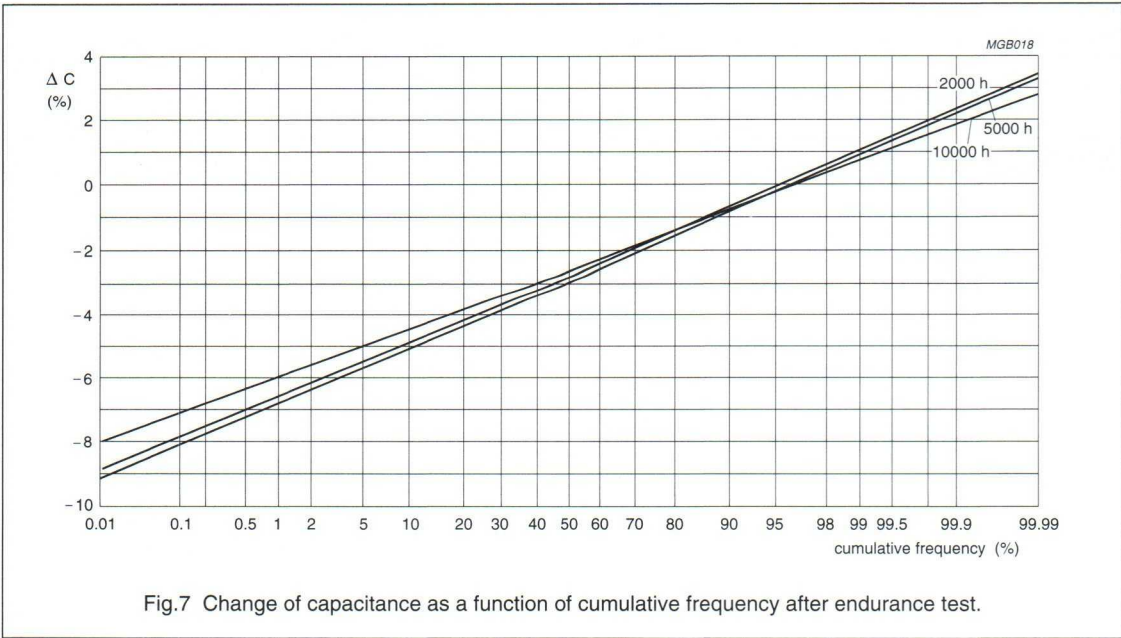
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Capacitance (C)



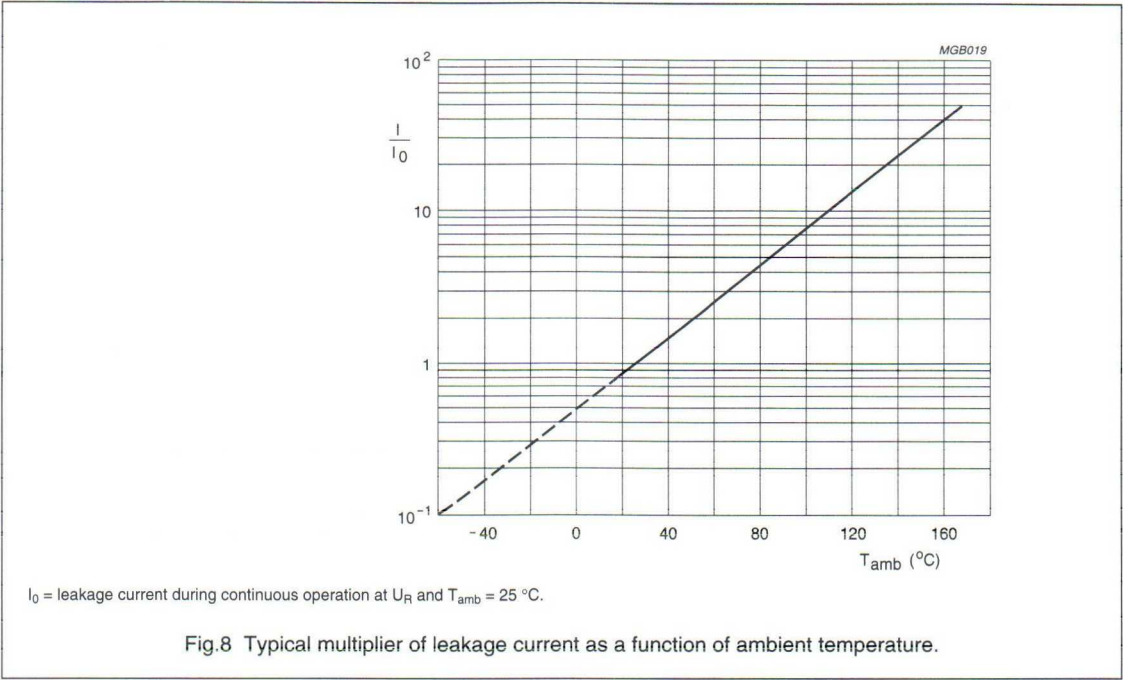
Typical capacitance change after endurance test at $T_{amb} = 125\text{ }^{\circ}\text{C}$



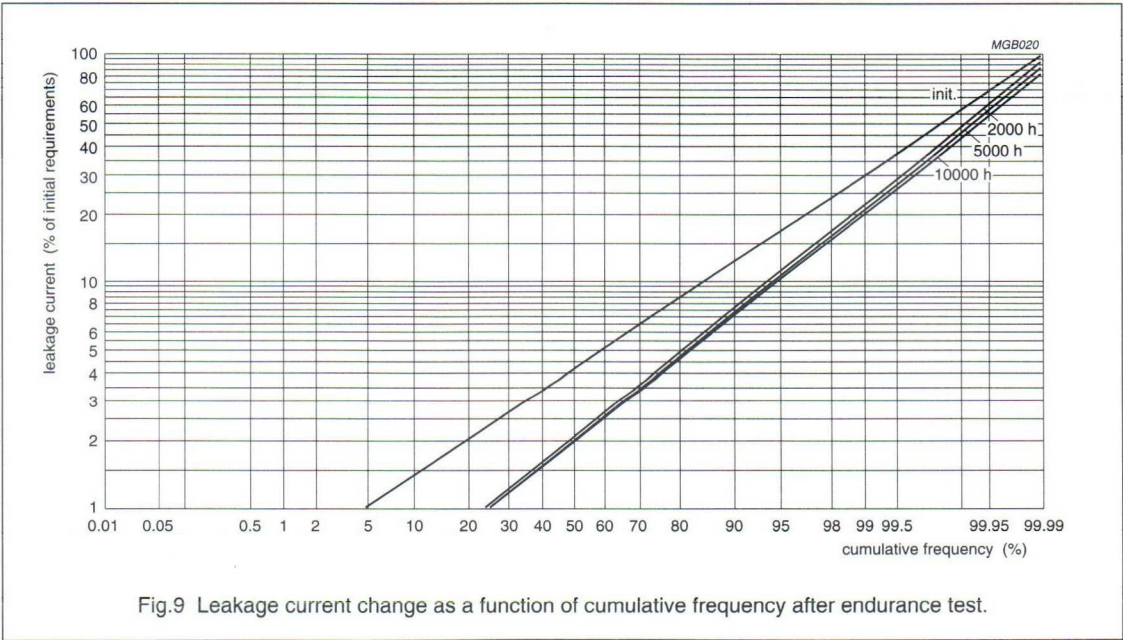
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Leakage current



Typical leakage current change after endurance test at $T_{amb} = 125\text{ }^{\circ}\text{C}$

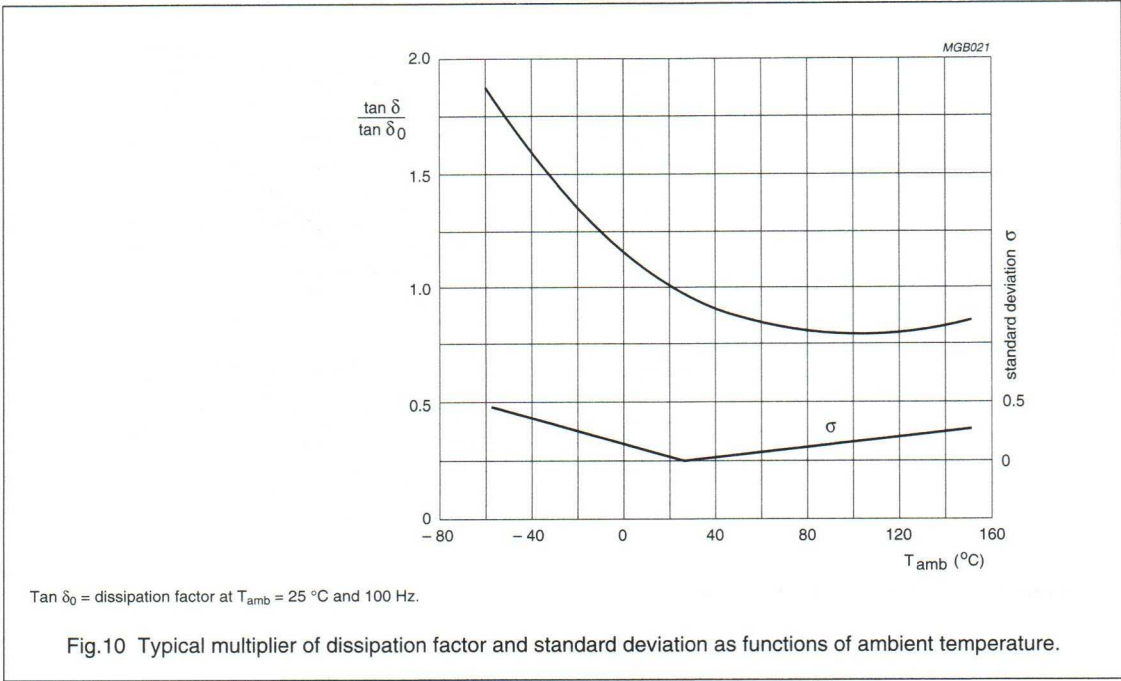


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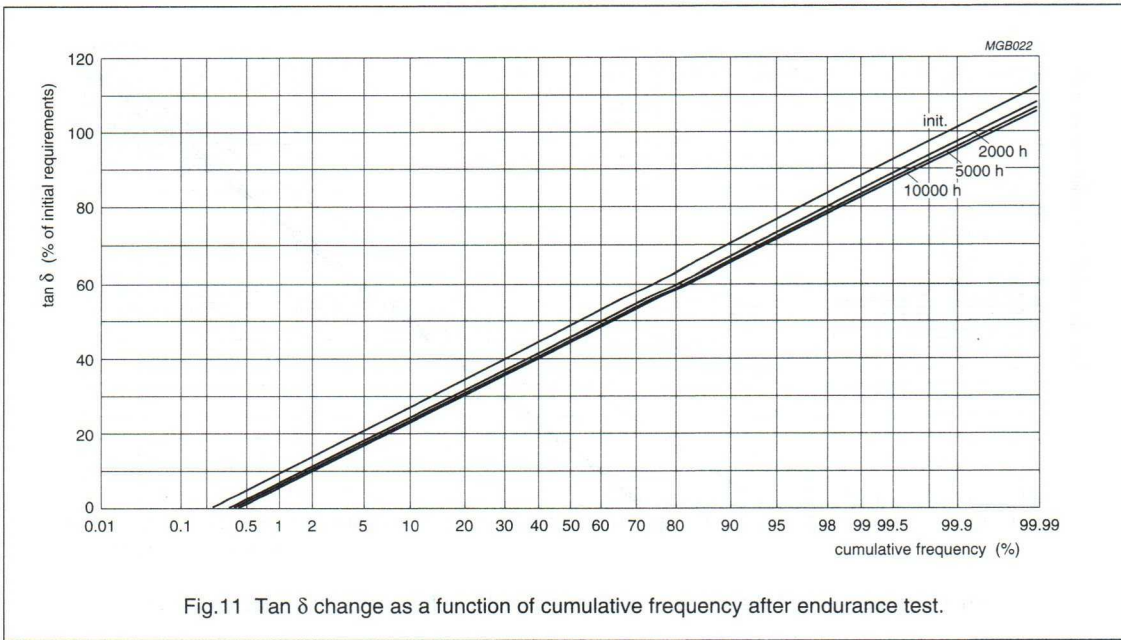
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Dissipation factor ($\tan \delta$)



Typical $\tan \delta$ change after endurance test at $T_{amb} = 125^\circ\text{C}$

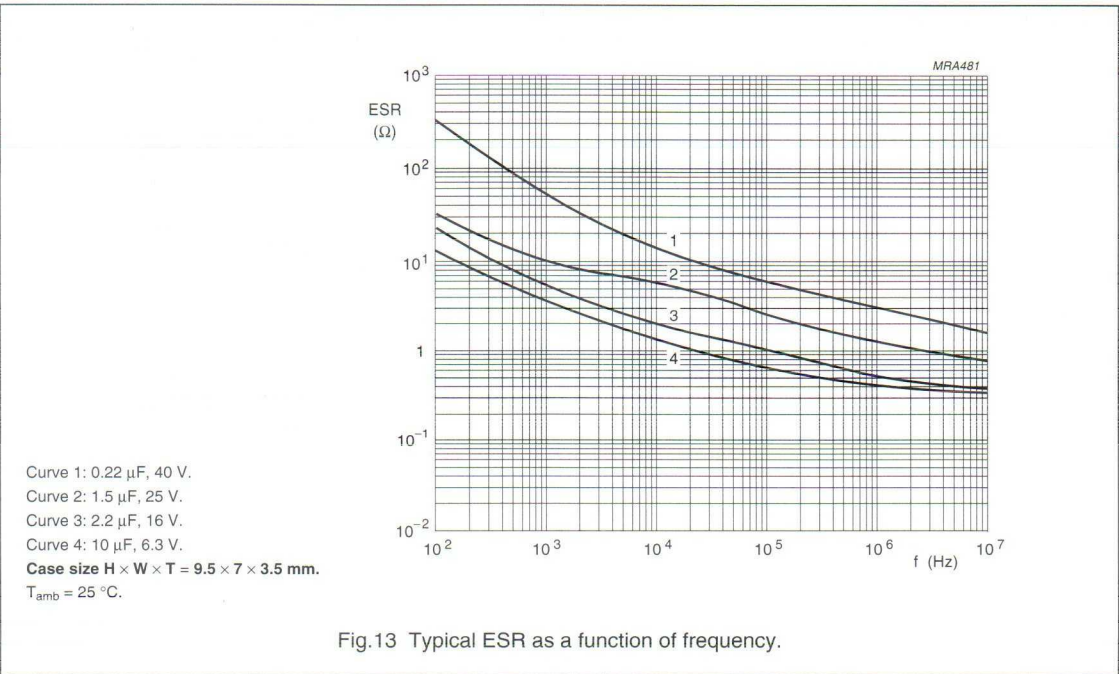
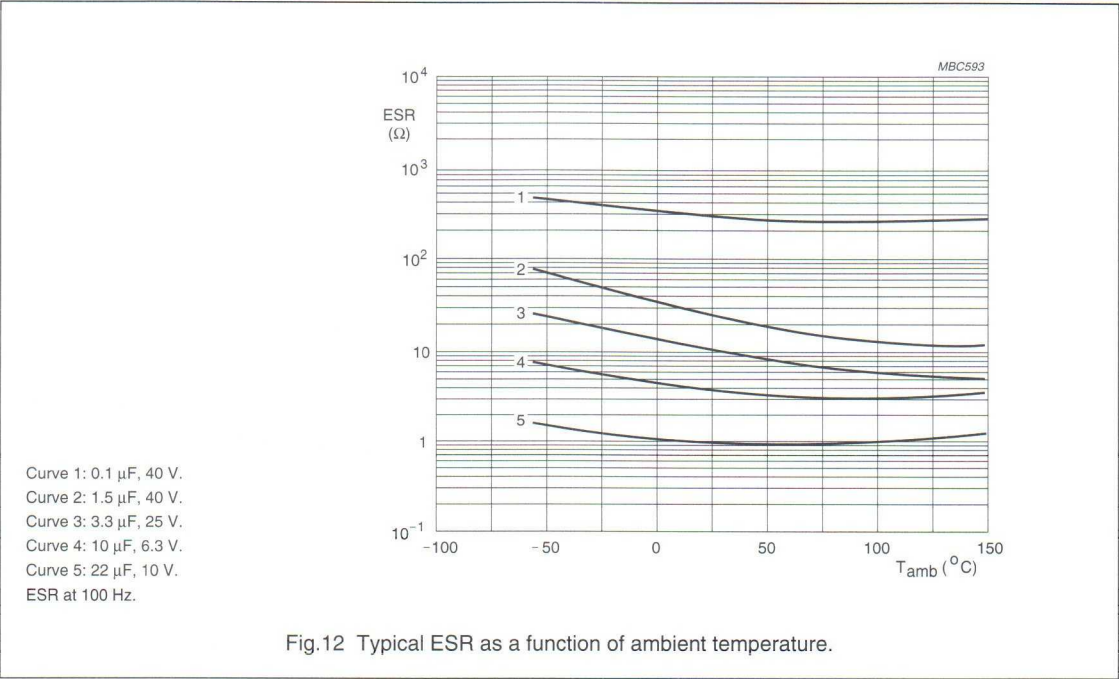


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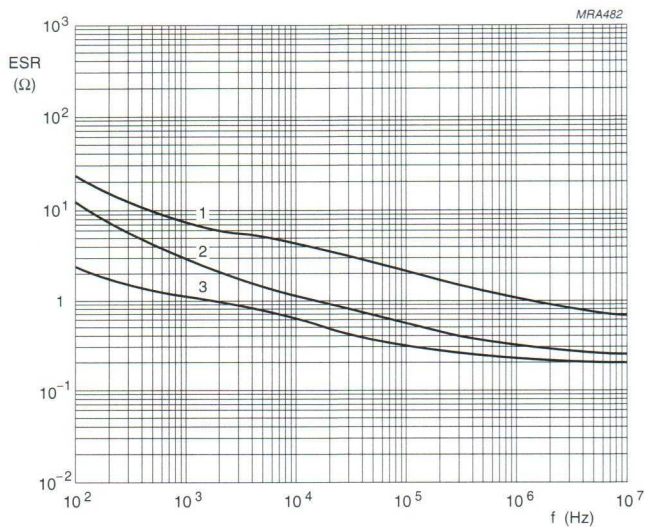
Equivalent series resistance (ESR)



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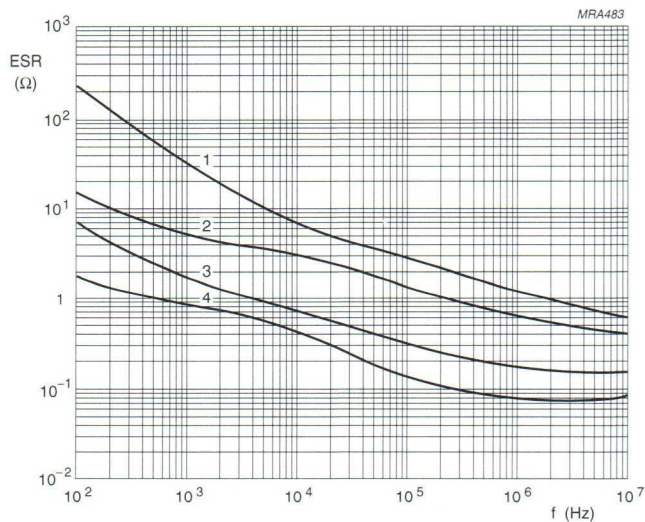
Curve 1: 2.2 μF, 25 V.

Curve 2: 4.7 μF, 16 V.

Curve 3: 22 μF, 6.3 V.

Case size H × W × T = 9.5 × 7 × 4 mm. $T_{amb} = 25\text{ }^{\circ}\text{C}.$

Fig.14 Typical ESR as a function of frequency.



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.

Case size H × W × T = 9.5 × 7 × 5 mm. $T_{amb} = 25\text{ }^{\circ}\text{C}.$

Fig.15 Typical ESR as a function of frequency.

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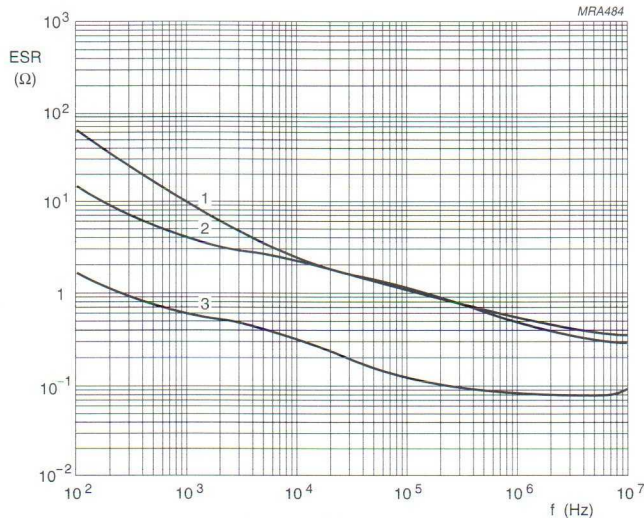


Fig.16 Typical ESR as a function of frequency.

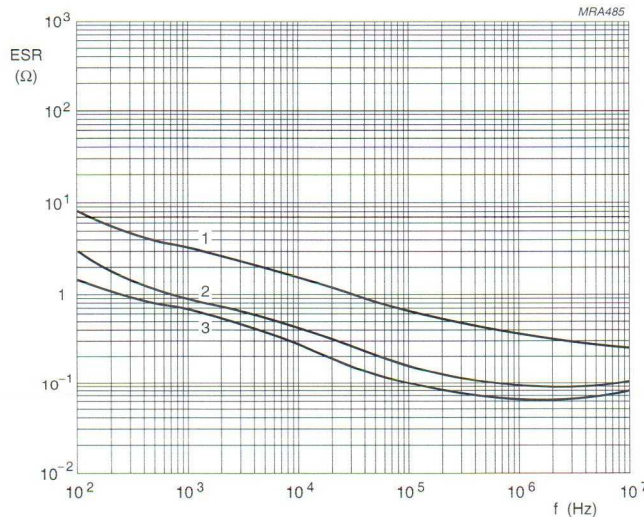


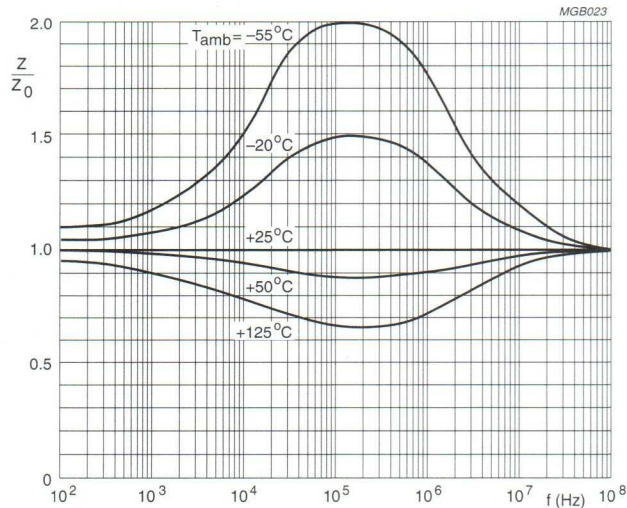
Fig.17 Typical ESR as a function of frequency.

