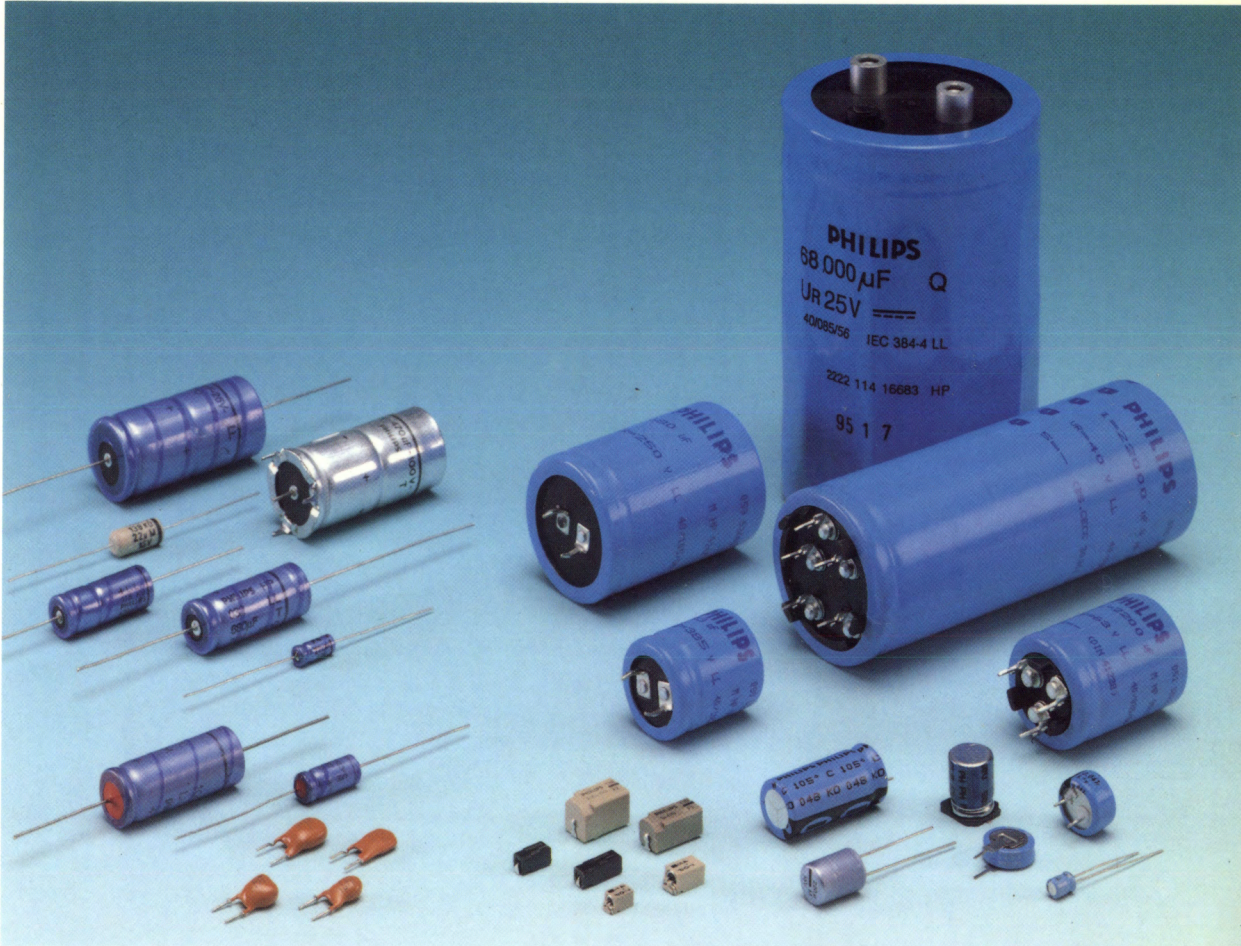


Electrolytic Capacitors



1996

DATA HANDBOOK PA01

Philips
Components



PHILIPS

QUALITY ASSURED

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

PRODUCT SAFETY

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

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

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

Electrolytic Capacitors

GENERAL DATA

Type index; selection charts; replacement list for withdrawn series; selection guide; general introduction; application guidelines and product safety; tests and requirements; generic quality flowchart

PACKAGING

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

PRODUCT SPECIFICATIONS

Surface Mounting Devices

Radial leaded

Axial leaded

Power and mounting accessories

Solid Aluminium

Energy Storage Capacitors (Double layer)

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.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
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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PRODUCT SPECIFICATIONS	82
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Electrolytic Capacitors

Type index

TYPE INDEX

Sequence of catalogue numbers

2222	SERIES	PAGE
013	RLC	162
021	ASM	293
030/031	AS	312
036	RSP	180
036 92	RB	176
036 93	RBA	178
037	RSM	132
041 to 043	ASH	325
042/043	ASH-ELB	339
044	RSH	150
046	RSL	243
047	RMS	193
048	RML	230
050/052	PED-PW	493
051/053	PEC-PW	475
056/057	PSM-SI	428
058/059	PLL-SI	445
085	CS	82
097	RLP 7	125
114/115	PED-ST	534
116	RLL	206
117	ASD	284
118	AHT	392
119	AHT-DIN	410
122	SAL-RP	579
123	SAL-A	597
128	SAL-RPM	560
132/133	ALL-DIN	374
134	RLP 5	118
135	RLI	219
136	RVI	256
137	ABA	350
137 92	AB	348
138	AML	352
139	CLL	104
154/155	PEC-ST	525
162/163	PLL-PW	514
165	RHT	272
166/167	PSM-4TSI	461
168/169	PLL-4TSI	468
172	CLP	96
196	DLC	626

Sequence of series names

SEQUENCE	2222	PAGE
AB	137 92	348
ABA	137	350
AHT	118	392
AHT-DIN	119	410
ALL-DIN	132/133	374
AML	138	352
AS	030/031	312
ASD	117	284
ASH	041 to 043	325
ASH-ELB	042/043	339
ASM	021	293
CLL	139	104
CLP	172	96
CS	085	82
DLC	196	626
PEC-PW	051/053	475
PEC-ST	154/155	525
PED-PW	050/052	493
PED-ST	114/115	534
PLL-PW	162/163	514
PLL-SI	058/059	445
PLL-4TSI	168/169	468
PSM-SI	056/057	428
PSM-4TSI	166/167	461
RB	036 92	176
RBA	036 93	178
RHT	165	272
RLC	013	162
RLI	135	219
RLL	116	206
RLP 5	134	118
RLP 7	097	125
RML	048	230
RMS	047	193
RSH	044	150
RSL	046	243
RSM	037	132
RSP	036	180
RVI	136	256
SAL-A	123	597
SAL-RP	122	579
SAL-RPM	128	560

Technical sequence in handbook

	SEQUENCE	2222	PAGE
SMD	CS	085	82
	CLP	172	96
	CLL	139	104
	RLP 5	134	118
	RLP 7	097	125
	RSM	037	132
	RSH	044	150
	RLC	013	162
	RB	039 92	176
	RBA	036 93	178
RADIAL	RSP	036	180
	RMS	047	193
	RLL	116	206
	RLI	135	219
	RML	048	230
	RSL	046	243
	RVI	136	256
	RHT	165	272
	ASD	117	284
	ASM	021	293
AXIAL	AS	030/031	312
	ASH	041 to 043	325
	ASH-ELB	042/043	339
	AB	137 92	348
	ABA	137	350
	AML	138	352
	ALL-DIN	132/133	374
	AHT	118	392
	AHT-DIN	119	410
	PSM-SI	056/057	428
POWER	PLL-SI	058/059	445
	PSM-4TSI	166/167	461
	PLL-4TSI	168/169	468
	PEC-PW	051/053	475
	PED-PW	050/052	493
	PLL-PW	162/163	514
	PEC-ST	154/155	525
	PED-ST	114/115	534
	SAL-RPM	128	560
	SAL-RP	122	579
E SAL	SAL-A	123	597
	DLC	196	626

SELECTION CHARTS

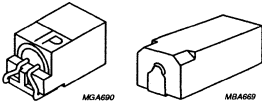


Electrolytic Capacitors

Selection charts

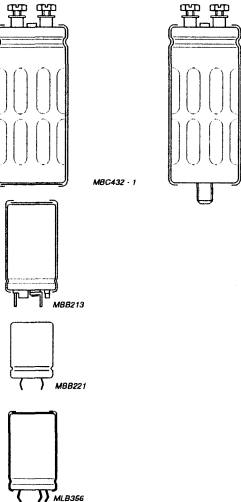
SELECTION CHARTS

SMD ELECTROLYTIC CAPACITORS ('CHIPS')

 <p>MC4690 MDA689</p> <p>NON-SOLID ALUMINIUM</p>	STANDARD	INDUSTRIAL	PROFESSIONAL
	<p>CS085 1500 hours 85 °C page 82</p>	<p>CLP172 1000 hours 105 °C page 96</p>	<p>CLL139 2000 hours 105 °C page 104</p>

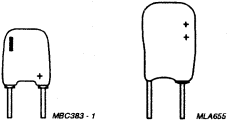

MBC592 - 1

POWER ELECTROLYTIC CAPACITORS

 <p>MBB432 - 1 MBB213 MBB221 MBB356</p>	ECONOMY	EURO-DIN	LONG-LIFE
	10 000-12 000 hours 85 °C	15-20 000 hours 85 °C	5-10 000 hours 105 °C
	<p>PEC-ST PEC-STB 154-155 page 525</p>	<p>PED-ST PED-STB 114-115 page 534</p>	
	<p>PEC-PW 051-053 page 475</p>	<p>PED-PW 050-052 page 493</p>	<p>PLL-PW 162-163 page 514</p>
	<p>PSM-SI 056-057 page 428</p>		<p>PLL-SI 058-059 page 445</p>
	<p>PSM-4TSI 166-167 page 461</p>		<p>PLL-4TSI 168-169 page 468</p>

MBB746 - 2

SOLID ALUMINIUM (SAL) ELECTROLYTIC CAPACITORS

<p>RADIAL (pearl)</p>  <p>MBB383 - 1 MDA655</p>	PROFESSIONAL 20 000 hours / 125 °C	
	<p>SAL- RPM128 H: 9 mm page 560</p>	<p>SAL- RP122 H: 12 mm page 579</p>
<p>AXIAL</p>  <p>MBB107</p>	<p>SAL- A123 page 597</p>	

MBB742 - 2

MBG289

Electrolytic Capacitors

Selection charts

RADIAL NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS

STANDARD & MINIATURE	SEMI-PROFESSIONAL	LONG-LIFE	EXTRA LONG-LIFE or HIGH TEMP.
1500-3000 hours 85 °C	750-1500 hours 105 °C	1500-4000 hours 105 °C	1500 hours / 125 °C ≥ 4000 hours / 105 °C
	page 176 RB 036 92 bipolar RBA 036 93 bipolar audio page 178	RSL 046 page 243	RHT 165 125 °C page 272
RSH 044 HV page 150	RLC 013 low leakage page 162	RLI 135 low Z page 219	RVI 136 105 °C very low Z page 256
RSM 037 LV page 132	page 180 RSP 036 RMS 047 page 193	page 206 RLL 116 RML 048 page 230	
page 125 RLP7 097 H: 7 mm RLP5 134 H: 5 mm page 118			

MBB745 - 1

AXIAL NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS

MINIATURE	STANDARD & SEMI-PROFESSIONAL	LONG-LIFE	EXTRA LONG-LIFE or HIGH TEMP.
1500-2000 hours 85 °C	2500-8000 hours 85 °C	10-15 000 hours / 85 °C 2-5000 hours / 105 °C	4000 hours 125 °C
	page 348 AB 137 92 bipolar ABA 137 bipolar audio page 350	ASH-ELB 042-043 600 V/24 hours page 339	
	page 312 AS 030-031 ASH 041 page 325	page 374 ALL-DIN 132-133 ASH 042-043 page 325	AHT-DIN 119 page 410
page 312 AS 030-031 Ø D = 3.3 mm ASD 117 page 284	ASM 021 page 293	AML 138 page 352	AHT 118 page 392

MBB747 - 2

MBG290

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

SELECTION GUIDE

Electrolytic Capacitors

Selection guide

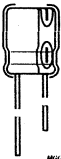
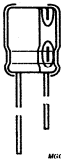
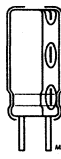
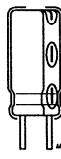
SURFACE MOUNTING DEVICES (SMD)

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μF)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
SMD Non-solid Aluminium Electrolytic Capacitors						
 CS 085	low height wave solderable general purpose	0.47 to 22	6.3 to 63	1500 h/85 °C 40000 h/40 °C 40/085/56	consumer low profile equipment	82
 CLP 172	low height industrial	1.0 to 33	6.3 to 50	1000 h/105 °C 100000 h/40 °C 40/105/56	telecom automotive general industrial low profile equipment	96
 CLL 139	moulded extended CV range wave solderable long life	1.0 to 220	6.3 to 100	2000 h/105 °C 200000 h/40 °C 55/105/56	automotive telecom general industrial domestic appliances	104

Electrolytic Capacitors

Selection guide

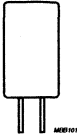
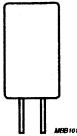
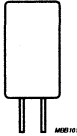
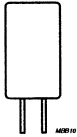
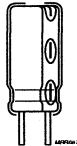
NON-SOLID, RADIAL

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μ F)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Standard types						
 MLC170	RLP 5 134 miniature very low profile height 5 mm general purpose	1.0 to 100	6.3 to 50	1500 h/85 °C 40000 h/40 °C 40/085/56	consumer low profile equipment high mounting density portable equipment	118
 MLC170	RLP 7 097 miniature low profile height 7 mm general purpose	0.1 to 220	6.3 to 63	1500 h/85 °C 40000 h/40 °C 40/085/56	consumer automotive low profile equipment portable equipment	125
 MRR007	RSM 037 high CV/volume general purpose	0.47 to 10000	6.3 to 100	2500 h/85 °C 70000 h/40 °C 40/085/56	consumer automotive general industrial audio-video	132
 MRR007	RSH 044 high voltage long life	1.0 to 100	160 to 450	3000 h/85 °C 80000 h/40 °C 40/085/56	consumer, lighting general industrial power supply smoothing	150

Electrolytic Capacitors

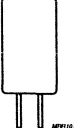
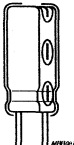
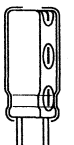
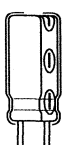
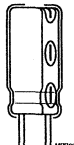
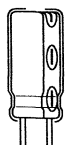
Selection guide

NON-SOLID, RADIAL (continued)

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (μ F)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Semi-Professional types						
	RLC 013 low leakage current e-pitch 2.5 or 5 mm, all-insulated LNZ 44-04	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	162
	RB 036 92 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	176
	RBA 036 93 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	178
	RSP 036 high CV/volume long life e-pitch 2.5 or 5 mm, all-insulated LNZ 44-04 (COJ)	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	180
	RMS 047 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	193

Electrolytic Capacitors

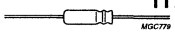
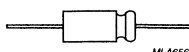
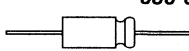
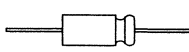
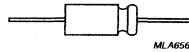
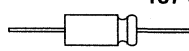

Selection guide

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (μ F)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Long-Life types						
	RLL 116 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	206
	RLI 135 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	219
	RML 048 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	230
	RSL 046 standard dimensions high ripple long life	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	243
Extra-Long-Life types						
	RVI 136 very low impedance very high ripple extra long life	47 to 6800	10 to 63	4-10000 h/105 °C 200-500000 h/40 °C 55/105/56	general industrial telecom, EDP automotive SMPS DC-DC converters	256
	RHT 165 standard dimensions high temp. 125 °C extra long life	22 to 4700	10 to 50	1500 h/125 °C 300000 h/40 °C 40/125/56	automotive outdoor electronics professional telecom military	272

Electrolytic Capacitors





Selection guide

NON-SOLID, AXIAL

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μ F)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Miniature types						
 <p>ASD 117 <small>MG0779</small></p>	ultra miniature diameter 3.3 mm general purpose	0.47 to 22	6.3 to 63	2000 h/85 °C 60 000 h/40 °C 40/085/56	consumer low height low profile equipment	284
 <p>ASM 021 <small>MLA656</small></p>	miniature high CV/volume general purpose/ long life	0.47 to 15 000	6.3 to 100	case length \leq 25 mm: 2500 h/85 °C, 70 000 h/40 °C case length \geq 30 mm: 8 000 h/85 °C, 200 000 h/40 °C 40/085/56	consumer automotive general industrial audio-video telecom, EDP SMPS	293
Semi-Professional types						
 <p>AS 030-031 <small>MLA656</small></p>	standard dimensions general purpose/ long life LNZ 44-04	0.47 to 1 000	6.3 to 100	1 500-3 000 h/85 °C 40-80 000 h/40 °C 40/085/56	consumer, telecom general industrial automotive SMPS	312
 <p>ASH 041-043 <small>MLA656</small></p>	high voltage long life 042-043: CECC 30301-801, (without approval)	1.0 to 220	160 to 450	5-15 000 h/85 °C 120-240 000 h/40 °C 40/085/56	consumer, lighting industrial power supply smoothing	325
 <p>ASH-ELB 042-043 <small>MLA656</small></p>	very high voltage 600 V/24 h/25 °C long life	6.8 to 33	450	15 000 h/85 °C 45 000 h/70 °C 25/085/56	electronic lighting ballast, power supply	339
 <p>AB 137 92 <small>MLA656</small></p>	bipolar-general high CV/volume	1.0 to 470	16 to 63	1 000 h/105 °C 100 000 h/40 °C 40/085/56	AC, non-fixed polarity automotive telecom general industrial	348
 <p>ABA 137 <small>MLA656</small></p>	bipolar- audio-frequency low dissipation factor	2.2 to 22	40 to 100	1 500 h/105 °C 150 000 h/40 °C 40/105/56	audio: speaker crossover network simple wiring AC applications	350

Electrolytic Capacitors




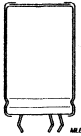
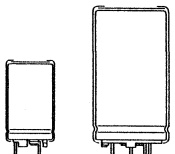
Selection guide

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μ F)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
Long-Life types						
 AML 138	miniature high CV/volume high temp., 105 °C long life	1.0 to 15000	6.3 to 100	2-5000 h/105 °C 200000 h/40 °C 40/105/56	automotive general industrial telecom, EDP SMPS, stand-by	352
 ALL-DIN 132/133	long life, high reliability high ripple current CECC 30301-056 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	374
High Temperature (Extra-Long-Life) types						
 AHT 118	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	392
 AHT-DIN 119	high temp. 125 °C high ripple current extra long life CECC 30301-055 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	410

Electrolytic Capacitors

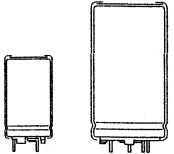
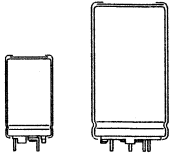
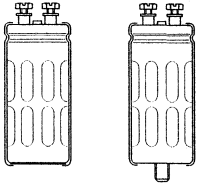
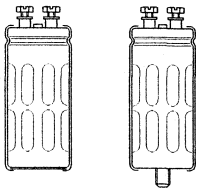

Selection guide

NON-SOLID, POWER

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μF)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	PAGE
Snap-in types						
 <p>PSM-SI 056/057</p>	very 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	428
 <p>PLL-SI 058/059</p>	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	445
4 Terminal snap-in types						
 <p>PSM-4TSI 166/167</p>	high CV/volume 4 snap-in pins keyed polarity high shock and vibration resistance	330 to 68000	10 to 400	10000 h/85 °C 175000 h/40 °C 40/085/56	general industrial power supply smoothing	461
 <p>PLL-4TSI 168/169</p>	high CV/volume 4 snap-in pins keyed polarity high shock and vibration resistance 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	468
PW-Pin types						
 <p>PED-PW 050/052</p>	high ripple, low ESR keyed polarity high shock and vibration resistance LNZ 44-04	47 to 68000	10 to 400	15000 h/85 °C 250000 h/40 °C 40/085/56	general industrial telecom power supply smoothing	493

Electrolytic Capacitors


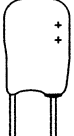


Selection guide

SERIES	FEATURES, STANDARDS, APPROVALS	C_R (μF)	U_R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
 <p>PEC-PW 051/053</p>	high CV/volume keyed polarity high shock and vibration resistance LNZ 44-04	68 to 150000	10 to 400	12000 h/85 °C 200000 h/40 °C 40/085/56	general industrial audio-video power supply smoothing	475
 <p>PLL-PW 162/163</p>	high CV/volume very long life high temp. 105 °C keyed polarity high shock and vibration resistance	68 to 150000	10 to 400	5000 h/105 °C 150000 h/40 °C 40/105/56	general industrial telecom power supply smoothing	514
Screw Terminal/Bolt Types						
 <p>PED-ST 114/115</p>	very long life high ripple low ESR DIN 45910-T128	150 to 220000	10 to 400	20000 h/85 °C 350,000 h/40 °C 40/085/56	general industrial telecom power supply smoothing	534
 <p>PEC-ST 154/155</p>	high CV/volume high ripple	220 to 470000	10 to 400	12000 h/85 °C 200000 h/40 °C 40/085/56	general industrial power supply smoothing	525
Mounting accessories						
	clamps washers nuts				Power types	555

Electrolytic Capacitors

Selection guide

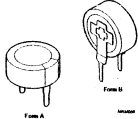
SAL, SOLID ALUMINIUM

SERIES	FEATURES, STANDARDS, APPROVALS	C _R (μF)	U _R (V)	USEFUL LIFE, CLIMATIC CATEGORY	PREFERRED APPLICATIONS	P A G E
 SAL-RPM 128	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	560
 SAL-RP 122	height 12 mm CECC 30302 LNZ 44-04	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	579
 SAL-A 123	extremely long life very high reliability CECC 30302-003 LNZ 44-04	1 to 2200	4 to 40	20000 h/125 °C 450000 h/40 °C 55/125/56	general industrial telecom SMPS military	597
 SAL-AG 123 8	shock- proof 10000 g	1 to 2200	4 to 40	20000 h/125 °C 450000 h/40 °C 55/125/56	aerospace military	597

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
<p style="text-align: center;">DLC 196</p> 	<p>high charge density, ecologically beneficial, maintenance-free</p>	<p>0.047 to 1.0</p>	<p>5.5 or 6.3</p>	<p>1 000 h/70 °C or 85 °C 8 000 h/40 °C or 23 000 h/40 °C 25/070/21 or 25/085/21</p>	<p>energy storage IC memory backup (CMOS) telecom, EDP audio-video</p>	<p>626</p>

SPECIAL DESIGNS

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

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

GENERAL INTRODUCTION

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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
Piercing 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
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:

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

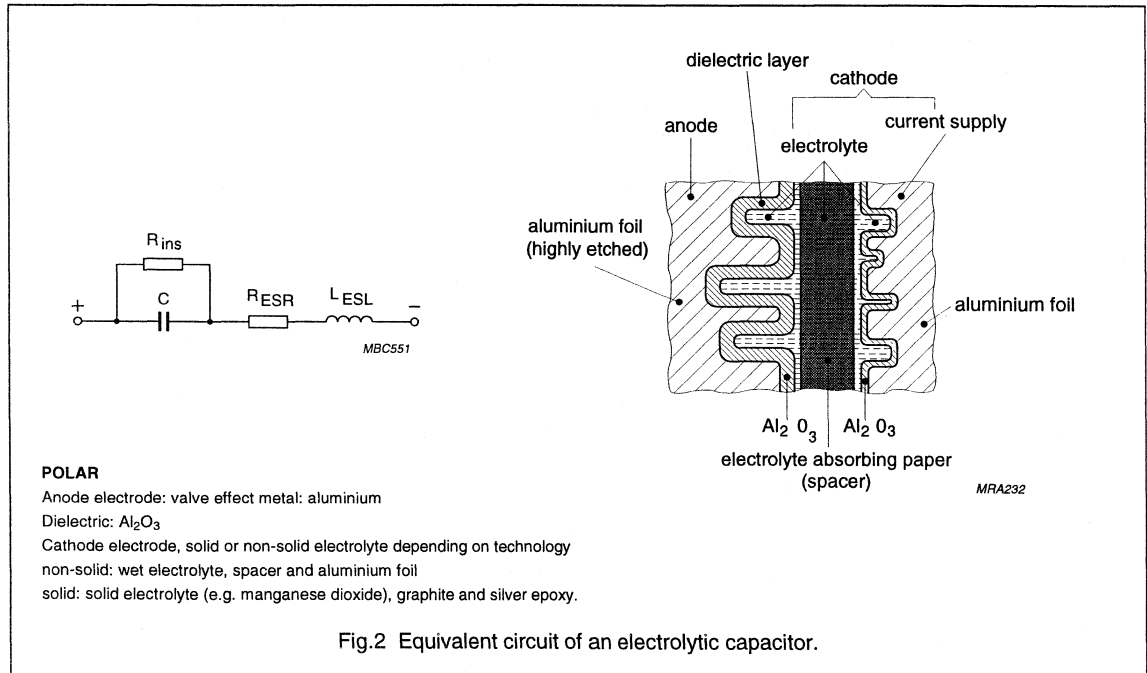
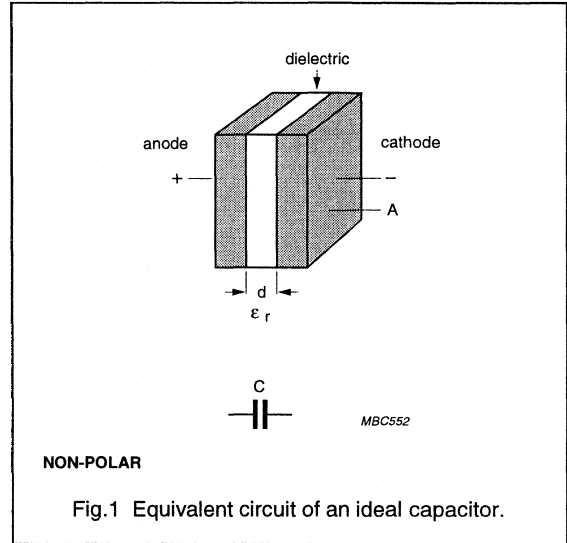
where

- 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:

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



ELECTRICAL BEHAVIOUR

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

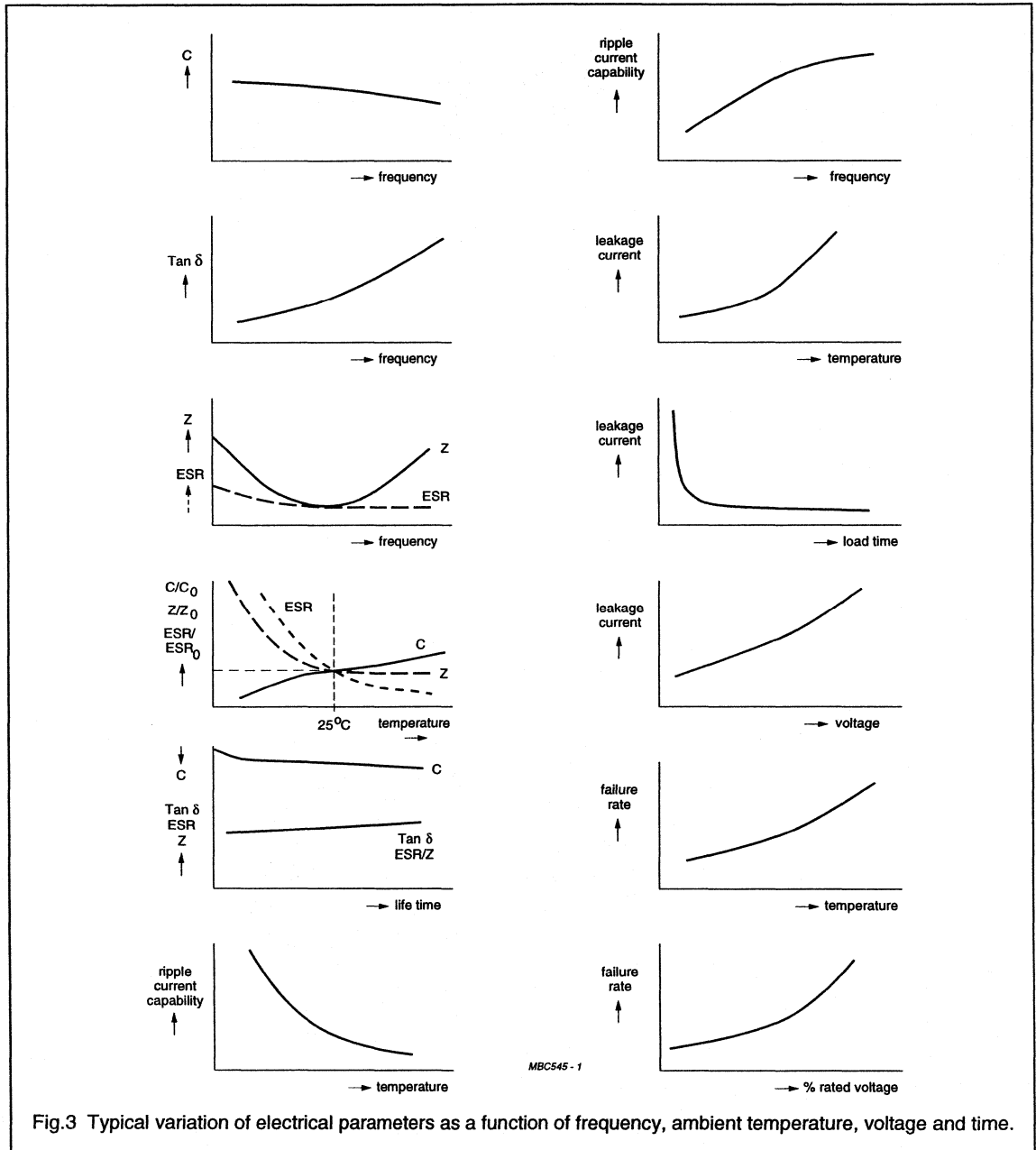
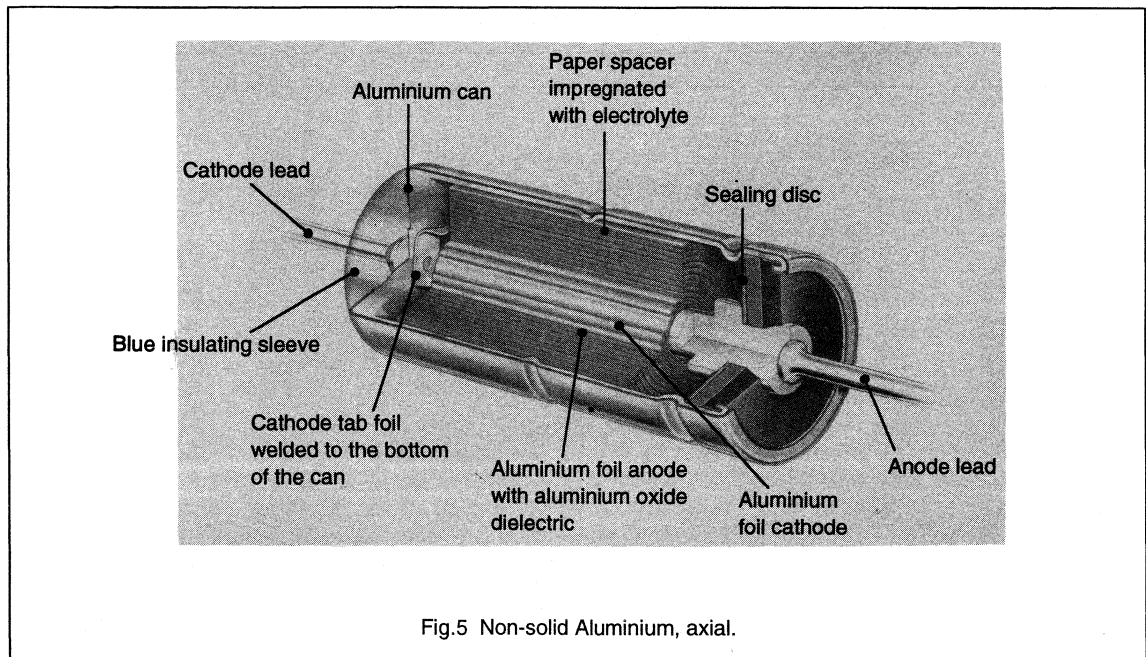
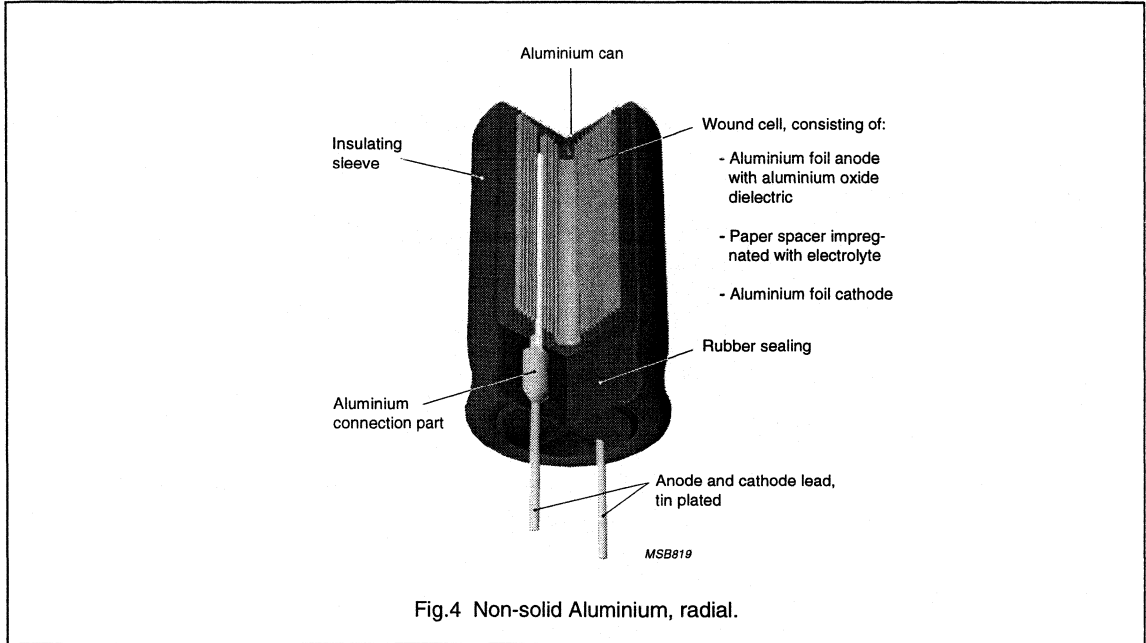


Fig.3 Typical variation of electrical parameters as a function of frequency, ambient temperature, voltage and time.

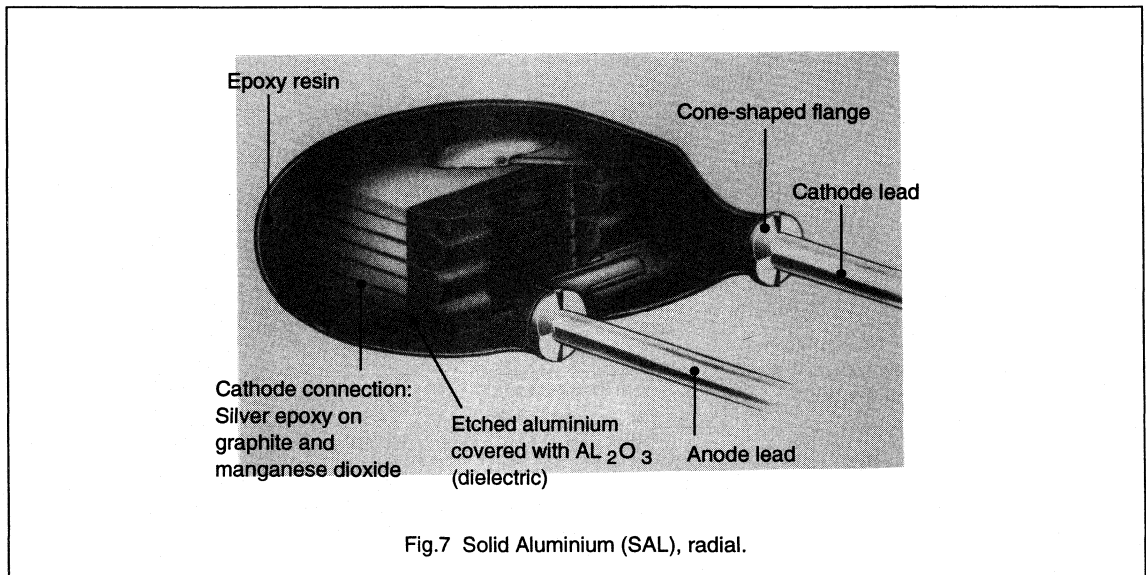
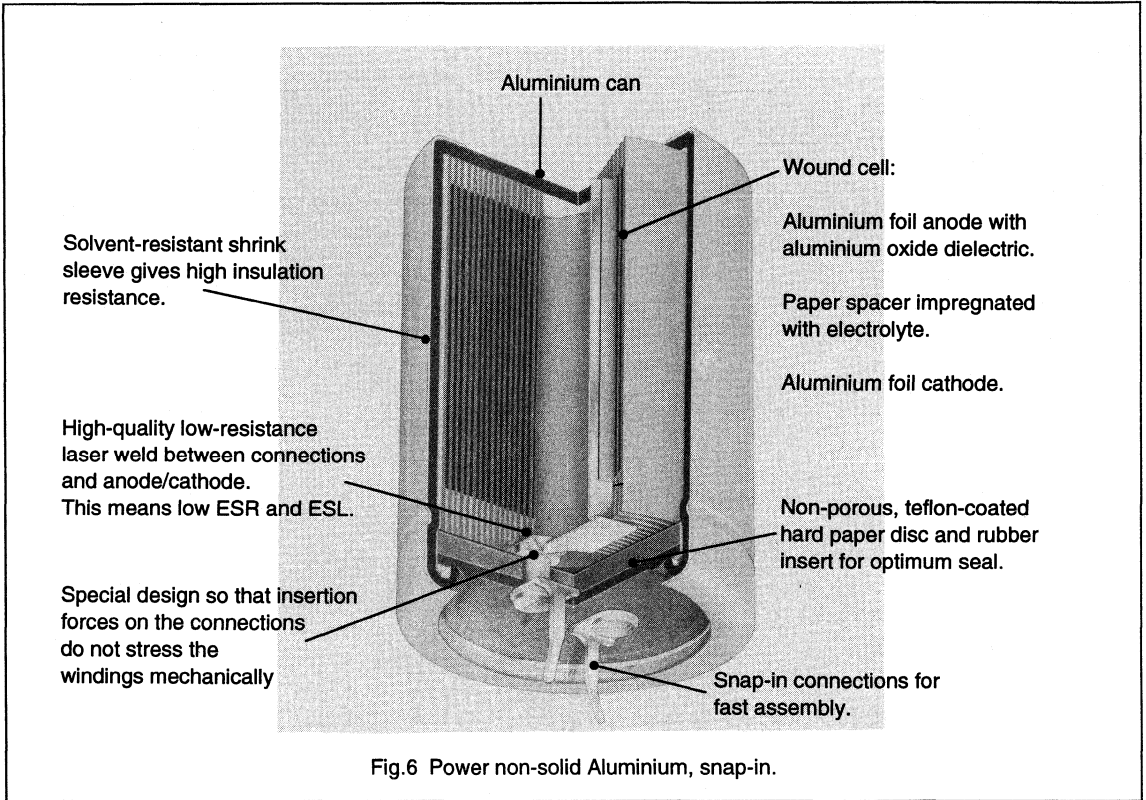
CONSTRUCTION

Examples



Electrolytic Capacitors

General Introduction



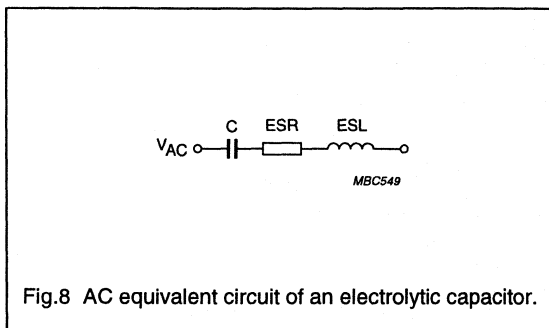
DEFINITIONS OF ELECTRICAL PARAMETERS

Capacitance

AC CAPACITANCE OF AN ELECTROLYTIC CAPACITOR

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

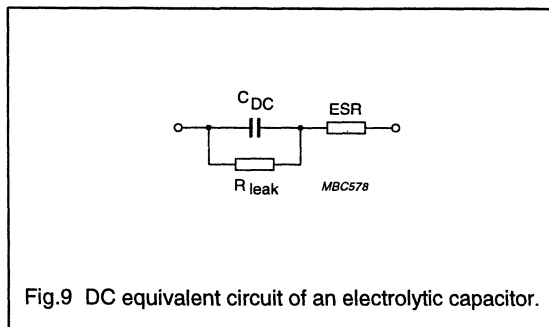
Standard measuring frequencies for electrolytic capacitors are 100 or 120 Hz.



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 are: $-20/+20\%$, $-10/+50\%$, $-10/+30\%$ and $-10/+10\%$.

These values depend on the relevant series.

VoltageRATED VOLTAGE (U_R)

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

CATEGORY VOLTAGE (U_C)

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

TEMPERATURE DERATED VOLTAGE

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

RIPPLE VOLTAGE (U_{RPL})

An alternating voltage may be applied, provided that the peak voltage resulting from the alternating voltage, when superimposed on the direct voltage, does not exceed the value of rated direct voltage or fall under 0 V and that the ripple current is not exceeded.

REVERSE VOLTAGE (U_{REV})

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

SURGE VOLTAGE (U_S)

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

Temperature

CATEGORY TEMPERATURE RANGE

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

RATED TEMPERATURE

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

MINIMUM STORAGE TEMPERATURE

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

Resistance/Reactance

EQUIVALENT SERIES RESISTANCE (ESR)

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

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.8.

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.10):

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

CurrentLEAKAGE 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)

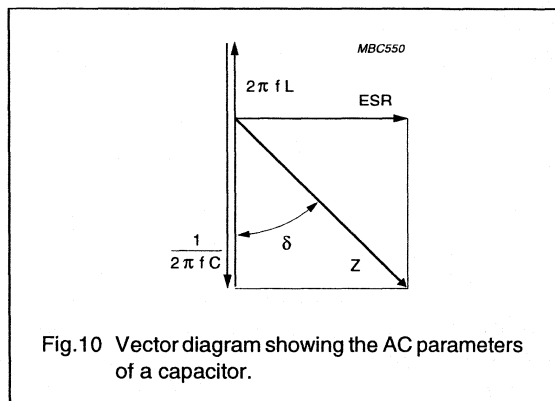
If non-solid electrolytic capacitors are stored above room temperature for long periods of time, the oxide layer may react with the electrolyte, causing increased leakage current when switched on for the first time after storage.

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 carried off heat by radiation, convection and conduction:

$$P = \Delta T \times A \times \beta$$

where

ΔT = difference of temperature between ambient and case surface

A = geometric surface area of the capacitor

β = specific heat conductivity.

The heat, generated by ripple current, is an important factor of influence for non-solid electrolytic capacitors for calculating the useful life under certain circumstances.

In the detail specifications this factor is considered in the so-called 'life-time nomograms' ('Multiplier of useful life' graph) as a ratio between actual ripple current (I_A) and rated ripple current (I_R), drawn on the vertical axis.

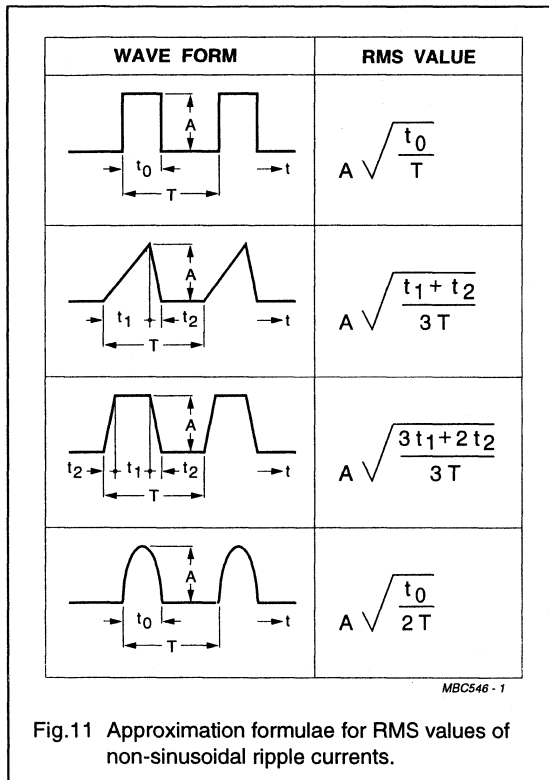
Care should be taken to ensure that the actual ripple current remains inside the graph at any time of the entire useful life. If this cannot be realized, it is more appropriate to choose a capacitor with a higher rated voltage or higher capacitance, than originally required by the application.

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

CALCULATION OF THE APPLICABLE RMS RIPPLE CURRENT

Non-sinusoidal ripple currents (if not accessible by direct measurement) have to be analyzed into a number of sinusoidal ripple currents by means of Fourier-analysis; the sum of the currents thus found may not exceed the applicable ripple current.

For some frequently occurring waveforms, approximation formulae are stated in Fig.11 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:

- 2-3 years for non-solid 85 °C types
- 4 years for non-solid 105 °C types
- 10 years for non-solid 125 °C types
- 20 years for solid types.

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

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

OPERATIONAL CONDITIONS

Charge-discharge proof

This term means the capability of capacitors to withstand frequent switching operations without significant change of capacitance.

Philips Al-electrolytic capacitors are charge-discharge proof in accordance with "IEC 384-4" 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.

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

Electrolytic Capacitors

General Introduction

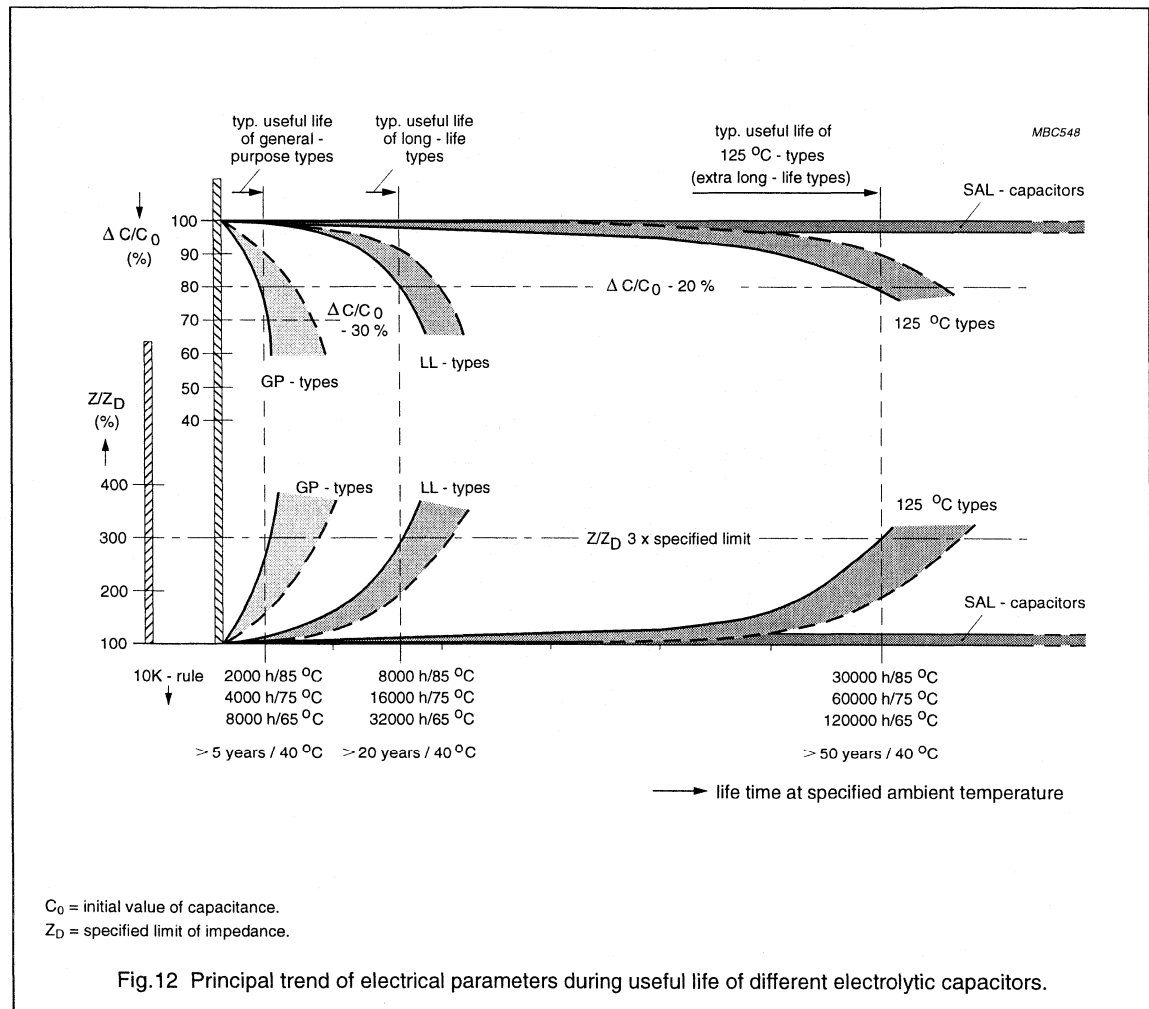
capacitors is solely determined by evaporation of electrolyte through the sealing.

Figure 12 shows the principal electrical consequences of this electrolyte loss: increasing impedance and decreasing capacitance at the end of useful life, for different non-solid (general purpose, long life and 125 °C types) and solid (SAL-) electrolytic capacitors.

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

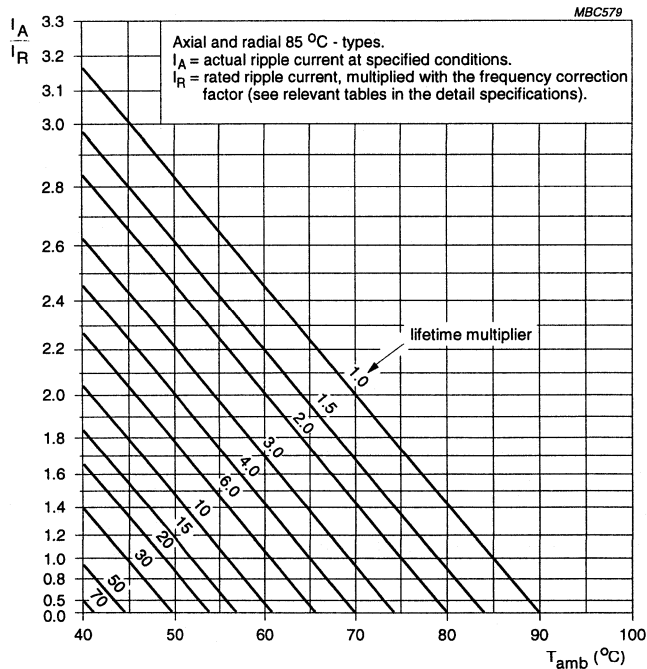
CALCULATION OF USEFUL LIFE BY MEANS OF 'LIFE-TIME NOMOGRAMS'

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.

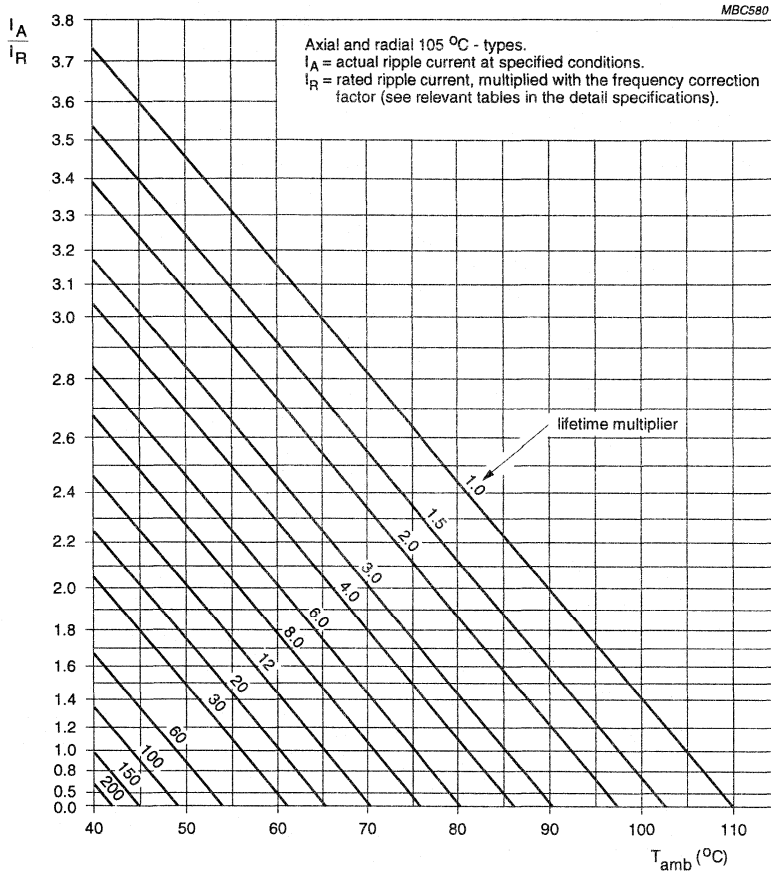
At the intersection of these two operational conditions the appropriate multiplier (correction factor) for useful life can be read. The useful life under certain conditions shall be calculated by multiplying (or dividing respectively) the specified useful life, with the resultant correction factor.

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.13 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.14 Typical example of a life-time nomogram: useful life as a function of ambient temperature and ripple current load.

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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 ° type this is '30' (see Fig.13) and for the 105 °C type it is '90' (see Fig.14).

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_{R0}) as a function of frequency; I_{R0} = 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

Table 4 Life-time calculation in "Example 2"

LIFE CONDITIONS	85 °C TYPES (see Fig.13)	105 °C TYPES (see Fig.14)
1 000 hours at 75 °C	1000/2.9 = 345 hours	1 000/8 = 125 hours
9 000 hours at 65 °C	9 000/6 = 1 500 hours	9 000/20 = 450 hours
90 000 hours at 40 °C	90 000/80 = 1 125 hours	90 000/250 = 360 hours
	sum for 85 °C = 2970 hours	sum for 105 °C = 935 hours

FAILURE RATE (λ)

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

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

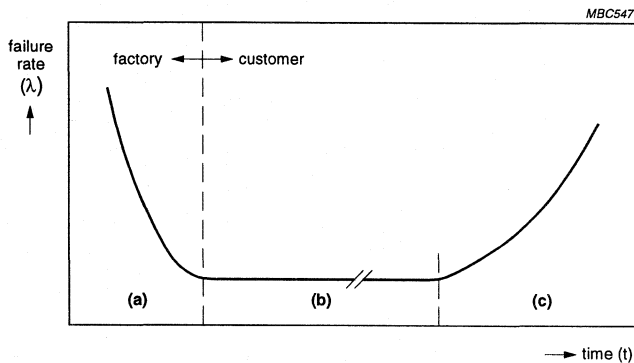
or

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

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.15):



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

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

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

For other operational conditions, λ has to be converted correspondingly with the aid of Figs 16 and 17, failure rates as a function of stress factors (T 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.

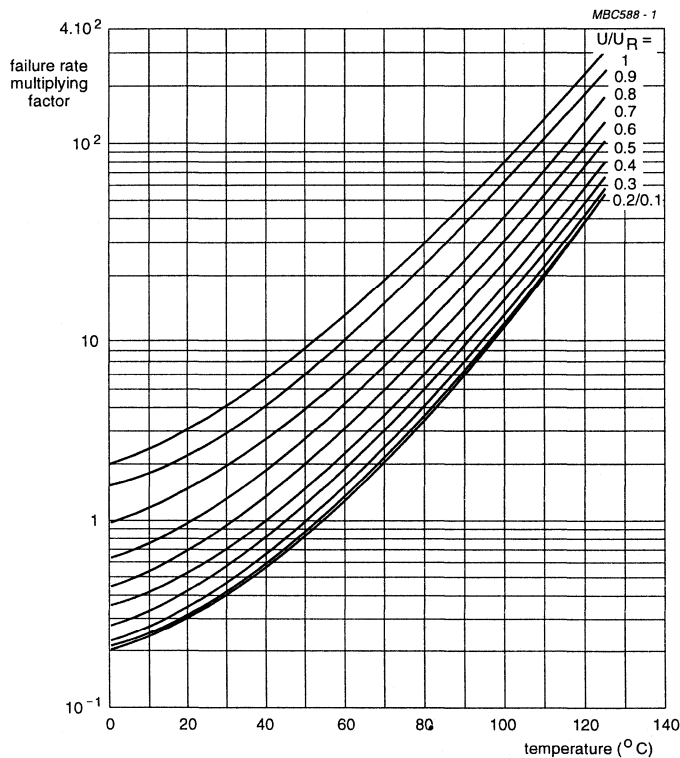


Fig.16 Conversion factors for failure rate (λ) as a function of ambient temperature (T_{amb}) and voltage ratio (U/U_R) for non-solid electrolytic capacitors.

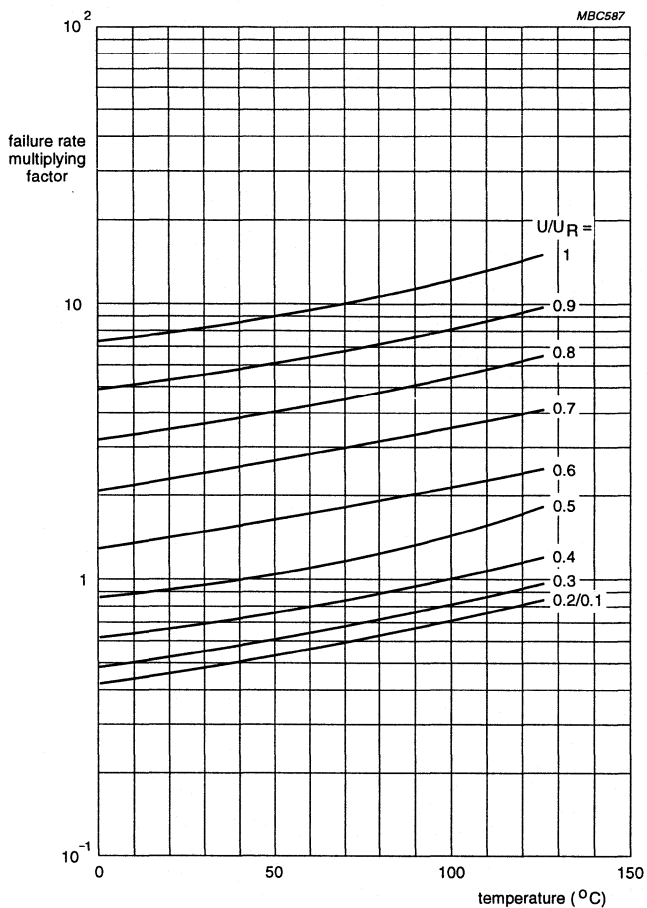


Fig.17 Conversion factors for failure rate (λ) as a function of ambient temperature (T_{amb}) and voltage ratio (U/U_R) for SAL electrolytic capacitors.

Table 5 Example of climatic categories

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

Table 6 Maximum humidity condition indication for the application class

CODE LETTER	RELATIVE AIR HUMIDITY			
	YEARLY AVERAGE	30 DAYS PER YEAR	OCCASIONALLY	DEWING
C	≤95%	100%	100%	permitted
D	≤80%	100%	90%	permitted
E	≤75%	95%	85%	slightly/rarely
F	≤75%	95%	85%	not permitted

APPLICATION CLASS

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

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:

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

Combined series/parallel connection

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

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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.

1st digit

2nd digit

C = 1992

1 = January

D = 1993

2 = February

E = 1994

...

F = 1995

9 = September

H = 1996

O = October

J = 1997

N = November

K = 1998

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.

APPLICATION GUIDELINES AND PRODUCT SAFETY



Non-solid Al - electrolytic capacitors

Application guidelines

WARNING

Correct application and strict adherence to the important information listed below, will ensure optimum performance of the capacitors over their entire specified useful life.

Please note, that ignoring these rules may reduce the equipment life time or even destroy the capacitor, together with parts of the equipment or property involved. The consequences may be a short or open circuit of the component, 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	<p>Electrolytic capacitors for DC applications require polarization.</p> <p>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.</p>	<p>detail specification,</p> <p>TESTS AND REQUIREMENTS</p>
VOLTAGE	<p>Do not apply a voltage exceeding the capacitor's voltage rating.</p> <p>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>.</p>	<p>detail specification,</p> <p>TESTS AND REQUIREMENTS</p>
RIPPLE LOAD	<p>Do not allow excessive ripple current to pass.</p> <p>The rated ripple current given for certain conditions (temperature, frequency and useful life) shall not be exceeded. If so, early failure may result.</p> <p>Keep ripple voltage within ratings.</p> <p>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</p>	<p>detail specification</p>
TEMPERATURE RANGE	<p>Use capacitors within specified temperature range.</p> <p>Applicable temperature range is given in the relevant detail specification.</p> <p>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</p>	<p>detail specification</p>

Non-solid Al - electrolytic capacitors

Application guidelines

PARAMETER	IMPORTANT INFORMATION – PRODUCT SAFETY	MORE DETAILS
CHARGE-DISCHARGE	<p>Observe charge-discharge limitations.</p> <p>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.</p>	TESTS AND REQUIREMENTS
SERIES/PARALLEL CONNECTIONS	<p>When connecting in series/parallel, apply corresponding design rules.</p> <p>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</p>	INTRODUCTION
PC BOARD DESIGN	<p>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.</p>	
INSULATION	<p>The capacitor case is not insulated from the cathode terminal.</p> <p>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.</p> <p>Dummy pins are connected to the cathode.</p>	
STORAGE AND TRANSPORT	<p>Excessive storage time or conditions may have adverse effects on capacitors.</p> <p>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.</p> <p>Packages with electrolytic capacitors should be handled with care, or bent leads and/or incorrect taping dimensions could be the result.</p>	INTRODUCTION TESTS AND REQUIREMENTS
HIGH AIR PRESSURE	<p>Do not expose capacitors to overpressure.</p> <p>Maximum operating pressure is 150 kPa. Higher pressure may cause a short circuit.</p>	
LOW AIR PRESSURE	<p>The capacitors may be used at an altitude of ≤ 12000 m.</p> <p>Minimum air pressure: 8.5 kPa for short periods (in accordance with <i>"IEC 384-4, subclause 4.11.4"</i>)</p>	TESTS AND REQUIREMENTS
MOUNTING	<p>Avoid excessive stress to the lead wires or terminals.</p> <p>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 <i>"This Handbook, Section Tests and Requirements"</i>.</p> <p>Mechanically damaged capacitors may not be used.</p> <p>Safety vent should have enough space to function correctly.</p>	TESTS AND REQUIREMENTS

Non-solid Al - electrolytic capacitors

Application guidelines

PARAMETER	IMPORTANT INFORMATION – PRODUCT SAFETY	MORE DETAILS
SOLDERING	<p>Keep soldering temperature and time under control.</p> <p>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.</p>	TESTS AND REQUIREMENTS
BOARD CLEANING	<p>No guarantees can be given with regard to solvents based on halogenated hydrocarbons or ozone depleting chemicals (ODCs).</p> <p>Warning: such solvents are hazardous to the environment.</p> <p>Component cleaning using solvents such as demineralized or distilled water, isopropanol, methanol, etanol 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.</p>	
ADHESIVES, COATING MATERIALS	<p>Some adhesives and coating materials affect capacitors adversely.</p> <p>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.</p>	
DISPOSAL	<p>Electrolytic capacitors are subject to special waste regulations.</p> <p>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.</p> <p>In general, electrolytic capacitors have to be disposed under controlled circumstances in a high temperature incinerator at minimum 900 °C.</p>	
PERSONNEL SAFETY	<p>WARNING NOTE.</p> <p>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.</p> <p>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.</p>	

TEST 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.

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	Ua	leaded types: loading force 10 N for 10 s; power types: loading force 20 N for 10 s	no visible damage
Tensile strength		Ub	leaded types: loading force 5 N; two consecutive bends	no visible damage
Bending		Uc	leaded types, axial: two successive rotations of 180° in opposite direction; 5 s per rotation	no visible damage
Torsion		Ud	power types/screw terminal: torque of 1.76 Nm gradually applied	no visible damage
Torque on nut (stud)	4.5	Tb (method 1A)	solder bath for capacitors with printed-wiring pins: 260 °C; 10 s	no visible damage; marking legible
Resistance to soldering heat		Tb (method 1B)	solder bath for capacitors with solder leads or tags: 350 °C; 3.5 s	$\Delta C/C: \pm 5\%$
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	long-life grade types: 10 to 500 Hz; 0.75 mm or 10 g (whichever is less); 3 directions; 2 hours per direction	no visible damage; no leakage of electrolyte; marking legible
			general-purpose grade and Form MR types: 10 to 55 Hz; 0.75 mm or 10 g (whichever is less); 3 directions; 2 hours per direction	$\Delta C/C \pm 5\%$ 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	long-life grade types: 40 g; 2 directions; 4 000 bumps total	no visible damage; no leakage of electrolyte
			general-purpose grade types: 40 g; 2 directions; 1 000 bumps total	$\Delta C/C$: $\pm 5\%$ 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 \pm 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: \leq stated limit $\tan \delta \leq 1.2 \times$ stated limit $\Delta C/C$: $\pm 10\%$
Additional tests in accordance with IEC 384-1 and EN 130000 (external insulation)				
Insulation resistance	4.5		foil method	insulation resistance $\geq 100 \text{ M}\Omega$
Voltage proof	4.6		foil method; 1000 V for 1 minute	no breakdown or flashover

Note

1. For vibration and bump testing, the components shall be mounted by their terminations (with mounting accessories where applicable). The capacitors listed below shall also be clamped by their body:

$$\varnothing D_{\text{nom}} \geq 12.5 \text{ mm}$$

- a) $L_{\text{nom}} \geq 15 \text{ mm}$ (for radial types)
b) $L_{\text{nom}} \geq 30 \text{ mm}$ (for axial types).

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 1 000 V
				long-life grade types: $\Delta C/C: \pm 10\%$
				general-purpose grade types: $\Delta C/C: \pm 20\%$
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 1 000 V
				long-life grade types: $U_R \leq 6.3 \text{ V}; \Delta C/C: +15/-30\%$; $U_R 10 \text{ to } 160 \text{ V}; \Delta C/C: \pm 15\%$; $U_R \geq 200 \text{ V}; \Delta C/C: \pm 10\%$ $\tan \delta \leq 1.3 \times$ stated limit impedance $\leq 2 \times$ stated limit
				general-purpose grade types: $U_R \leq 6.3 \text{ V}; \Delta C/C: +25/-40\%$; $U_R 10 \text{ to } 160 \text{ V}; \Delta C/C: \pm 30\%$; $U_R \geq 200 \text{ V}; \Delta C/C: \pm 15\%$ $\tan \delta \leq 1.5 \times$ stated limit or 0.40 (whichever is greater) impedance $\leq 3 \times$ 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 $U_R > 315 \text{ V}$; $RC = 0.1 \pm 0.05 \text{ s}$; 1 000 cycles of 30 s on, 330 s off	no visible damage; no leakage of electrolyte leakage current: \leq stated limit $\tan \delta \leq$ stated limit
			long-life grade types: at upper category temperature	$\Delta C/C: \pm 15\%$
			general-purpose grade types: at 25 °C	

Electrolytic Capacitors

Tests and Requirements

NAME OF TEST	IEC 384-4/ CECC 30300 subclause	IEC 68-2 TEST METHOD	PROCEDURE (quick reference)	REQUIREMENTS
Reverse voltage	4.15		1 V in reverse polarity followed by U_R in forward polarity, both for 125 hours at upper category temperature	leakage current: \leq stated limit $\tan \delta \leq$ stated limit $\Delta C/C: \pm 10\%$
Pressure relief (for types with vent only)	4.16		DC voltage applied in reverse direction producing a current of 1 to 10 A	pressure relief opens prior to danger of explosion or fire
Storage at upper category temperature	4.17	Ba	test duration 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 $\Delta C/C: \pm 10\%$
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 \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

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	4.4			
Tensile strength		Ua	loading force; note 1: 10 N for 10 s	no visible damage
Bending		Ub	loading force; note 1: 5 N; two consecutive bends	no visible damage
Torsion (axial types)		Uc	two successive rotations of 180° in opposite direction; 5 s duration per rotation	no visible damage
Resistance to soldering heat	4.5	Tb (method 1A)	radial types: solder bath: 260 °C; 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	SAL-AG 123: 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

- SPECIAL PLIERS MUST BE USED TO PROTECT THE CELL BODY AND CONSEQUENTLY KEEP THE BENDING LOCATION UNDER CONTROL.
- 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
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	
Low air pressure	4.11.4	M	5 minutes at 25 ±10 °C; atmospheric pressure: 8.5 kPa; U _R applied during last minute of test	
Damp heat, cyclic	4.11.5	Db	5 cycles (55 °C → 25 °C) of 24 hours each; 25 °C; RH 95 to 100%; no voltage applied	
	4.11.7		final measurements after climatic sequence	no visible damage; markings legible leakage current: ≤stated limit tan δ and Z ≤ 1.2 × stated limit
Damp heat, steady state	4.12	Ca	56 days at 40 °C; RH 90-95%; no voltage applied	axial types: ΔC/C: ±5% with respect to initial measurement radial types: ΔC/C: ±10% with respect to initial measurement
				no visible damage; markings legible leakage current: ≤stated limit tan δ and Z ≤ × 1.2 stated limit ΔC/C: ±10% of initial measurement
Additional tests in accordance with IEC 384-1 and EN 130000 (external insulation)				
Insulation resistance	4.5		foil method	insulation resistance ≥100 MΩ
Voltage proof	4.6		foil method; 1000 V for 1 minute	no breakdown or flashover

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 axial types: insulation resistance $\geq 100 \text{ M}\Omega$; no breakdown or flashover at 1000 V
Endurance (additional) SAL-A			2000 hours at 175 °C; maximum $0.63 \times U_R$ applied	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: \leq 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 $\Delta C/C$: $\pm 5\%$ with respect to initial measurement
Long storage ≥ 1 year (additional)			at ambient temperature	SAL-RPM: $\Delta C/C$ $\pm 10\%$ with respect to initial measurement 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 (note 1) 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 ± 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 publication 695-2-2	needle flame test	category of flammability: B

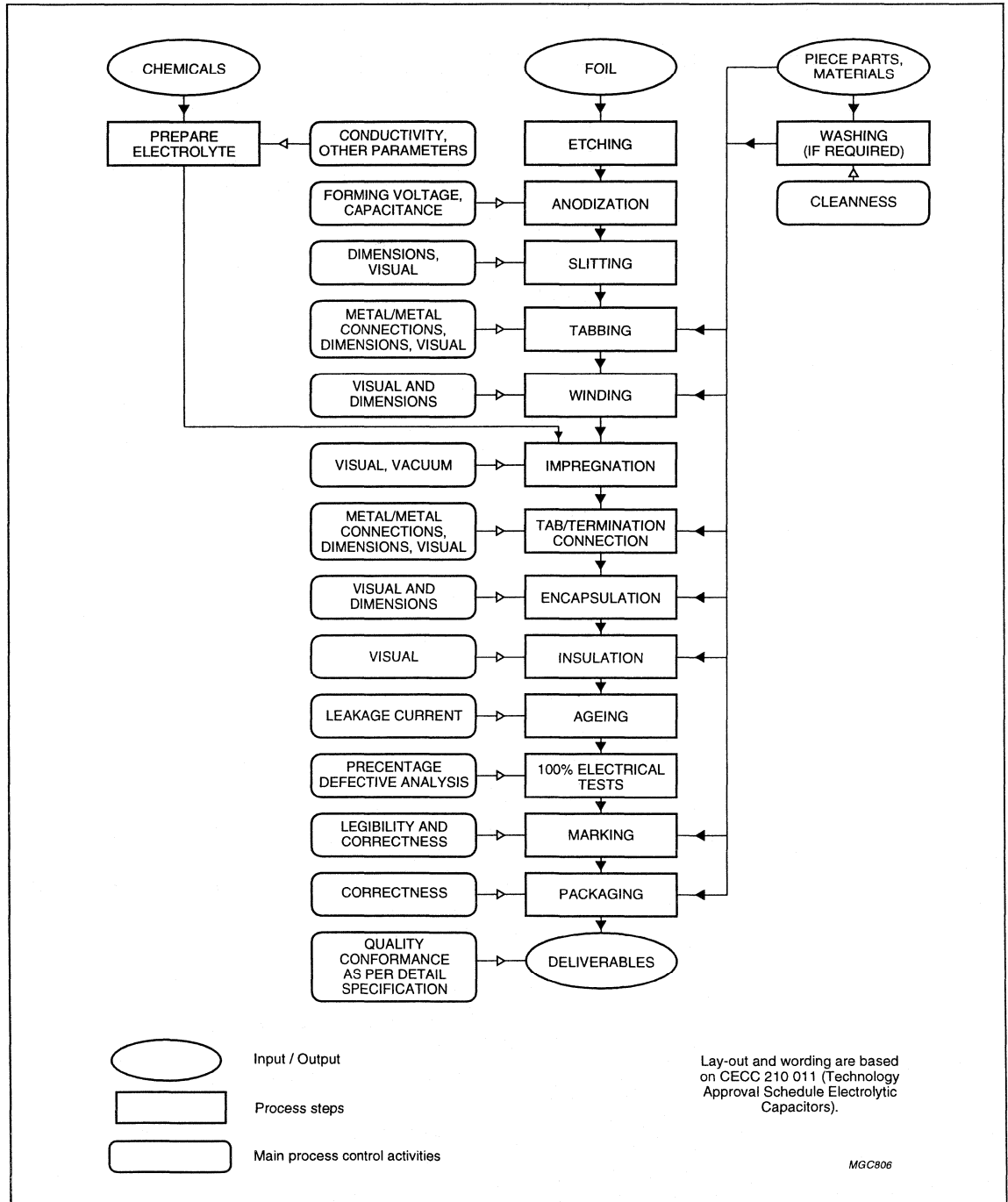
Notes

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

Electrolytic Capacitors

Quality flowchart

GENERIC QUALITY FLOWCHART FOR NON-SOLID ELECTROLYTIC CAPACITORS



PACKAGING - SURFACE MOUNTING DEVICES (SMD)



Electrolytic capacitors

Packaging - Surface Mounting Devices (SMD)

TAPE AND REEL DATA

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

- CS 085
- CLL 139
- CLP 172

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

Philips SMD non-solid 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.

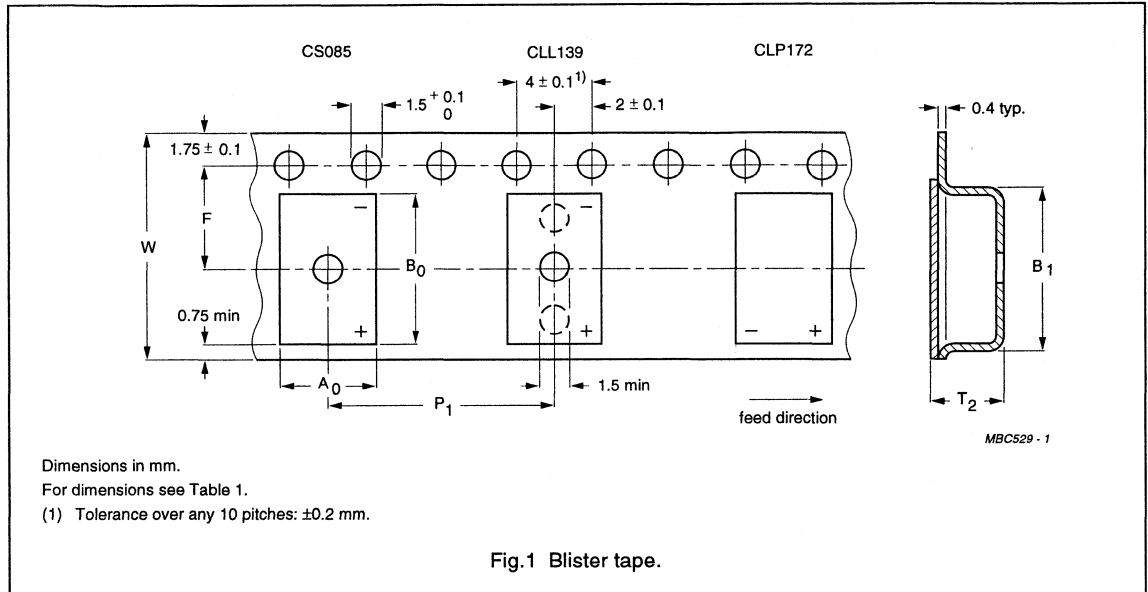
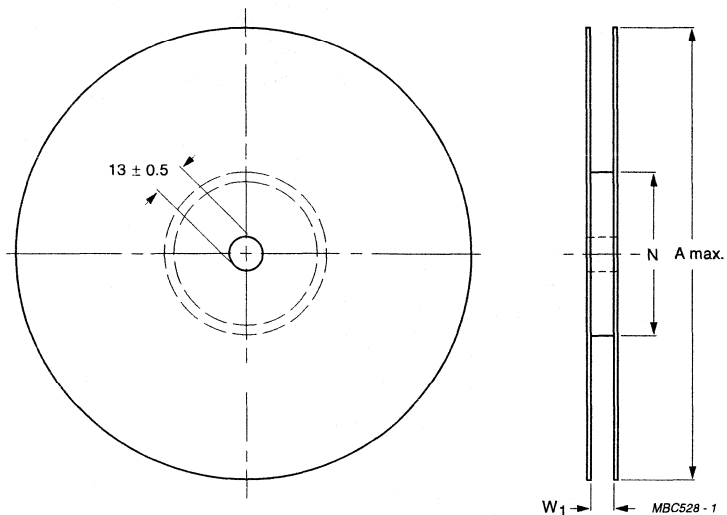


Table 1 Physical dimensions of blister tape (in mm) and packaging quantities; see Fig.1

PARAMETER	SERIES								TOLERANCE
	CS 085		CLL 139		CLP 172				
Case code	1a	1	2	3	63	64	65	85	
Case size:									
L _{nom}	8.8	11.9	14.3	14.3	6.3	6.3	6.3	8.3	—
W _{nom}	3.7	3.7	6.2	7.6	3.5	4.0	4.5	4.5	—
H _{nom}	3.9	3.9	6.9	8.2	3.5	4.0	4.5	4.5	—
W	16	24	24	24	12	12	12	16	±0.3
T ₂	4.9	4.9	7.7	9.1	4.2	4.7	5.2	5.2	max.
F	7.5	11.5	11.5	11.5	5.5	5.5	5.5	7.5	±0.1
P ₁	8	8	12	12	8	8	8	8	±0.1
A ₀	4.1	4.1	6.5	7.9	4.2	4.7	5.2	5.2	±0.2
B ₀	9.3	12.5	14.8	14.8	6.8	6.8	6.8	8.8	±0.2
B ₁	10	13.2	15.5	15.5	8	8	8	10.5	max.
Quantity per reel	2000	2000	700	700	3000	2500	2500	2500	—



Dimensions in mm.
For dimensions, see Table 2.

Fig.2 Reel for blister tape.

Table 2 Reel dimensions; see Fig.2

TAPE WIDTH (mm)	A MAX. (mm)		N MIN. (mm)	W ₁ (mm)
	CS 085 CLL 139	CLP 172		
12	—	382	50	14
16	330	382	50	18
24	330	—	50	26

PACKAGING - RADIAL LEADED DEVICES



Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors

TAPING

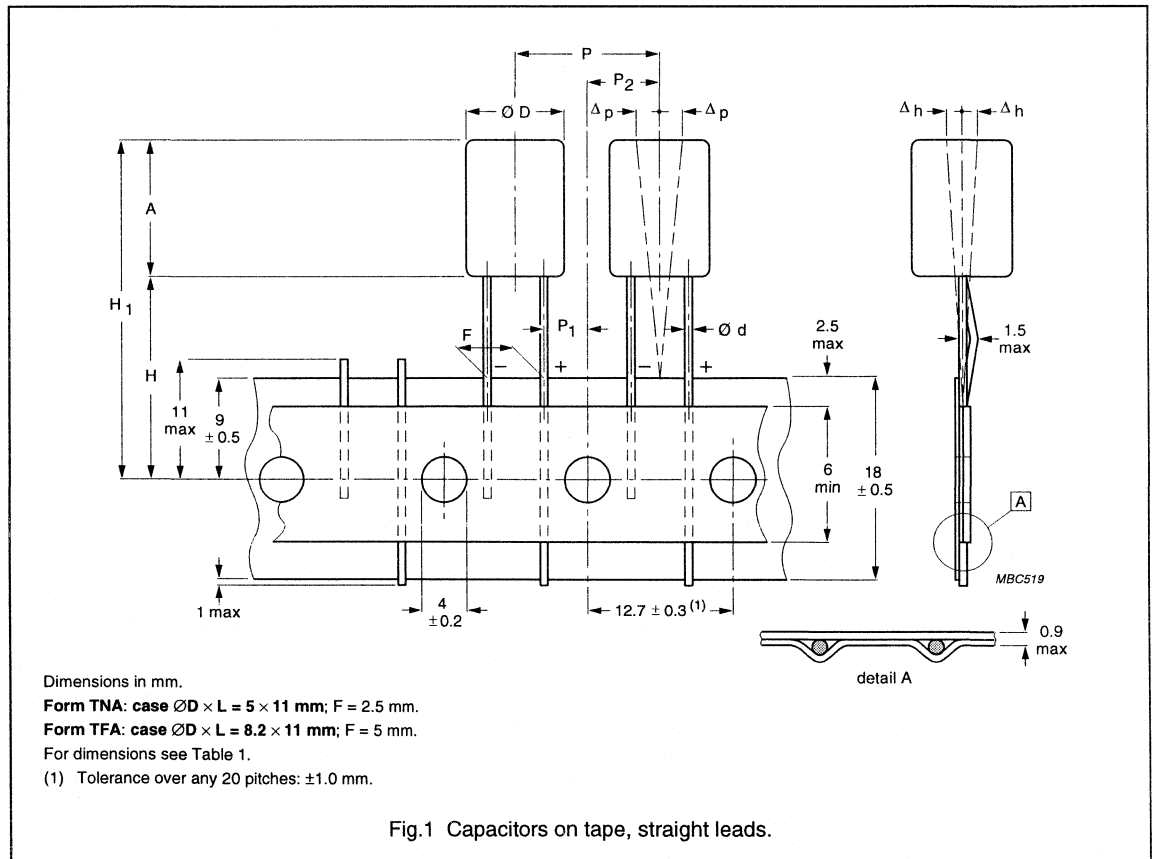
Philips radial, solid and non-solid aluminium electrolytic capacitors in sizes up to $\varnothing D = 16$ mm, are available in taped version corresponding to "IEC 286-2" or "JIS C 0805" respectively. They are most suitable for use on automatic insertion machines, mounting robots or cutting and forming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

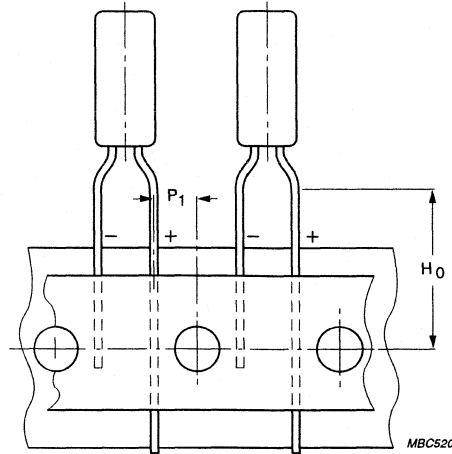
CAUTION
 Packages must be handled with care to avoid bent leads

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:

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





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 ($\varnothing D \times L$) 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)	
$\varnothing D$	5.5	5.5	8.7	max.
A	12	12	12	max.
$\varnothing d$	0.5	0.5	0.6	± 0.05
P	12.7	12.7	12.7	± 1.0
P_1	5.1	3.85	3.85	± 0.7
P_2	6.35	6.35	6.35	± 0.7
F	2.5	5.0	5.0	+0.6/-0.1
Δh	0	0	0	± 2.0
Δp	0	0	0	± 1.3
H	18	18	18	+1.5/-0
H_0	-	16	-	± 0.5
H_1	32	32	32	max.

Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors

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

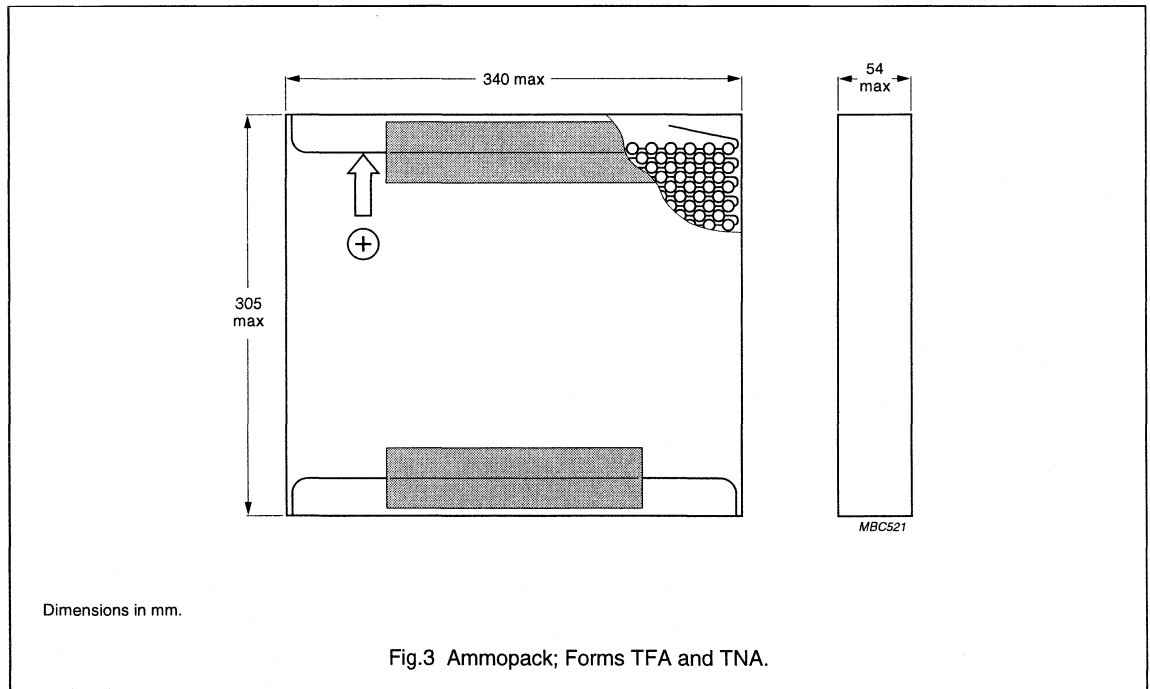
QUANTITIES PER PACKAGING UNIT

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.



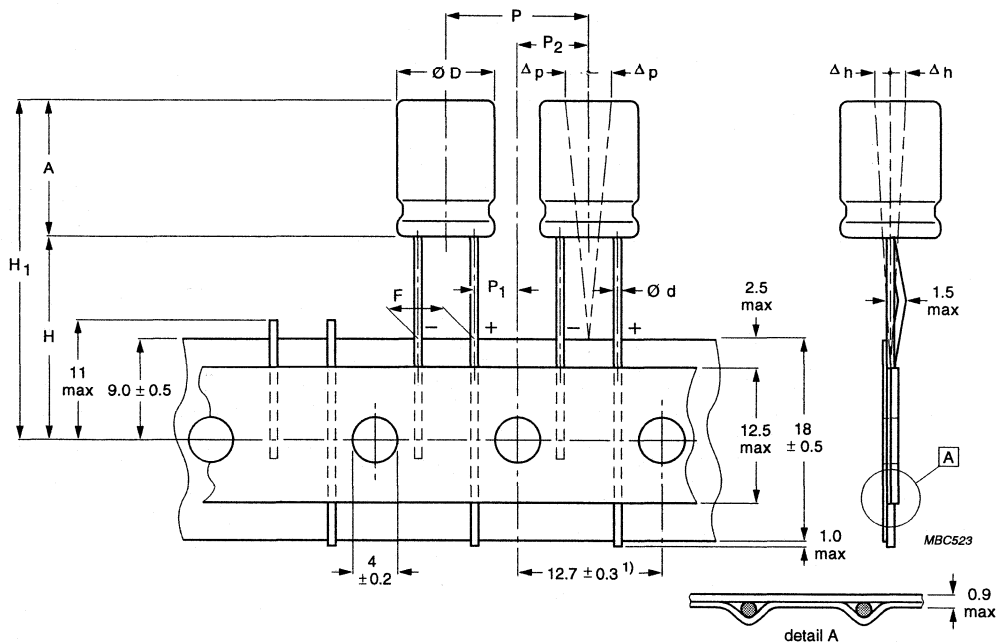
Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors

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

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

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.

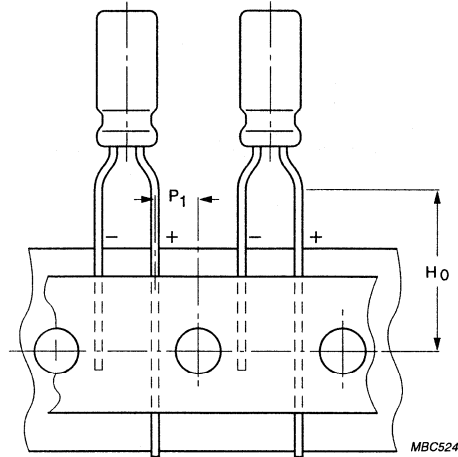
For dimensions see Table 3.

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

Fig.4 Capacitors on tape, straight leads.

Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors



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 ($\varnothing D \times L$) 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)	
$\varnothing D$	5.5	6.8	8.5	5.5	6.8	8.5	max.
A	12.5	12.5	13	12.5	12.5	13	max.
$\varnothing d$	0.5	0.6	0.6	0.5	0.6	0.6	± 0.05
P	12.7	12.7	12.7	12.7	12.7	12.7	± 1.0
P ₁	5.1	5.1	4.6	3.85	3.85	3.85	± 0.7
P ₂	6.35	6.35	6.35	6.35	6.35	6.35	± 1.0
F	2.5	2.5	3.5	5.0	5.0	5.0	+0.8/-0.2
Δh	0	0	0	0	0	0	± 2.0
Δp	0	0	0	0	0	0	± 1.3
H	18.5	18.5	20	18.5	18.5	20	± 0.75
H ₀	-	-	-	16	16	16	± 0.5
H ₁	32.2	32.2	32.2	32.2	32.2	32.2	max.

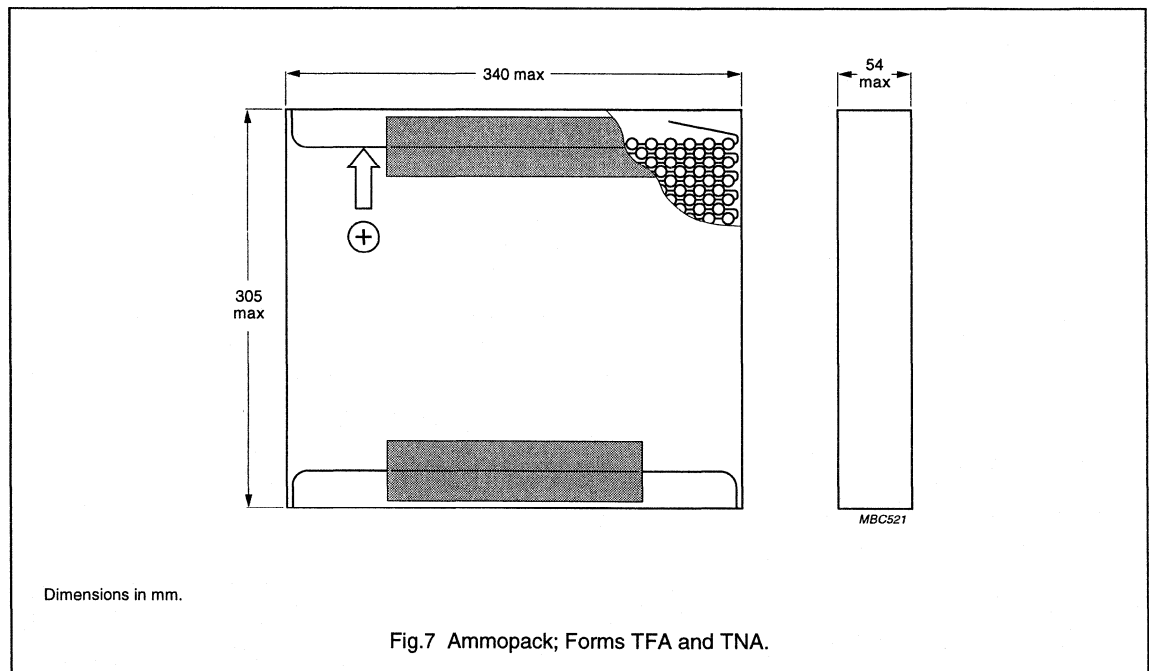
Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors

QUANTITIES PER PACKAGING UNIT

Table 5 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 x 5	51	3000	3000	-
3.5 x 5	52	3000	3000	-
4 x 5	53	2000	2000	-
5 x 5	54	2000	2000	-
6.3 x 5	55	2000	2000	-
4 x 7	71	2000	2000	-
5 x 7	72	1000	2000	-
6.3 x 7	73	1000	2000	-
7 x 7	74	1000	1000	-
5 x 11	11	3000	2000	2000
6.3 x 11	12	2000	2000	2000
8 x 12	13	1000	1000	1000



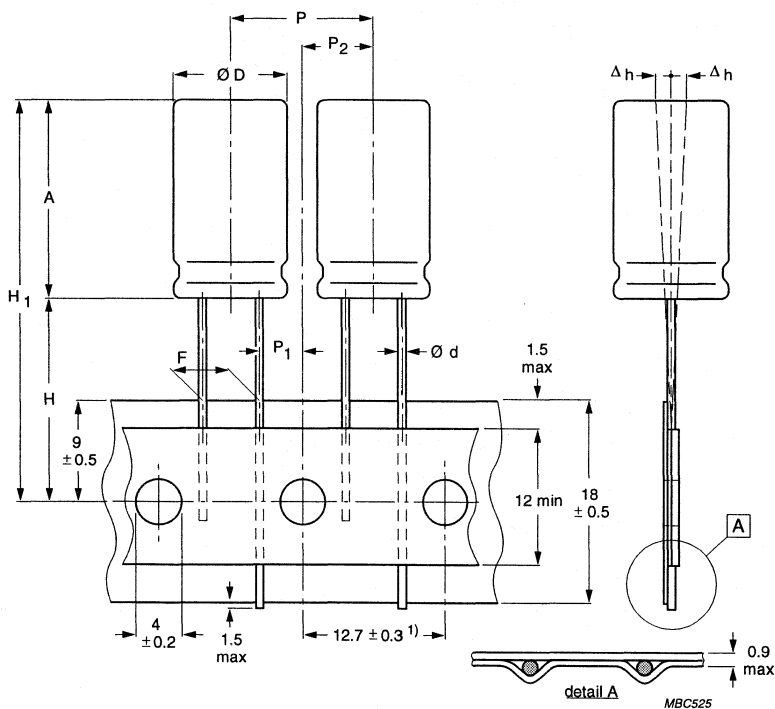
Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors

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

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

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



Dimensions in mm.

Case $\varnothing D = 10$ mm.

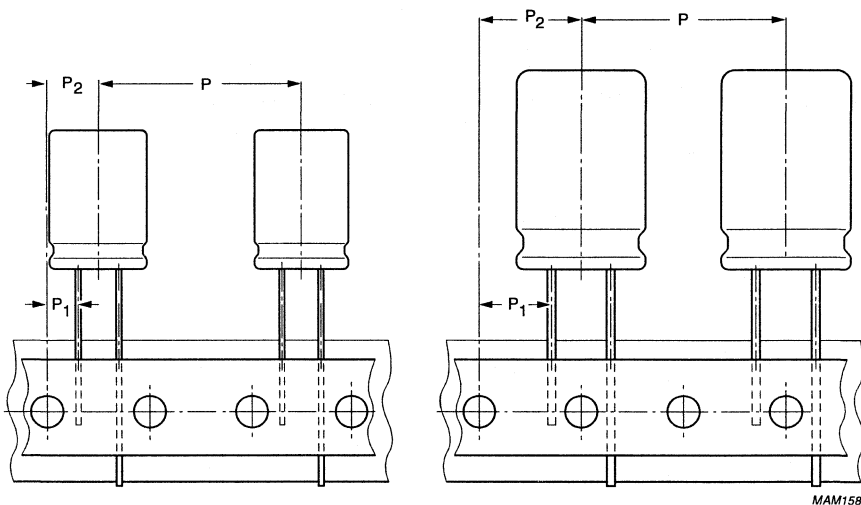
For dimensions see Table 6.

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

Fig.8 Capacitors on tape.

Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors



Case $\varnothing D = 12.5$ and 16 mm.
For dimensions see Table 6.

Fig.9 Capacitors on tape.

Table 6 Dimensions of capacitors on tape; see Figs 8 and 9

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.

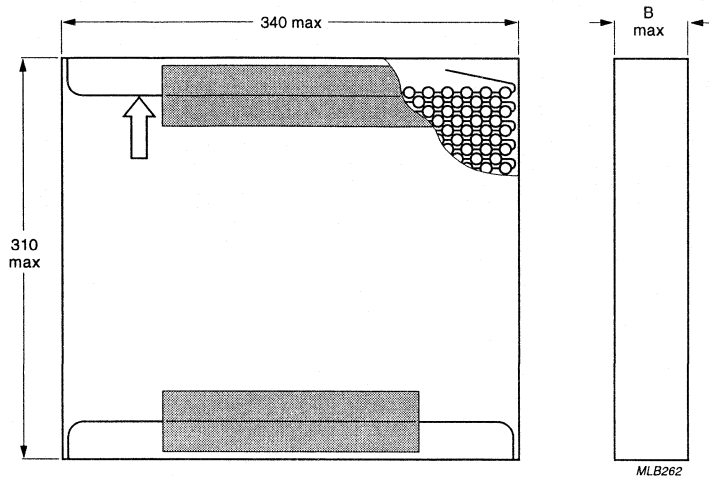
Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors

Series RSM 037, RSH 044, RSL 046, RMS 047, RML 048, RLI 135, RVI 136 and RHT 165
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 6.

Fig.10 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.

Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors

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

- SAL-RP 122
- SAL-RPM 128.

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

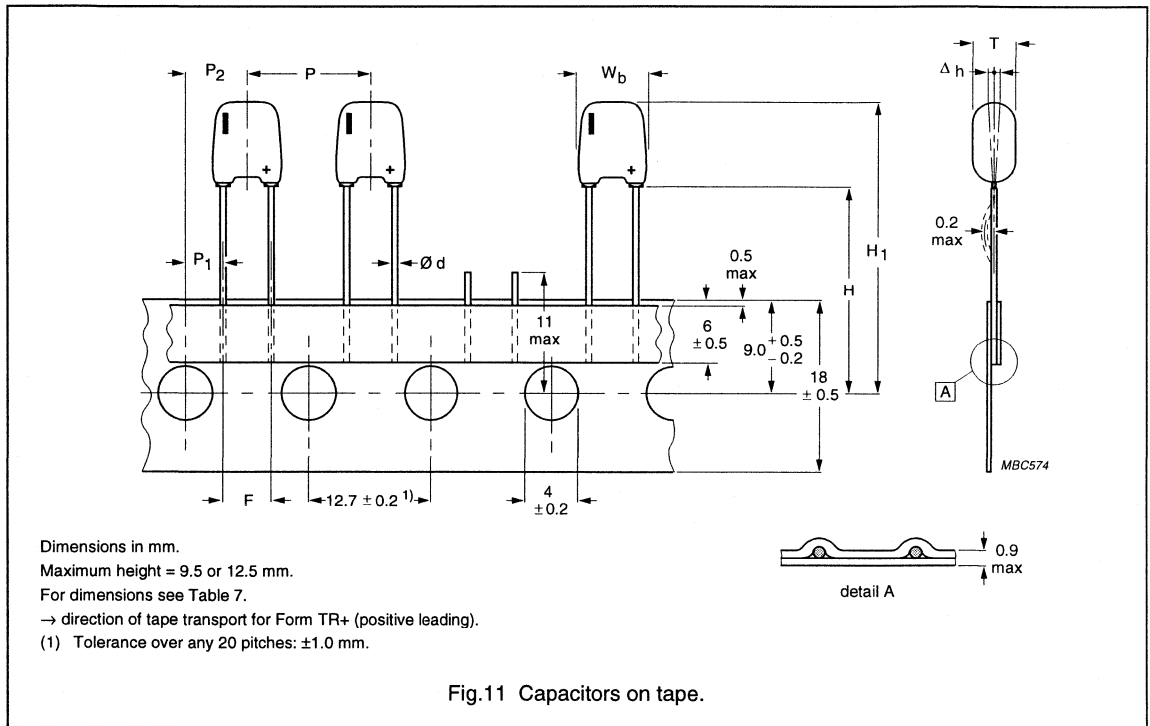


Table 7 Tape dimensions (in mm) for solid radial capacitors; see Fig.11

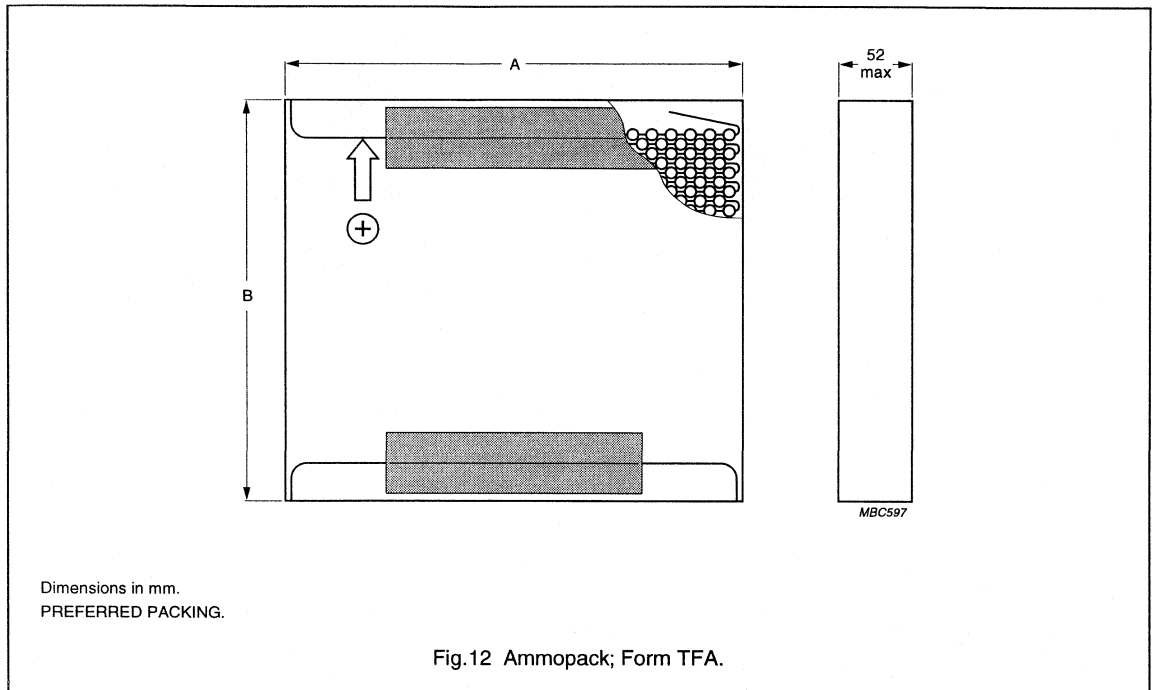
PARAMETER	SAL-RP 122 MAX. HEIGHT 12.5 mm				SAL-RPM 128 MAX. HEIGHT 9.5 mm						TOLERANCE
	1	2	3	4	10	20	30	40	50	60	
Case code	1	2	3	4	10	20	30	40	50	60	
T	3.5	4.5	5.0	6.0	3.0	3.5	4.0	5.0	5.0	6.0	max.
W _b	8.0	8.0	8.0	8.0	7.0	7.0	7.0	7.0	8.0	8.0	max.
Ød	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	+0.02/-0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

Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors

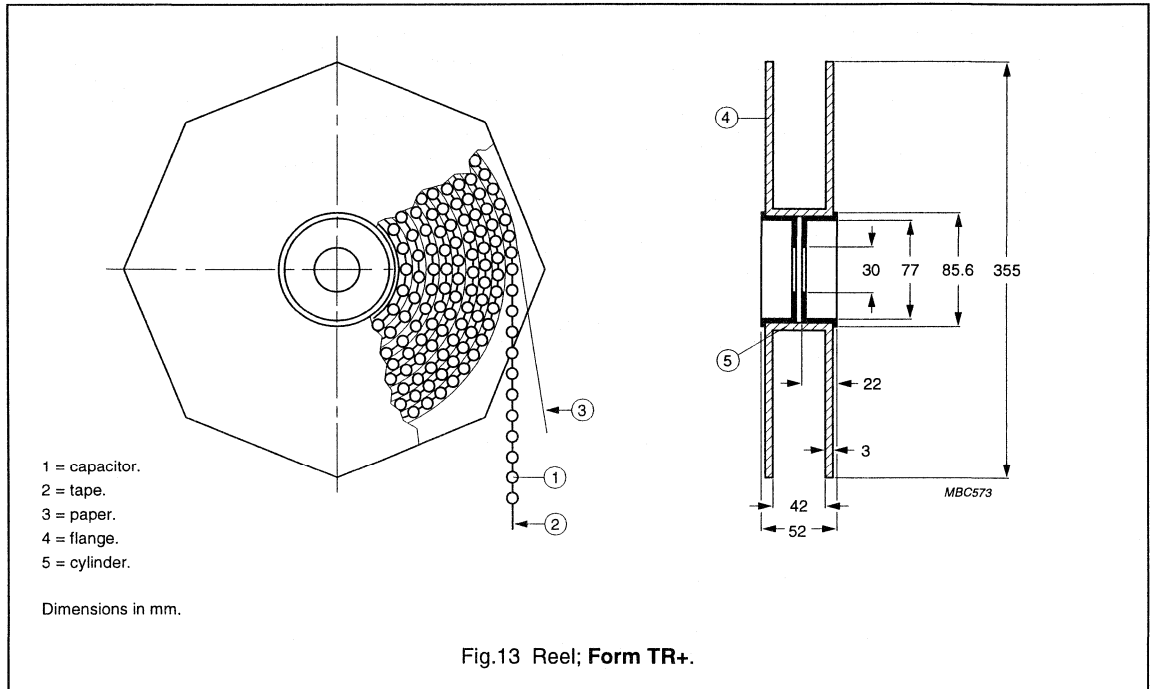
Table 8 Ammopack dimensions for the relevant case codes

PARAMETER	SAL-RP 122	SAL-RPM 128	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



Electrolytic capacitors

Packaging - Radial Electrolytic Capacitors



QUANTITIES PER PACKAGING UNIT

Table 9 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



Electrolytic capacitors

Packaging - Axial Electrolytic Capacitors

TAPING

Philips axial, solid and non-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

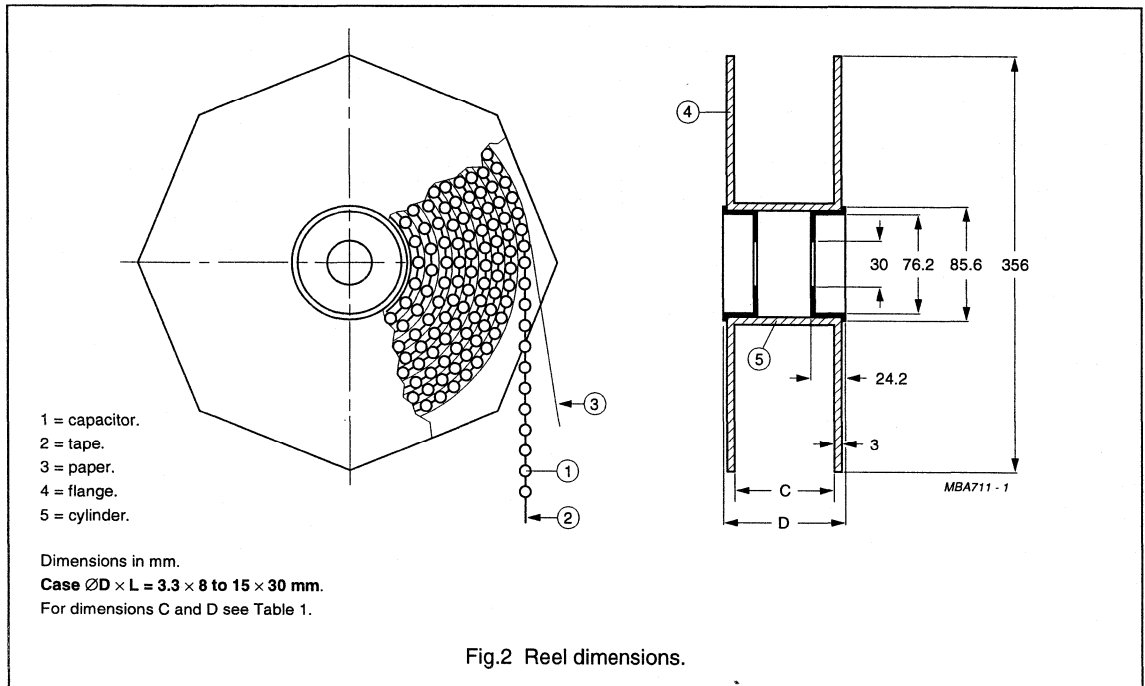
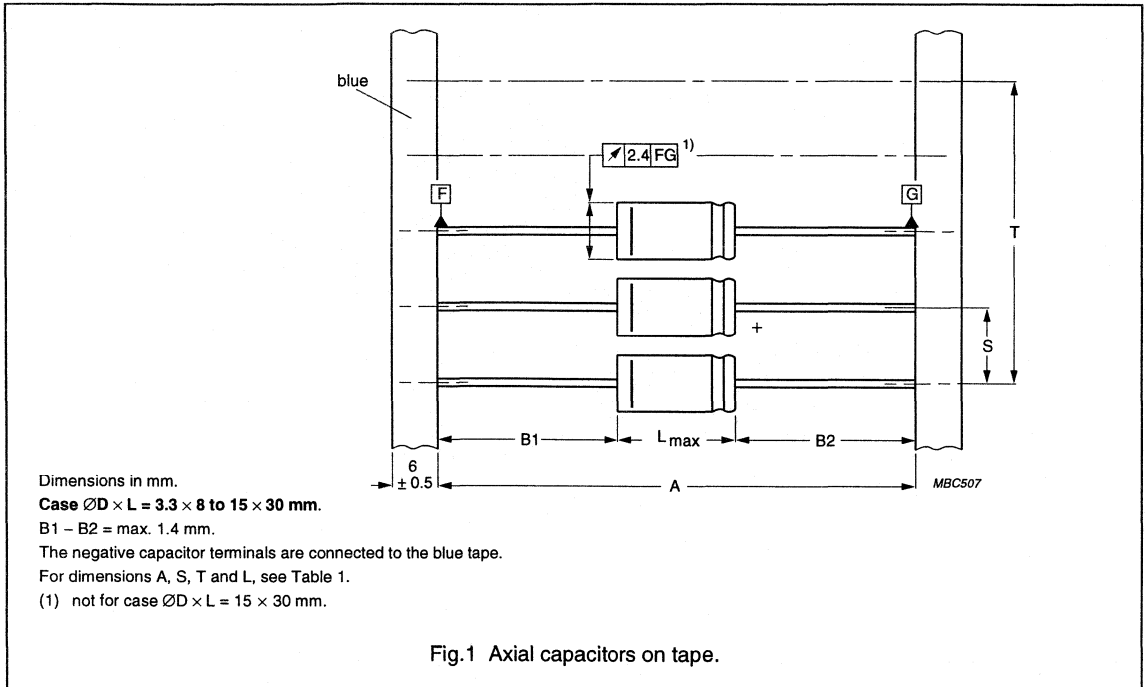
NOMINAL CASE SIZE ($\varnothing D \times L$) (mm)	CASE CODE	A (mm)	S (mm)	T FOR NUMBER (n)		L _{max} (mm)	C (mm)	D (mm)
				n<50	50<n<100			
Non-solid types								
3.3 × 8	1a	63.5 ±1.5 ⁽¹⁾	5 ±0.4	5(n-1) ±2	5(n-1) ±4	9	83.5	94.5
3.3 × 11	1	63.5 ±1.5 ⁽¹⁾	5 ±0.4	5(n-1) ±2	5(n-1) ±4	12	83.5	94.5
4.5 × 10	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

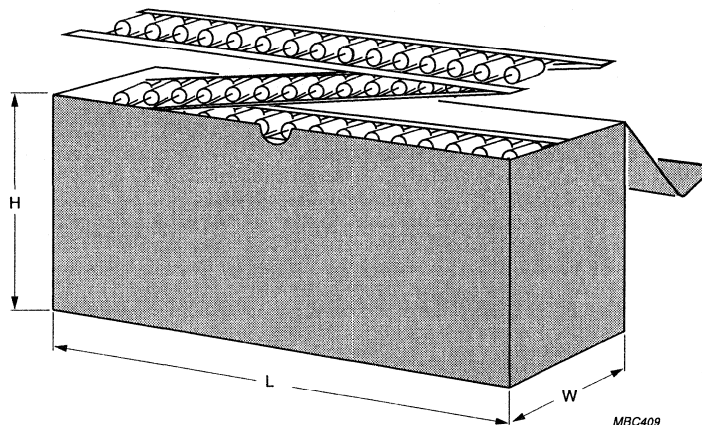
Note

1. 52 ±1.5 mm on request.

Electrolytic capacitors

Packaging - Axial Electrolytic Capacitors





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

Electrolytic capacitors

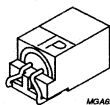
Packaging - Axial Electrolytic
Capacitors

QUANTITIES PER PACKAGING UNIT

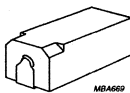
Table 3 Number of capacitors per packaging unit

NOMINAL CASE SIZE ($\varnothing D \times L$) (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 ELECTROLYTIC CAPACITORS ('CHIPS')



MBAG80



MBAG60

NON-SOLID ALUMINIUM

STANDARD

CS085

1500 hours 85 °C

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INDUSTRIAL

CLP172

1000 hours 105 °C

page 96

PROFESSIONAL

CLL139

2000 hours 105 °C

page 104

MBC592 - 1

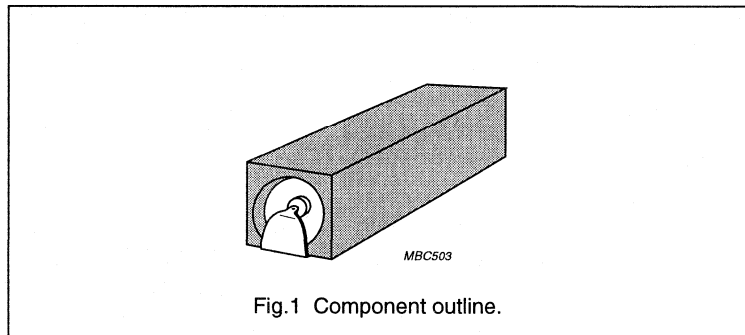
Non-solid Al - electrolytic capacitors

SMD (Chip) Standard

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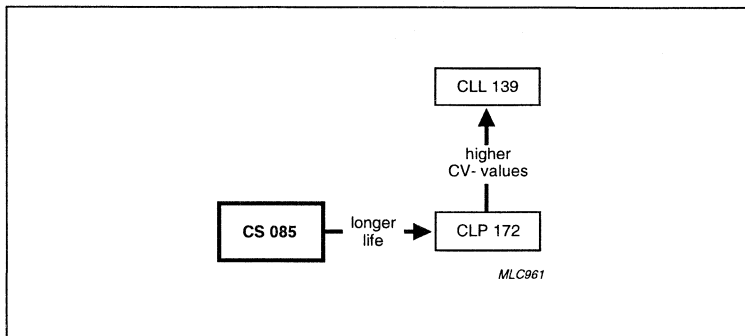
FEATURES

- 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.



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	1000 hours
Useful life at 85 °C	1500 hours
Useful life at 40 °C, 1.4 × I _R applied	40000 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 (DIN 40040)	40/085/56 (GPF)

Non-solid Al - 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**.

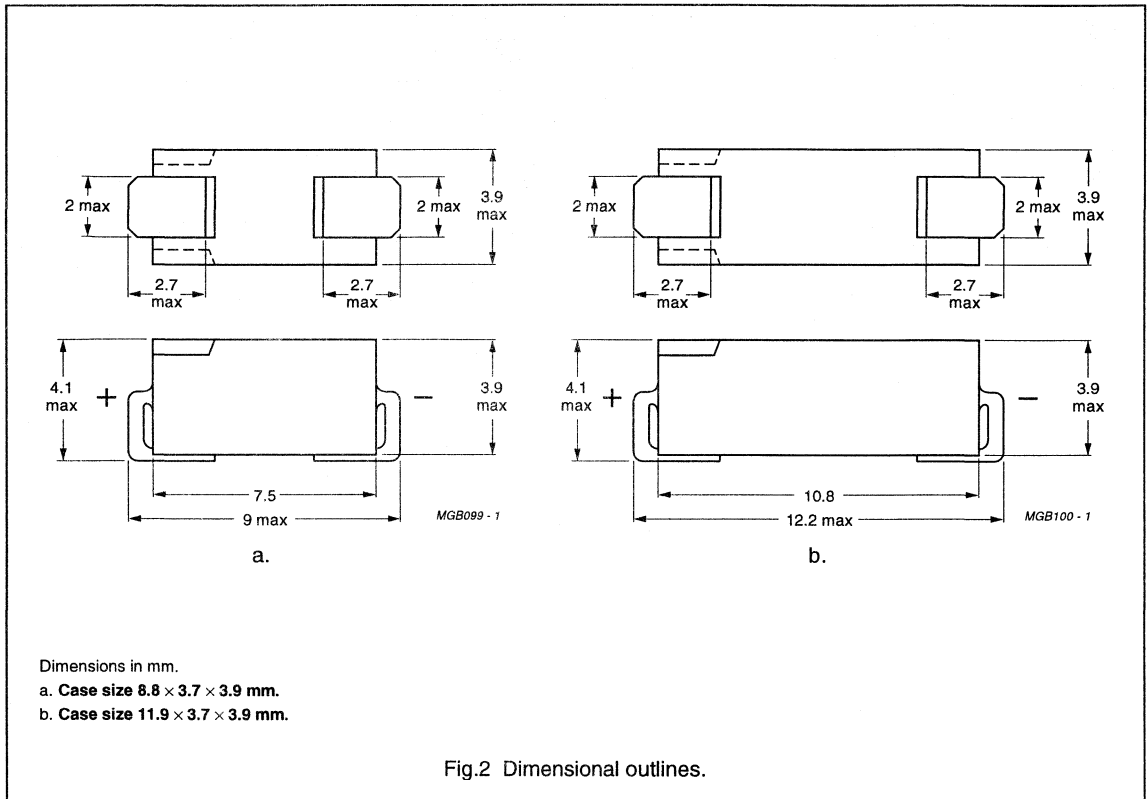
C_R (μF)	U_R (V)					
	6.3	10	16	25	40	63
0.47	–	–	–	–	–	8.8 × 3.7 × 3.9
1.0	–	–	–	–	–	8.8 × 3.7 × 3.9
2.2	–	–	–	–	8.8 × 3.7 × 3.9	11.9 × 3.7 × 3.9
3.3	–	–	–	8.8 × 3.7 × 3.9	–	11.9 × 3.7 × 3.9
4.7	–	–	8.8 × 3.7 × 3.9	–	11.9 × 3.7 × 3.9	–
6.8	–	8.8 × 3.7 × 3.9	–	11.9 × 3.7 × 3.9	–	–
10	8.8 × 3.7 × 3.9	–	11.9 × 3.7 × 3.9	–	–	–
15	–	11.9 × 3.7 × 3.9	–	–	–	–
22	11.9 × 3.7 × 3.9	–	–	–	–	–

SM

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

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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 (bevelled edges identify the anode).

Examples for C_{nom} ; U_R marking:

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

Table 1 Rated voltage marking code

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

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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.

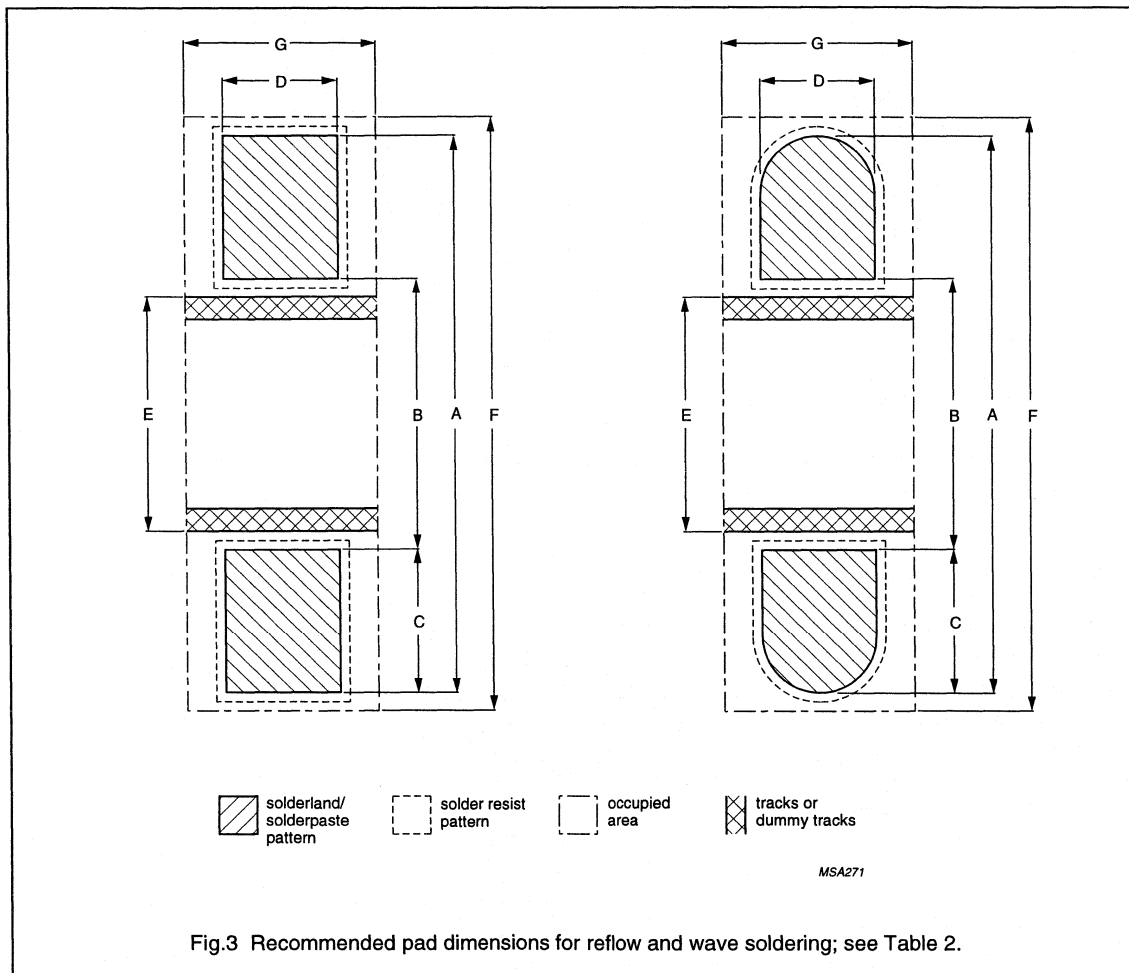


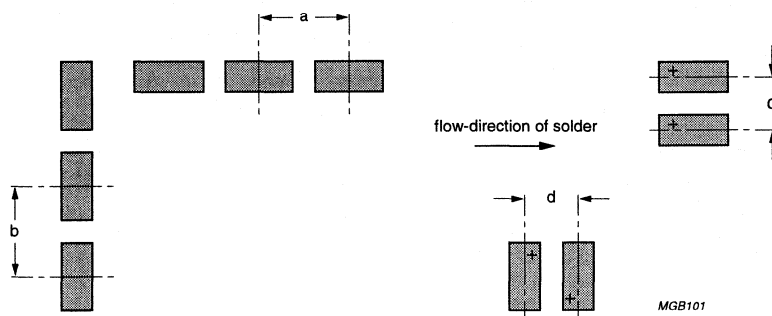
Table 2 Recommended soldering pad dimensions in mm (placement accuracy ± 0.25 mm); see Fig.3

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

Non-solid Al - electrolytic capacitors

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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 CS 085 capacitors on a printed-circuit board for wave soldering.

Soldering

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

For maximum conditions of different soldering methods see Figs 5, 6 and 7.

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

After soldering under maximum conditions, some drift of the electrical parameters may occur. Typical behaviour which can be expected under these circumstances is shown in Fig.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 × W × H (mm)	a _{min} (mm)	b _{min} (mm)	c _{min} (mm)	d _{min} (mm)
8.8 × 3.7 × 3.9	12	12	6.8	6.8
11.9 × 3.7 × 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

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

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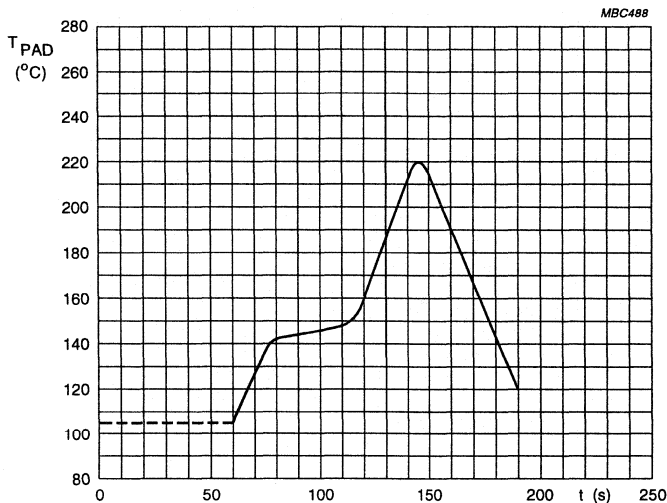


Fig.5 Maximum temperature load during infrared reflow soldering.

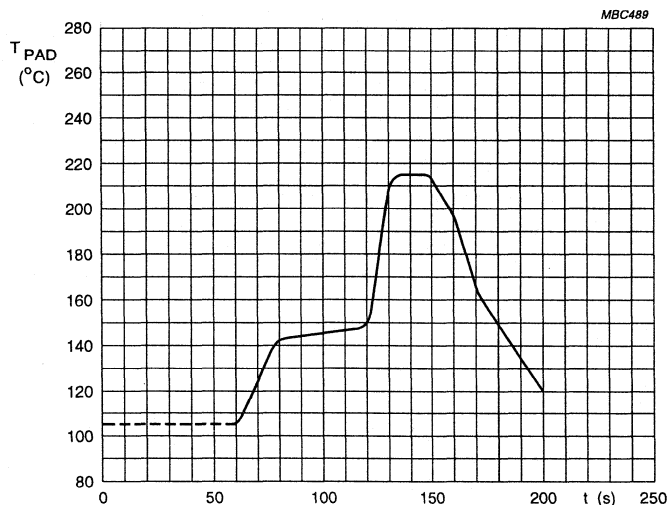


Fig.6 Maximum temperature load during vapour phase reflow soldering.

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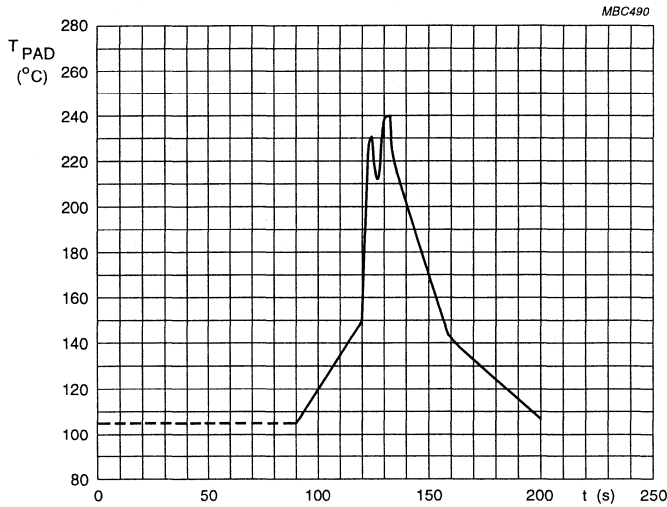


Fig.7 Maximum temperature load during (double-) wave soldering.

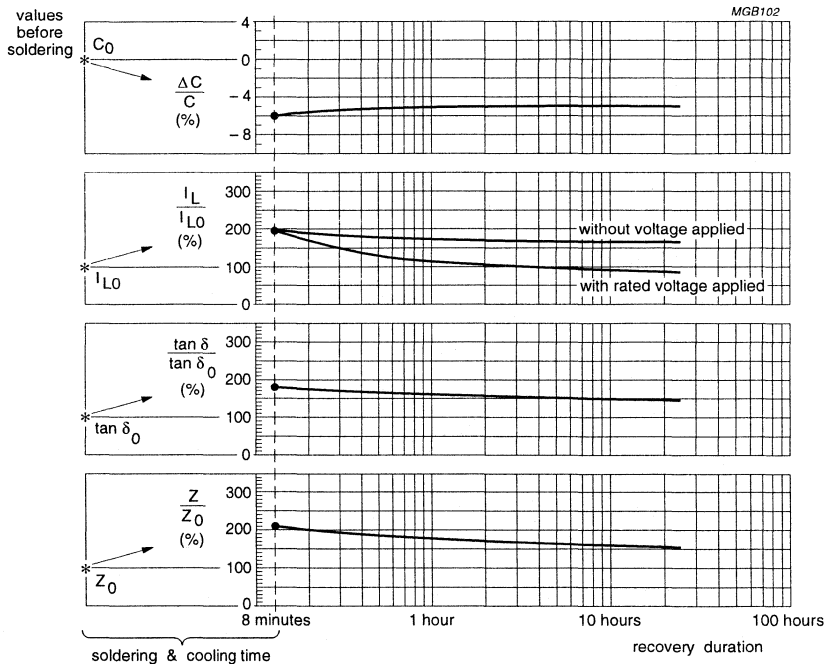


Fig.8 Typical drift of electrical parameters after soldering under maximum conditions, and subsequent recovery.

Non-solid Al - electrolytic capacitors

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Ordering example

Electrolytic capacitor CS 085

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.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz (tolerance -10 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
Tan δ	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

ELECTRICAL DATA AND ORDERING INFORMATION

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

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

U_R (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)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222	
										-10/+50%	$\pm 20\%$
										BLISTER TAPE ON REEL FORM BR	BLISTER TAPE ON REEL FORM BR
6.3	10.0 22	$8.8 \times 3.7 \times 3.9$ $11.9 \times 3.7 \times 3.9$	1a 1	11 20	4 6	3.1 3.3	0.30 0.30	48 22	20 9	085 23109 085 23229	085 63109 085 63229
10	6.8 15	$8.8 \times 3.7 \times 3.9$ $11.9 \times 3.7 \times 3.9$	1a 1	10 18	4 6	3.1 3.3	0.25 0.25	59 27	24 11	085 24688 085 24159	085 64888 085 64159
16	4.7 10	$8.8 \times 3.7 \times 3.9$ $11.9 \times 3.7 \times 3.9$	1a 1	9 16	5 6	3.2 3.3	0.20 0.20	68 32	26 12	085 25478 085 25109	085 65478 085 65109
25	3.3 6.8	$8.8 \times 3.7 \times 3.9$ $11.9 \times 3.7 \times 3.9$	1a 1	8 14	5 6	3.2 3.3	0.18 0.18	87 42	27 13	085 26338 085 26688	085 66338 085 66688
40	2.2 4.7	$8.8 \times 3.7 \times 3.9$ $11.9 \times 3.7 \times 3.9$	1a 1	7 13	5 7	3.2 3.4	0.16 0.16	120 54	32 15	085 27228 085 27478	085 67228 085 67478
63	0.47 1.0	$8.8 \times 3.7 \times 3.9$ $8.8 \times 3.7 \times 3.9$	1a 1a	4 6	4 4	3.1 3.1	0.10 0.12	340 190	120 55	085 28477 085 28108	085 68477 085 68108
	2.2 3.3	$11.9 \times 3.7 \times 3.9$ $11.9 \times 3.7 \times 3.9$	1 1	11 13	6 7	3.3 3.4	0.14 0.14	87 68	25 17	085 28228 085 28338	085 68228 085 68338

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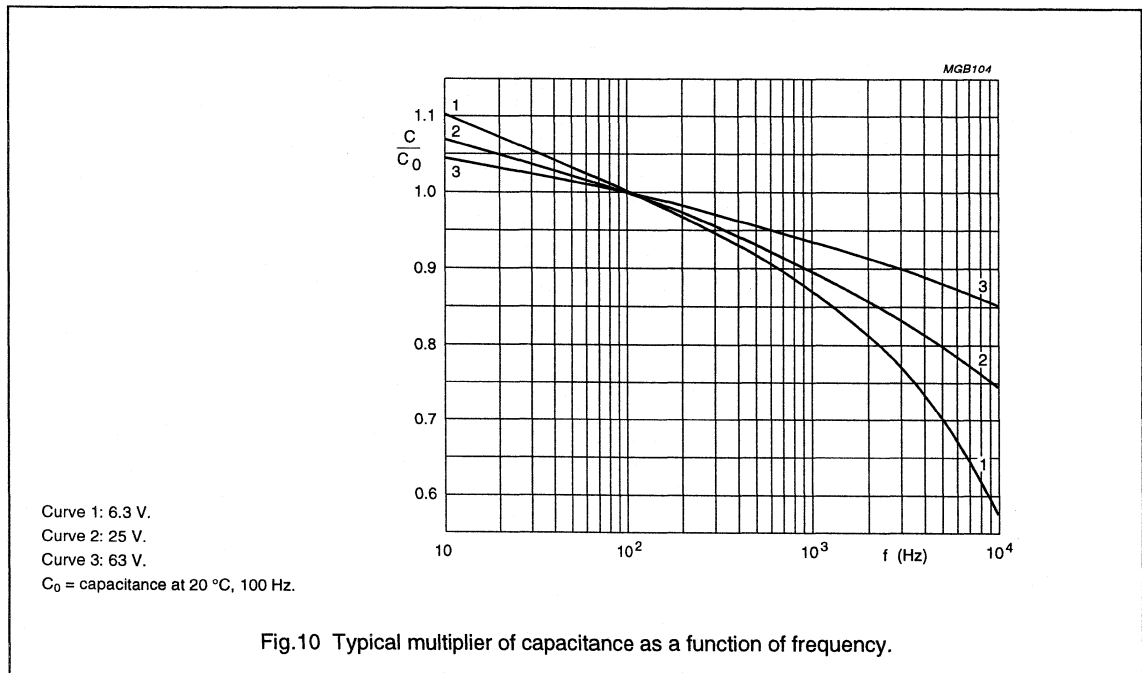
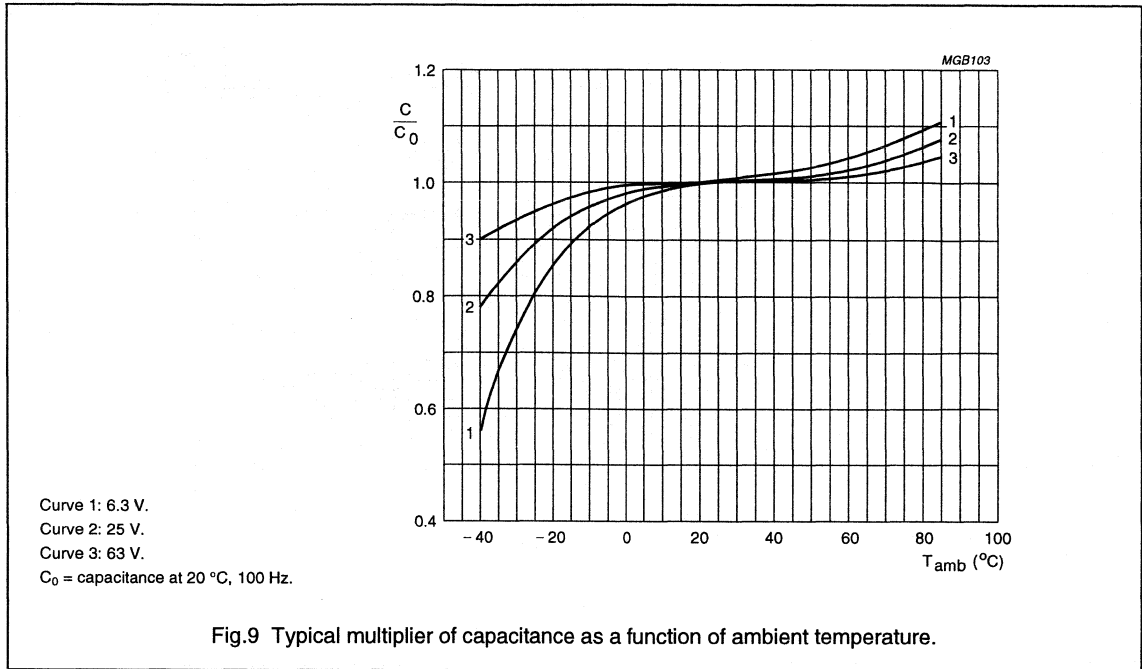
Additional electrical data

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 $8.8 \times 3.7 \times 3.9 \text{ mm}$	typ. 11 nH
	nominal case size $11.9 \times 3.7 \times 3.9 \text{ mm}$	typ. 13 nH

Non-solid Al - electrolytic capacitors
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Capacitance (C)



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Dissipation factor ($\tan \delta$)

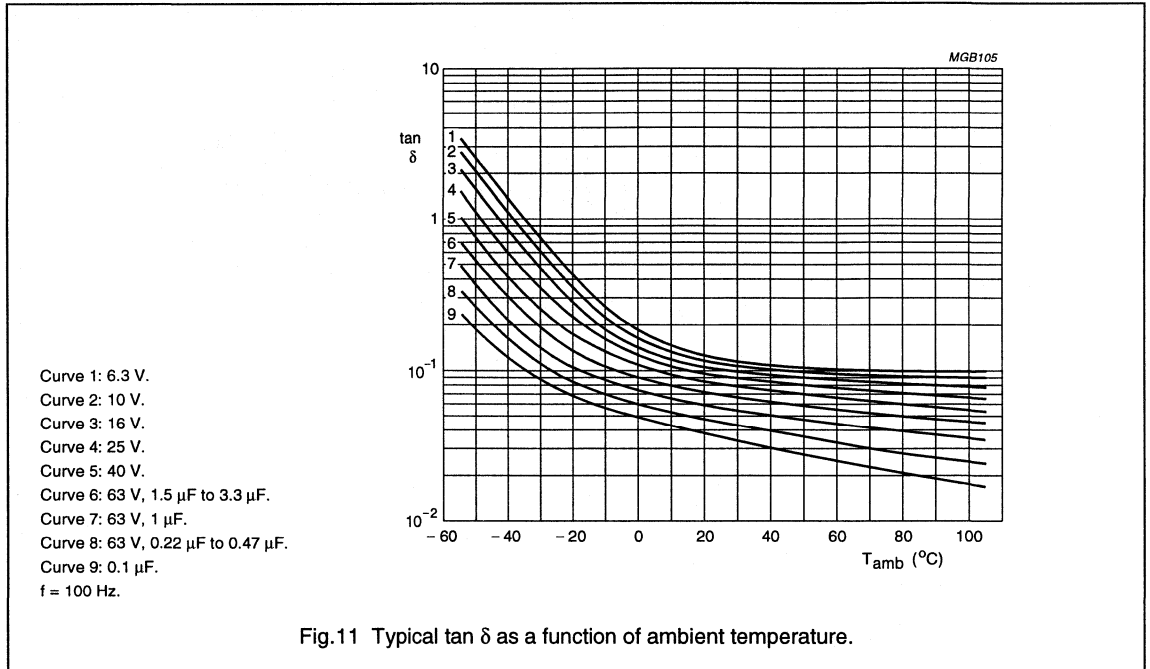


Fig.11 Typical $\tan \delta$ as a function of ambient temperature.

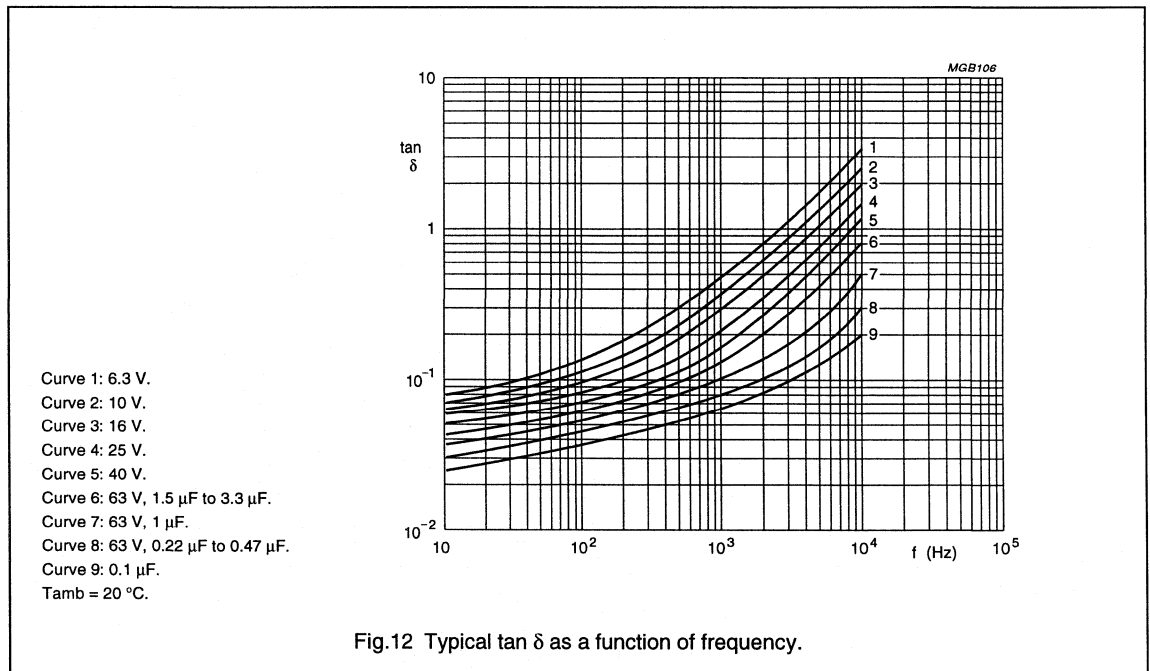


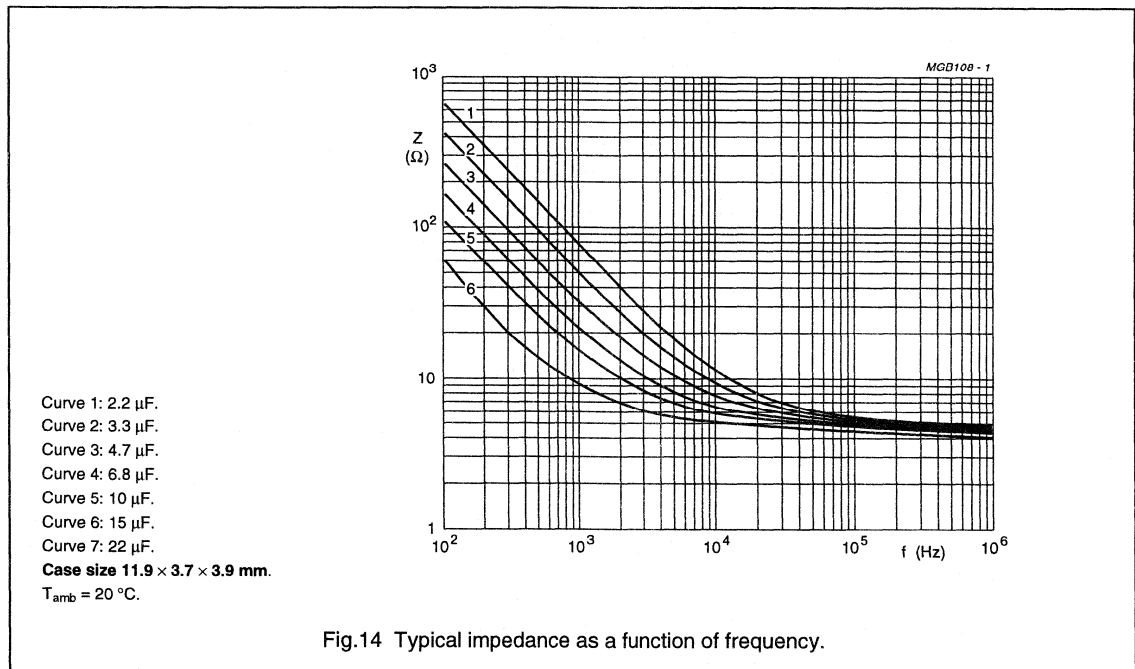
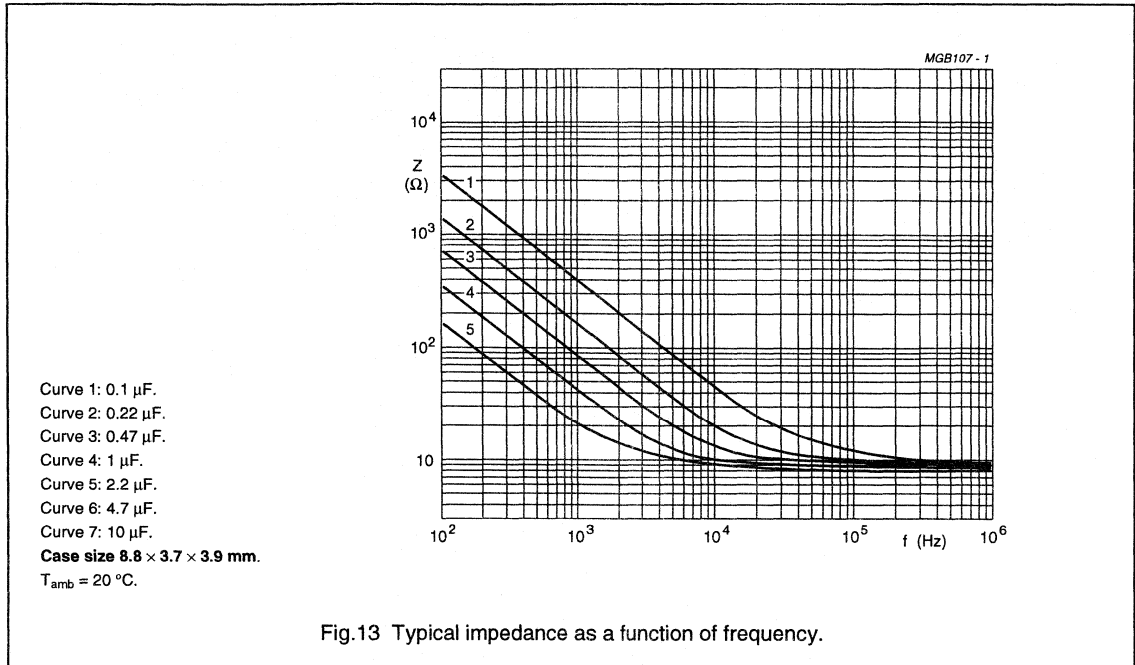
Fig.12 Typical $\tan \delta$ as a function of frequency.

Non-solid Al - electrolytic capacitors

SMD (Chip) Standard

CS 085

Impedance (Z)



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

CS 085

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

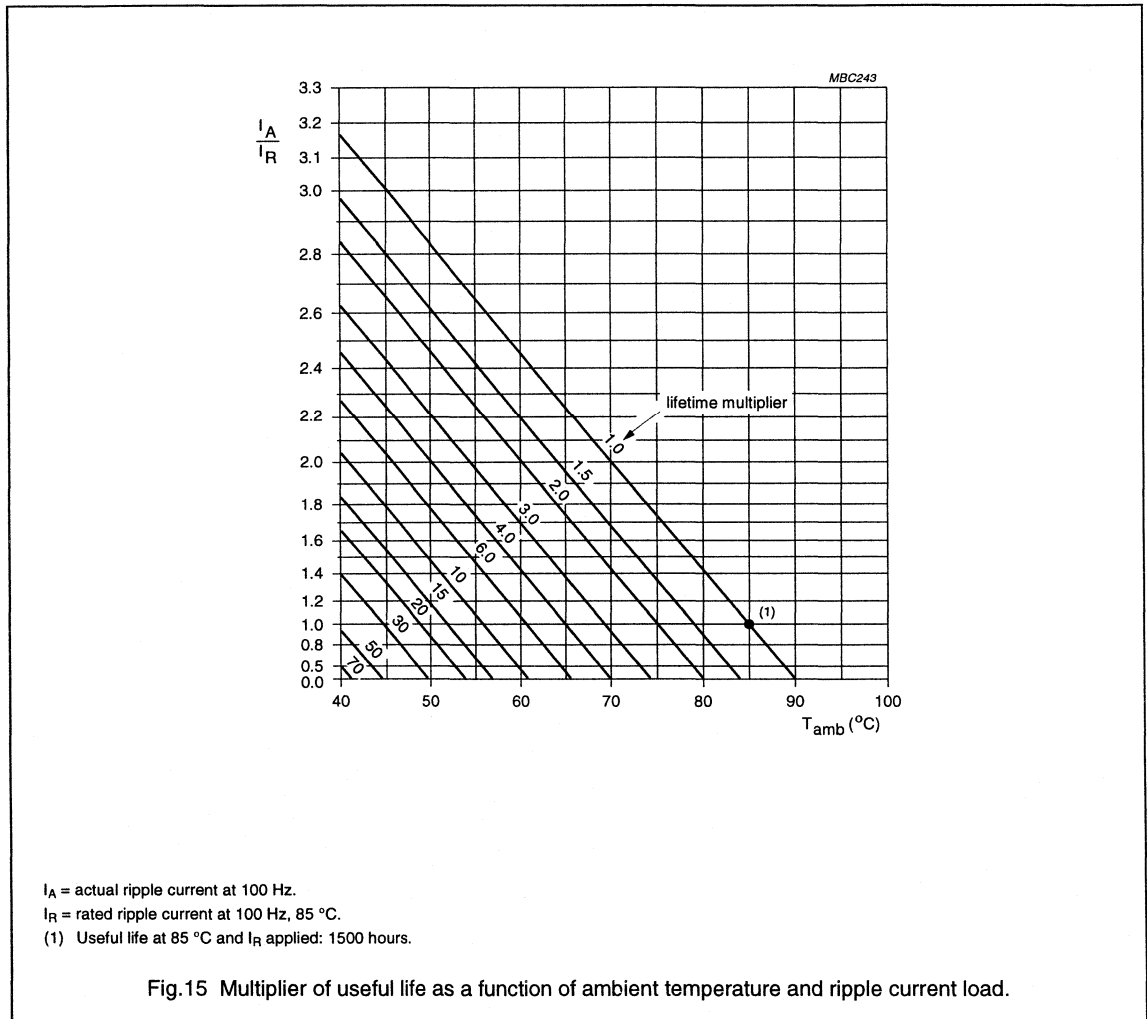


Fig.15 Multiplier of useful life as a function of ambient temperature and ripple current load.

Non-solid Al - electrolytic capacitors

SMD (Chip) Standard

CS 085

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	$T_{\text{amb}} = 85 \text{ }^\circ\text{C}$; 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	$T_{\text{amb}} = 85 \text{ }^\circ\text{C}$; U_R and I_R applied; 1500 hours	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-18/ CECC 32300, subclause 4.17	$T_{\text{amb}} = 85 \text{ }^\circ\text{C}$; 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 $I_{L5} \leq 2 \times \text{spec. limit}$

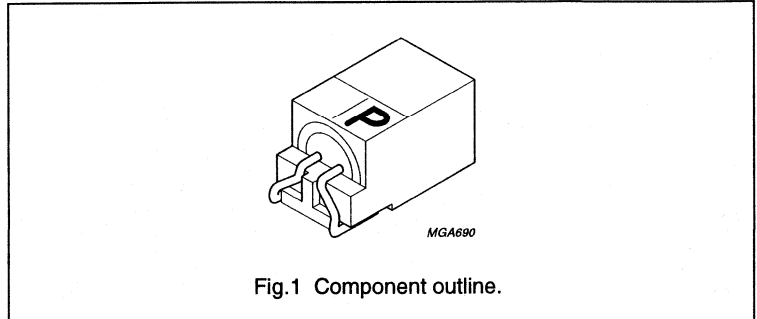
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Non-solid Al - electrolytic capacitors SMD (Chip) Low Profile

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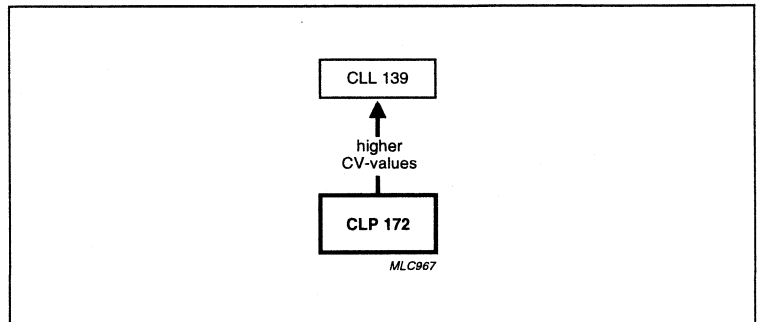
FEATURES

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



APPLICATIONS

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



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes (L × W × H in mm)	6.3 × 3.5 × 3.5 to 8.3 × 4.5 × 4.5
Rated capacitance range, C _R	1.0 to 33 μF
Tolerance on C _R	±20%
Rated voltage range, U _R	6.3 to 50 V
Category temperature range	-40 to +105 °C
Useful life at 105 °C	1 000 hours
Useful life at 40 °C; 1.3 × I _R applied	100 000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 384-18/CECC 32300
Climatic category IEC 68 (DIN 40040)	40/105/56 (GMF)

Non-solid Al - 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 (mF)	U_R (V)					
	6.3	10	16	25	35	50
1.0	–	–	–	–	–	6.3 × 3.5 × 3.5
2.2	–	–	–	–	6.3 × 3.5 × 3.5	6.3 × 4.0 × 4.0
3.3	–	–	–	6.3 × 3.5 × 3.5	–	6.3 × 4.5 × 4.5
4.7	–	–	6.3 × 3.5 × 3.5	6.3 × 4.0 × 4.0	6.3 × 4.5 × 4.5	8.3 × 4.5 × 4.5
6.8	–	6.3 × 3.5 × 3.5	–	6.3 × 4.5 × 4.5	8.3 × 4.5 × 4.5	–
10	6.3 × 3.5 × 3.5	–	6.3 × 4.0 × 4.0	8.3 × 4.5 × 4.5	–	–
15	–	6.3 × 4.5 × 4.5	8.3 × 4.5 × 4.5	–	–	–
22	6.3 × 4.5 × 4.5	8.3 × 4.5 × 4.5	–	–	–	–
33	8.3 × 4.5 × 4.5	–	–	–	–	–

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MECHANICAL DATA

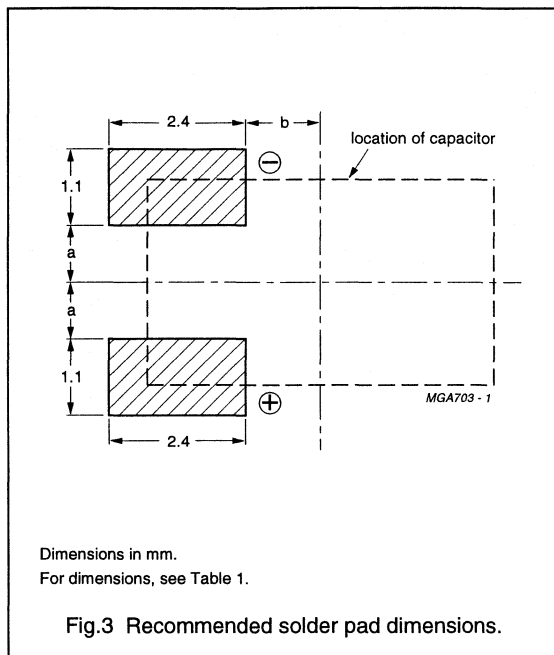
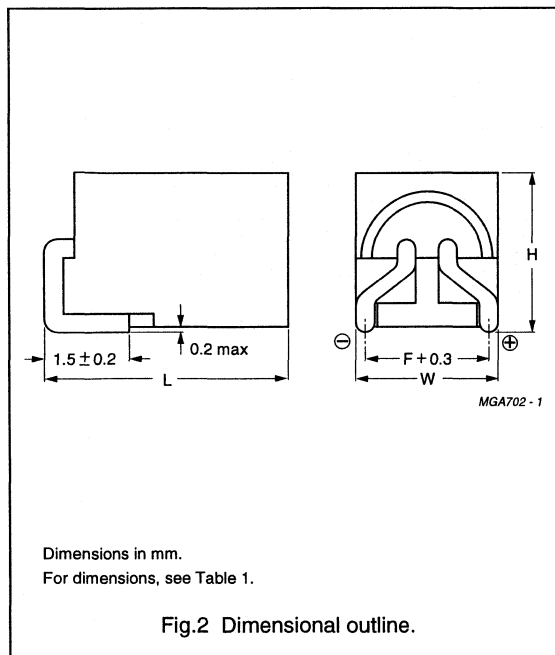


Table 1 Physical and recommended soldering pad dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE L × W × H (mm)	CASE CODE	L _{max} (mm)	W _{max} (mm)	H _{max} (mm)	F (mm)	a (mm)	b (mm)	MASS (g)	PACKAGING QUANTITIES PER REEL
6.3 × 3.5 × 3.5	63	6.5	3.8	3.7	3.0	1.0	1.2	≈0.13	3000
6.3 × 4.0 × 4.0	64	6.5	4.3	4.2	3.5	1.3	1.2	≈0.17	2500
6.3 × 4.5 × 4.5	65	6.5	4.8	4.7	4.0	1.5	1.2	≈0.20	2500
8.3 × 4.5 × 4.5	85	8.5	4.8	4.7	4.0	1.5	2.2	≈0.25	2500

Non-solid Al - electrolytic capacitors

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MARKING

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

MOUNTING

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

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

For recommended pad dimensions, refer to Fig.3 and Table 1.

Soldering

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

For maximum conditions of different soldering methods see Figs 4 and 5.

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

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

Maximum temperature load

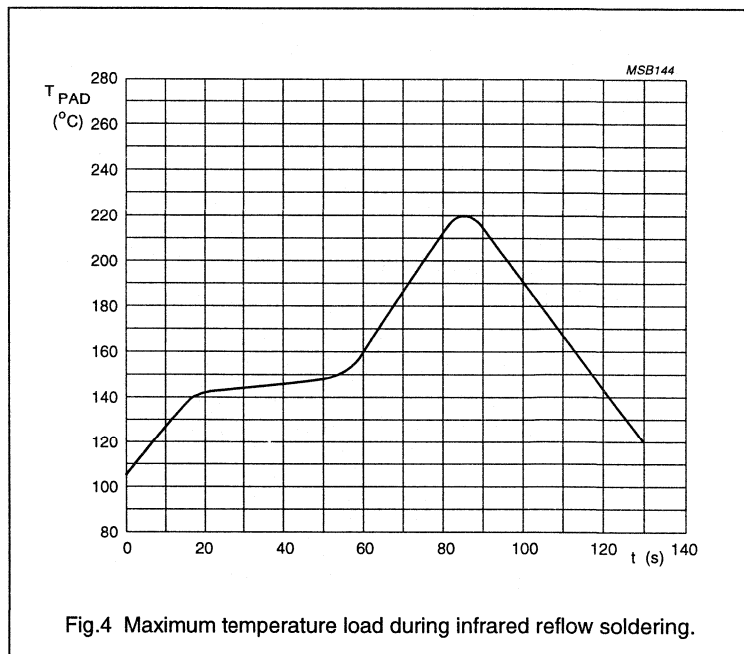


Fig.4 Maximum temperature load during infrared reflow soldering.

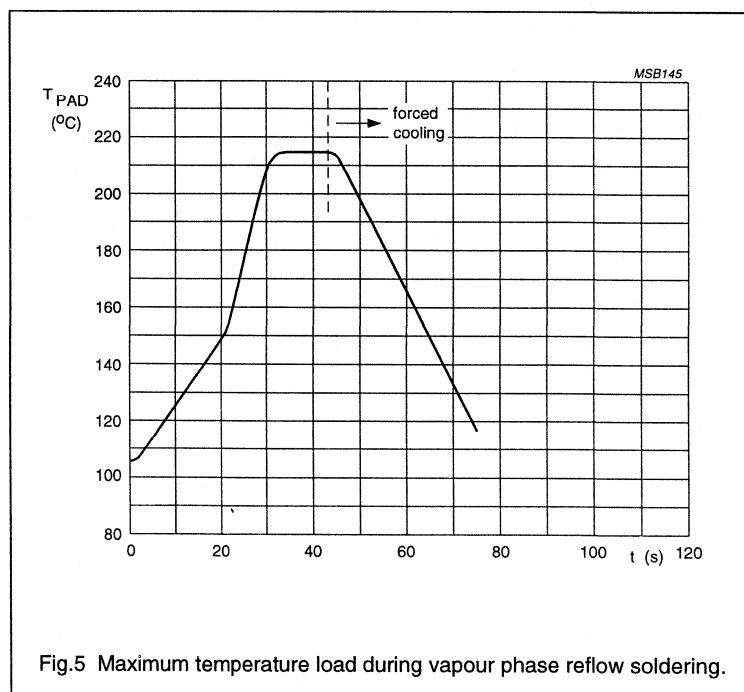


Fig.5 Maximum temperature load during vapour phase reflow soldering.

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Non-solid Al - electrolytic capacitors

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at
 $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86$ 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, $105\text{ }^{\circ}\text{C}$
I_{L2}	max. leakage current after 2 minutes at U_R
$\text{Tan } \delta$	max. dissipation factor at 120 Hz
ESR	equivalent series resistance at 120 Hz (calculated from $\text{tan } \delta_{max}$ and C_R)

Ordering example

Electrolytic capacitor CLP 172

10 $\mu\text{F}/16\text{ V}$; $\pm 20\%$

Nominal case size:

6.3 \times 4.0 \times 4.0 mm; taped on reel

Catalogue number: 2222 172 65109

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

U_R (V)	C_R 120 Hz (μF)	NOMINAL CASE SIZE L \times W \times H (mm)	CASE CODE	I_R 120 Hz $105\text{ }^{\circ}\text{C}$ (mA)	I_{L2} 2 min (μA)	$\text{Tan } \delta$ 120 Hz	ESR 120 Hz (Ω)	CATALOGUE NUMBER 2222
6.3	10	6.3 \times 3.5 \times 3.5	63	11	3	0.38	50	172 63109
	22	6.3 \times 4.5 \times 4.5	65	20	3	0.32	19	172 63229
	33	8.3 \times 4.5 \times 4.5	85	27	3	0.32	13	172 63339
10	6.8	6.3 \times 3.5 \times 3.5	63	10	3	0.30	59	172 64688
	15	6.3 \times 4.5 \times 4.5	65	19	3	0.28	25	172 64159
	22	8.3 \times 4.5 \times 4.5	85	25	3	0.28	17	172 64229
16	4.7	6.3 \times 3.5 \times 3.5	63	9	3	0.24	68	172 65478
	10	6.3 \times 4.0 \times 4.0	64	14	3	0.24	32	172 65109
	15	8.3 \times 4.5 \times 4.5	85	23	3	0.24	21	172 65159
25	3.3	6.3 \times 3.5 \times 3.5	63	8.3	3	0.18	72	172 66338
	4.7	6.3 \times 4.0 \times 4.0	64	11	3	0.18	51	172 66478
	6.8	6.3 \times 4.5 \times 4.5	65	16	3	0.16	31	172 66688
	10	8.3 \times 4.5 \times 4.5	85	21	3	0.16	21	172 66109
35	2.2	6.3 \times 3.5 \times 3.5	63	7.2	3	0.16	96	172 60228
	4.7	6.3 \times 4.5 \times 4.5	65	14	3	0.14	40	172 60478
	6.8	8.3 \times 4.5 \times 4.5	85	18	3	0.14	27	172 60688
50	1.0	6.3 \times 3.5 \times 3.5	63	5.2	3	0.14	190	172 61108
	2.2	6.3 \times 4.0 \times 4.0	64	8.4	3	0.14	84	172 61228
	3.3	6.3 \times 4.5 \times 4.5	65	13	3	0.12	48	172 61338
	4.7	8.3 \times 4.5 \times 4.5	85	16	3	0.12	34	172 61478

Non-solid Al - electrolytic capacitors

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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

Impedance (Z)**Table 3** Ratio of impedance at 120 Hz, between -25 and $+20$ °C

NOMINAL CASE SIZE L × W × H (mm)	$Z_{-25^\circ\text{C}}/Z_{+20^\circ\text{C}}$ at U_R					
	6.3 V	10 V	16 V	25 V	35 V	50 V
6.3 × 3.5 × 3.5	6	4	3	2	2	2
6.3 × 4.0 × 4.0						
6.3 × 4.5 × 4.5	4	3	2	2	2	2
8.3 × 4.5 × 4.5						

Table 4 Ratio of impedance at 120 Hz, between -40 and $+20$ °C

NOMINAL CASE SIZE L × W × H (mm)	$Z_{-40^\circ\text{C}}/Z_{+20^\circ\text{C}}$ at U_R					
	6.3 V	10 V	16 V	25 V	35 V	50 V
6.3 × 3.5 × 3.5	12	9	7	5	4	4
6.3 × 4.0 × 4.0						
6.3 × 4.5 × 4.5	10	8	6	4	3	3
8.3 × 4.5 × 4.5						

SMI

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

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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	0.6
120	1.0
400	1.2
800	1.3
≥ 2000	1.4

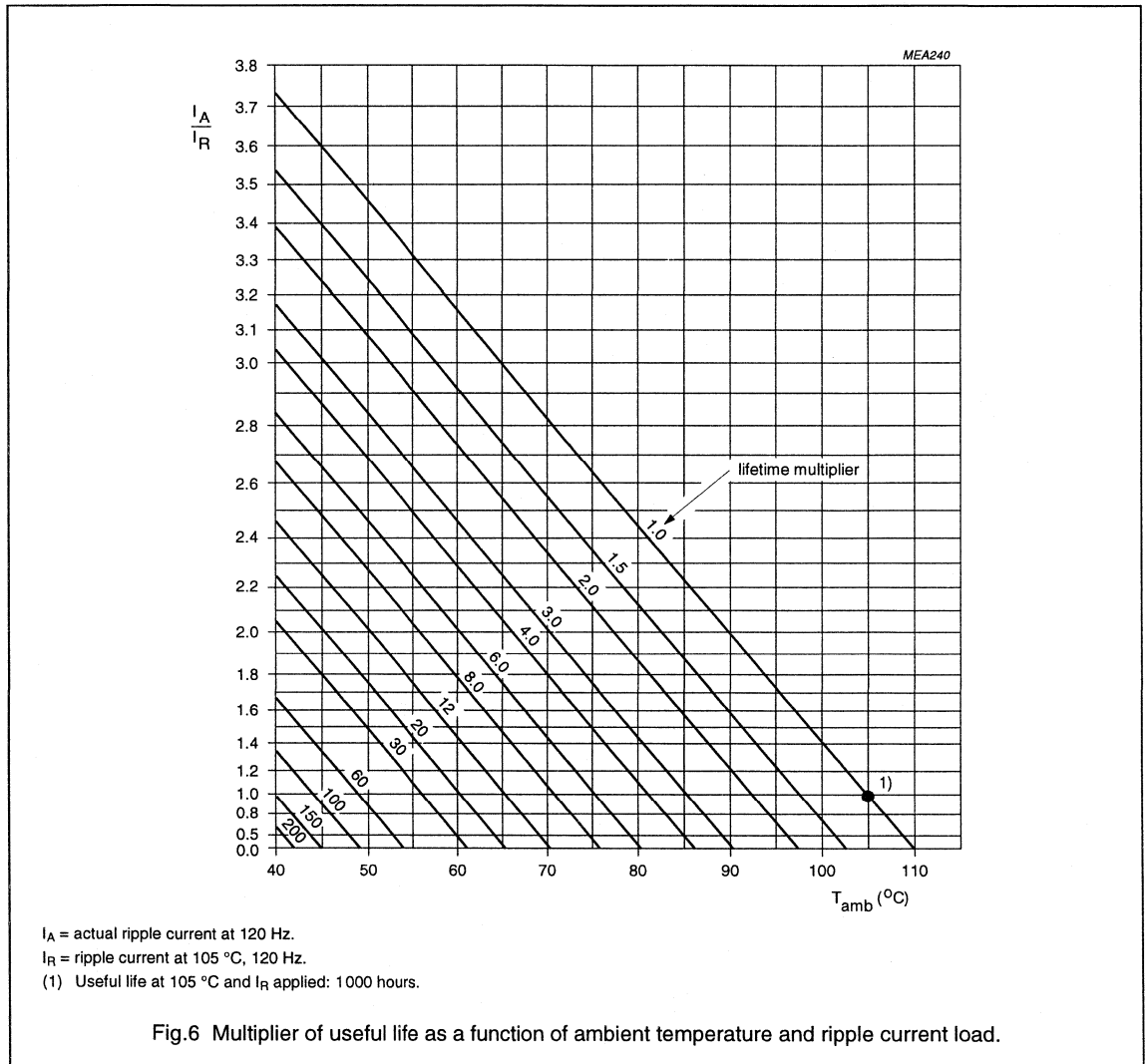


Fig.6 Multiplier of useful life as a function of ambient temperature and ripple current load.