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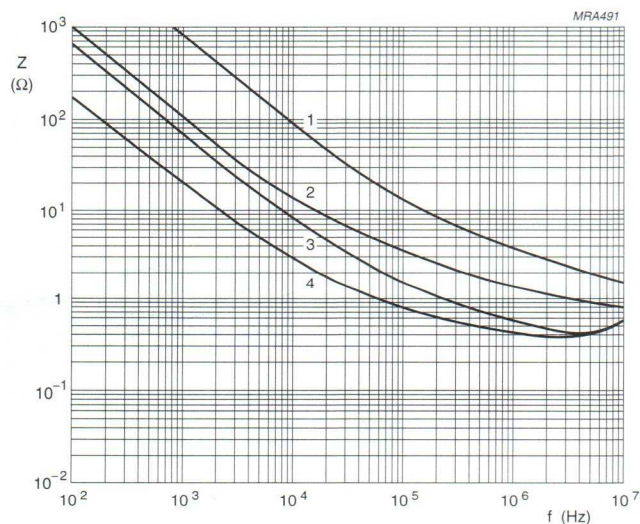
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Impedance (Z)



Z_0 = initial impedance value at $T_{amb} = 25^\circ\text{C}$.

Fig.18 Typical multiplier of impedance as a function of frequency at different ambient temperatures.



Curve 1: $0.22\ \mu\text{F}$, $40\ \text{V}$.

Curve 2: $1.5\ \mu\text{F}$, $25\ \text{V}$.

Curve 3: $2.2\ \mu\text{F}$, $16\ \text{V}$.

Curve 4: $10\ \mu\text{F}$, $6.3\ \text{V}$.

Case size $H \times W \times T = 9.5 \times 7 \times 3.5\ \text{mm}$.

$T_{amb} = 25^\circ\text{C}$.

Fig.19 Typical impedance as a function of frequency.

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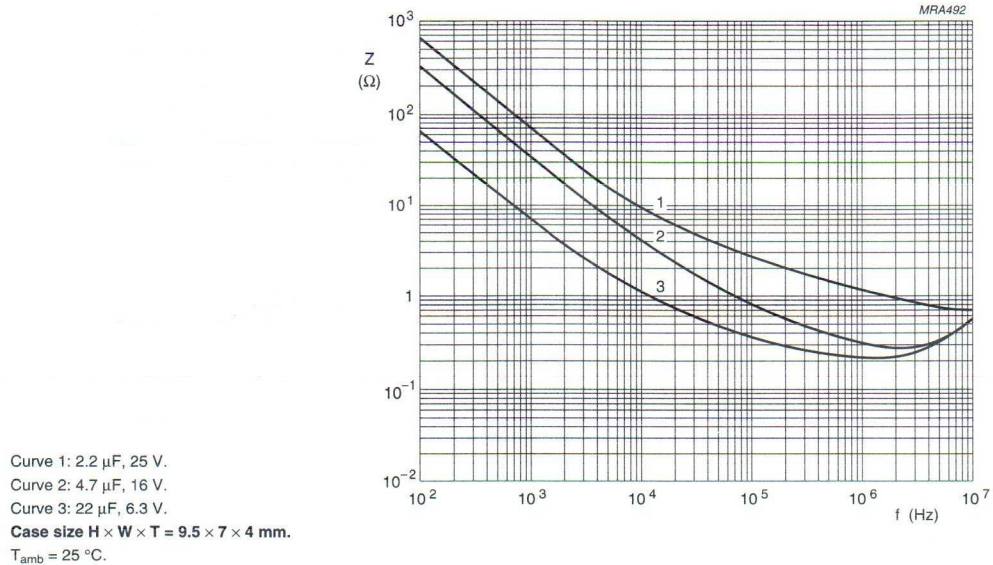


Fig.20 Typical impedance as a function of frequency.

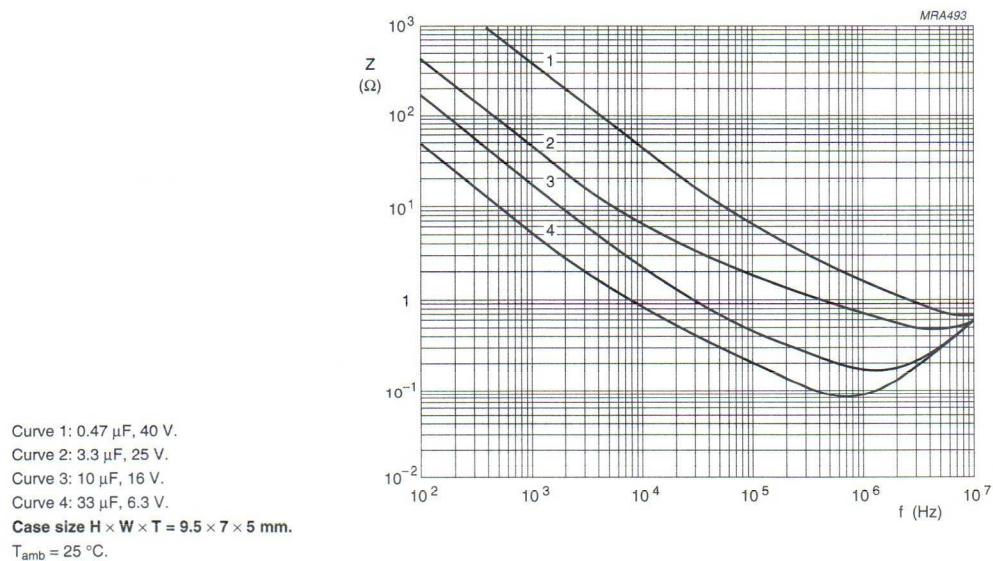


Fig.21 Typical impedance as a function of frequency.

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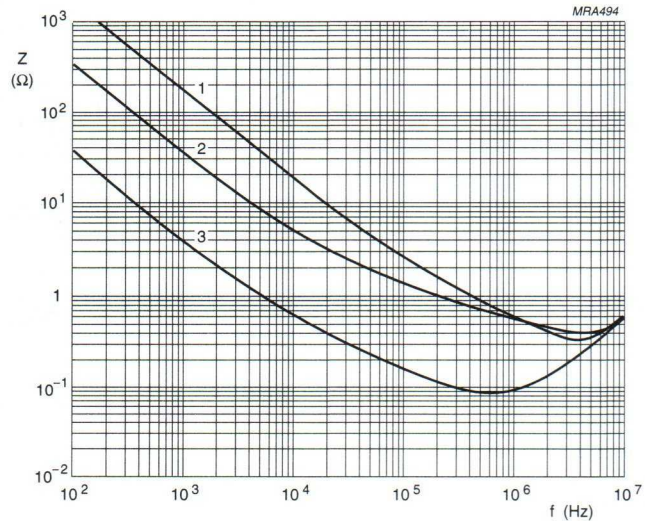
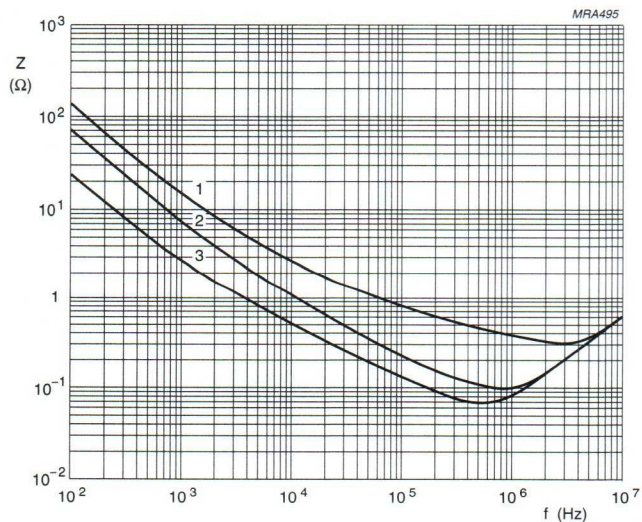


Fig.22 Typical impedance as a function of frequency.

Fig.23 Typical impedance as a function of frequency at $T_{\text{amb}} = 25^\circ\text{C}$.

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 3 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 125\text{ }^{\circ}\text{C}$; $U_R = 6.3$ to 25 V with U_R applied; $U_R = 35$ and 40 V with U_C applied; 10000 hours	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $Z \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30302 subclause 1.8.1	$T_{amb} = 125\text{ }^{\circ}\text{C}$; 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; 20000 hours	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $Z \leq 1.5 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $< 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30302 subclause 4.17	$T_{amb} = 125\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 1 \times \text{spec. limit}$
Charge and discharge	IEC 384-4-2 subclause 9.21	10^6 cycles without series resistance: 0.5 s to U_R ; 0.5 s to ground	$\Delta C/C: \pm 5\%$ no short or open circuit, no visible damage
Solvent resistance	IEC 68-2-45 test XA IEC 653	immersion: 5 ± 0.5 minutes with or without ultrasonic at $55 \pm 5\text{ }^{\circ}\text{C}$ 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	IEC 68-2-6 test Fc	10 to 2000 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 $\Delta C/C: \pm 5\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $Z \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 1.5 \times \text{spec. limit}$
Shock test	IEC 68-2-27 test Ea	half-sine or sawtooth 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 $\Delta C/C: \pm 5\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $Z \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 1.5 \times \text{spec. limit}$
Passive flammability test	IEC 695-2-2	capacitor mounted to a vertical printed-circuit board, one flame on capacitor body; $T_{\text{amb}} = 20 \text{ to } 25 \text{ }^{\circ}\text{C}$; 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

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FEATURES

- Polarized aluminium electrolytic capacitors, solid electrolyte MnO_2
- Radial leads, max. height 12.5 mm, resin dipped, orange coloured
- Extremely long useful life, 20000 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 $0.3 \times U_R$ allowed
- AC voltage up to $0.8 \times U_R$ allowed
- Advanced technology to achieve high reliability and high stability.

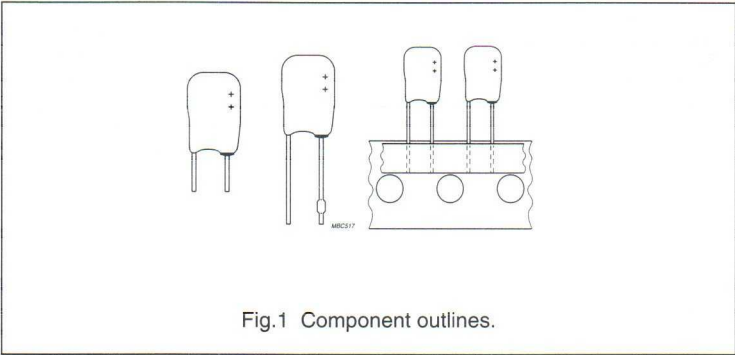
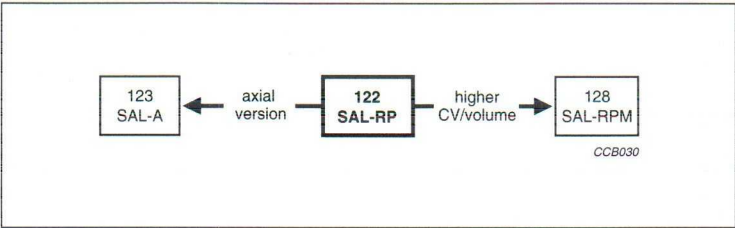


Fig.1 Component outlines.



APPLICATIONS

- EDP, telecommunication, general industrial
- Automotive and audio-video
- Smoothing, filtering and buffering
- For small power supplies, DC/DC converters.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($H_{\max} \times W_{\max} \times T_{\max}$ in mm)	12.5 × 8 × 3.5 to 12.5 × 8 × 6
Rated capacitance range (E6 series), C_R	0.33 to 68 μF
Tolerance on C_R	±20%
Rated voltage range, U_R	6.3 to 40 V
Category temperature range: $U_R = 6.3$ to 40 V $U_C = 6.3$ to 25 V	−55 to +85 °C −55 to +125 °C
Endurance test at 125 °C	10000 hours
Useful life at 125 °C	20000 hours
Useful life at 175 °C	2000 hours
Useful life at 40 °C, I_R applied	>300000 hours
Shelf life at 0 V, 125 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Detail specification	IEC 384-4-2/CECC 30302
Climatic category IEC 68	55/125/56

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Selection chart for C_R , U_R , U_C and relevant maximum case sizes ($H \times W \times T$ in mm)

Preferred types in **bold**.

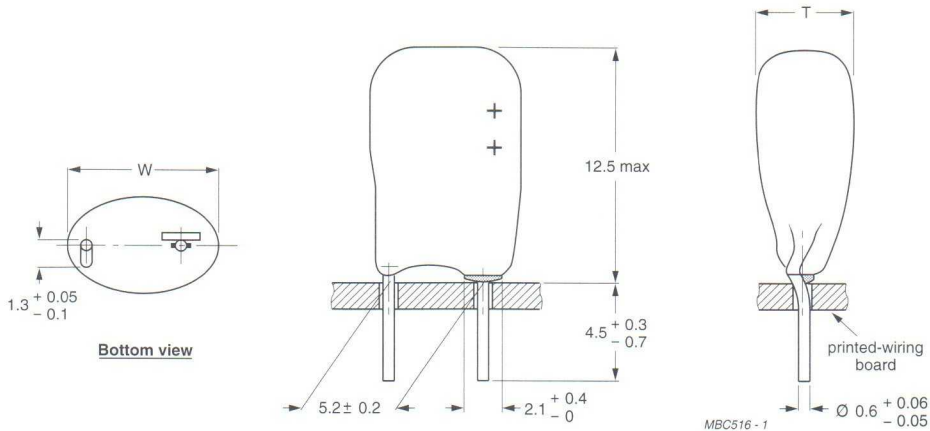
C_R (μF)	U_R (V) at $T_{amb} = 85^\circ C$					
	6.3	10	16	25	35	40
	U_C (V) at $T_{amb} = 125^\circ C$					
	6.3	10	16	25	25	25
0.33	—	—	—	—	—	$12.5 \times 8 \times 3.5$
0.47	—	—	—	—	—	$12.5 \times 8 \times 4.5$
0.68	—	—	—	$12.5 \times 8 \times 3.5$	—	$12.5 \times 8 \times 4.5$
1.0	—	—	—	$12.5 \times 8 \times 3.5$	$12.5 \times 8 \times 4.5$	$12.5 \times 8 \times 5$
1.5	—	—	—	$12.5 \times 8 \times 3.5$	—	$12.5 \times 8 \times 6$
2.2	—	—	$12.5 \times 8 \times 3.5$	$12.5 \times 8 \times 4.5$	—	$12.5 \times 8 \times 6$
3.3	—	—	$12.5 \times 8 \times 3.5$	$12.5 \times 8 \times 4.5$	$12.5 \times 8 \times 6$	—
4.7	—	$12.5 \times 8 \times 3.5$	$12.5 \times 8 \times 4.5$	$12.5 \times 8 \times 5$	—	—
6.8	—	$12.5 \times 8 \times 3.5$	$12.5 \times 8 \times 4.5$	$12.5 \times 8 \times 6$	—	—
10	$12.5 \times 8 \times 3.5$	$12.5 \times 8 \times 4.5$	$12.5 \times 8 \times 5$	$12.5 \times 8 \times 6$	—	—
15	$12.5 \times 8 \times 4.5$	$12.5 \times 8 \times 4.5$	$12.5 \times 8 \times 6$	—	—	—
22	$12.5 \times 8 \times 4.5$	$12.5 \times 8 \times 5$	—	—	—	—
33	$12.5 \times 8 \times 5$	$12.5 \times 8 \times 6$	—	—	—	—
47	$12.5 \times 8 \times 6$	—	—	—	—	—
68	$12.5 \times 8 \times 6$	—	—	—	—	—

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MECHANICAL DATA AVAILABLE FORMS AND PACKAGING QUANTITIES

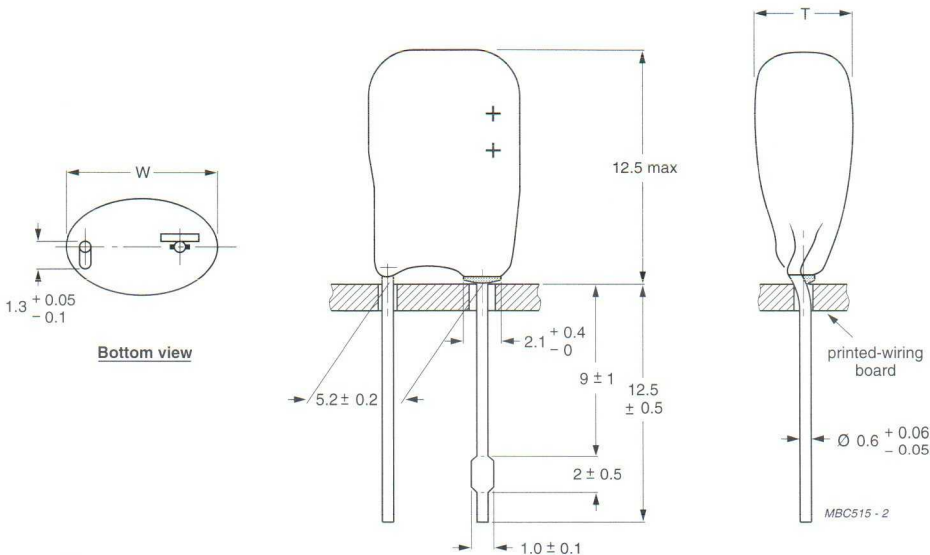


Dimensions in mm.

For dimensions see Table 1.

The diameter of the mounting holes in the printed-circuit board is 0.8 ± 0.1 mm.

Fig.2 Form CB: Short leads, in boxes.



Dimensions in mm.

For dimensions see Table 1.

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.

Fig.3 Form CA: Long leads with keyed polarity, in boxes.

SAL

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Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

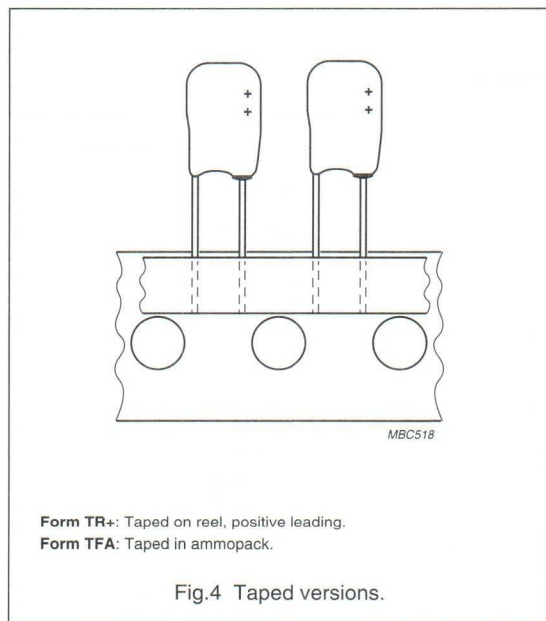
CASE		MASS (g)	PACKAGING QUANTITIES			
MAXIMUM SIZE H × W × T (mm)	CODE		FORM CA (note 1)	FORM CB (note 1)	FORM TR+	FORM TFA
12.5 × 8 × 3.5	1	≈0.35	1000	1000	2000	2000
12.5 × 8 × 4.5	2	≈0.38	1000	1000	2000	2000
12.5 × 8 × 5	3	≈0.45	1000	1000	1000	1000
12.5 × 8 × 6	4	≈0.58	800	1000	1000	1000

Note

1. In plastic bags of 200 units each.

Taped products

Tape dimensions are specified in this handbook, Section "Packaging".

**MARKING**

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

- Rated capacitance (in μF)
- Tolerance code on rated capacitance ($M = \pm 20\%$)
- Rated voltage (in V) and category voltage if applicable
- Date code in accordance with "IEC 62"
- Name of manufacturer
- '+' signs to identify the anode terminal.

MOUNTING

When bending, cutting or straightening the leads, ensure that the capacitor body is relieved of stress.

Bending after soldering must be avoided.

Solid Aluminium electrolytic capacitors

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Ordering example

Electrolytic capacitors 122 series

10 $\mu\text{F}/16 \text{ V}$; $\pm 20\%$ Maximum case size: $12.5 \times 8 \times 5 \text{ mm}$; Form TFA

Catalogue number: 2222 122 35109.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{\text{amb}} = 20$ to 25°C , $P = 86$ to 106 kPa , $\text{RH} = 45$ to 75% .

C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	max. RMS ripple current, no necessary DC voltage applied
I_{L5}	max. leakage current after 5 minutes at U_R
$\text{Tan } \delta$	max. dissipation factor at 100 Hz
ESR	max. equivalent series resistance at 100 Hz
Z	max. impedance at 100 kHz

Table 2 Electrical data and ordering information; preferred types in **bold**

U_C (V)	U_R (V)	C_R 100 Hz (μF)	MAXIMUM CASE SIZE $H \times W \times T$ (mm)	CASE CODE	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)	$\text{Tan } \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222 122			
												FORM CB	FORM CA	FORM TR+ REEL	FORM TFA AMMO
6.3	6.3	10	12.5 × 8 × 3.5	1	9	156	211	3	0.15	30	5	53109	73109	23109	33109
		15	12.5 × 8 × 4.5	2	13	195	264	5	0.15	20	3	53159	73159	23159	33159
		22	12.5 × 8 × 4.5	2	20	234	317	7	0.15	14	1.3	53229	73229	23229	33229
		33	12.5 × 8 × 5	3	30	293	396	11	0.15	9	0.9	53339	73339	23339	33339
		47	12.5 × 8 × 6	4	42	371	502	15	0.15	6.4	0.7	53479	73479	23479	33479
		68	12.5 × 8 × 6	4	61	449	607	22	0.15	4.4	0.5	53689	73689	23689	33689
10	10	4.7	12.5 × 8 × 3.5	1	7	117	158	3	0.15	64	7	54478	74478	24478	34478
		6.8	12.5 × 8 × 3.5	1	10	137	185	4	0.15	44	5	54688	74688	24688	34688
		10	12.5 × 8 × 4.5	2	14	156	211	5	0.15	30	1.5	54109	74109	24109	34109
		15	12.5 × 8 × 4.5	2	21	195	264	8	0.15	20	1	54159	74159	24159	34159
		22	12.5 × 8 × 5	3	31	234	317	11	0.15	14	0.7	54229	74229	24229	34229
		33	12.5 × 8 × 6	4	47	312	422	17	0.15	9	0.5	54339	74339	24339	34339
16	16	2.2	12.5 × 8 × 3.5	1	5	98	132	2	0.10	91	10	55228	75228	25228	35228
		3.3	12.5 × 8 × 3.5	1	8	117	158	3	0.10	61	7	55338	75338	25338	35338
		4.7	12.5 × 8 × 4.5	2	11	137	185	4	0.10	43	2	55478	75478	25478	35478
		6.8	12.5 × 8 × 4.5	2	16	156	211	6	0.10	29.5	1.5	55688	75688	25688	35688
		10	12.5 × 8 × 5	3	23	195	264	8	0.10	20	1	55109	75109	25109	35109
		15	12.5 × 8 × 6	4	34	254	343	12	0.10	13.5	0.7	55159	75159	25159	35159

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U _C (V)	U _R (V)	C _R 100 Hz (μF)	MAXIMUM CASE SIZE H × W × T (mm)	CASE CODE	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)	CATALOGUE NUMBER 2222 122			
												FORM CB	FORM CA	FORM TR+ REEL	FORM TFA AMMO
25	25	0.68	12.5 × 8 × 3.5	1	2	55	74	2	0.10	295	30	56687	76687	26687	36687
		1.0	12.5 × 8 × 3.5	1	4	62	85	2	0.10	200	20	56108	76108	26108	36108
		1.5	12.5 × 8 × 3.5	1	5	78	106	2	0.10	135	15	56158	76158	26158	36158
		2.2	12.5 × 8 × 4.5	2	8	98	132	3	0.10	91	10	56228	76228	26228	36228
		3.3	12.5 × 8 × 4.5	2	12	117	158	4	0.10	61	7	56338	76338	26338	36338
		4.7	12.5 × 8 × 5	3	17	137	185	6	0.10	43	5	56478	76478	26478	36478
		6.8	12.5 × 8 × 6	4	24	176	238	9	0.10	29.5	3	56688	76688	26688	36688
		10	12.5 × 8 × 6	4	35	200	238	13	0.15	20	2	56109	76109	26109	36109
25	35	1.0	12.5 × 8 × 4.5	2	3	62	85	2	0.10	200	15	50108	70108	20108	30108
		3.3	12.5 × 8 × 6	4	12	117	132	6	0.10	61	5	50338	70338	20338	30338
25	40	0.33	12.5 × 8 × 3.5	1	1	39	53	2	0.10	610	30	57337	77337	27337	37337
		0.47	12.5 × 8 × 4.5	2	2	47	63	2	0.10	430	20	57477	77477	27477	37477
		0.68	12.5 × 8 × 4.5	2	2	55	74	2	0.10	295	15	57687	77687	27687	37687
		1.0	12.5 × 8 × 5	3	4	62	85	2	0.10	200	10	57108	77108	27108	37108
		1.5	12.5 × 8 × 6	4	5	78	106	3	0.10	135	7	57158	77158	27158	37158
		2.2	12.5 × 8 × 6	4	8	98	132	5	0.10	91	5	57228	77228	27228	37228

Solid Aluminium electrolytic capacitors

Solid Al, Radial Pearl

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Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage	for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} < 0.3 \times U_R$
Maximum peak AC voltage, reverse voltage applied		$\leq 2 \text{ V}$
Maximum peak AC voltage, without reverse voltage applied	$T_{amb} \leq 85 \text{ }^\circ\text{C}$: at $f \leq 0.1 \text{ Hz}$ at $0.1 \text{ Hz} < f \leq 1 \text{ Hz}$ at $1 \text{ Hz} < f \leq 10 \text{ Hz}$ at $10 \text{ Hz} < f \leq 50 \text{ Hz}$ at $f > 50 \text{ Hz}$ $85 \text{ }^\circ\text{C} < T_{amb} \leq 125 \text{ }^\circ\text{C}$: at $f \leq 0.1 \text{ Hz}$ at $0.1 \text{ Hz} < f \leq 1 \text{ Hz}$ at $1 \text{ Hz} < f \leq 10 \text{ Hz}$ at $10 \text{ Hz} < f \leq 50 \text{ Hz}$ at $f > 50 \text{ Hz}$	$0.30 \times U_R$ $0.45 \times U_R$ $0.60 \times U_R$ $0.65 \times U_R$ $0.80 \times U_R$ $0.15 \times U_R$ $0.22 \times U_R$ $0.30 \times U_R$ $0.32 \times U_R$ $0.40 \times U_R$
Inductance		
Equivalent series inductance (ESL)	case size $12.5 \times 8 \times 3.5$ to $12.5 \times 8 \times 4.5 \text{ mm}$	typ. 9 to 14 nH
	case size $12.5 \times 8 \times 5$ and $12.5 \times 8 \times 6 \text{ mm}$	typ. 11 to 16 nH
	all case sizes	max. 20 nH
Dissipation		
Maximum power dissipation	case sizes $12.5 \times 8 \times 3.5$ to $12.5 \times 8 \times 5 \text{ mm}$	$P_{125} = 88 \text{ mW}$
	case size $12.5 \times 8 \times 6 \text{ mm}$	$P_{125} = 104 \text{ mW}$
Current		
Maximum leakage current	after 5 minutes at U_R and $T_{amb} = 25 \text{ }^\circ\text{C}$	$I_{L5} \leq 0.05C_R \times U_R$ or $2 \text{ } \mu\text{A}$ whichever is greater; see Table 2
Typical leakage current	after 15 s at U_R and $T_{amb} = 25 \text{ }^\circ\text{C}$: $U_R = 6.3$ to 16 V	$\approx 0.2 \times$ value stated in Table 2
	$U_R = 25$ to 40 V	$\approx 0.1 \times$ value stated in Table 2

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Voltage

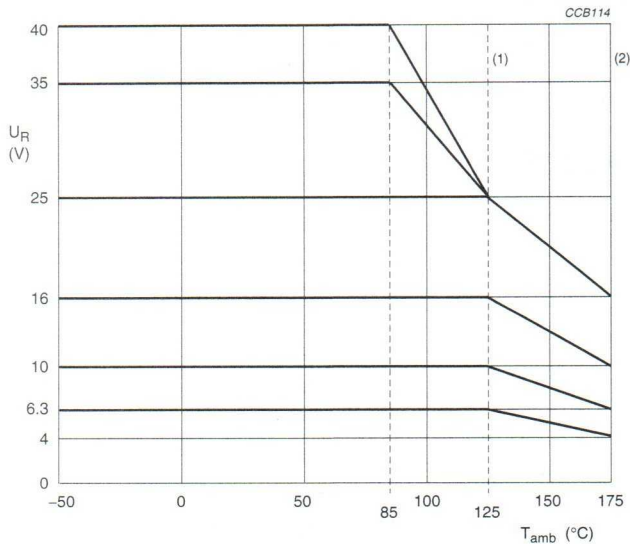


Fig.5 Maximum permissible voltage up to 175 °C.

Ripple current (I_R)

Applying the maximum RMS ripple current given in Table 2 will cause a device temperature of 138 °C.
The 100 kHz values in Table 2 for other temperatures are to be calculated with the following I_R multipliers:

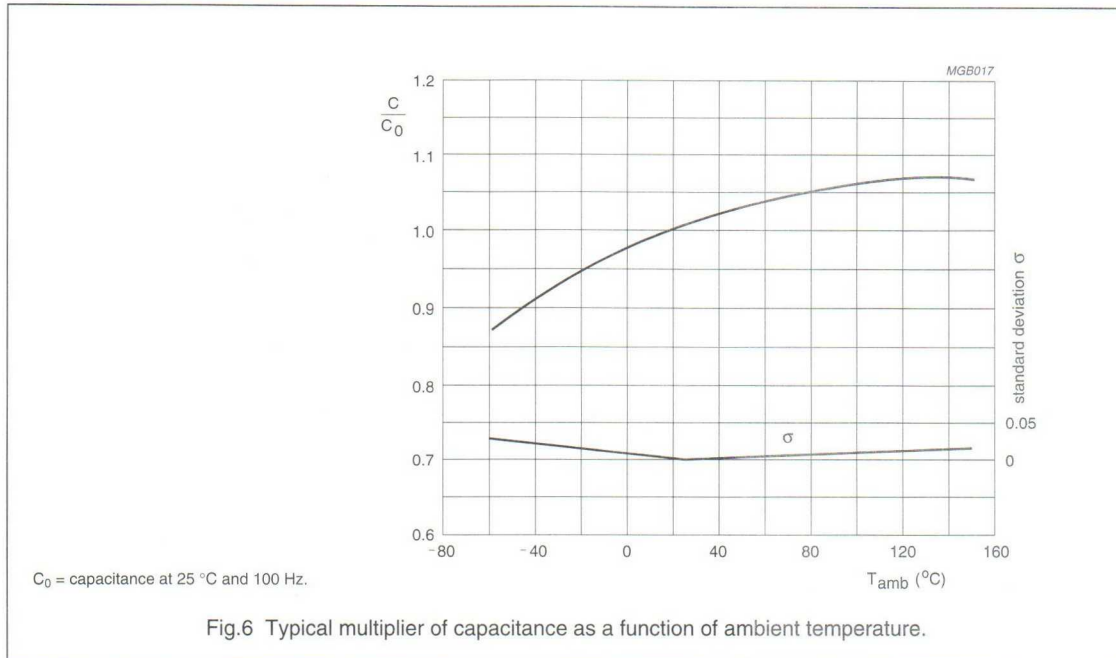
PARAMETER	T _{amb}					
	25 °C	40 °C	65 °C	85 °C	105 °C	125 °C
I _R multiplier	1.1	1.0	0.88	0.75	0.59	0.37

Solid Aluminium electrolytic capacitors

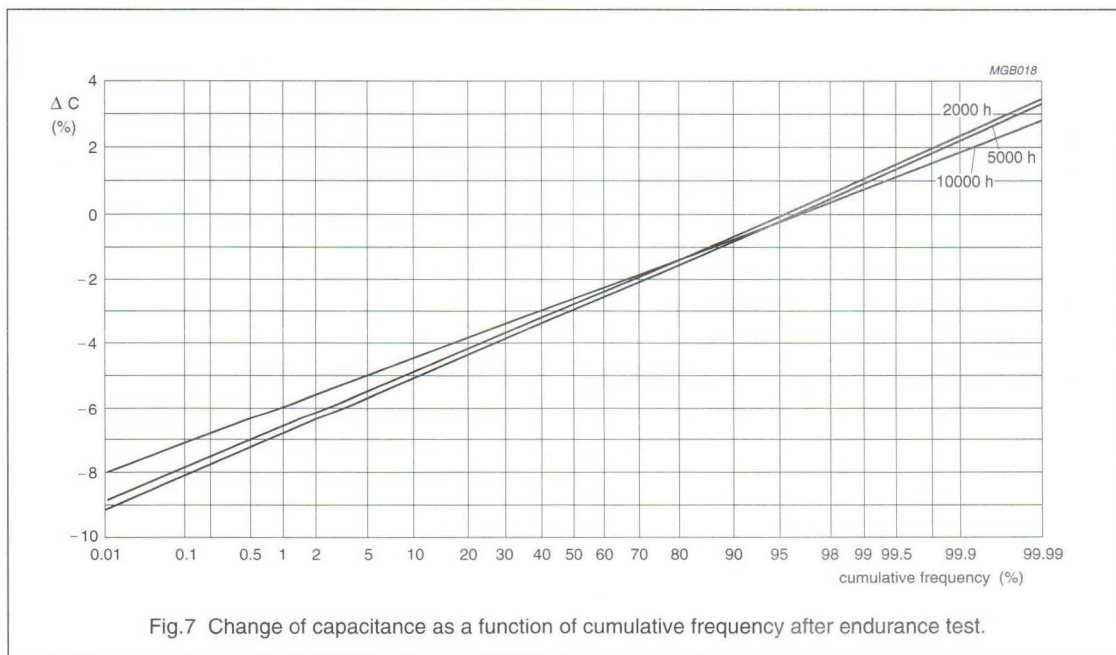
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Capacitance (C)



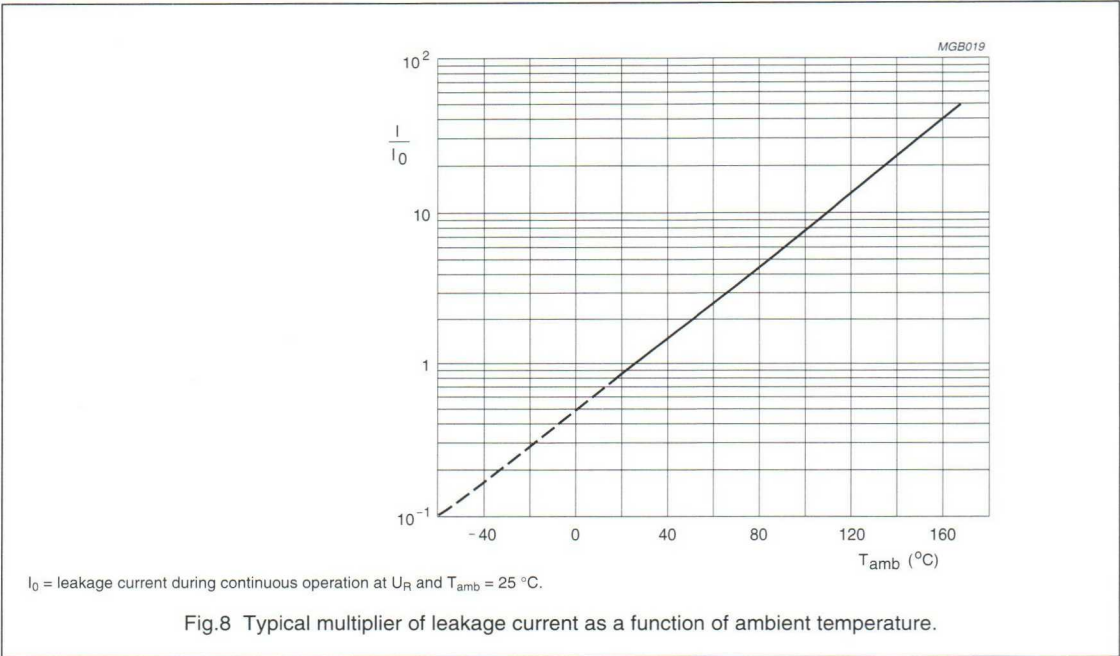
Typical capacitance change after endurance test at $T_{amb} = 125^{\circ}\text{C}$



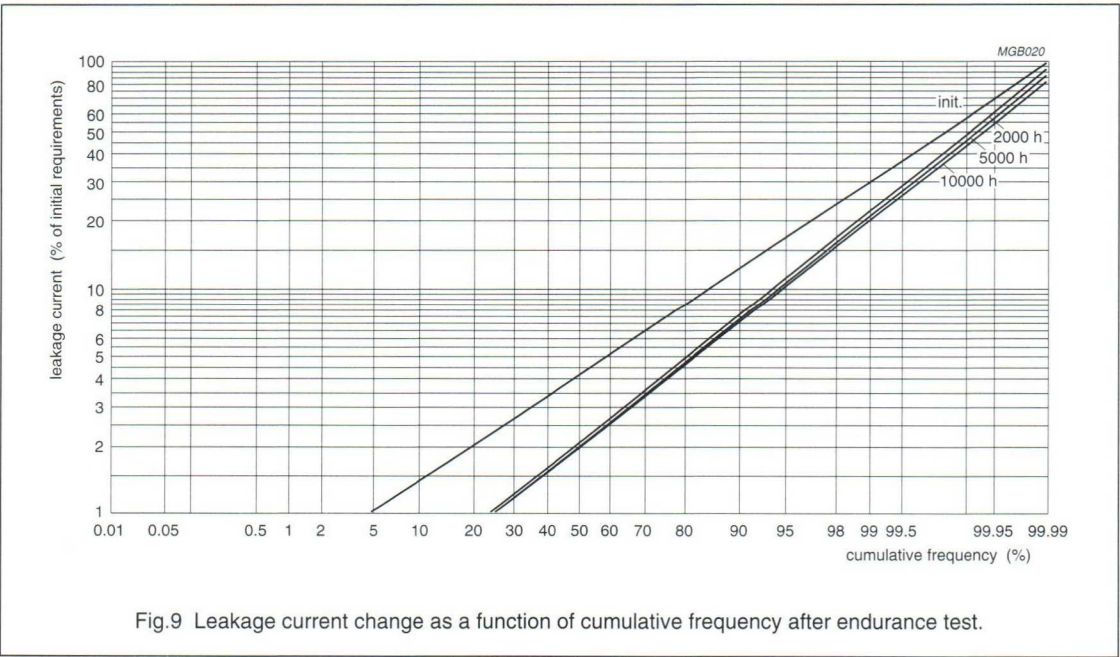
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Leakage current



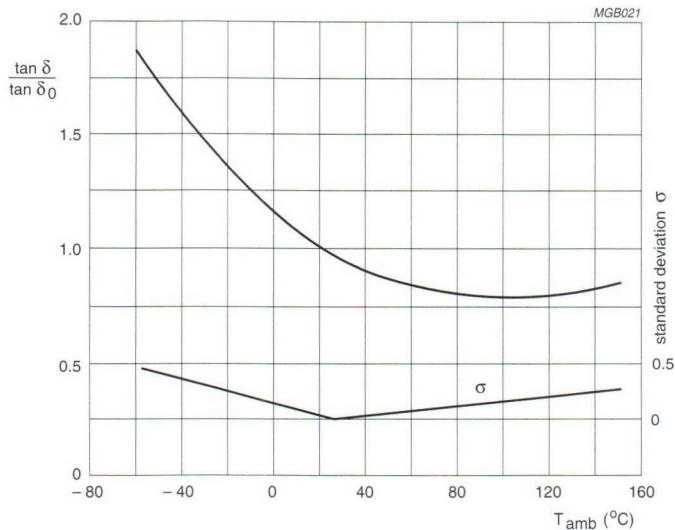
Typical leakage current change after endurance test at $T_{amb} = 125\text{ }^{\circ}\text{C}$



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Dissipation factor ($\tan \delta$)



$\tan \delta_0$ = dissipation factor at $T_{amb} = 25^\circ\text{C}$ and 100 Hz.

Fig.10 Typical multiplier of dissipation factor and standard deviation as functions of ambient temperature.

Typical $\tan \delta$ change after endurance test at $T_{amb} = 125^\circ\text{C}$

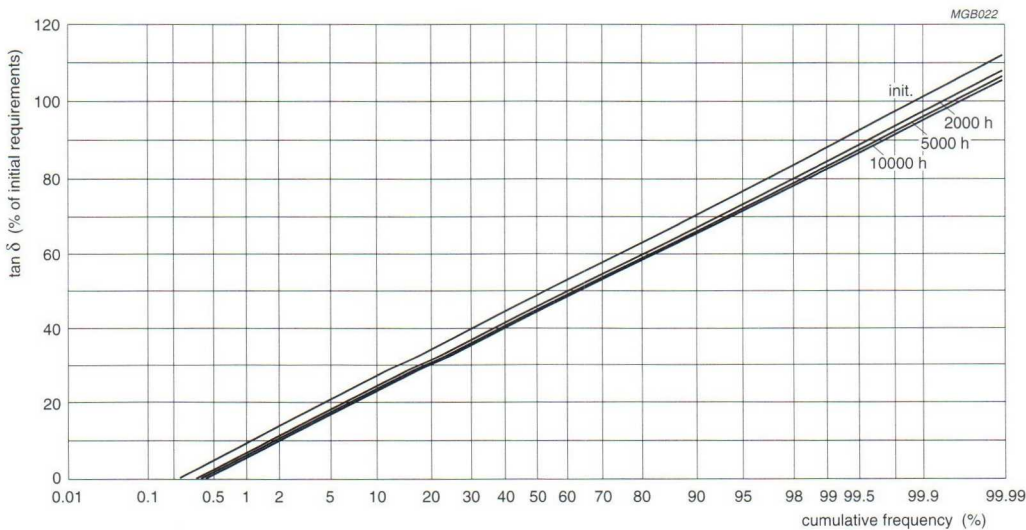
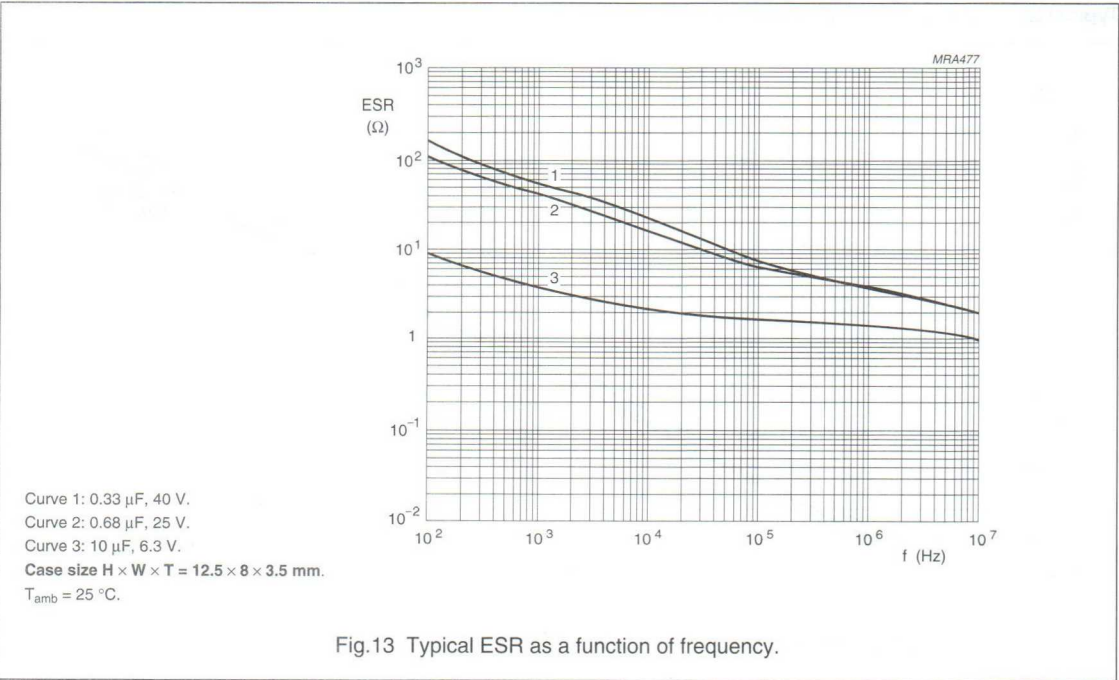
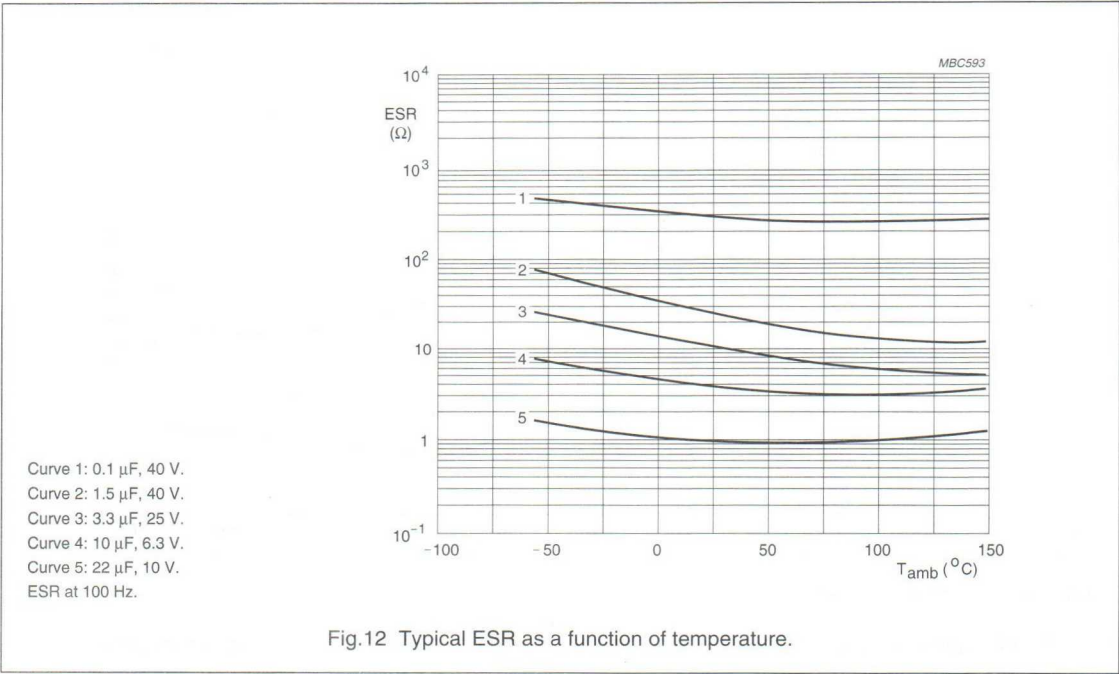


Fig.11 $\tan \delta$ change as a function of cumulative frequency after endurance test.