Non-solid Al - electrolytic capacitors

SMD (Chip) Low Profile

CLP 172

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 'Useful life' and 'Shelf life' as mentioned below; reflow soldering; for maximum temperature load refer to Chapter "Mounting"	$\Delta C/C: \pm 8\%$ $\tan \delta \leq \text{spec. limit}$ $I_{L2} \leq 2 \times \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{amb} = 105\text{ }^\circ\text{C}$; U_R and I_R applied; 1000 hours	$\Delta C/C$: case codes 63 and 64: $\pm 25\%$ case codes 65 and 85: $\pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-18/ CECC 32300, subclause 4.17	$T_{amb} = 105\text{ }^\circ\text{C}$; no voltage applied; 500 hours; after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$: case codes 63 and 64: $\pm 25\%$ case codes 65 and 85: $\pm 15\%$ $\tan \delta$: case codes 63 and 64: $\leq 2 \times \text{spec. limit}$ case codes 65 and 85: $\leq 1.5 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$

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

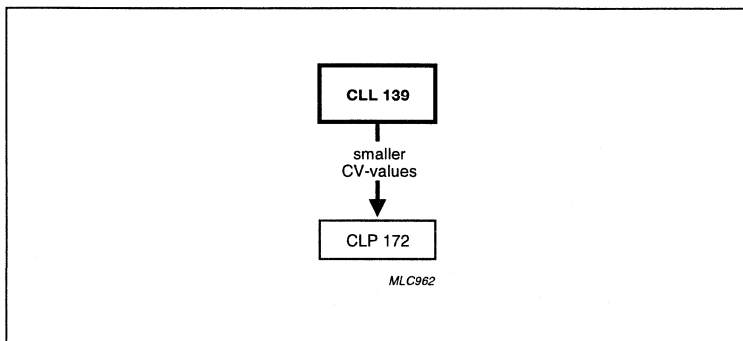
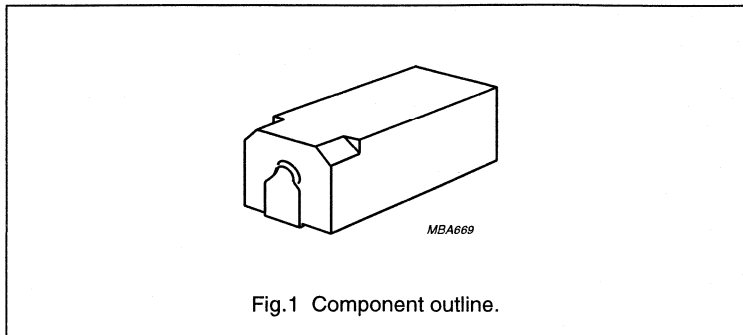
CLL 139

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid, self healing
- Extended voltage and capacitance range
- SMD-version, fully moulded, insulated
- Flexible terminals, reflow and wave solderable
- Compact, rectangular shape
- Charge and discharge proof, no peak current limitation
- Supplied in blister tape on reel.

APPLICATIONS

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



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 uF
Tolerance on C _R	±20%
Rated voltage range, U _R	6.3 to 100 V
Category temperature range	-55 to +105 °C
Endurance test at 105 °C	1000 hours
Useful life at 105 °C	2000 hours
Useful life at 40 °C; 1.3 × 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 (DIN 40040)	55/105/56 (FMF)

Non-solid Al - 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 ⁽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	-	-	-	-	-	-	-

Note

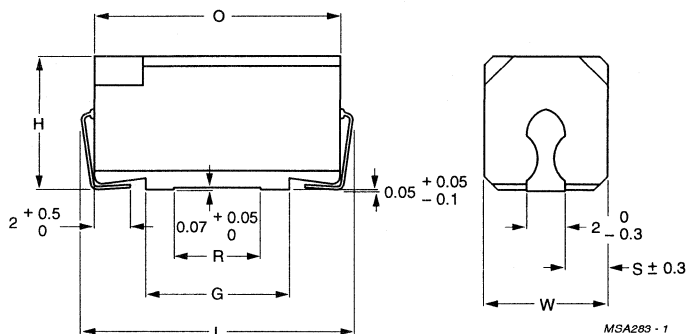
- For lower CV-values see "data sheet CLP 172".

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Non-solid Al - electrolytic capacitors

SMD (Chip) Long Life

CLL 139

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 $L \times W \times H$ (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.

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

CLL 139

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.

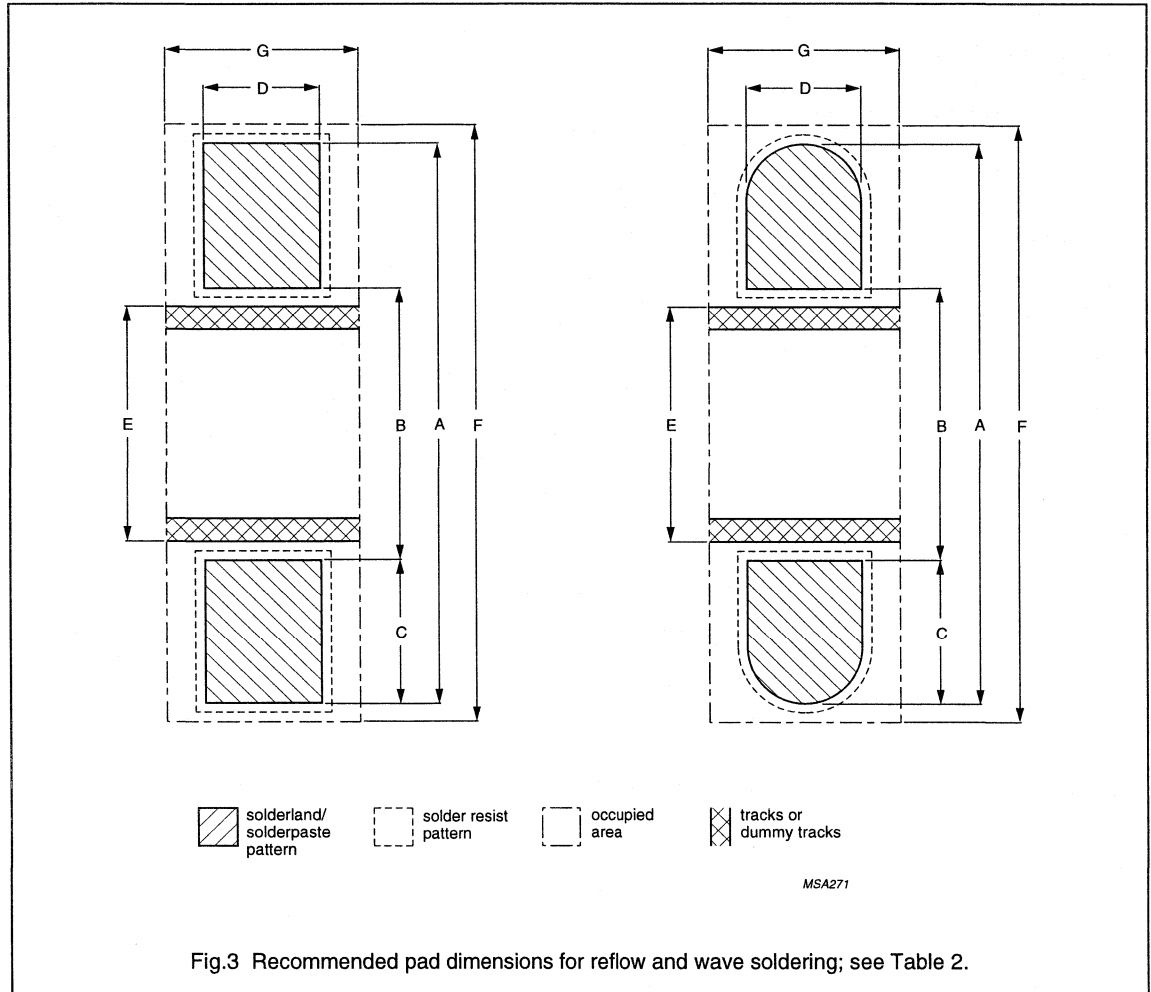


Table 2 Recommended soldering pad dimensions in mm (placement accuracy ± 0.25 mm); see Fig.3

NOMINAL CASE SIZE L x W x H (mm)	FOR REFLOW SOLDERING							FOR WAVE SOLDERING						
	A	B	C	D	E	F	G	A	B	C	D	E	F	G
14.3 x 6.2 x 6.9	15.8	8.8	3.5	2.8	8.0	16.2	7.7	18.6	10.0	4.3	5.0	8.8	20.5	11.5
14.3 x 7.6 x 8.2	15.8	8.8	3.5	2.8	8.0	16.2	9.1	18.6	10.0	4.3	6.0	8.8	21.5	13.0

SM

Non-solid Al - electrolytic capacitors

SMD (Chip) Long Life

CLL 139

Soldering

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

For maximum conditions of different soldering methods see Figs 4, 5 and 6.

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

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

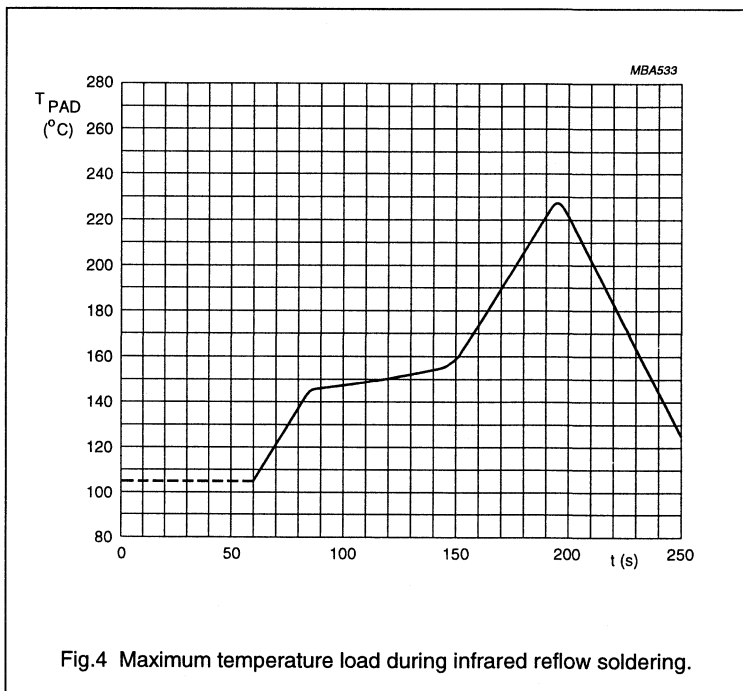


Fig.4 Maximum temperature load during infrared reflow soldering.

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

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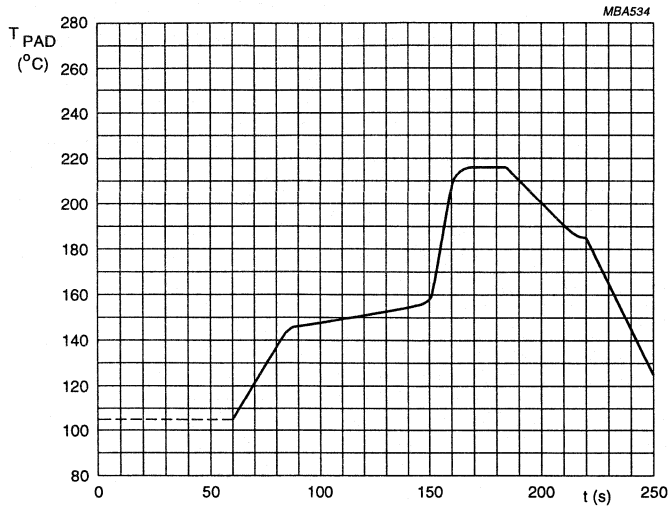


Fig.5 Maximum temperature load during vapour phase reflow soldering.

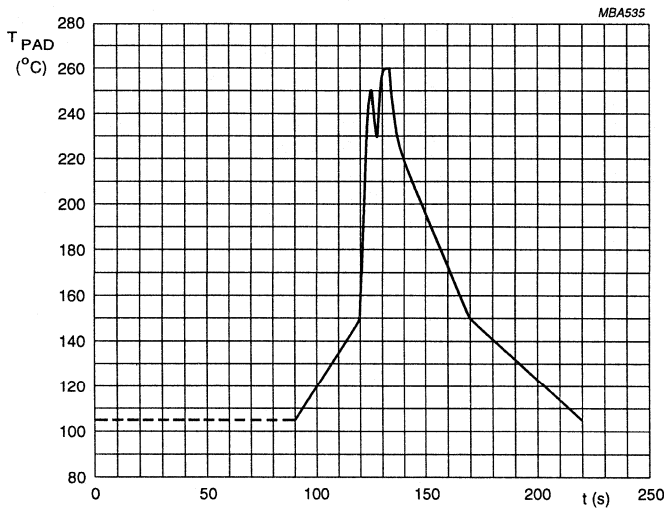


Fig.6 Maximum temperature load during (double-) wave soldering.

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Non-solid Al - electrolytic capacitors

SMD (Chip) Long Life

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ELECTRICAL DATA AND ORDERING INFORMATION

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

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, $105\text{ }^{\circ}\text{C}$
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 CLL 139

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

Nominal case size:
 $14.3 \times 7.6 \times 8.2\text{ mm}$; taped on reel

Catalogue number: 2222 139 65101.

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 $105\text{ }^{\circ}\text{C}$ (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
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

Non-solid Al - electrolytic capacitors

SMD (Chip) Long Life

CLL 139

Additional electrical data

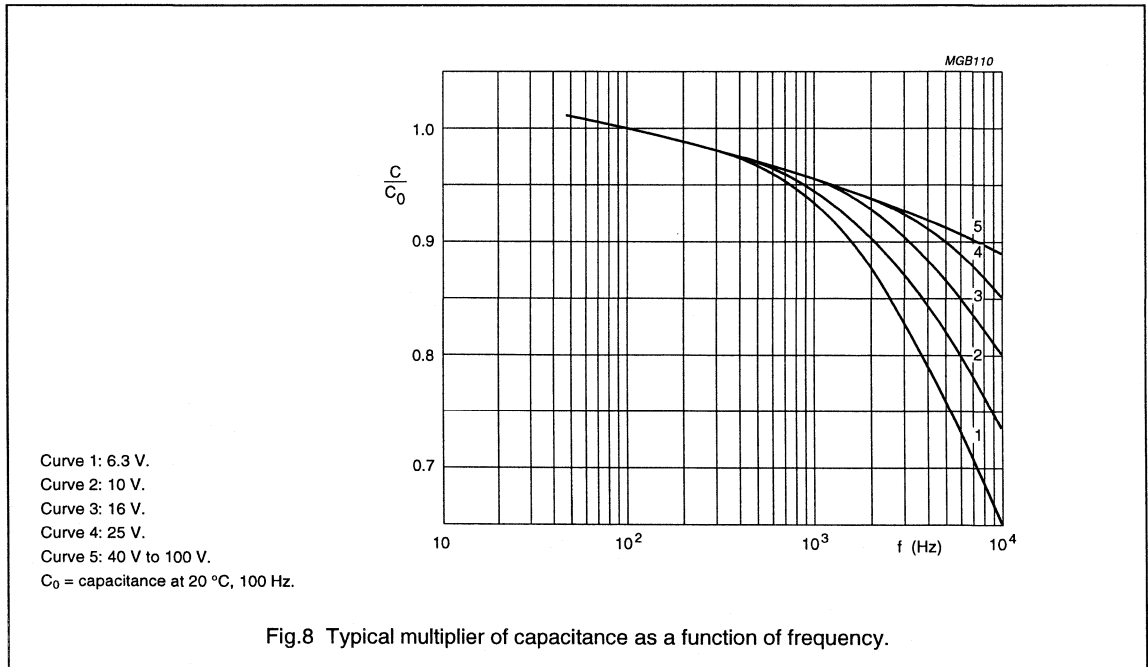
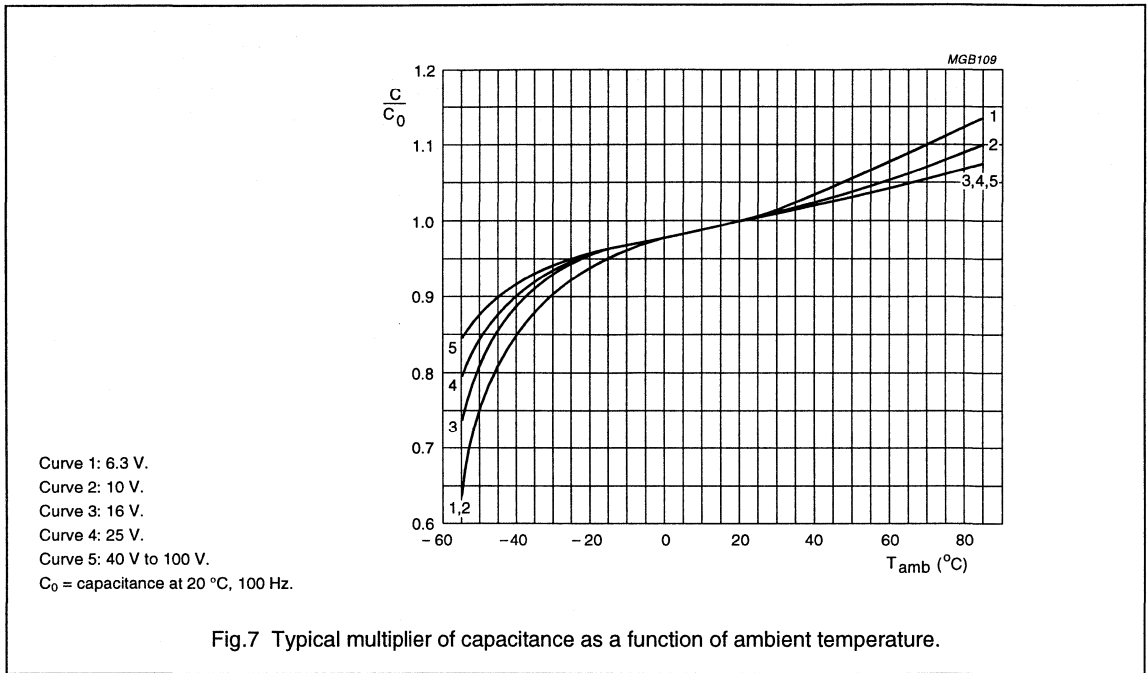
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.02C_R \times U_R + 3 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 3 \mu\text{A}$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

SA

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

CLL 139

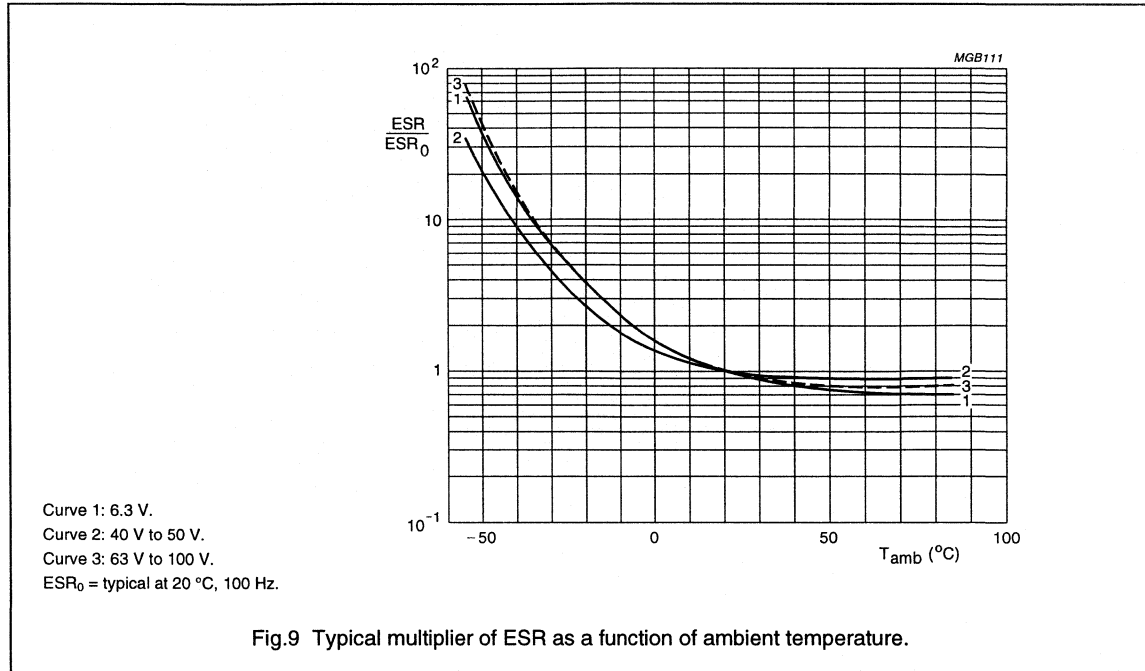
Capacitance (C)



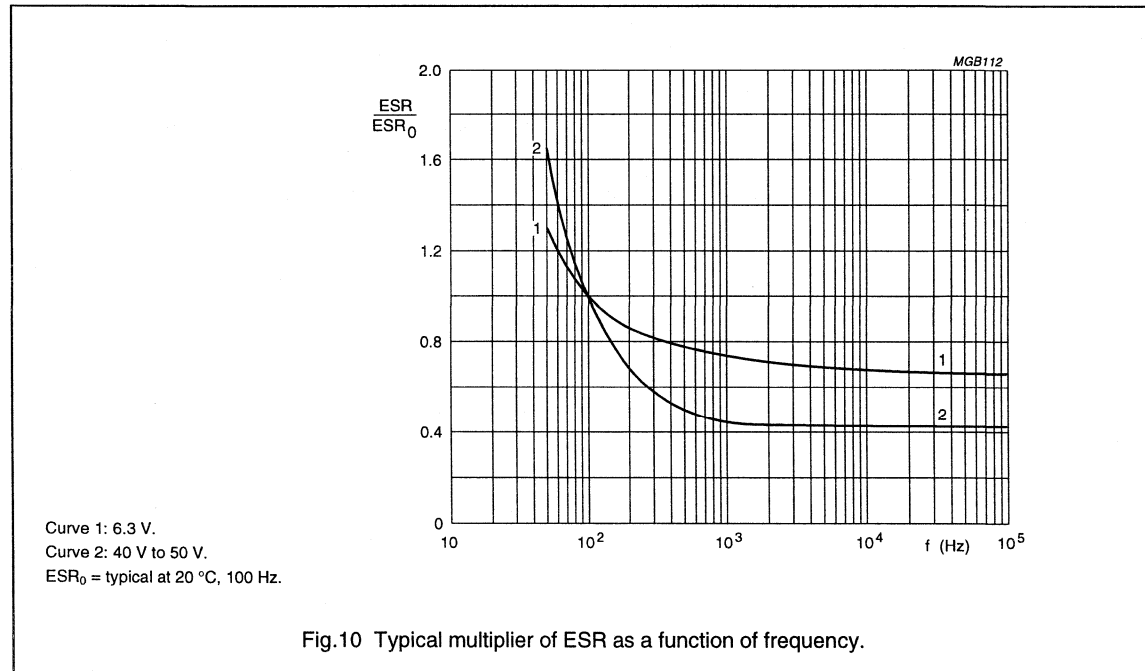
Non-solid Al - electrolytic capacitors
SMD (Chip) Long Life

CLL 139

Equivalent series resistance (ESR)



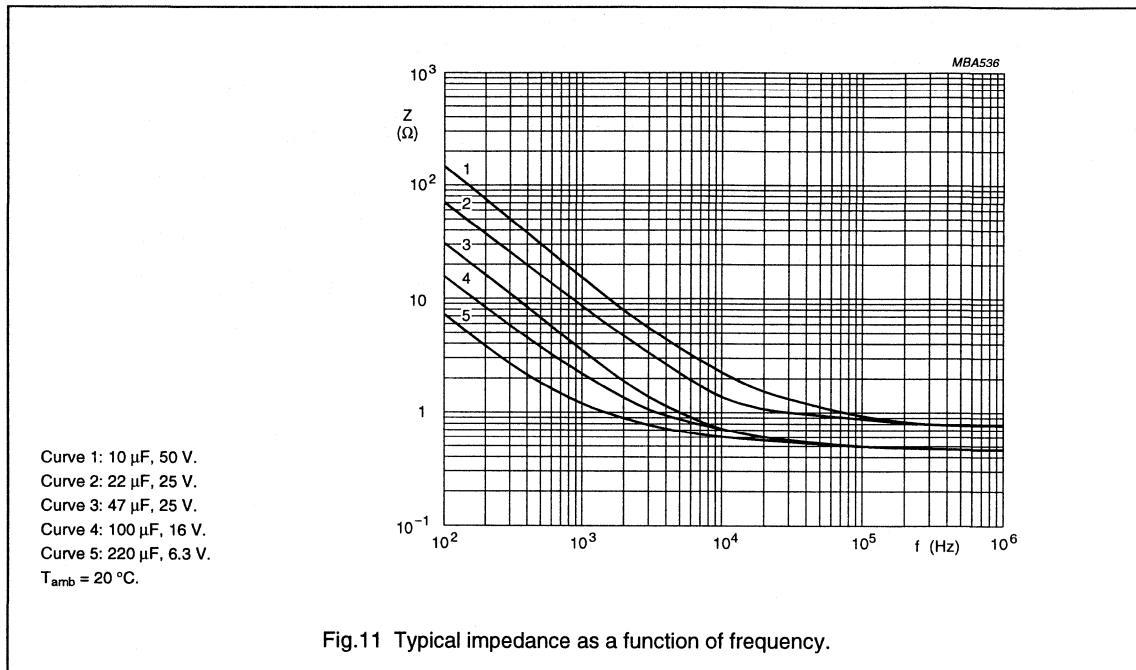
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Non-solid Al - electrolytic capacitors SMD (Chip) Long Life

CLL 139

Impedance (Z)



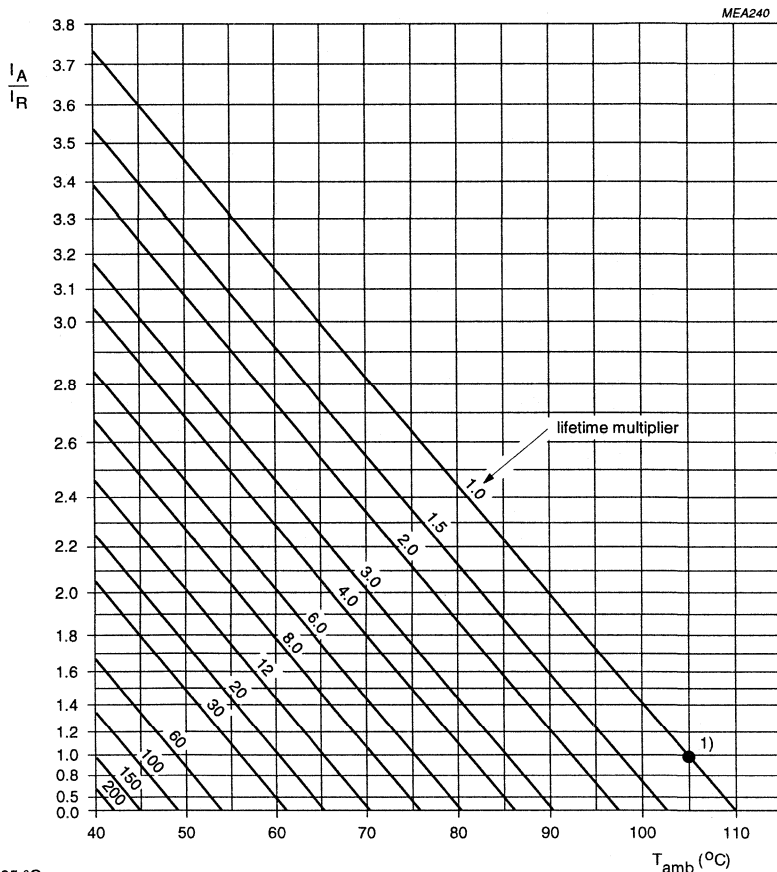
Non-solid Al - electrolytic capacitors SMD (Chip) Long Life

CLL 139

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



I_A = actual ripple current at 100 Hz.
 I_R = rated ripple current at 100 Hz, 105 °C.
 (1) Useful life at 105 °C and I_R applied: 2000 hours.

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

Non-solid Al - electrolytic capacitors

SMD (Chip) Long Life

CLL 139


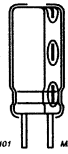
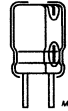
SPECIFIC TESTS AND REQUIREMENTS

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	$T_{\text{amb}} = 105 \text{ }^\circ\text{C}$; 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	$T_{\text{amb}} = 105 \text{ }^\circ\text{C}$; U_R and I_R applied; 2000 hours	$U_R \leq 6.3 \text{ V}$; $\Delta C/C: +45/-50\%$ $U_R = 10 \text{ to } 100 \text{ V}$; $\Delta C/C: \pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-18/ CECC 32300, subclause 4.17	$T_{\text{amb}} = 105 \text{ }^\circ\text{C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	for requirements see 'Endurance' test above

RADIAL NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS

	STANDARD & MINIATURE	SEMI-PROFESSIONAL	LONG-LIFE	EXTRA LONG-LIFE or HIGH TEMP.
 MBB101  MBB007 smaller dimension ↓ higher CV per volume  MBB007	1500-3000 hours 85 °C	750-1500 hours 105 °C	1500-4000 hours 105 °C	1500 hours / 125 °C ≥ 4000 hours / 105 °C
		<i>page 176</i> RB 036 92 <i>bipolar</i> RBA 036 93 <i>bipolar audio</i> <i>page 178</i>	RSL 046 <i>page 243</i>	RHT 165 125 °C <i>page 272</i>
	RSH 044 HV <i>page 150</i>	RLC 013 <i>low leakage</i> <i>page 162</i>	RLI 135 <i>low Z</i> <i>page 219</i>	RVI 136 105 °C <i>very low Z</i> <i>page 256</i>
	RSM 037 LV <i>page 132</i>	<i>page 180</i> RSP 036 RMS 047 <i>page 193</i>	<i>page 206</i> RLL 116 RML 048 <i>page 230</i>	
	<i>page 125</i> RLP7 097 H: 7 mm RLP5 134 H: 5 mm <i>page 118</i>			

Non-solid Al - electrolytic capacitors

Radial Low Profile, 5 mm

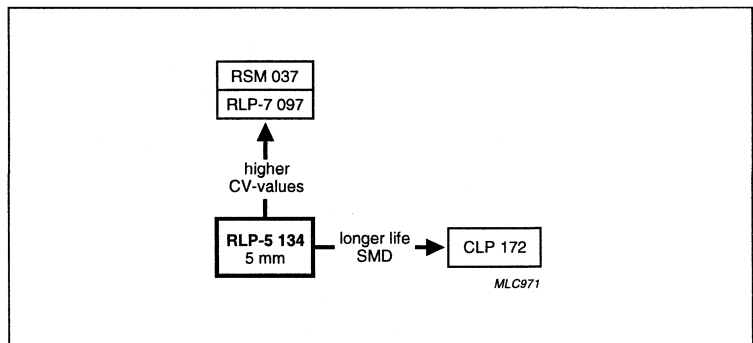
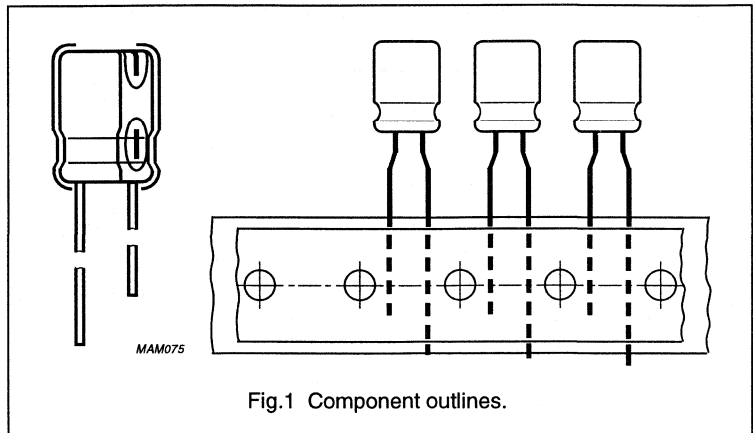
RLP 5-134

FEATURES

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

APPLICATIONS

- General purpose, industrial, automotive and audio-video
- Coupling, decoupling, smoothing, filtering and timing
- 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 °C
Endurance test at 85 °C	1000 hours
Useful life at 85 °C	1500 hours
Useful life at 40 °C, $1.4 \times I_R$ applied	40000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300, GP grade
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)

Non-solid Al - electrolytic capacitors

Radial Low Profile, 5 mm

RLP 5-134

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
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".

R

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

RLP 5-134

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

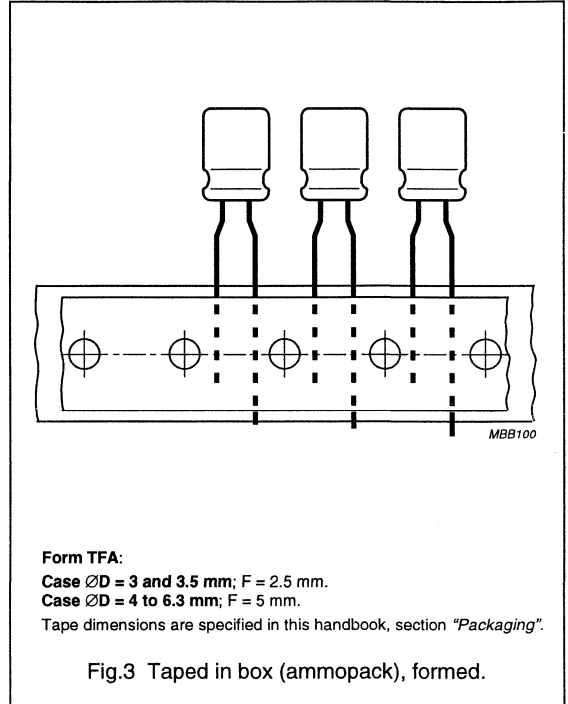
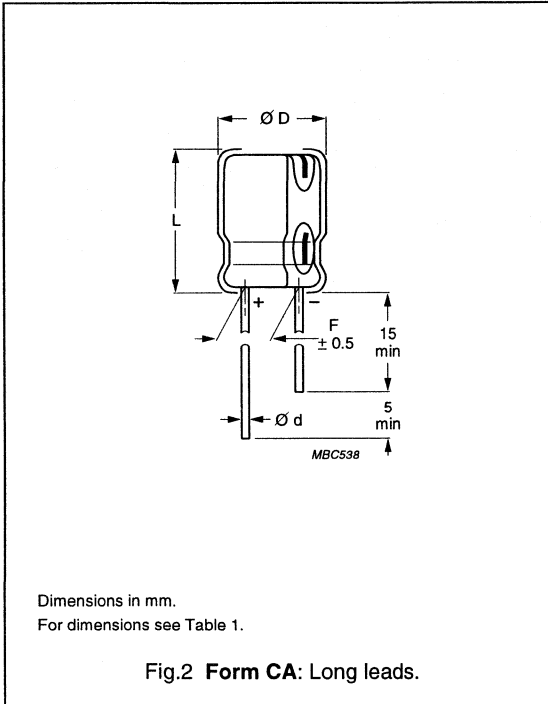


Table 1 Physical dimensions and packaging quantities; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	PACKAGING QUANTITIES	
						FORM CA	FORM TFA
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
5 × 5	54	0.45	5.5	6.0	2.0 ±0.5	2000	2000
6.3 × 5	55	0.45	6.8	6.0	2.5 ±0.5	2000	2000

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

RLP 5-134

Ordering example

Electrolytic capacitor RLP 5 - 134

22 µF/16 V; ±20%

Nominal case size: Ø5 × 5; Form TFA

Catalogue number: 2222 134 35229

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, RH = 45 to 75%.

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

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

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)	CATALOGUE NUMBER			
										BULK LONG LEADS		TAPED AMMOPACK	
										FORM CA	F (mm)	FORM TFA	F (mm)
6.3	22	4 × 5	53	23	3	0.24	14	12	11	134 53229	1.5	134 33229	5.0
	47	5 × 5	54	38	3	0.24	6.8	6.7	5.2	134 53479	2.0	134 33479	5.0
	100	6.3 × 5	55	60	7	0.24	3.2	4.4	3.4	134 53101	2.5	134 33101	5.0
10	33	5 × 5	54	35	4	0.20	8.0	7.7	6.0	134 54339	2.0	134 34339	5.0
16	10	3.5 × 5	52	17	3	0.16	21	18	17	134 55109	1.0	134 35109	2.5
	22	5 × 5	54	32	4	0.16	9.6	8.0	6.4	134 55229	2.0	134 35229	5.0
	47	6.3 × 5	55	50	8	0.16	4.5	5.2	4.2	134 55479	2.5	134 35479	5.0
25	3.3	3 × 5	51	9.5	3	0.14	56	29	24	134 56338	1.0	134 36338	2.5
	4.7	3.5 × 5	52	12	3	0.14	40	22	19	134 56478	1.0	134 36478	2.5
	33	6.3 × 5	55	45	9	0.14	5.6	6.0	4.6	134 56339	2.5	134 36339	5.0



Non-solid Al - electrolytic capacitors

Radial Low Profile, 5 mm

RLP 5-134

		CATALOGUE NUMBER				Z 100 kHz (Ω)	Z 10 kHz (Ω)	ESR 120 Hz (Ω)	Tan δ 120 Hz	I _{L2} 2 min (μ A)	I _R 120 Hz 85 °C (mA)	CASE CODE	NOMINAL CASE SIZE \varnothing D x L (mm)	C _R 120 Hz (μ F)	U _R (V)
		2222		TAPED											
		LONG LEADS		AMMOPACK											
		FORM CA	F (mm)	FORM TFA	F (mm)										
35		134 50228	1.0	134 30228	2.5	41	48	72	0.12	3	8.3	51	3 x 5	2.2	35
		134 50478	1.5	134 30478	5.0	27	31	34	0.12	3	15	53	4 x 5	4.7	
		134 50109	2.0	134 30109	5.0	17	21	16	0.12	4	25	54	5 x 5	10	
		134 50229	2.5	134 30229	5.0	11	13	7.2	0.12	8	40	55	6.3 x 5	22	
50		134 51108	1.0	134 31108	2.5	50	70	130	0.10	3	6.2	51	3 x 5	1.0	50
		134 51228	1.0	134 31228	2.5	33	44	60	0.10	3	10	52	3.5 x 5	2.2	
		134 51338	1.5	134 31338	5.0	25	36	40	0.10	3	14	53	4 x 5	3.3	
		134 51478	2.0	134 31478	5.0	22	29	28	0.10	3	19	54	5 x 5	4.7	
		134 51109	2.5	134 31109	5.0	14	19	13	0.10	5	29	55	6.3 x 5	10	

Additional electrical data

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

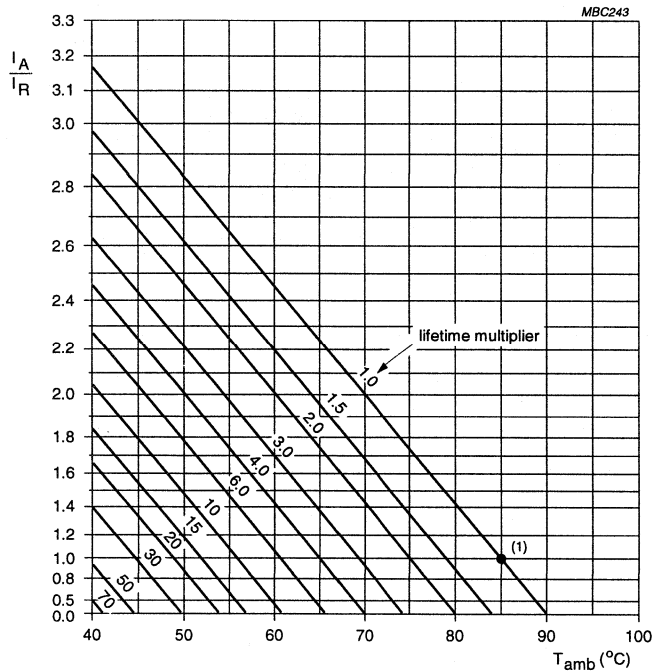
Non-solid Al - electrolytic capacitors
 Radial Low Profile, 5 mm

RLP 5-134

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

Non-solid Al - electrolytic capacitors

Radial Low Profile, 5 mm

RLP 5-134

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 $I_{L2} \leq \text{spec. limit}$

Non-solid Al - electrolytic capacitors

Radial Low Profile, 7 mm

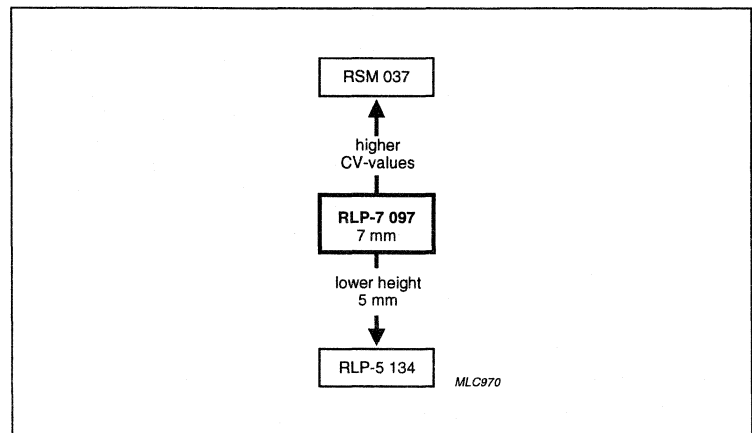
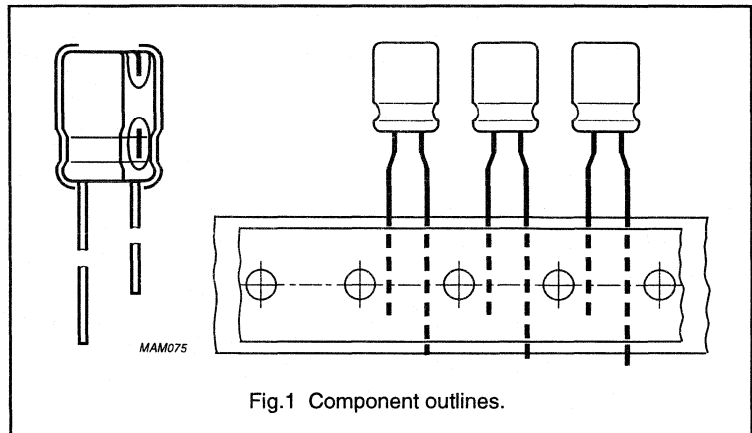
RLP 7-097

FEATURES

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



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	±20%
Rated voltage, U_R	6.3 to 63 V
Category temperature range	-40 to +85 °C
Endurance test at 85 °C	1000 hours
Useful life at 85 °C	1500 hours
Useful life at 40 °C, $1.4 \times I_R$ applied	40 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300, GP grade
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)

Non-solid Al - electrolytic capacitors

Radial Low Profile, 7 mm

RLP 7-097

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".

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

RLP 7-097

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

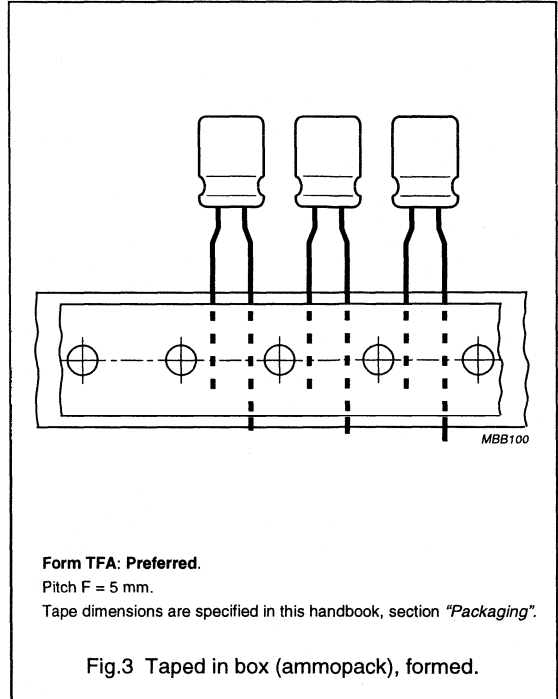
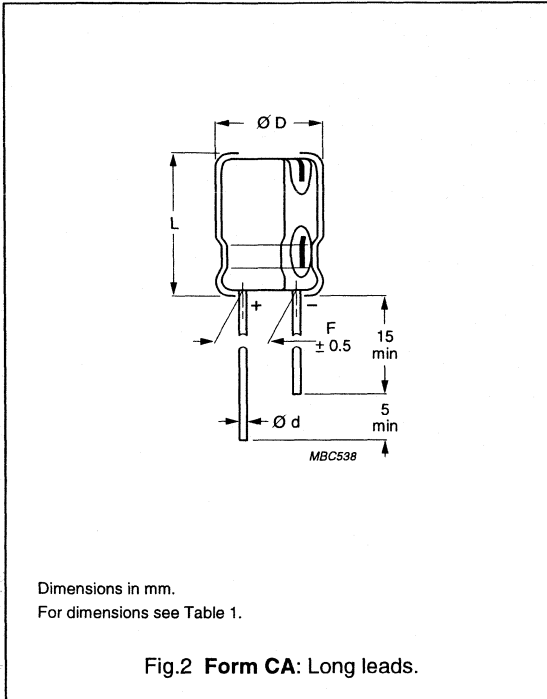


Table 1 Physical dimensions and packaging quantities; see Fig.2

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

R

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

RLP 7-097

Ordering example

Electrolytic capacitor RLP 7 - 097

100 µF/16 V; ±20%

Nominal case size: Ø7 × 7; Form TFA

Catalogue number: 2222 097 35101

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 120 Hz, tolerance ±20%
I _R	rated RMS ripple current at 120 Hz, 85 °C
I _{L2}	max. leakage current after 2 minutes at U _R
Tan δ	max. dissipation factor at 120 Hz
ESR	equivalent series resistance at 120 Hz (calculated from tan δ _{max} and C _R)
Z	max. impedance at 10 kHz and 100 kHz

Table 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			
										BULK LONG LEADS		TAPED AMMOPACK	
										FORM CA	F (mm)	FORM TFA	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
	47	5 × 7	72	47	3	0.24	6.8	5	4.6	097 53479	2.0	097 33479	5.0
	220	7 × 7	74	95	14	0.24	1.4	2	1.8	097 53221	2.5	097 33221	5.0
10	33	5 × 7	72	43	4	0.20	8.0	4	3.7	097 54339	2.0	097 34339	5.0
	100	6.3 × 7	73	80	10	0.20	2.7	2.3	2.2	097 54101	2.5	097 34101	5.0
16	10	4 × 7	71	25	3	0.16	21	11	10	097 55109	1.5	097 35109	5.0
	22	5 × 7	72	39	4	0.16	9.6	6	5	097 55229	2.0	097 35229	5.0
	47	6.3 × 7	73	59	8	0.16	4.5	4	3.5	097 55479	2.5	097 35479	5.0
	100	7 × 7	74	97	16	0.16	2.1	3	2.5	097 55101	2.5	097 35101	5.0
25	33	6.3 × 7	73	53	9	0.14	5.6	3.3	2.6	097 56339	2.5	097 36339	5.0
	47	7 × 7	74	71	12	0.14	4.0	2.5	1.9	097 56479	2.5	097 36479	5.0

Non-solid Al - electrolytic capacitors

Radial Low Profile, 7 mm

RLP 7-097

U _R (V)	C _R 120 Hz (μF)	NOMINAL CASE SIZE ∅D × 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)
35	4.7	4 × 7	71	20	3	0.12	34	12	10	097 50478	1.5	097 30478	5.0
	10	5 × 7	72	30	4	0.12	16	6.5	5.6	097 50109	2.0	097 30109	5.0
	22	6.3 × 7	73	47	8	0.12	7.2	3.3	3	097 50229	2.5	097 30229	5.0
	33	7 × 7	74	64	12	0.12	4.8	2.9	2.6	097 50339	2.5	097 30339	5.0
50	3.3	4 × 7	71	18	3	0.10	40	16	14	097 51338	1.5	097 31338	5.0
	4.7	5 × 7	72	23	3	0.10	28	12	10	097 51478	2.0	097 31478	5.0
	10	6.3 × 7	73	34	5	0.10	13	6.2	5.5	097 51109	2.5	097 31109	5.0
	22	7 × 7	74	57	11	0.10	6.0	3.2	2.9	097 51229	2.5	097 31229	5.0
63	0.10	4 × 7	71	1.3	3	0.08	1100	238	170	097 58107	1.5	097 38107	5.0
	0.22	4 × 7	71	2.9	3	0.08	480	138	110	097 58227	1.5	097 38227	5.0
	0.47	4 × 7	71	7.9	3	0.08	230	88	66	097 58477	1.5	097 38477	5.0
	1	4 × 7	71	11	3	0.08	110	42	36	097 58108	1.5	097 38108	5.0
	2.2	4 × 7	71	17	3	0.08	48	22	19	097 58228	1.5	097 38228	5.0
	3.3	5 × 7	72	21	3	0.08	32	16	14	097 58338	2.0	097 38338	5.0
	4.7	6.3 × 7	73	26	3	0.08	23	12	10	097 58478	2.5	097 38478	5.0
	10	7 × 7	74	43	7	0.08	11	6.2	5.5	097 58109	2.5	097 38109	5.0

Additional electrical data

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

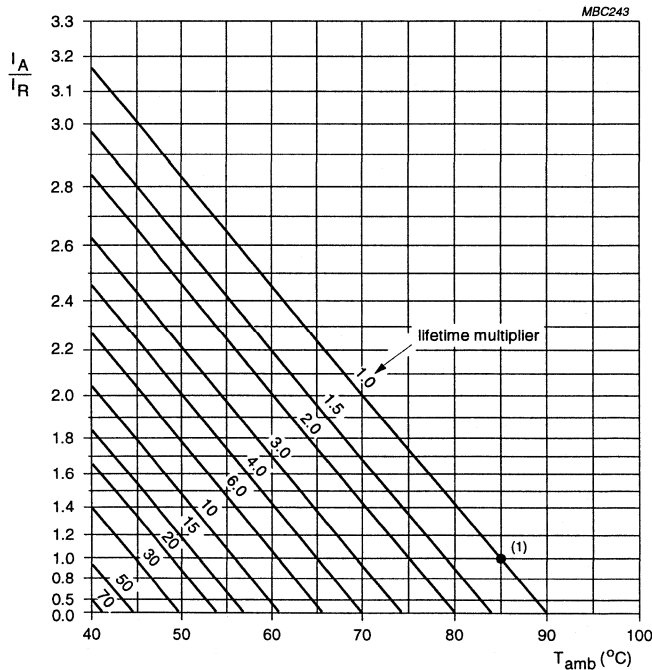
Non-solid Al - electrolytic capacitors
Radial Low Profile, 7 mm

RLP 7-097

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

Non-solid Al - electrolytic capacitors

Radial Low Profile, 7 mm

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in 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; 1 000 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	$T_{amb} = 85\text{ }^{\circ}\text{C}$, U_R and I_R applied; 1 500 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: $\leq 3\%$
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 $I_{L2} \leq \text{spec. limit}$

R

Non-solid Al - electrolytic capacitors Radial Standard Miniature

RSM 037

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, insulated with a blue vinyl sleeve
- Pressure relief for case $\varnothing D \geq 6.3$ mm
- Charge and discharge proof
- Miniaturized, high CU-product per unit volume.

APPLICATIONS

- General purpose, industrial, automotive and audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- Portable and mobile equipment (small size, low mass).

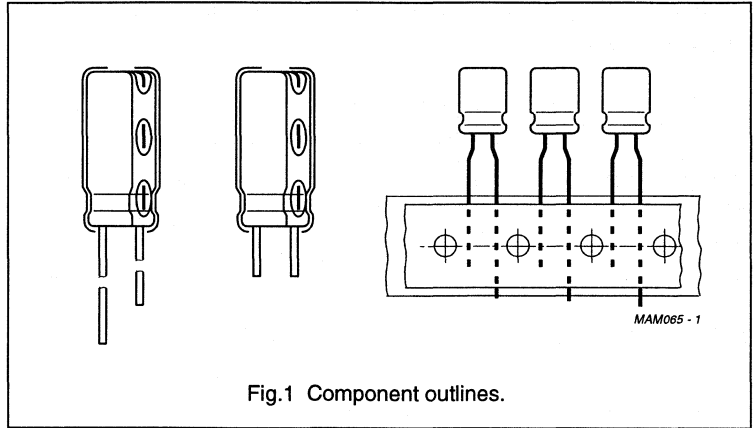
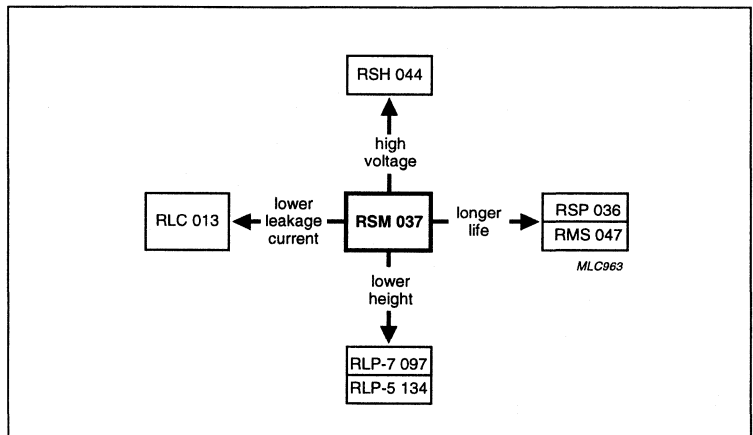


Fig.1 Component outlines.



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	$\pm 20\%$ ($\pm 10\%$ 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, GP grade
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)

Non-solid Al - 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	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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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

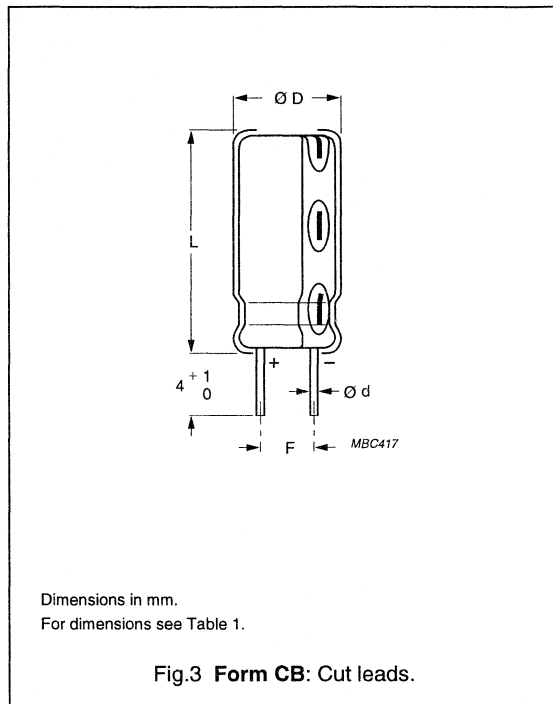
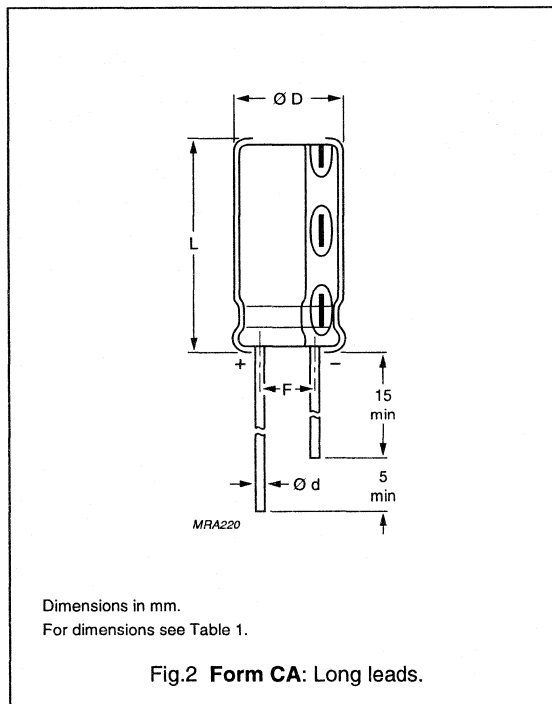


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

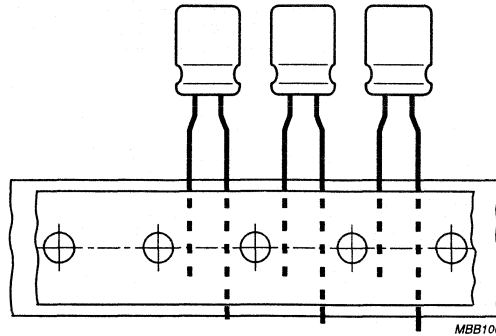
NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA, TNA
5 × 11	11	0.5	5.5	12.5	2.0 ±0.5	≈0.4	3000	–	2000
6.3 × 11	12	0.5	6.8	12.5	2.5 ±0.5	≈0.6	2000	–	2000
8 × 12	13	0.6	8.5	13.0	3.5 ±0.5	≈1.1	1000	–	1000
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

Non-solid Al - electrolytic capacitors

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Taped products



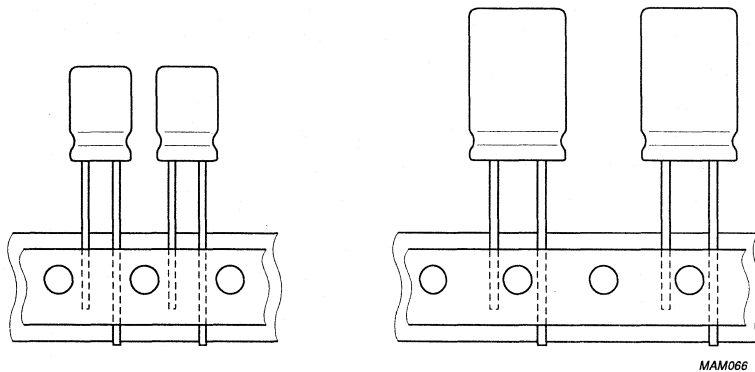
Form TFA.

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; $F = 2.5$ mm (leads slightly bent).

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

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

Form TFA

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

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

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

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Non-solid Al - electrolytic capacitors

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 2, 4, 6 and 8 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 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 $\text{tan } \delta_{max}$ 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)	$\text{Tan } \delta$ 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

Non-solid Al - electrolytic capacitors

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ORDERING INFORMATION**Ordering example**

Electrolytic capacitor RSM 037

1000 μ F/16 V; \pm 20%Nominal case size: \varnothing 10 \times 20 mm, Form TFA

Catalogue number: 2222 037 35102.

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

U_R (V)	C_R 100 Hz (μ F)	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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Non-solid Al - 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 (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 δ 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

Non-solid Al - 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)
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	–	–
400	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	–	–

R

Non-solid Al - electrolytic capacitors
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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 δ 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

Non-solid Al - electrolytic capacitors

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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	–	–

Non-solid Al - electrolytic capacitors

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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 $\varnothing \times L$ (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)
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

Non-solid Al - electrolytic capacitors

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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

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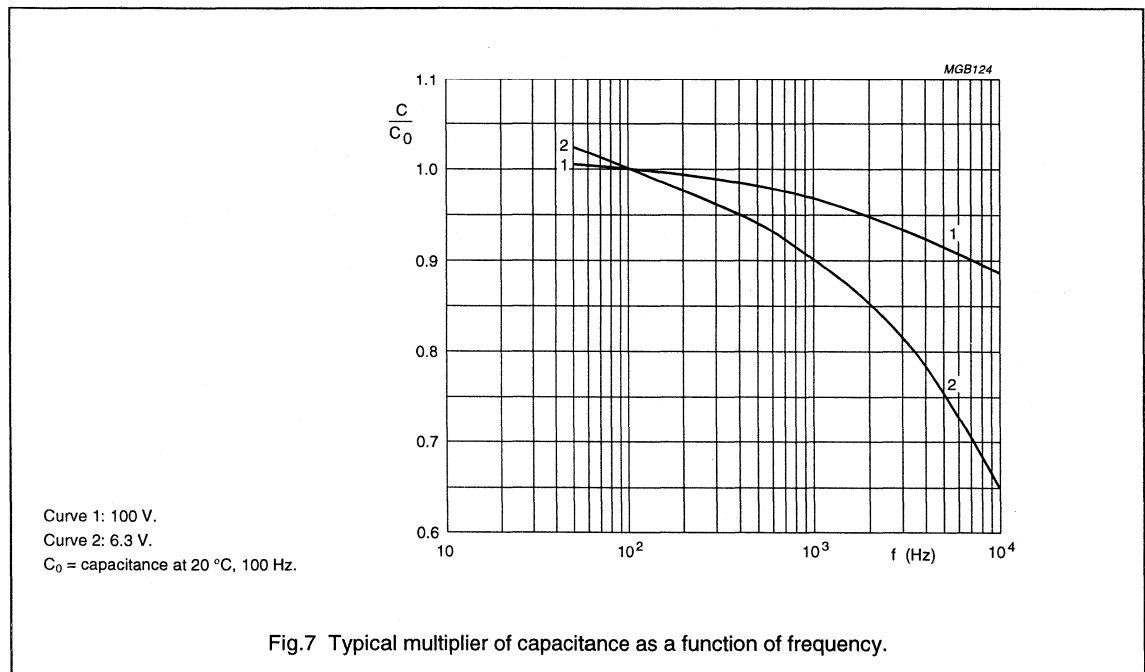
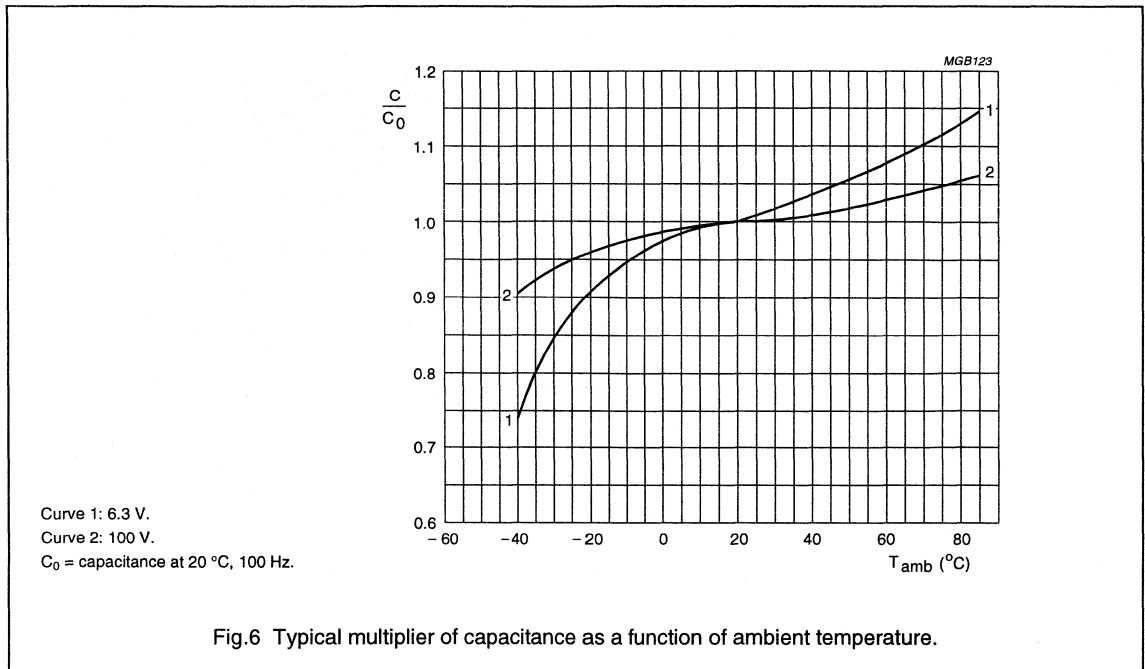
ELECTRICAL DATA (continued)**Additional electrical data**

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

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Capacitance (C)



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Equivalent series resistance (ESR)

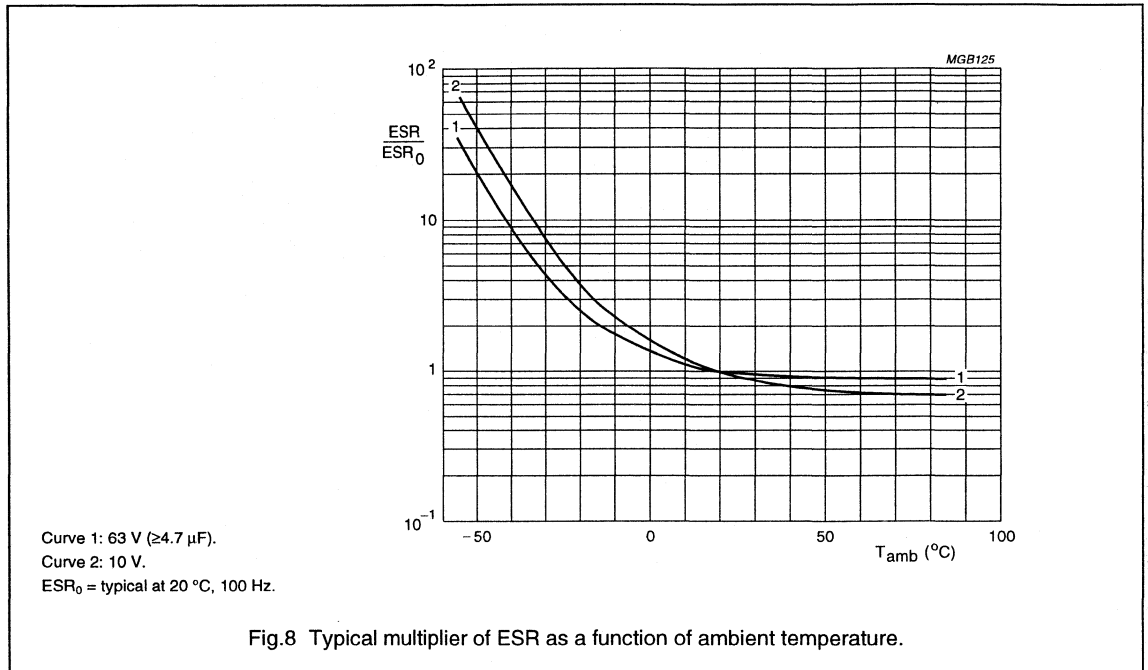


Fig.8 Typical multiplier of ESR as a function of ambient temperature.

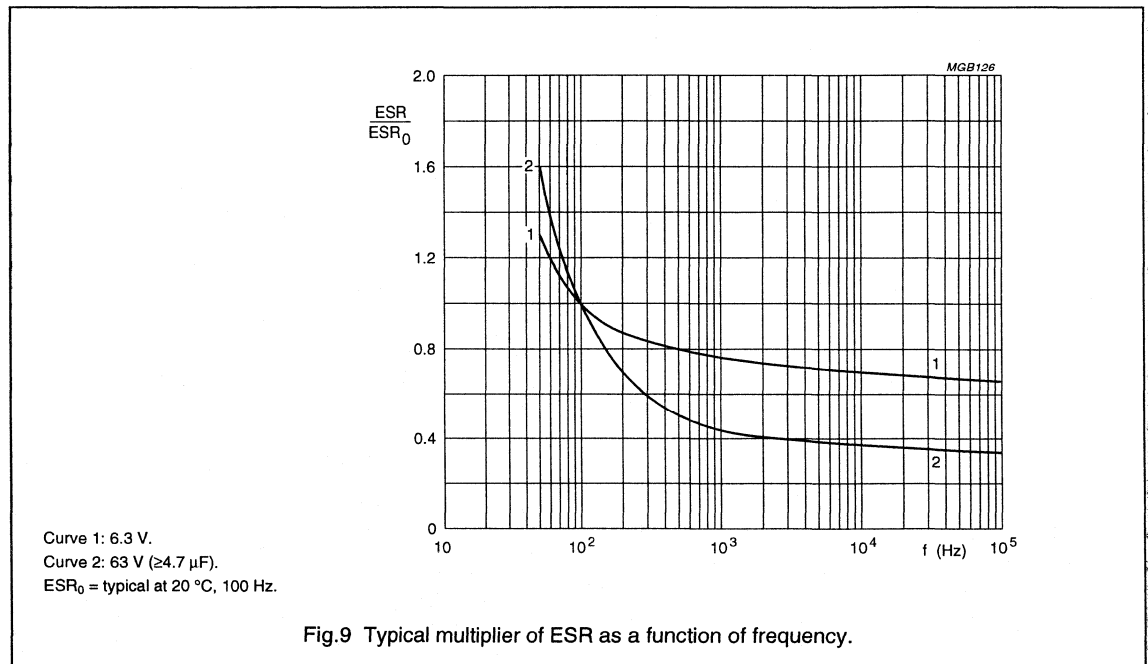


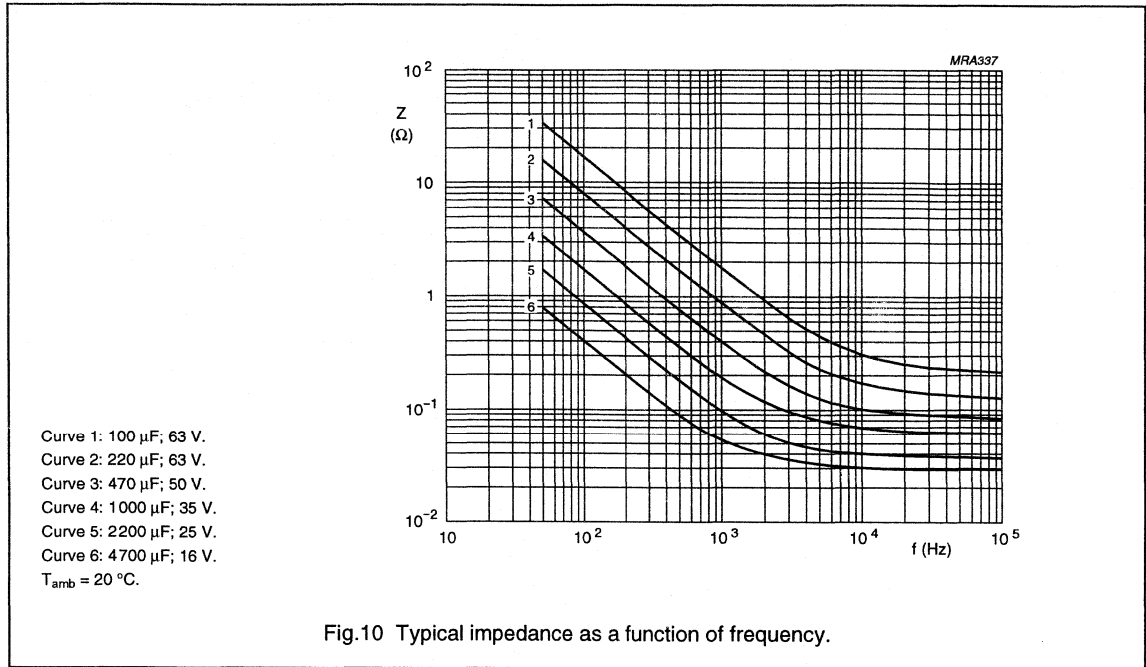
Fig.9 Typical multiplier of ESR as a function of frequency.

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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.

R

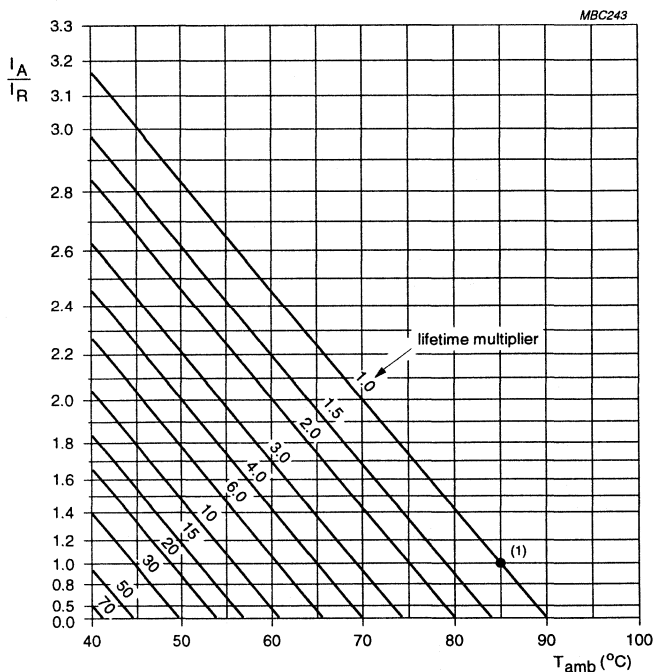
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RIPPLE CURRENT AND USEFUL LIFE

Table 10 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{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.

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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 $I_{L5} \leq 2 \times \text{spec. limit}$

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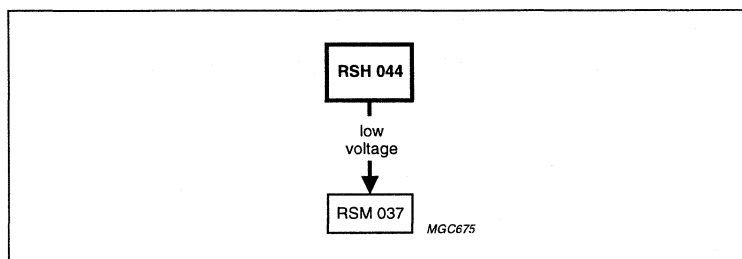
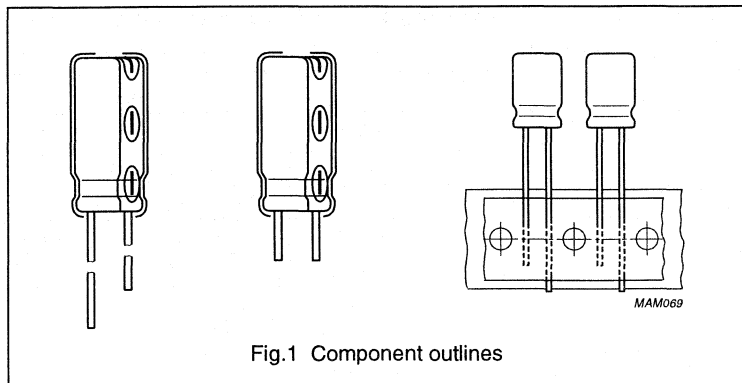
RSH 044

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, insulated with a blue vinyl sleeve
- Pressure relief
- Charge and discharge proof
- Reduced dimensions
- High rated voltage, up to 450 V.

APPLICATIONS

- General purpose, audio-video, lighting, general industrial
- Smoothing, filtering, buffering of high voltages.



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	$\pm 20\%$
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, LL grade
Climatic category:	
IEC 68	≤ 400 V: 40/085/56; 450 V: 25/085/56
DIN 40040	≤ 400 V: GPF; 450 V: HPF

Non-solid Al - electrolytic capacitors

Radial Standard, High Voltage

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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.



Non-solid Al - electrolytic capacitors

Radial Standard, High Voltage

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

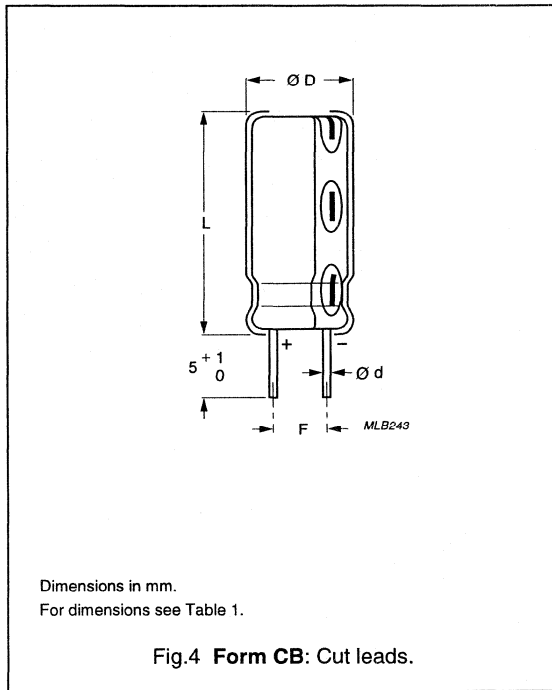
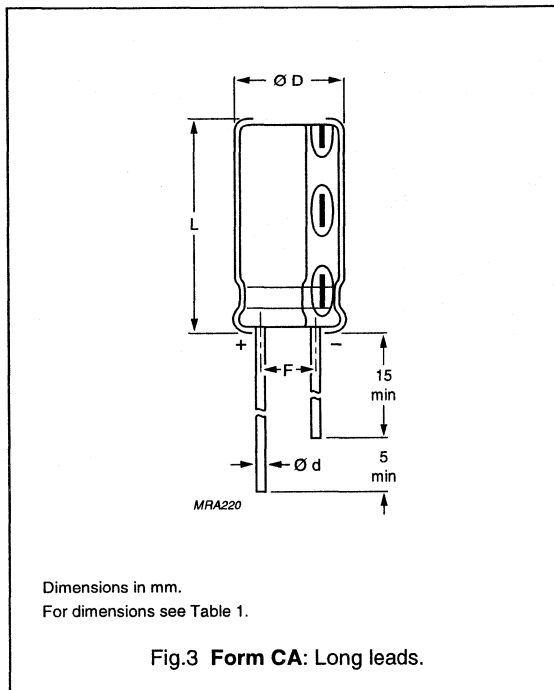


Table 1 Physical dimensions, mass and packaging quantities; see Figs 3 and 4

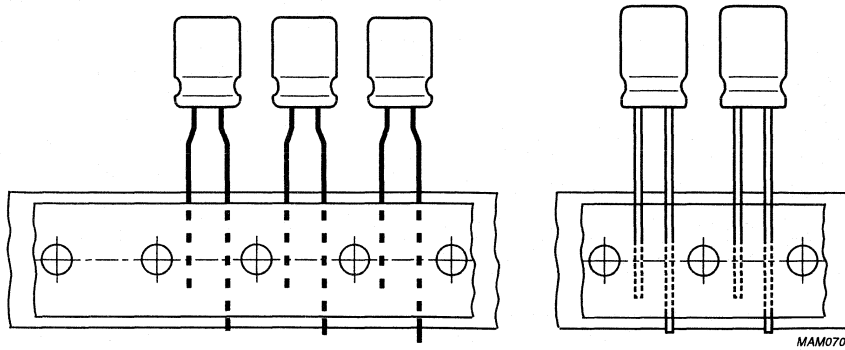
NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA, TNA
6.3 × 11	12	0.5	6.8	12.5	2.5 ± 0.5	≈ 0.6	2000	2000	2000
8 × 12	13	0.6	8.5	13.0	3.5 ± 0.5	≈ 1.1	1000	2000	1000
10 × 12	14	0.6	10.5	14.0	5.0 ± 0.5	≈ 1.6	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	–

Non-solid Al - electrolytic capacitors

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Taped products



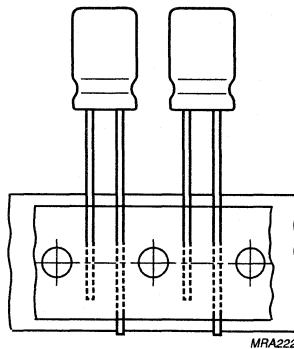
Form TFA: formed, pitch $F = 5$ mm.

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).