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Equivalent series resistance (ESR)



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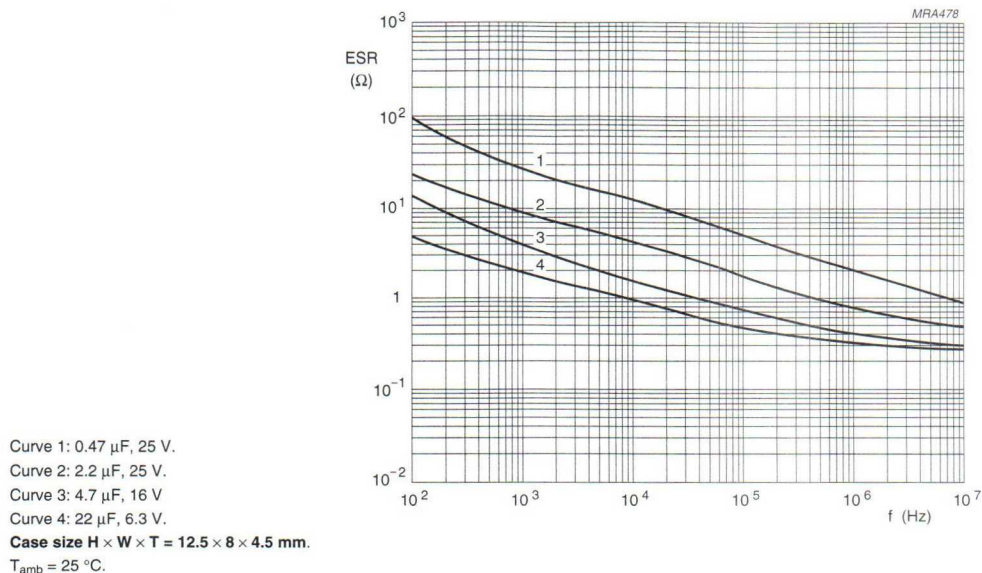


Fig.14 Typical ESR as a function of frequency.

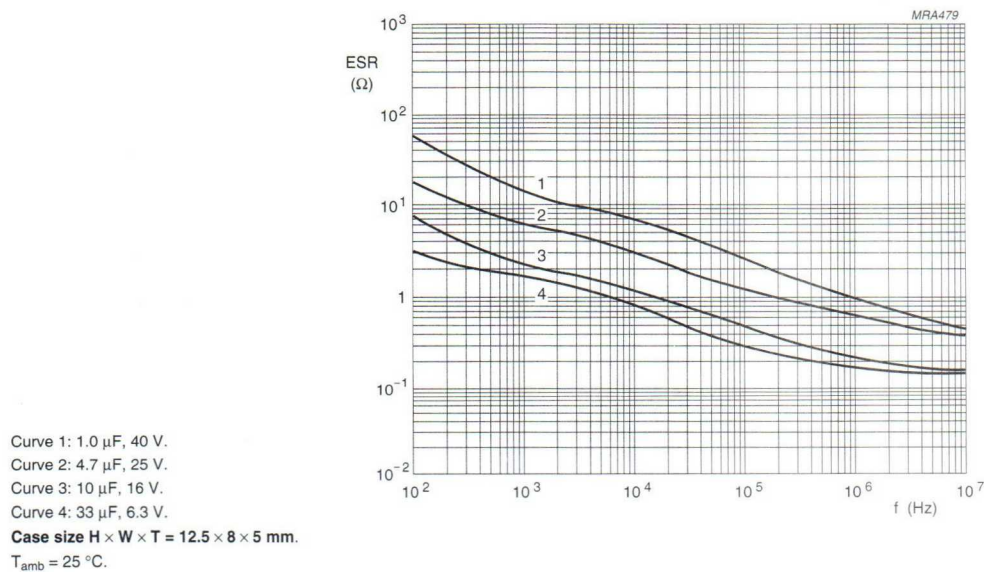


Fig.15 Typical ESR as a function of frequency.

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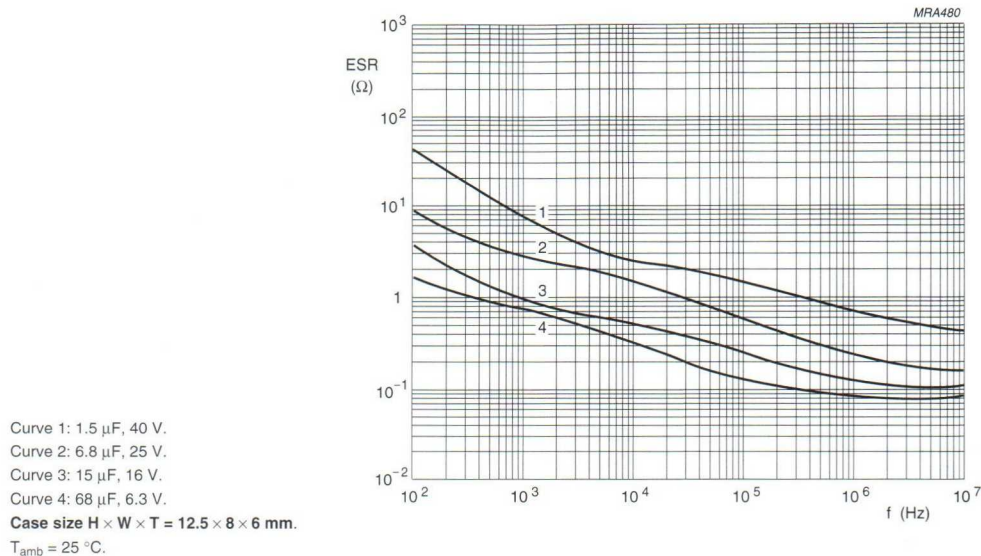
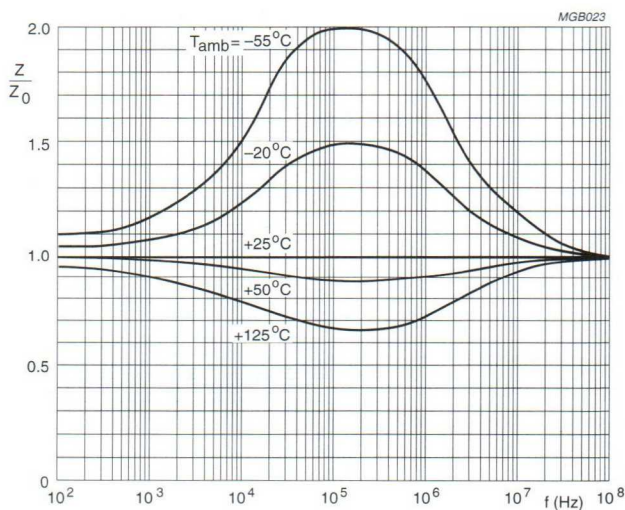


Fig.16 Typical ESR as a function of frequency.

Impedance (Z)



Z_0 = initial impedance value at $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$.

Fig.17 Typical multiplier of impedance as a function of frequency at different temperatures.

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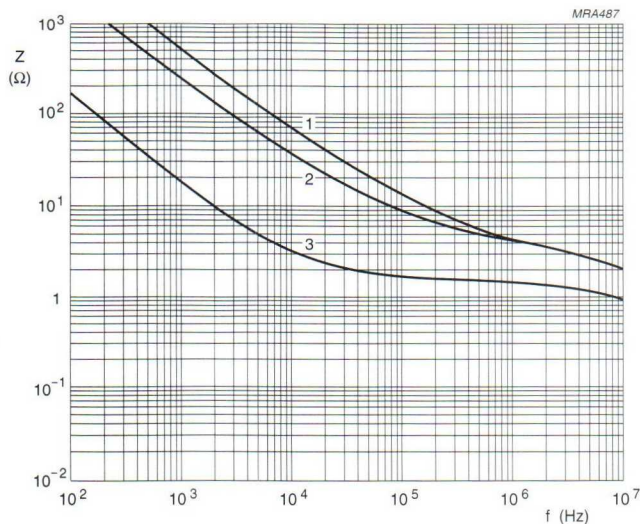


Fig.18 Typical impedance as a function of frequency

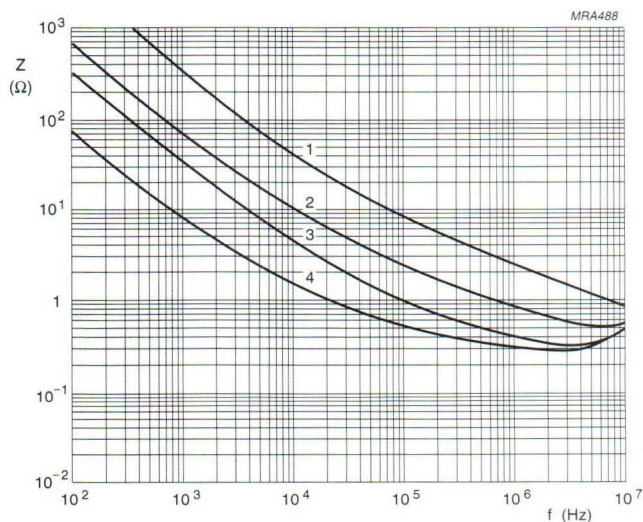


Fig.19 Typical impedance as a function of frequency.

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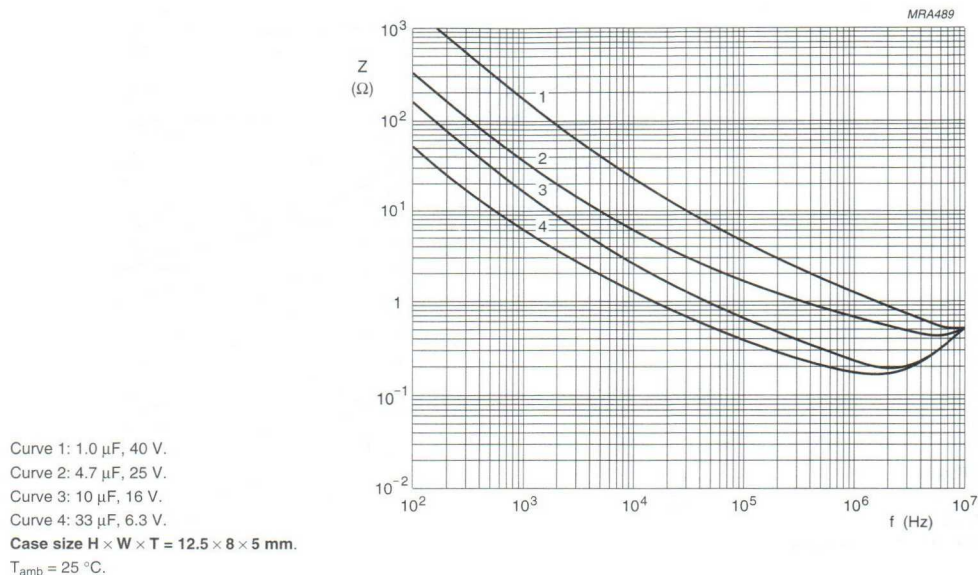


Fig.20 Typical impedance as a function of frequency.

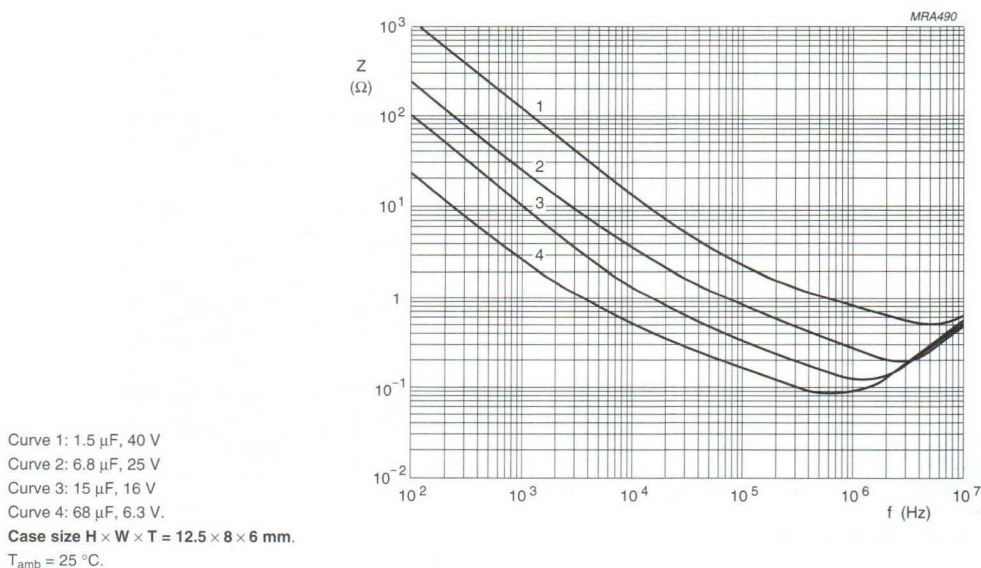


Fig.21 Typical impedance as a function of frequency.

Solid Aluminium electrolytic capacitors

Solid Al, Radial Pearl

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 3 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 125\text{ }^{\circ}\text{C}$; $U_R = 6.3$ to 25 V with U_R applied; $U_R = 35$ and 40 V with U_C applied; 10000 hours	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $Z \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30302 subclause 1.8.1	$T_{amb} = 125\text{ }^{\circ}\text{C}$; 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; 20000 hours	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $Z \leq 1.5 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $< 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 125\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 1 \times \text{spec. limit}$
Charge and discharge	IEC 384-4-2 subclause 9.21	10^6 cycles without series resistance: 0.5 s to U_R ; 0.5 s to ground	$\Delta C/C: \pm 5\%$ no short or open circuit, no visible damage
Solvent resistance	IEC 68-2-45, test XA IEC 653	immersion: 5 ± 0.5 minutes with or without ultrasonic at $55 \pm 5\text{ }^{\circ}\text{C}$ solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected

Solid Aluminium electrolytic capacitors

Solid Al, Radial Pearl

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TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Extended vibration	IEC 68-2-6 test Fc	10 to 2000 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 $\Delta C/C: \pm 5\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $Z \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 1.5 \times \text{spec. limit}$
Shock	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 $\Delta C/C: \pm 5\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $Z \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 1.5 \times \text{spec. limit}$
Passive flammability	IEC 695-2-2	capacitor mounted to a vertical printed-circuit board; one flame on capacitor body; $T_{\text{amb}} = 20 \text{ to } 25 \text{ }^{\circ}\text{C}$; 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

Solid Aluminium electrolytic capacitors

Solid Al, Axial



123 SAL-A

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 10000 g
- Extremely long useful life 20000 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 $0.3 \times U_R$ allowed
- AC voltage up to $0.8 \times U_R$ allowed
- Advanced technology to achieve high reliability and high stability.

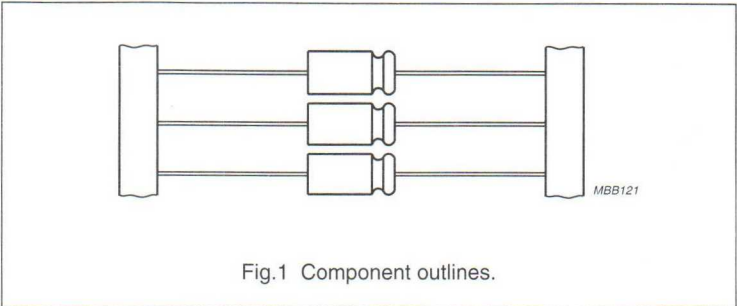
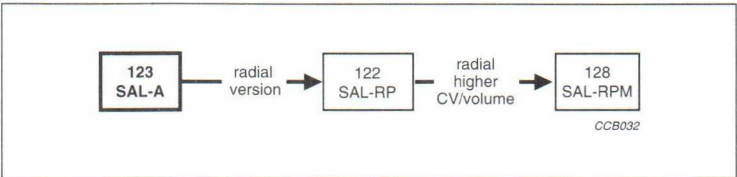


Fig.1 Component outlines.



APPLICATIONS

- EDP, telecommunications, general industrial, automotive, military and space
- Smoothing, filtering, buffering, timing
- For power supplies, DC/DC converters.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case size ($\varnothing D_{\text{max}} \times L_{\text{max}}$ in mm)	6.7 × 15.3 to 12.9 × 32.0
Rated capacitance range (E6 series), C_R	1.5 to 1500 μF
Tolerance on C_R	±20%; ±10% on request
Rated voltage range, U_R	6.3 to 40 V
Category temperature range	−55 to +125 °C
Usable temperature range	−80 to +200 °C
Endurance test at 155 and 125 °C	5000 and 8000 hours
Useful life at 125 °C	20000 hours
Useful life at 40 °C, I_R applied	450000 hours
Shelf life at 0 V, 125 °C	500 hours
Based on sectional specification	IEC 384-4, CECC 30300
Detail specification	IEC 384-4-2, CECC 30302
Approvals	CECC 30302-003 (excl. 40 V)
Climatic category IEC 68	55/125/56

Solid Aluminium electrolytic capacitors

Solid Al, Axial

123 SAL-A

Selection chart for C_R , U_R and relevant maximum case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

C_R (μF)	U_R (V) at $T_{amb} = 85^\circ C$					
	6.3	10	16	25	35	40 ⁽¹⁾
	U_C (V) at $T_{amb} = 125^\circ C$					
	6.3	10	16	25	25	25
1.0	—	—	—	—	6.7 × 15.3	—
1.5	—	—	—	—	6.7 × 15.3	—
2.2	—	—	—	—	6.7 × 15.3	6.7 × 15.3
3.3	—	—	—	—	6.7 × 15.3	6.7 × 15.3
4.7	—	—	—	—	6.7 × 15.3	6.7 × 15.3
6.8	—	—	—	—	6.7 × 15.3	6.7 × 15.3
10	—	—	6.7 × 15.3	6.7 × 15.3	7.6 × 20.4	7.6 × 20.4
15	—	—	6.7 × 15.3	6.7 × 15.3	7.6 × 20.4	7.6 × 20.4
22	—	—	6.7 × 15.3	7.6 × 20.4	7.6 × 20.4	9.3 × 23.3
33	—	6.7 × 15.3	7.6 × 20.4	7.6 × 20.4	9.3 × 23.3	9.3 × 23.3
47	6.7 × 15.3	6.7 × 15.3	7.6 × 20.4	7.6 × 20.4	9.3 × 23.3	10.3 × 32.0
68	6.7 × 15.3	7.6 × 20.4	7.6 × 20.4	9.3 × 23.3	10.3 × 32.0	10.3 × 32.0
100	—	7.6 × 20.4	9.3 × 23.3	9.3 × 23.3	12.9 × 32.0	12.9 × 32.0
150	7.6 × 20.4	9.3 × 23.3	9.3 × 23.3	10.3 × 32.0	12.9 × 32.0	—
220	—	9.3 × 23.3	10.3 × 32.0	12.9 × 32.0	—	—
330	9.3 × 23.3	10.3 × 32.0	10.3 × 32.0	12.9 × 32.0	—	—
470	—	10.3 × 32.0	12.9 × 32.0	—	—	—
680	10.3 × 32.0	12.9 × 32.0	12.9 × 32.0	—	—	—
1000	12.9 × 32.0	12.9 × 32.0	—	—	—	—
1500	12.9 × 32.0	—	—	—	—	—

Note

1. 40 V type is not CECC approved.

MARKING

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

- Rated capacitance (in μF)
- Tolerance code on rated capacitance ($M = \pm 20\%$, $K = \pm 10\%$, in accordance with "IEC 62")
- Rated voltage (in V) 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")
- '+' sign to indicate the positive terminal
- A band to identify the negative terminal.