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

Non-solid Al - electrolytic capacitors

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ELECTRICAL DATA AND ORDERING INFORMATION

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

Non-solid Al - electrolytic capacitors

Radial Standard, High Voltage

RSH 044

ORDERING INFORMATION**Ordering example**

Electrolytic capacitor RSH 044

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 (μ F)	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

Non-solid Al - electrolytic capacitors

Radial Standard, High Voltage

RSH 044

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)	$\text{Tan } \delta$ 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		$U_{\text{rev}} \leq 1$ V
Current		
Leakage current	after 1 minute at U_R :	
	$CV \leq 1000 \mu\text{C}$	$I_{L1} \leq 0.06C_R \times U_R + 40 \mu\text{A}$
	$CV > 1000 \mu\text{C}$	$I_{L1} \leq 0.03C_R \times U_R + 70 \mu\text{A}$
	after 5 minutes at U_R :	
$CV \leq 1000 \mu\text{C}$	$I_{L5} \leq 0.03C_R \times U_R + 15 \mu\text{A}$	
$CV > 1000 \mu\text{C}$	$I_{L5} \leq 0.015C_R \times U_R + 30 \mu\text{A}$	
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

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

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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 TFA	F (mm)	FORM TNA	F (mm)
			FORM CA	F (mm)	FORM CB	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	–	–	–	–

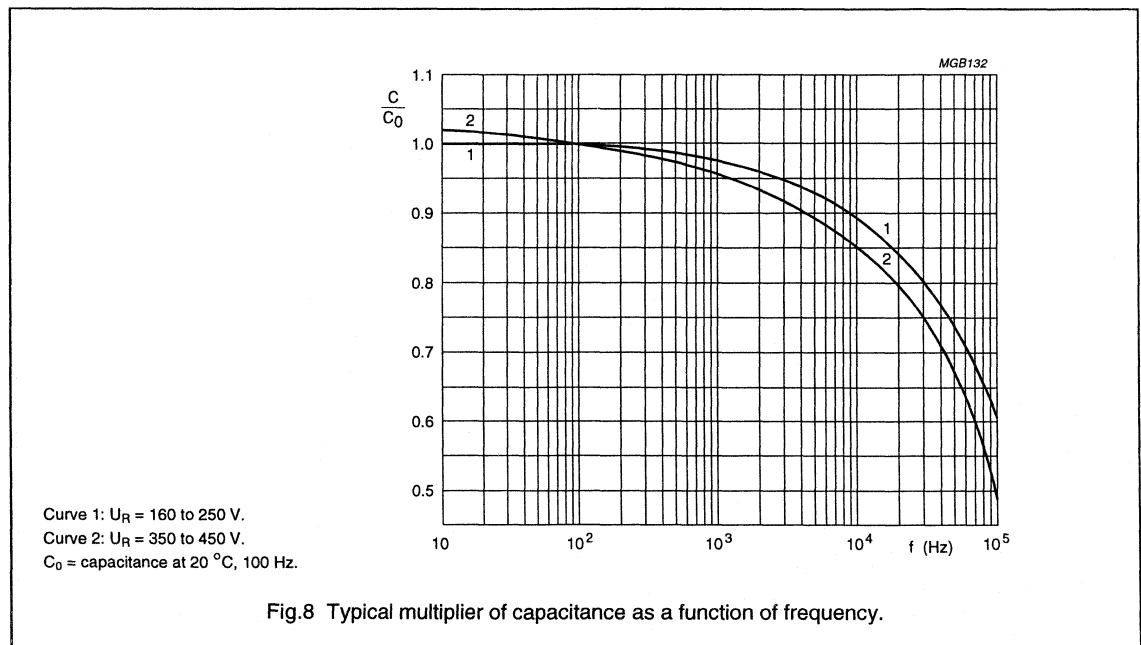
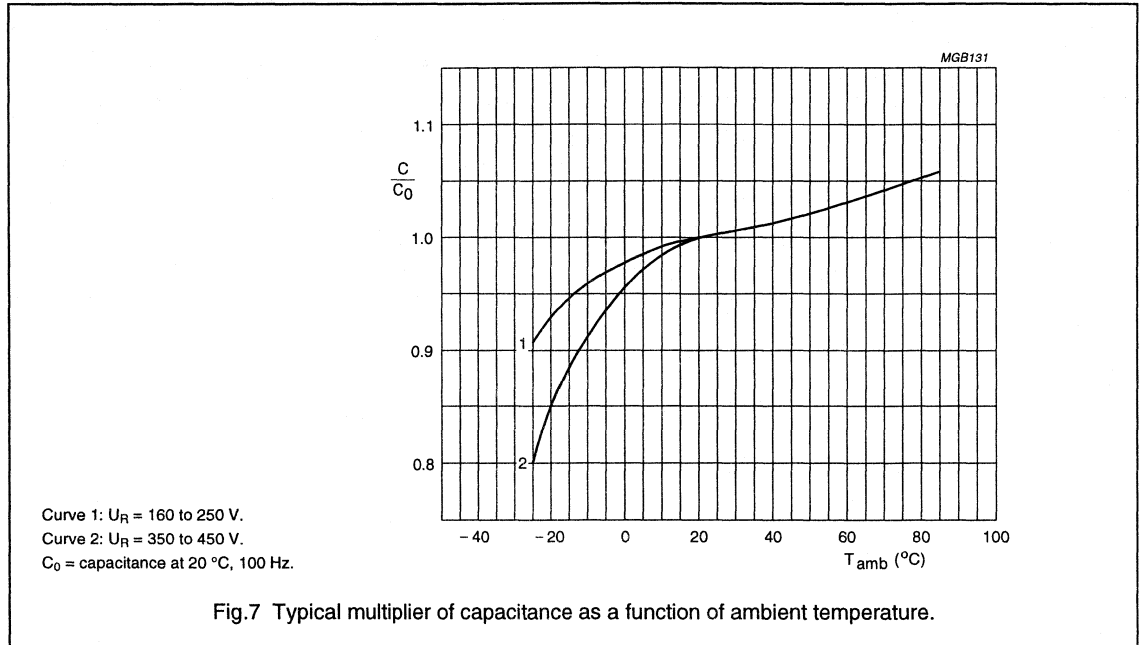
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Non-solid Al - electrolytic capacitors
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ELECTRICAL DATA (continued)

Capacitance (C)



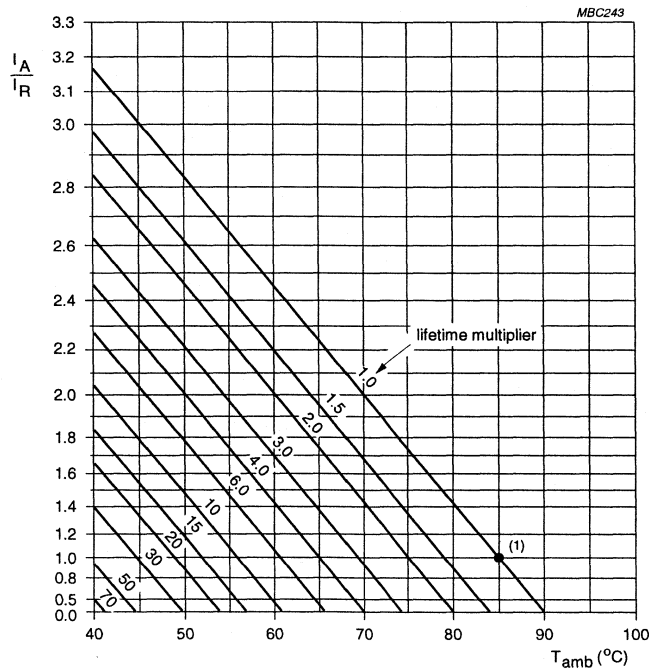
Non-solid Al - electrolytic capacitors
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RIPPLE CURRENT AND USEFUL LIFE

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.

Non-solid Al - electrolytic capacitors

Radial Standard, High Voltage

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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	$T_{amb} = 85\text{ °C}$; U_R applied; 2000 hours	$\Delta C/C: \pm 20\%$ $\leq 400\text{ V}: \tan \delta \leq 2 \times \text{spec. limit}$ $450\text{ V}: \tan \delta \leq 1.5 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
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 $I_{L5} \leq 2 \times \text{spec. limit}$

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

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NOTES

R

Non-solid Al-electrolytic capacitors

Radial Low Leakage Current

RLC 013

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Low leakage current, low energy consumption.

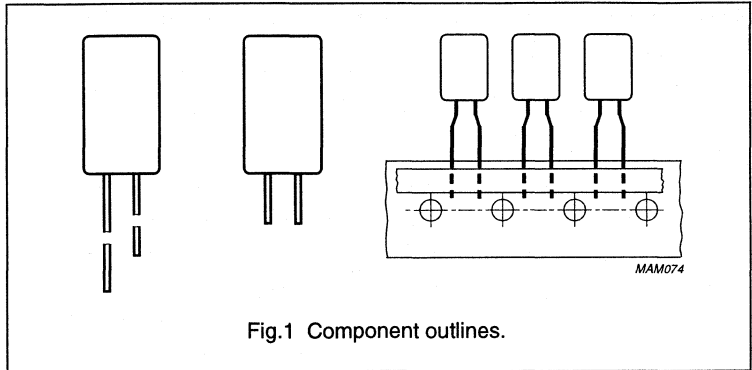
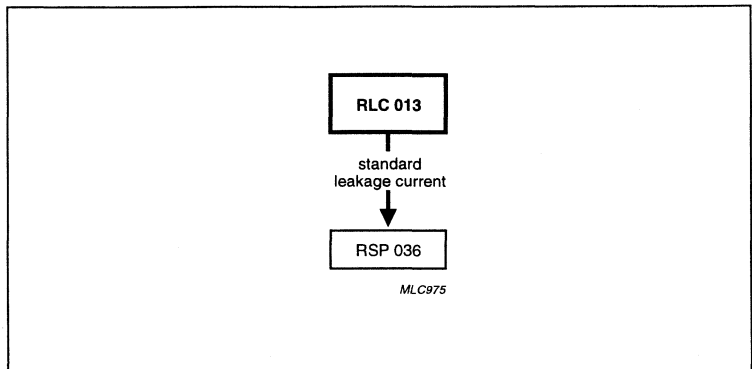


Fig.1 Component outlines.

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 μ F
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 °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 μ A (whichever is greater) $0.002C_R \times U_R + 1 \mu$ A
Endurance test at 85 °C	2000 hours
Useful life at 105 °C	750 hours
Useful life at 85 °C	3000 hours
Useful life at 40 °C, $1.4 \times I_R$ applied	80000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300, LL grade
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)
Approvals	LNZ 44-04

Non-solid Al-electrolytic capacitors

Radial Low Leakage Current

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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	–	–	–	–	–

Non-solid Al-electrolytic capacitors
Radial Low Leakage Current

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

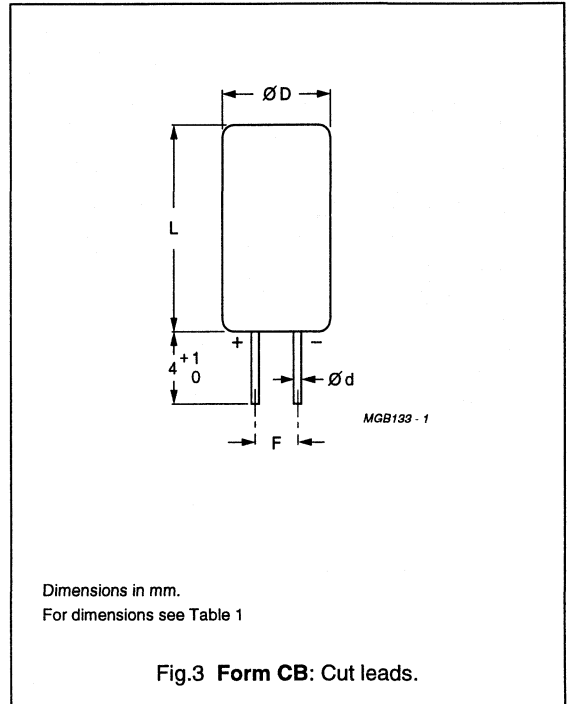
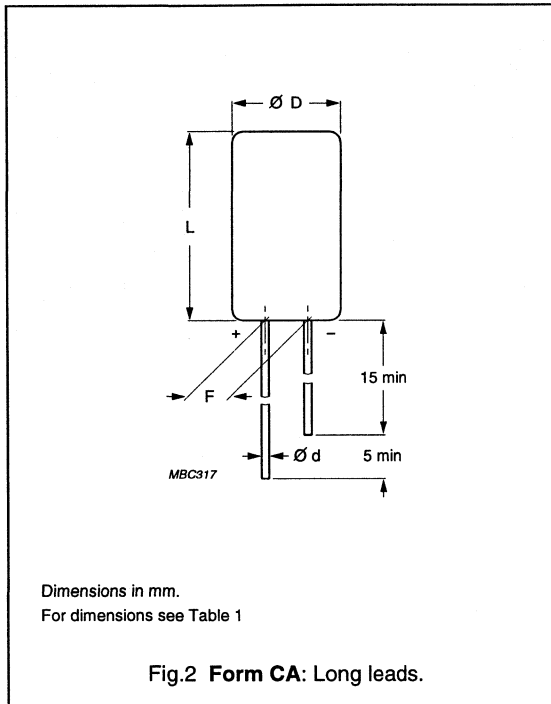


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

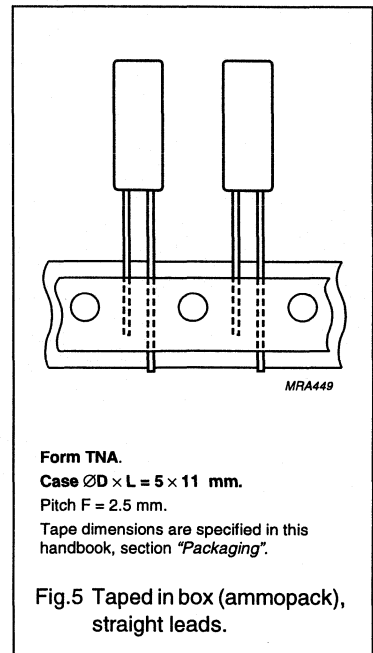
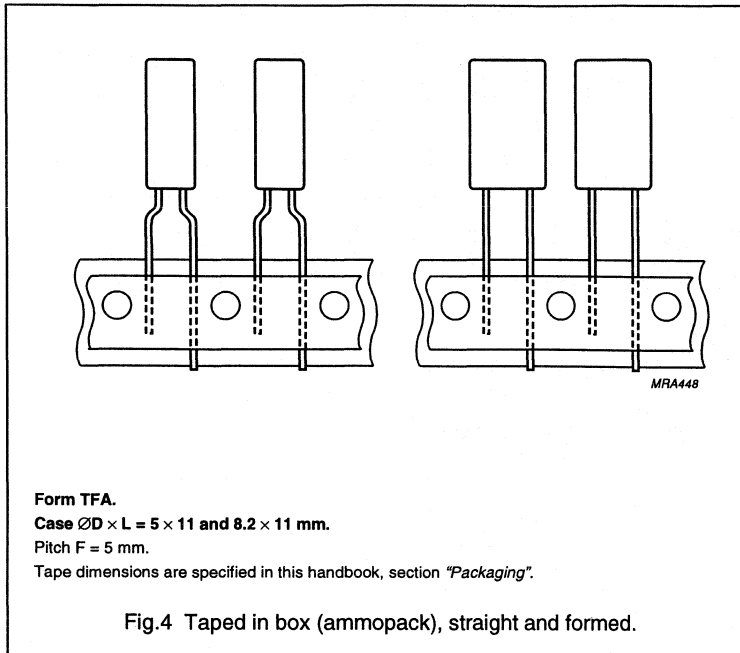
NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES	
							FORM CA, CB	FORM TFA, TNA
5 × 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	2000
8.2 × 11	13	0.6	8.7	12	5.0 ± 0.5	≈ 1.1	1000	1000

Non-solid Al-electrolytic capacitors

Radial Low Leakage Current

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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.

R

Non-solid Al-electrolytic capacitors

Radial Low Leakage Current

RLC 013

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

**Non-solid Al-electrolytic capacitors
Radial Low Leakage Current**

RLC 013

ORDERING INFORMATION

Ordering example

Electrolytic capacitor RLC 013

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 TFA	F (mm)	FORM TNA	F (mm)
			FORM CA	F (mm)	FORM CB	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	-	-

Non-solid Al-electrolytic capacitors

Radial Low Leakage Current

RLC 013

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_{L2} 2 min (μA)	$\text{Tan } \delta$ 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		$U_{\text{rev}} \leq 1 \text{ V}$
Current		
Leakage current	after 2 minutes at U_R : $U_R = 6.3$ to 25 V $U_R = 35$ and 50 V	$I_{L2} \leq 0.002C_R \times U_R$ or $0.7 \mu\text{A}$ (whichever is greater) $I_{L2} \leq 0.002C_R \times U_R + 1 \mu\text{A}$
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

Non-solid Al-electrolytic capacitors

Radial Low Leakage Current

RLC 013

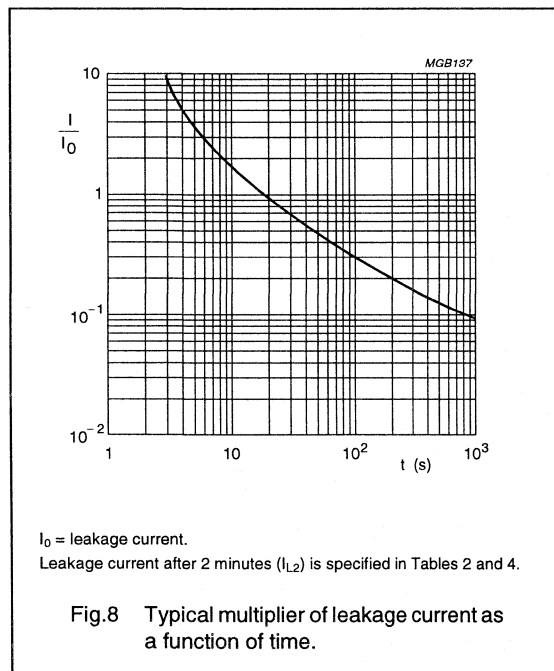
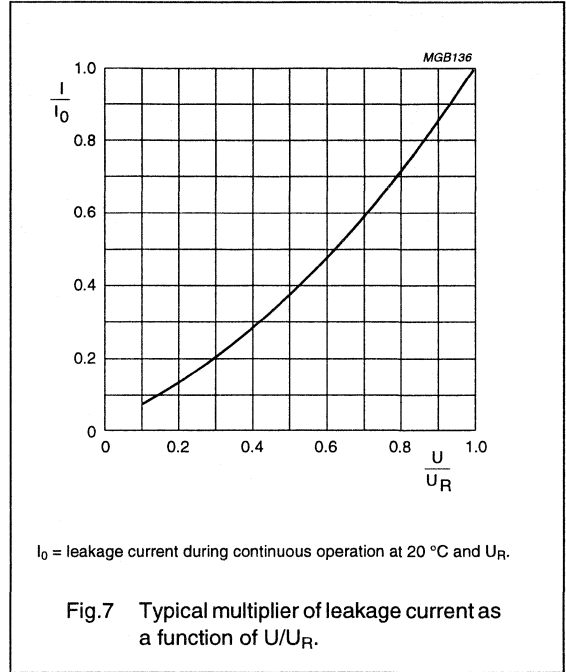
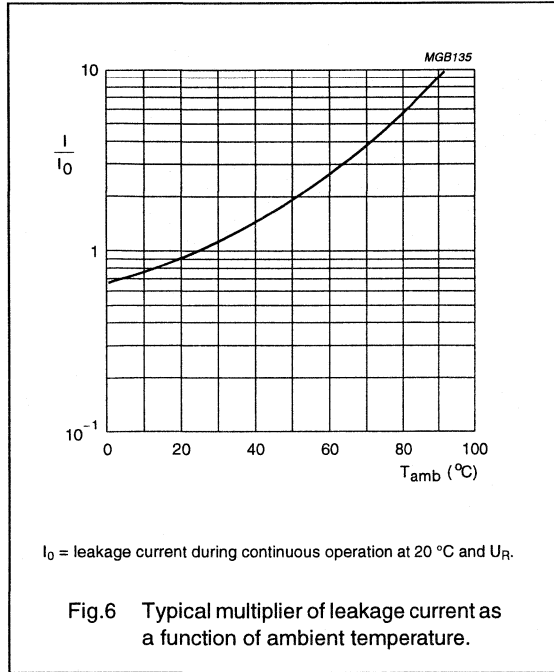
ORDERING INFORMATION (continued)**Table 5** Ordering information continued; preferred types in **bold**

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	–	–

Non-solid Al-electrolytic capacitors Radial Low Leakage Current

RLC 013

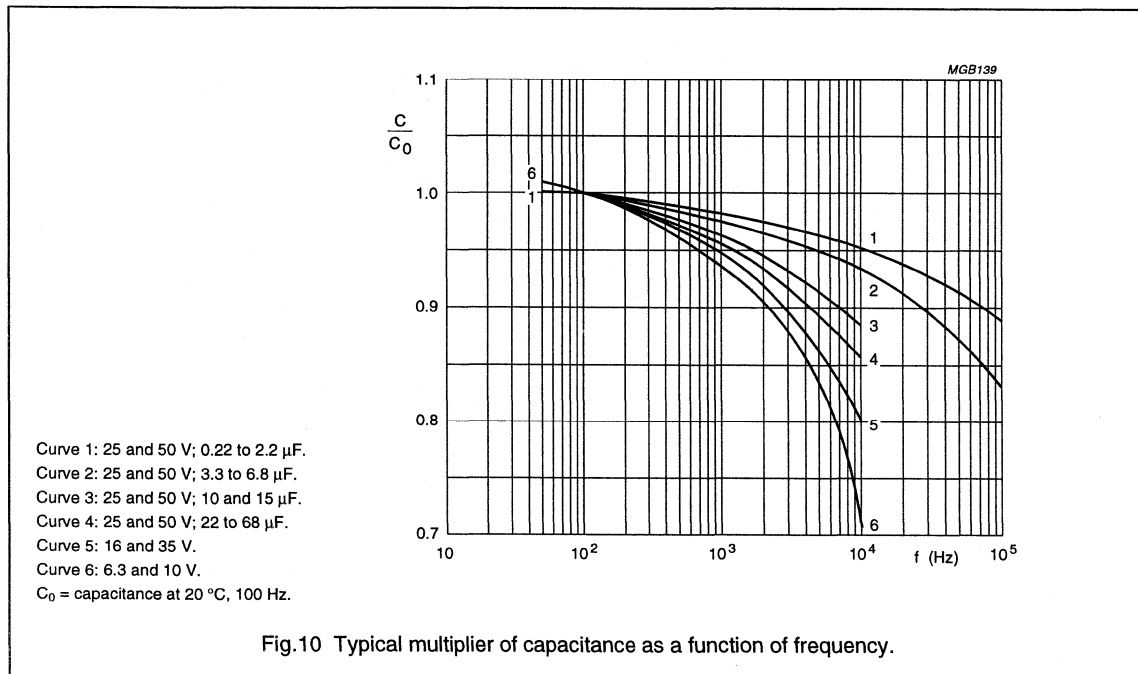
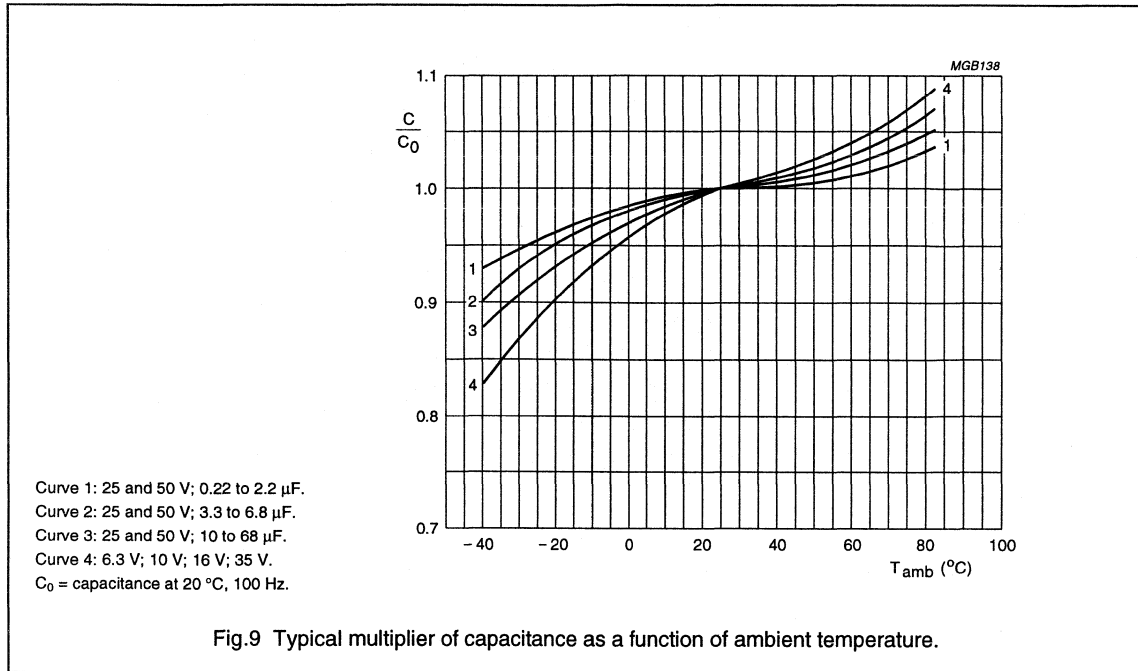
ELECTRICAL DATA (continued)



Non-solid Al-electrolytic capacitors
Radial Low Leakage Current

RLC 013

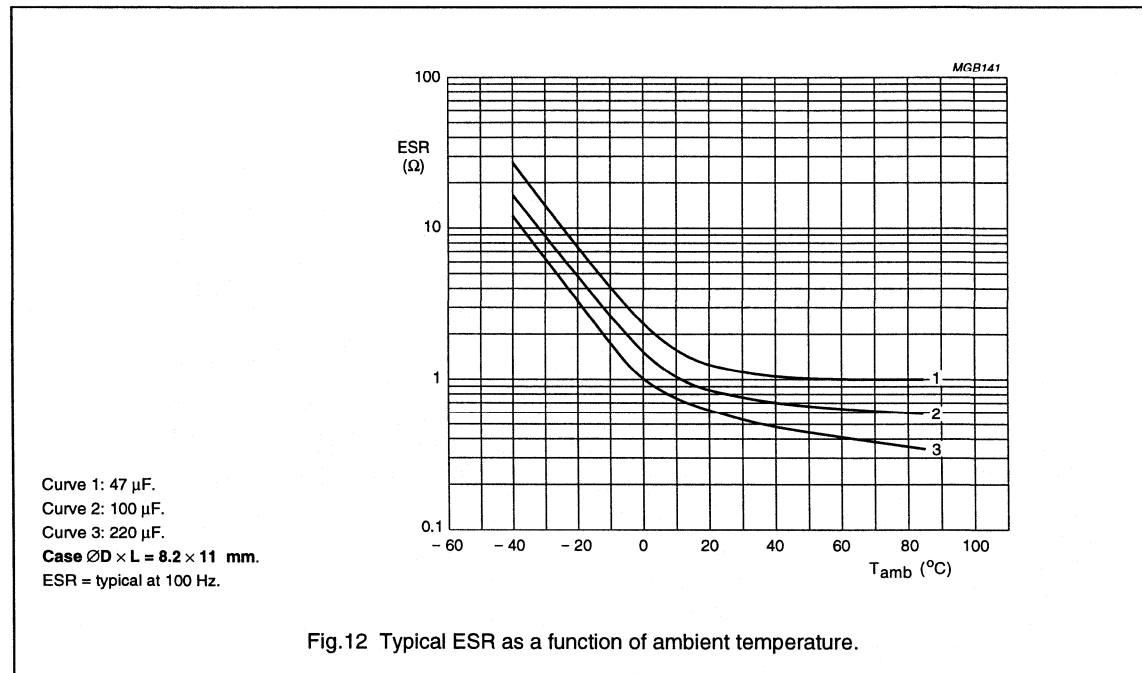
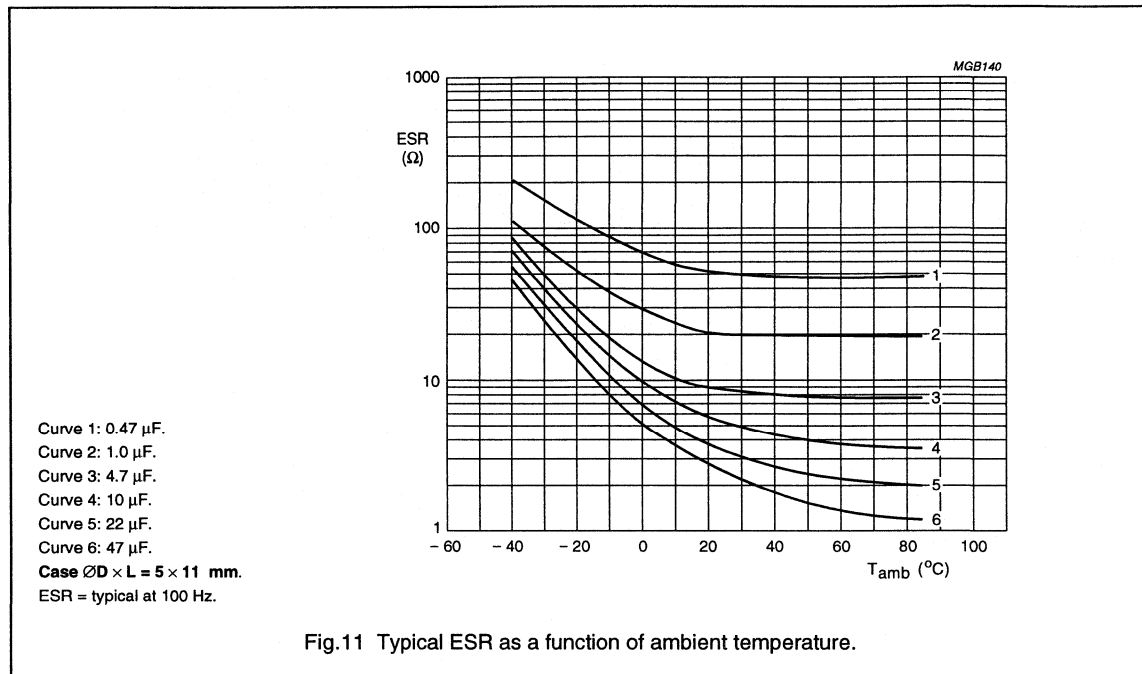
Capacitance (C)



Non-solid Al-electrolytic capacitors
Radial Low Leakage Current

RLC 013

Equivalent series resistance (ESR)

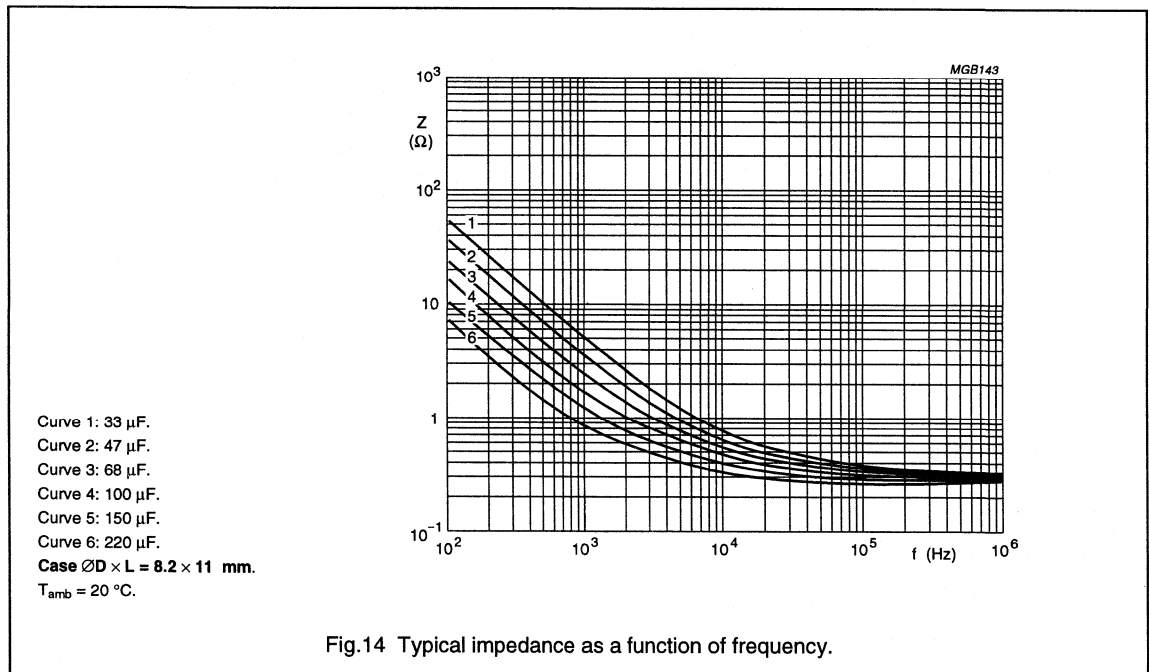
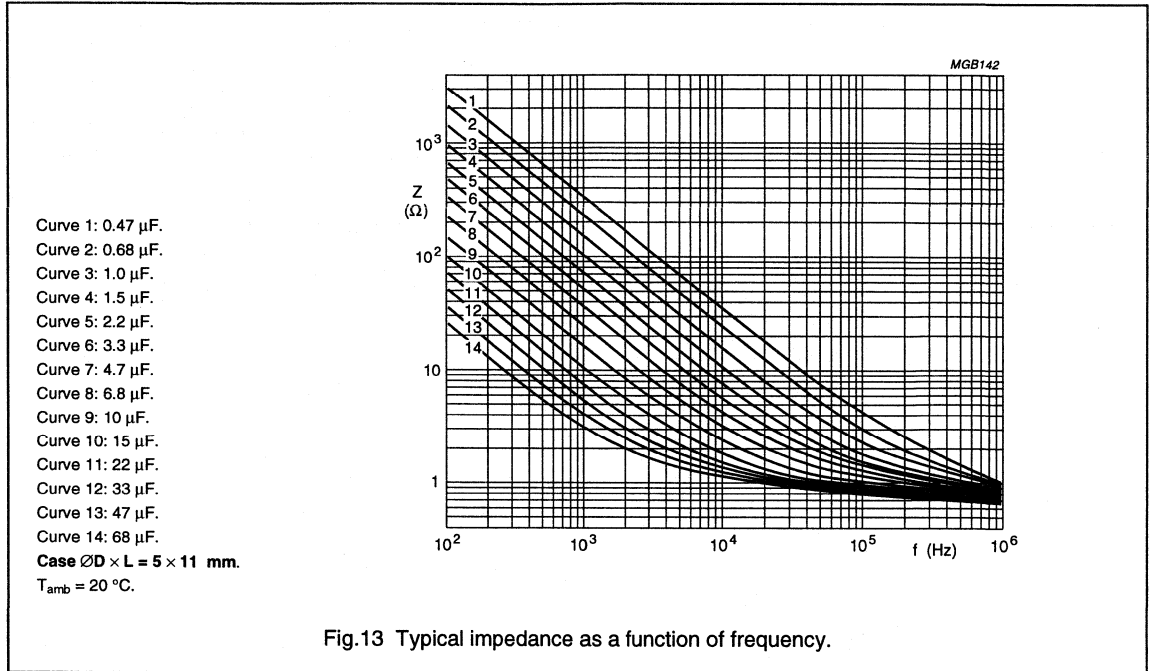


Non-solid Al-electrolytic capacitors

Radial Low Leakage Current

RLC 013

Impedance (Z)



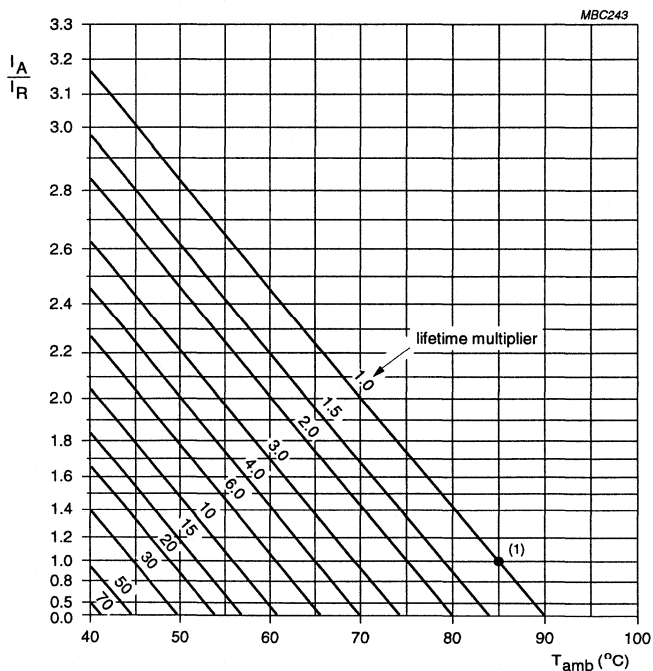
Non-solid Al-electrolytic capacitors Radial Low Leakage Current

RLC 013

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		
	$U_R = 6.3$ V	$U_R = 10, 16$ and 35 V	$U_R = 25$ and 50 V
50	0.9	0.85	0.8
100	1.0	1.0	1.0
300	1.12	1.2	1.25
1000	1.2	1.3	1.4
3000	1.25	1.35	1.5
≥ 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.

Non-solid Al-electrolytic capacitors

Radial Low Leakage Current

RLC 013

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

Non-solid Al - electrolytic capacitors

Radial Bipolar

RB 036 92

FEATURES

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

APPLICATIONS

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

REMARK

Please consult your sales representative for more details.

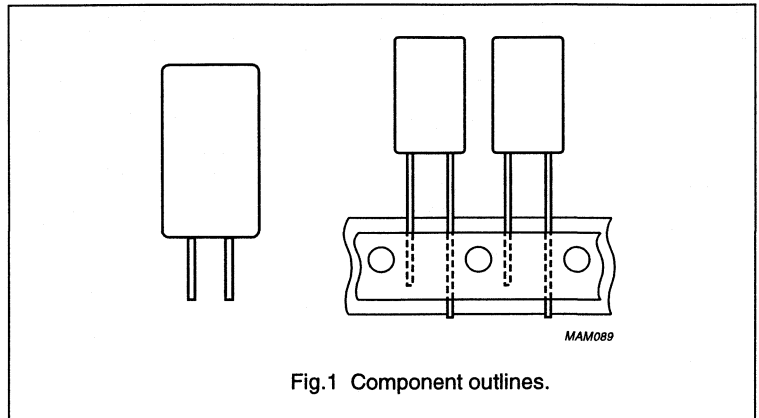
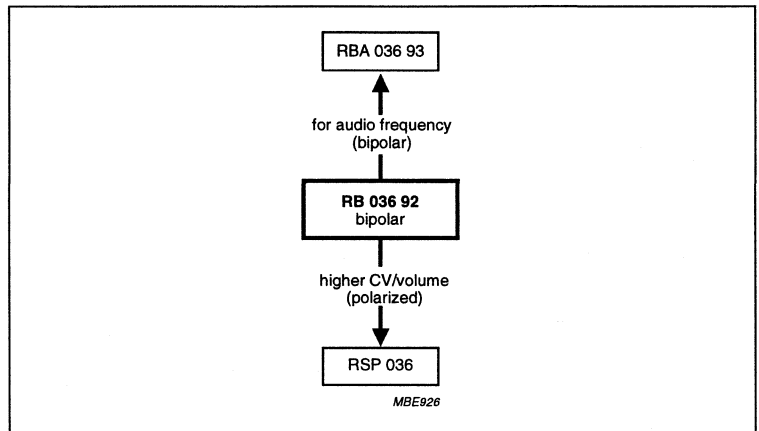


Fig.1 Component outlines.



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	$\pm 20\%$
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

**Non-solid Al - electrolytic capacitors
Radial Bipolar****RB 036 92****Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ 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	–	–	–

F

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

RBA 036 93

FEATURES

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

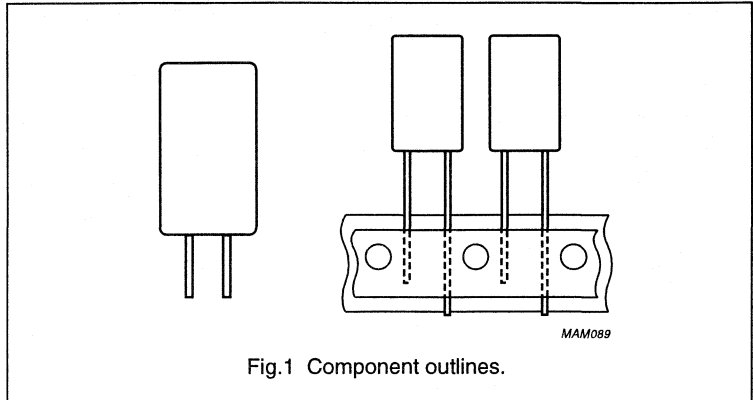


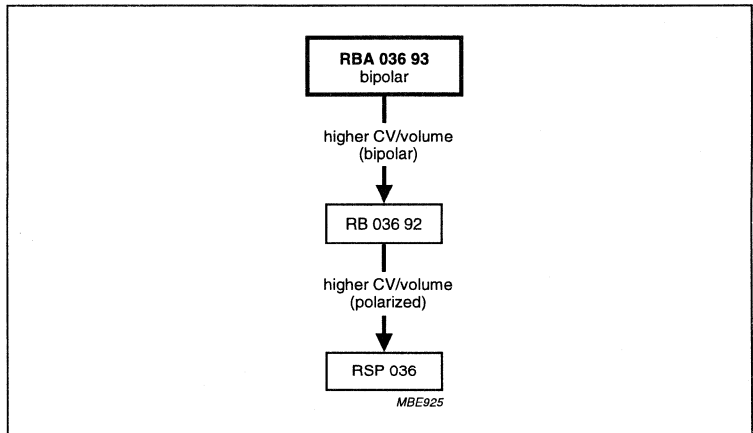
Fig.1 Component outlines.

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

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

RBA 036 93

NOTES



Non-solid Al - electrolytic capacitors Radial Semi-Professional

RSP 036

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Reduced leakage current.

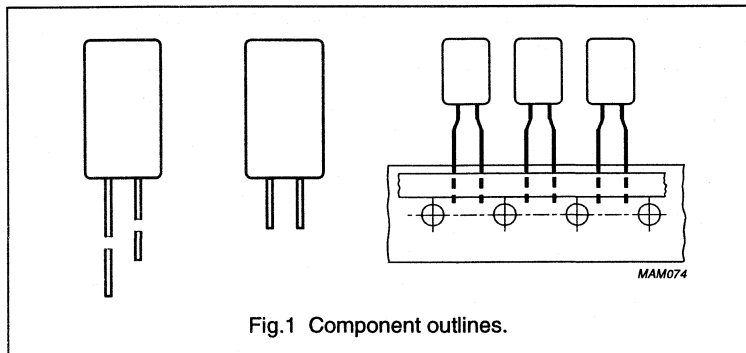
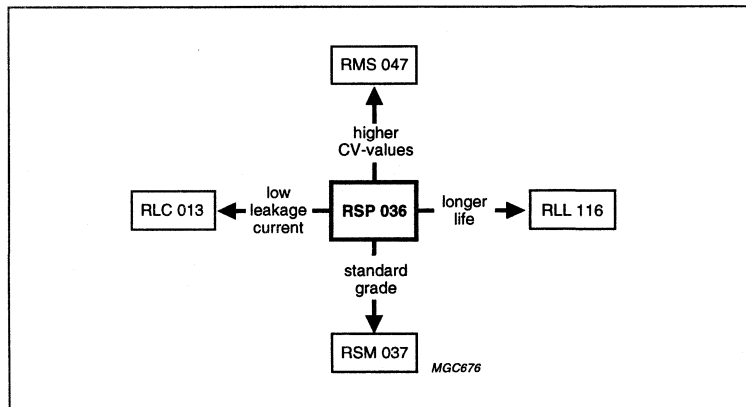


Fig.1 Component outlines.

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 ($\varnothing D_{nom} \times L_{nom}$)	5 × 11 and 8.2 × 11 mm
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 °C
Endurance test at 85 °C	2000 hours
Useful life at 105 °C	750 hours
Useful life at 85 °C	3000 hours
Useful life at 40 °C, 1.4 × I_R applied	80000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300, LL grade
Climatic category IEC 68 (DIN 40040)	55/085/56 (FPF)
Approvals	LNZ 44-04 (COJ)

Non-solid Al - electrolytic capacitors

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RSP 036

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 RMS 047".

R

Non-solid Al - electrolytic capacitors
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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

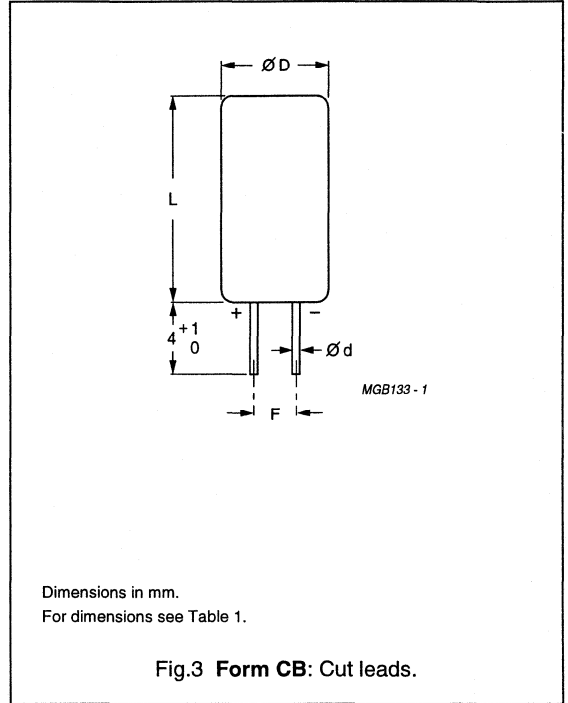
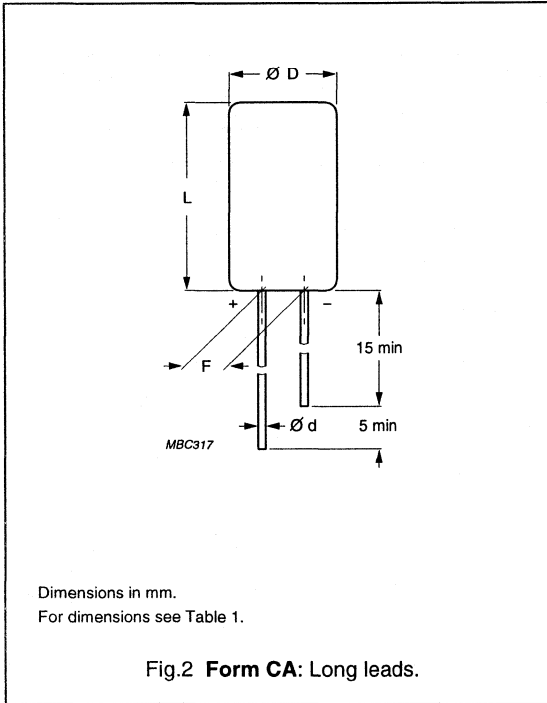


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

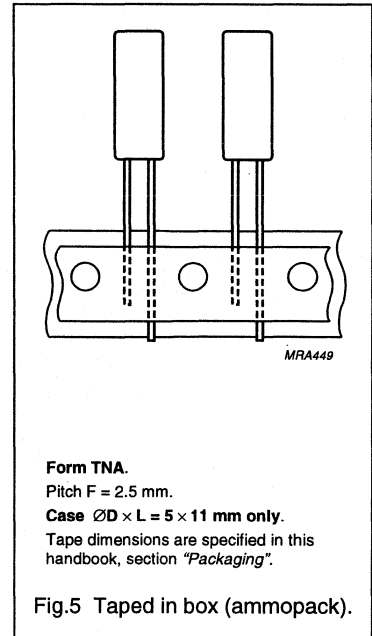
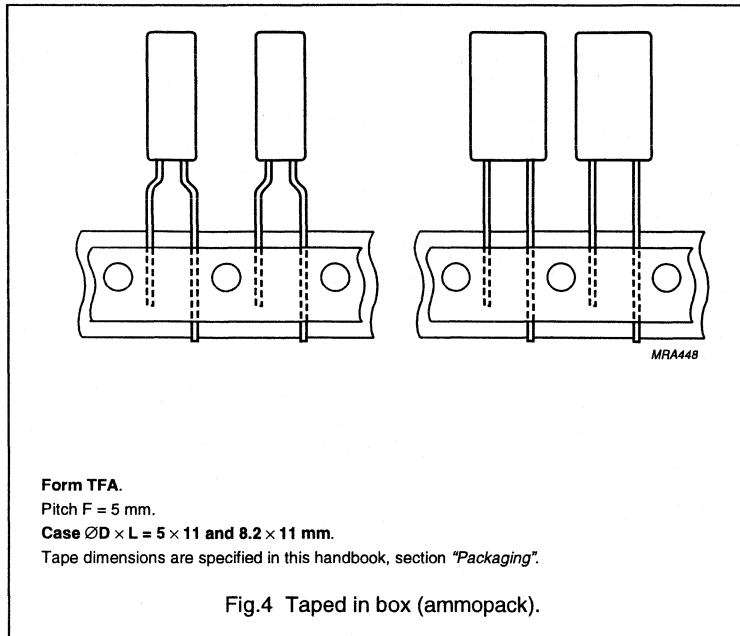
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES	
							FORM CA, CB	FORM TFA, TNA
5 × 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	2000
8.2 × 11	13	0.6	8.7	12	5.0 ± 0.5	≈ 1.1	1000	1000

Non-solid Al - electrolytic capacitors

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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 (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.

R

Non-solid Al - 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 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

Non-solid Al - electrolytic capacitors

Radial Semi-Professional

RSP 036

ORDERING INFORMATION**Ordering example**

Electrolytic capacitor RSP 036

100 μF /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	–	–

R

Non-solid Al - electrolytic capacitors

Radial Semi-Professional

RSP 036

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 85 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\text{Tan } \delta$ 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

Non-solid Al - 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 78447	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	035 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	–	–

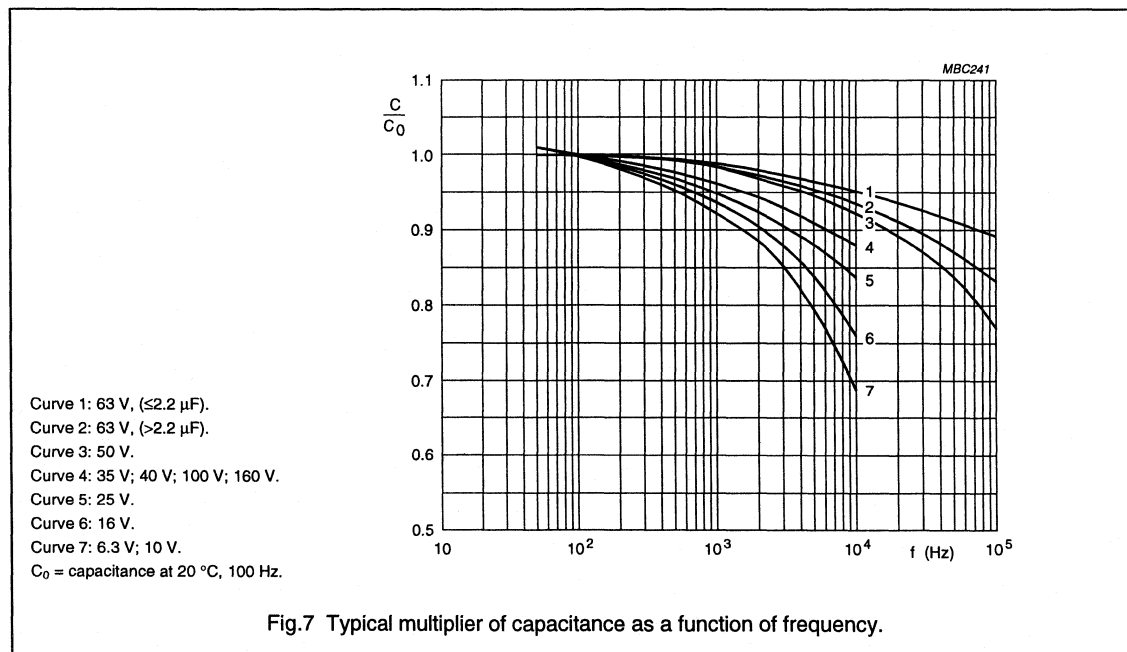
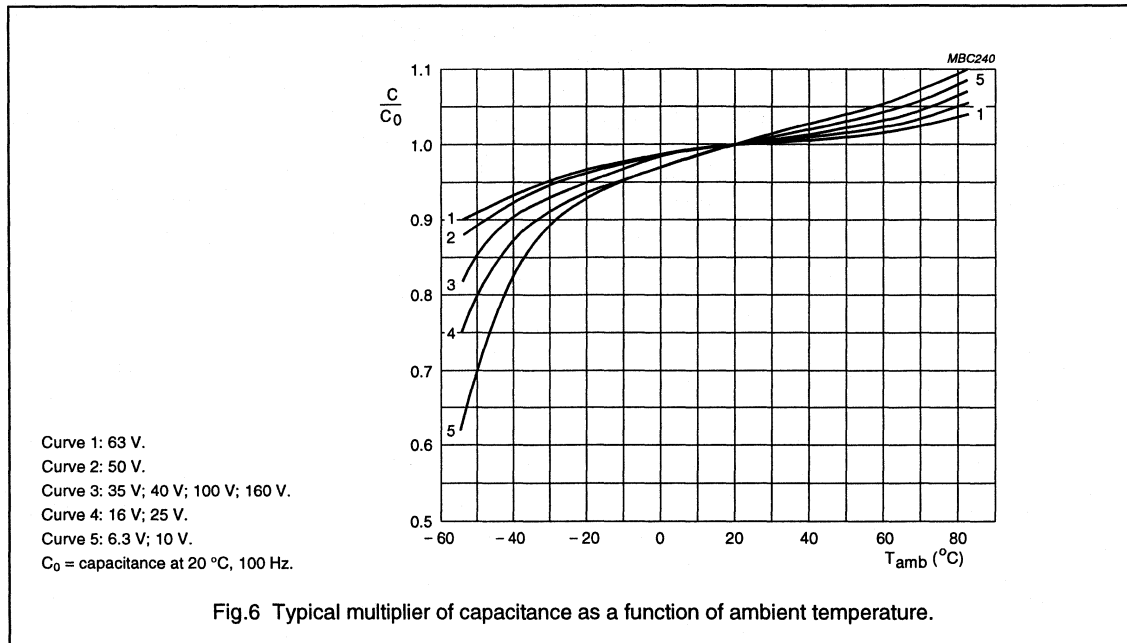
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ELECTRICAL DATA (continued)

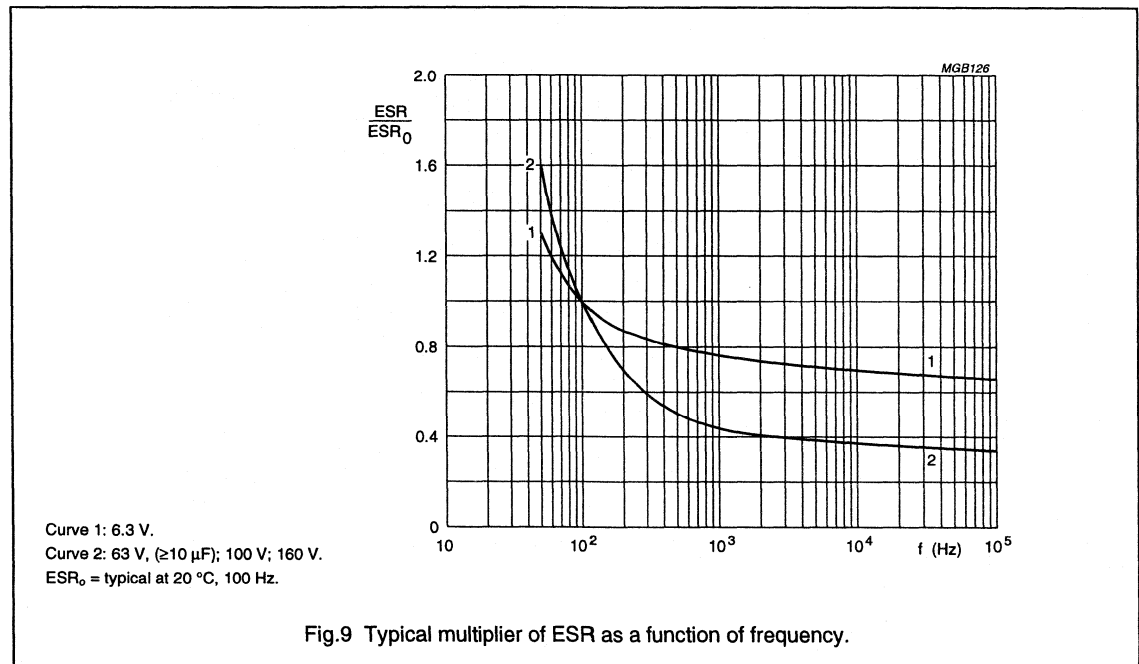
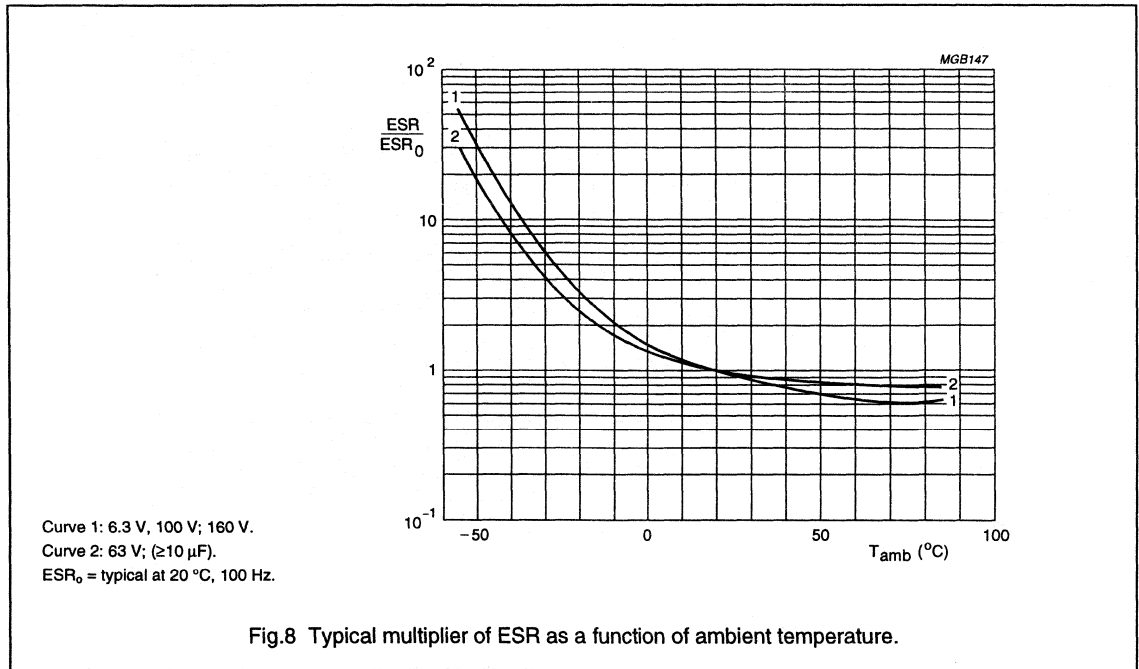
Capacitance (C)



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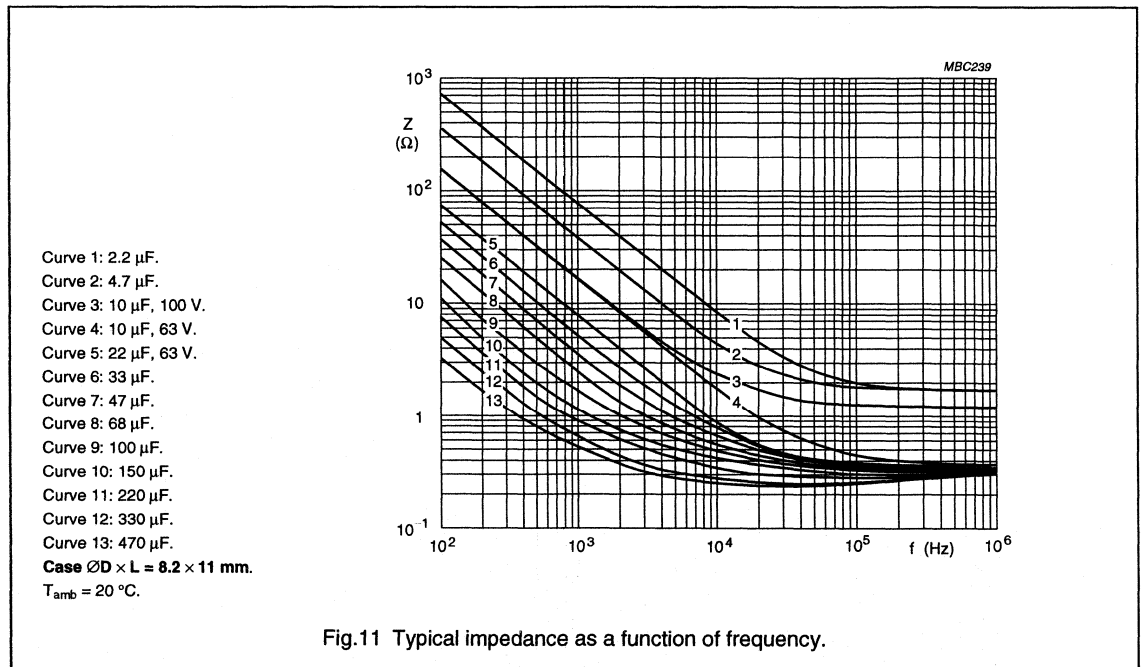
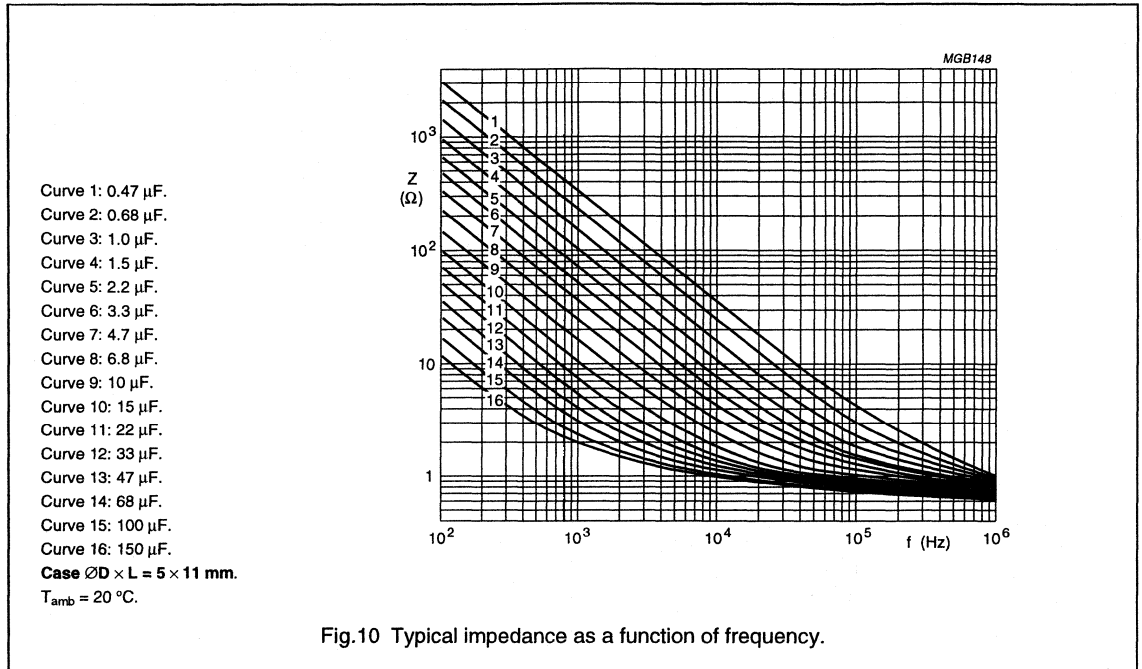
Equivalent series resistance (ESR)



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Impedance (Z)



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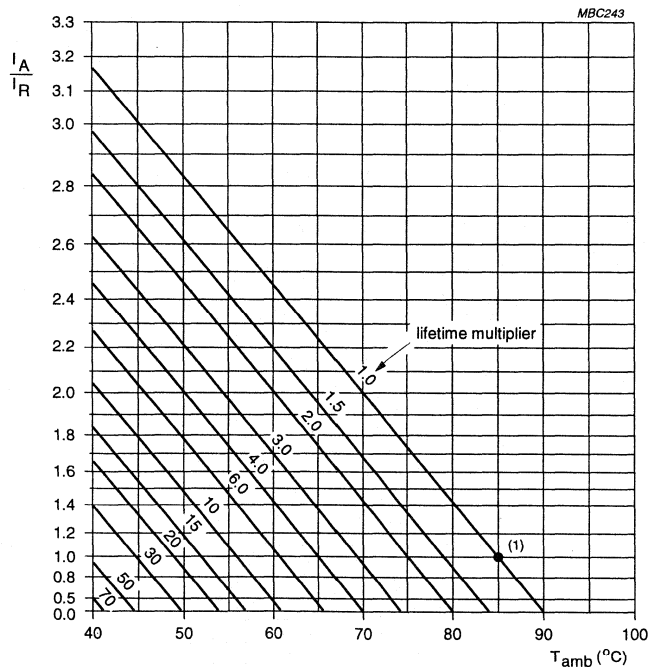
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RIPPLE CURRENT AND USEFUL LIFE

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		
	$U_R = 6.3$ to 10 V	$U_R = 16$ to 35 V	$U_R = 40$ to 160 V
50	0.9	0.85	0.8
100	1.0	1.0	1.0
300	1.12	1.2	1.25
1000	1.2	1.3	1.4
3000	1.25	1.35	1.5
≥ 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	$T_{amb} = 85\text{ °C}$; 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	$T_{amb} = 85\text{ °C}$; 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	$T_{amb} = 85\text{ °C}$; 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 $I_{L5} \leq \text{spec. limit}$

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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 hours at 105 °C
- Miniaturized, high CV product per unit volume.

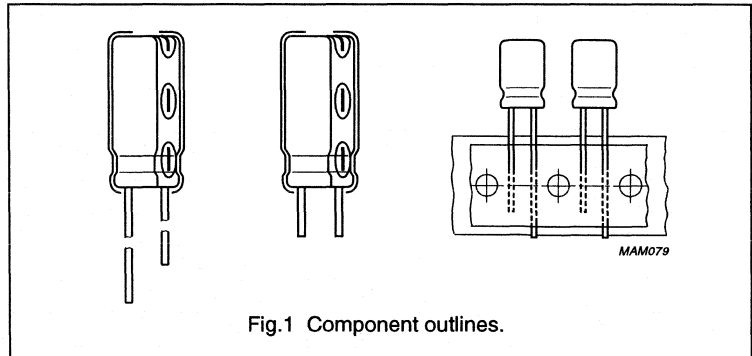
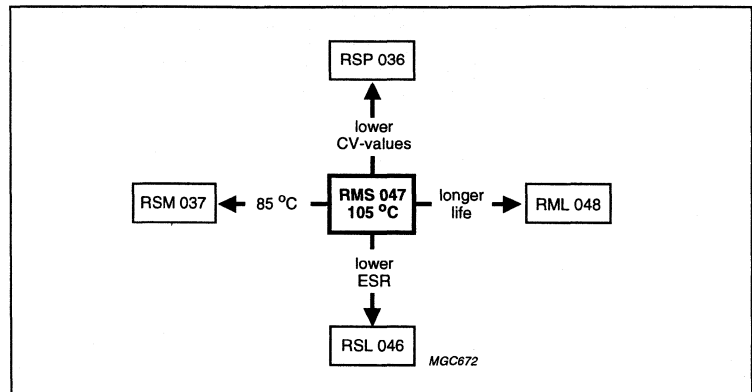


Fig.1 Component outlines.

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 × 40
Rated capacitance range, C_R	100 to 10000 μF
Tolerance on C_R	$\pm 20\%$
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 (DIN 40040)	40/105/56 (GMF)



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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 × 40
3300	16 × 25	16 × 31	18 × 35	18 × 35	18 × 40	–
4700	16 × 31	18 × 35	18 × 40	–	–	–
6800	16 × 35	18 × 40	–	–	–	–
10000	18 × 40	–	–	–	–	–

Note

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

Non-solid Al - electrolytic capacitors
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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

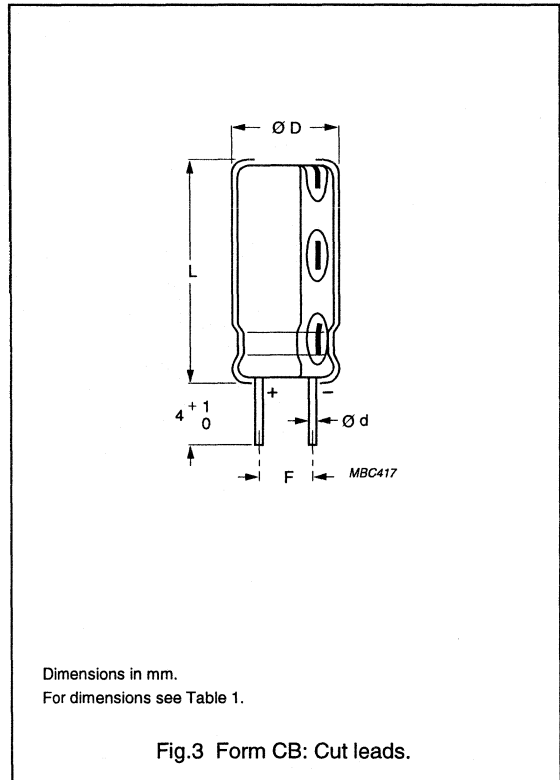
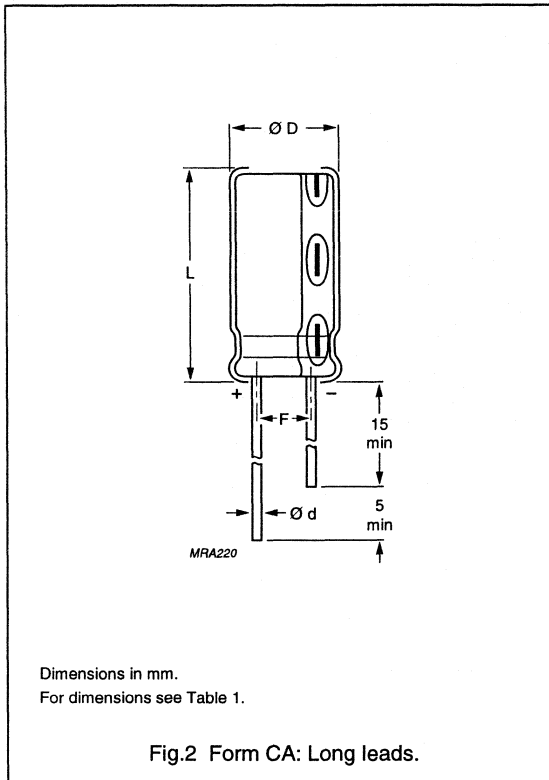


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

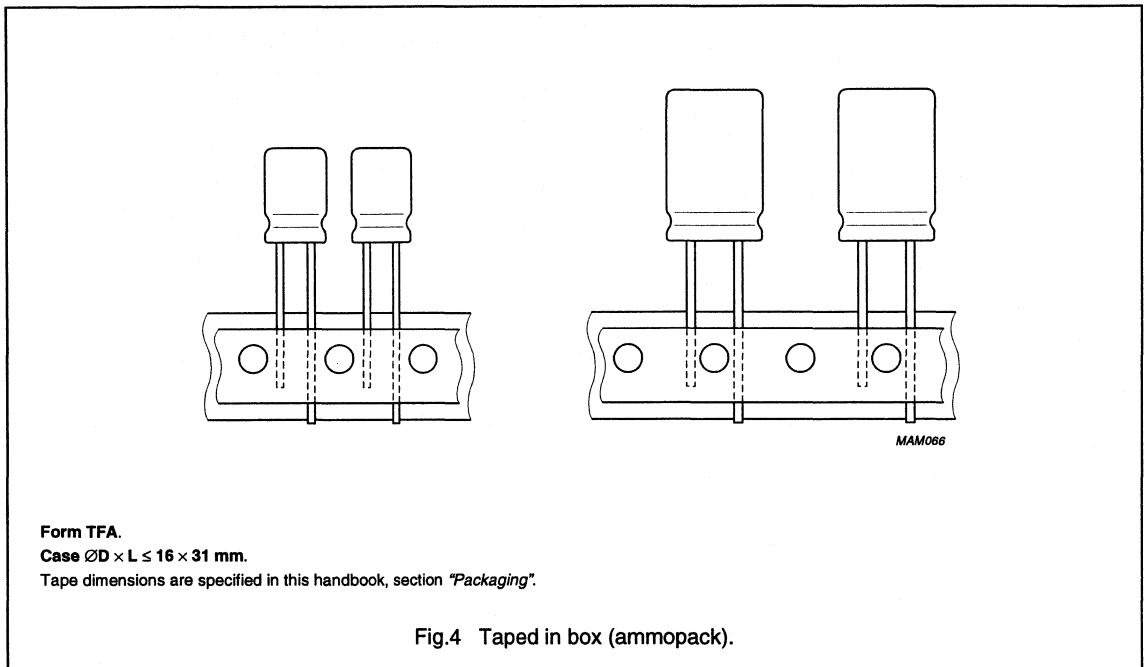
NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA per box	FORM CB per box	FORM TFA per box
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	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	300	1000	–
18 × 40	23	0.8	18.5	42.0	7.5 ± 0.5	≈ 16.0	300	1000	–

Non-solid Al - electrolytic capacitors

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Taped products



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 RMS 047

1000 µF/35 V; ±20%

Nominal case size: Ø12.5 x 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 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 × 40	23	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 × 40	23	1700	1700	340	0.26	0.06	0.04	0.04	047 56682	047 66682	—

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		CATALOGUE NUMBER 2222			Z 100 kHz (Ω)	Z 10 kHz (Ω)	ESR 100 Hz (Ω)	Tan δ 100 Hz	I _{L5} 5 min (μ A)	I _{L1} 1 min (μ A)	I _R 105 °C (mA)	CASE CODE	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	C _R 100 Hz (μ F)	U _R (V)				
		BULK PACKAGING																	
		FORM CA	FORM CB	FORM TFA															
35	220	10 × 12	14	270	80	18	0.12	0.83	0.57	0.38	0.38	0.26	0.43	0.65	0.93	0.47 51221	0.47 61221	0.47 61332	0.47 31221
	330	10 × 16	15	350	120	26	0.12	0.55	0.38	0.28	0.33	0.10	0.20	0.32	0.17	0.47 51471	0.47 61471	0.47 61332	0.47 31471
	470	10 × 20	16	450	170	36	0.12	0.39	0.27	0.22	0.22	0.10	0.15	0.10	0.09	0.47 51102	0.47 61102	0.47 61222	0.47 31102
40	1000	12.5 × 25	18	780	350	73	0.12	0.18	0.13	0.12	0.12	0.14	0.05	0.05	0.05	0.47 51222	0.47 61222	0.47 61332	0.47 31222
	2200	16 × 31	20	1200	770	160	0.16	0.11	0.07	0.07	0.07	0.18	0.06	0.06	0.06	0.47 50222	0.47 60222	0.47 60332	0.47 30222
	3300	18 × 35	22	1500	1200	230	0.18	0.09	0.05	0.05	0.05	0.20	0.04	0.04	0.04	0.47 50332	0.47 60332	0.47 60332	0.47 30332
50	4700	18 × 40	23	1800	1600	330	0.20	0.06	0.04	0.04	0.04	0.18	0.08	0.08	0.08	0.47 50472	0.47 60472	0.47 60472	0.47 30472
	330	10 × 20	16	380	140	29	0.12	0.55	0.33	0.26	0.26	0.12	0.43	0.69	0.10	0.47 57331	0.47 67331	0.47 67331	0.47 37331
	2200	16 × 35	21	1200	880	180	0.16	0.11	0.06	0.06	0.06	0.16	0.06	0.10	0.10	0.47 57222	0.47 67222	0.47 67222	0.47 37222
63	3300	18 × 35	22	1500	1300	270	0.18	0.08	0.04	0.04	0.04	0.18	0.08	0.08	0.08	0.47 57332	0.47 67332	0.47 67332	0.47 37332
	220	10 × 16	15	310	110	25	0.10	0.69	0.43	0.33	0.26	0.10	0.43	0.69	0.10	0.47 51221	0.47 61221	0.47 61332	0.47 31221
	470	12.5 × 20	17	540	240	50	0.10	0.32	0.20	0.20	0.20	0.10	0.20	0.32	0.10	0.47 51471	0.47 61471	0.47 61332	0.47 31471
63	1000	16 × 25	19	940	500	100	0.10	0.15	0.10	0.10	0.10	0.10	0.15	0.10	0.09	0.47 51102	0.47 61102	0.47 61222	0.47 31102
	2200	18 × 35	22	1400	1100	220	0.14	0.10	0.05	0.05	0.05	0.14	0.05	0.05	0.05	0.47 51222	0.47 61222	0.47 61332	0.47 31222
	3300	18 × 40	23	1600	1700	330	0.16	0.07	0.03	0.04	0.04	0.16	0.07	0.03	0.04	0.47 51332	0.47 61332	0.47 61332	0.47 31332
63	100	10 × 12	14	210	66	16	0.09	1.40	0.75	0.65	0.65	0.09	1.40	0.75	0.65	0.47 58101	0.47 68101	0.47 68101	0.47 38101
	220	10 × 20	16	350	140	31	0.09	0.62	0.34	0.32	0.32	0.09	0.62	0.34	0.32	0.47 58221	0.47 68221	0.47 68221	0.47 38221
	330	12.5 × 20	17	470	210	45	0.09	0.41	0.23	0.22	0.22	0.09	0.41	0.23	0.22	0.47 58331	0.47 68331	0.47 68331	0.47 38331
63	470	12.5 × 25	18	620	300	62	0.09	0.29	0.16	0.16	0.16	0.09	0.29	0.16	0.16	0.47 58471	0.47 68471	0.47 68471	0.47 38471
	1000	16 × 31	20	1100	630	130	0.09	0.14	0.08	0.08	0.08	0.09	0.14	0.08	0.08	0.47 58102	0.47 68102	0.47 68102	0.47 38102
	2200	18 × 40	23	1500	1400	280	0.13	0.09	0.04	0.04	0.04	0.13	0.09	0.04	0.04	0.47 58222	0.47 68222	0.47 68222	0.47 38222

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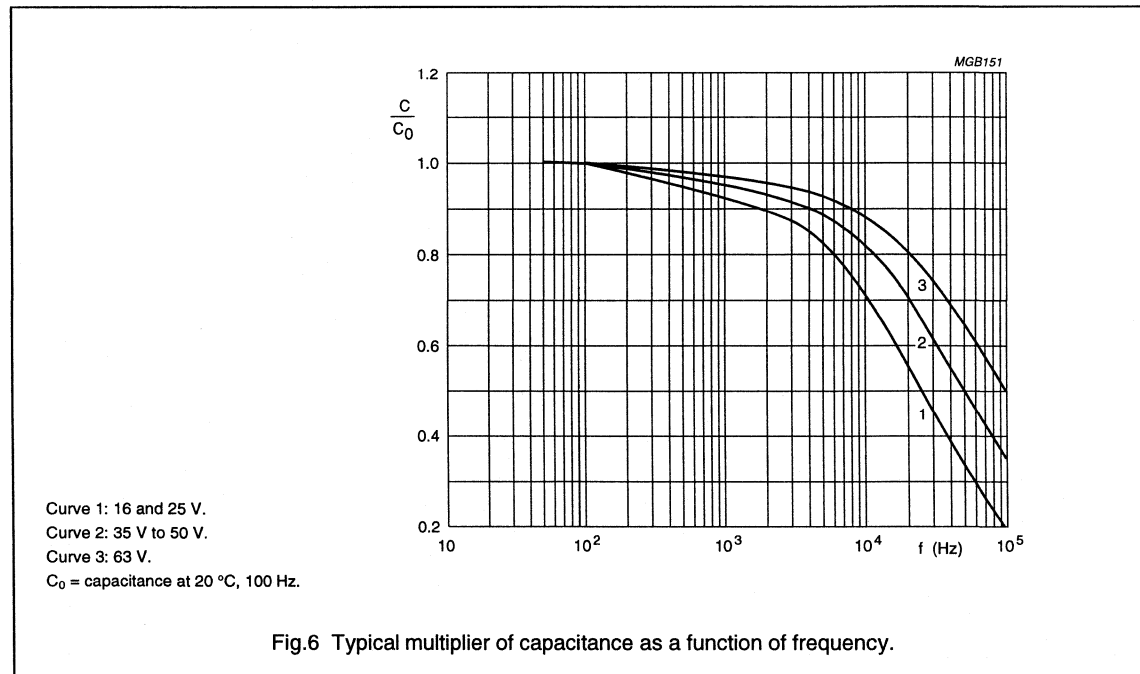
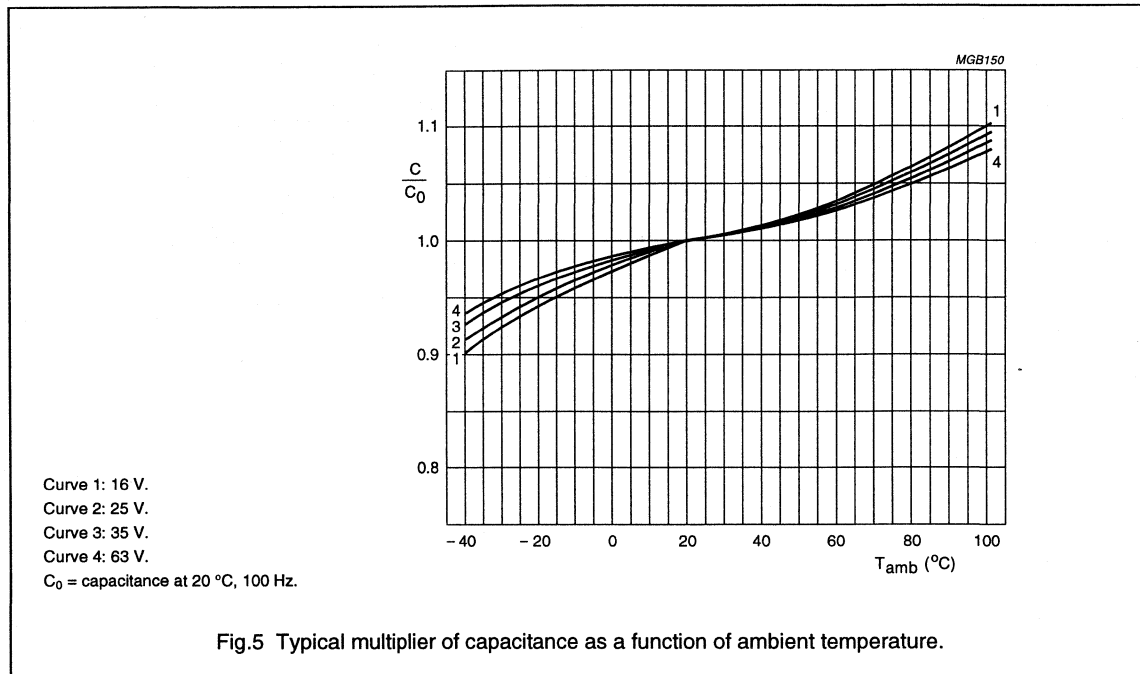
Additional electrical data