Solid Aluminium electrolytic capacitors
Solid Al, Axial

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

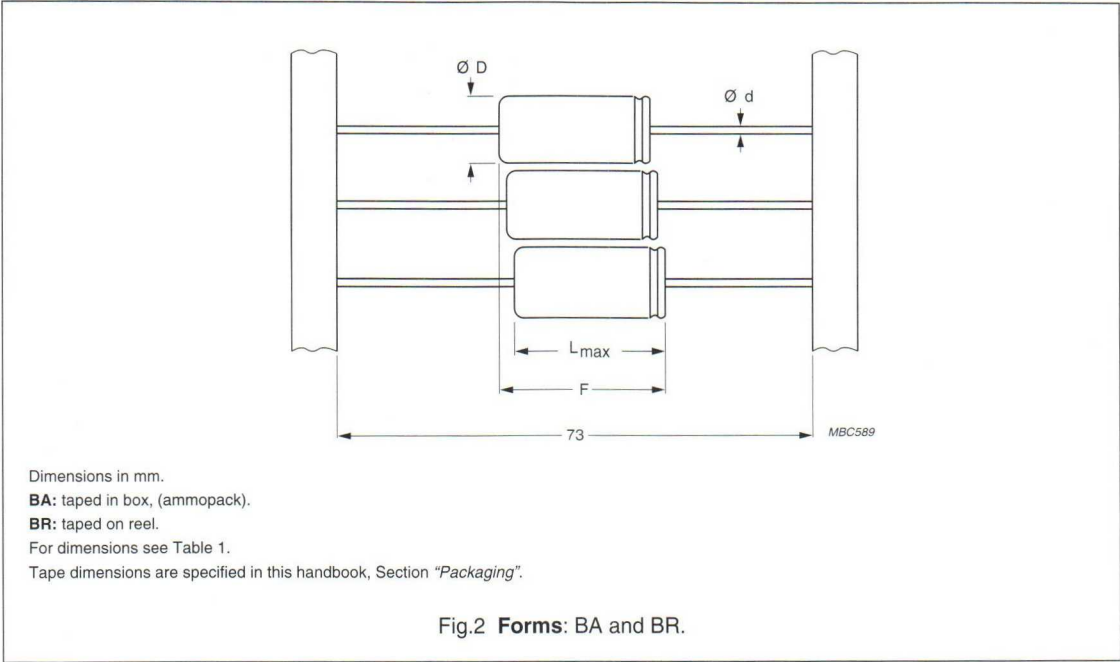


Table 1 Physical dimensions, mass and packaging quantities; see Fig.2

CASE		F _{max} (mm)	Ød (mm)	MASS ⁽²⁾ (g)	PACKAGING QUANTITIES	
MAXIMUM SIZE ØD × L ⁽¹⁾ (mm)	CODE				FORM BA	FORM BR
6.7 × 15.3	1	20.0	0.6	≈ 1.05	100	800
7.6 × 20.4	2A	22.5	0.6	≈ 1.55	100	800
9.3 × 23.3	4	25.0	0.6	≈ 2.6	100	500
10.3 × 32.0	5	35.0	0.8	≈ 4.2	100	500
12.9 × 32.0	6	35.0	0.8	≈ 7	100	400

Notes

1. For epoxy-filled versions add 1 mm to stated L_{max}.
2. Add 10% for SAL-AG epoxy-filled versions.

Solid Aluminium electrolytic capacitors

Solid Al, Axial

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 2, 4 and 6 apply at $T_{amb} = 20$ to $25\text{ }^{\circ}\text{C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
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
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	max. equivalent series resistance at 100 Hz
Z	max. impedance at 100 kHz

Table 2 Electrical data for 123 series; preferred types in **bold**

U_C (V)	U_R (V)	C_R 100 Hz (μF)	MAXIMUM CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 125 $^{\circ}\text{C}$ (mA)	I_R 10 kHz 85 $^{\circ}\text{C}$ (mA)	I_R 100 kHz 40 $^{\circ}\text{C}$ (mA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
6.3	6.3	47	6.7×15.3	58	440	640	15	0.18	7.6	1.2
		68	6.7×15.3	83	520	760	21	0.18	5.3	1.2
		150	7.6×20.4	160	870	1270	47	0.18	2.4	1.0
		330	9.3×23.3	330	1470	2140	104	0.18	1.1	0.4
		680	10.3×32.0	680	2340	3410	214	0.18	0.55	0.3
		1000	12.9×32.0	940	3180	4640	315	0.18	0.36	0.2
		1500	12.9×32.0	1220	4140	6020	473	0.18	0.24	0.2
10	10	33	6.7×15.3	63	360	530	17	0.18	11	1.2
		47	6.7×15.3	83	440	640	24	0.18	7.6	1.2
		68	7.6×20.4	110	590	850	34	0.18	5.3	1.0
		100	7.6×20.4	160	710	1040	50	0.18	3.6	1.0
		150	9.3×23.3	240	990	1450	75	0.18	2.4	0.4
		220	9.3×23.3	350	1180	1720	110	0.18	1.7	0.4
		330	10.3×32.0	490	1650	2410	165	0.18	1.1	0.3
		470	10.3×32.0	570	1940	2830	235	0.18	0.8	0.3
		680	12.9×32.0	760	2580	3750	340	0.18	0.55	0.2
		1000	12.9×32.0	1000	3380	4920	500	0.18	0.36	0.2

Solid Aluminium electrolytic capacitors

Solid Al, Axial

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ORDERING INFORMATION

Ordering example

Electrolytic capacitors 123 series

10 μF /16 V; $\pm 20\%$ Maximum case size: $\varnothing 6.7 \times 15.3$ mm; Form BR

Catalogue number: 2222 123 25109.

Table 3 Ordering information for **123** series; preferred types in **bold**

U _C (V)	U _R (V)	C _R 100 Hz (μF)	MAXIMUM CASE SIZE $\varnothing D \times L$ (mm)	CATALOGUE NUMBER 2222			
				SAL-A FORM BA tol. $\pm 20\%$	SAL-A FORM BR tol. $\pm 20\%$	SAL-AG ⁽¹⁾ FORM BA tol. $\pm 10\%$ level S	SAL-AG ⁽¹⁾ FORM BA tol. $\pm 20\%$
6.3	6.3	47	6.7 $\times$ 15.3	123 13479	123 23479	123 83479	123 63479
		68	6.7 $\times$ 15.3	123 13689	123 23689	123 83689	123 63689
		150	7.6 $\times$ 20.4	123 13151	123 23151	123 83151	123 63151
		330	9.3 $\times$ 23.3	123 13331	123 23331	123 83331	123 63331
		680	10.3 $\times$ 32.0	123 13681	123 23681	123 83681	123 63681
		1000	12.9 $\times$ 32.0	123 13102	123 23102	123 83102	123 63102
		1500	12.9 $\times$ 32.0	123 13152	123 23152	123 83152	123 63152
10	10	33	6.7 $\times$ 15.3	123 14339	123 24339	123 84339	123 64339
		47	6.7 $\times$ 15.3	123 14479	123 24479	123 84479	123 64479
		68	7.6 $\times$ 20.4	123 14689	123 24689	123 84689	123 64689
		100	7.6 $\times$ 20.4	123 14101	123 24101	123 84101	123 64101
		150	9.3 $\times$ 23.3	123 14151	123 24151	123 84151	123 64151
		220	9.3 $\times$ 23.3	123 14221	123 24221	123 84221	123 64221
		330	10.3 $\times$ 32.0	123 14331	123 24331	123 84331	123 64331
		470	10.3 $\times$ 32.0	123 14471	123 24471	123 84471	123 64471
		680	12.9 $\times$ 32.0	123 14681	123 24681	123 84681	123 64681
		1000	12.9 $\times$ 32.0	123 14102	123 24102	123 84102	123 64102

Note

1. SAL-AG types are epoxy-filled.

Solid Aluminium electrolytic capacitors

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ELECTRICAL DATA (continued)

Table 4 Electrical data for 123 series continued; preferred types in **bold**

U _C (V)	U _R (V)	C _R 100 Hz (μF)	MAXIMUM CASE SIZE ØD × 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	16	10	6.7 × 15.3	31	230	330	16	0.14	28	2.5
		15	6.7 × 15.3	47	280	400	24	0.14	19	2.5
		22	6.7 × 15.3	63	340	490	35	0.14	13	2.5
		33	7.6 × 20.4	89	470	680	55	0.14	8.4	2.0
		47	7.6 × 20.4	120	560	810	75	0.14	5.9	2.0
		68	7.6 × 20.4	180	670	970	110	0.14	4.1	2.0
		100	9.3 × 23.3	260	920	1340	160	0.14	2.8	0.8
		150	9.3 × 23.3	310	1060	1550	240	0.16	2.1	0.8
		220	10.3 × 32.0	420	1420	2060	350	0.16	1.5	0.6
		330	10.3 × 32.0	510	1740	2530	500	0.16	1.0	0.6
		470	12.9 × 32.0	680	2280	3330	750	0.16	0.7	0.4
		680	12.9 × 32.0	850	2870	4170	870	0.16	0.5	0.4
25	25	10	6.7 × 15.3	43	230	330	25	0.14	28	5
		15	6.7 × 15.3	60	280	400	35	0.14	19	5.0
		22	7.6 × 20.4	88	370	550	55	0.14	13	2.5
		33	7.6 × 20.4	130	470	680	85	0.14	8.4	2.5
		47	7.6 × 20.4	160	560	810	100	0.14	5.9	2.5
		68	9.3 × 23.3	230	760	1110	170	0.14	4.1	1.0
		100	9.3 × 23.3	250	860	1250	250	0.16	3.2	1.0
		150	10.3 × 32.0	350	1200	1740	400	0.16	2.1	0.8
		220	12.9 × 32.0	460	1560	2270	550	0.16	1.5	0.6
		330	12.9 × 32.0	600	2030	2950	800	0.16	1.0	0.6
25	35	1.5	6.7 × 15.3	7	68	98	5	0.12	160	11.0
		2.2	6.7 × 15.3	10	82	120	5	0.12	109	7.5
		3.3	6.7 × 15.3	14	100	150	7	0.12	73	7.5
		4.7	6.7 × 15.3	20	120	170	10	0.12	51	7.5
		6.8	6.7 × 15.3	27	140	210	15	0.12	35	7.5
		10	7.6 × 20.4	37	200	280	20	0.12	24	2.5
		15	7.6 × 20.4	53	240	350	30	0.12	16	2.5
		22	7.6 × 20.4	78	290	420	45	0.12	11	2.5
		33	9.3 × 23.3	120	410	590	65	0.12	7.2	1.0
		47	9.3 × 23.3	140	480	700	95	0.12	5.1	1.0
		68	10.3 × 32.0	170	570	820	135	0.16	4.7	0.8
		100	12.9 × 32.0	220	760	1100	200	0.16	3.2	0.6
		150	12.9 × 32.0	290	990	1440	300	0.16	2.1	0.6

Solid Aluminium electrolytic capacitors

Solid Al, Axial

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ORDERING INFORMATION (continued)**Table 5** Ordering information for **123** series continued; preferred types in **bold**

U _R (V)	U _R (V)	C _R 100 Hz (µF)	MAXIMUM CASE SIZE ØD × L (mm)	CATALOGUE NUMBER 2222			
				SAL-A FORM BA tol ±20%	SAL-A FORM BR tol ±20%	SAL-AG ⁽¹⁾ FORM BA tol. ±10% level S	SAL-AG ⁽¹⁾ FORM BA tol. ±20%
16	16	10	6.7 × 15.3	123 15109	123 25109	123 85109	123 65109
		15	6.7 × 15.3	123 15159	123 25159	123 85159	123 65159
		22	6.7 × 15.3	123 15229	123 25229	123 85229	123 65229
		33	7.6 × 20.4	123 15339	123 25339	123 85339	123 65339
		47	7.6 × 20.4	123 15479	123 25479	123 85479	123 65479
		68	7.6 × 20.4	123 15689	123 25689	123 85689	123 65689
		100	9.3 × 23.3	123 15101	123 25101	123 85101	123 65101
		150	9.3 × 23.3	123 15151	123 25151	123 85151	123 65151
		220	10.3 × 32.0	123 15221	123 25221	123 85221	123 65221
		330	10.3 × 32.0	123 15331	123 25331	123 85331	123 65331
		470	12.9 × 32.0	123 15471	123 25471	123 85471	123 65471
		680	12.9 × 32.0	123 15681	123 25681	123 85681	123 65681
25	25	10	6.7 × 15.3	123 16109	123 26109	123 86109	123 66109
		15	6.7 × 15.3	123 16159	123 26159	123 86159	123 66159
		22	7.6 × 20.4	123 16229	123 26229	123 86229	123 66229
		33	7.6 × 20.4	123 16339	123 26339	123 86339	123 66339
		47	7.6 × 20.4	123 16479	123 26479	123 86479	123 66479
		68	9.3 × 23.3	123 16689	123 26689	123 86689	123 66689
		100	9.3 × 23.3	123 16101	123 26101	123 86101	123 66101
		150	10.3 × 32.0	123 16151	123 26151	123 86151	123 66151
		220	12.9 × 32.0	123 16221	123 26221	123 86221	123 66221
		330	12.9 × 32.0	123 16331	123 26331	123 86331	123 66331
25	35	1.5	6.7 × 15.3	123 10158	123 20158	123 80158	123 60158
		2.2	6.7 × 15.3	123 10228	123 20228	123 80228	123 60228
		3.3	6.7 × 15.3	123 10338	123 20338	123 80338	123 60338
		4.7	6.7 × 15.3	123 10478	123 20478	123 80478	123 60478
		6.8	6.7 × 15.3	123 10688	123 20688	123 80688	123 60688
		10	7.6 × 20.4	123 10109	123 20109	123 80109	123 60109
		15	7.6 × 20.4	123 10159	123 20159	123 80159	123 60159
		22	7.6 × 20.4	123 10229	123 20229	123 80229	123 60229
		33	9.3 × 23.3	123 10339	123 20339	123 80339	123 60339
		47	9.3 × 23.3	123 10479	123 20479	123 80479	123 60479
		68	10.3 × 32.0	123 10689	123 20689	123 80689	123 60689
		100	12.9 × 32.0	123 10101	123 20101	123 80101	123 60101
		150	12.9 × 32.0	123 10151	123 20151	123 80151	123 60151

Note

1. SAL-AG types are epoxy-filled.

Solid Aluminium electrolytic capacitors

Solid Al, Axial

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ELECTRICAL DATA (continued)**Table 6** Electrical data for **123** series continued; preferred types in **bold**

U_C (V)	U_R (V)	C_R 100 Hz (μF)	MAXIMUM CASE SIZE $\varnothing D \times L$ (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)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
25	40	2.2	6.7 × 15.3	11	82	120	9	0.12	109	7.5
		3.3	6.7 × 15.3	16	100	150	13	0.12	73	7.5
		4.7	6.7 × 15.3	22	120	170	19	0.12	51	7.5
		6.8	6.7 × 15.3	28	140	210	27	0.12	35	7.5
		10	7.6 × 20.4	41	200	280	40	0.12	24	2.5
		15	7.6 × 20.4	61	240	350	60	0.12	16	2.5
		22	9.3 × 23.3	89	330	480	90	0.12	11	1.5
		33	9.3 × 23.3	120	410	590	130	0.12	7.2	1.0
		47	10.3 × 32.0	160	540	790	190	0.12	5.1	1.0
		68	10.3 × 32.0	170	570	820	270	0.16	4.7	0.8
		100	12.9 × 32.0	220	760	1100	400	0.16	3.2	0.6

ORDERING INFORMATION (continued)**Table 7** Ordering information for **123** series continued; preferred types in **bold**

U_C (V)	U_R (V)	C_R 100 Hz (μF)	MAXIMUM CASE SIZE $\varnothing D \times L$ (mm)	CATALOGUE NUMBER 2222			
				SAL-A FORM BA tol ±20%	SAL-A FORM BR tol ±20%	SAL-AG ⁽¹⁾ FORM BA tol. ±10% level S	SAL-AG ⁽¹⁾ FORM BA tol. ±20%
25	40	2.2	6.7 × 15.3	123 17228	123 27228	123 87228	123 67228
		3.3	6.7 × 15.3	123 17338	123 27338	123 87338	123 67338
		4.7	6.7 × 15.3	123 17478	123 27478	123 87478	123 67478
		6.8	6.7 × 15.3	123 17688	123 27688	123 87688	123 67688
		10	7.6 × 20.4	123 17109	123 27109	123 87109	123 67109
		15	7.6 × 20.4	123 17159	123 27159	123 87159	123 67159
		22	9.3 × 23.3	123 17229	123 27229	123 87229	123 67229
		33	9.3 × 23.3	123 17339	123 27339	123 87339	123 67339
		47	10.3 × 32.0	123 17479	123 27479	123 87479	123 67479
		68	10.3 × 32.0	123 17689	123 27689	123 87689	123 67689
		100	12.9 × 32.0	123 17101	123 27101	123 87101	123 67101

Note

1. SAL-AG types are epoxy-filled.

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ELECTRICAL DATA (continued)**Additional electrical data**

PARAMETER	CONDITIONS	VALUE
Surge voltage	for short periods	$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} < 0.3 \times U_R$
Maximum peak AC voltage, reverse voltage applied		$\leq 2 \text{ V}$
Maximum peak AC voltage, without reverse voltage applied	$T_{amb} \leq 85 \text{ }^\circ\text{C}$: at $f \leq 0.1 \text{ Hz}$ at $0.1 \text{ Hz} < f \leq 1 \text{ Hz}$ at $1 \text{ Hz} < f \leq 10 \text{ Hz}$ at $10 \text{ Hz} < f \leq 50 \text{ Hz}$ at $f > 50 \text{ Hz}$ $85 \text{ }^\circ\text{C} < T_{amb} \leq 125 \text{ }^\circ\text{C}$: at $f \leq 0.1 \text{ Hz}$ at $0.1 \text{ Hz} < f \leq 1 \text{ Hz}$ at $1 \text{ Hz} < f \leq 10 \text{ Hz}$ at $10 \text{ Hz} < f \leq 50 \text{ Hz}$ at $f > 50 \text{ Hz}$	$0.30 \times U_R$ $0.45 \times U_R$ $0.60 \times U_R$ $0.65 \times U_R$ $0.80 \times U_R$ $0.15 \times U_R$ $0.22 \times U_R$ $0.30 \times U_R$ $0.32 \times U_R$ $0.40 \times U_R$
Current		
Maximum leakage current	after 5 minutes at U_R and $T_{amb} = 25 \text{ }^\circ\text{C}$	$I_{L5} \leq 0.05 C_R \times U_R$ or $2 \text{ } \mu\text{A}$ whichever is greater; see Tables 2, 4 and 6
Typical leakage current	after 15 s at U_R and $T_{amb} = 25 \text{ }^\circ\text{C}$: $U_R = 6.3 \text{ to } 16 \text{ V}$ $U_R = 25 \text{ to } 40 \text{ V}$	$\approx 0.2 \times$ value stated in Tables 2, 4 and 6 $\approx 0.1 \times$ value stated in Tables 2, 4 and 6

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Voltage

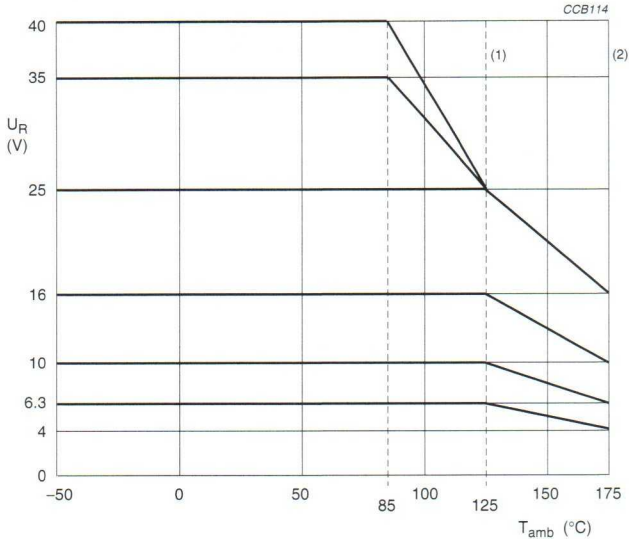


Fig.3 Maximum permissible voltage up to 175 °C.

Ripple current (I_R)

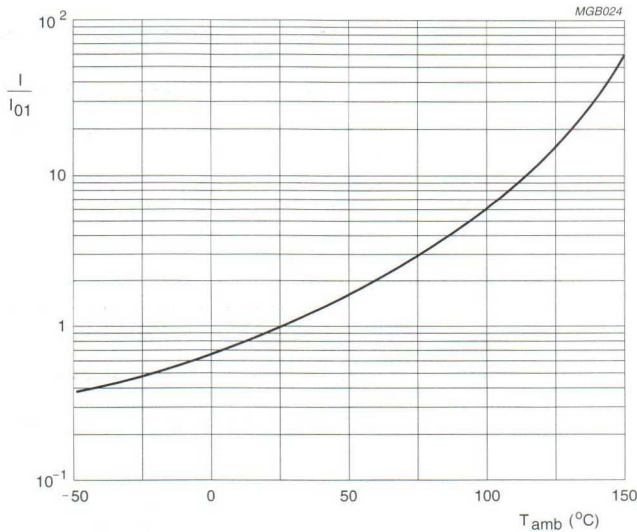
Applying the maximum RMS ripple current given in Tables 2, 4 and 6 will cause a device temperature of 138 °C. The 100 kHz values in Tables 2, 4 and 6 for other temperatures are to be calculated with the following I_R multipliers:

PARAMETER	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

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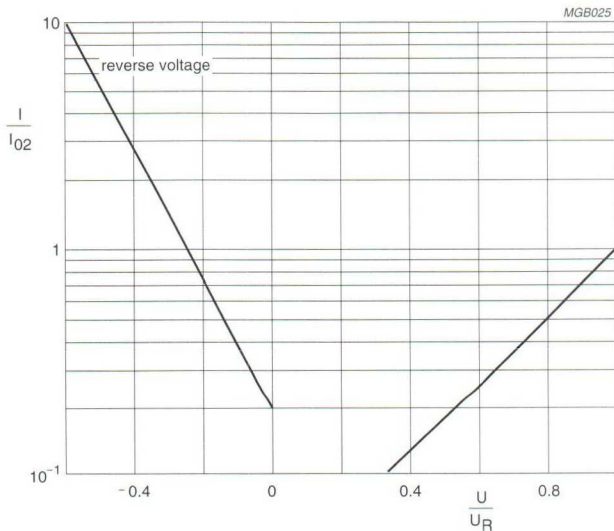
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Leakage current



I_{01} = leakage current during continuous operation at U_R and $T_{amb} = 25^{\circ}C$.

Fig.4 Typical multiplier of leakage current 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 as a function of U/U_R .

SAL

Solid Aluminium electrolytic capacitors

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Maximum power dissipation

MAXIMUM CASE SIZE $\varnothing D \times L$ (mm)	$P_{\max} = P_{125}$ (W)
6.7×15.3	0.13
7.6×20.4	0.16
9.3×23.3	0.21
10.3×32.0	0.26
12.9×32.0	0.32

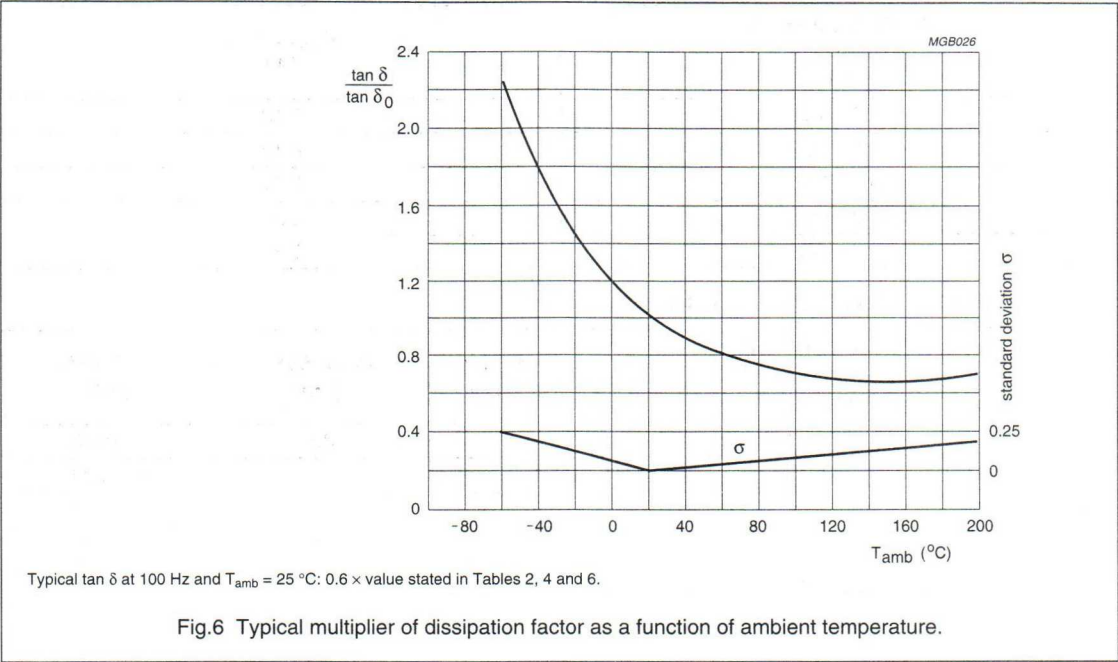
Equivalent series inductance (ESL), $f = 10$ MHz

MAXIMUM CASE SIZE $\varnothing D \times L$ (mm)	PITCH (mm)	MAX. ESL (nH)	TYP. ESL (nH)
6.7×15.3	20.3	30	15 to 23
7.6×20.4	25.4	30	16 to 24
9.3×23.3	27.9	35	20 to 27
10.3×32.0	35.6	40	26 to 33
12.9×32.0	35.6	55	32 to 49

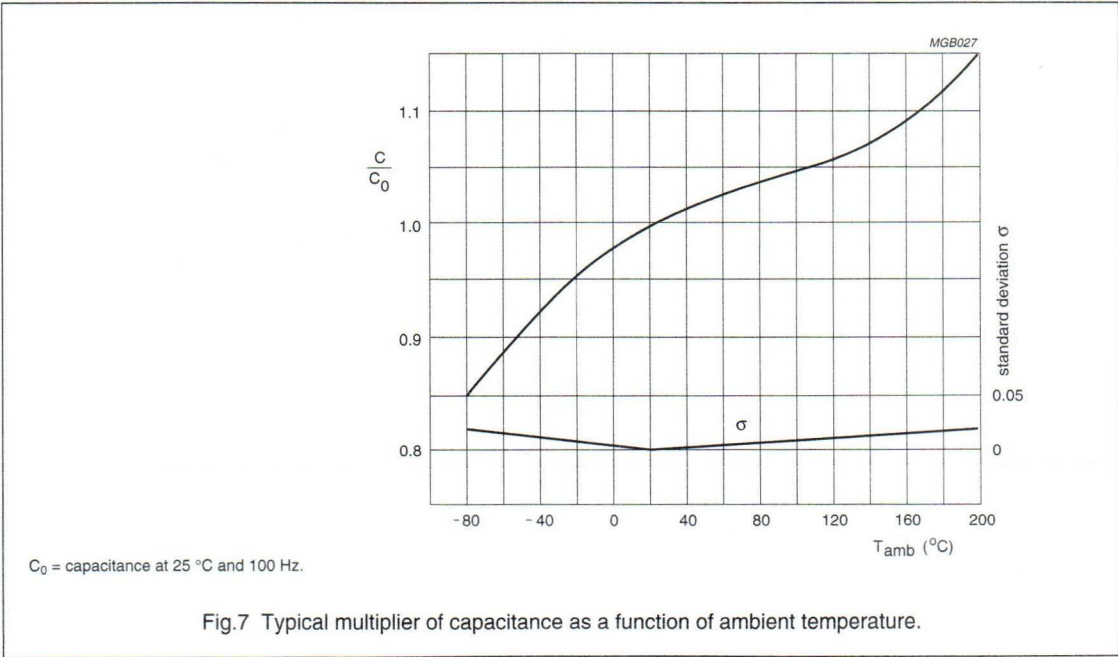
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Dissipation factor ($\tan \delta$)



Capacitance (C)



SAL

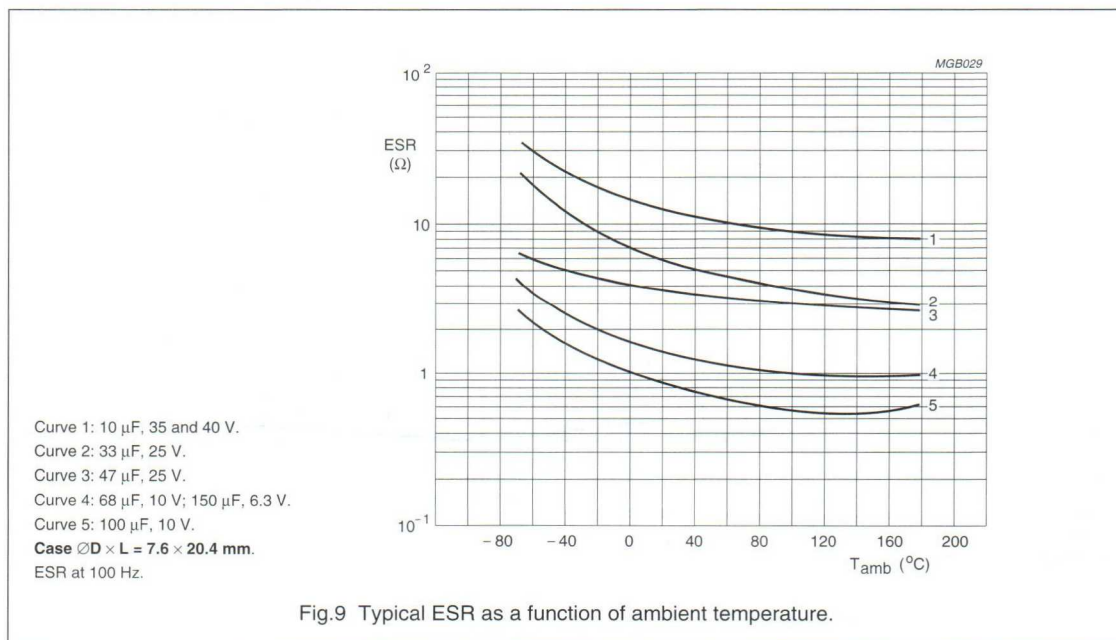
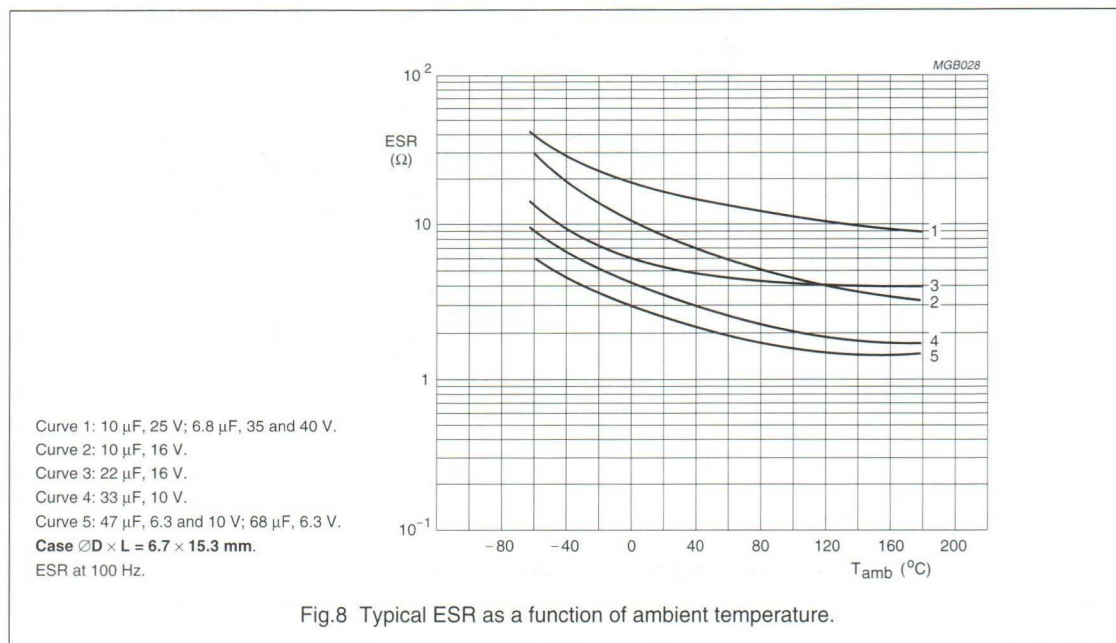
Solid Aluminium electrolytic capacitors

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123 SAL-A

Equivalent series resistance (ESR)

Typical ESR: see Figs 8 to 17; the standard deviation is 20% of each value.



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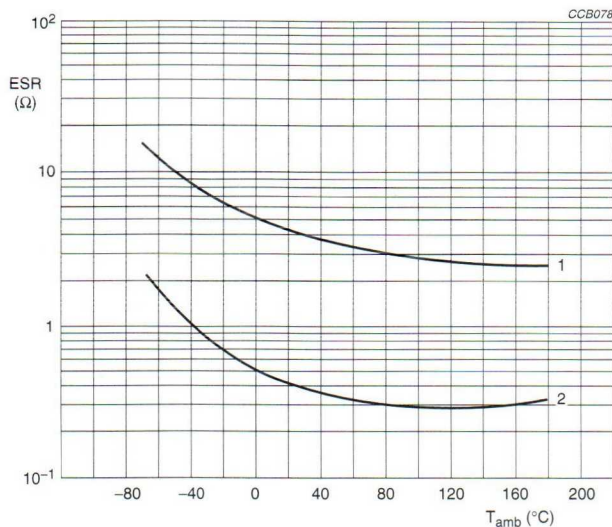


Fig.10 Typical ESR as a function of ambient temperature.

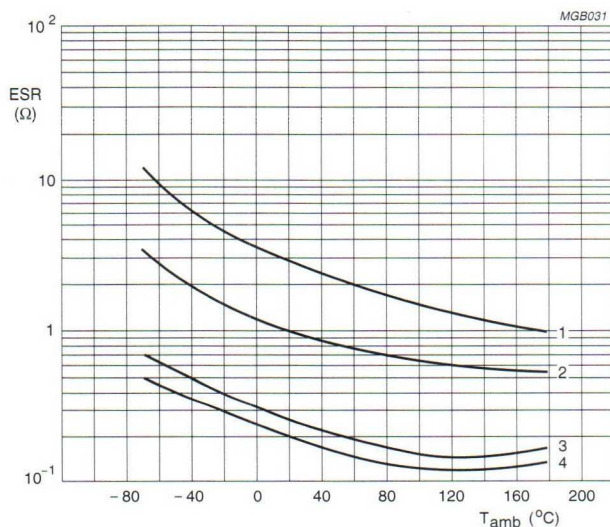


Fig.11 Typical ESR as a function of ambient temperature.

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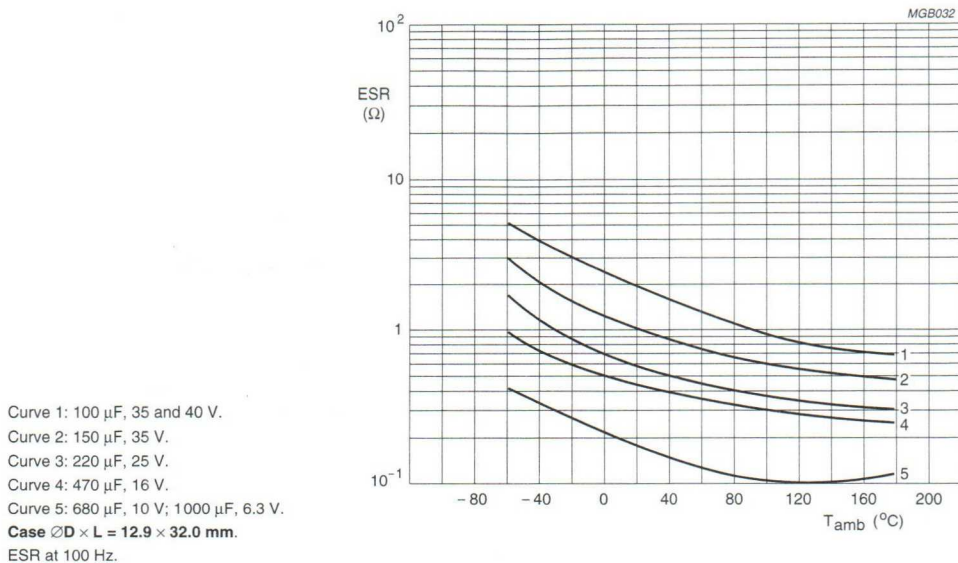


Fig.12 Typical ESR as a function of ambient temperature.

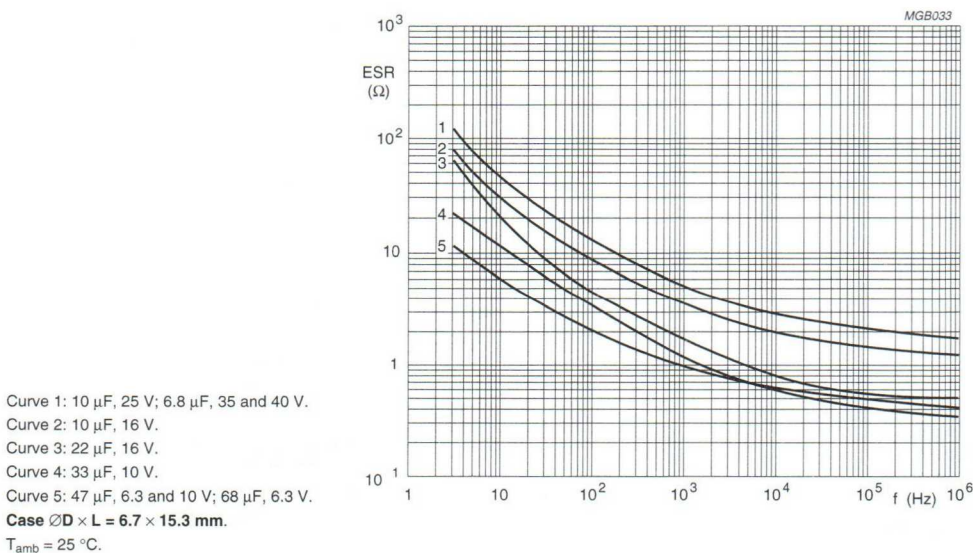


Fig.13 Typical ESR as a function of frequency.

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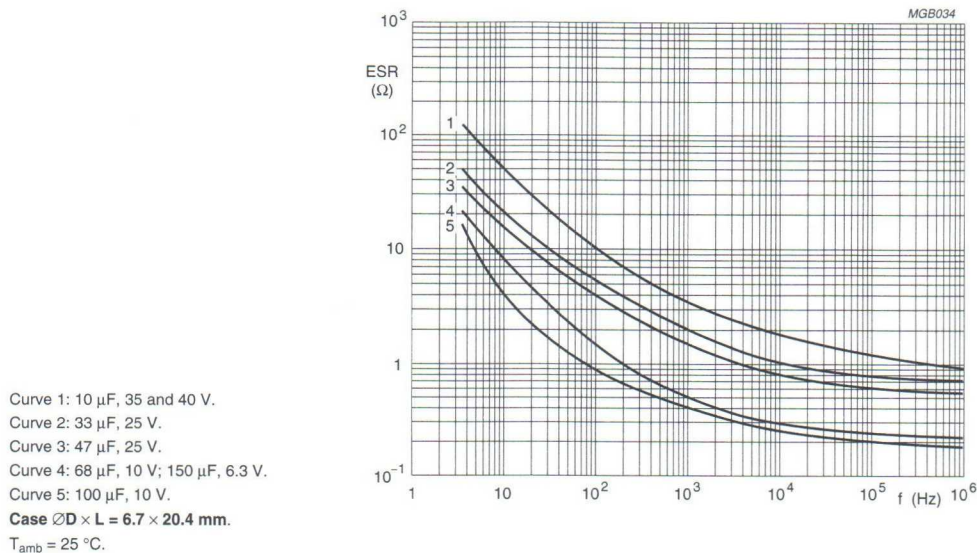


Fig.14 Typical ESR as a function of frequency.

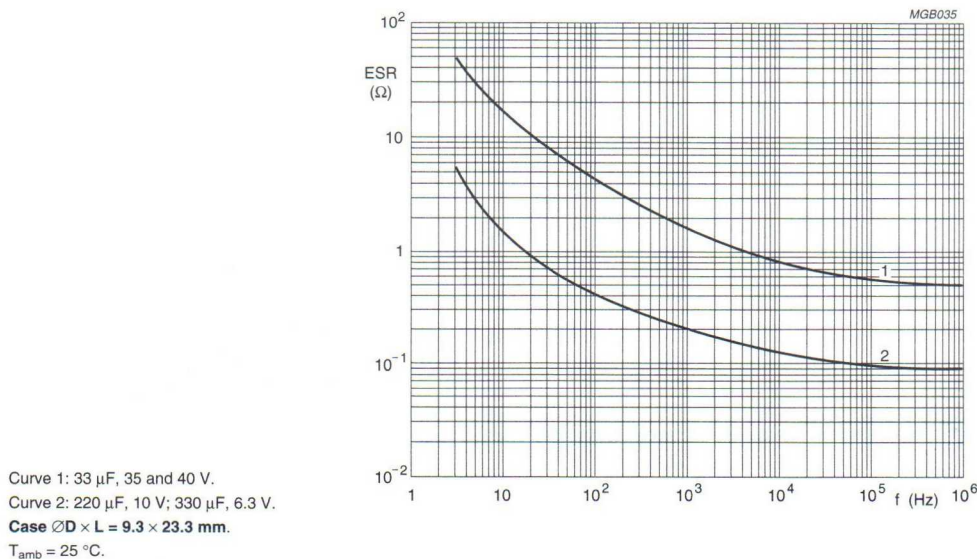


Fig.15 Typical ESR as a function of frequency.

Solid Aluminium electrolytic capacitors

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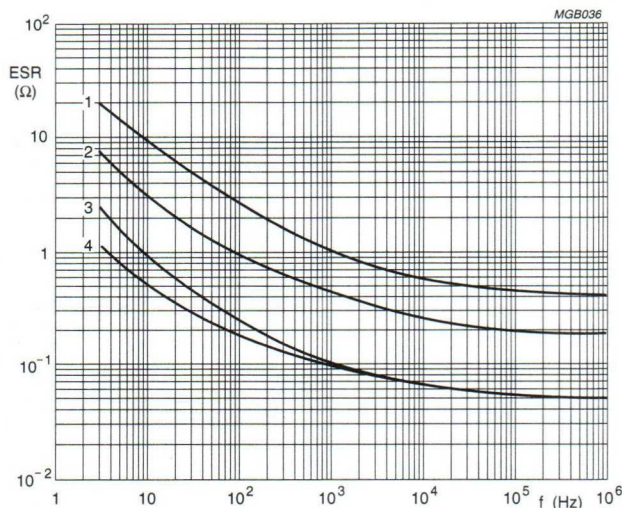
Curve 1: 68 μ F, 35 and 40 V.Curve 2: 150 μ F, 25 V.Curve 3: 330 μ F, 10 V.Curve 4: 470 μ F, 10 V.**Case** $\varnothing D \times L = 10.3 \times 32.0$ mm. $T_{amb} = 25$ °C.

Fig.16 Typical ESR as a function of frequency.

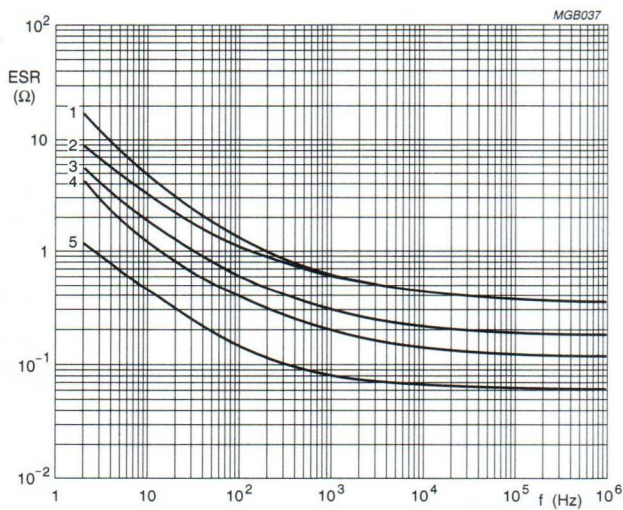
Curve 1: 100 μ F, 35 and 40 V.Curve 2: 150 μ F, 35 V.Curve 3: 220 μ F, 25 V.Curve 4: 470 μ F, 16 V.Curve 5: 680 μ F, 10 V; 1000 μ F, 6.3 V.**Case** $\varnothing D \times L = 12.9 \times 32.0$ mm. $T_{amb} = 25$ °C.

Fig.17 Typical ESR as a function of frequency.