DESCRIPTION	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 U_R$
Reverse voltage		$U_{rev} \leq 1 V$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.01 C_R U_R + 3 \mu A$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R U_R + 3 \mu A$
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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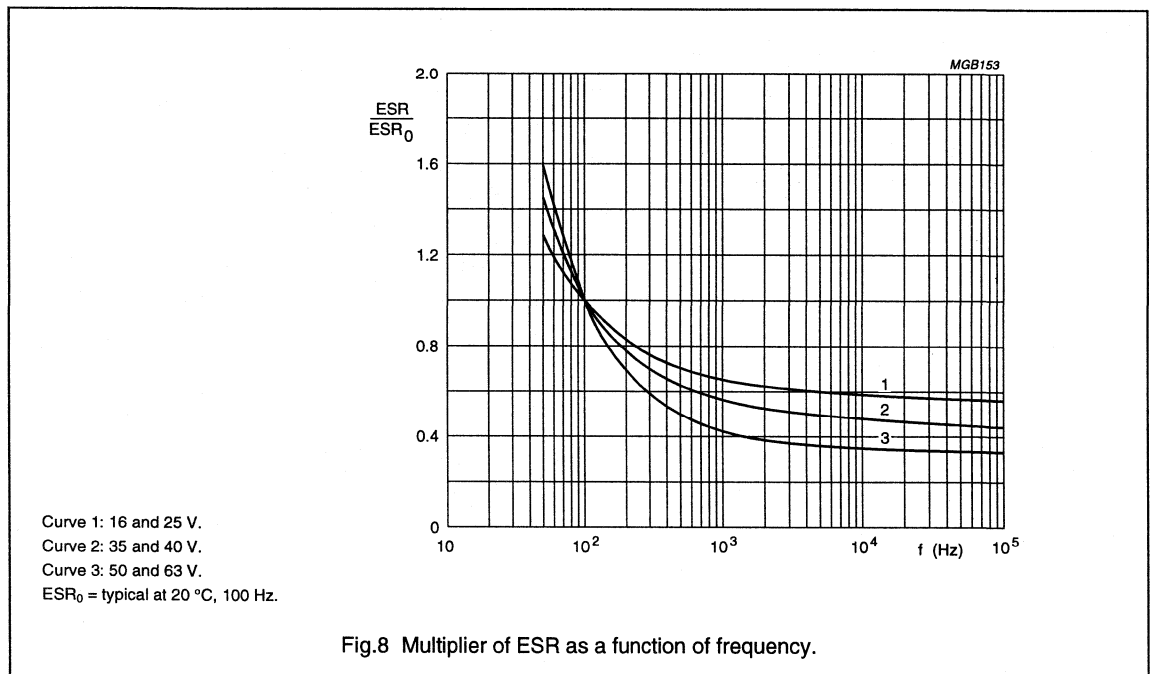
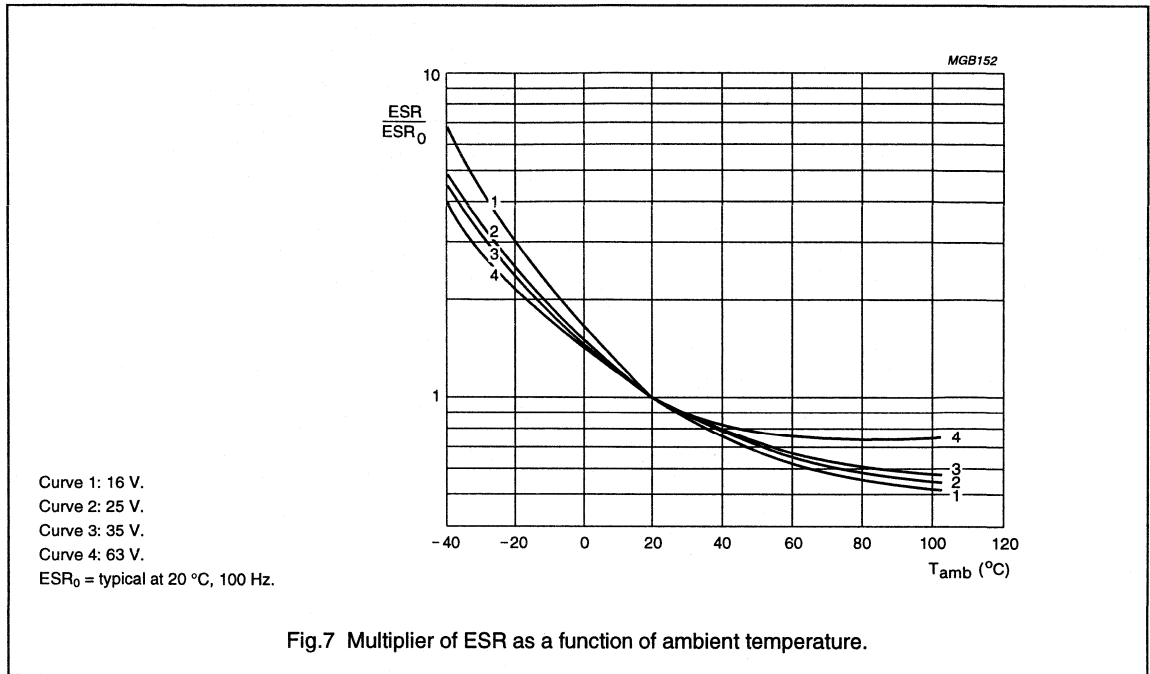
Capacitance (C)



Non-solid Al - electrolytic capacitors
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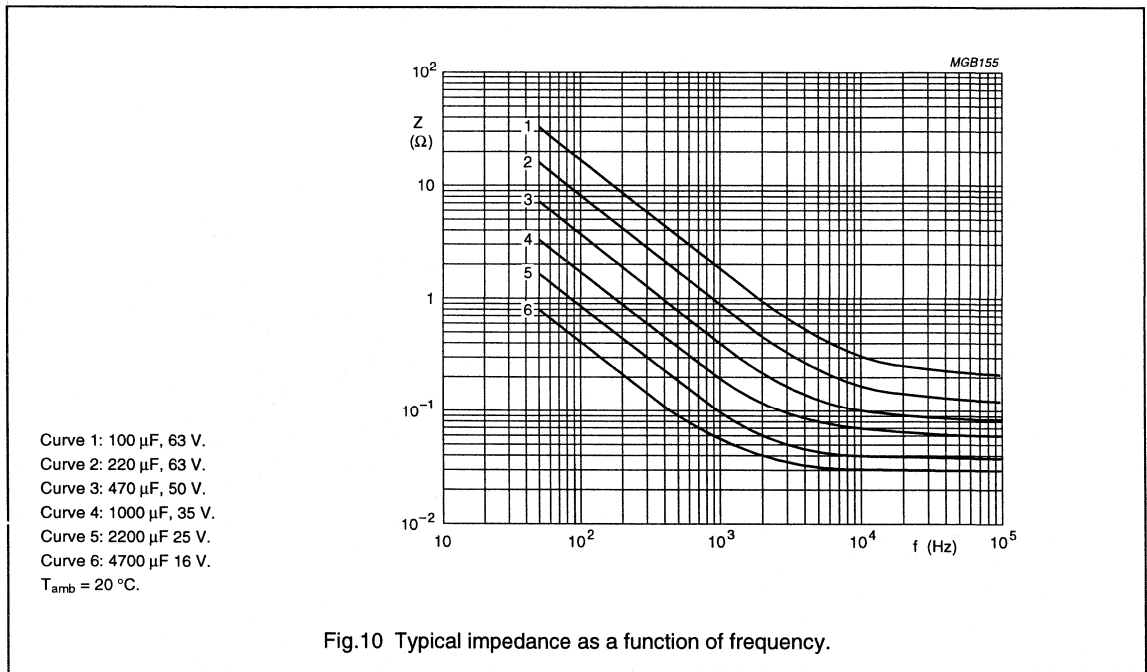
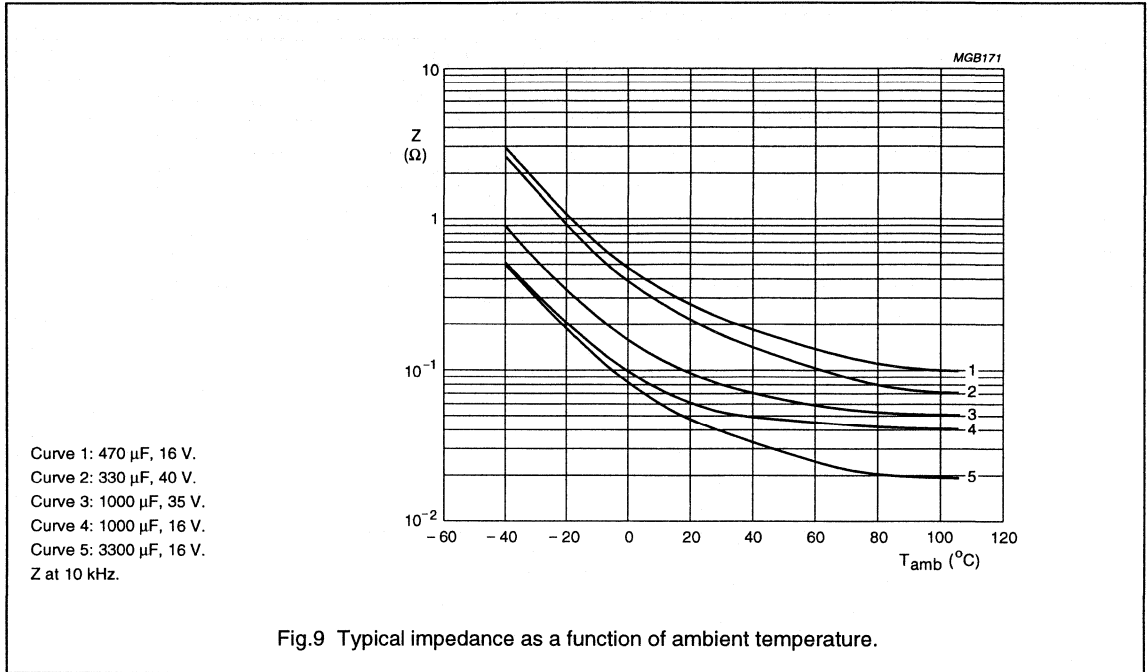
Equivalent series resistance (ESR)



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Impedance (Z)



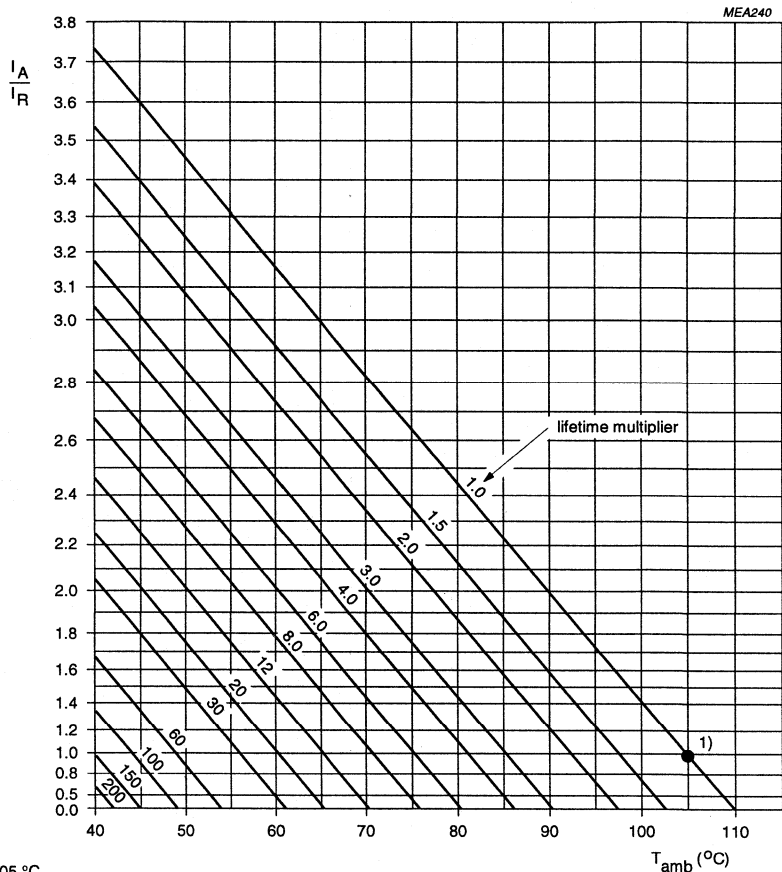
Non-solid Al - electrolytic capacitors Radial Miniature Semi-Professional

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

Non-solid Al - 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	$T_{amb} = 105\text{ °C}$; 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	$T_{amb} = 105\text{ °C}$; 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	$T_{amb} = 105\text{ °C}$; no voltage applied; 500 hours; after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$

**Non-solid Al - electrolytic capacitors
Radial Miniature Semi-Professional**

RMS 047

NOTES



Non-solid Al - electrolytic capacitors

Radial Long Life

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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.

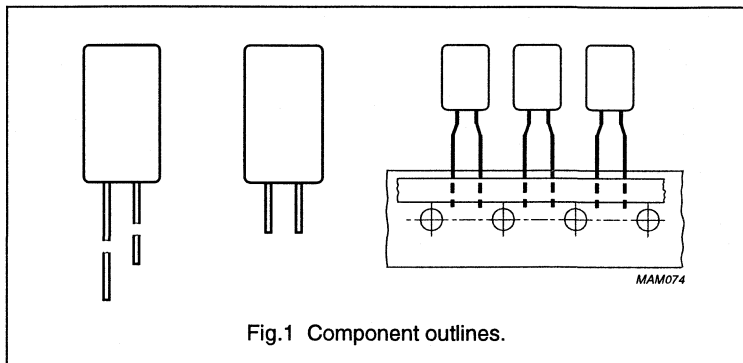
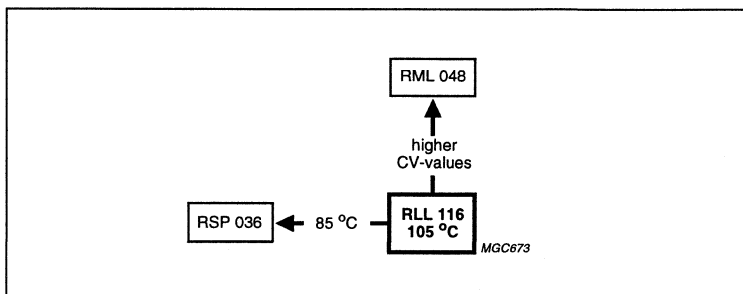


Fig.1 Component outlines.

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 ($\varnothing D_{nom} \times L_{nom}$)	5 × 11 and 8.2 × 11 mm
Rated capacitance range, C_R	0.47 to 470 μ F
Tolerance on C_R	$\pm 20\%$
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 (DIN 40040)	55/105/56 (FMF)

Non-solid Al - 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 RML 048".



Non-solid Al - electrolytic capacitors
Radial Long Life

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

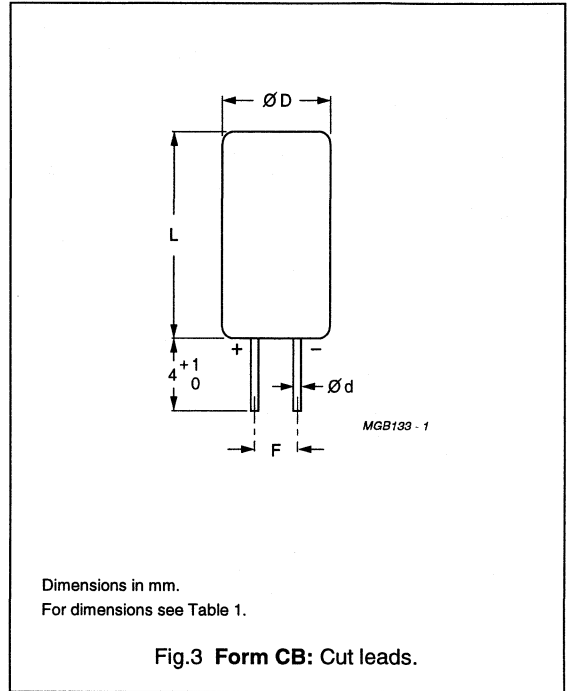
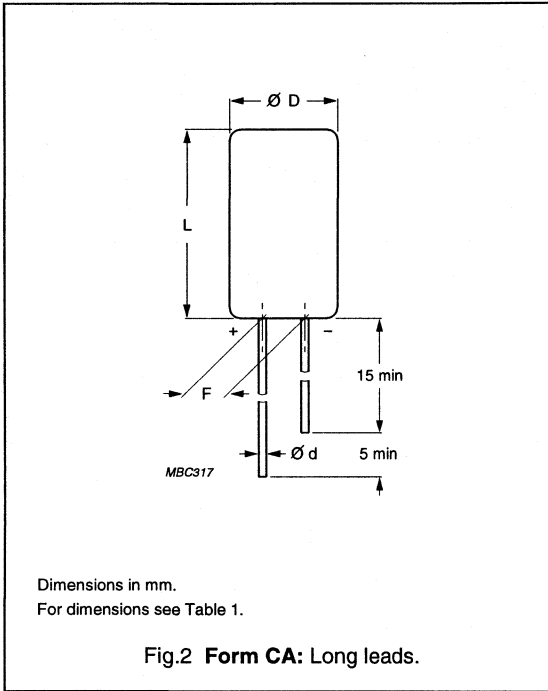


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

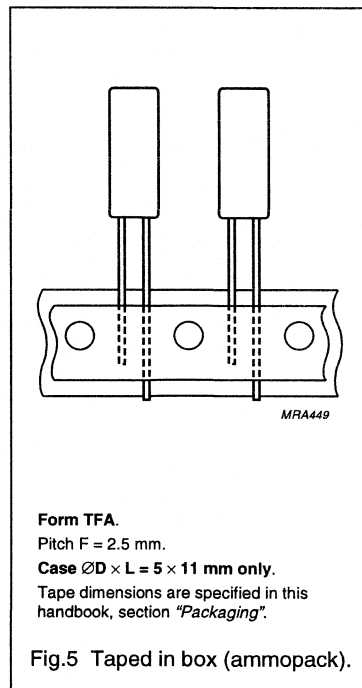
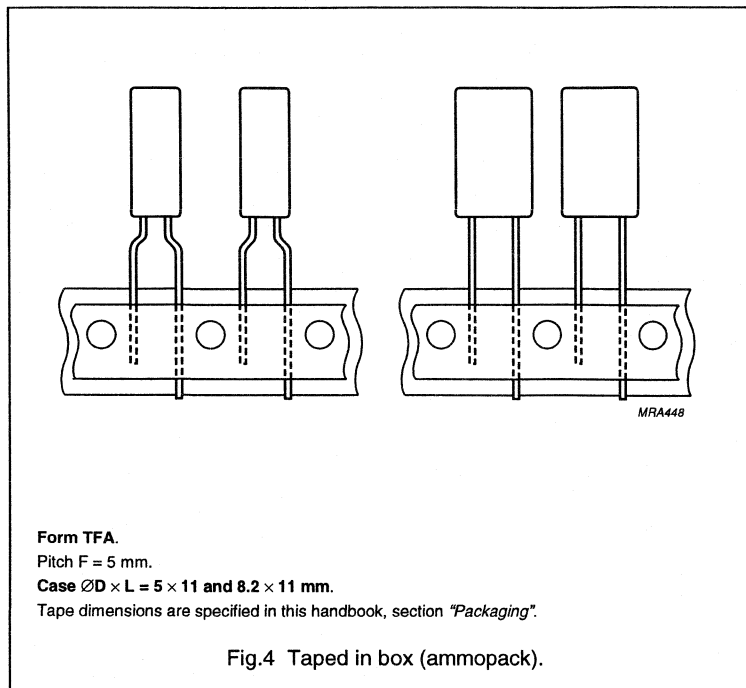
NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA, CB	FORM TR+, TN+	FORM TFA, TNA
5 × 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	1000	2000
8.2 × 11	13	0.6	8.7	12	5 ± 0.5	≈ 1.1	1000	500	1000

Non-solid Al - electrolytic capacitors

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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 (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.

R

Non-solid Al - electrolytic capacitors

Radial Long Life

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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

Non-solid Al - electrolytic capacitors

Radial Long Life

RLL 116

ORDERING INFORMATION**Ordering example**

Electrolytic capacitor RLL 116

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 (μ F)	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	–	–

R

Non-solid Al - 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 (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 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} 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		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 3 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.001 C_R \times U_R + 3 \mu\text{A}$
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

Non-solid Al - electrolytic capacitors

Radial Long Life

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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	–	–

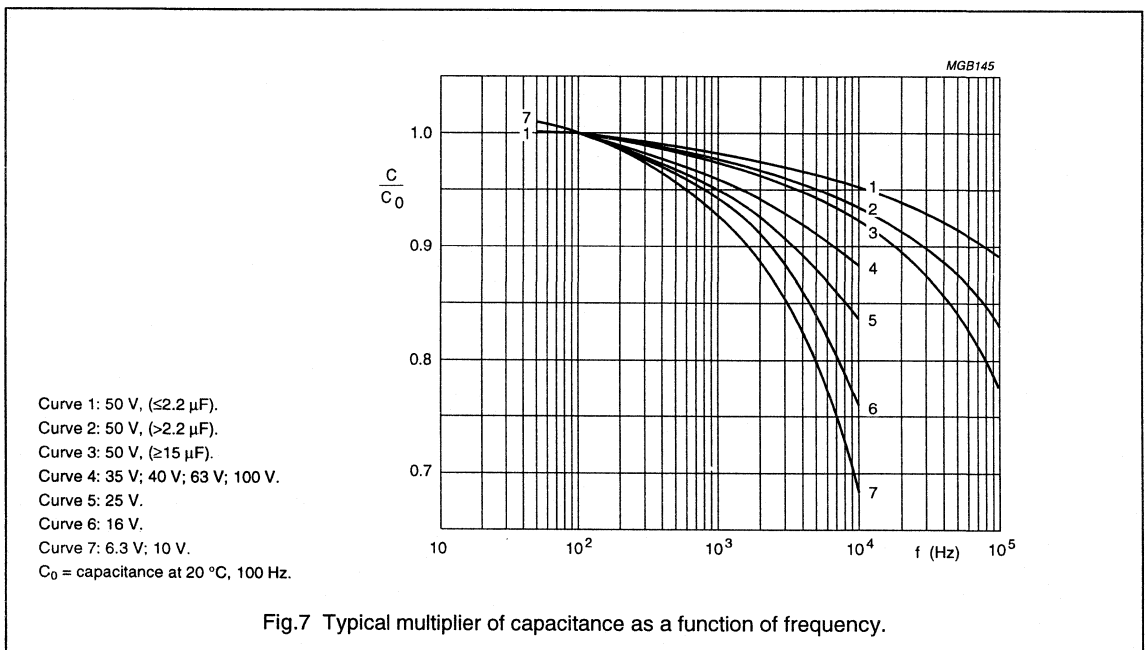
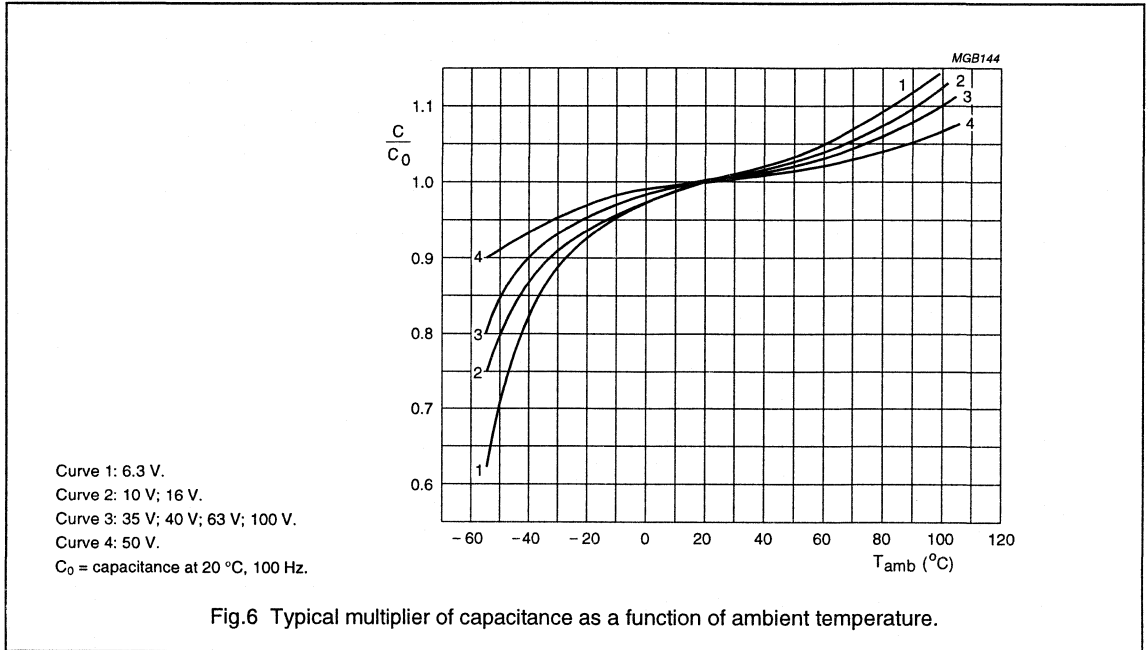
R

Non-solid Al - electrolytic capacitors
Radial Long Life

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ELECTRICAL DATA (continued)

Capacitance (C)



Non-solid Al - electrolytic capacitors

Radial Long Life

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Equivalent series resistance (ESR)

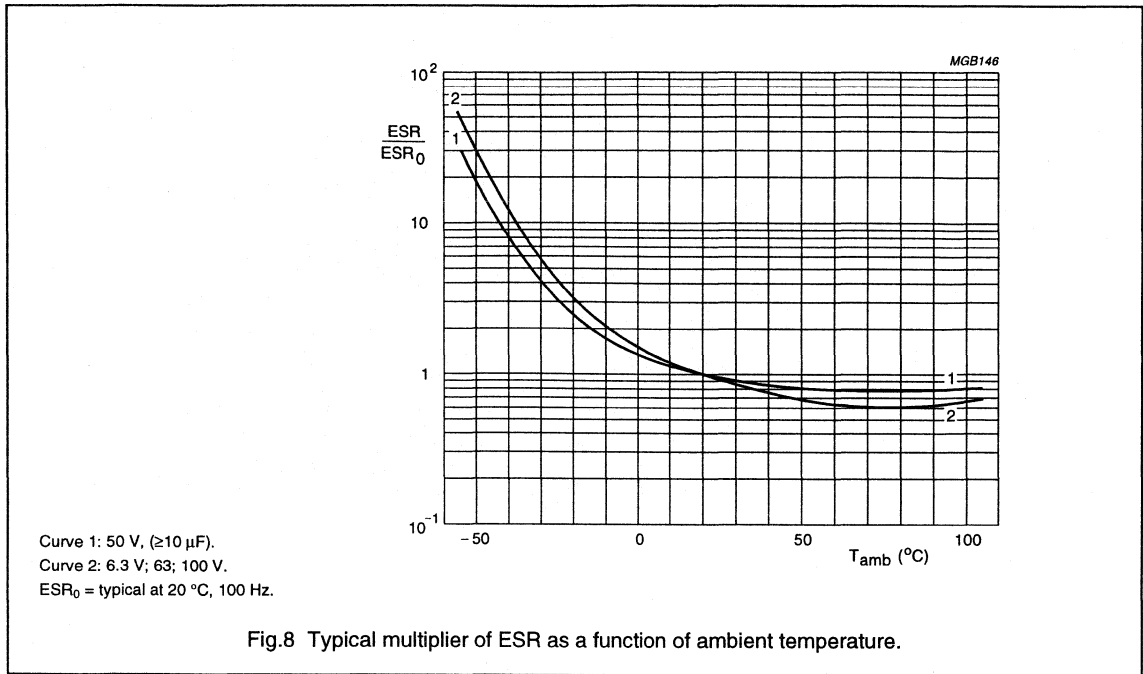


Fig.8 Typical multiplier of ESR as a function of ambient temperature.

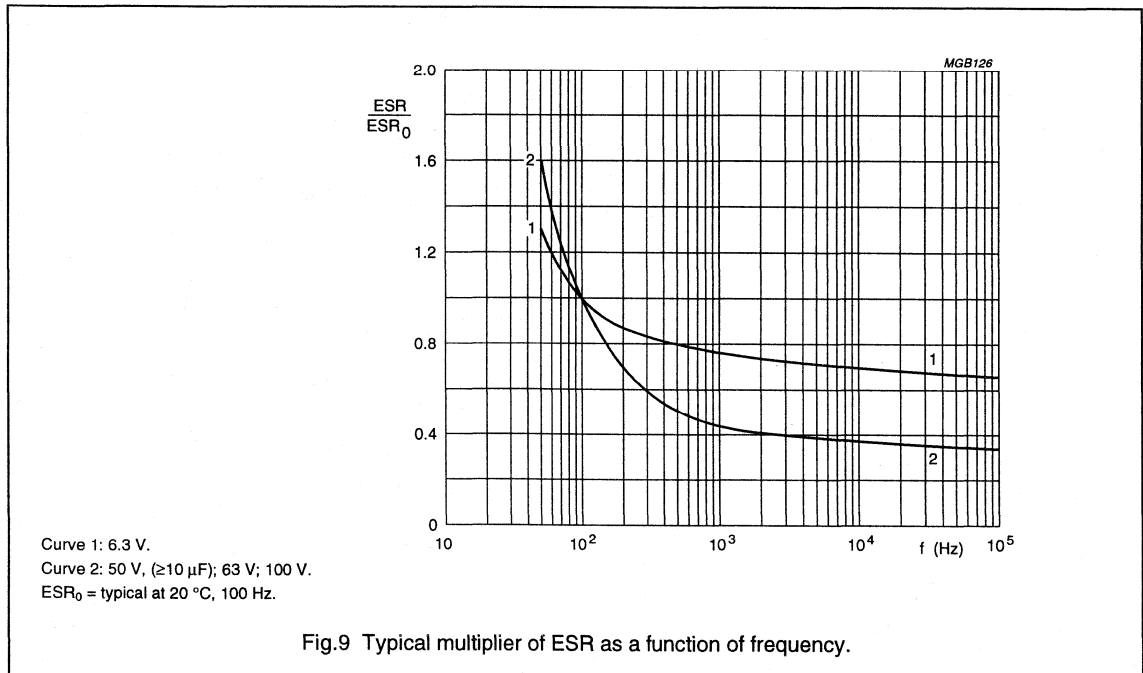


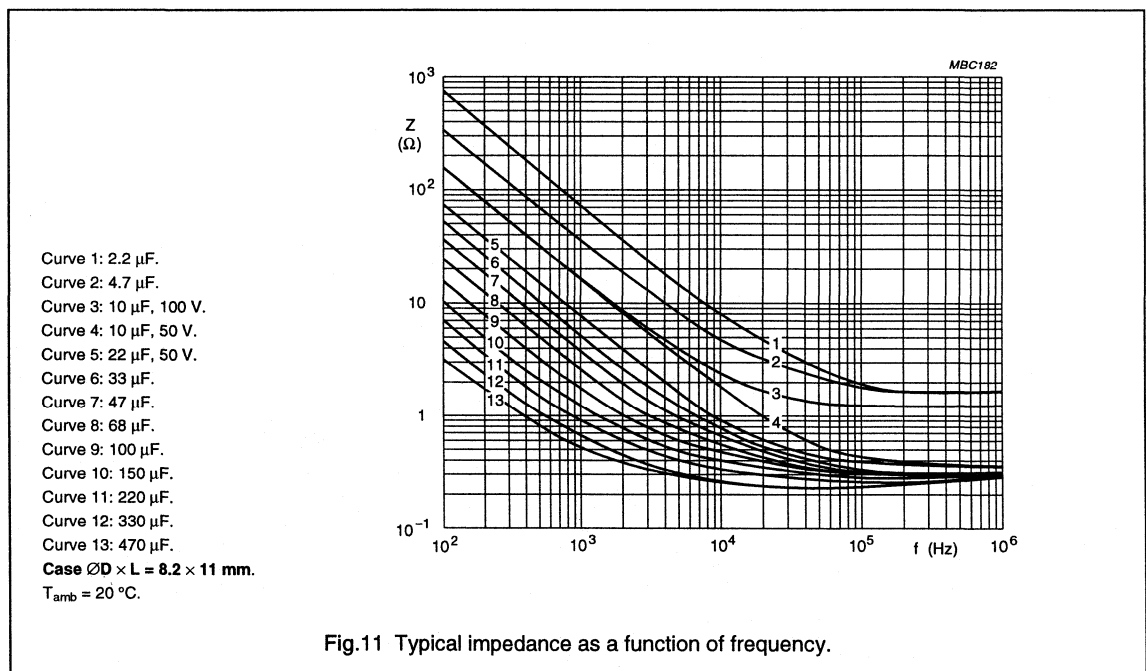
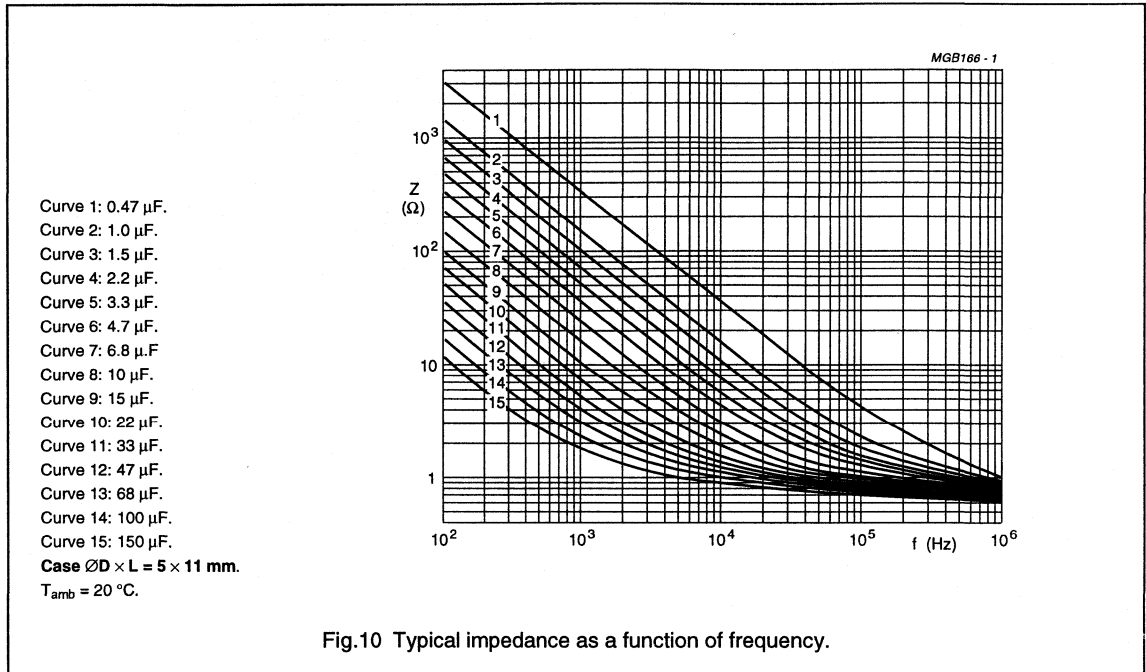
Fig.9 Typical multiplier of ESR as a function of frequency.

Non-solid Al - electrolytic capacitors

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Impedance (Z)



Non-solid Al - electrolytic capacitors

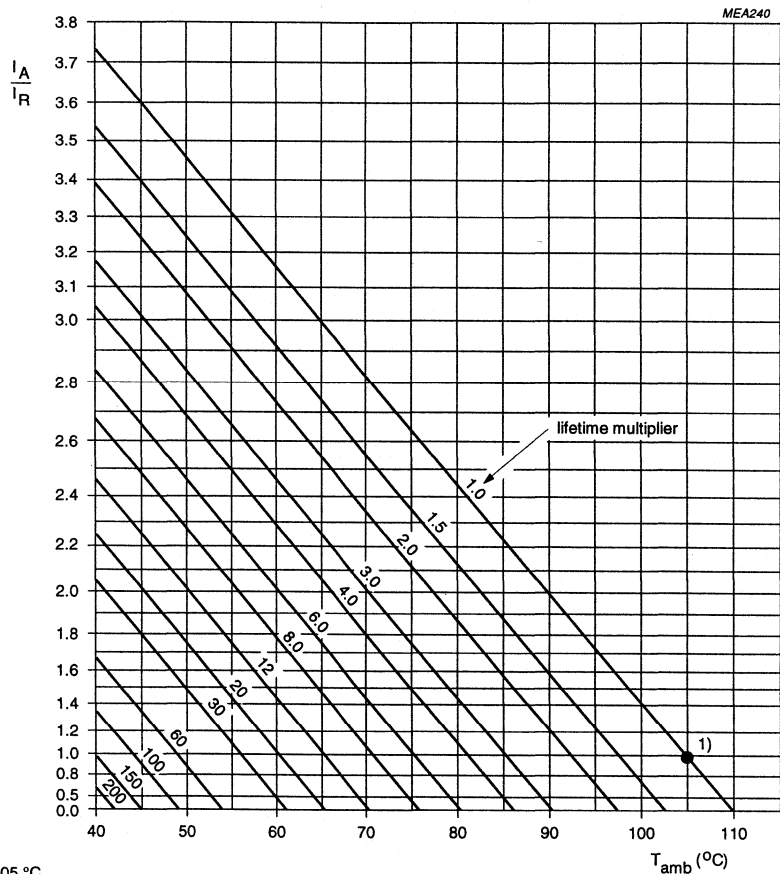
Radial Long Life

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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		
	$U_R = 6.3$ to 10 V	$U_R = 16$ to 35 V	$U_R = 40$ to 100 V ($C_R \geq 10 \mu\text{F}$)
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



I_A = actual ripple current at 100 Hz.

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

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

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

Non-solid Al - electrolytic capacitors

Radial Long Life

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in 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% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z_{10} \leq 3 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$ 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 $I_{L5} \leq \text{spec. limit}$

Non-solid Al - electrolytic capacitors

Radial, Low Impedance

RLI 135

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.

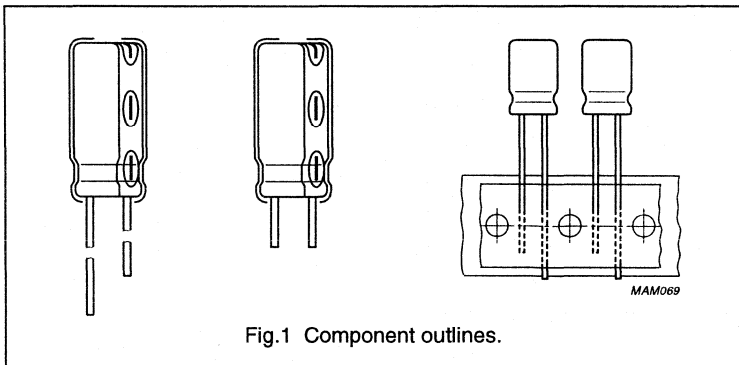
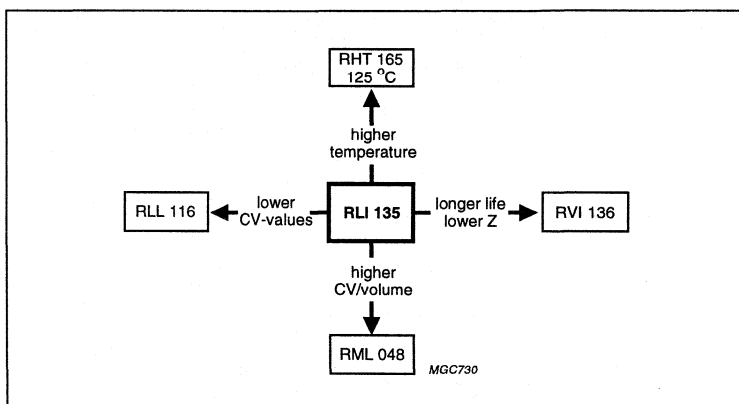


Fig.1 Component outlines.

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	1 000 hours	2 000 hours
Useful life at 105 °C	1 500 hours	2 500 hours
Useful life at 40 °C, $1.3 \times I_R$ applied	150 000 hours	250 000 hours
Shelf life at 0 V, 105 °C	1 000 hours	1 000 hours
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68 (DIN 40040)	55/105/56 (FMF)	



Non-solid Al - electrolytic capacitors

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

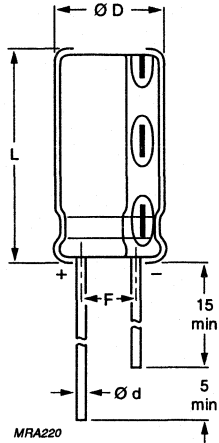
Preferred types in bold.

C_R (μF)	U_R (V)							
	6.3	10	16	25	35	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	-	-	-	-	-	-

Non-solid Al - electrolytic capacitors
Radial, Low Impedance

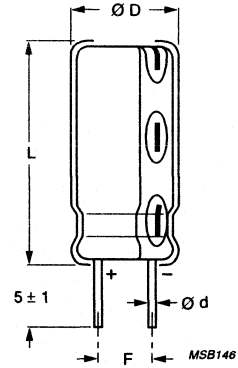
RLI 135

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.
For dimensions see Table 1.

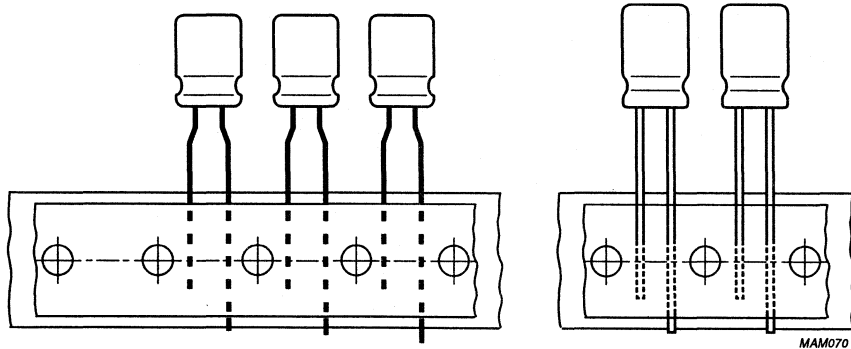
Fig.2 Form CA: Long leads.



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).

Non-solid Al - electrolytic capacitors

Radial, Low Impedance

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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	2000	1500	800
10 × 16	15	0.6	10.5	17.5	5 ± 0.5	≈ 1.9	2000	1500	800
10 × 20	16	0.6	10.5	22	5 ± 0.5	≈ 2.2	2000	1500	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	1000	1500	500
12.5 × 25	18	0.6	13	27	5 ± 0.5	≈ 5.0	1000	1500	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	500	500	250
16 × 25	19	0.8	16.5	27	7.5 ± 0.5	≈ 8.0	500	500	250
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	500	500	250
16 × 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11	500	500	–
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	500	500	–
18 × 25	1825	0.8	18.5	27.5	7.5 ± 0.5	≈ 10	500	500	–
18 × 31	22a	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	250	500	–
18 × 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	250	500	–
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.

Non-solid Al - electrolytic capacitors

Radial, Low Impedance

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Ordering example

Electrolytic capacitor RLI 135

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.

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, 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
$\text{Tan } \delta$	max. dissipation factor at 120 Hz
ESR	equivalent series resistance at 120 Hz (calculated from $\text{tan } \delta_{\text{max}}$ 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 120 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 120 Hz 105°C (mA)	I_{RH} 100 kHz 105°C (mA)	I_{L1} 1 min (μA)	I_{L2} 2 min (μA)	$\text{Tan } \delta$ 120 Hz	ESR 120 Hz (Ω)	Z 100 kHz 20°C (Ω)	Z 100 kHz -10°C (Ω)	CATALOGUE NUMBER 2222			
											CASE CODE	LONG LEADS FORM CA	CUT LEADS FORM CB	TAPED FORM TFA
6.3	470	10×12	410	510	89	30	0.22	0.62	0.28	0.73	135 53471	135 63471	135 63471	135 33471
	680	10×16	510	640	129	43	0.22	0.43	0.22	0.57	135 53681	135 63681	135 63681	135 33681
	2200	12.5×20	1000	1100	416	140	0.24	0.14	0.089	0.23	135 53222	135 63222	135 63222	135 33222
	6800	16×31	1600	1800	1290	430	0.32	0.062	0.055	0.14	135 53682	135 63682	135 63682	135 33682
	10000	18×31	1800	2000	1890	630	0.40	0.053	0.047	0.12	135 53103	135 63103	135 63103	-
10	470	8×15	400	500	141	47	0.19	0.54	0.24	0.62	135 54471	135 64471	135 64471	135 34471
	1000	12.5×16	780	970	300	100	0.19	0.25	0.12	0.31	135 54102	135 64102	135 64102	135 34102
	1500	10×30	1000	1200	450	150	0.19	0.17	0.093	0.24	135 54152	135 64152	135 64152	-
	2200	12.5×25	1200	1300	660	220	0.21	0.13	0.073	0.19	135 54222	135 64222	135 64222	135 34222
	2200	18×15	1200	1300	660	220	0.21	0.13	0.080	0.21	135 90001	135 90002	135 90002	-
	3300	12.5×35	1600	1800	990	330	0.23	0.092	0.052	0.14	135 54332	135 64332	135 64332	-
	3300	16×20	1200	1400	990	330	0.23	0.092	0.075	0.20	135 90025	135 90026	135 90026	135 90042
	4700	16×31	1600	1800	1410	470	0.25	0.071	0.054	0.14	135 54472	135 64472	135 64472	135 34472

Non-solid Al - electrolytic capacitors

Radial, Low Impedance

RLI 135

UR (V)	CR 120 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	IR 120 Hz 105 °C (mA)	IRH 100 kHz 105 °C (mA)	IL1 1 min (μ A)	IL2 2 min (μ A)	Tan δ 120 Hz	ESR 120 Hz (Ω)	Z 100 kHz 20 °C (Ω)	Z 100 kHz -10 °C (Ω)	CATALOGUE NUMBER 2222			
												BULK PACKAGING		CUT LEADS FORM CB	TAPED
												LONG LEADS FORM CA	LEADS FORM CB		
10	4700	18 x 25	1825	1700	1800	1410	470	0.25	0.071	0.053	0.14	135 90003	135 90004	-	-
	6800	16 x 35	22	1800	2000	2040	680	0.29	0.057	0.046	0.12	135 54682	135 64682	-	-
	10000	18 x 40	23	2200	2500	3000	1000	0.37	0.049	0.037	0.096	135 54103	135 64103	-	-
	220	8 x 12	13	220	400	106	35	0.16	0.96	0.33	0.86	135 55221	135 85221	135 35221	135 35221
	330	8 x 15	13L	350	500	158	53	0.16	0.64	0.23	0.60	135 55331	135 85331	135 35331	135 35331
	470	8 x 20	13LL	520	650	226	75	0.16	0.45	0.18	0.47	135 55471	135 85471	135 35471	135 35471
	680	10 x 20	16	690	860	326	110	0.16	0.31	0.14	0.36	135 55681	135 65681	135 35681	135 35681
	1000	10 x 30	16LL	920	1200	480	160	0.16	0.21	0.091	0.24	135 55102	135 65102	-	-
	1500	12.5 x 25	18	1200	1300	720	240	0.16	0.14	0.072	0.19	135 55152	135 65152	135 35152	135 35152
	2200	12.5 x 31	18L	1400	1500	1060	350	0.18	0.11	0.063	0.16	135 55222	135 65222	-	-
16	2200	16 x 20	19a	1200	1400	1060	350	0.18	0.11	0.073	0.19	135 90007	135 90008	135 90043	135 90043
	4700	16 x 35	21	1800	2000	2260	750	0.22	0.062	0.046	0.12	135 55472	135 65472	-	-
	4700	18 x 31	22a	1800	2000	2260	750	0.22	0.062	0.046	0.12	135 90009	135 90011	-	-
	6800	18 x 35	22	2000	2200	3260	1100	0.26	0.051	0.040	0.10	135 55682	135 65682	-	-
	220	8 x 15	13L	350	500	165	55	0.14	0.84	0.23	0.60	135 56221	135 86221	135 36221	135 36221
	470	10 x 20	16	690	860	353	120	0.14	0.40	0.14	0.36	135 56471	135 66471	135 36471	135 36471
	1000	12.5 x 25	18	1100	1300	750	250	0.14	0.19	0.071	0.18	135 56102	135 66102	135 36102	135 36102
	1500	12.5 x 31	18L	1400	1500	1125	380	0.14	0.12	0.062	0.16	135 56152	135 66152	-	-
	2200	12.5 x 40	1240	1800	2000	1650	550	0.16	0.10	0.044	0.11	135 56222	135 66222	-	-
	2200	18 x 20	1820	1400	1600	1650	550	0.16	0.10	0.060	0.16	135 90012	135 90013	-	-
35	3300	16 x 35	21	1800	2000	2475	830	0.18	0.072	0.045	0.12	135 56332	135 66332	-	-
	3300	18 x 31	22a	1800	2000	2475	830	0.18	0.072	0.045	0.12	135 90014	135 90015	-	-
	4700	18 x 40	23	2200	2500	3525	1200	0.20	0.056	0.036	0.94	135 56472	135 66472	-	-
	100	8 x 12	13	280	400	105	35	0.12	1.59	0.32	0.83	135 50101	135 80101	135 30101	135 30101
	220	8 x 20	13LL	460	650	231	77	0.12	0.72	0.18	0.47	135 50221	135 80221	135 30221	135 30221
	330	10 x 20	16	610	860	347	120	0.12	0.48	0.13	0.34	135 50331	135 60331	135 30331	135 30331
	470	10 x 30	16LL	920	1200	490	160	0.12	0.34	0.089	0.23	135 50471	135 60471	-	-

Non-solid Al - electrolytic capacitors

Radial, Low Impedance

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U _R (V)	C _R 120 Hz (μF)	NOMINAL CASE SIZE ∅D × 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 δ 120 Hz	ESR 120 Hz (Ω)	Z 100 kHz 20 °C (Ω)	Z 100 kHz -10 °C (Ω)	CATALOGUE NUMBER 2222			
												BULK PACKAGING		TAPED	
												LONG LEADS FORM CA	CUT LEADS FORM CB		FORM TFA
35	680	12.5 × 25	18	1100	1300	714	240	0.12	0.23	0.070	0.18	135 50681	135 60681	135 30681	
	1000	12.5 × 31	18L	1400	1500	1050	350	0.12	0.16	0.061	0.16	135 50102	135 60102	-	
	1000	16 × 20	19a	1100	1370	1050	350	0.12	0.16	0.071	0.18	135 90016	135 90017	135 90044	
	1500	12.5 × 40	1240	1800	2000	1575	530	0.12	0.11	0.043	0.11	135 50152	135 60152	-	
	2200	16 × 35	21	1800	2000	2310	770	0.14	0.084	0.044	0.11	135 50222	135 60222	-	
	2200	18 × 31	22a	1800	2000	2310	770	0.14	0.084	0.044	0.11	135 90018	135 90019	-	
	3300	18 × 40	23	2200	2500	3465	1200	0.16	0.064	0.035	0.091	135 50332	135 60332	-	
	100	10 × 16	15	450	640	150	50	0.10	1.33	0.20	0.52	0.52	135 51101	135 61101	135 31101
	220	10 × 25	16L	730	1000	330	110	0.10	0.60	0.11	0.29	0.29	135 51221	135 61221	135 31221
	330	12.5 × 20	17	790	1100	495	170	0.10	0.40	0.081	0.22	0.22	135 51331	135 61331	135 31331
470	12.5 × 25	18	1100	1300	705	240	0.10	0.28	0.068	0.19	0.19	135 51471	135 61471	135 31471	
470	18 × 15	1815	1000	1300	705	240	0.10	0.28	0.074	0.19	0.19	135 90021	135 90022	-	
1000	16 × 31	20	1500	1800	1500	500	0.10	0.13	0.050	0.13	0.13	135 51102	135 61102	135 31102	
1500	16 × 40	21L	2100	2300	2250	750	0.10	0.088	0.035	0.091	0.091	135 51152	135 61152	-	
2200	18 × 40	23	2200	2500	3300	1100	0.12	0.072	0.034	0.091	0.091	135 51222	135 61222	-	
63	47	8 × 12	13	220	300	89	30	0.08	2.26	0.56	1.5	135 58479	135 88479	135 38479	
	220	12.5 × 20	17	630	890	416	140	0.08	0.48	0.16	0.42	135 58221	135 68221	135 38221	
	470	16 × 25	19	1200	1400	888	300	0.08	0.23	0.091	0.25	135 58471	135 68471	135 38471	
	680	16 × 31	20	1400	1800	1285	430	0.08	0.16	0.065	0.18	135 58681	135 68681	135 38681	
	1000	16 × 40	21L	1800	2200	1890	630	0.08	0.11	0.049	0.13	135 58102	135 68102	-	
	22	8 × 12	13	120	310	66	22	0.07	4.22	0.53	1.4	135 59229	135 89229	135 39229	
	100	12.5 × 20	17	630	890	300	100	0.07	0.93	0.15	0.40	0.40	135 59101	135 69101	135 39101
	220	16 × 25	19	1000	1400	660	220	0.07	0.42	0.086	0.23	0.23	135 59221	135 69221	-
	330	16 × 31	20	1300	1800	990	330	0.07	0.28	0.062	0.17	0.17	135 59331	135 69331	-
	330	18 × 25	1825	1200	1700	990	330	0.07	0.28	0.074	0.20	0.20	135 90023	135 90024	-
470	16 × 40	21L	1800	2200	1410	470	0.07	0.20	0.047	0.13	0.13	135 59471	135 69471	-	
680	18 × 40	23	1900	2400	2040	680	0.07	0.14	0.043	0.12	0.12	135 59681	135 69681	-	

Non-solid Al - electrolytic capacitors

Radial, Low Impedance

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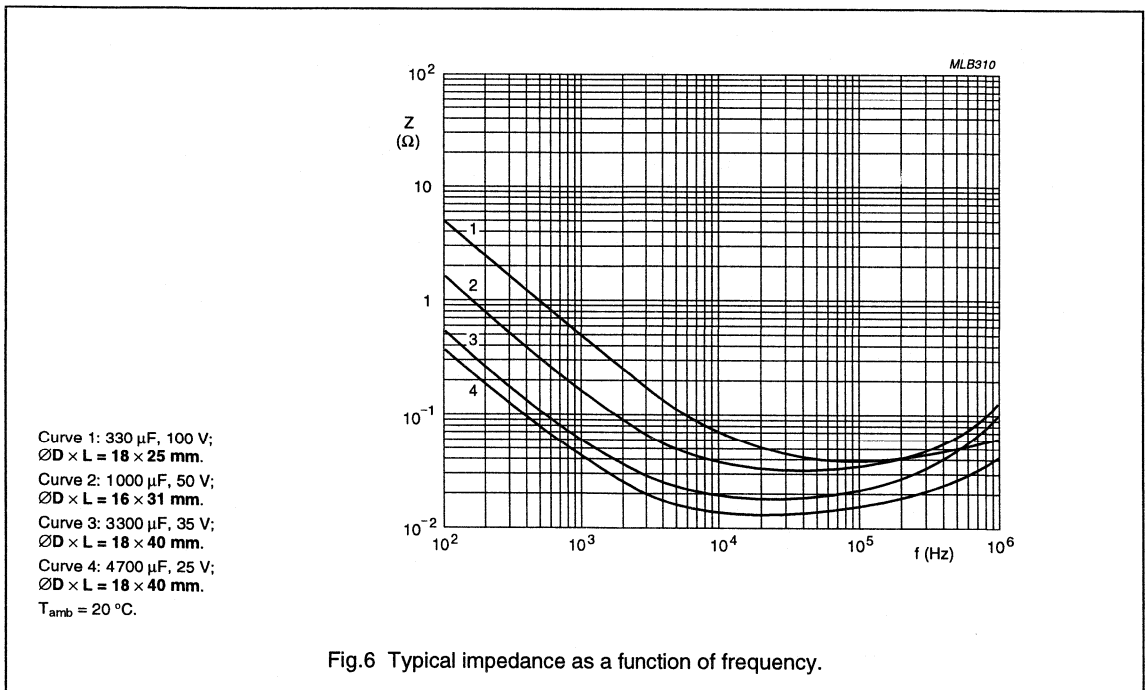
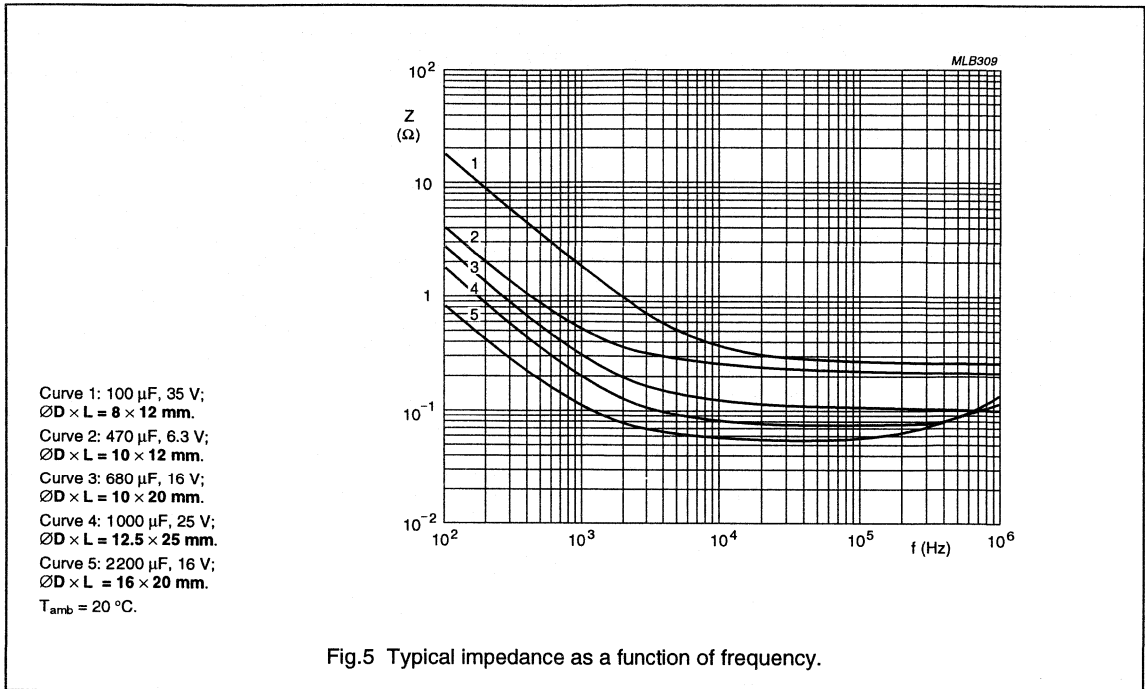
Additional electrical data

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

Non-solid Al - electrolytic capacitors

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Non-solid Al - electrolytic capacitors

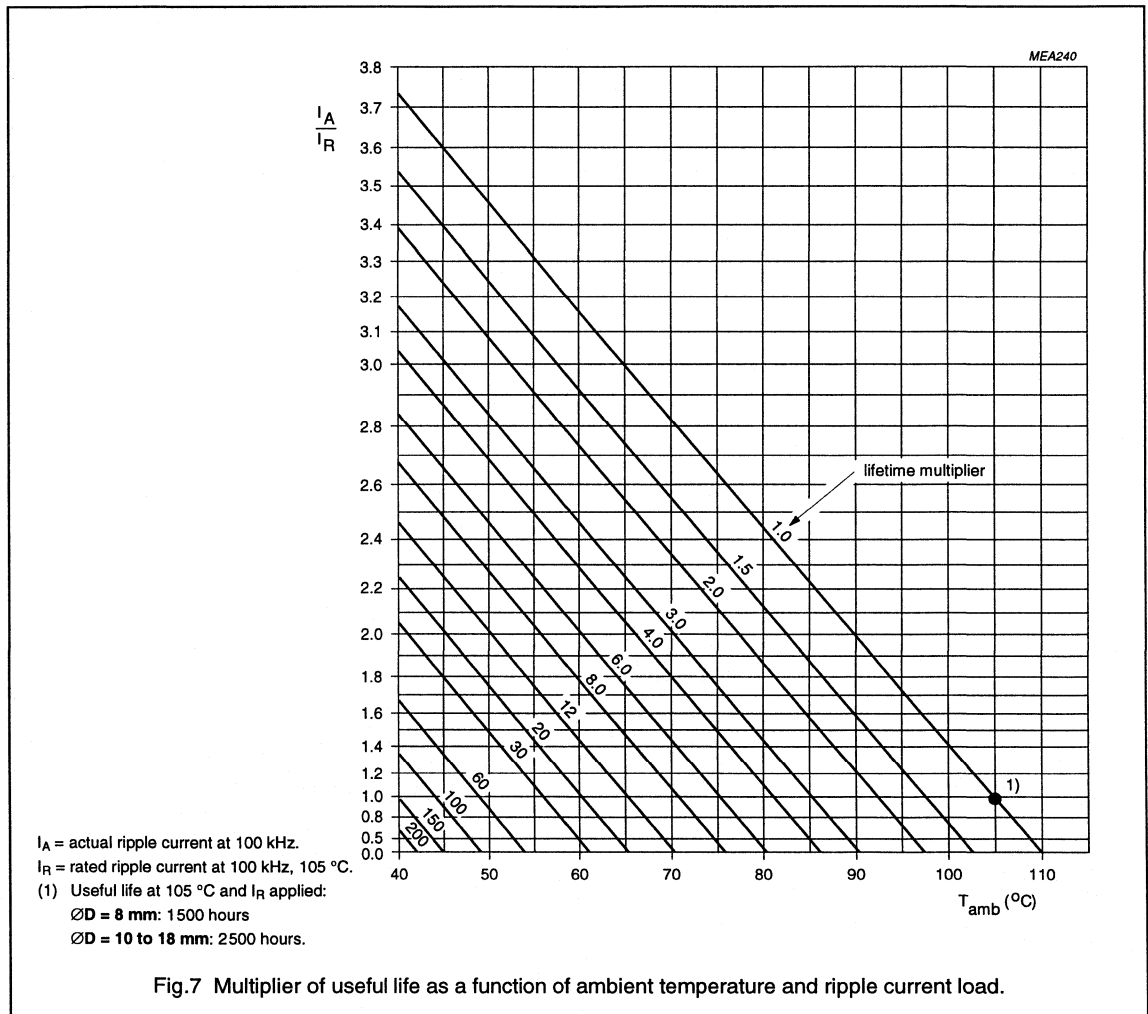
Radial, Low Impedance

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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 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
1000	0.8	0.9	0.98	0.98
10000	0.9	0.95	1.0	1.0
100000	1.0	1.0	1.0	1.0



Non-solid Al - electrolytic capacitors

Radial, Low Impedance

RLI 135

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	$T_{amb} = 105\text{ °C}$; U_R applied; $\varnothing D = 8\text{ mm}$: 1000 hours $\varnothing D = 10\text{ to }18\text{ mm}$: 2000 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	$T_{amb} = 105\text{ °C}$; U_R and I_R applied; $\varnothing D = 8\text{ mm}$: 1500 hours $\varnothing D = 10\text{ to }18\text{ mm}$: 2500 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 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	$\Delta C/C$: $\pm 20\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$

R

Non-solid Al - electrolytic capacitors

Radial Miniature Long-Life

RML 048

FEATURES

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

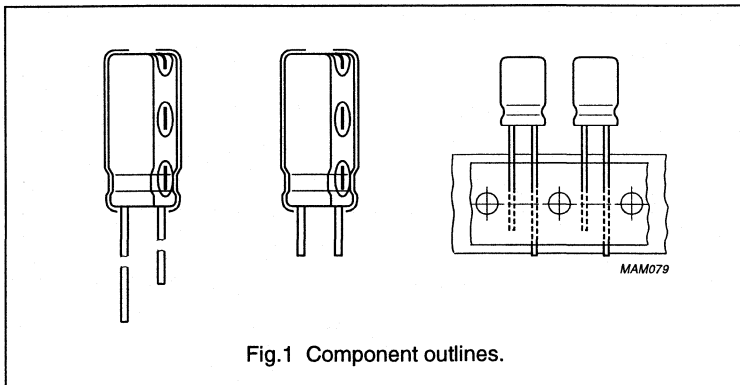
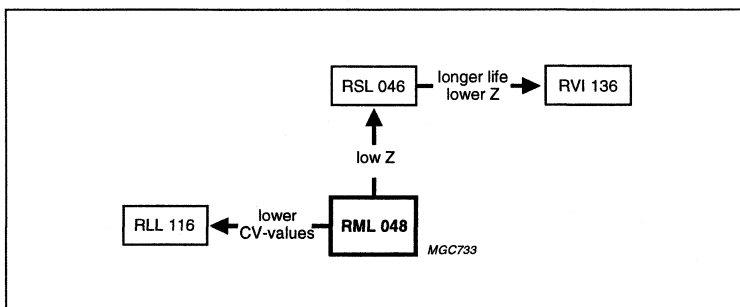


Fig.1 Component outlines.

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 × 40
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, LL grade
Climatic category IEC 68 (DIN 40040)	40/105/56 (GMF)

Non-solid Al - electrolytic capacitors

Radial Miniature Long-Life

RML 048

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 ⁽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 × 40
3300	–	12.5 × 25	16 × 25	16 × 31	18 × 35	18 × 35	18 × 40	–
4700	–	16 × 25	16 × 31	18 × 35	18 × 40	–	–	–
6800	16 × 25	16 × 31	16 × 35	–	–	–	–	–
10000	16 × 35	18 × 35	18 × 40	–	–	–	–	–

Note

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

R

Non-solid Al - electrolytic capacitors

Radial Miniature Long-Life

RML 048

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

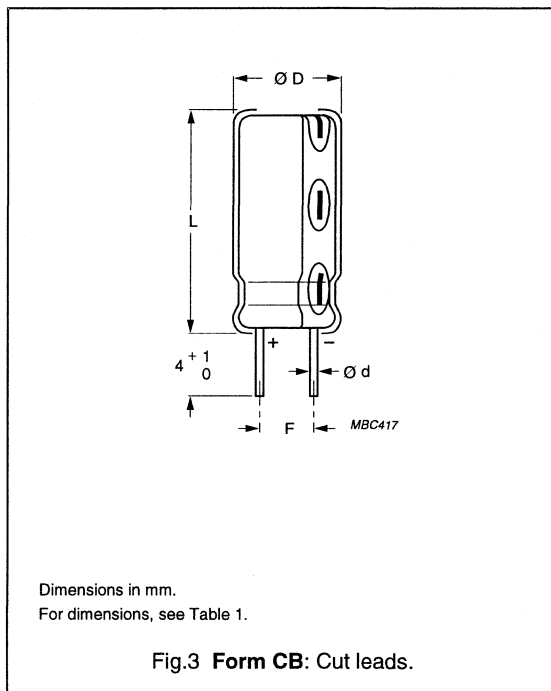
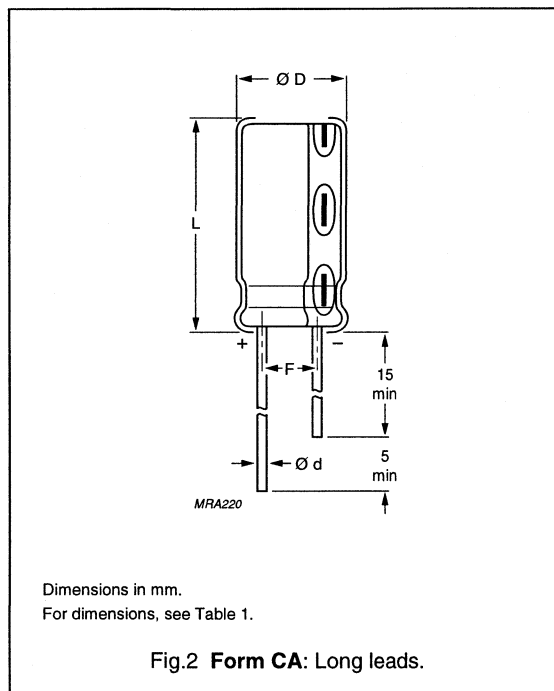


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

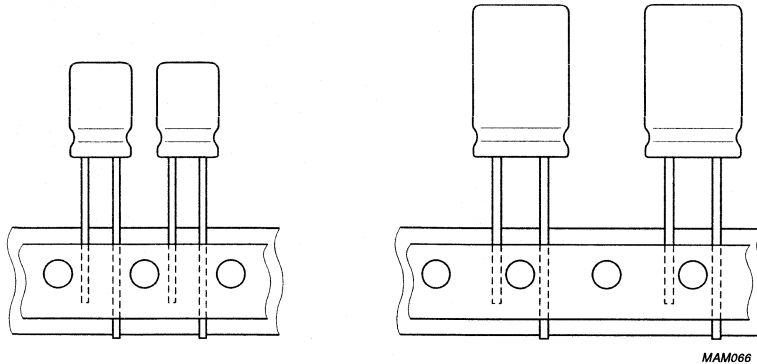
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{\max}$ (mm)	L_{\max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES PER BOX		
							FORM CA	FORM CB	FORM TFA
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	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 × 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	–

Non-solid Al - electrolytic capacitors

Radial Miniature Long-Life

RML 048

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

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

RML 048

Ordering example

Electrolytic capacitor RML 048

2200 μ F/16 V; \pm 20%

Nominal case size: \varnothing 12.5 x 25 mm; Form TFA

Catalogue number: 2222 048 35222.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{amb} = 20^\circ\text{C}$,
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 $^\circ\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
Tan 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 (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 105 $^\circ\text{C}$ (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	Tan δ 100 Hz	ESR 100 kHz (m Ω)	Z 10 kHz (m Ω)	Z 100 kHz (m Ω)	CATALOGUE NUMBER 2222			
											BULK PACKAGING			FORM TFA
											FORM CA	FORM CB	FORM TFA	
6.3	6800 10000	16 x 25 16 x 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 x 16 12.5 x 20 12.5 x 25 16 x 25 16 x 31 18 x 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 x 12 10 x 20 12.5 x 25 16 x 25 16 x 31 16 x 35 18 x 40	14 16 18 19 20 21 23	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 - -	

Non-solid Al - electrolytic capacitors

Radial Miniature Long-Life

RML 048

U _R (V)	C _R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I _R 105 °C (mA)	I _{L1} 1 min (μ A)	I _{L5} 5 min (μ A)	Tan δ 100 Hz	ESR 100 kHz (m Ω)	Z 10 kHz (m Ω)	Z 100 kHz (m Ω)	CATALOGUE NUMBER 2222		
											BULK PACKAGING		FORM TFA
											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	-
	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
40	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	-
	4700	18 × 40	23	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	-
	4700	18 × 40	23	1900	1700	330	0.14	68	40	40	048 51332	048 61332	-
50	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
	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 × 40	23	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 × 40	23	1600	1400	280	0.11	80	45	45	048 58222	048 68222	-

Non-solid Al - electrolytic capacitors

Radial Miniature Long-Life

RML 048

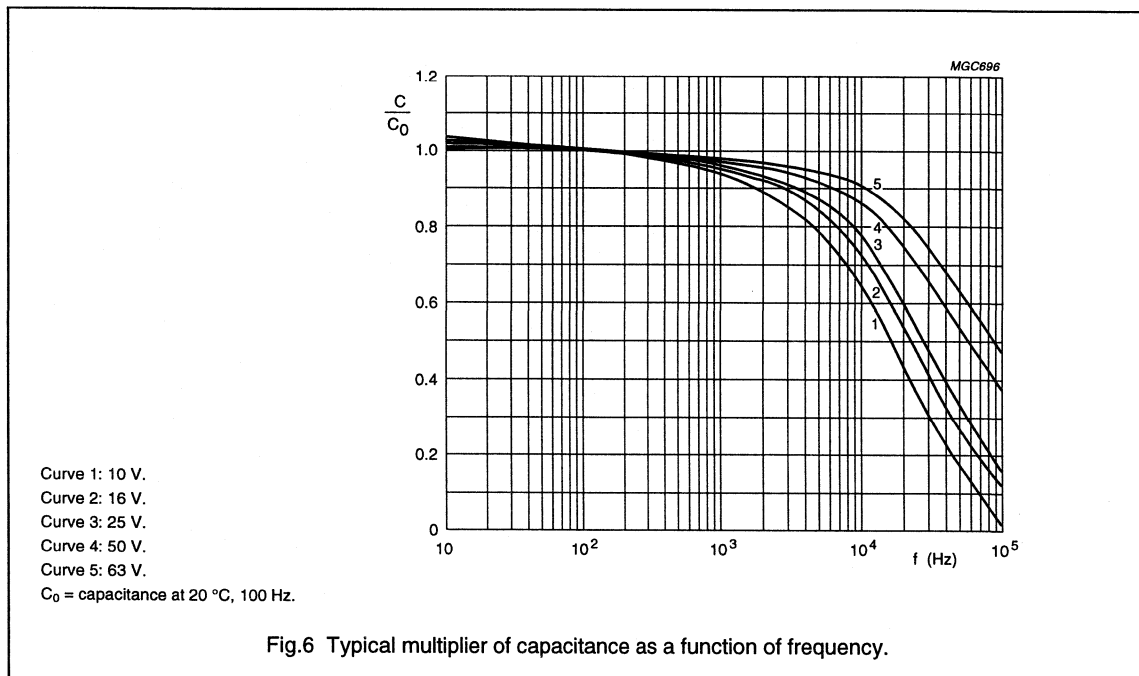
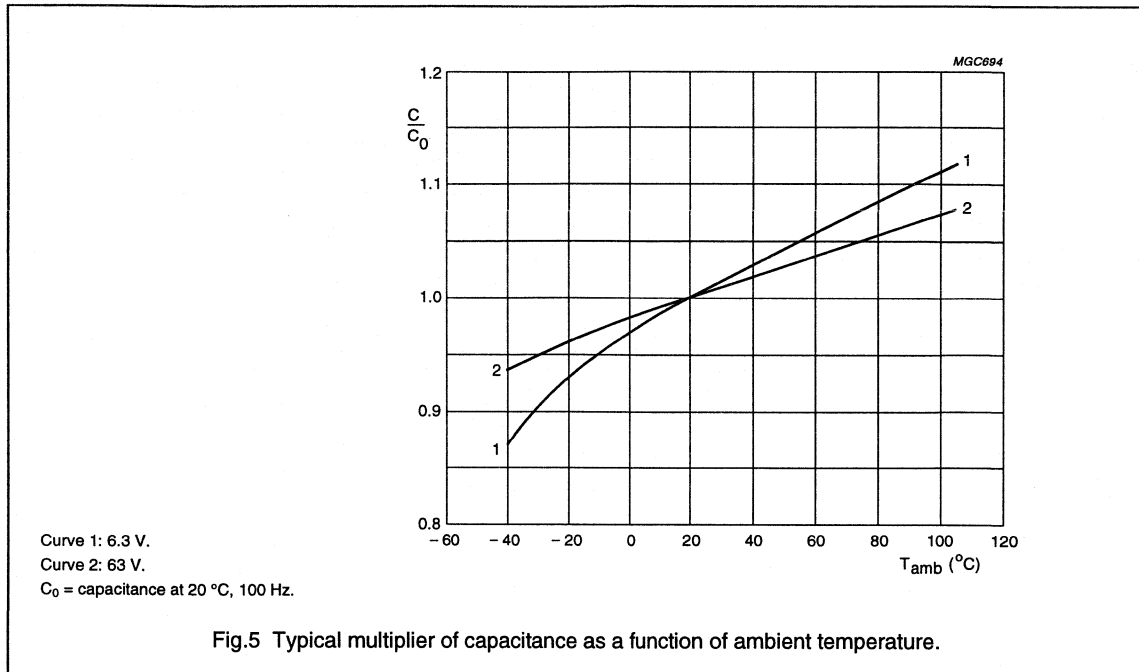
Additional electrical data

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

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

RML 048

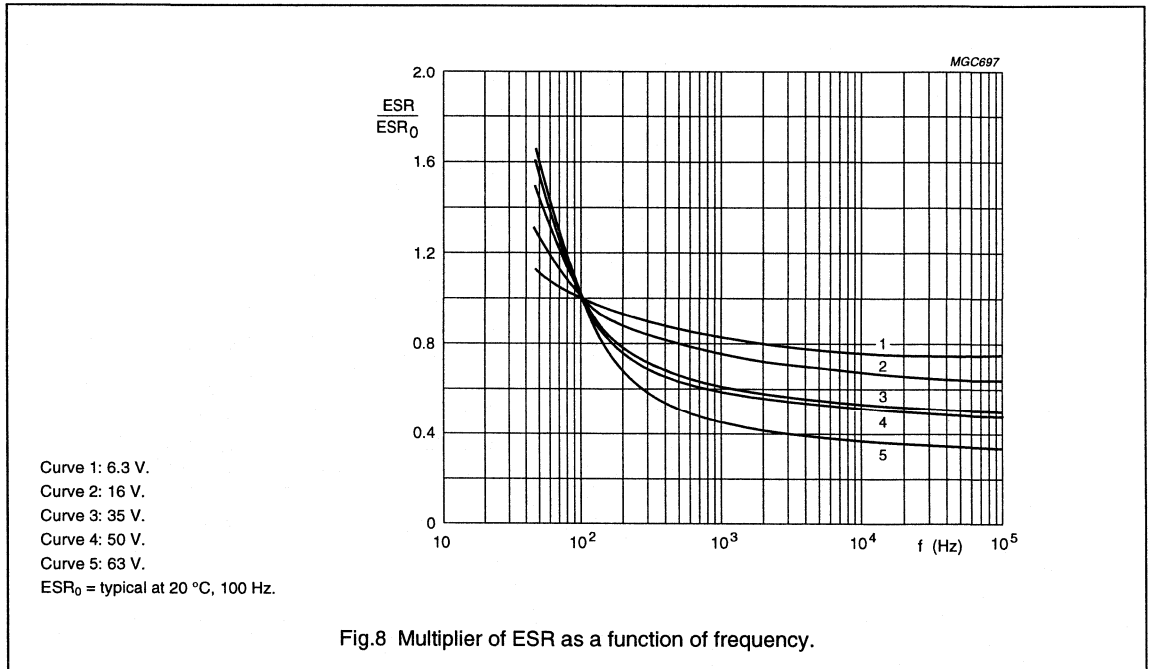
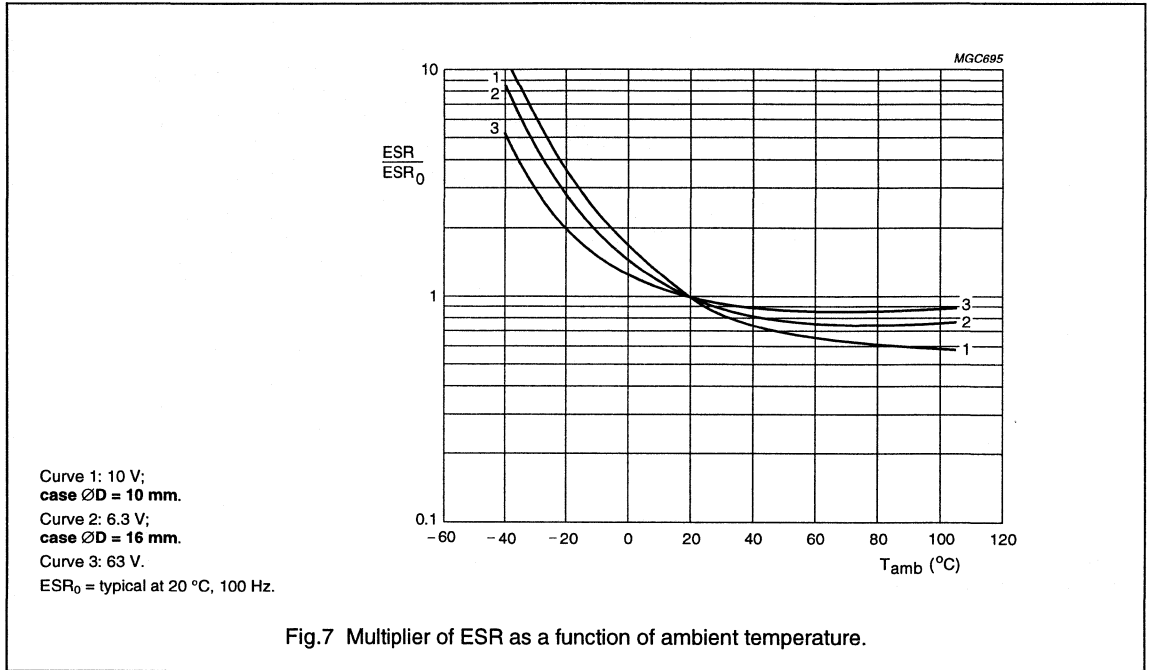
Capacitance (C)



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

RML 048

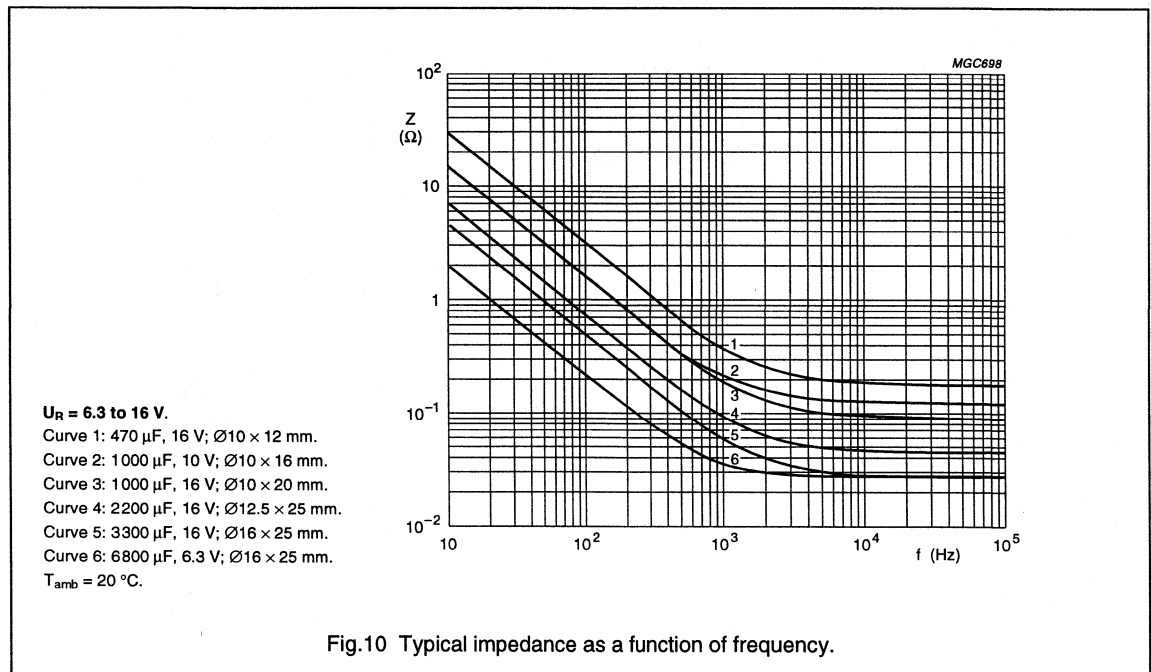
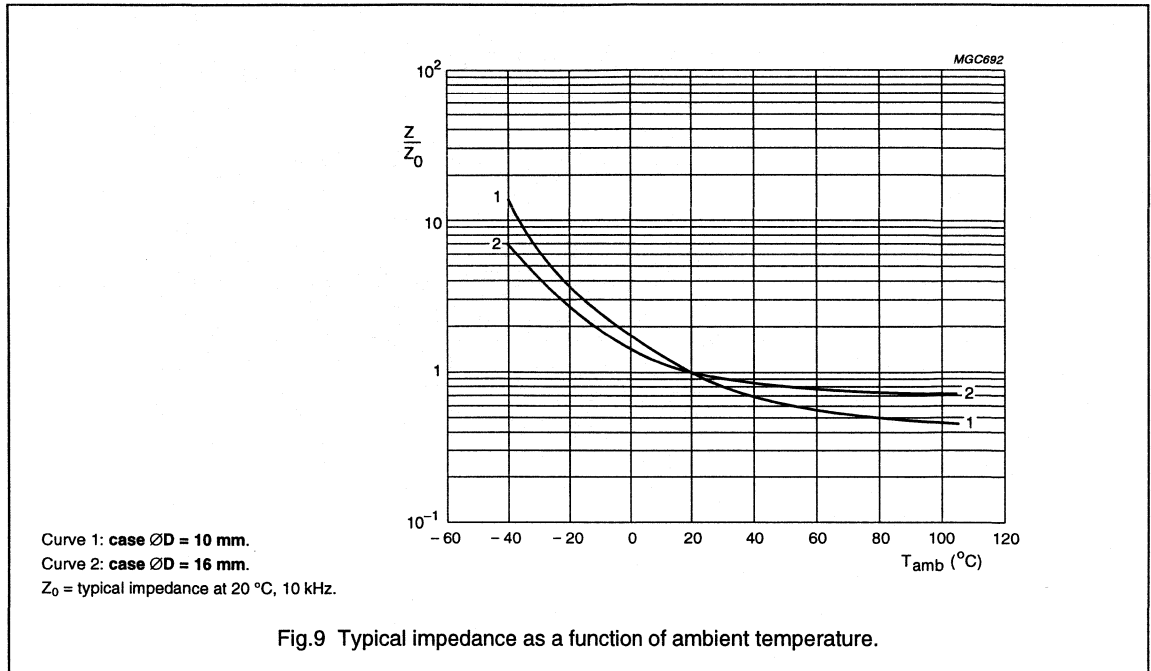
Equivalent series resistance (ESR)