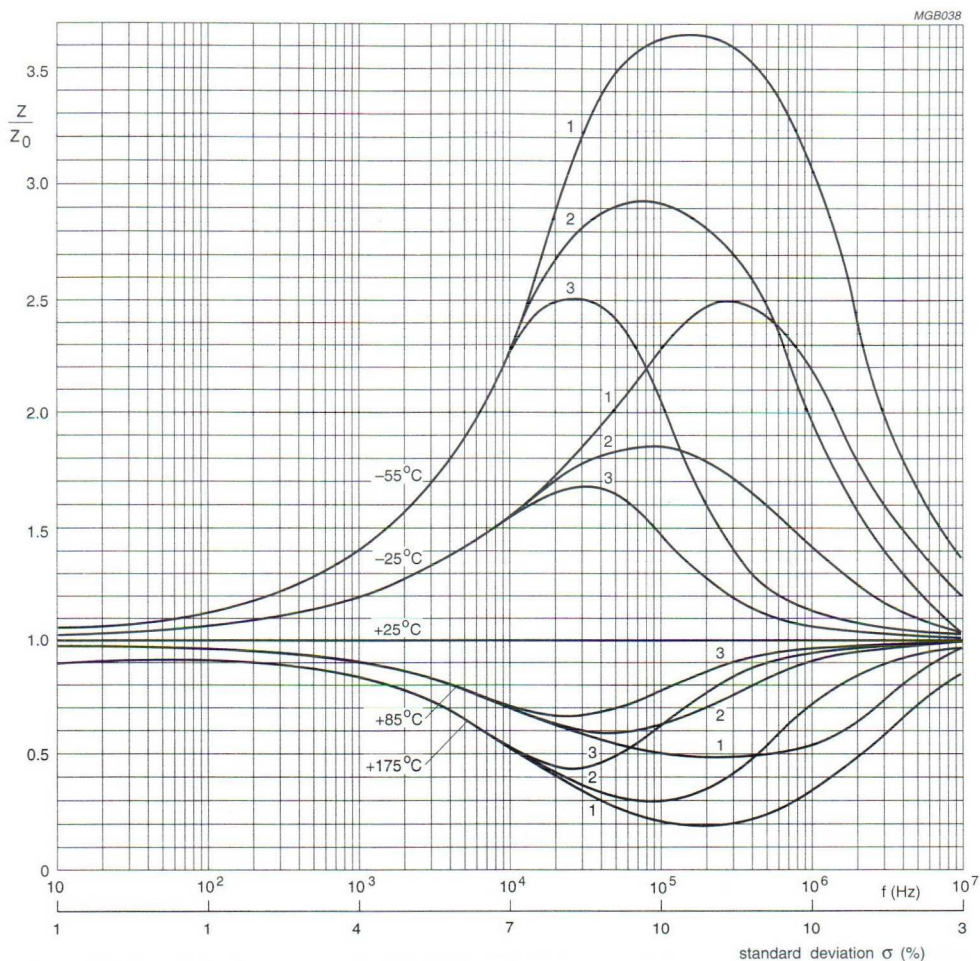
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Impedance (Z)

Typical impedance at 100 kHz and $T_{amb} = 25^\circ\text{C}$: $0.5 \times$ value stated in Tables 2, 4 and 6.



Curve 1: case $\varnothing D \times L = 6.7 \times 15.3$ and 7.6×20.4 mm; 16 to 40 V.
 Curve 2: case $\varnothing D \times L = 6.7 \times 15.3$ and 7.6×20.4 mm; 6.3 to 10 V.
 Curve 3: case $\varnothing D \times L = 9.3 \times 32.0$, 10.3×32.0 and 12.9×32.0 mm.
 Z_0 = initial impedance value at any frequency and $T_{amb} = 25^\circ\text{C}$.

Fig.18 Typical multiplier of impedance as a function of frequency at different ambient temperatures.

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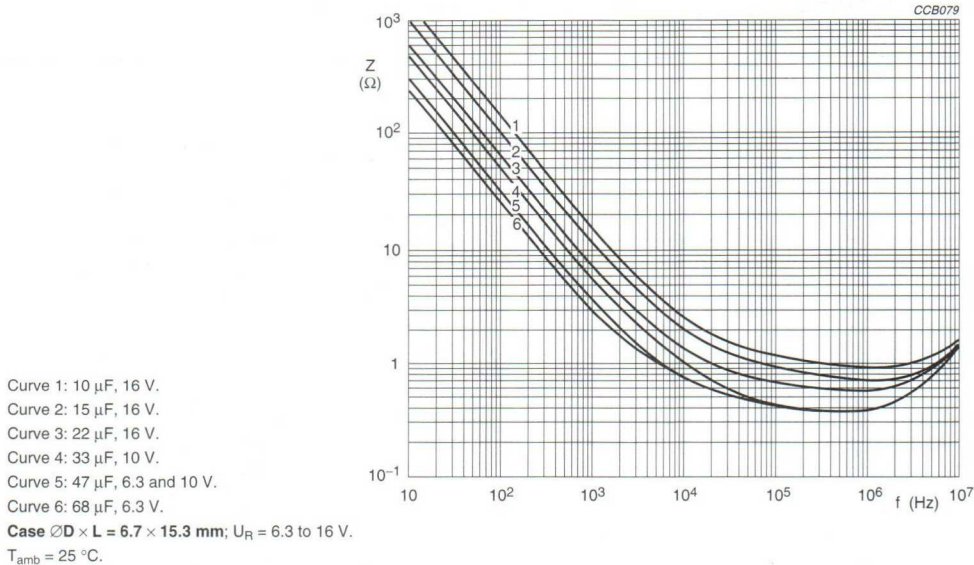


Fig.19 Typical impedance as a function of frequency.

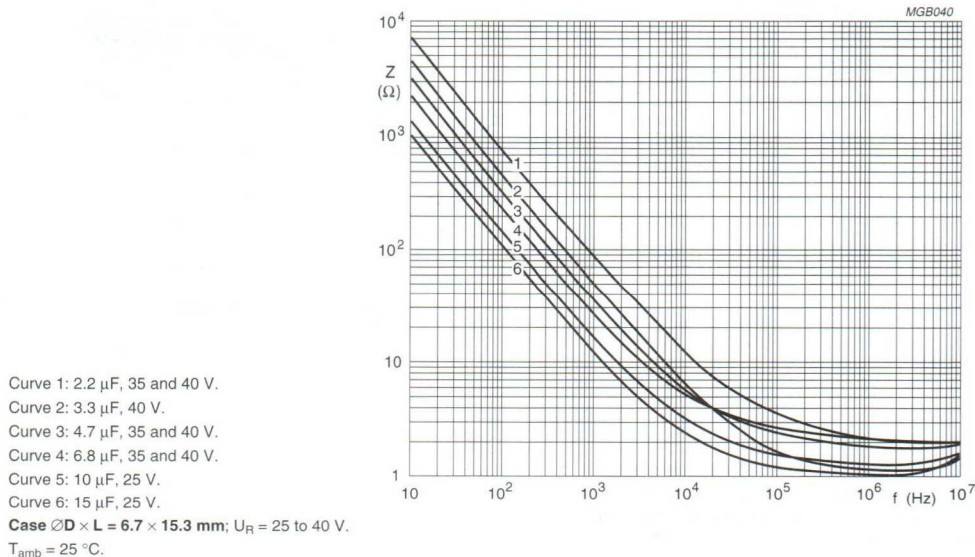


Fig.20 Typical impedance as a function of frequency.

Solid Aluminium electrolytic capacitors

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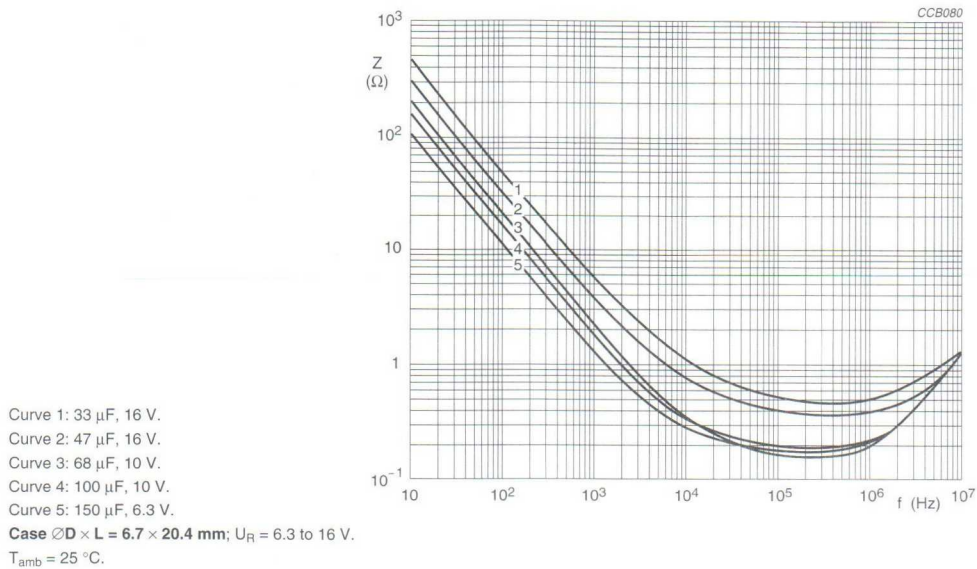


Fig.21 Typical impedance as a function of frequency.

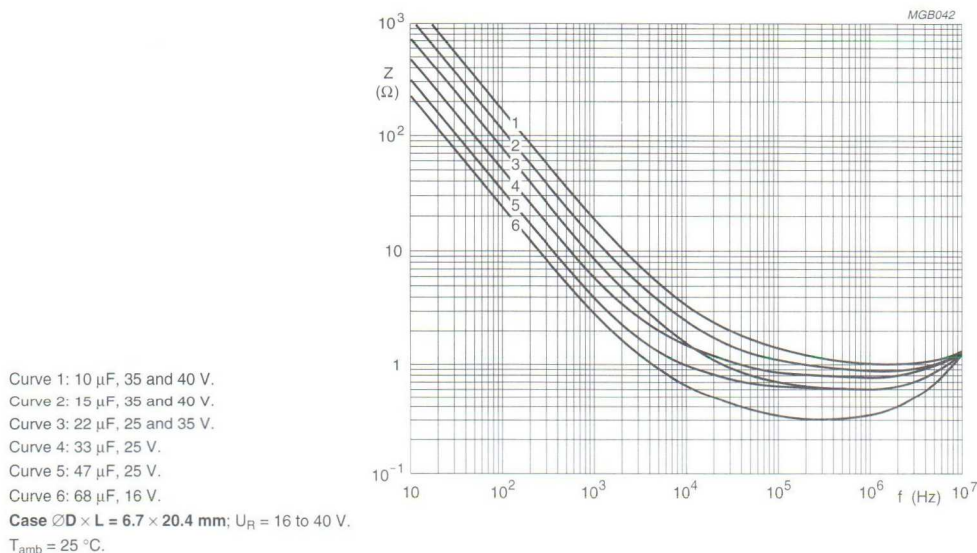
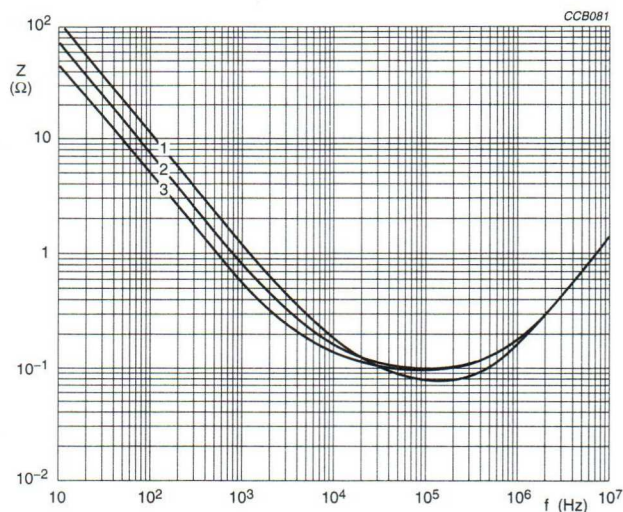


Fig.22 Typical impedance as a function of frequency.

Solid Aluminium electrolytic capacitors

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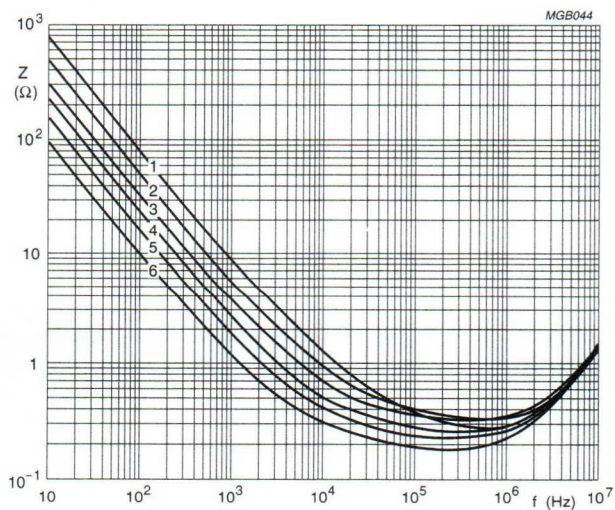
123 SAL-A



Case $\varnothing D \times L = 9.3 \times 23.3 \text{ mm}$; $U_R = 6.3 \text{ to } 10 \text{ V}$.

$T_{\text{amb}} = 25^\circ\text{C}$.

Fig.23 Typical impedance as a function of frequency.



Case $\varnothing D \times L = 9.3 \times 23.3 \text{ mm}$; $U_R = 16 \text{ to } 40 \text{ V}$.

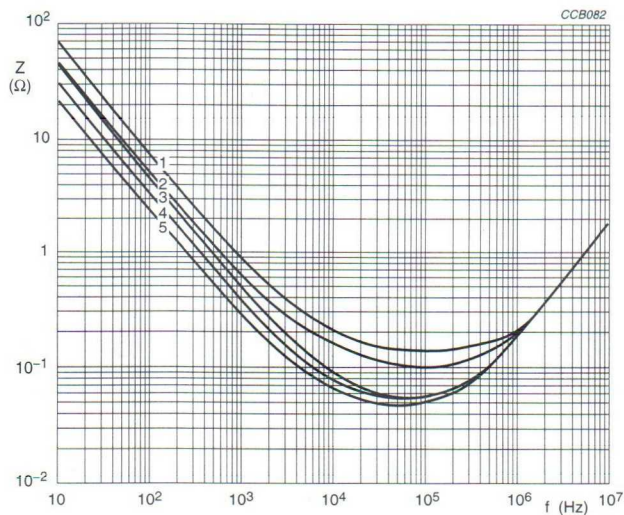
$T_{\text{amb}} = 25^\circ\text{C}$.

Fig.24 Typical impedance as a function of frequency.

Solid Aluminium electrolytic capacitors

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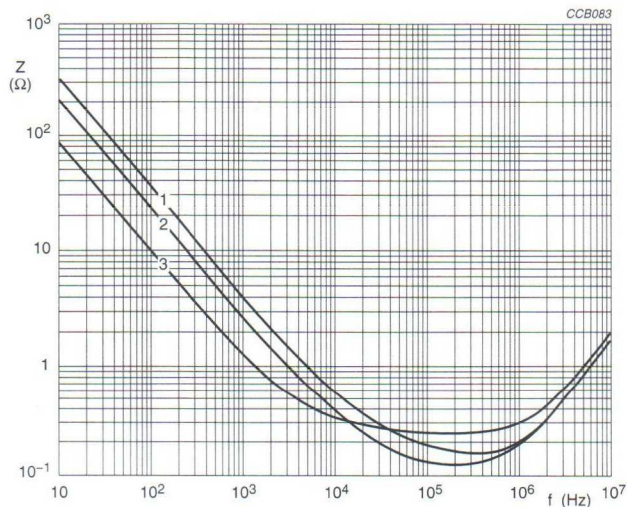


Curve 1: 220 μ F, 16 V.
 Curve 2: 330 μ F, 16 V.
 Curve 3: 330 μ F, 10 V.
 Curve 4: 470 μ F, 10 V.
 Curve 5: 680 μ F, 6.3 V.

Case $\varnothing D \times L = 10.3 \times 32.0$ mm; $U_R = 6.3$ to 16 V.

$T_{amb} = 25$ °C.

Fig.25 Typical impedance as a function of frequency.



Curve 1: 47 μ F, 40 V.
 Curve 2: 68 μ F, 35 and 40 V.
 Curve 3: 150 μ F, 25 V.

Case $\varnothing D \times L = 10.3 \times 32.0$ mm; $U_R = 25$ to 40 V.

$T_{amb} = 25$ °C.

Fig.26 Typical impedance as a function of frequency.

Solid Aluminium electrolytic capacitors

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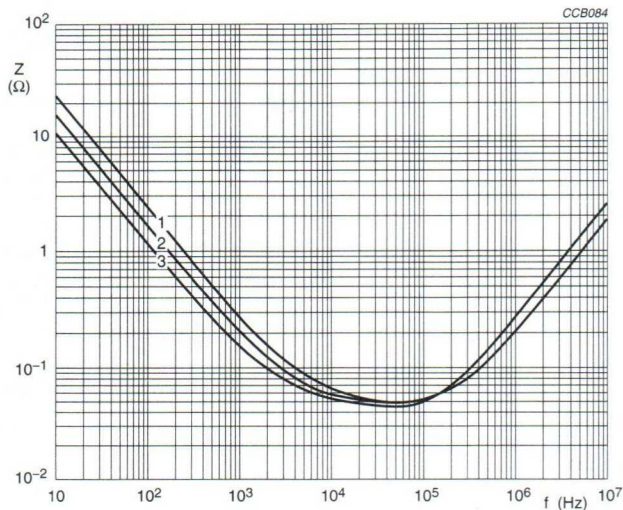
Curve 1: 680 μ F, 10 V.Curve 2: 1000 μ F, 6.3 V.Curve 3: 1500 μ F, 6.3 V.**Case** $\varnothing D \times L = 12.9 \times 32.0$ mm; $U_R = 6.3$ to 10 V. $T_{amb} = 25$ °C.

Fig.27 Typical impedance as a function of frequency.

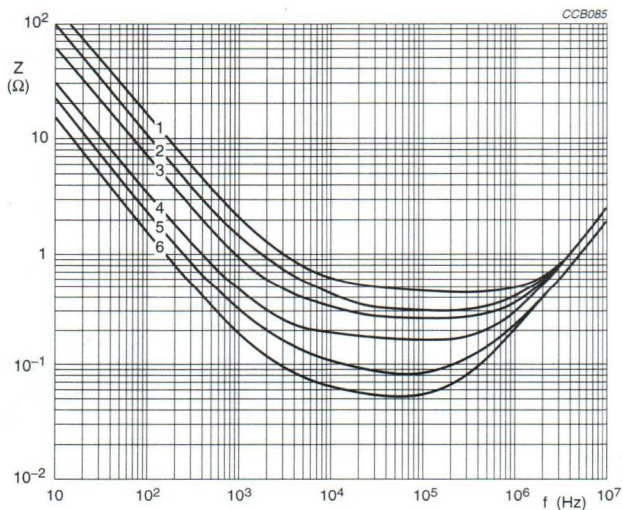
Curve 1: 100 μ F, 35 and 40 V.Curve 2: 150 μ F, 35 V.Curve 3: 220 μ F, 25 V.Curve 4: 470 μ F, 16 V.Curve 5: 680 μ F, 16 V.Curve 6: 1000 μ F, 10 V.**Case** $\varnothing D \times L = 12.9 \times 32.0$ mm; $U_R = 10$ to 40 V. $T_{amb} = 25$ °C.

Fig.28 Typical impedance as a function of frequency.

Solid Aluminium electrolytic capacitors

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 8 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-2/ CECC 30300 subclause 4.13	$T_{amb} = 125\text{ }^{\circ}\text{C}$; $U_R = 6.3$ to 25 V with U_R applied; $U_R = 35$ and 40 V with U_C applied; 10000 hours	$\Delta C/C: \pm 25\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $Z \leq 2.0 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30302 subclause 1.8.1	$T_{amb} = 125\text{ }^{\circ}\text{C}$; 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; 20000 hours	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $Z \leq 1.5 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $<1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 125\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 1 \times \text{spec. limit}$
Charge and discharge	IEC 384-4-2 subclause 9.21	10^6 cycles without series resistance: 0.5 s to U_R ; 0.5 s to ground	$\Delta C/C: \pm 5\%$ no short or open circuit, no visible damage
Shock	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 $\Delta C/C: \pm 5\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $Z \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 1.5 \times \text{spec. limit}$

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TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Severe rapid change of temperature		100 cycles of 30 minutes at $-40\text{ }^{\circ}\text{C}$ and $+125\text{ }^{\circ}\text{C}$	$\Delta C/C: \pm 25\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $Z \leq 2.0 \times \text{spec. limit}$ $I_{L5} \leq 1 \times \text{spec. limit}$
Solvent resistance	IEC 68-2-45, test XA IEC 653	immersion: 5 ± 0.5 minutes with or without ultrasonic at $55 \pm 5\text{ }^{\circ}\text{C}$ solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected
Passive flammability	IEC 695-2-2	capacitor mounted to a vertical printed-circuit board, one flame on capacitor body; $T_{\text{amb}} = 20$ to $25\text{ }^{\circ}\text{C}$; 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

Solid Aluminium electrolytic capacitors

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ADDITIONAL TESTS AND REQUIREMENTS FOR EPOXY-FILLED VERSIONS SAL-AG2222 123 6.... Form BA $\pm 20\%$ 2222 123 8.... Form BA $\pm 10\%$, level S**Table 9** Test procedures and requirements

TEST	PROCEDURE	REQUIREMENTS
Severe vibration tests in accordance with "IEC 68-2-6" and "MIL STD-202", method 204, letter E, with the following details and additions		
Method of mounting:	clamping both body and leads	$\Delta C/C: \pm 10\%$
severity 1	frequency range temperature 10 to 3000 Hz; 20-25 °C	$\tan \delta \leq 1.2 \times \text{stated limit}$
severity 2	frequency range temperature 50 to 2000 Hz; 125 °C	$Z \leq 1.4 \times \text{stated limit}$
severity 1 and 2	vibration amplitude: 50 g or 3.5 mm, whichever is less	DC leakage current: $\leq \text{stated limit}$
Direction and duration of motion:		no intermittent contacts
severity 1	1 octave/minute; 3 directions (mutually perpendicular); 20 sweeps per direction (total 60 sweeps or 18 hours)	no indication of breakdown
severity 2	1 octave/minute; 2 directions (longitudinal and transversal); 3 sweeps per direction (total 6 sweeps or 1 hour)	no open circuiting
Functioning:		no evidence of mechanical damage
severity 1	rated voltage applied	
severity 2	no voltage applied	
Typical capability	>80 g at 10 to 3000 Hz (also at 125 °C)	
Severe shock tests in accordance with "IEC 68-2-27" and "MIL STD-202", method 213, letter F, with the following details and additions:		
Method of mounting	clamping both body and leads	$\Delta C/C: \pm 10\%$
Pulse shape:	half-sine or sawtooth	$\tan \delta \leq 1.2 \times \text{stated limit}$
severity 1	1500 g; 0.5 ms ("MIL STD-202", method 213, letter F)	$Z \leq 1.4 \times \text{stated limit}$
severity 2	3000 g; 0.2 ms	DC leakage current: $\leq \text{stated limit}$
severity 3	10000 g; 0.1 ms	no intermittent contacts
Direction and number of shocks:		no indication of breakdown
severity 1 and 2	3 successive shocks in each direction of 3 mutually perpendicular axes (total 18 shocks)	no open circuiting
severity 3	1 shock in any direction	no evidence of mechanical damage
Functioning	rated voltage applied	

SAL

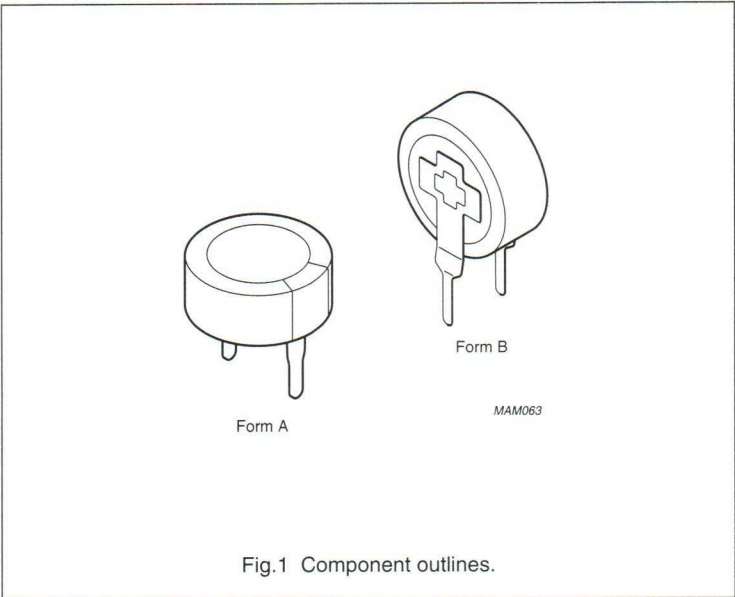
ENERGY STORAGE CAPACITORS (DOUBLE LAYER)

Double layer capacitors

196 DLC

FEATURES

- Polarized capacitor with high charge density, alternative product to rechargeable backup batteries
- Dielectric: electric double layer
- Radial leads, cylindrical case, insulated with a blue vinyl sleeve
- Available in both vertical and low-profile versions
- Unlimited charge and discharge cycle numbers
- No charge-discharge control circuitry and no series resistor 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.

QUICK REFERENCE DATA

DESCRIPTION	VALUE			
	STANDARD FORM A	HIGH VOLTAGE FORM A	HIGH TEMPERATURE FORM A	VERTICAL, MINIATURIZED FORM B
Case sizes ($\varnothing D \times L$ in mm)	13 $\times$ 7 and 21 $\times$ 7.5	13 $\times$ 9 and 21 $\times$ 9	13 $\times$ 9 and 21 $\times$ 9	11.5 $\times$ 13 (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 at 20 °C	-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 :				
at 85 °C	—	—	1 000 hours	—
at 70 °C	1 000 hours	1 000 hours	2 800 hours	1 000 hours
at 40 °C	8 000 hours	8 000 hours	23 000 hours	8 000 hours
at 25 °C	23 000 hours	23 000 hours	64 000 hours	23 000 hours
Shelf life at 0 V	1 000 hours at upper category temperature			
Climatic category IEC 68	25/070/21	25/070/21	25/085/21	25/070/21

Double layer capacitors

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Selection chart for C_R , U_R , upper category temperature (UCT), relevant nominal case sizes ($\varnothing D \times L$ in mm) and Form

Preferred types in **bold**.

C_R (F)	FORM	$U_R = 5.5 \text{ V}$		$U_R = 6.3 \text{ V}$
		UCT = 85 °C	UCT = 70 °C	UCT = 70 °C
0.047	A	13 × 9	13 × 7	13 × 9
	B	—	11.5 × 13	—
0.1	A	13 × 9	13 × 7	13 × 9
	B	—	11.5 × 13	—
0.22	A	—	13 × 7	—
	B	—	11.5 × 13	—
0.33	A	—	13 × 7	—
	B	—	11.5 × 13	—
0.47	A	21 × 9	21 × 7.5	21 × 9
	B	—	—	—
0.68	A	21 × 9	—	21 × 9
	B	—	—	—
1.0	A	—	21 × 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).

Double layer capacitors

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

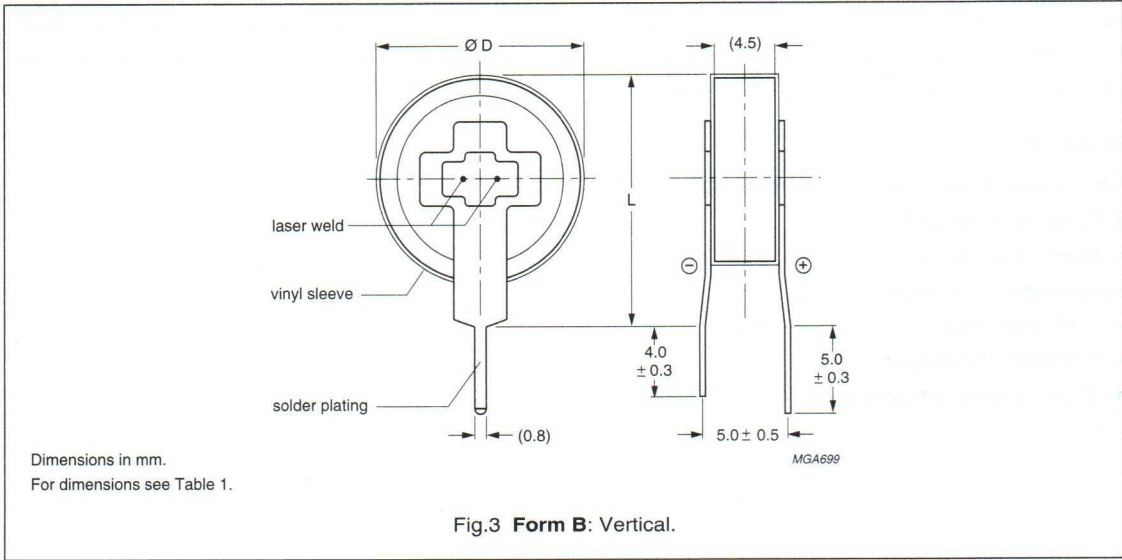
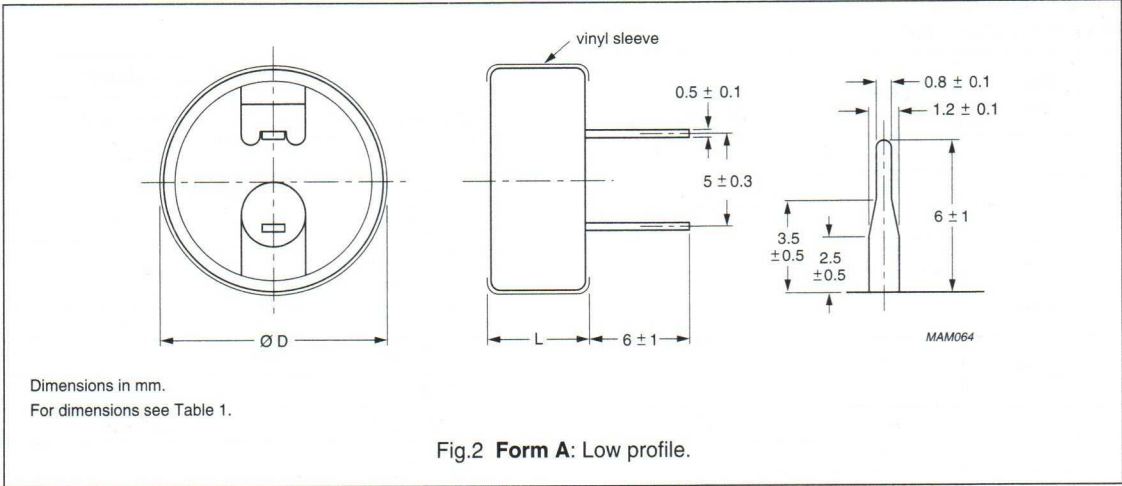


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	FORM	$\varnothing D_{max}$ (mm)	L_{max} (mm)	MASS (g)	PACKAGING QUANTITIES
11.5 × 13	1	B	11.8	13.5	≈1.5	2000
13 × 7	2	A	13.5	7.5	≈2.8	1000
13 × 9	3	A	13.5	9.5	≈3.4	1000
21 × 7.5	4	A	21.5	8.0	≈7.1	500
21 × 9	5	A	21.5	9.5	≈8.8	500

Double layer capacitors

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at
 $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86$ to 106 kPa and $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
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

Ordering example

Double layer capacitor 196 series

1.0 F/5.5 V

Nominal case size: $\varnothing 21 \times 7.5\text{ mm}$;
Form A

Catalogue number: 2222 196 12105.

For test methods see Chapter "Measuring of characteristics".

Table 2 Electrical data and ordering information; preferred types in **bold**

U_R (V)	C_R (F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	Form	UCT ($^{\circ}\text{C}$)	I_L 30 min (μA)	R_i 1 kHz (Ω)	CATALOGUE NUMBER
Standard series								
5.5	0.047	13 × 7	2	A	70	69	120	2222 196 12473
	0.1	13 × 7	2	A	70	100	75	2222 196 12104
	0.22	13 × 7	2	A	70	135	75	2222 196 12224
	0.33	13 × 7	2	A	70	182	75	2222 196 12334
	0.47	21 × 7.5	4	A	70	216	30	2222 196 12474
	1.0	21 × 7.5	4	A	70	315	30	2222 196 12105
High temperature series								
5.5	0.047	13 × 9	3	A	85	69	300	2222 196 22473
	0.1	13 × 9	3	A	85	100	200	2222 196 22104
	0.47	21 × 9	5	A	85	216	50	2222 196 22474
	0.68	21 × 9	5	A	85	260	50	2222 196 22684
Vertical, miniaturized series								
5.5	0.047	11.5 × 13	1	B	70	69	120	2222 196 32473
	0.1	11.5 × 13	1	B	70	100	75	2222 196 32104
	0.22	11.5 × 13	1	B	70	135	75	2222 196 32224
	0.33	11.5 × 13	1	B	70	182	75	2222 196 32334
High voltage series								
6.3	0.047	13 × 9	3	A	70	69	300	2222 196 13473
	0.1	13 × 9	3	A	70	100	200	2222 196 13104
	0.47	21 × 9	5	A	70	216	50	2222 196 13474
	0.68	21 × 9	5	A	70	260	50	2222 196 13684

Double layer capacitors

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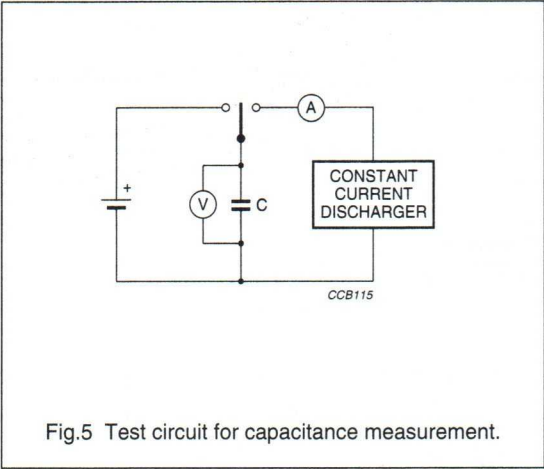
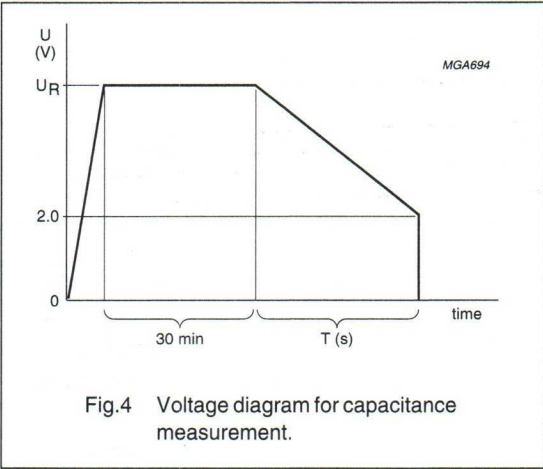
MEASURING OF CHARACTERISTICS

Capacitance (C)

Capacitance shall be measured by constant current discharge method.

Discharge current as a function of rated capacitance

PARAMETER	VALUE							UNIT
Rated capacitance, C _R	0.047	0.1	0.22	0.33	0.47	0.68	1.0	F
Discharge current, I _D	0.1				1.0			mA

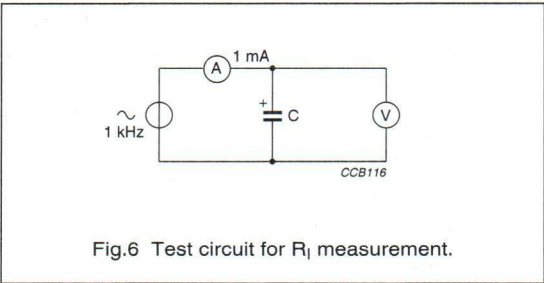


Capacitance value C_R is given by discharge current I_D, time T and rated voltage U_R, according to the following equation:

$$C(F) = \frac{I_D(mA) \times 10^{-3} \times T(s)}{U_R(V) - 2}$$

Internal resistance (R_I) at 1 kHz

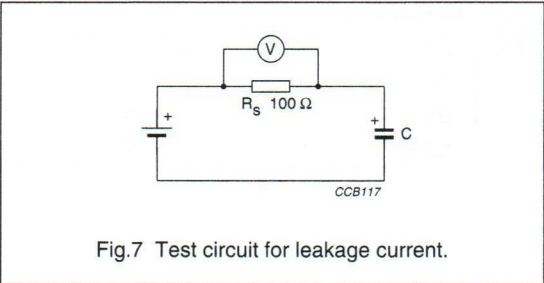
$$R_I(\Omega) = \frac{V_C(V)}{10^{-3}}$$



Leakage current (I_L)

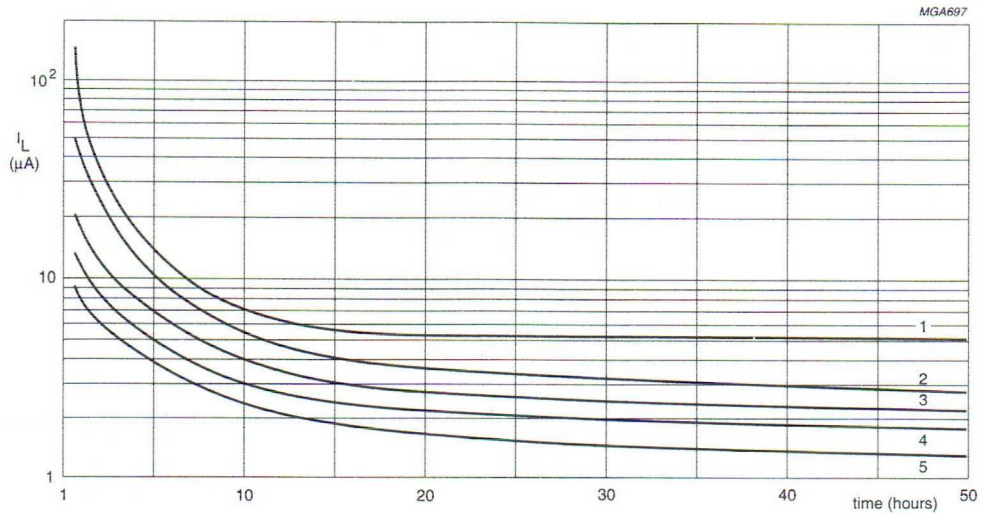
Leakage current shall be measured after 30 minutes application of rated voltage U_R:

$$I_L(\mu A) = \frac{V(V)}{10^{-4}}$$



Double layer capacitors

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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.
 $R_s = 100 \Omega$.

Fig.8 Typical leakage current as a function of time.

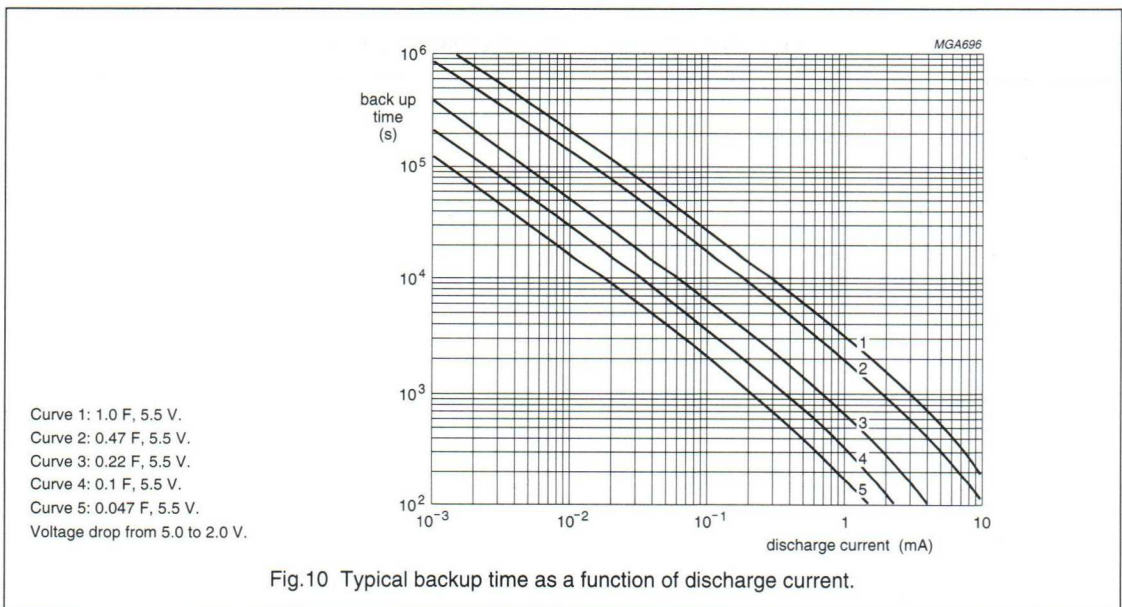
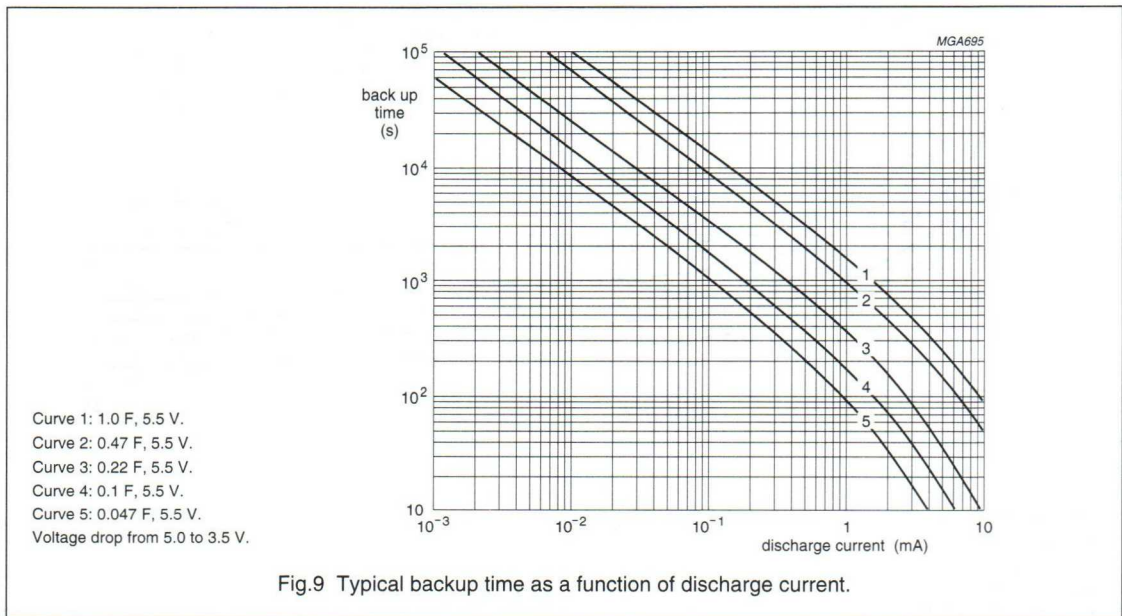
Double layer capacitors

196 DLC

DISCHARGE CHARACTERISTICS

Backup time of 196 DLC series 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 see Figs 9 and 10 (charging time ≥ 24 hours).



Double layer capacitors

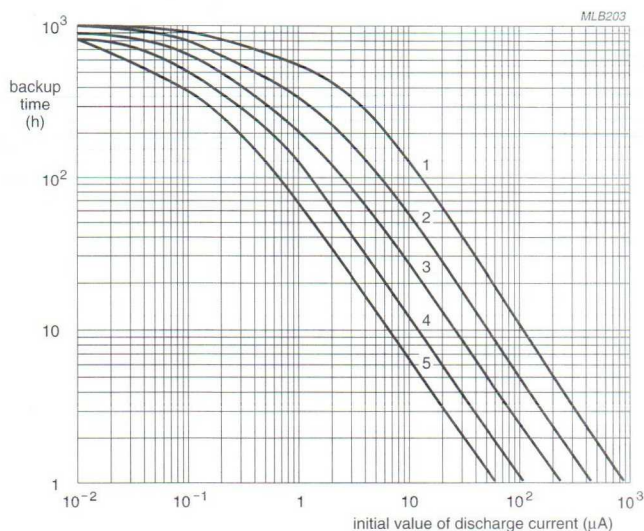
196 DLC

Figure 11 shows the backup time when a 196 DLC capacitor is discharged by a constant resistance (charging time ≥ 24 hours).

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 M Ω and 0.1 μA corresponds to 50 M Ω

The vertical axis shows that period of time during which the voltage drops from 5 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.

Discharge from 5.0 to 2.0 V by means of a fixed resistor.

Fig.11 Typical backup time as a function of initial discharge current.

Double layer capacitors

196 DLC

TESTS AND REQUIREMENTS

Standard and vertical miniaturized series (5.5 V; 70 °C)

Table 3 Test procedures and requirements

NAME OF TEST	IEC 384-4/ CECC 30 300 subclause	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	$\Delta C/C: \pm 10\%$ R_I and $I_L \leq \text{spec. limit}$
Solderability	4.6	solder bath; 235 °C; 2 seconds	$\geq 75\%$ tinning
Vibration	4.8	10 to 55 Hz; 1.5 mm; 3 directions; 2 hours per direction	$\Delta C/C: \pm 10\%$ R_I and $I_L \leq \text{spec. limit}$
Damp heat, steady state	4.12	500 hours at 55 °C; RH 90 to 95%; no voltage applied	$\Delta C/C: \pm 30\%$ $R_I \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$
Endurance	4.13	$T_{\text{amb}} = 70 \text{ °C}$; 5.5 V applied; 1000 hours	$\Delta C/C: \pm 30\%$ $R_I \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$
Storage at upper category temperature	4.17	$T_{\text{amb}} = 70 \text{ °C}$; no voltage applied; 1000 hours	$\Delta C/C: \pm 30\%$ $R_I \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$
Self discharge	—	24 hours storage at room temperature after application of 5 V for 1 hour	remaining voltage: $\geq 4 \text{ V}$
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	$\Delta C/C: \pm 30\%$ of +20 °C value $R_I \leq 5 \times \text{the } +20 \text{ °C value}$ $I_L \leq 4 \times \text{the } +20 \text{ °C value}$

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DATA HANDBOOK SYSTEM

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