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

RML 048

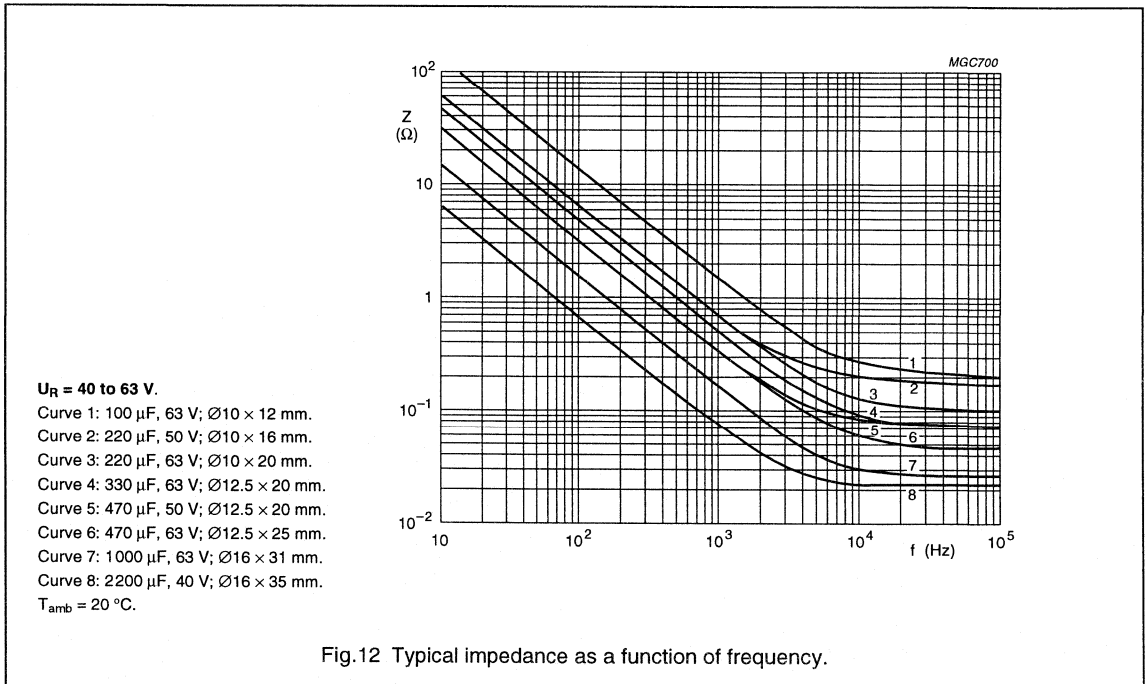
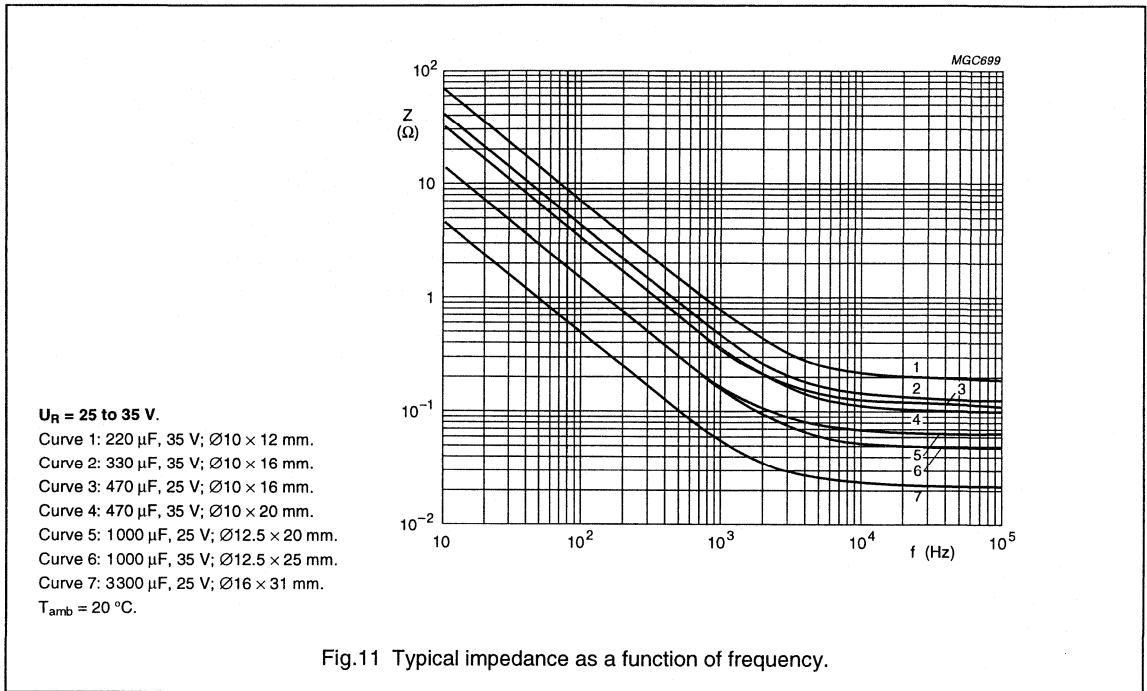
Impedance (Z)



Non-solid Al - electrolytic capacitors

Radial Miniature Long-Life

RML 048



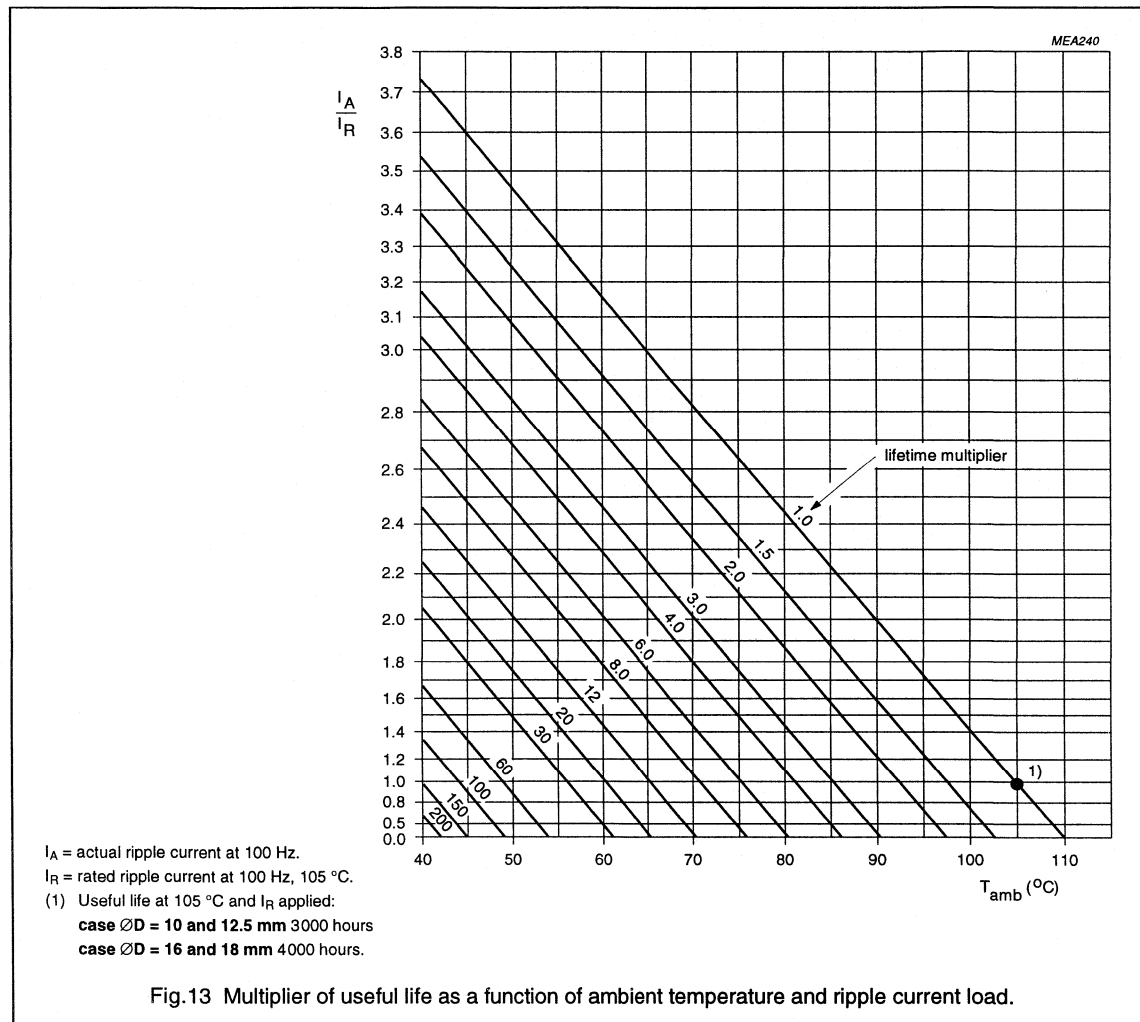
Non-solid Al - electrolytic capacitors Radial Miniature Long-Life

RML 048

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		
	$U_R = 6.3$ 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



Non-solid Al - electrolytic capacitors

Radial Miniature Long-Life

RML 048

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	$U_R = 6.3\text{ V}$; $\Delta C/C: +15/-30\%$ $U_R > 6.3\text{ V}$; $\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$

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

RSL 046

FEATURES

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

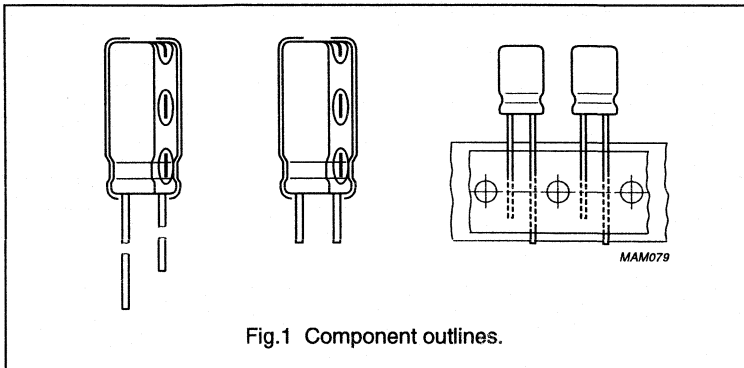
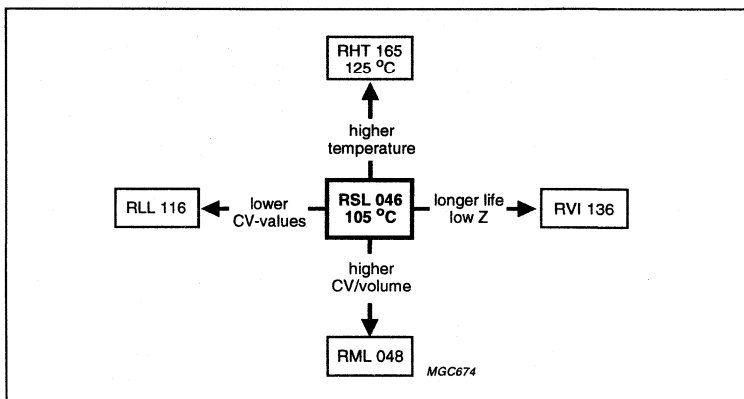


Fig.1 Component outlines.

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 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	1000 hours
Based on sectional specification	IEC 384-4/CECC 30300, LL grade
Climatic category IEC 68 (DIN 40040)	40/105/56 (GMF)

Non-solid Al - electrolytic capacitors

Radial Standard Long-Life

RSL 046

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	–	–	–	–	–
10000	18 × 35	18 × 40	–	–	–	–	–	–

Note

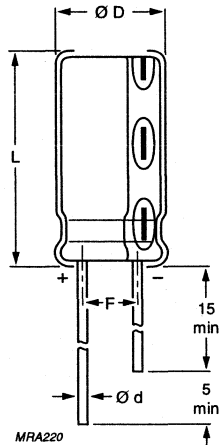
1. For lower CV-values see "data sheet RLL 116".

Non-solid Al - electrolytic capacitors

Radial Standard Long-Life

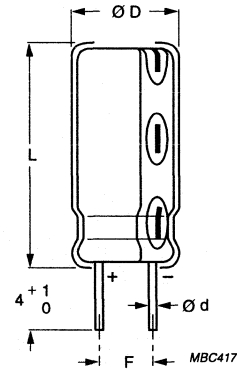
RSL 046

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

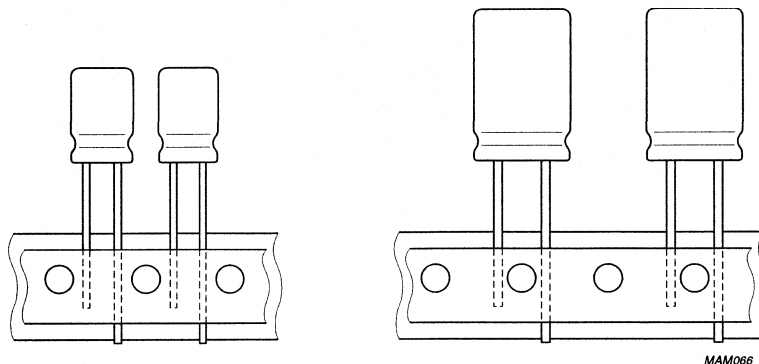
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing d$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 × 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	–

Non-solid Al - electrolytic capacitors

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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 "IEC62" (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.

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Ordering example

Electrolytic capacitor RSL 046

2200 μ F/16 V; \pm 20%

Nominal case size: \varnothing 16 x 25 mm; Form TFA

Catalogue number: 2222 046 35222.

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, 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 $^{\circ}\text{C}$
I_{RH}	rated RMS ripple current at 100 kHz, 105 $^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
Tan 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 (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105 $^{\circ}\text{C}$ (mA)	I_{RH} 100 kHz 105 $^{\circ}\text{C}$ (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 TFA
												FORM CA	FORM CB	FORM CA	
6.3	470	10 x 12	14	360	600	33	9	0.19	0.64	0.32	0.28	046 53471	046 63471	046 33471	
	1000	10 x 20	16	600	1000	66	16	0.19	0.30	0.15	0.14	046 53102	046 63102	046 33102	
	2200	12.5 x 25	18	950	1500	140	31	0.23	0.17	0.08	0.07	046 53222	046 63222	046 33222	
	3300	16 x 25	19	1200	1700	210	45	0.25	0.12	0.06	0.06	046 53332	046 63332	046 33332	
	4700	16 x 31	20	1400	2000	300	62	0.27	0.09	0.05	0.05	046 53472	046 63472	046 33472	
	6800	16 x 35	21	1600	2100	430	89	0.31	0.07	0.05	0.05	046 53682	046 63682	-	
	10000	18 x 35	22	1800	2300	630	130	0.39	0.06	0.04	0.04	046 53103	046 63103	-	
10	330	10 x 12	14	370	620	36	10	0.15	0.72	0.38	0.31	046 54331	046 64331	046 34331	
	470	10 x 16	15	460	800	50	12	0.15	0.51	0.27	0.22	046 54471	046 64471	046 34471	
	1000	12.5 x 20	17	770	1100	100	23	0.15	0.24	0.13	0.12	046 54102	046 64102	046 34102	
	4700	16 x 35	21	1600	2300	470	97	0.23	0.08	0.04	0.04	046 54472	046 64472	-	
	6800	18 x 35	22	1800	2500	680	140	0.27	0.06	0.03	0.03	046 54682	046 64682	-	
	10000	18 x 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 ∅D × 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 TFA
												FORM CA	FORM CB	
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 65102	046 65102	046 35102
	2200	16 × 25	19	1300	1800	360	73	0.17	0.12	0.06	0.05	046 65222	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
	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
35	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	-
	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	046 30222
	100	10 × 12	14	300	560	43	11	0.09	1.43	0.60	0.35	046 57101	046 67101	046 37101
	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
40	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	-

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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 TFA
												FORM CA	FORM CB	FORM CA	
50	100 220 330 1000 2200	10 × 16 12.5 × 20 12.5 × 25 16 × 31 18 × 40	15 17 18 20 23	310 500 680 1400 2000	610 980 1200 1800 2600	53 110 170 500 1100	13 25 36 100 220	0.07 0.07 0.07 0.07 0.09	1.11 0.51 0.34 0.11 0.07	0.50 0.23 0.15 0.05 0.03	0.28 0.13 0.09 0.05 0.03	046 51101 046 51221 046 51331 046 51102 046 51222	046 61101 046 61221 046 61331 046 61102 046 61222	046 31101 046 31221 046 31331 046 31102 -	
63	22 47 100 220 330 470 1000	10 × 12 10 × 12 10 × 20 12.5 × 25 16 × 25 16 × 25 18 × 35	14 14 16 18 19 19 22	170 230 360 610 750 950 1500	310 430 710 1100 1300 1600 2100	17 33 66 140 210 300 630	9 9 16 31 45 62 130	0.06 0.06 0.06 0.06 0.06 0.06 0.06	4.3 2.03 0.95 0.43 0.29 0.20 0.10	1.6 0.96 0.45 0.20 0.14 0.10 0.04	0.7 0.40 0.20 0.11 0.08 0.06 0.04	046 58229 046 58479 046 58101 046 58221 046 58331 046 58471 046 58102	046 68229 046 68479 046 68101 046 68221 046 68331 046 68471 046 68102	046 38229 046 38479 046 38101 046 38221 046 38331 046 38471 -	

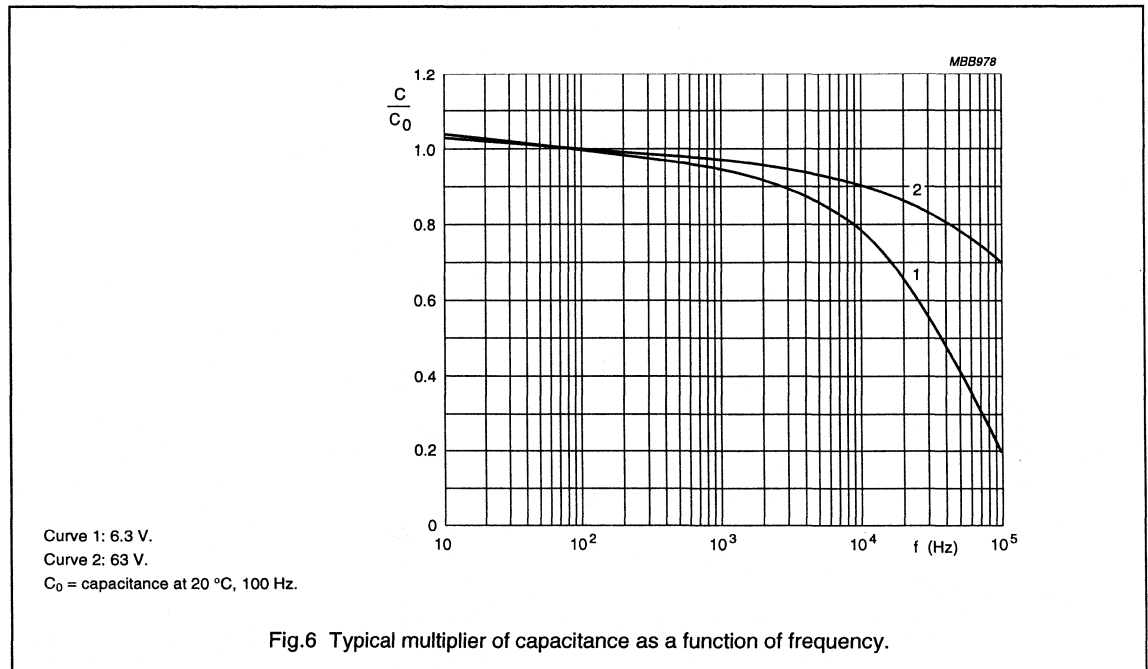
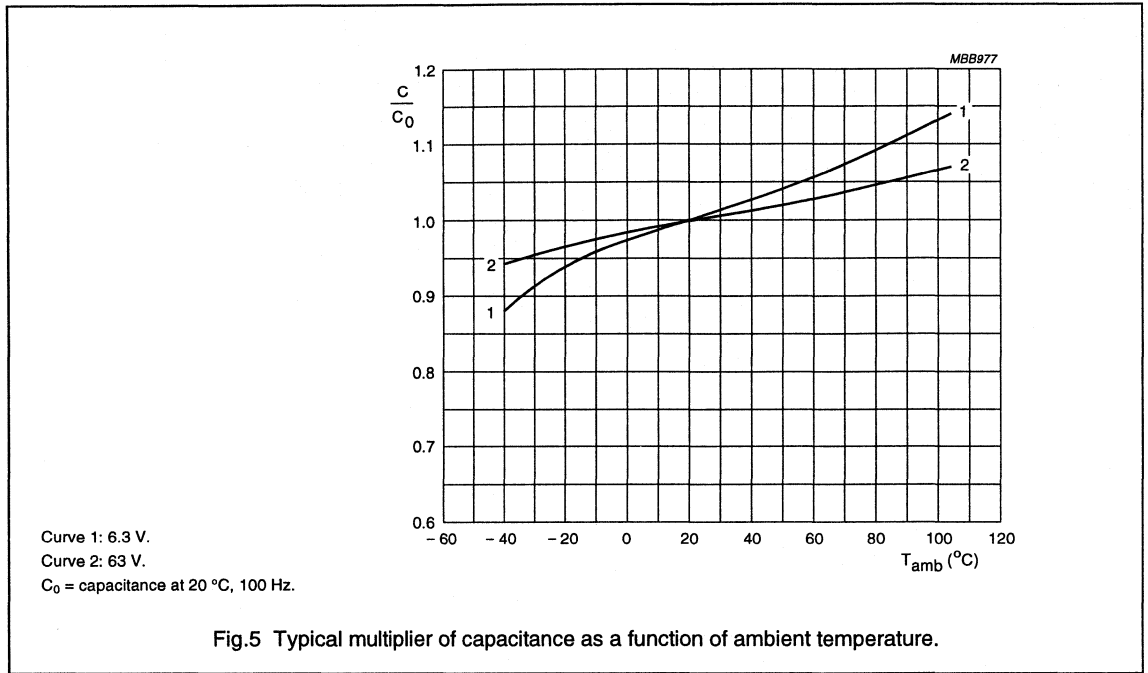
Additional electrical data

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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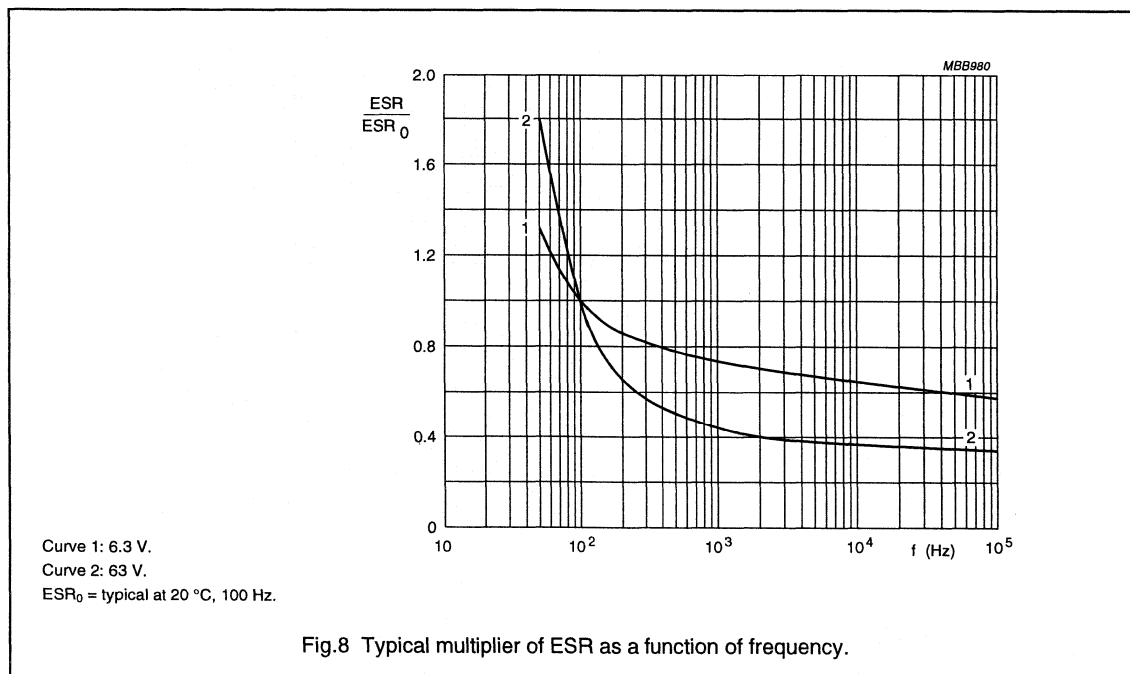
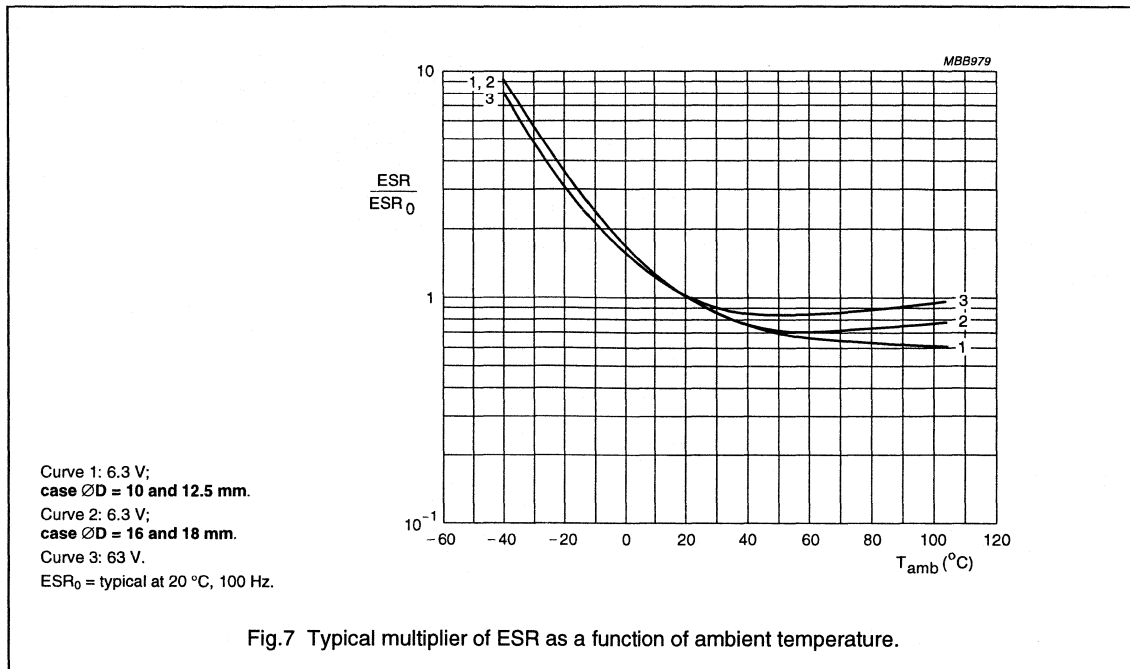
Capacitance (C)



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Equivalent series resistance (ESR)



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Impedance (Z)

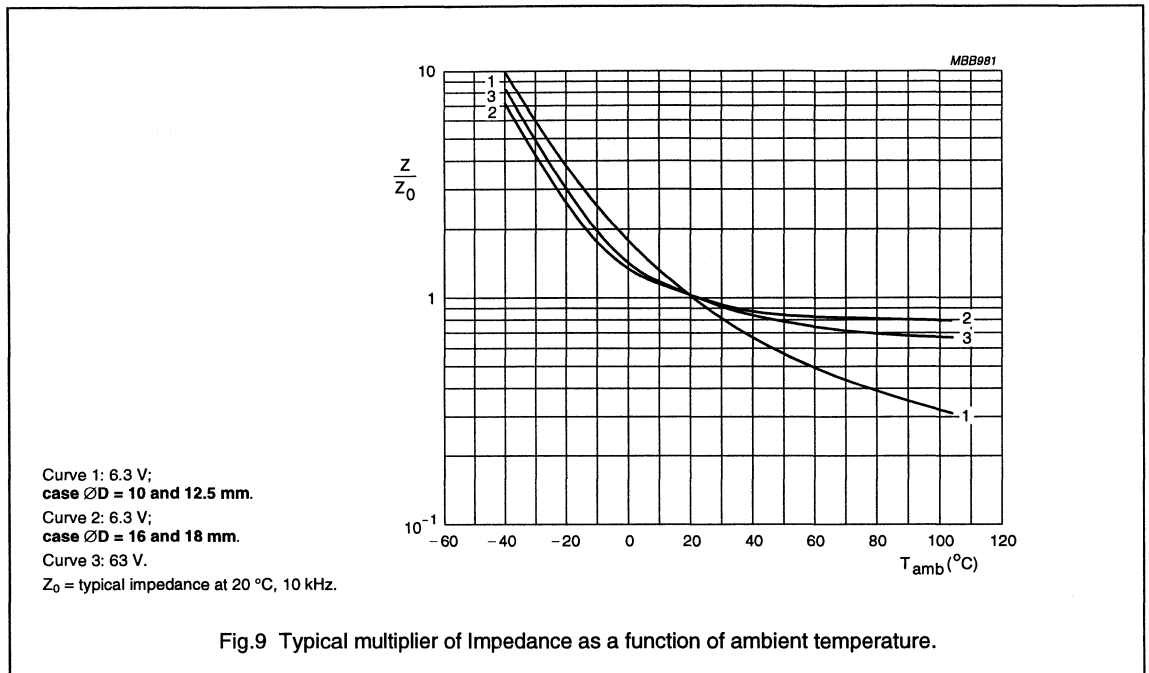


Fig.9 Typical multiplier of Impedance as a function of ambient temperature.

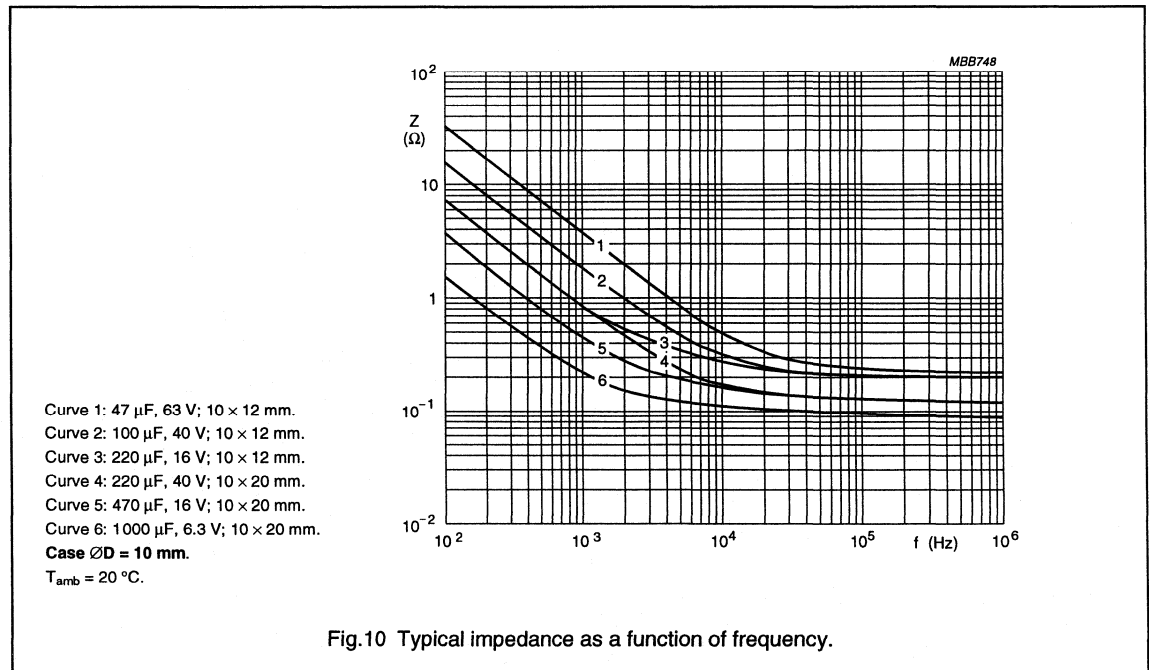
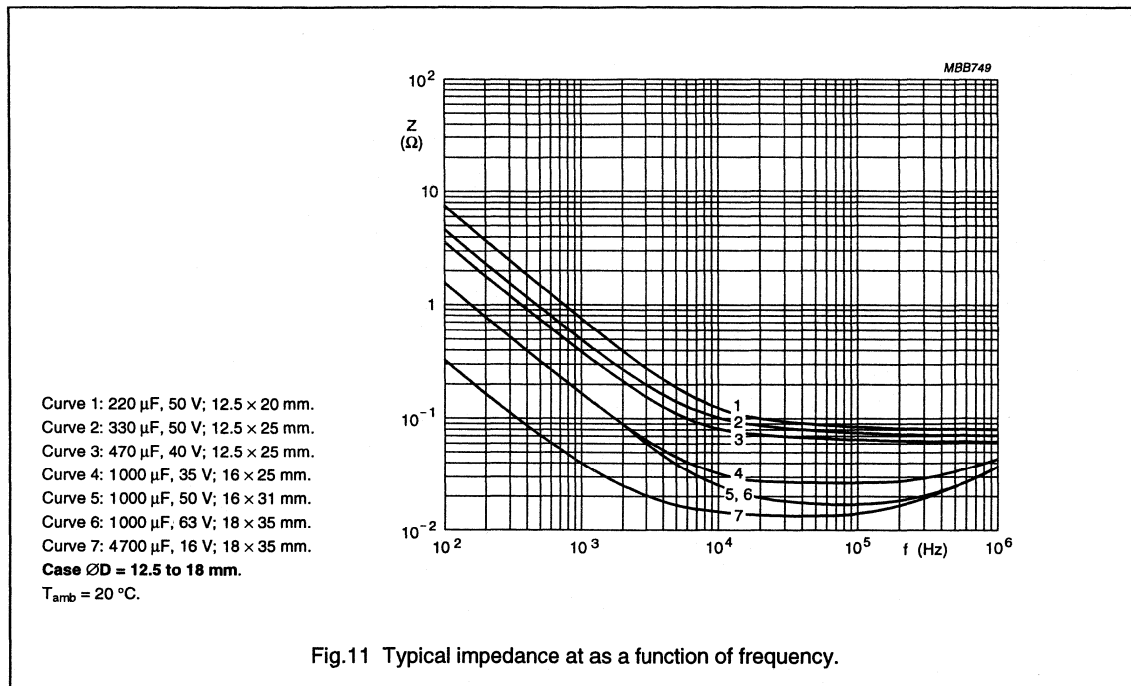


Fig.10 Typical impedance as a function of frequency.

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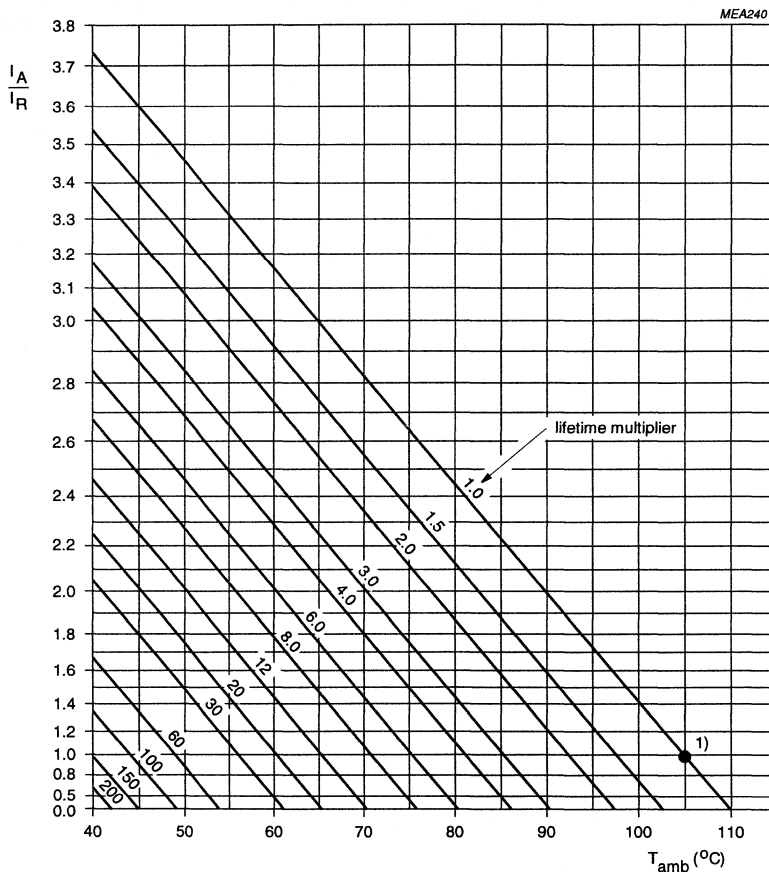


R

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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% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$

R

Non-solid Al - electrolytic capacitors

Radial, Very Low Impedance

RVI 136

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, 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.

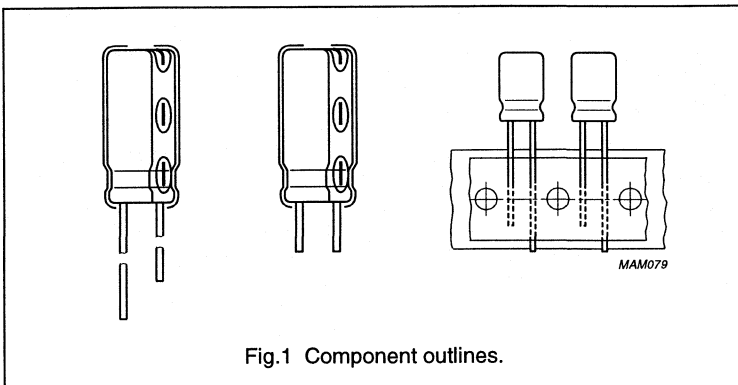
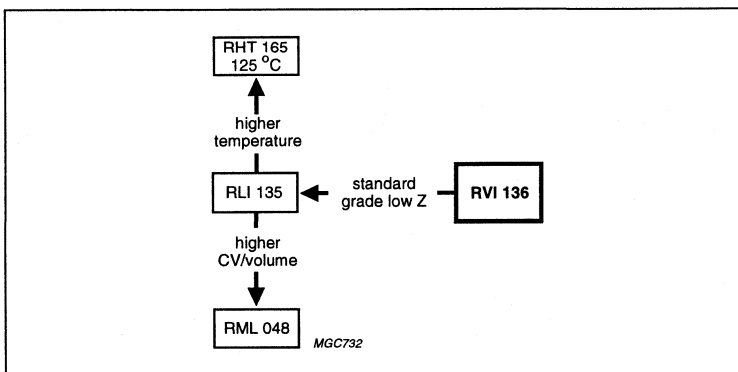


Fig.1 Component outlines.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	10 × 12 to 16 × 35
Rated capacitance range, C_R	47 to 6800 μF
Tolerance on C_R	±20%
Rated voltage range, C_R	10 to 63 V
Category temperature range	-55 to +105 °C
Endurance test at 105 °C	3000 to 5000 hours (dependent on case size)
Useful life at 105 °C	4000 to 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	1000 hours
Based on sectional specification	IEC 384-4/CECC 30300, LL grade
Climatic category IEC 68 (DIN 40040)	55/105/56 (FMF)

Non-solid Al - electrolytic capacitors

Radial, Very Low Impedance

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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**.

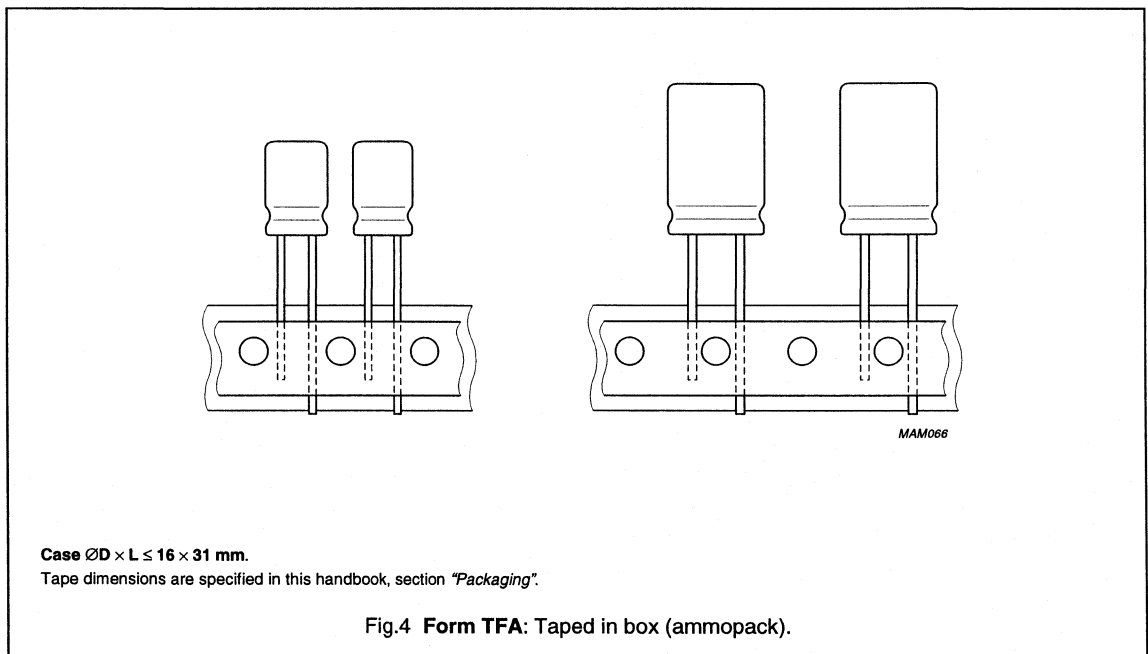
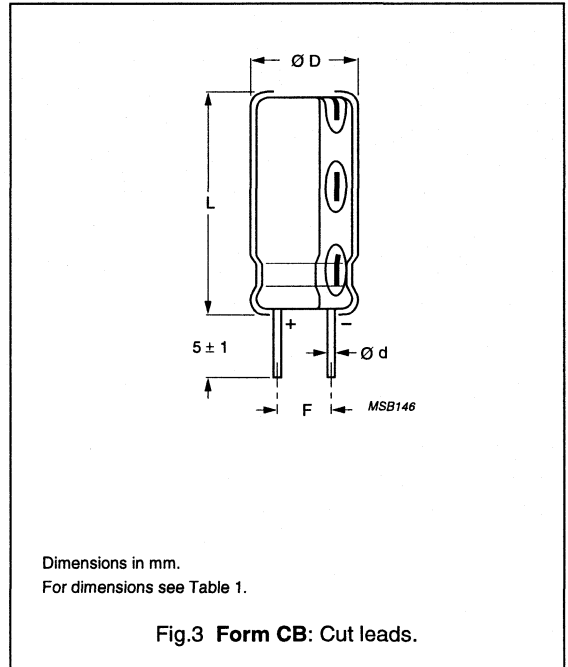
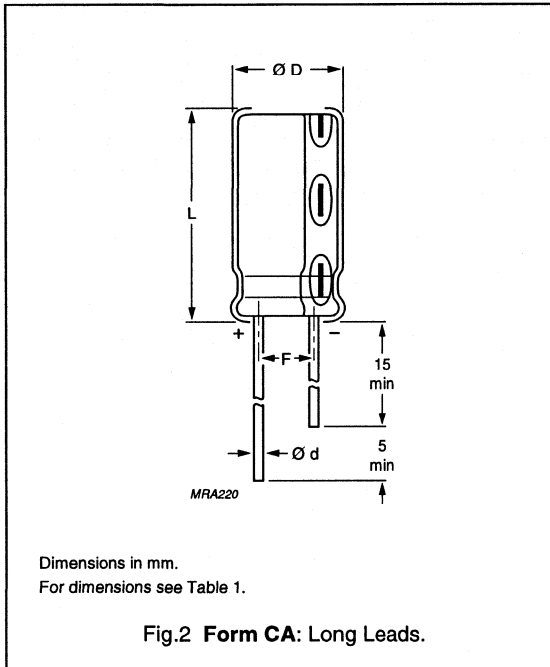
C_R (μF)	U_R (V)					
	10	16	25	35	50	63
47	-	-	-	-	-	10 × 12
56	-	-	-	-	-	10 × 12
68	-	-	-	-	-	10 × 16
82	-	-	-	-	10 × 12	-
100	-	-	-	-	10 × 12	10 × 16
120	-	-	-	10 × 12	10 × 16	10 × 20
	-	-	-	-	-	12.5 × 16
150	-	-	-	10 × 12	10 × 20	10 × 25
180	-	-	10 × 12	-	10 × 20	10 × 30
	-	-	-	-	12.5 × 16	-
220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

R

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

RVI 136

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Non-solid Al - electrolytic capacitors

Radial, Very Low Impedance

RVI 136

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	–

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.

R

Non-solid Al - electrolytic capacitors

Radial, Very Low Impedance

RVI 136

Ordering example

Electrolytic capacitor RVI 136

1000 $\mu\text{F}/25 \text{ V}; \pm 50\%$ Nominal case size: $\varnothing 12.5 \times 25 \text{ mm}$; Form TFA

Catalogue number: 2222 136 36102.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{\text{amb}} = 20^\circ\text{C}$,
 $P = 86$ 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 kHz, 105 $^\circ\text{C}$
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 $^\circ\text{C}$

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 100 kHz 105 $^\circ\text{C}$ (mA)	I_{L2} 2 min (μA)	Tan δ 100 Hz	ESR 100 Hz (m Ω)	Z 100 kHz +20 $^\circ\text{C}$ (m Ω)	Z 100 kHz -10 $^\circ\text{C}$ (m Ω)	CATALOGUE NUMBER		
										BULK PACKAGING		TAPED
										FORM CA	FORM CB	
10	390	10 x 12	14	630	39	0.19	780	120	240	136 54391	136 64391	136 34391
	470	10 x 12	14	630	47	0.19	640	120	240	136 54471	136 64471	136 34471
	680	10 x 16	15	830	68	0.19	450	84	170	136 54681	136 64681	136 34681
	1000	10 x 20	16	1000	100	0.19	300	62	130	136 54102	136 64102	136 34102
	1000	12.5 x 16	17a	940	100	0.19	300	76	160	136 94105	136 94106	136 94103
	1200	10 x 25	16L	1300	120	0.19	250	52	110	136 54122	136 64122	136 34122
	1500	10 x 30	16LL	1400	150	0.19	200	44	88	136 94155	136 94156	-
	1500	12.5 x 20	17	1300	150	0.19	200	46	92	136 54152	136 64152	136 34152
	1800	12.5 x 20	17	1340	180	0.19	170	46	92	136 54182	136 64182	136 34182
	2200	12.5 x 25	18	1700	220	0.21	150	34	68	136 54222	136 64222	136 34222
	2700	12.5 x 31	18L	2000	270	0.21	120	30	60	136 54272	136 64272	-
	3300	16 x 20	19a	1600	330	0.23	110	38	76	136 54332	136 64332	136 34332
	3900	16 x 25	19	2100	390	0.23	94	28	56	136 54392	136 64392	-
	4700	16 x 31	20	2400	470	0.25	85	25	50	136 54472	136 64472	136 34472
	5600	16 x 31	20	2400	560	0.27	77	25	50	136 54562	136 64562	-
	6800	16 x 35	21	2600	680	0.29	68	22	44	136 54682	136 64682	-

Non-solid Al - electrolytic capacitors

Radial, Very Low Impedance

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × 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	
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	-	
	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		

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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 kHz 105 °C (mA)	I_{L2} 2 min (μ A)	Tan δ 100 Hz	ESR 100 Hz (m Ω)	Z 100 kHz +20 °C (m Ω)	Z 100 kHz -10 °C (m Ω)	CATALOGUE NUMBER		
										2222		
										BULK PACKAGING		TAPED
FORM CA	FORM CB	FORM TFA										
25	2200	16 x 31	20	2400	550	0.16	120	25	50	136 56222	136 66222	136 36222
	2700	16 x 31	20	2400	680	0.16	94	25	50	136 56272	136 66272	136 36272
	3300	16 x 35	21	2600	830	0.18	87	22	44	136 56332	136 66332	-
35	120	10 x 12	14	630	42	0.12	1600	120	240	136 50121	136 60121	136 30121
	150	10 x 12	14	630	53	0.12	1300	120	240	136 50151	136 60151	136 30151
	220	10 x 16	15	830	77	0.12	870	84	170	136 50221	136 60221	136 30221
	330	10 x 20	16	1000	120	0.12	580	62	130	136 50331	136 60331	136 30331
	330	12.5 x 16	17a	940	120	0.12	580	76	160	136 90335	136 90336	136 90333
	390	10 x 25	16L	1300	140	0.12	490	52	110	136 50391	136 60391	136 30391
	470	12.5 x 20	17	1300	170	0.12	410	48	96	136 50471	136 60471	136 30471
	560	10 x 30	16LL	1400	200	0.12	340	44	88	136 90565	136 90566	-
	560	12.5 x 20	17	1300	200	0.12	340	46	92	136 50561	136 60561	136 30561
	680	12.5 x 25	18	1700	240	0.12	280	34	68	136 50681	136 60681	136 30681
	1000	12.5 x 31	18L	2000	350	0.12	190	30	60	136 90105	136 90106	-
	1000	16 x 20	19a	1700	350	0.12	190	38	76	136 50102	136 60102	136 30102
	1200	16 x 25	19	2100	420	0.12	160	28	56	136 50122	136 60122	136 30122
	1500	16 x 25	19	2100	530	0.12	130	28	56	136 50152	136 60152	136 30152
	1800	16 x 31	20	2400	630	0.12	110	25	50	136 50182	136 60182	136 30182
	2200	16 x 35	21	2600	770	0.14	100	22	44	136 50222	136 60222	-
50	82	10 x 12	14	480	41	0.10	1900	200	400	136 51829	136 61829	136 31829
	100	10 x 12	14	480	50	0.10	1600	200	400	136 51101	136 61101	136 31101
	120	10 x 16	15	760	60	0.10	1300	100	200	136 51121	136 61121	136 31121
	150	10 x 20	16	850	75	0.10	1100	90	180	136 51151	136 61151	136 31151
	180	10 x 20	16	950	90	0.10	880	75	150	136 51181	136 61181	136 31181
	180	12.5 x 16	17a	780	90	0.10	880	110	120	136 91185	136 91186	136 91183
	220	10 x 25	16L	1200	110	0.10	720	63	130	136 51221	136 61221	136 31221
	330	10 x 30	16LL	1300	170	0.10	480	54	110	136 91335	136 91336	-
	330	12.5 x 20	17	1200	170	0.10	480	59	120	136 51331	136 61331	136 31331

Non-solid Al - 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 kHz 105 °C (mA)	I_{L2} 2 min (μ A)	Tan δ 100 Hz	ESR 100 Hz (m Ω)	Z 100 kHz +20 °C (m Ω)	Z 100 kHz -10 °C (m Ω)	CATALOGUE NUMBER		
										2222		
										BULK PACKAGING		TAPED
FORM CA	FORM CB	FORM TFA										
50	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 61681	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
	1200	16 × 35	21	2300	600	0.10	130	27	54	136 51122	136 61122	-
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
	820	16 × 35	21	1900	520	0.10	190	40	100	136 58821	136 68821	-

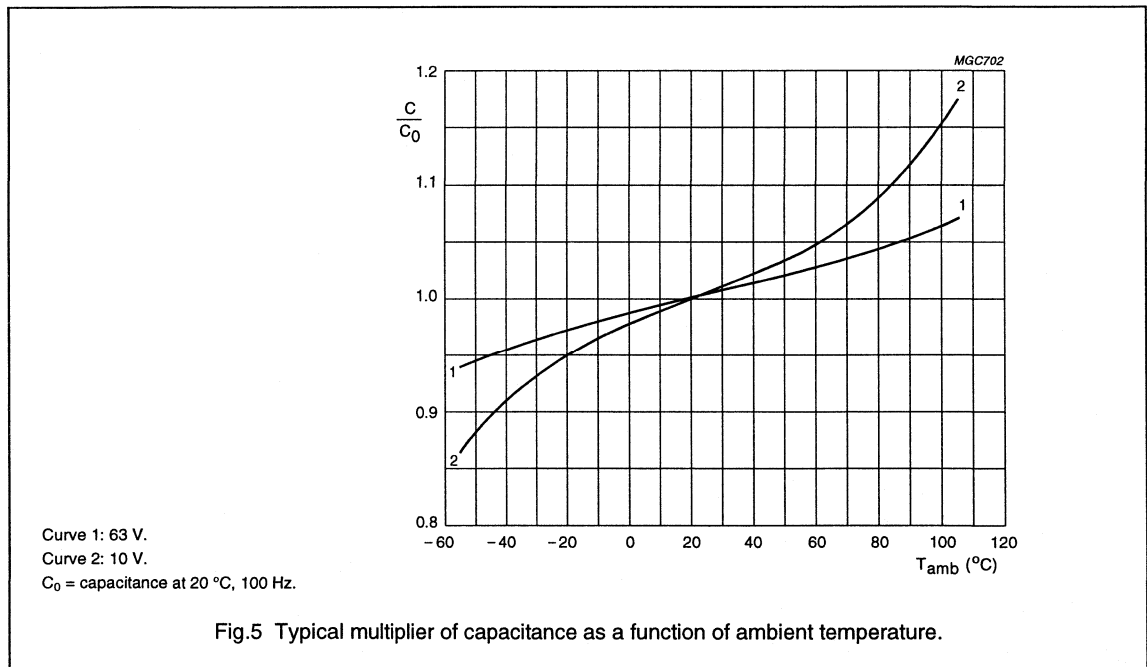
Non-solid Al - electrolytic capacitors
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Additional electrical data

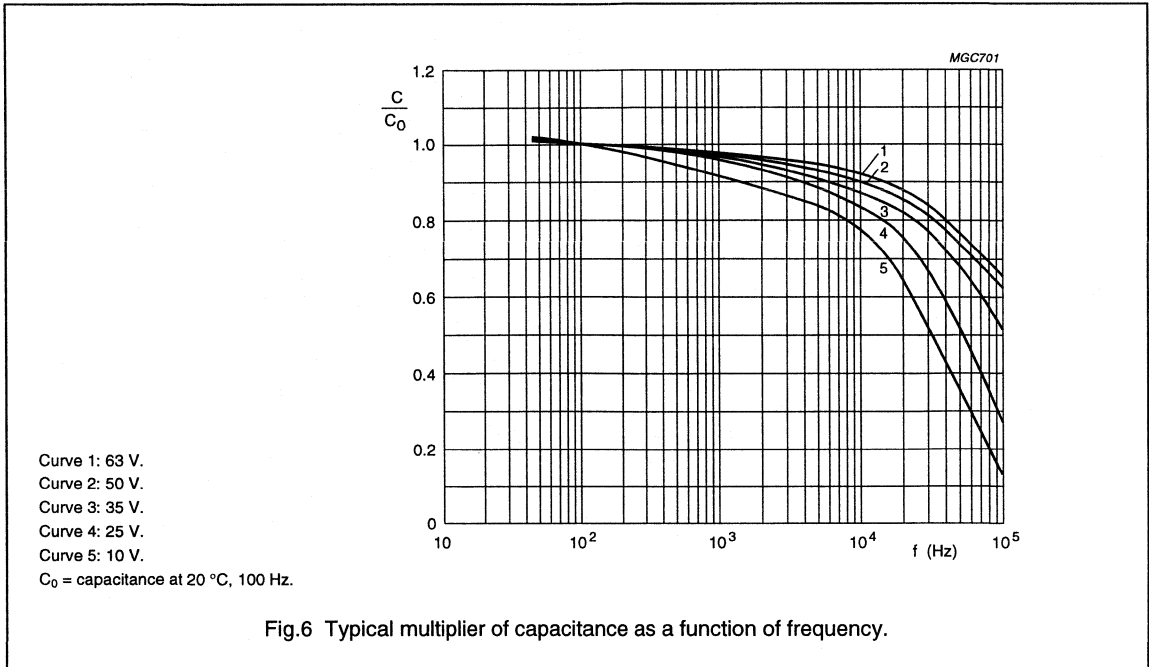
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 2 minutes at U_R	$I_{L2} \leq 0.01 C_R \times U_R$ or $3 \mu\text{A}$, whichever is greater
Inductance		
Equivalent series inductance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

Capacitance (C)

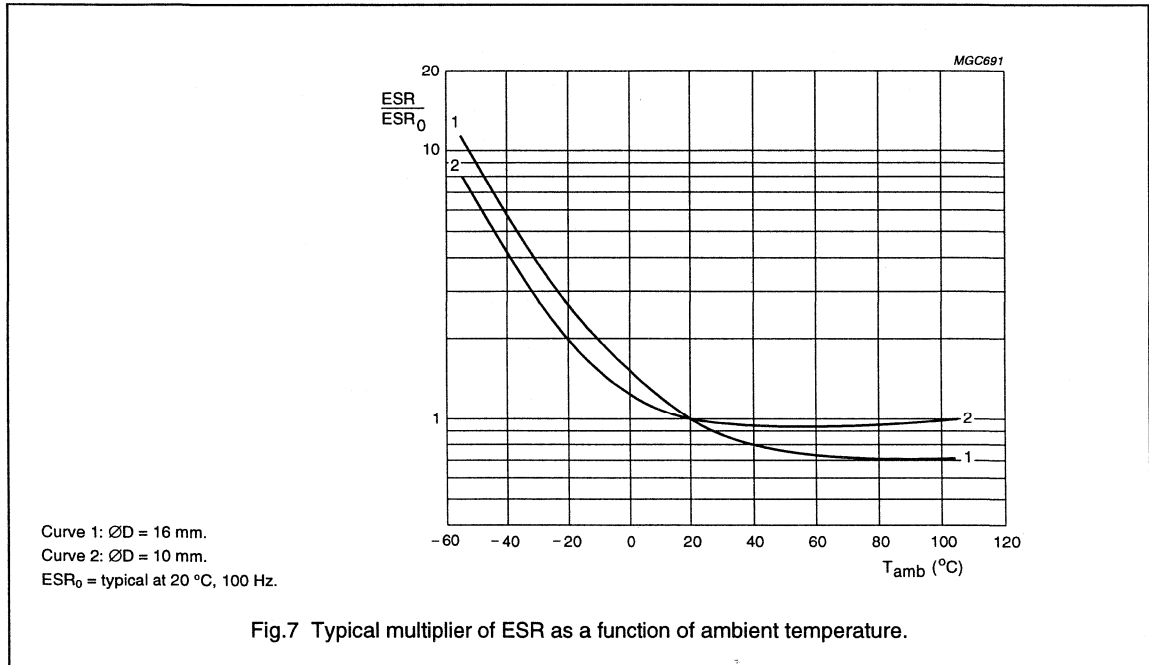


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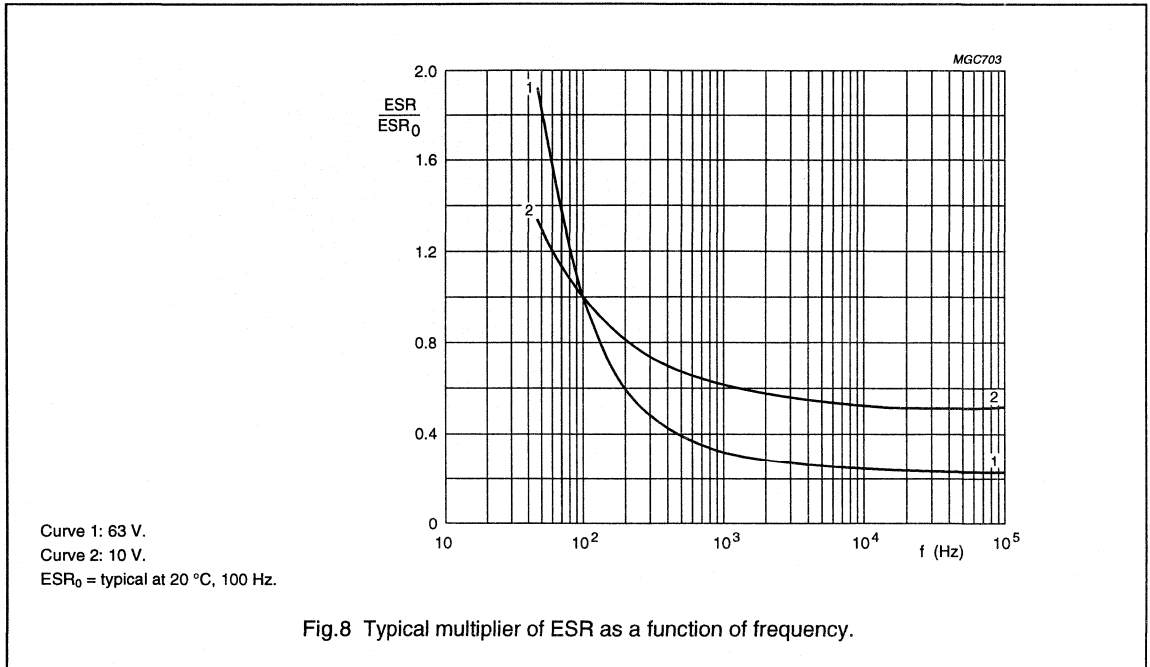


Equivalent series resistance (ESR)

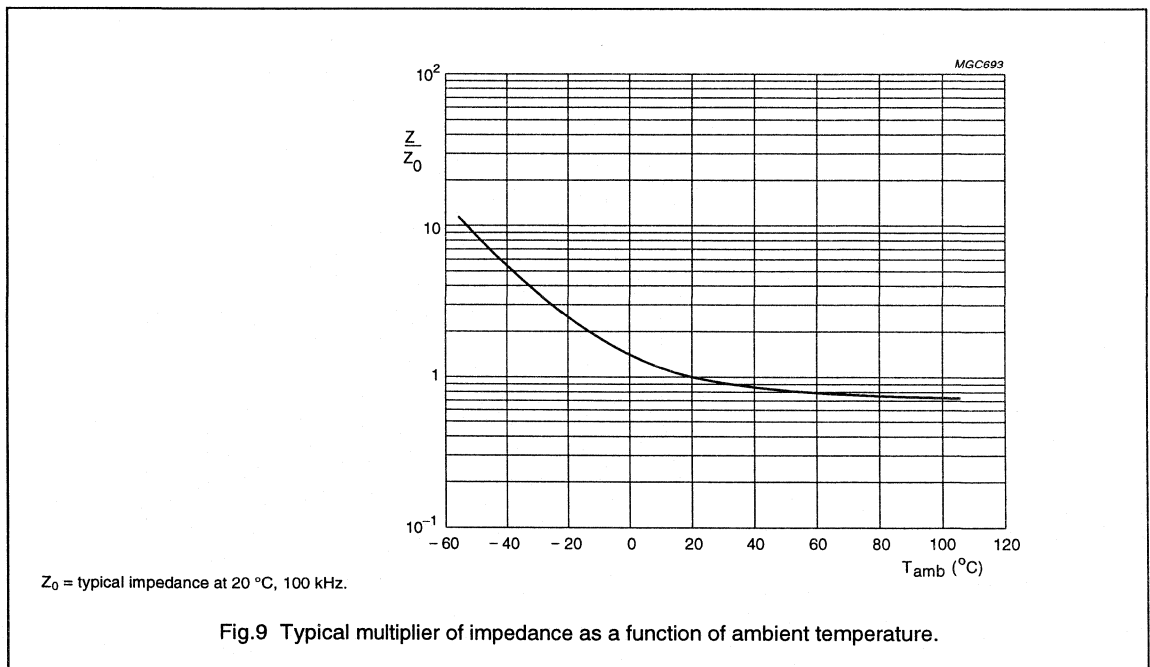


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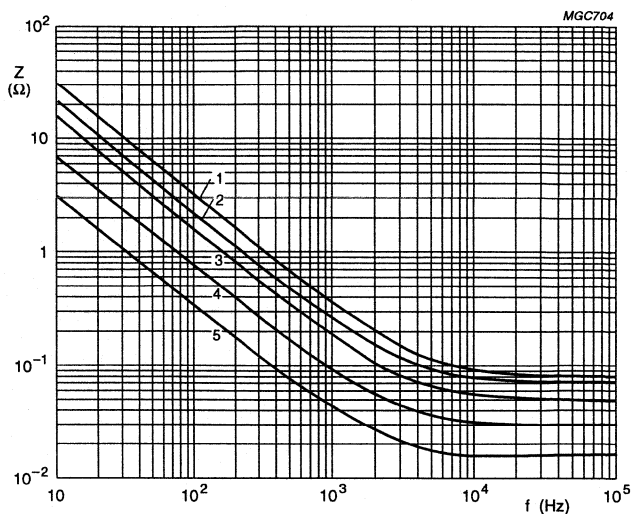
Impedance (Z)



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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.

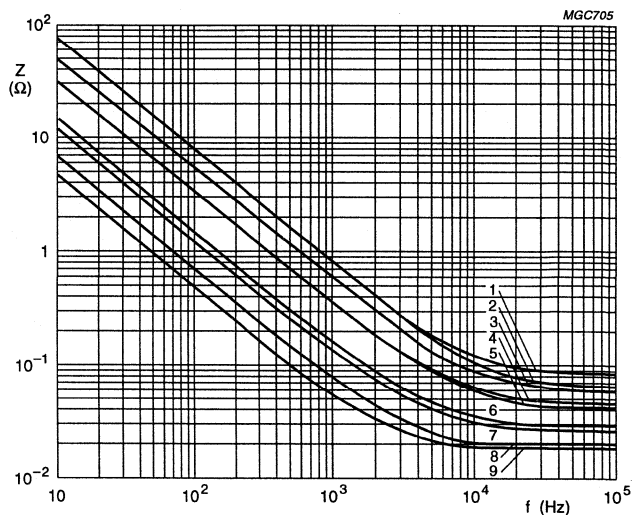
Curve 3: $1000 \mu\text{F}$, 10 V; $\varnothing 10 \times 20$ mm.

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.

$T_{\text{amb}} = 20$ °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.

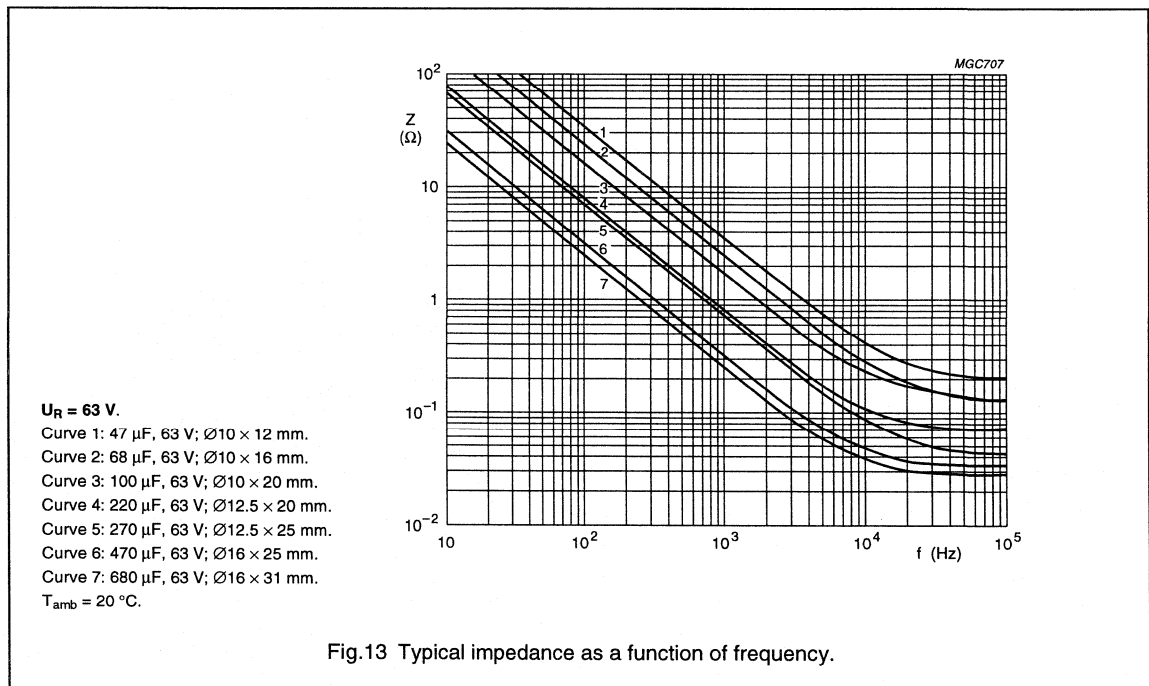
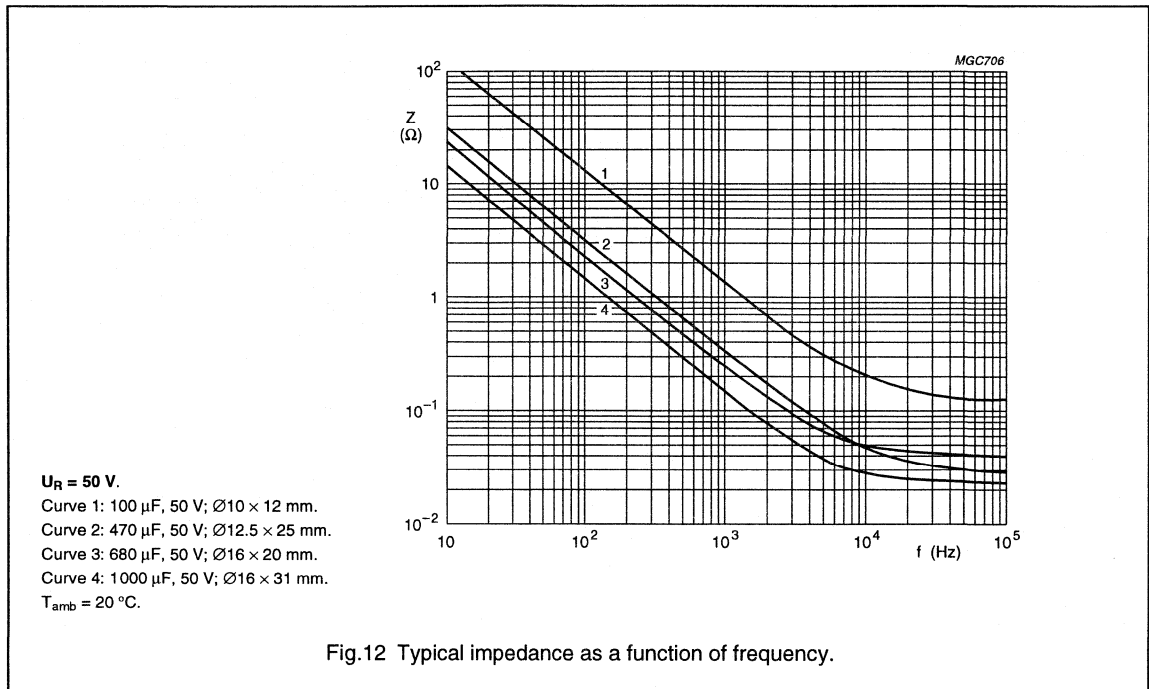
$T_{\text{amb}} = 20$ °C.

Fig.11 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_{R0}) as a function of frequency; I_{R0} = ripple current at 100 kHz

FREQUENCY (Hz)	I_R MULTIPLIER							
	$U_R = 10\text{ V}$		$U_R = 16\text{ and }25\text{ V}$		$U_R = 35\text{ and }50\text{ V}$		$U_R = 63\text{ V}$	
	$\varnothing \leq 12.5$	$\varnothing \geq 16$	$\varnothing \leq 12.5$	$\varnothing \geq 16$	$\varnothing \leq 12.5$	$\varnothing \geq 16$	$\varnothing \leq 12.5$	$\varnothing \geq 16$
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

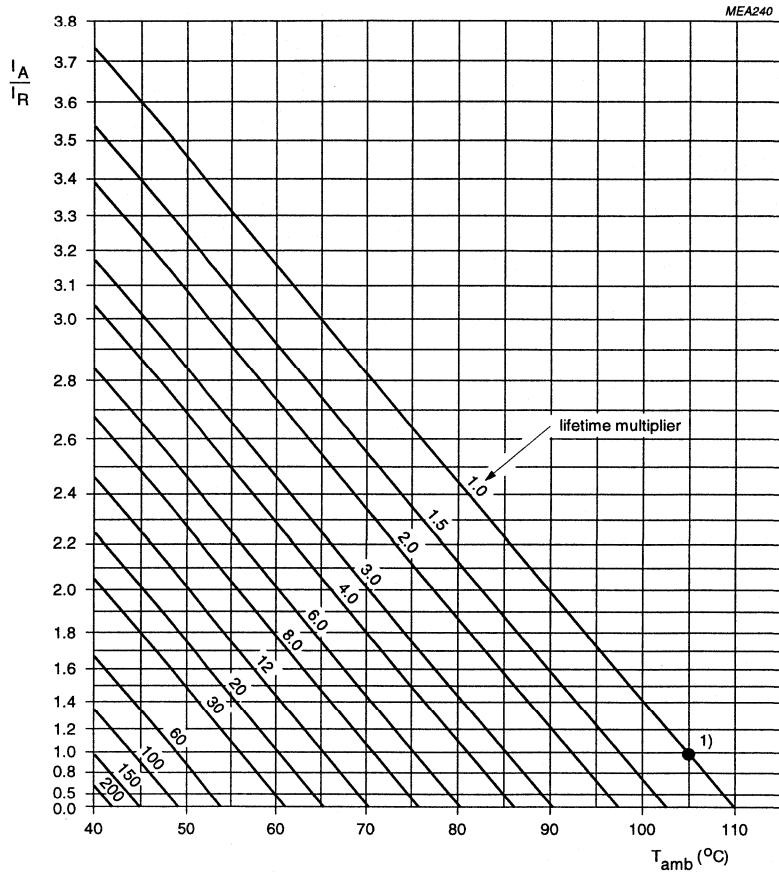
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	ENDURANCE TEST at 105 °C (hours)	USEFUL LIFE at 105 °C (hours)
10 × 12	14	3000	4000
10 × 16	15	3000	6000
10 × 20	16	3000	6000
10 × 25	16L	5000	7000
10 × 30	16LL	5000	7000
12.5 × 16	17a	3000	5000
12.5 × 20	17	3000	7000
12.5 × 25	18	5000	8000
12.5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

R

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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; see Table 4.

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

Non-solid Al - 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	$T_{amb} = 105\text{ °C}$; 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; 1 000 hours; after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$

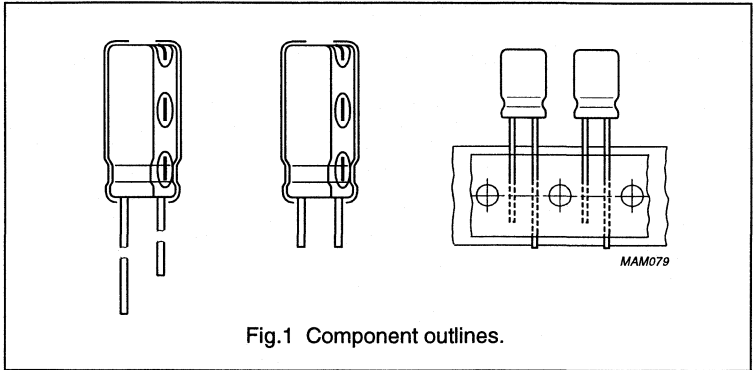
R

Non-solid Al - electrolytic capacitors Radial High Temperature

RHT 165

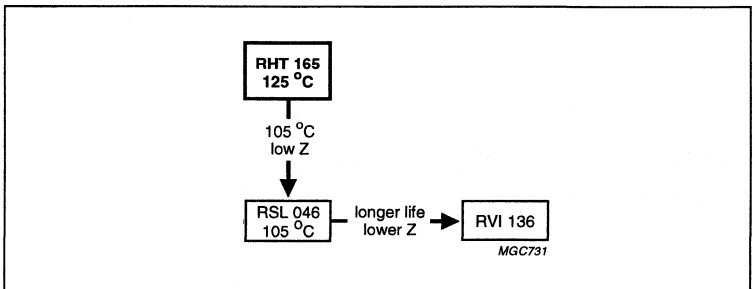
FEATURES

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



APPLICATIONS

- EDP, telecommunication, industrial, automotive and military
- Smoothing, filtering, buffering in SMPS
- High ambient temperature environments.



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	$\pm 20\%$
Rated voltage range, U_R	10 to 50 V
Category temperature range	-40 to +125 °C
Endurance test at 125 °C	1000 hours
Useful life at 125 °C	1500 hours
Useful life at 40 °C, $1.6 \times I_R$ applied	300000 hours
Shelf life at 0 V, 125 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300, LL grade
Climatic category IEC 68 (DIN 40040)	40/125/56 (GKF)

Non-solid Al - electrolytic capacitors

Radial High Temperature

RHT 165

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	-	-	-	-	-

Non-solid Al - electrolytic capacitors

Radial High Temperature

RHT 165

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

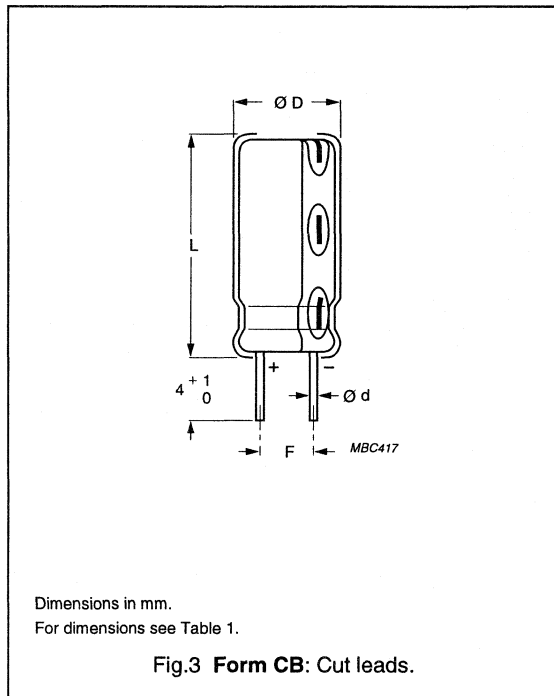
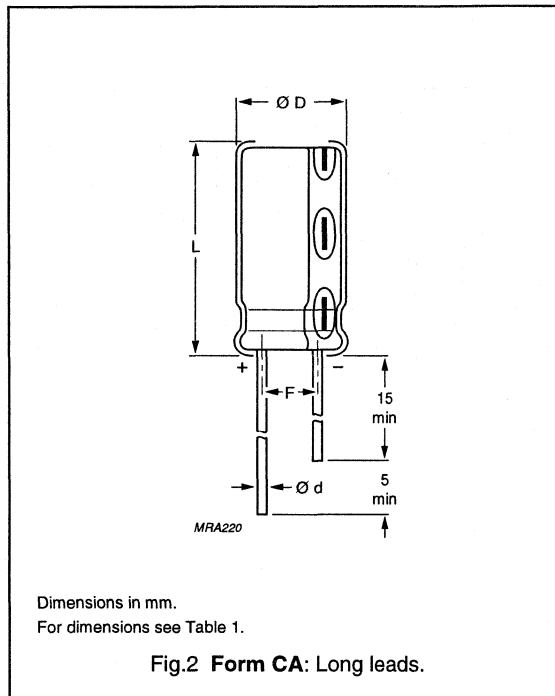


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

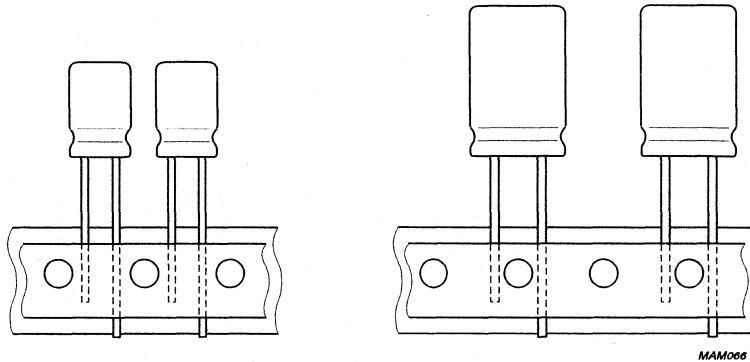
NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES PER BOX		
							FORM CA	FORM CB	FORM TFA
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	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	—

Non-solid Al - electrolytic capacitors

Radial High Temperature

RHT 165

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 ($125\text{ }^\circ\text{C}$)
- Group number (165)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with "IEC 62"
- Negative terminal identification.

Non-solid Al - electrolytic capacitors Radial High Temperature

RHT 165

Ordering example

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

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, 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 (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	I _R 125 °C (mA)	I _{L1} 1 min (µA)	I _{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222		
												
											BULK PACKAGING		TAPED
											FORM CA	FORM CB	FORM TFA
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	-

Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE ∅D × L (mm)	CASE CODE	I _R 125 °C (mA)	I _{L1} 1 min (µA)	I _{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222		
											BULK PACKAGING		FORM TFA
											FORM CA	FORM CB	
35	100	10 × 16	15	200	38	10	0.12	1.70	-	0.65	165 50101	165 60101	165 30101
	470	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
50	1000	16 × 35	21	1000	400	83	0.12	0.17	-	0.06	165 57102	165 67102	-
	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

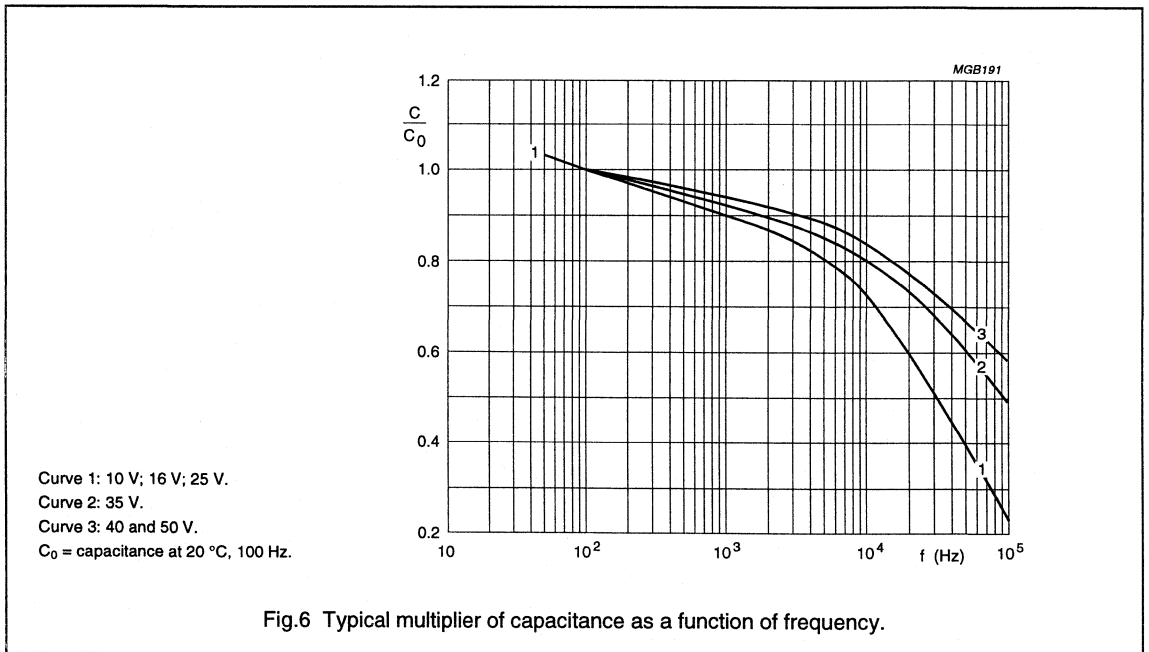
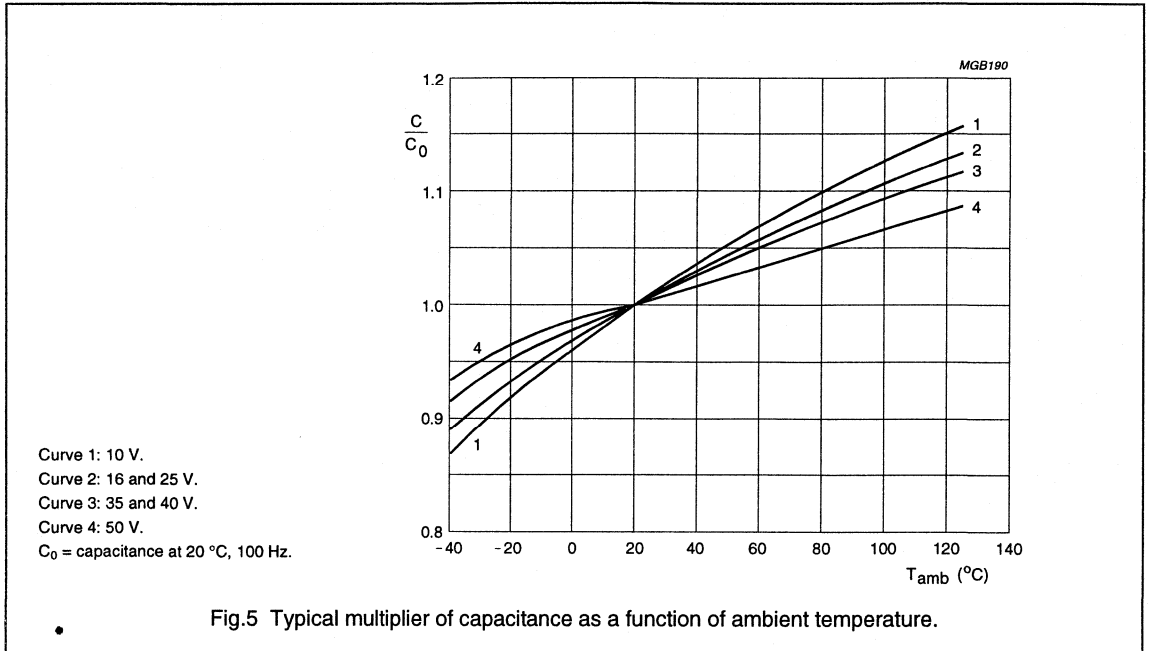
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		U _s ≤ 1.3 U _R
Reverse voltage		U _{rev} ≤ 1 V
Current		
Leakage current	after 1 minute at U _R	I _{L1} ≤ 0.01C _R × U _R + 3 µA
	after 5 minutes at U _R	I _{L5} ≤ 0.002C _R × U _R + 3 µA
Inductance		
Equivalent series inductance (ESL)	case ∅D = 10 mm	typ. 16 nH
	case ∅D ≥ 12.5 mm	typ. 18 nH



Non-solid Al - electrolytic capacitors Radial High Temperature

RHT 165

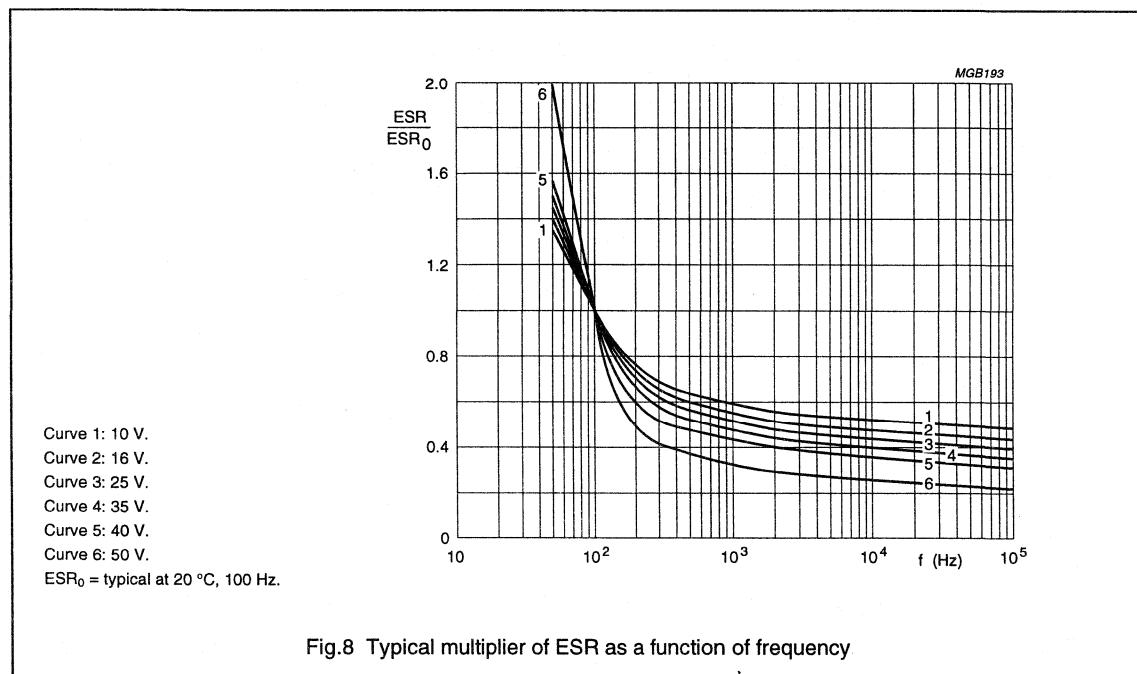
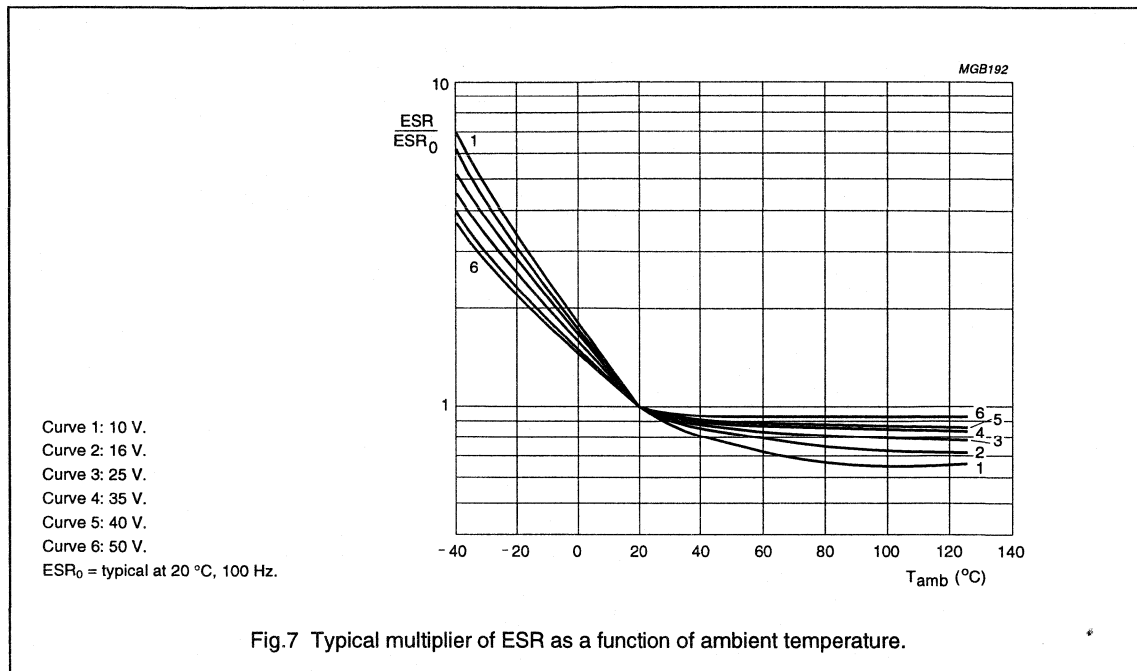
Capacitance (C)



Non-solid Al - electrolytic capacitors Radial High Temperature

RHT 165

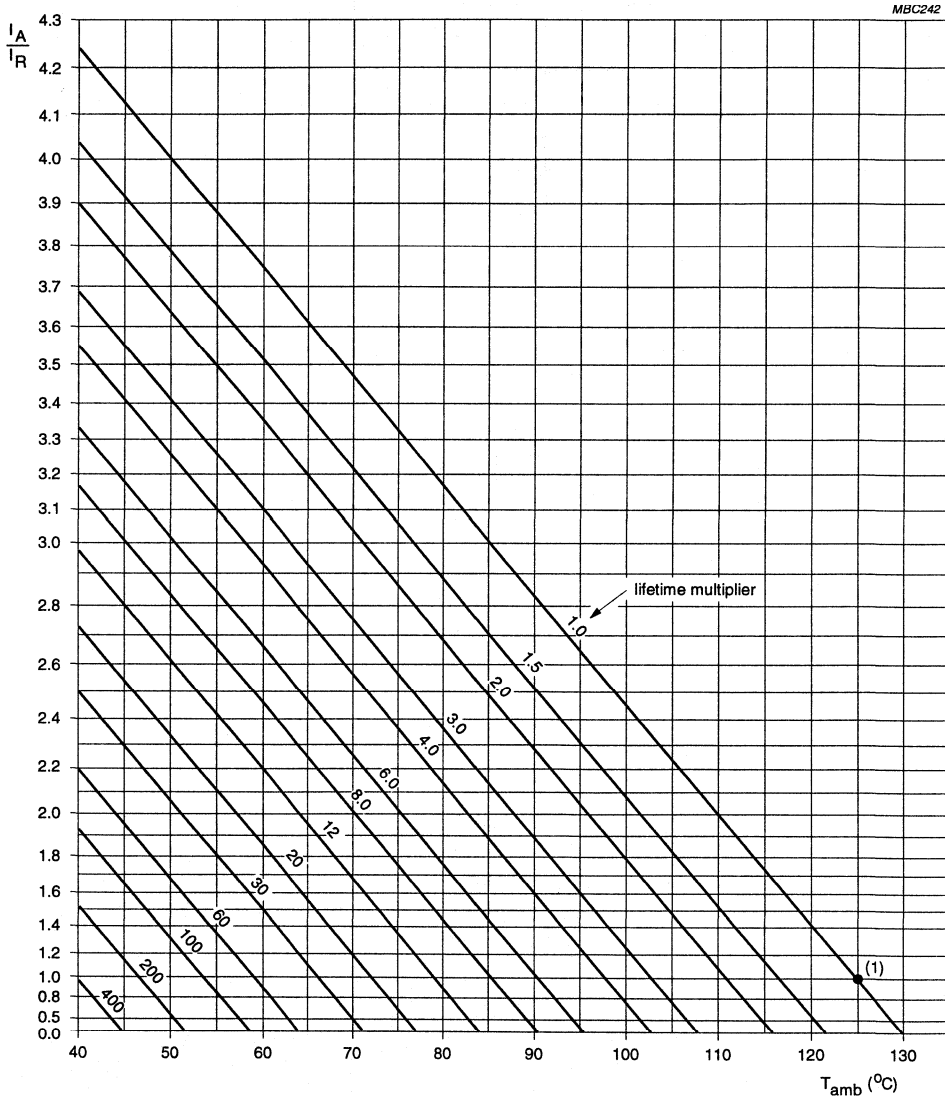
Equivalent series resistance (ESR)



Non-solid Al - electrolytic capacitors
Radial High Temperature

RHT 165

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz.
 I_R = rated ripple current at 100 Hz, 125 °C.
 (1) Useful life at 125 °C and I_R applied: 1500 hours.

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

Non-solid Al - electrolytic capacitors

Radial High Temperature

RHT 165

Table 3 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 100 Hz; see Fig.9

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10$ to 25 V	$U_R = 35$ or 40 V	$U_R = 50$ V
50	0.85	0.80	0.75
100	1.00	1.00	1.00
300	1.20	1.25	1.30
1000	1.30	1.40	1.50
3000	1.35	1.50	1.65
≥ 10000	1.40	1.60	1.80

SPECIFIC TESTS AND REQUIREMENTS

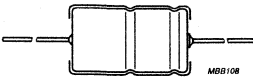
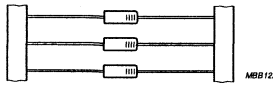
General tests and requirements are specified in this handbook, section "Tests and Requirements".

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 125$ °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	$T_{amb} = 125$ °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	$T_{amb} = 125$ °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 NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS

	MINIATURE	STANDARD & SEMI-PROFESSIONAL	LONG-LIFE	EXTRA LONG-LIFE or HIGH TEMP.
	1500-2000 hours 85 °C	2500-8000 hours 85 °C	10-15 000 hours / 85 °C 2-5000 hours / 105 °C	4000 hours 125 °C
dimension (smaller) ↓ CV per volume (higher)		page 348 AB 137 92 bipolar ABA 137 bipolar audio page 350	ASH-ELB 042-043 600 V/24 hours page 339	
		page 312 AS 030-031 Ø D = 3.3 mm ASD 117 page 284	page 374 ALL-DIN 132-133 ASH 042-043 page 325	AHT-DIN 119 page 410
		ASM 021 page 293	AML 138 page 352	AHT 118 page 392

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Non-solid Al - electrolytic capacitors

Axial, Smallest Diameter

ASD 117

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Taped for automatic insertion
- Charge and discharge proof
- Ultra miniature, diameter 3.3 mm.

APPLICATIONS

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

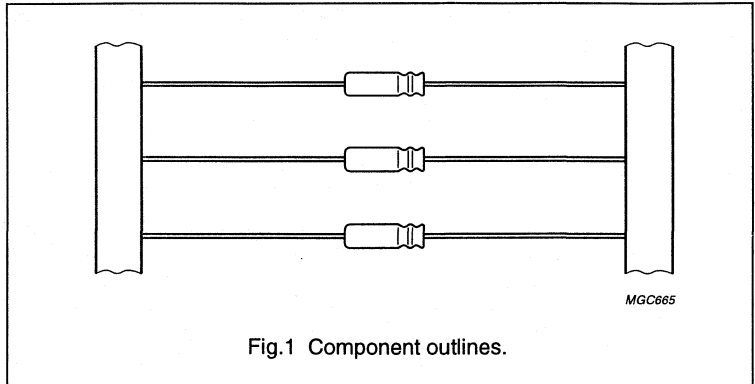
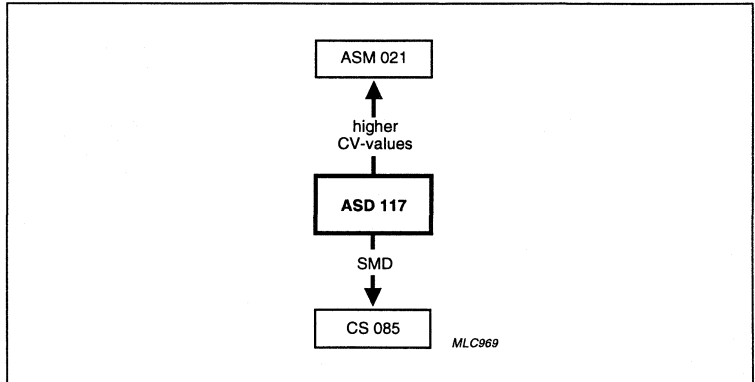


Fig.1 Component outlines.



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, GP grade
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)

Non-solid Al - 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	–	–	–	–	–

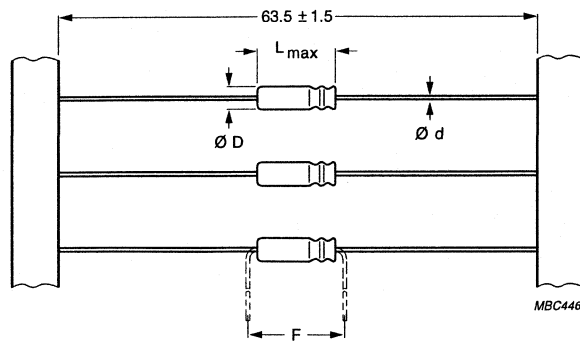
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Non-solid Al - electrolytic capacitors

Axial, Smallest Diameter

ASD 117

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

Form BR: Taped on reel.

Form BA: Taped in box.

Case $\text{ØD} \times \text{L} = 3.3 \times 8$ and 3.3×11 mm.

For dimensions see Table 1.

Fig.2 Components insulated with a blue plastic sleeve.

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

NOMINAL CASE SIZE $\text{ØD} \times \text{L}$ (mm)	CASE CODE	AXIAL: FORM BA and BR				MASS (g)	PACKAGING QUANTITIES	
		Ød (mm)	ØD_{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.

Non-solid Al - electrolytic capacitors

Axial, Smallest Diameter

ASD 117

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, 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
$\tan \delta$	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 ASD 117

10 μF /16 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 °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	0.47	3.3 × 8	1a	4	4	3	0.10	340	120	117 28477
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

Non-solid Al - electrolytic capacitors
Axial, Smallest Diameter

ASD 117

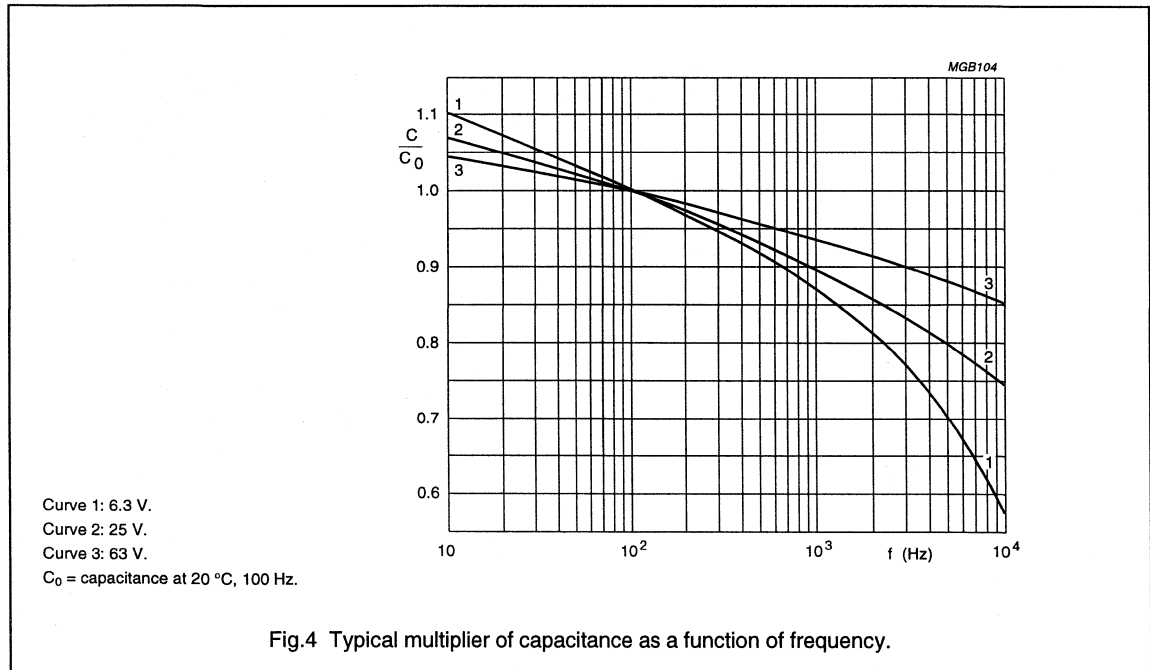
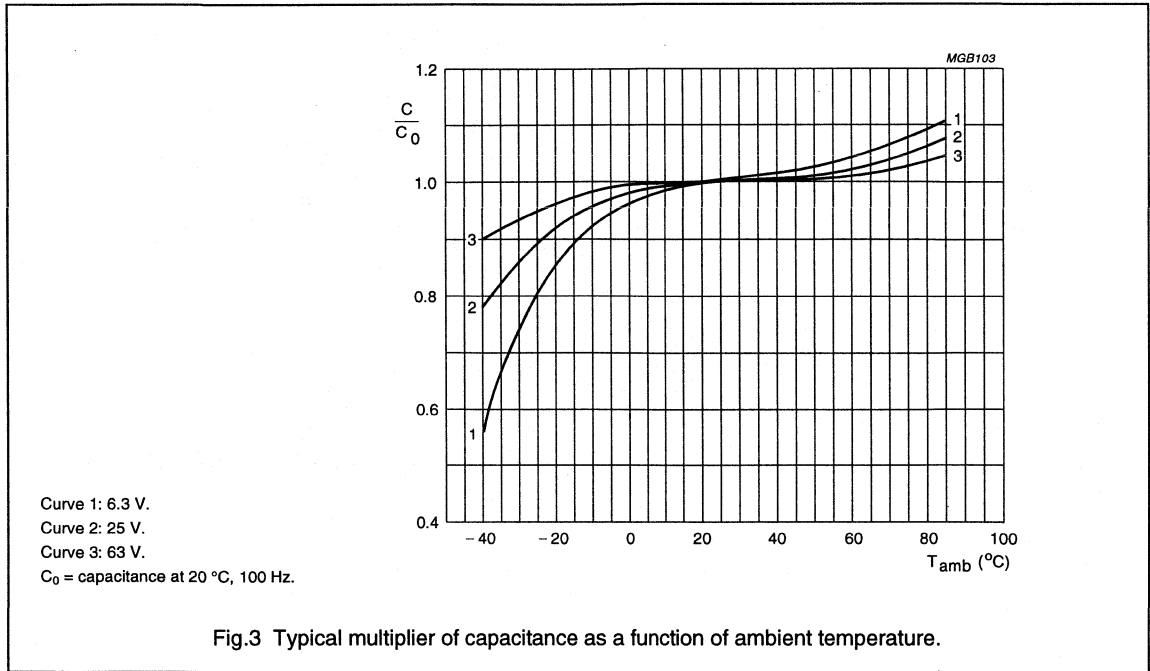
Additional electrical data

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

Non-solid Al - electrolytic capacitors
Axial, Smallest Diameter

ASD 117

Capacitance (C)

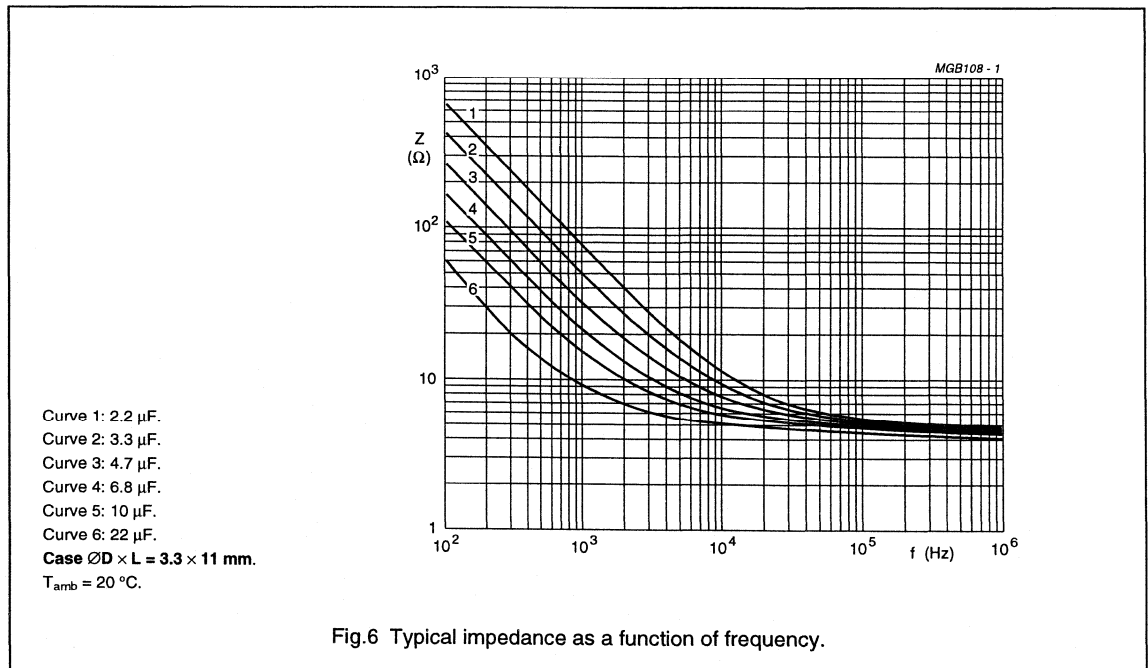
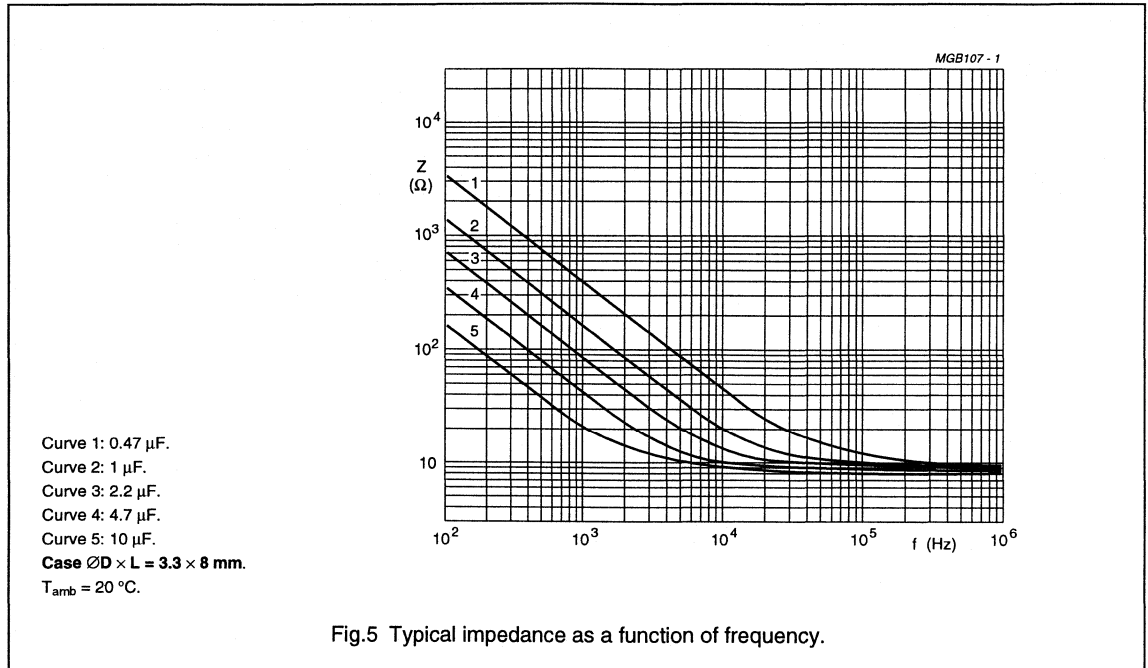


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Non-solid Al - electrolytic capacitors
Axial, Smallest Diameter

ASD 117

Impedance (Z)



Non-solid Al - electrolytic capacitors

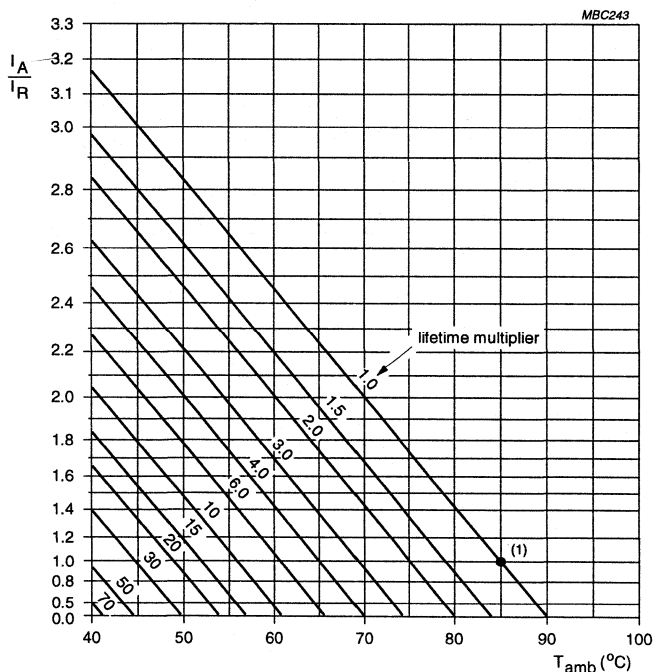
Axial, Smallest Diameter

ASD 117

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.

Non-solid Al - electrolytic capacitors

Axial, Smallest Diameter

ASD 117

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 $I_{L5} \leq 2 \times \text{spec. limit}$

Non-solid Al - electrolytic capacitors

Axial Standard Miniature

ASM 021

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case $\varnothing 10 \times 30$ 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.

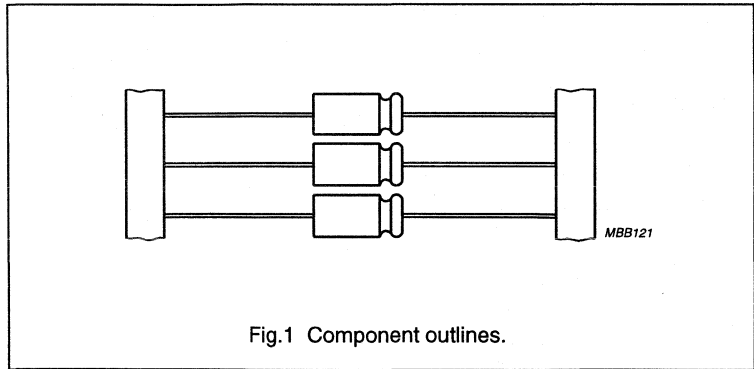
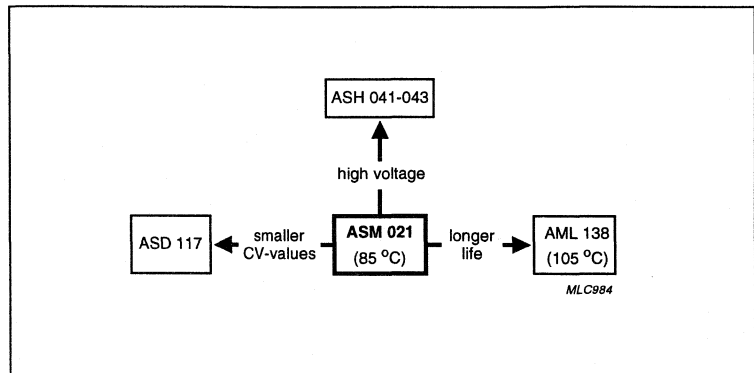


Fig.1 Component outlines.



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	1000 hours	5000 hours
$U_R = 40$ to 100 V	2000 hours	5000 hours
Useful life at 85 °C	2500 hours	8000 hours
Useful life at 40 °C, $1.4 \times I_R$ applied	70000 hours	200000 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
$U_R = 6.3$ to 25 V	GP grade	LL grade
$U_R = 40$ to 100 V	LL grade	LL grade
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)	

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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	–	–	–	–	–	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	–	–	–	–	–

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

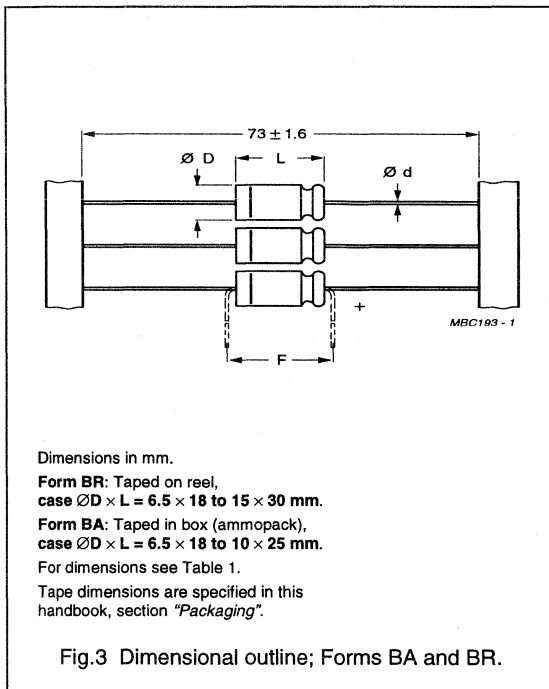
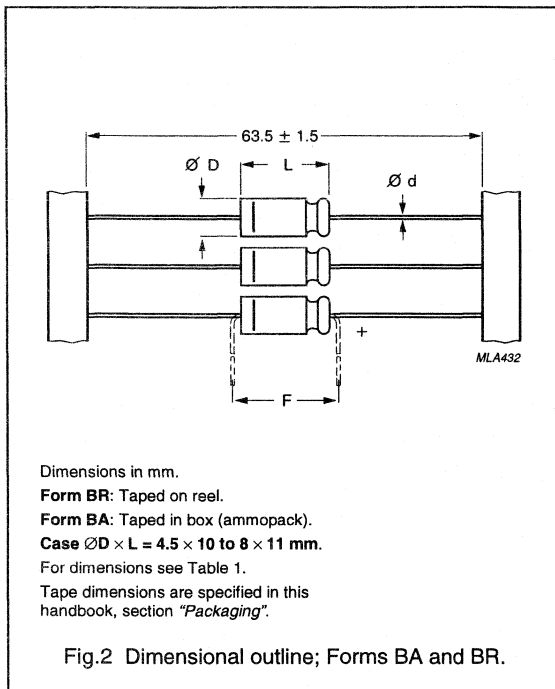


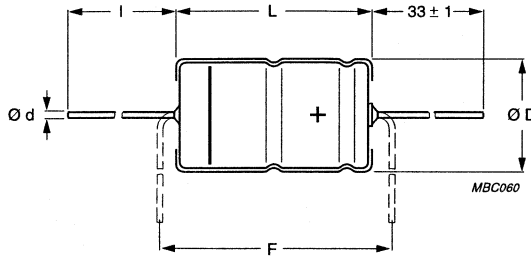
Table 1 Axial; physical dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	AXIAL: FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		$\varnothing d$	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.

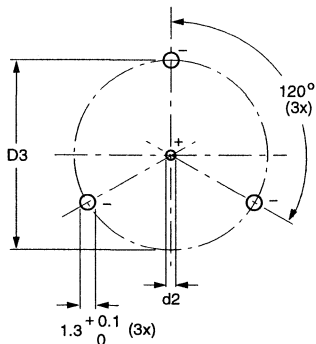
Form AA: Axial in box.

Case $\varnothing D \times L = 10 \times 30$ and 21×40 mm.

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.

Fig.4 Dimensional outline; Form AA.



piercing diagram

Dimensions in mm.

Form MR: case $\varnothing D \times L = 15 \times 30$ to 21×40 mm.

Case not insulated (insulation on request).

Especially for applications with severe shocks and vibrations.

For dimensions see Table 2.

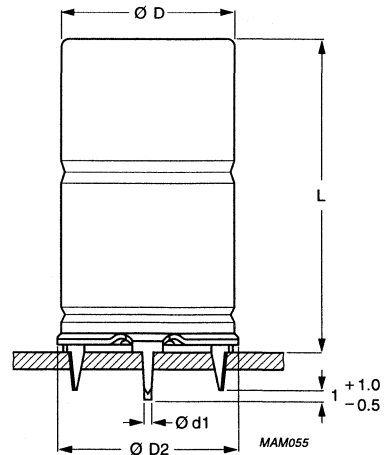
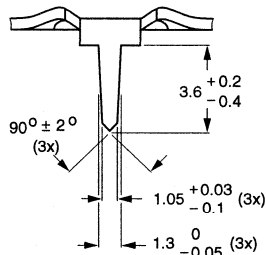


Fig.5 Piercing diagram and outline; Form MR; single ended with mounting ring and pins.

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

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	SINGLE ENDED WITH MOUNTING RING: FORM MR					MASS (g)	PACKAGING QUANTITIES
		$\varnothing d_1$ (mm)	$\varnothing d_2$ (mm)	$\varnothing D_{2max}$ (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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Ordering example

Electrolytic capacitor ASM 021
1000 μ F/16 V; \pm 20%
Nominal case size: \varnothing 10 x 25; Form BA
Catalogue number: 2222 021 90518.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 apply at $T_{amb} = 20^\circ C$,
 $P = 86$ 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 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 (μ F)	NOMINAL CASE SIZE $\varnothing \times L$ (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		SINGLE ENDED		
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR	
6.3	470 1000 2200	8 x 11 8 x 18 10 x 25	5a 5 7	260 440 710	22 42 87	10 17 32	0.25 0.25 0.29	0.85 0.4 0.21	0.64 0.5 0.16	- - -	021 23471 021 23102 021 90588	021 33471 021 33102 021 90589	- - -	
10	100 220 330 470 680 1000 1500 1500 2200 3300 4700 6800 10000 15000	4.5 x 10 6 x 10 8 x 11 6.5 x 18 8 x 18 10 x 18 10 x 25 10 x 30 12.5 x 30 12.5 x 30 15 x 30 18 x 30 18 x 40 21 x 40	2 3 5a 4 5 6 7 00 01 01 02 03 04 05	100 160 230 310 400 550 690 740 800 1000 1180 1480 1860 2250	10 17 24 32 45 64 94 94 136 202 286 412 604 904	6 8.4 11 13 18 24 34 34 48 70 98 140 204 304	0.20 0.20 0.20 0.20 0.20 0.20 0.23 0.23 0.25 0.27 0.29 0.34 0.40 0.50	3.2 1.5 1.0 0.68 0.47 0.32 0.25 0.245 0.177 0.128 0.100 0.079 0.064 0.054	2.0 0.91 0.61 0.43 0.29 0.20 0.18 0.18 0.095 0.095 0.07 0.065 0.04 0.035	- - - - - - - - - - - - - - -	021 24101 021 24221 021 24331 021 24471 021 24681 021 24102 021 90524 021 24152 021 14222 021 14332 021 14472 - - -	021 34101 021 34221 021 34331 021 34471 021 34681 021 34102 021 90525 - - - - - -	- - - - - - - - - - - - - - -	021 44472 021 44682 021 44103 021 44153

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CATALOGUE NUMBER 2222													
UR (V)	CR 100 Hz (µF)	NOMINAL CASE SIZE ØD x L (mm)	CASE CODE	IR 100 Hz 85 °C (mA)	IL1 1 min (µA)	IL5 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	68	4.5 x 10	2	90	11	6.2	0.16	3.8	2.4	-	021 25689	021 35689	-
	150	6 x 10	3	140	18	8.8	0.16	1.7	1.1	-	021 25151	021 35151	-
	220	8 x 11	5a	210	25	11	0.16	1.2	0.73	-	021 25221	021 35221	-
	330	6.5 x 18	4	290	36	15	0.16	0.77	0.48	-	021 25331	021 35331	-
	470	8 x 18	5	380	49	19	0.16	0.55	0.34	-	021 25471	021 35471	-
	680	10 x 18	6	500	69	26	0.16	0.38	0.24	-	021 25681	021 35681	-
	1000	10 x 25	7	660	100	36	0.16	0.26	0.18	-	021 90517	021 90518	-
	1000	10 x 30	00	700	100	36	0.16	0.260	0.175	021 15102	021 25102	-	
	1500	12.5 x 30	01	740	148	52	0.19	0.205	0.095	021 15152	021 25152	-	
	2200	12.5 x 30	01	890	216	74	0.21	0.150	0.095	021 15222	021 25222	-	
	3300	15 x 30	02	1130	321	110	0.23	0.111	0.07	021 15332	021 25332	021 45332	
	4700	18 x 30	03	1410	455	154	0.25	0.087	0.065	021 15472	-	021 45472	
	6800	18 x 40	04	1780	656	222	0.30	0.070	0.04	021 15682	-	021 45682	
	10000	21 x 40	05	2170	964	324	0.36	0.058	0.035	021 15103	-	021 45103	
25	47	4.5 x 10	2	80	11	6.4	0.14	4.8	2.6	-	021 26479	021 36479	-
	100	6 x 10	3	150	19	9	0.14	2.3	1.2	-	021 26101	021 36101	-
	150	8 x 11	5a	190	27	12	0.14	1.5	0.80	-	021 90534	021 90535	-
	150	6.5 x 18	4	210	27	12	0.14	1.5	0.80	-	021 26151	021 36151	-
	220	6.5 x 18	4	250	37	15	0.14	1.0	0.55	-	021 26221	021 36221	-
	330	8 x 18	5	340	54	21	0.14	0.68	0.36	-	021 26331	021 36331	-
	470	10 x 18	6	450	75	28	0.14	0.48	0.26	-	021 26471	021 36471	-
	680	10 x 25	7	560	106	38	0.14	0.33	0.18	-	021 90527	021 90528	-
	680	10 x 30	00	640	106	38	0.14	0.323	0.175	021 16681	021 26681	-	
	1000	12.5 x 30	01	720	154	54	0.14	0.220	0.095	021 16102	021 26102	-	
	1500	12.5 x 30	01	790	229	79	0.17	0.179	0.095	021 16152	021 26152	-	
	2200	15 x 30	02	1030	334	114	0.19	0.132	0.07	021 16222	021 26222	021 46222	
	3300	18 x 30	03	1310	499	169	0.21	0.099	0.065	021 16332	-	021 46332	
	4700	18 x 40	04	1680	709	239	0.23	0.079	0.04	021 16472	-	021 46472	
	6800	21 x 40	05	2070	1024	344	0.28	0.064	0.035	021 16682	-	021 46682	

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CATALOGUE NUMBER 2222													
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × 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 MOUNTING RING FORM MR
										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	-	021 47152
	680	12.5 × 30	01	620	167	58	0.12	0.297	0.095	021 17681	021 27681	-	021 47222
	1000	12.5 × 30	01	770	244	84	0.12	0.190	0.095	021 17102	021 27102	-	021 47332
	1500	15 × 30	02	930	364	124	0.15	0.159	0.07	021 17152	021 27152	-	021 47472
	2200	18 × 30	03	1200	532	180	0.17	0.118	0.065	021 17222	-	-	-
	3300	18 × 40	04	1550	796	268	0.19	0.090	0.04	021 17332	-	-	-
	4700	21 × 40	05	1880	1132	380	0.21	0.072	0.035	021 17472	-	-	-
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	2.7	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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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × 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 MOUNTING RING FORM MR
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA		
63	150	10 × 18	6	320	61	23	0.08	0.85	0.37	-	021 28151	021 38151	021 38151	-
	220	10 × 25	7	430	88	32	0.08	0.60	0.25	-	021 90511	021 90512	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	4.6	0.08	130	90	-	021 29108	021 39108	021 39108	-
	2.2	4.5 × 10	2	20	5.3	5.3	0.08	58	41	-	021 29228	021 39228	021 39228	-
	4.7	4.5 × 10	2	30	7	7	0.08	27	19	-	021 29478	021 39478	021 39478	-
	10	6 × 10	3	65	10	10	0.08	13	9	-	021 29109	021 39109	021 39109	-
	15	8 × 11	5a	77	13	13	0.08	8.5	6	-	021 90547	021 90548	021 90548	-
	15	6.5 × 18	4	85	13	13	0.08	8.5	6	-	021 29159	021 39159	021 39159	-
	22	8 × 11	5a	95	17	17	0.08	5.8	4.1	-	021 90551	021 90552	021 90552	-
	22	6.5 × 18	4	100	17	17	0.08	5.8	4.1	-	021 29229	021 39229	021 39229	-
	33	6.5 × 18	4	120	24	24	0.08	3.9	2.7	-	021 29339	021 39339	021 39339	-
	47	8 × 18	5	160	32	32	0.08	2.7	1.9	-	021 29479	021 39479	021 39479	-
	68	10 × 18	6	220	45	45	0.08	1.9	1.3	-	021 29689	021 39689	021 39689	-
	100	10 × 25	7	300	64	64	0.08	1.3	0.9	-	021 90531	021 90532	021 90532	-
	100	10 × 30	00	360	64	64	0.07	1.150	1.0	021 19101	021 29101	-	-	-
	150	12.5 × 30	01	420	94	94	0.07	0.645	0.61	021 19151	021 29151	-	-	-
	220	12.5 × 30	01	460	136	136	0.08	0.610	0.56	021 19221	021 29221	-	-	-
	330	15 × 30	02	580	202	202	0.09	0.420	0.40	021 19331	021 29331	-	-	021 49331
	470	18 × 30	03	740	286	286	0.09	0.310	0.29	021 19471	-	-	-	021 49471
	680	18 × 40	04	1050	412	412	0.09	0.195	0.18	021 19681	-	-	-	021 49681
	1000	21 × 40	05	1260	604	604	0.10	0.160	0.15	021 19102	-	-	-	021 49102

Non-solid Al - electrolytic capacitors

Axial Standard Miniature

ASM 021

Additional electrical data

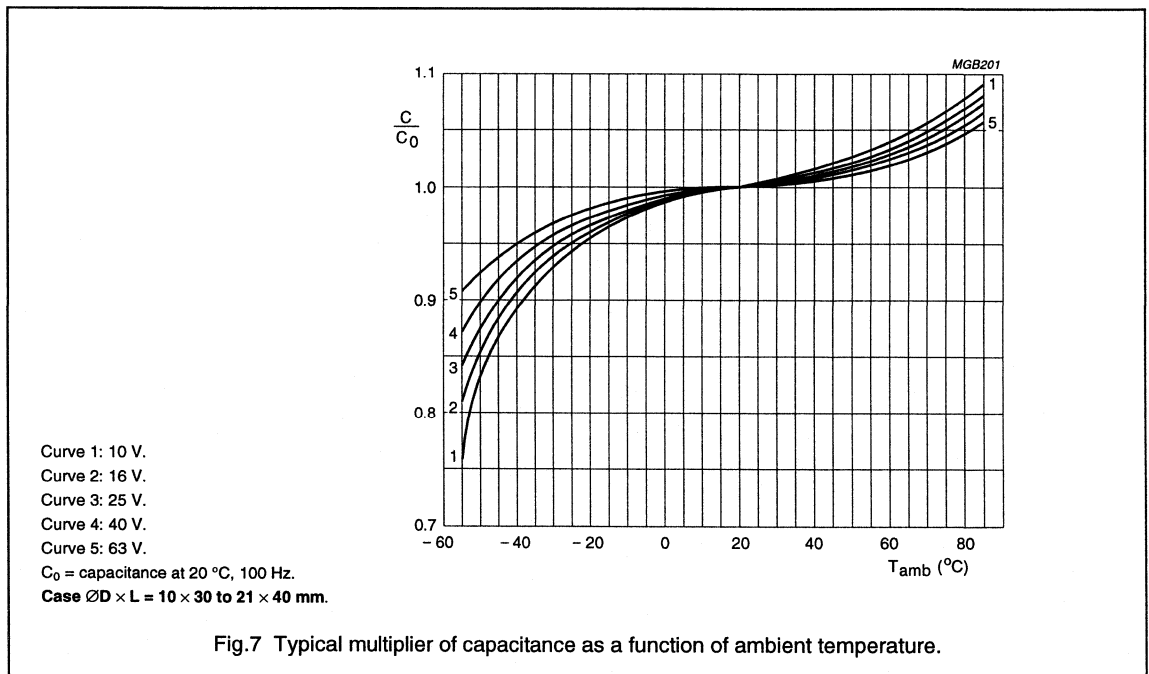
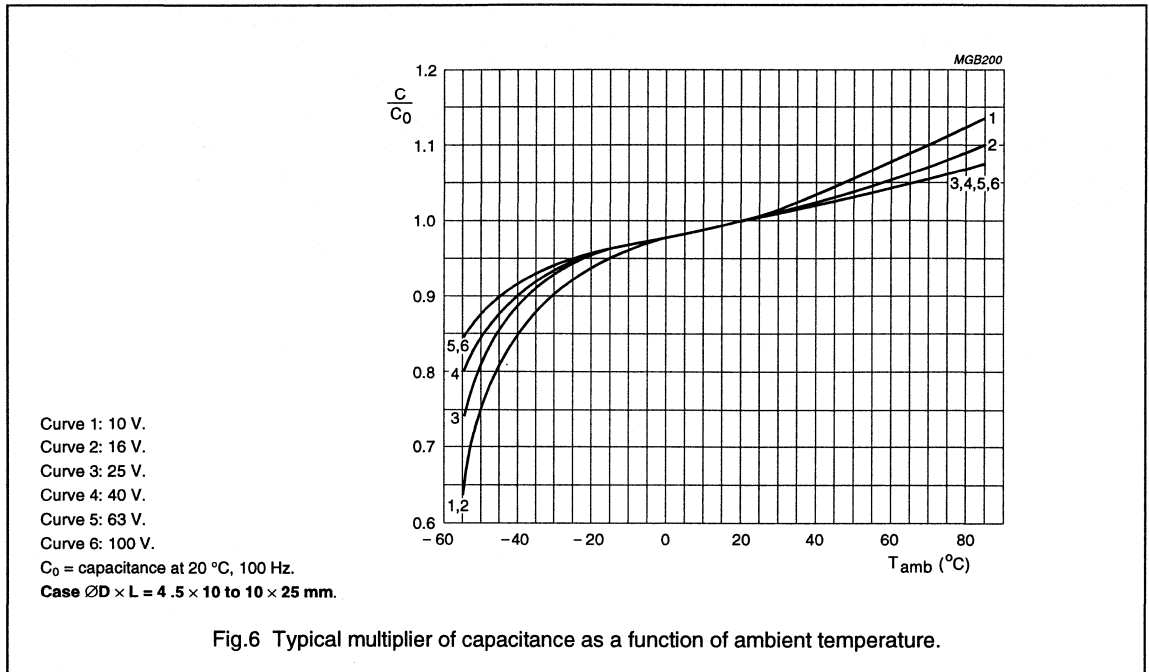
PARAMETER	CONDITIONS	VALUE	
		AXIAL	SINGLE ENDED
Voltage			
Surge voltage for short periods		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1 \text{ V}$	
Current			
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$	
	after 5 minutes at U_R : $U_R = 6.3 \text{ V to } 63 \text{ V}$ $U_R = 100 \text{ V}$	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$ $I_{L5} \leq 0.006C_R \times U_R + 4 \mu\text{A}$	
Inductance			
Equivalent series inductance (ESL)	case $\varnothing D \times L$ mm:		
	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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Non-solid Al - electrolytic capacitors
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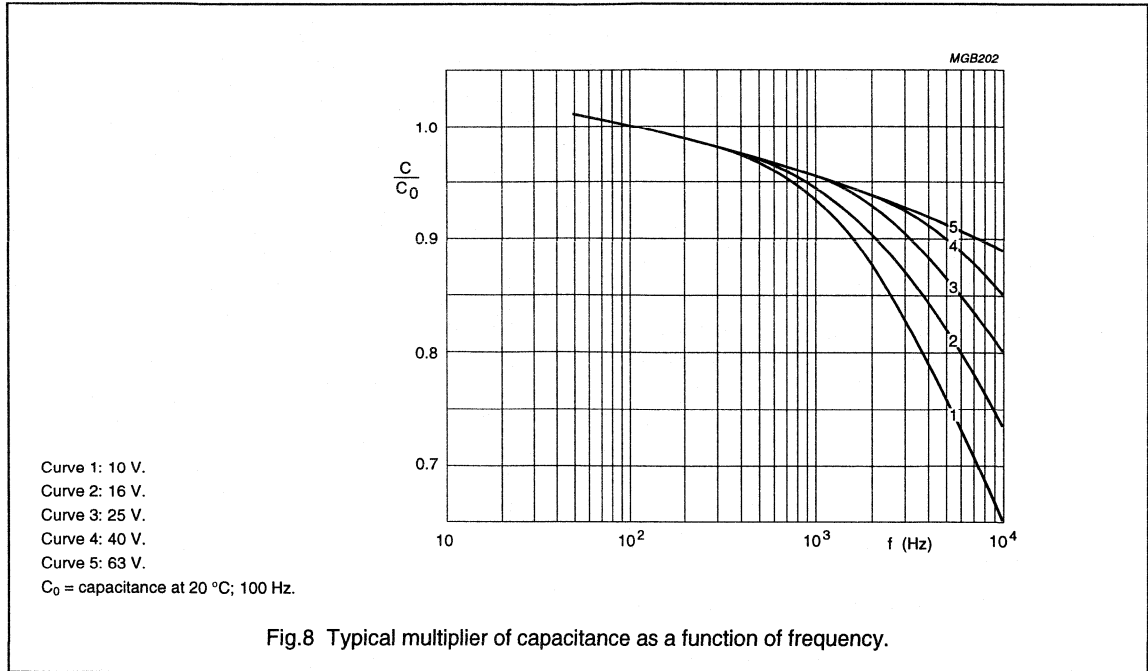
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Capacitance (C)

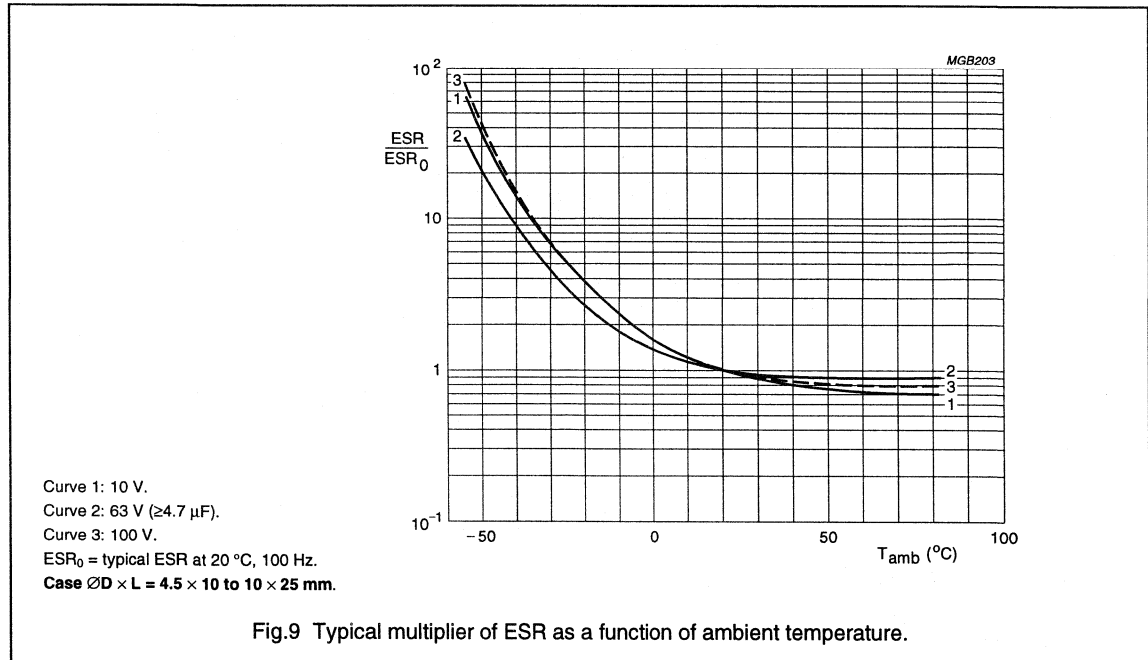


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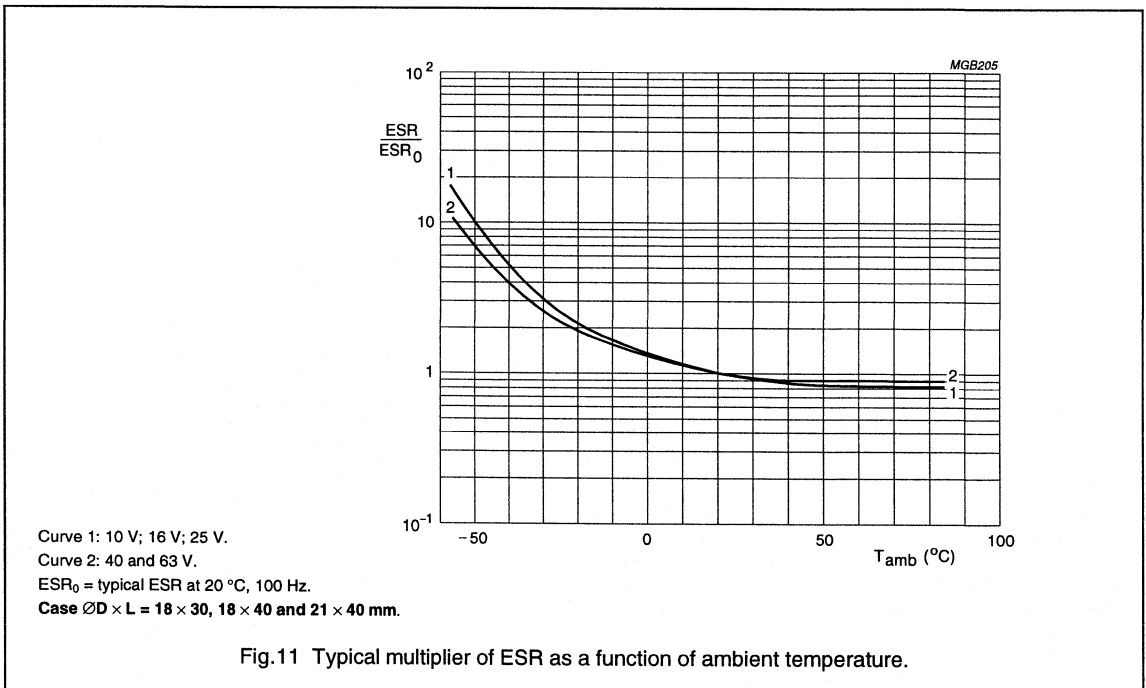
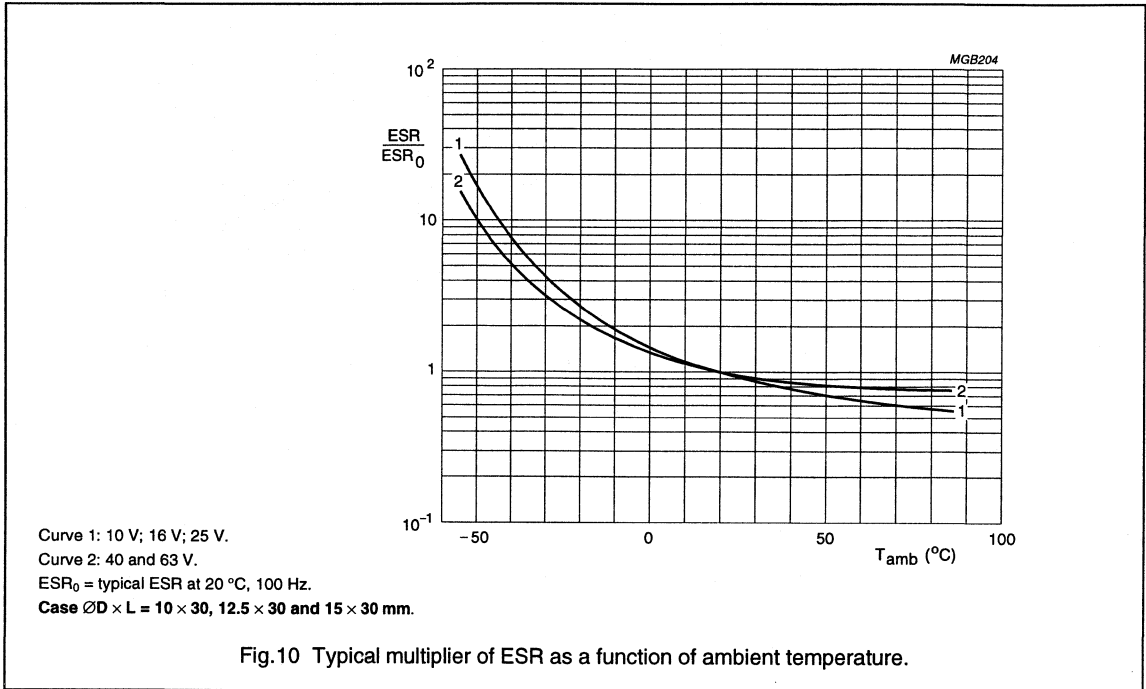
Equivalent series resistance (ESR)



Non-solid Al - electrolytic capacitors

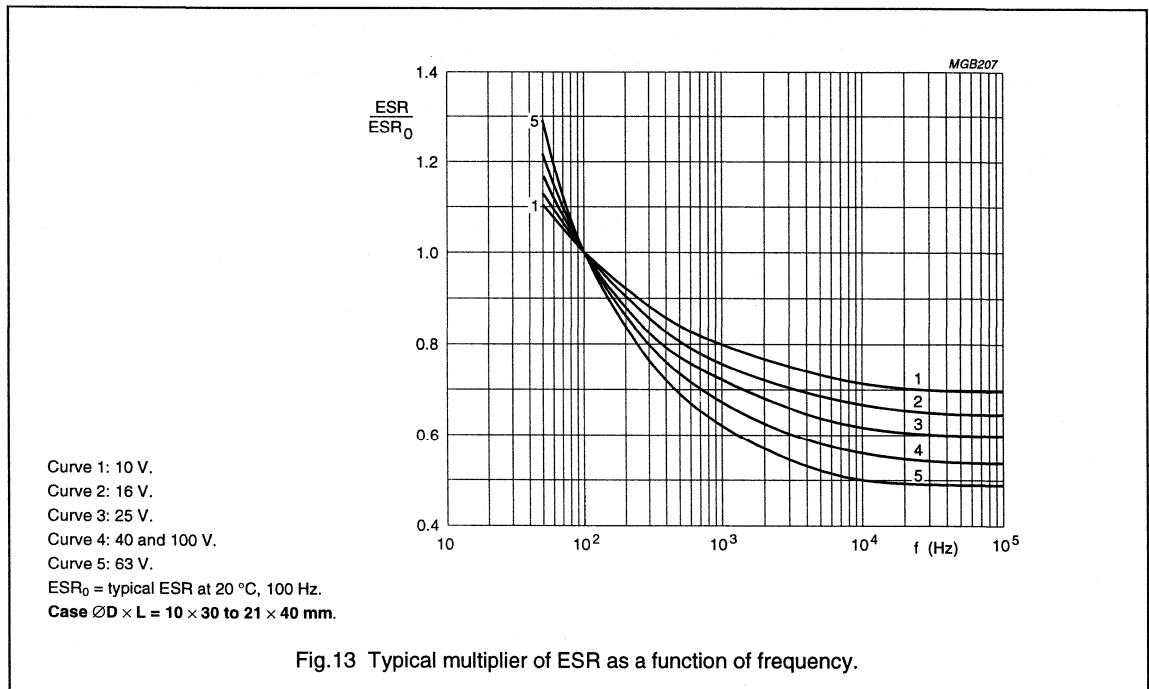
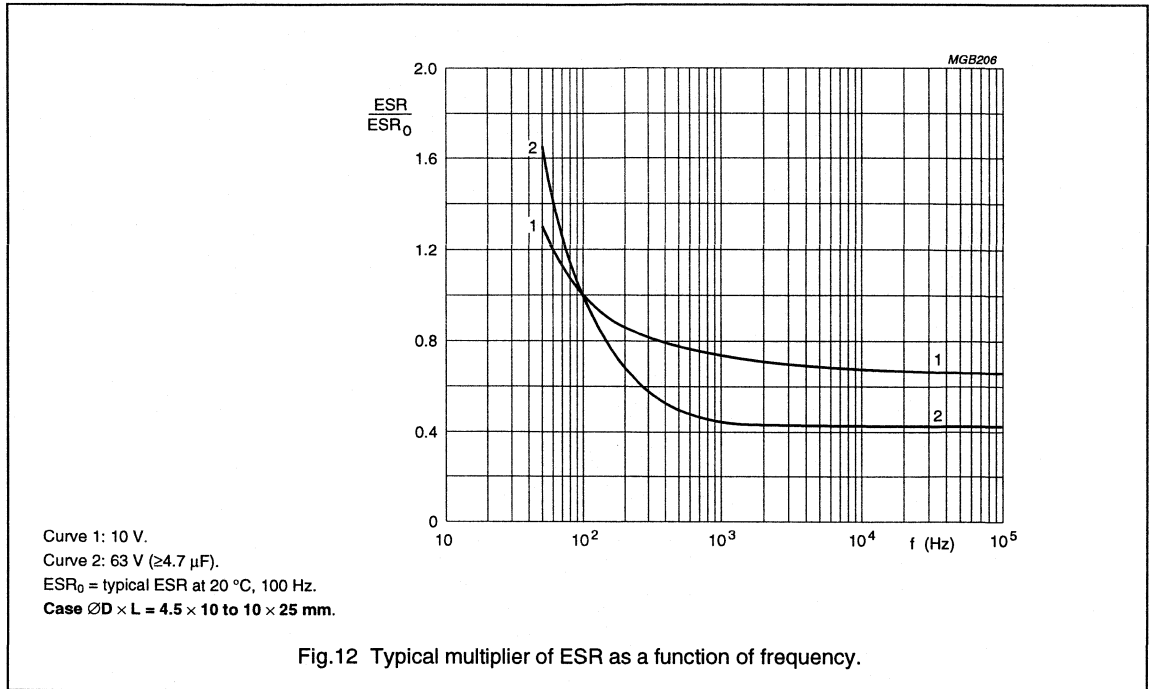
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Non-solid Al - electrolytic capacitors

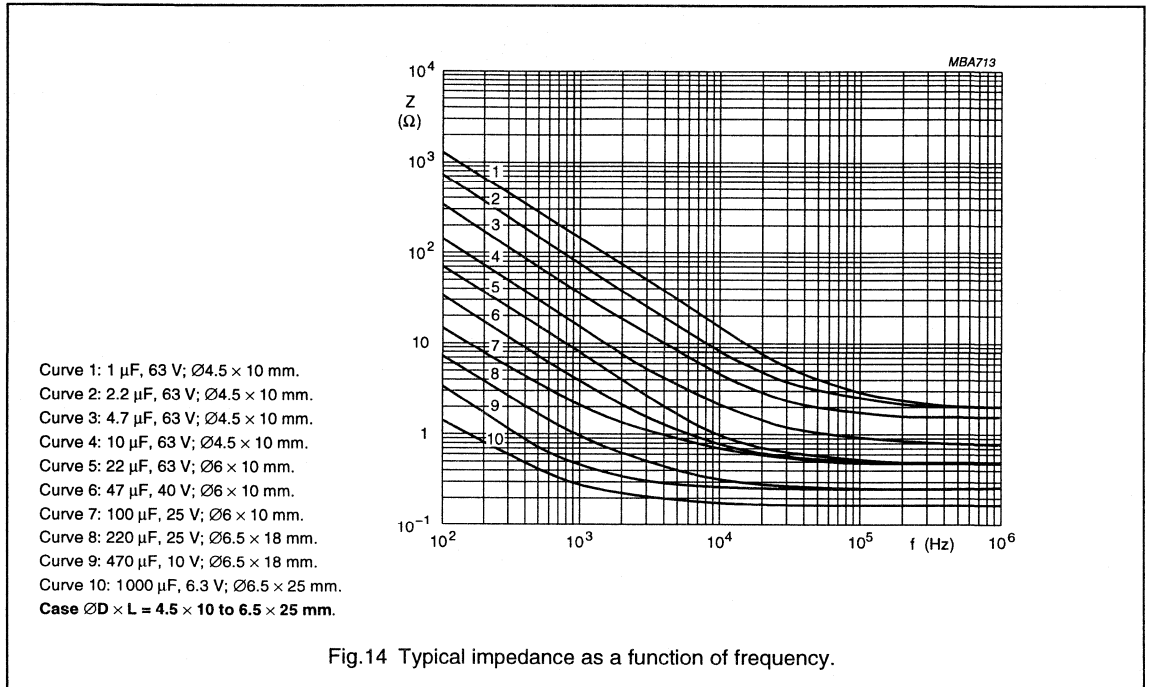
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Impedance (Z)

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

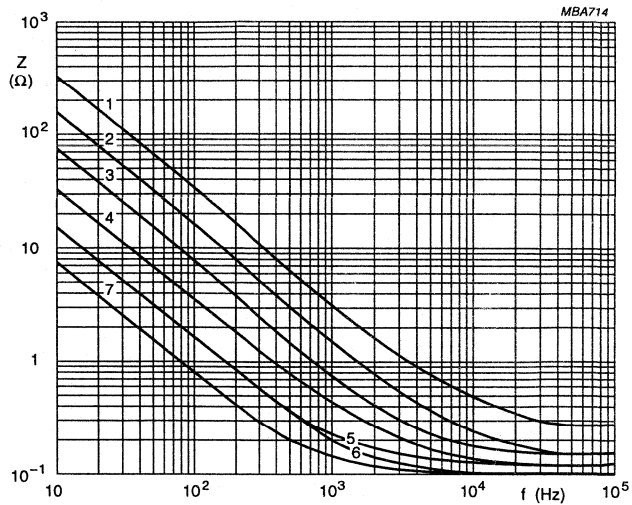
T_{amb}	$Z = Z \times C_R (\Omega \cdot \mu F)$ at 10 kHz						
	6.3 V	10 V	16 V	25 V	40 V	63 V	100 V
+20 °C	≤ 300	≤ 200	≤ 160	≤ 120	≤ 70	≤ 55	≤ 90
-25 °C	≤ 2000	≤ 1200	≤ 750	≤ 560	≤ 300	≤ 180	≤ 600
-40 °C	≤ 5500	≤ 3200	≤ 2000	≤ 1500	≤ 900	≤ 500	≤ 1600



Non-solid Al - electrolytic capacitors

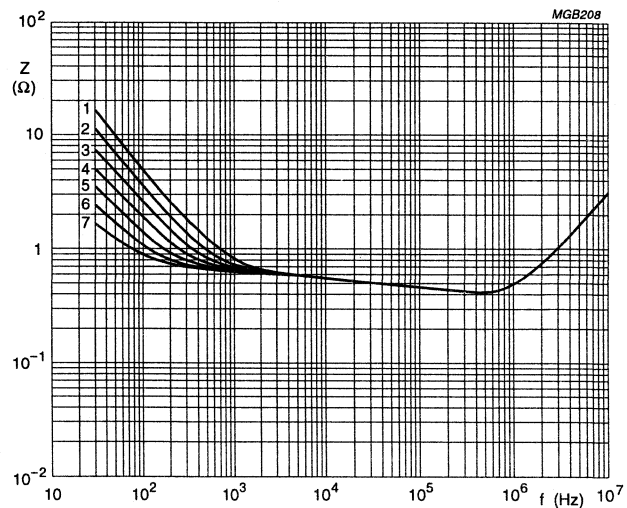
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Curve 1: 47 μF , 63 V; $\varnothing 8 \times 11$ mm.
 Curve 2: 100 μF , 63 V; $\varnothing 8 \times 18$ mm.
 Curve 3: 220 μF , 40 V; $\varnothing 10 \times 18$ mm.
 Curve 4: 470 μF , 25 V; $\varnothing 10 \times 18$ mm.
 Curve 5: 1000 μF , 10 V; $\varnothing 10 \times 18$ mm.
 Curve 6: 1000 μF , 16 V; $\varnothing 10 \times 25$ mm.
 Curve 7: 2200 μF , 6.3 V; $\varnothing 10 \times 25$ mm.
Case $\varnothing D \times L = 8 \times 11$ to 10×25 mm.

Fig.15 Typical impedance as a function of frequency.



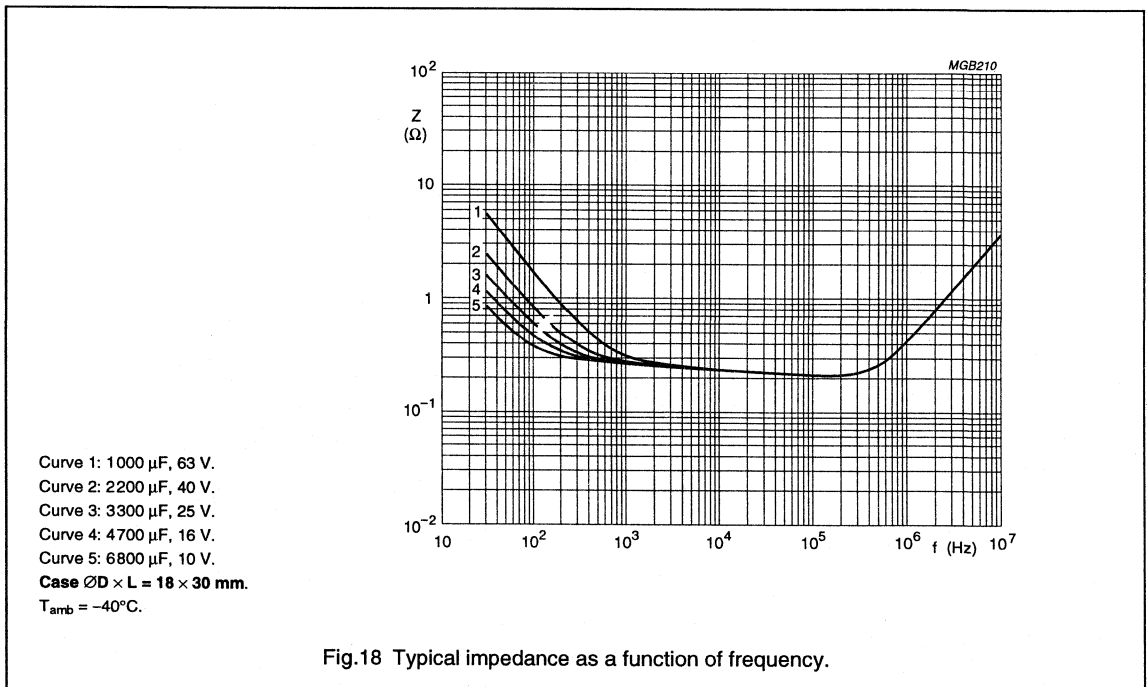
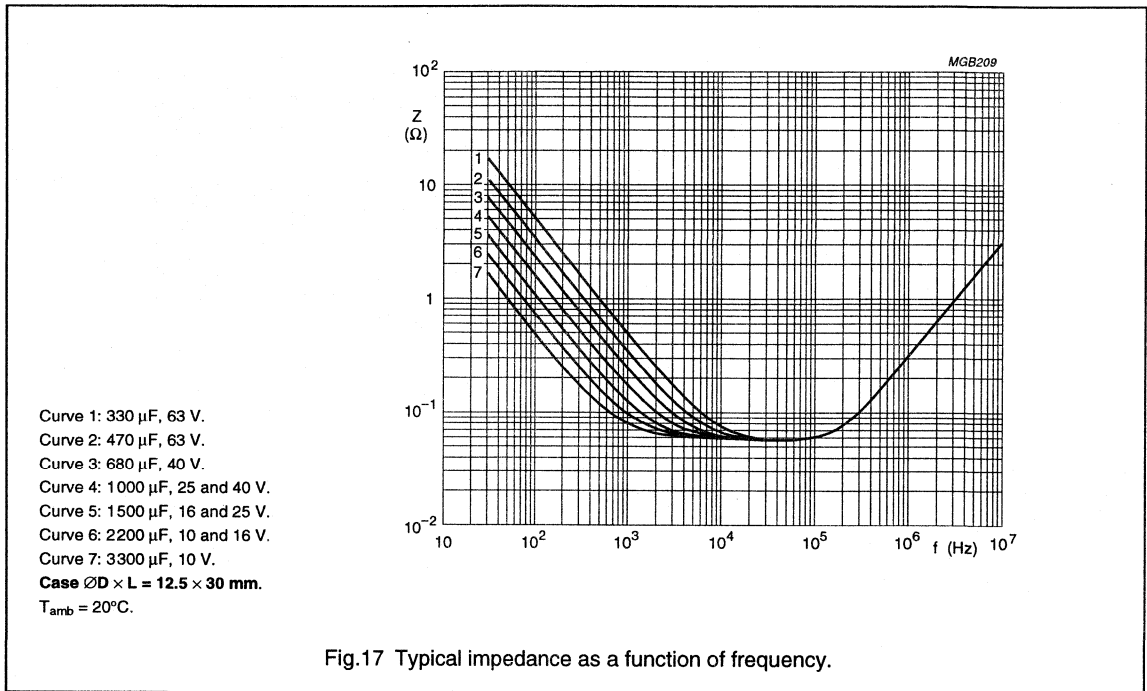
Curve 1: 330 μF , 63 V.
 Curve 2: 470 μF , 63 V.
 Curve 3: 680 μF , 40 V.
 Curve 4: 1000 μF , 25 and 40 V.
 Curve 5: 1500 μF , 16 and 25 V.
 Curve 6: 2200 μF , 10 and 16 V.
 Curve 7: 3300 μF , 10 V.
Case $\varnothing D \times L = 12.5 \times 30$ mm.
 $T_{\text{amb}} = -40^\circ\text{C}.$

Fig.16 Typical impedance as a function of frequency.

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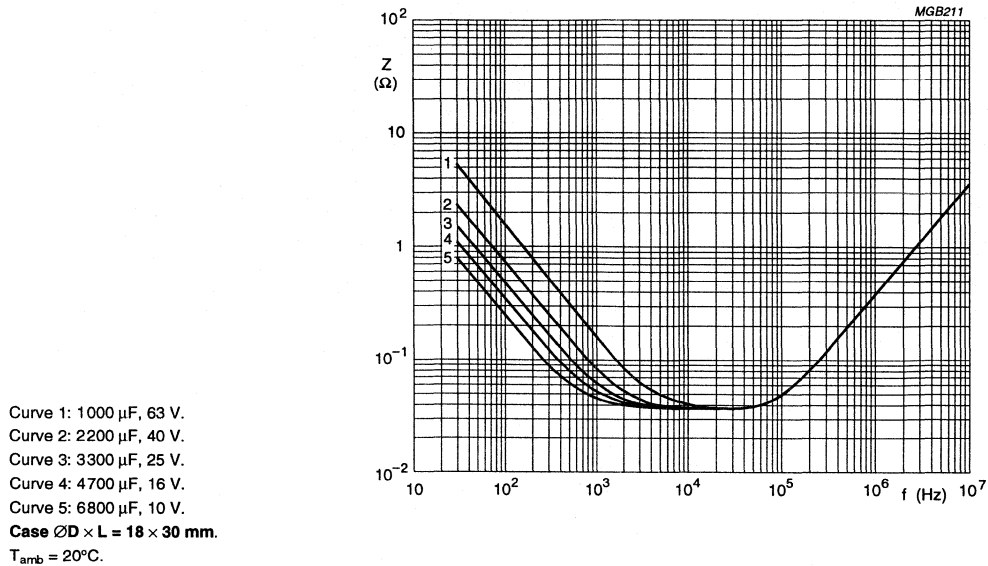


Fig.19 Typical impedance as a function of frequency.

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 $L < 18 \text{ mm}$).

A

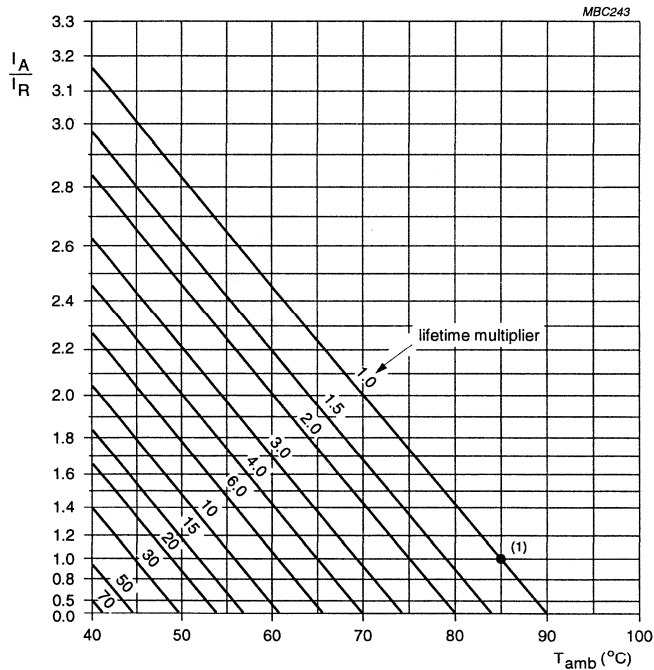
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Axial Standard Miniature

ASM 021

RIPPLE CURRENT AND USEFUL LIFE

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 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 $\varnothing D \times L = 4.5 \times 10$ 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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Non-solid Al - electrolytic capacitors

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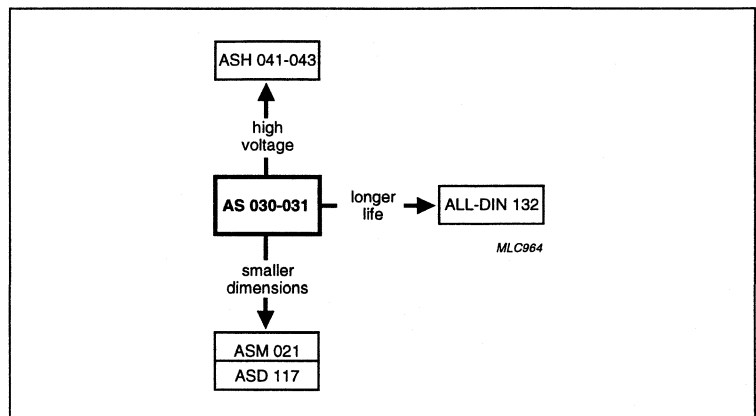
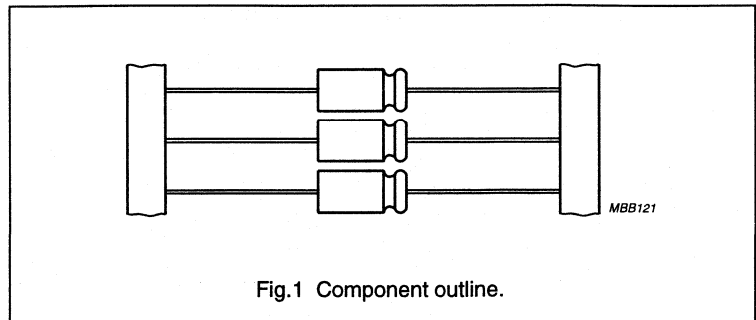
AS 030-031

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, $1.4 \times I_R$ applied	40000 hours	80000 hours
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300	
	GP grade	LL grade
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)	
Approvals	-	LNZ 44-04

Non-solid Al - 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	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 ASM 021".

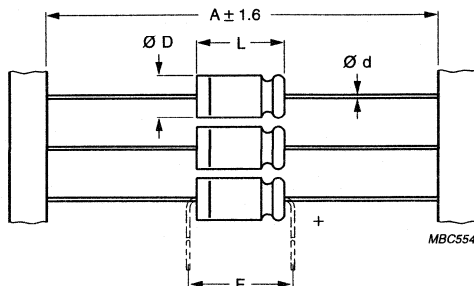
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Non-solid Al - electrolytic capacitors

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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 $\text{Ø}D \times L = 3.3 \times 11$ 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 $\text{Ø}D \times L$ (mm)	CASE CODE	AXIAL FORM BA and BR					MASS (g)	PACKAGING QUANTITIES	
		$\text{Ø}d$ (mm)	A (mm)	$\text{Ø}D_{\text{max}}$ (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 AS 031.

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 $T_{\text{amb}} = 20\text{ }^\circ\text{C}$, $P = 86$ to 106 kPa , $\text{RH} = 45$ 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
$\text{Tan } \delta$	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 (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
	10	47	4.5×10	2	70	24	5.9	6.78	3.4	030 24479	030 34479
	100	6×10	3	110	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 ∅D × 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	
	25	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
		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	
40	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	
	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 (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	
										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
100	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
	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)

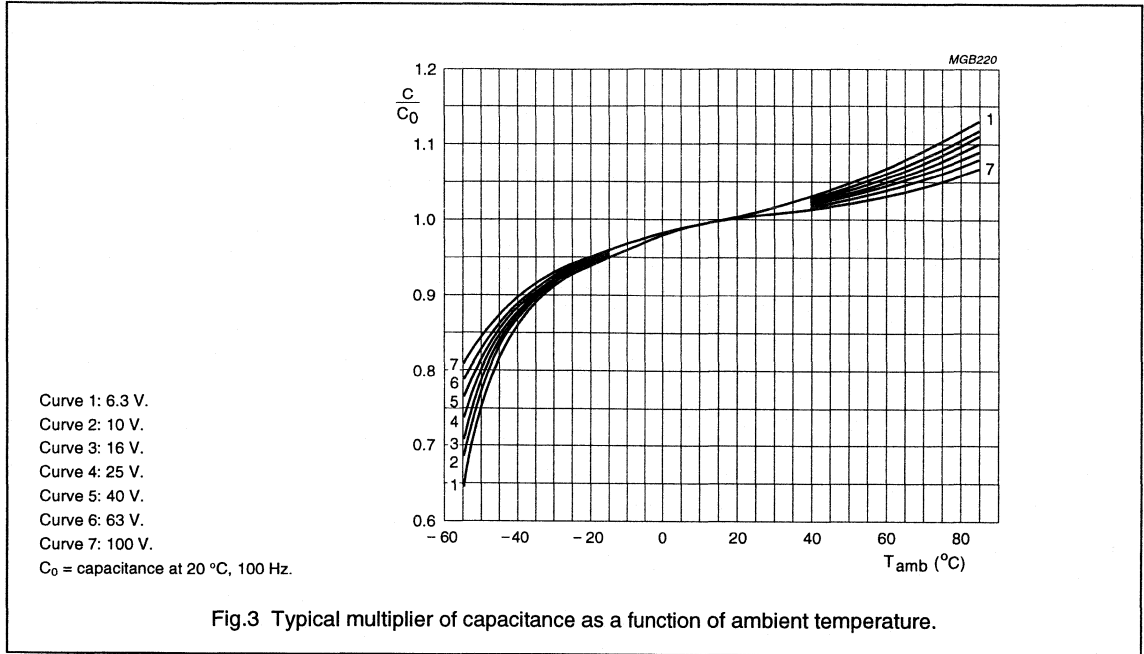


Fig.3 Typical multiplier of capacitance as a function of ambient temperature.

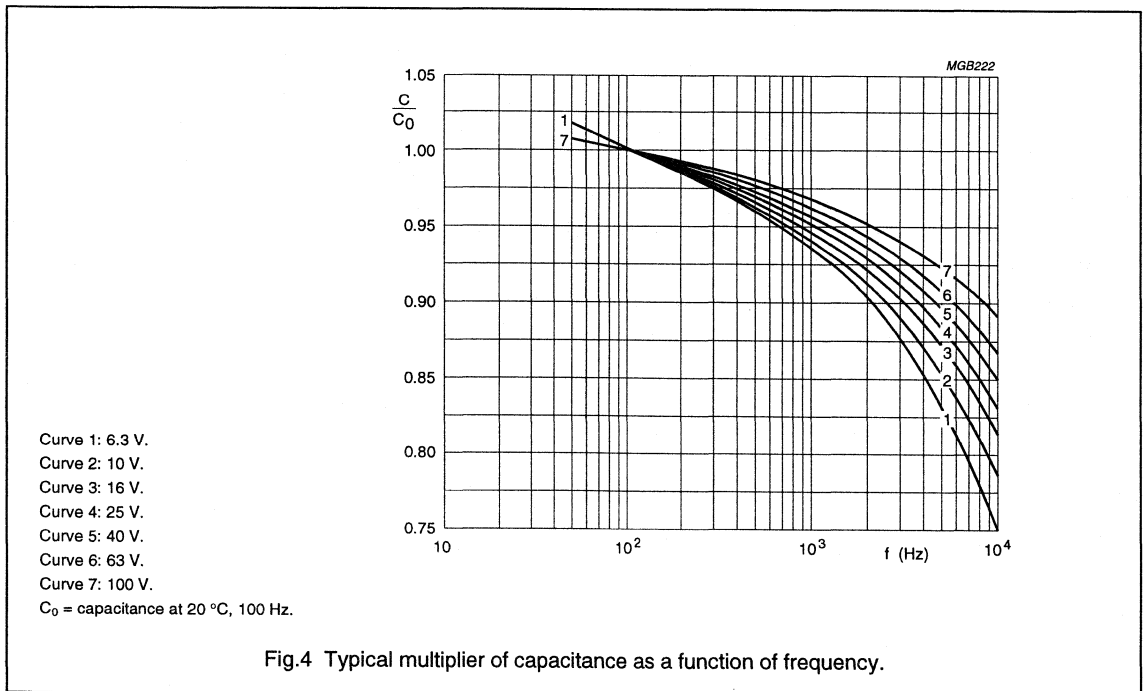
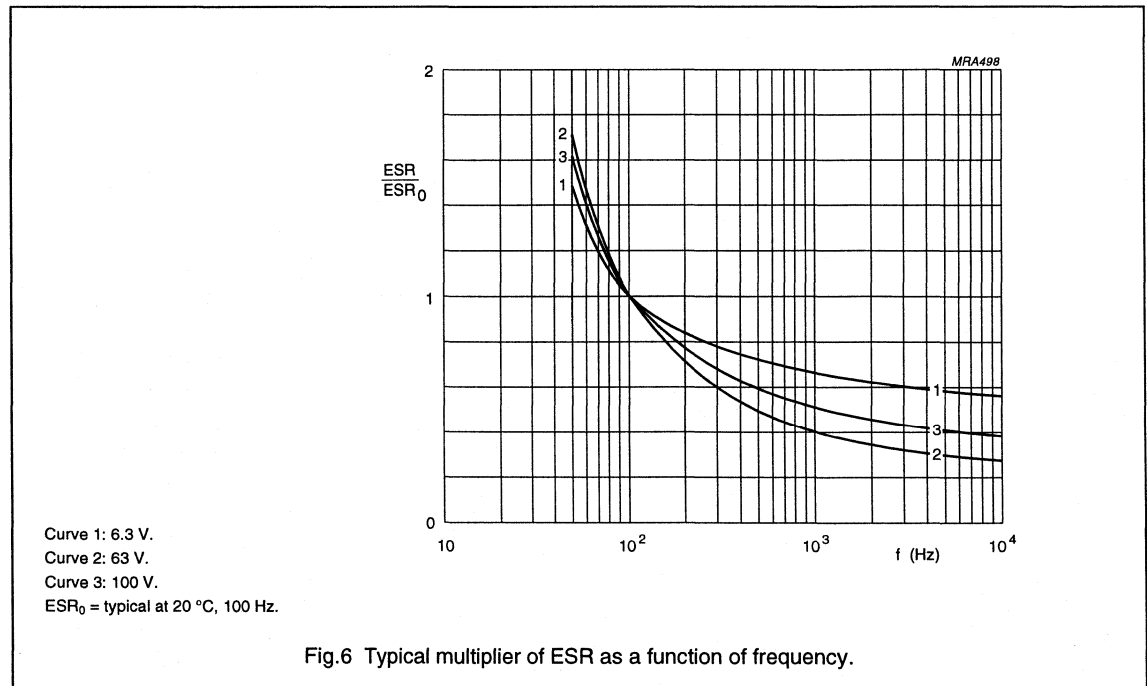
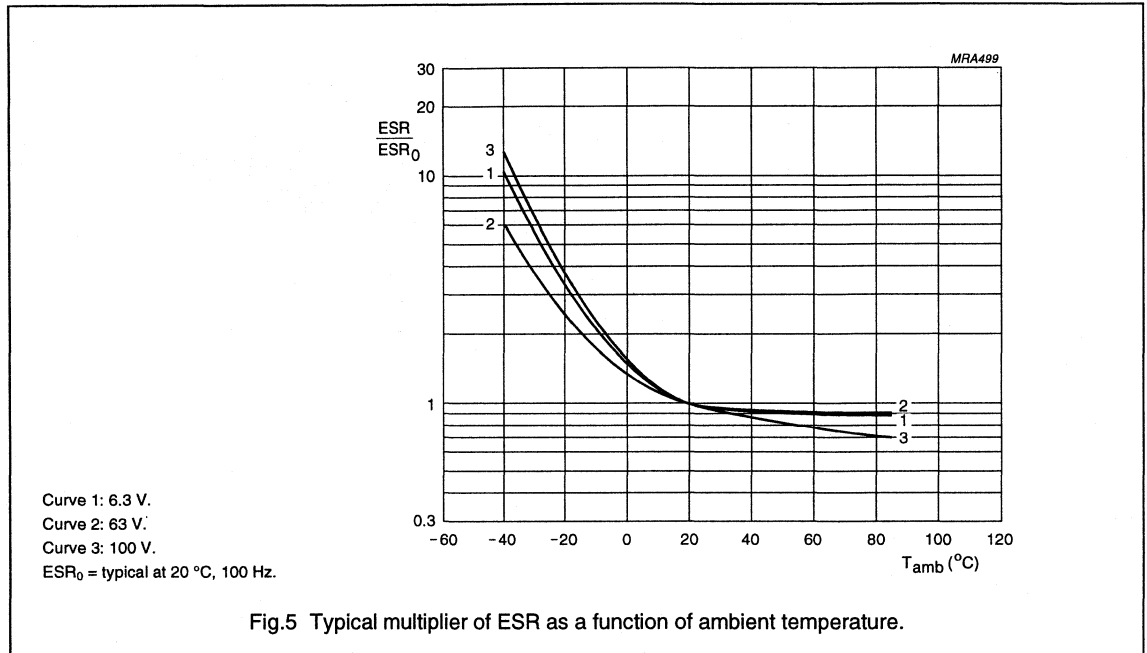


Fig.4 Typical multiplier of capacitance as a function of frequency.

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Equivalent series resistance (ESR)



Non-solid Al - electrolytic capacitors

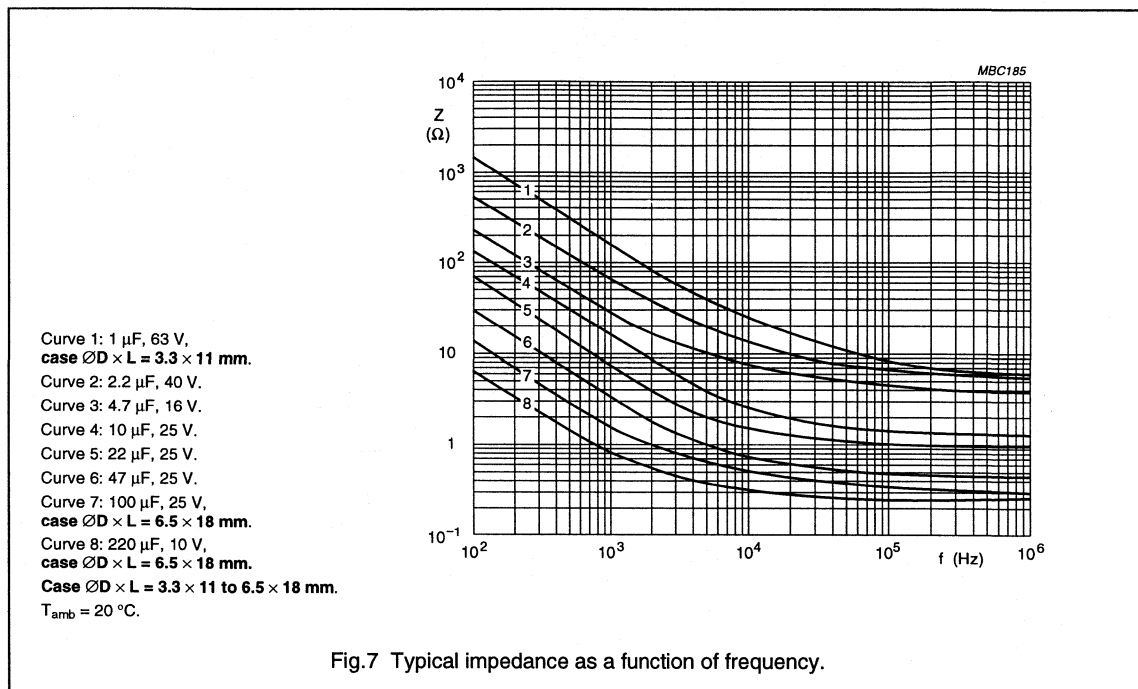
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Impedance (Z)

Table 3 Impedance \times capacitance values at 10 kHz

T_{amb}	$Z = Z \times C_R (\Omega \cdot \mu F) \text{ at } U_R$						
	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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Curve 1: 22 μF , 63 V,
case $\varnothing\text{D} \times \text{L} = 8 \times 11$ mm.
Curve 2: 47 μF , 40 V,
case $\varnothing\text{D} \times \text{L} = 8 \times 11$ mm.
Curve 3: 150 μF , 25 V.
Curve 4: 330 μF , 16 V.
Curve 5: 470 μF , 16 V.
Curve 6: 1000 μF , 6.3 V.
Case $\varnothing\text{D} \times \text{L} = 8 \times 11$ to 10×25 mm.
 $T_{\text{amb}} = 20$ °C.

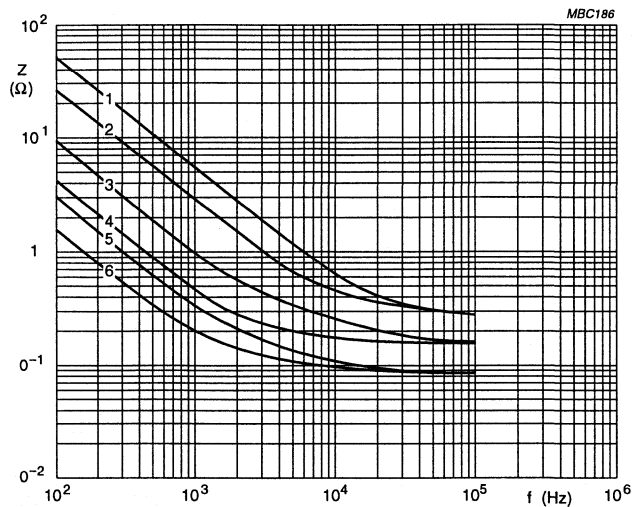


Fig.8 Typical impedance as a function of frequency.

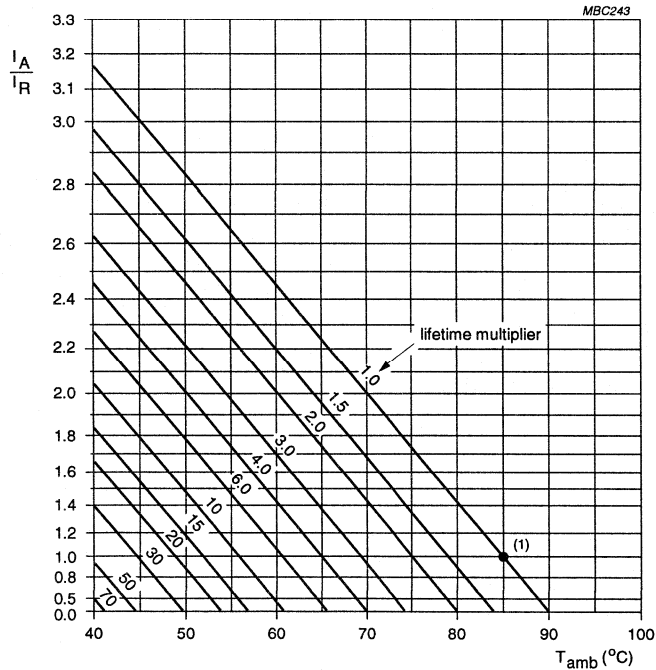
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RIPPLE CURRENT AND USEFUL LIFE

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.

Non-solid Al - 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		
Case $\varnothing D \times L = 3.3 \times 11$ mm			
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85$ °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	$T_{amb} = 85$ °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 384-4/ 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	$\Delta C/C, \tan \delta, Z$: for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$
Case $\varnothing D \times L = 4.5 \times 10$ to 10×25 mm			
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85$ °C; U_R applied; 2000 hours	$U_R \leq 6.3$ V; $\Delta C/C: +15/-30\%$ $U_R > 6.3$ V; $\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85$ °C; U_R and I_R applied; 3000 hours	$U_R \leq 6.3$ V; $\Delta C/C: +45/-50\%$ $U_R > 6.3$ V; $\Delta C/C: \pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85$ °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 $I_{L5} \leq 2 \times \text{spec. limit}$

Non-solid Al - electrolytic capacitors

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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.

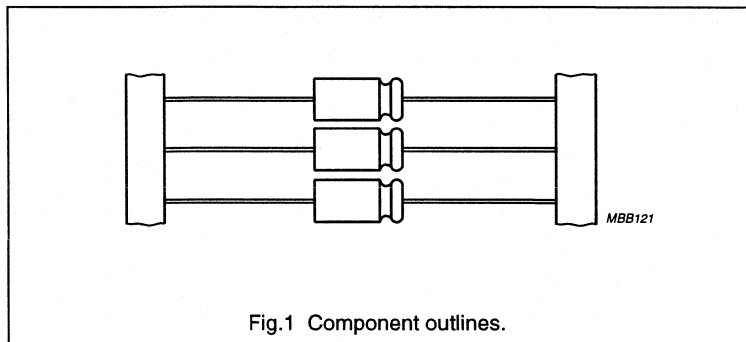
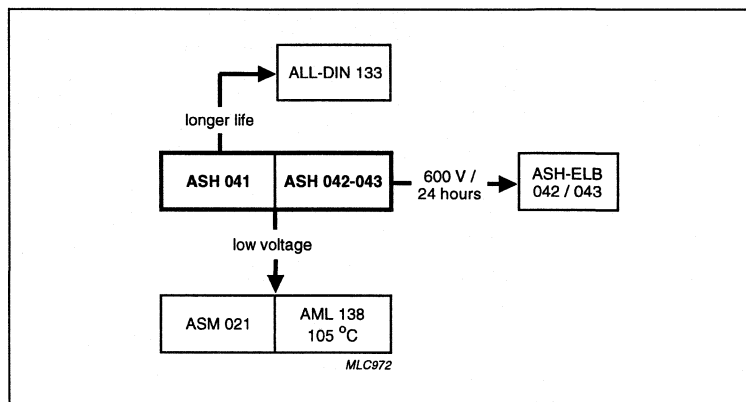


Fig.1 Component outlines.



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 μ F	
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, LL grade	
Climatic category IEC 68 (DIN 40040)	40/085/56 (450 V: 25/085/56); GPF (450 V: HPF)	

Non-solid Al - 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	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:

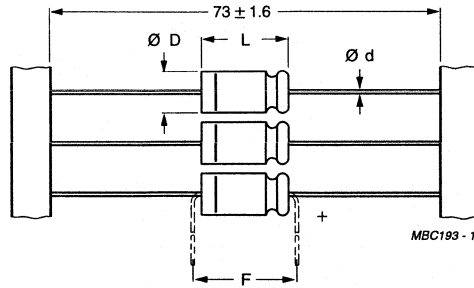
- Rated capacitance (in μF)
- Tolerance on rated capacitance, code letter in accordance with "IEC 62"
- Rated voltage (in V)
- Group number (041, 042 or 043)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with "IEC 62"
- Code indicating factory of origin
- Band to identify the negative terminal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

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

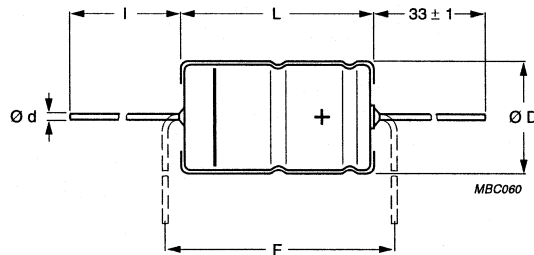
Form BR: Taped on reel,
case $\varnothing D \times L = 6.5 \times 18$ to 15×30 mm.

Form BA: Taped in box (ammpack),
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.

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

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

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	AXIAL: FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		Ød (mm)	l (mm)	ØD _{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	–	–

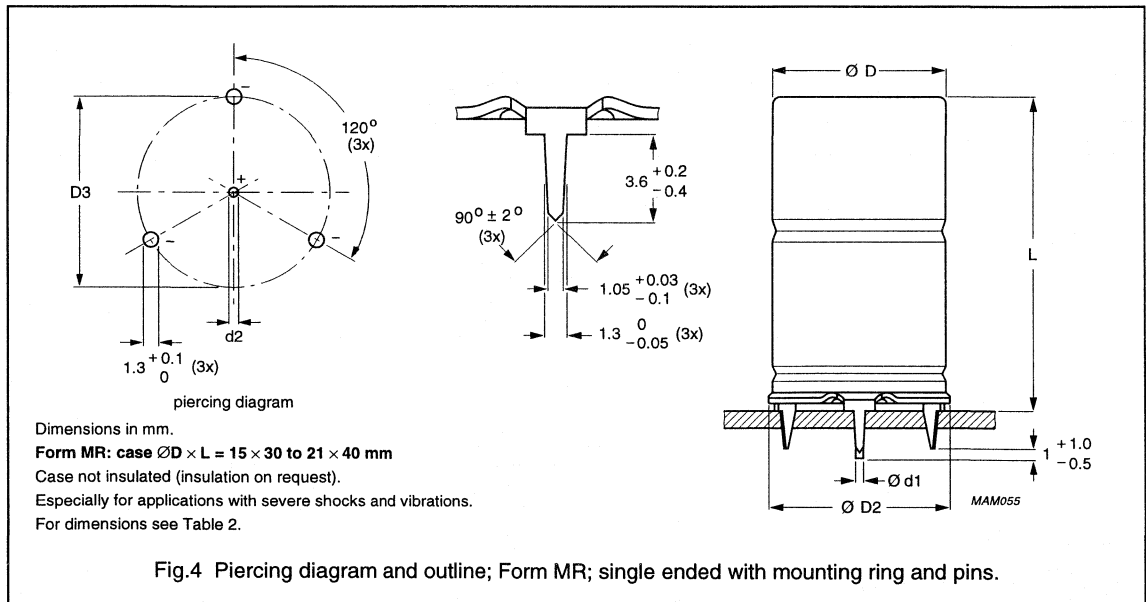


Fig. 4 Piercing diagram and outline; Form MR; single ended with mounting ring and pins.

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

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	SINGLE ENDED WITH MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		ØD ₁ (mm)	ØD ₂ (mm)	ØD _{max} (mm)	ØD _{2max} (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 ASH 041
10 μ F/250 V; -10/+50%
Nominal case size: \varnothing 10 x 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 $T_{amb} = 20^\circ C$,
 $P = 86$ 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

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 °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			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
160	4.7	6.5 x 18	4	50	38	8	0.15	51	26	-	041 21478	041 31478	-
	10	8 x 18	5	70	68	14	0.15	24	12	-	041 21109	041 31109	-
	22	10 x 25	7	150	130	25	0.15	11	5.5	-	041 21229	041 31229	-
	22	10 x 30	00	120	42	25	0.10	6.8	5.5	042 11229	042 21229	-	-
	33	12.5 x 30	01	150	58	36	0.10	4.5	3.1	042 11339	042 21339	-	-
	47	15 x 30	02	190	78	49	0.10	3.2	2.1	042 11479	042 21479	-	042 41479
	68	15 x 30	02	230	110	69	0.10	2.2	1.4	042 11689	042 21689	-	042 41689
	100	18 x 30	03	350	150	100	0.10	1.5	1.0	042 11101	-	-	042 41101
	150	18 x 40	04	430	230	150	0.10	1.0	0.7	043 11151	-	-	043 41151
	220	21 x 40	05	610	330	220	0.10	0.7	0.5	043 11221	-	-	043 41221
250	2.2	6.5 x 18	4	35	28	6	0.10	72	50	-	041 23228	041 33228	-
	4.7	8 x 18	5	55	55	11	0.10	34	23	-	041 23478	041 33478	-
	10	10 x 25	7	90	95	19	0.10	16	11	-	041 23109	041 33109	-
	10	10 x 30	00	72	33	19	0.10	15	11	042 13109	042 23109	-	-

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CATALOGUE NUMBER 2222													
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × 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 MOUNTING RING FORM MR
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	
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

Non-solid Al - electrolytic capacitors

Axial Standard, High Voltage

ASH 041 - 043

CATALOGUE NUMBER 2222														
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × 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				
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	SINGLE ENDED	
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	68	18 × 40	04	250	390	140	0.10	3.2	2.1	043 17479	-	-	043 47479	
														043 17689

Non-solid Al - electrolytic capacitors

Axial Standard, High Voltage

ASH 041 - 043

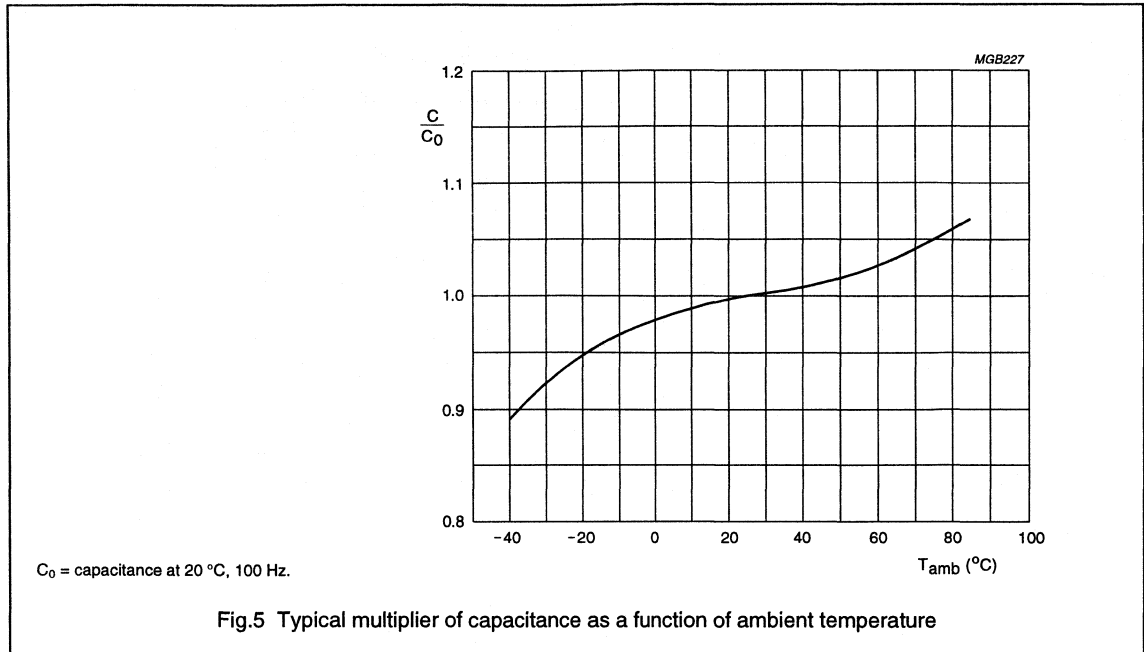
Additional electrical data

PARAMETER	CONDITIONS	VALUE	
		AXIAL	SINGLE ENDED
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:		
	case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm $CV \leq 1000 \mu C$ $CV > 1000 \mu C$	$I_{L1} \leq 0.05 C_R \times U_R$ or $5 \mu A$, whichever is greater $I_{L1} \leq 0.03 C_R \times U_R + 20 \mu A$	
	case $\varnothing D \times L = 10 \times 30$ to 21×40 mm $U_R = 160$ to 385 V $U_R = 400$ and 450 V	$I_{L1} \leq 0.009 C_R \times U_R + 10 \mu A$ $I_{L1} \leq 0.009 C_R \times U_R + 200 \mu A$	
	after 5 minutes: $U_R = 160$ to 385 V $CV \leq 1000 \mu C$ $CV > 1000 \mu C$ $U_R = 400$ and 450 V	$I_{L5} \leq 0.01 C_R \times U_R$ or $1 \mu A$, whichever is greater $I_{L5} \leq 0.006 C_R \times U_R + 4 \mu A$ $I_{L5} \leq 0.002 C_R \times U_R + 100 \mu A$	
Inductance			
Equivalent series inductance (ESL)	case $\varnothing D \times L$ 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

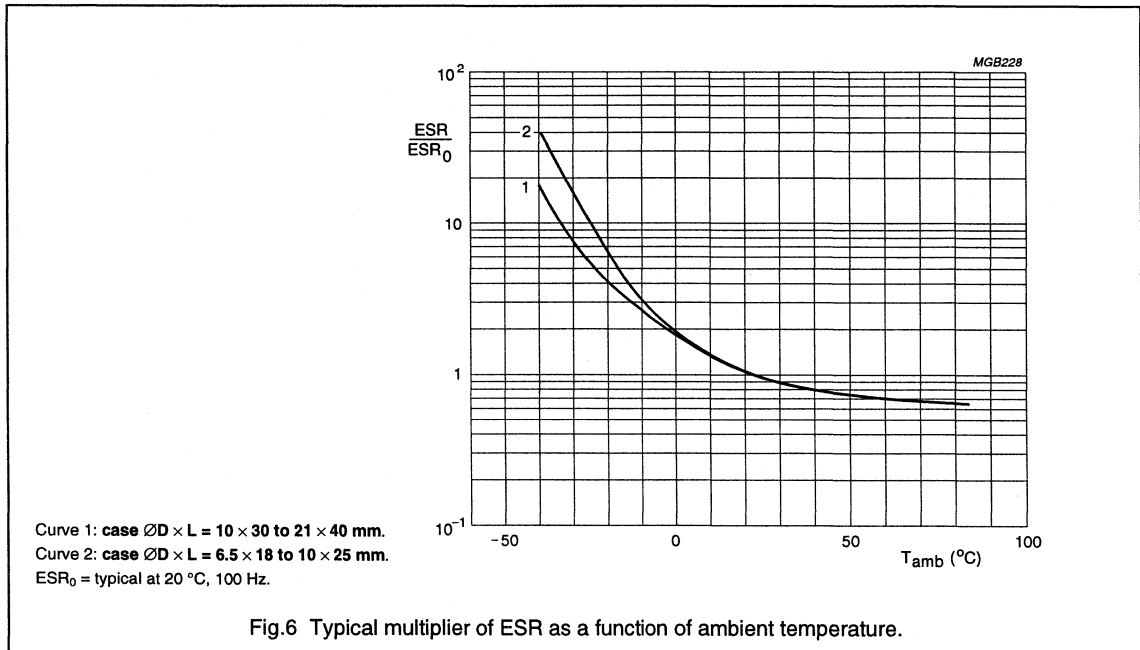
Non-solid Al - electrolytic capacitors
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Capacitance (C)

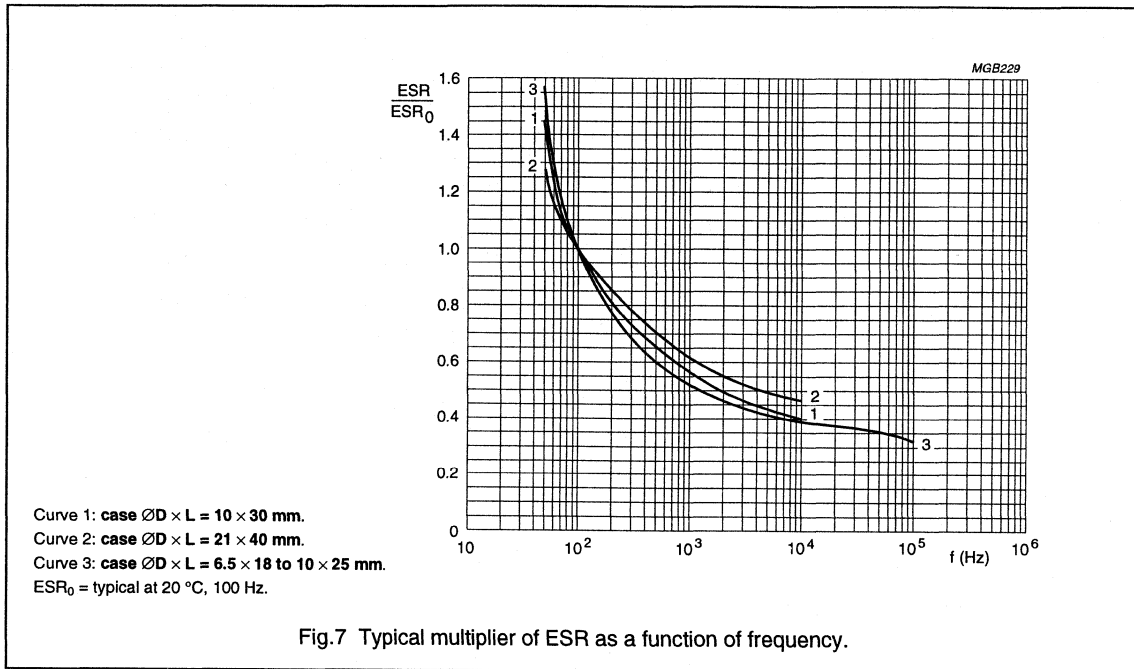


Equivalent series resistance (ESR)

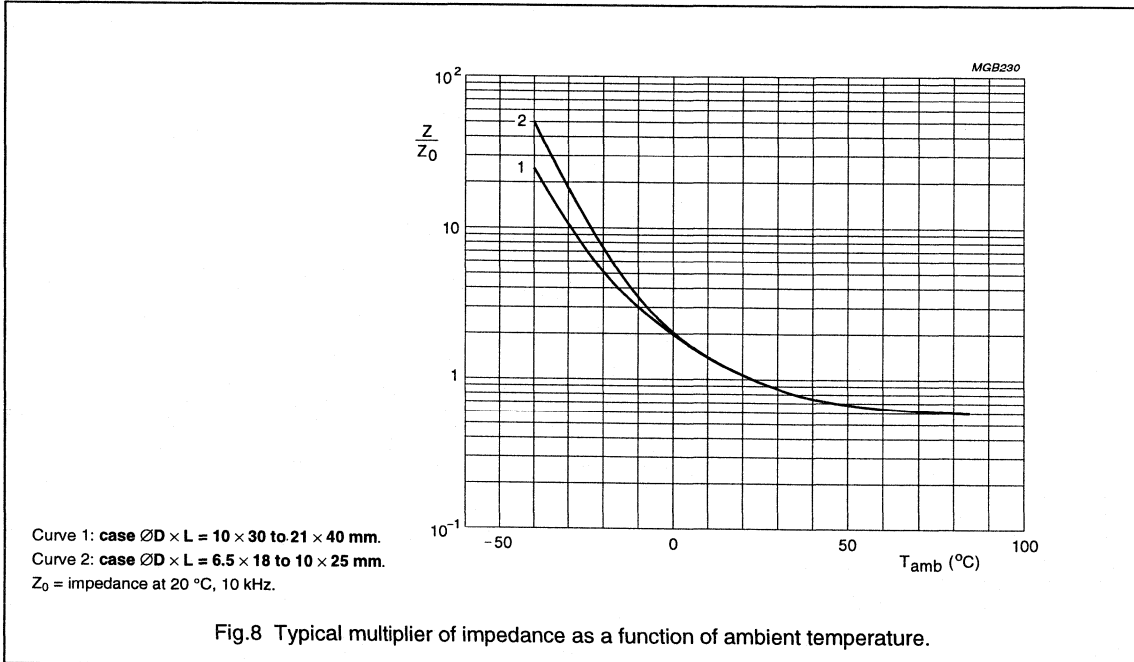


Non-solid Al - electrolytic capacitors
Axial Standard, High Voltage

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Impedance (Z)



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

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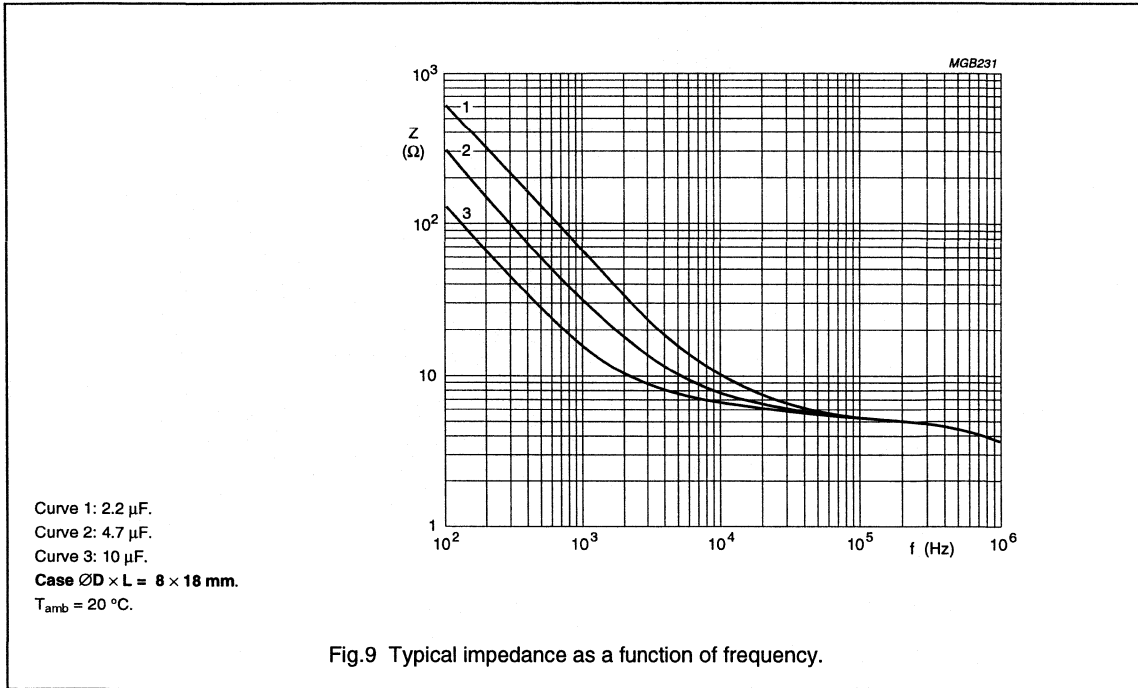


Fig.9 Typical impedance as a function of frequency.

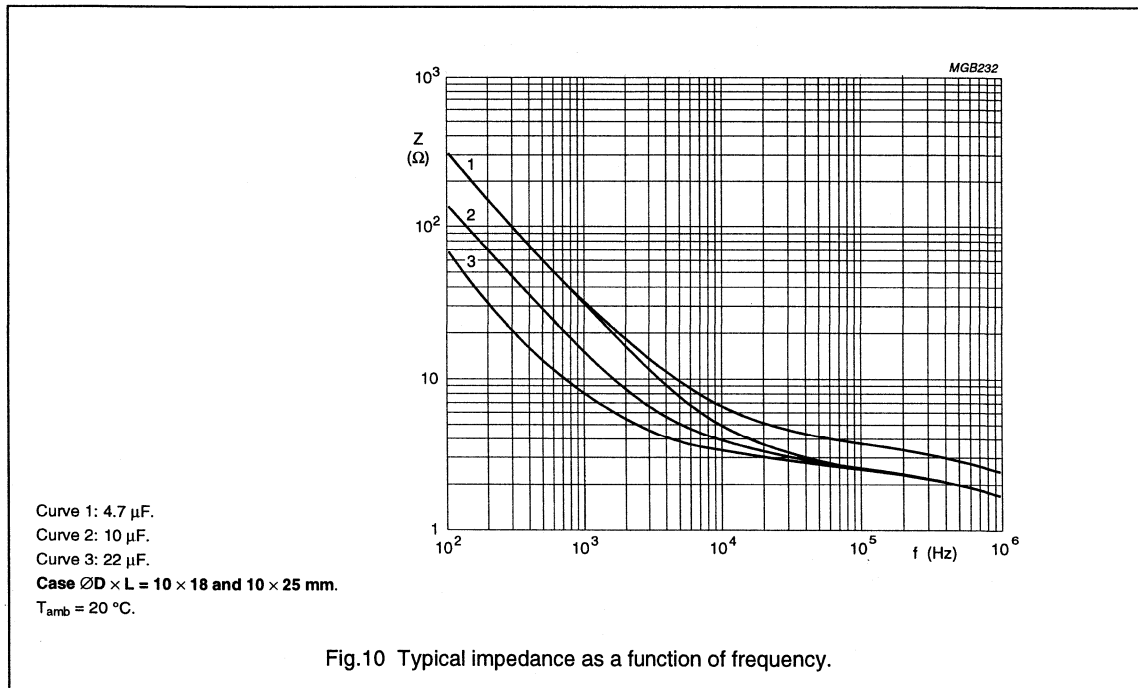
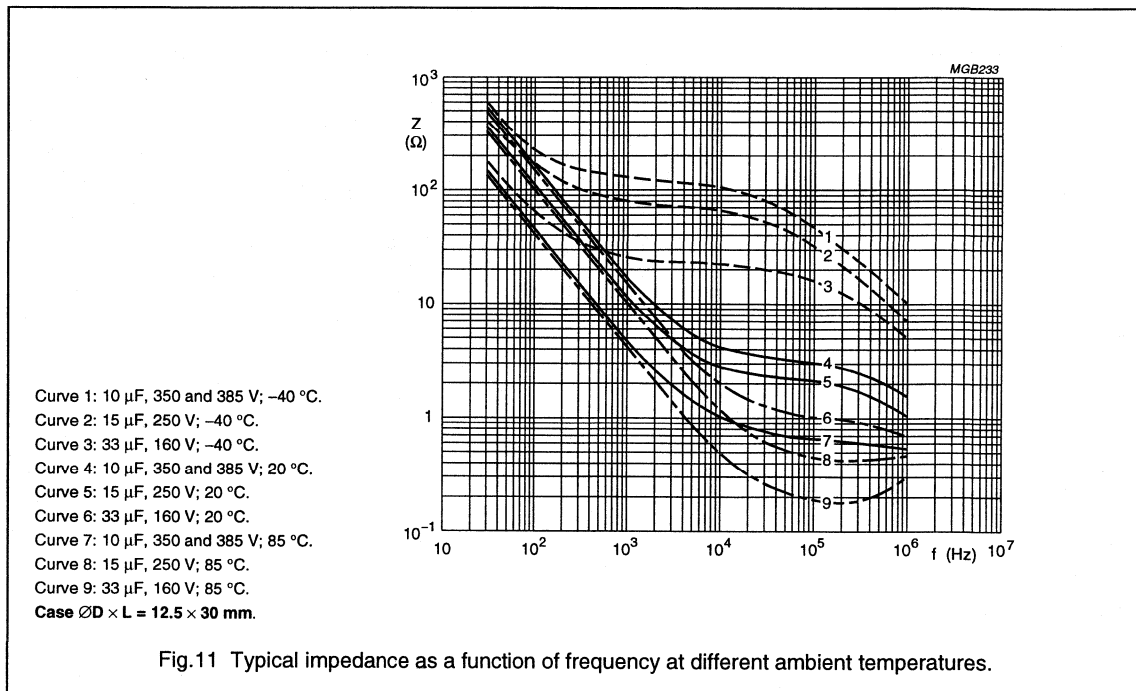


Fig.10 Typical impedance as a function of frequency.

Non-solid Al - electrolytic capacitors

Axial Standard, High Voltage

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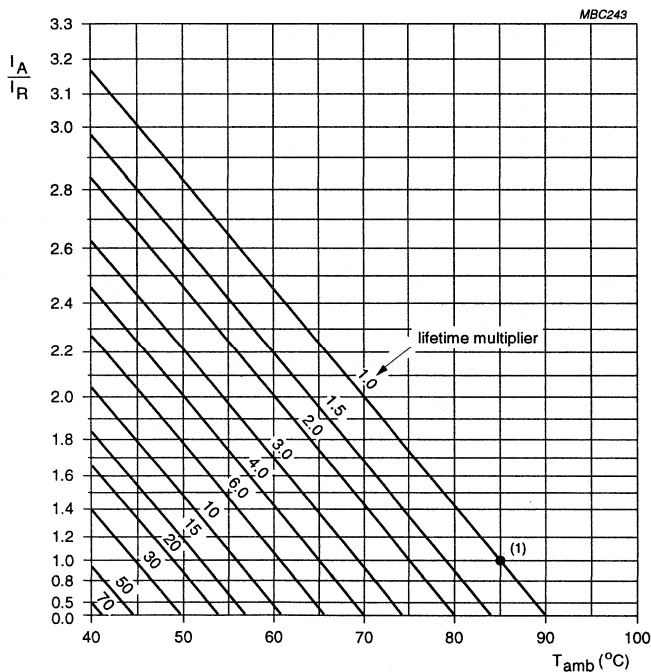
Non-solid Al - electrolytic capacitors Axial Standard, High Voltage

ASH 041 - 043

RIPPLE CURRENT AND USEFUL LIFE

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

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.75
100	1.0
300	1.15
1000	1.3
3000	1.4
≥ 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.

Non-solid Al - electrolytic capacitors

Axial Standard, High Voltage

ASH 041 - 043

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)	$U_R = 160\text{ V}$; $\Delta C/C: \pm 15\%$ $U_R = 250\text{ to }450\text{ V}$; $\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
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)	$U_R = 160\text{ V}$; $\Delta C/C: \pm 45\%$ $U_R = 250\text{ to }450\text{ V}$; $\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ 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 $I_{L5} \leq 2 \times \text{spec. limit}$

Non-solid Al - electrolytic capacitors

Axial, High Voltage for Electronic Lighting Ballast

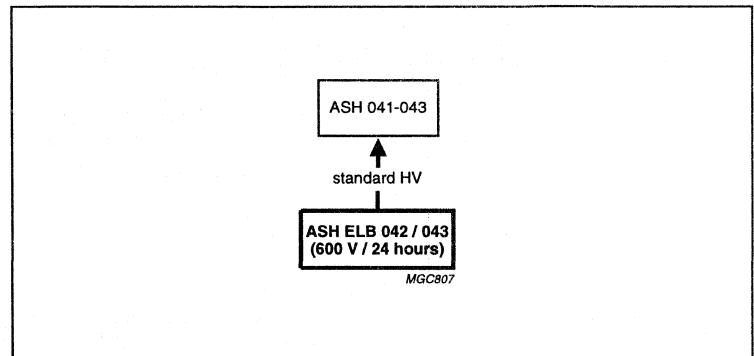
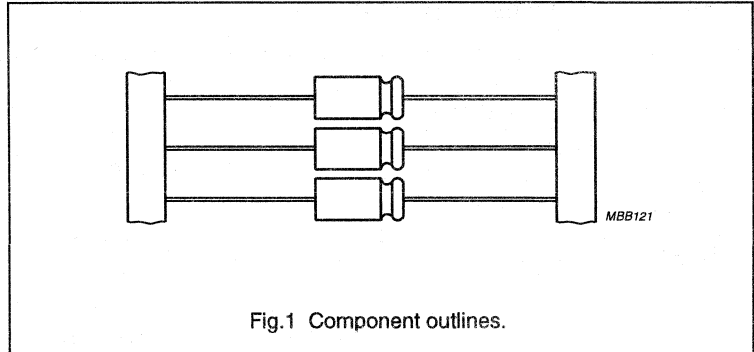
ASH-ELB 042-043

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium 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

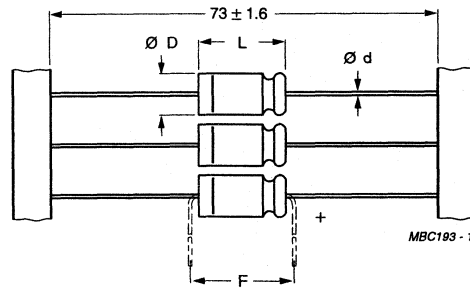
DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	12.5 × 30 to 21 × 40
Rated capacitance range, C_R	6.8 to 33 μ F
Tolerance on C_R	-10 to +50%
Rated voltage, U_R	450 V
Category temperature range	-25 to +85 °C
Endurance test at 85 °C	5000 hours
Useful life at 85 °C	15000 hours
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, LL grade
Climatic category IEC 68 (DIN 40040)	25/085/56 (GPF)

Non-solid Al - electrolytic capacitors

Axial, High Voltage for Electronic Lighting Ballast

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

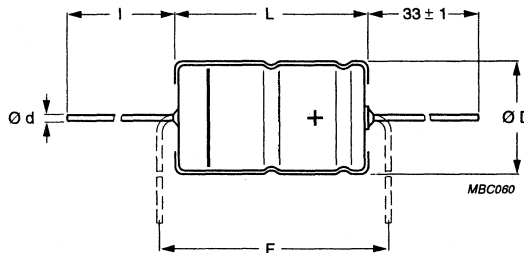
Form BR: Taped on reel.

Case $\varnothing D \times L = 12.5 \times 30$ and 15×30 mm.

For dimensions see Table 1.

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

Fig.2 Dimensional outline; Form BR.



Dimensions in mm.

Form AA: Axial in box.

Case $\varnothing D \times L = 12.5 \times 30$ 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.

Fig.3 Dimensional outline; Form AA.

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 and BR					MASS (g)	PACKAGING QUANTITIES	
		$\varnothing d$ (mm)	l (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F_{min} (mm)		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	–

Non-solid Al - electrolytic capacitors Axial, High Voltage for Electronic Lighting Ballast

ASH-ELB 042-043

Ordering example

Electrolytic capacitor ASH-ELB 042
10 μ F/450 V; -10/+50%
Nominal case size: \varnothing 15 x 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 $T_{amb} = 20\text{ }^{\circ}\text{C}$,
 $P = 86$ 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 $^{\circ}\text{C}$ or 10 kHz, 70 $^{\circ}\text{C}$
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

Table 2 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 $^{\circ}\text{C}$ (mA)	I_R 10 kHz 70 $^{\circ}\text{C}$ (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	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 x 30	01	110	630	230	105	7.9	4.4	042 91688	042 92688
	10	15 x 30	02	170	980	240	110	5.3	3.0	042 91109	042 92109
	15	18 x 30	03	250	1400	260	115	3.6	2.0	042 91159	-
	22	18 x 40	04	320	1850	290	120	2.4	1.4	043 91229	-
	33	21 x 40	05	390	2200	330	130	1.7	1.0	043 91339	-



Non-solid Al - electrolytic capacitors
Axial, High Voltage for Electronic Lighting Ballast

ASH-ELB 042-043

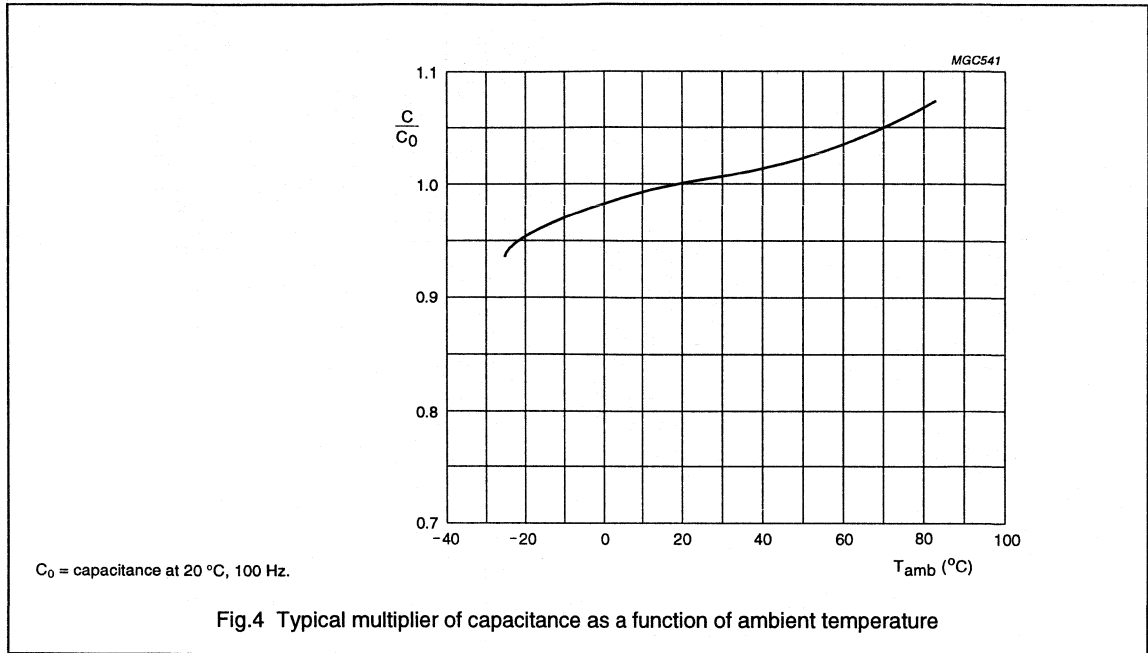
Additional electrical data

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 $21 \times 40 \text{ mm}$	$I_{L1} \leq 0.009 C_R \times U_R + 200 \mu\text{A}$
	after 5 minutes: $U_R = 450 \text{ V}$	$I_{L5} \leq 0.002 C_R \times U_R + 100 \mu\text{A}$
Inductance		
Equivalent series inductance	case $\varnothing D \times L$ in mm: 12.5 × 30 15 × 30 18 × 30 18 × 40 21 × 40	typ. 46 nH typ. 48 nH typ. 50 nH typ. 54 nH typ. 59 nH

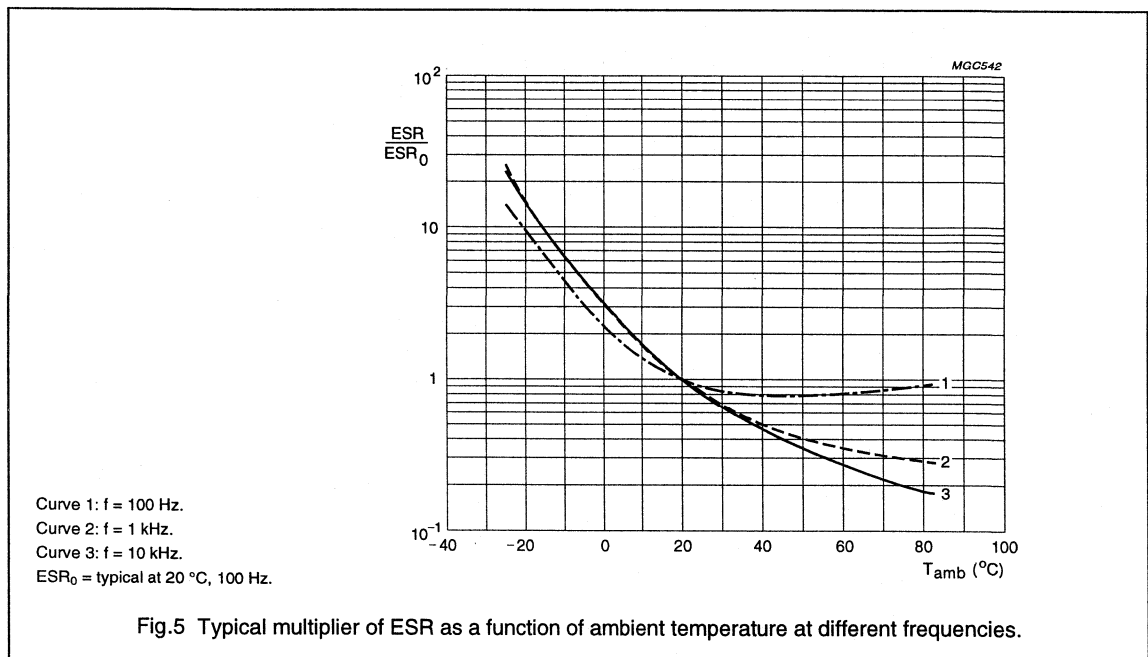
Non-solid Al - electrolytic capacitors
 Axial, High Voltage for Electronic Lighting Ballast

ASH-ELB 042-043

Capacitance (C)

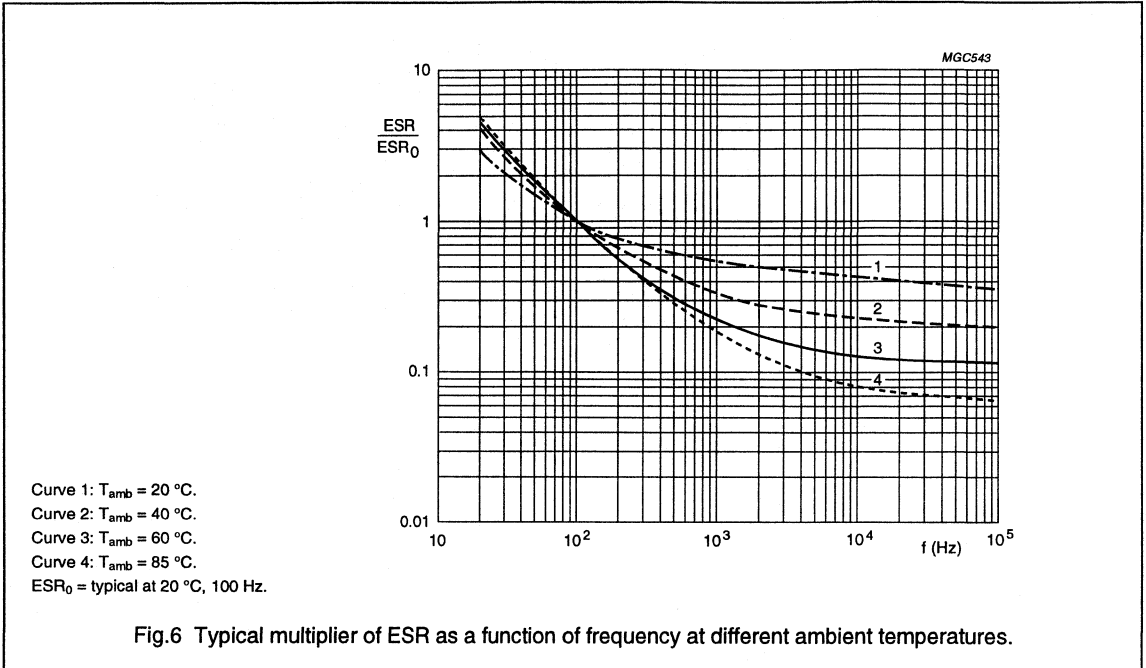


Equivalent series resistance (ESR)

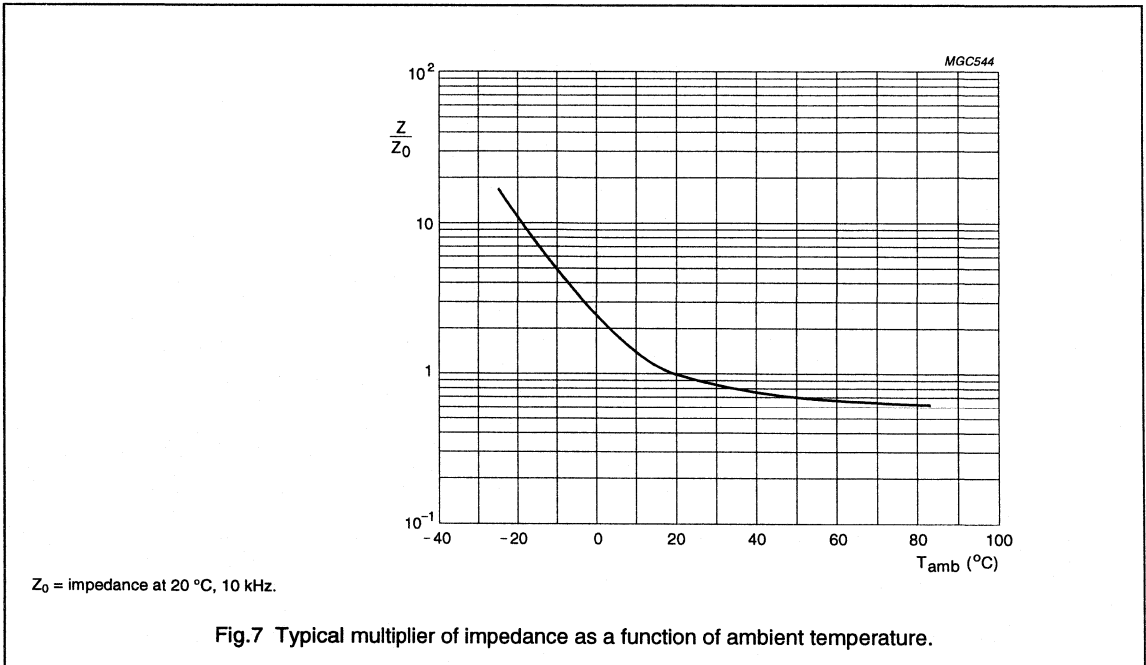


Non-solid Al - electrolytic capacitors
 Axial, High Voltage for Electronic Lighting Ballast

ASH-ELB 042-043



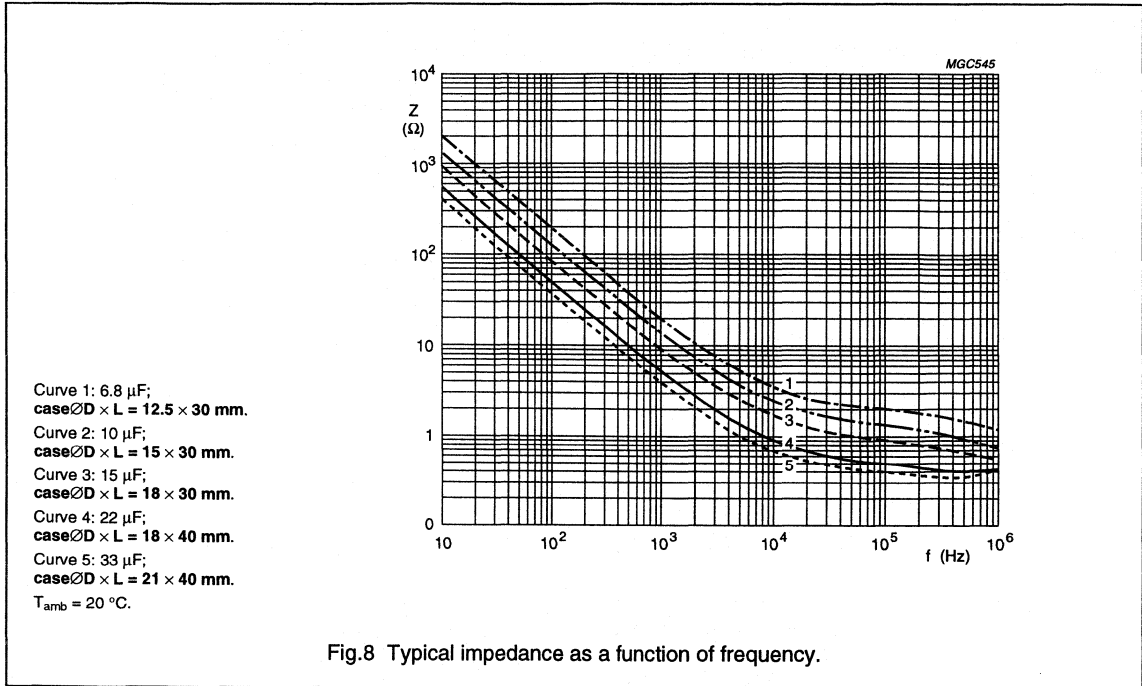
Impedance (Z)



Non-solid Al - electrolytic capacitors

Axial, High Voltage for Electronic Lighting Ballast

ASH-ELB 042-043



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)
- 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.

A

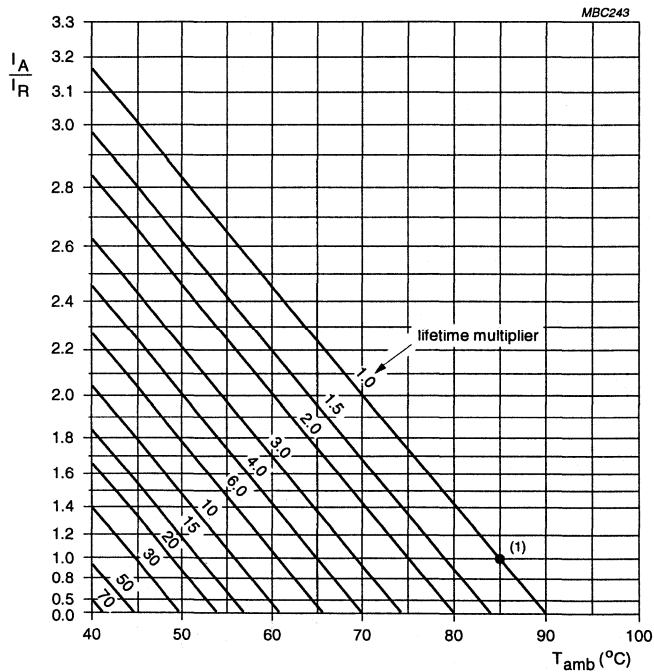
Non-solid Al - electrolytic capacitors
 Axial, High Voltage for Electronic Lighting Ballast

ASH-ELB 042-043

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 85 °C, 100 Hz

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.7
100	1.0
300	1.6
1000	2.5
3000	3.2
≥10000	3.5



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: 15 000 hours.

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

Non-solid Al - electrolytic capacitors

Axial, High Voltage for Electronic Lighting Ballast

ASH-ELB 042-043

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; 5000 hours	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ °C}$; U_R and I_R applied; 15000 hours	$\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ 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 $I_{L5} \leq 2 \times \text{spec. limit}$

A

Non-solid Al - electrolytic capacitors

Axial Bipolar

AB 137 92

FEATURES

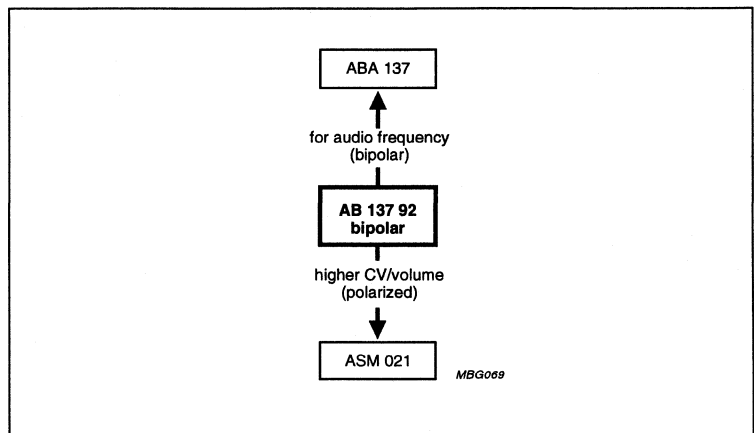
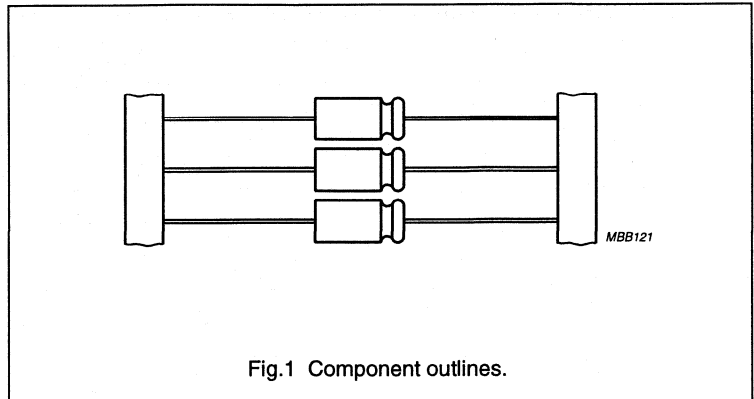
- Non-polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated
- Taped for automatic insertion
- AC-capability without DC bias
- Charge and discharge proof
- Long useful life: 1000 hours at 105 °C
- Miniaturized dimensions.

APPLICATIONS

- Telecommunication, automotive, audio-video and industrial
- Coupling, decoupling, buffering, smoothing and filtering
- For circuits where the polarity is not fixed, or where reverse voltages may occur
- Boards with restricted mounting height, vibration and shock resistant.

REMARK

Please consult your sales representative for more details.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ 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	2000 hours
Useful life at 105 °C	1000 hours
Useful life at 40 °C, 1.3 × I_R applied	100000 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

Non-solid Al - electrolytic capacitors

Axial Bipolar

AB 137 92

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

C_R (μF)	U_R (V)			
	16	25	40	63
1.0	–	–	–	6 × 10
2.2	–	–	–	6 × 10
3.3	–	–	–	6 × 10
4.7	–	–	–	6 × 10
10	–	–	6 × 10	6.5 × 18
22	–	6 × 10	6.5 × 18	8 × 18
33	6 × 10	–	–	10 × 18
47	–	6.5 × 18	8 × 18	10 × 25
100	8 × 18	10 × 18	10 × 25	–
220	10 × 18	10 × 25	–	–
330	10 × 25	–	–	–
470	10 × 25	–	–	–

A

Non-solid Al - electrolytic capacitors

Axial Bipolar Audio-frequency

ABA 137

FEATURES

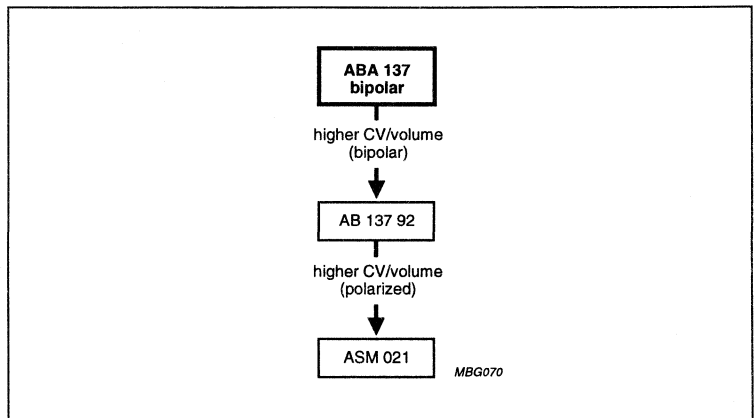
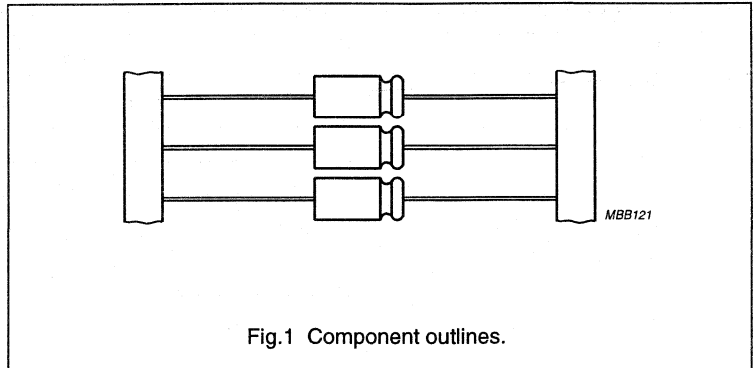
- Non-polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated
- AC-capability without DC bias
- Low dissipation factor, featuring low sound distortion
- Long useful life: 1500 hours at 105 °C
- LD grade types for extremely low dissipation factor.

APPLICATIONS

- Speaker crossover networks in audio equipment
- For splitting high, middle and low frequencies
- Axial version allows simple wiring in speaker box
- LD grade types for excellent sound quality.

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	2.2 to 22 μ F
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

Non-solid Al - electrolytic capacitors

Axial Bipolar Audio-frequency

ABA 137

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

C_R 1 kHz (μF)	U_R (DC); U_{RMS} (AC)		
	40 V; 15 V	63 V; 23 V	100 V; 35 V
2.2	–	8 × 18	8 × 18
	–	10 × 25 ⁽¹⁾	10 × 25 ⁽¹⁾
3.3	–	8 × 18	10 × 18
	–	10 × 25 ⁽¹⁾	–
4.7	8 × 18	10 × 18	10 × 18
	–	10 × 25 ⁽¹⁾	–
6.8	8 × 18	10 × 25	10 × 25
10	10 × 18	10 × 25	–
15	10 × 25	–	–
22	10 × 25	–	–

Note

- LD grade types.

Non-solid Al - electrolytic capacitors

Axial Miniature Long-Life

AML 138

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve (case $\varnothing 6.3 \times 12.7$ 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 5000 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

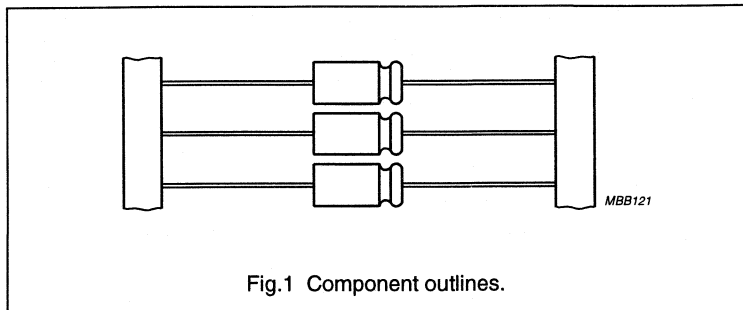
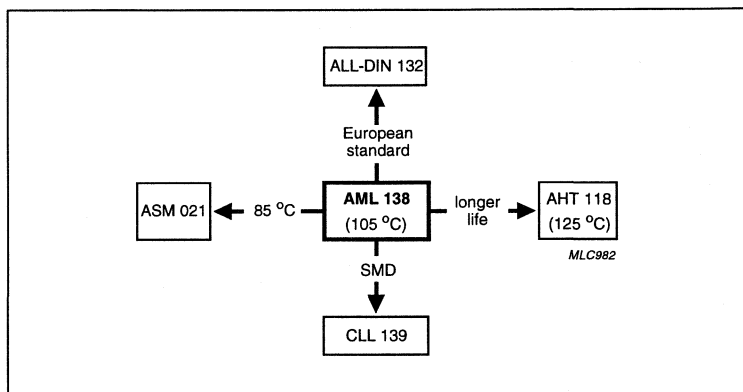


Fig.1 Component outlines.



- Portable and mobile equipment (small size, low mass)
- Stand-by applications
- Low mounting height boards, vibration and shock resistant.

QUICK REFERENCE DATA

DESCRIPTION	VALUE	
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	6.3 × 2.7 to 10 × 25	10 × 30 to 21 × 40
Rated capacitance range, C_R	1.0 to 15000 μF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	6.3 to 100 V	
Category temperature range	-40 to +105 °C	
Endurance test at 105 °C	1000 hours	2000 hours
Useful life at 105 °C	2000 hours	5000 hours
Useful life at 40 °C, I_R applied	$1.3 \times I_R$ applied: 200000 hours	$1.7 \times I_R$ applied: 200000 hours
Shelf life at 0 V, 105 °C	500 hours	500 hours
Based on sectional specification	IEC 384-4/CECC 30 300	
Climatic category IEC 68 (DIN 40040)	40/105/56 (GMF)	

Non-solid Al - electrolytic capacitors

Axial Miniature Long-Life

AML 138

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	7.7 × 12.7
10	–	–	–	6.3 × 12.7	–	6.3 × 12.7	7.7 × 12.7	6.5 × 18
22	–	–	6.3 × 12.7	6.3 × 12.7	–	7.7 × 12.7	6.5 × 18	8 × 18
33	–	–	–	6.3 × 12.7	7.7 × 12.7	–	–	–
47	–	–	6.3 × 12.7	7.7 × 12.7	6.5 × 18	–	8 × 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
150	–	7.7 × 12.7	–	–	–	–	10 × 30	15 × 30
220	7.7 × 12.7	6.5 × 18	8 × 18	10 × 18	10 × 25	–	12.5 × 30	15 × 30
330	–	–	–	–	10 × 30	–	12.5 × 30	18 × 30
470	6.5 × 18	8 × 18	10 × 18	10 × 25	12.5 × 30	–	15 × 30	18 × 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	–
1500	–	10 × 30	12.5 × 30	15 × 30	18 × 30	–	21 × 40	–
2200	10 × 25	12.5 × 30	15 × 30	18 × 30	18 × 40	–	–	–
3300	–	15 × 30	18 × 30	18 × 40	21 × 40	–	–	–
4700	–	18 × 30	18 × 30	18 × 40	–	–	–	–
6800	–	18 × 40	18 × 40	21 × 40	–	–	–	–
10000	–	18 × 40	21 × 40	–	–	–	–	–
15000	–	21 × 40	–	–	–	–	–	–

Non-solid Al - electrolytic capacitors

Axial Miniature Long-Life

AML 138

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

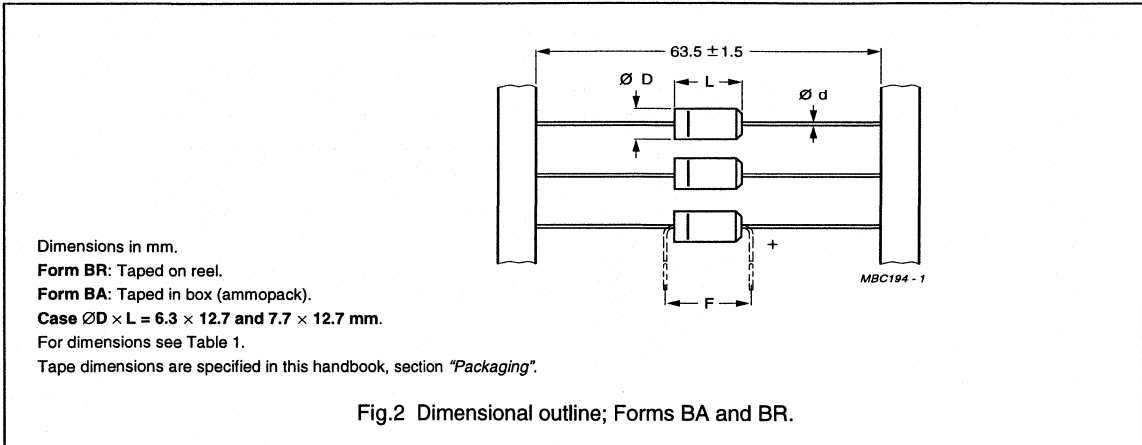


Fig.2 Dimensional outline; Forms BA and BR.

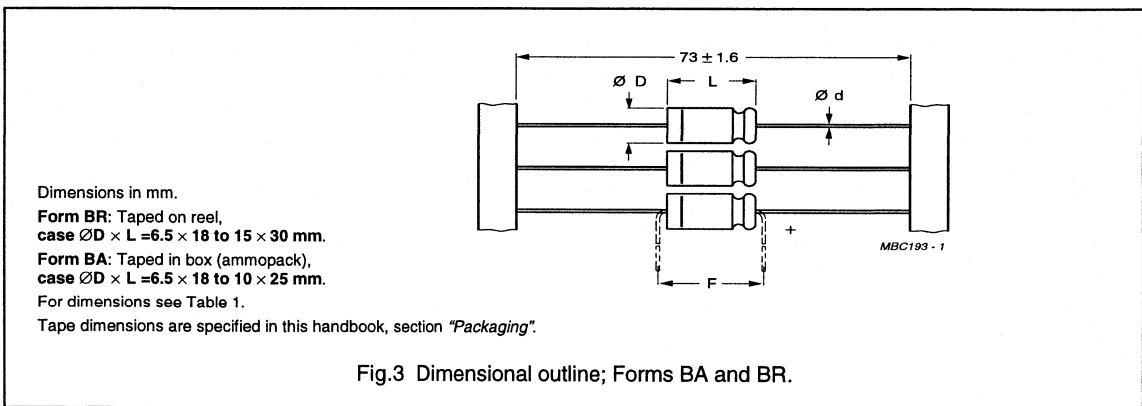


Fig.3 Dimensional outline; Forms BA and BR.

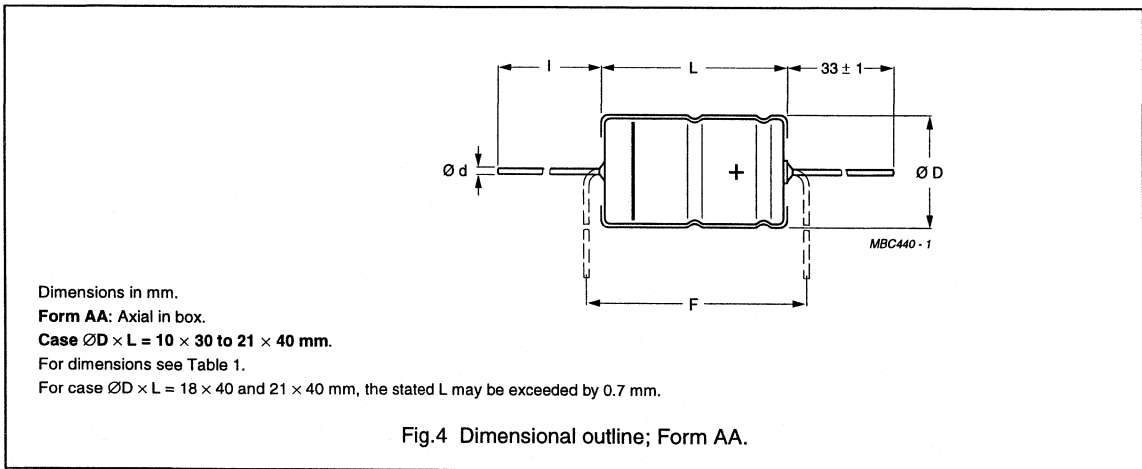


Fig.4 Dimensional outline; Form AA.

Non-solid Al - electrolytic capacitors

Axial Miniature Long-Life

AML 138

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

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	AXIAL: FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		Ød (mm)	L (mm)	ØD _{max} (mm)	L _{max} (mm)	F _{min} (mm)		FORM AA	FORM BA	FORM BR
6.3 × 12.7	(2)	0.6	–	6.5	12.9	17.5	≈1.1	–	1000	1000
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	–	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	–	–

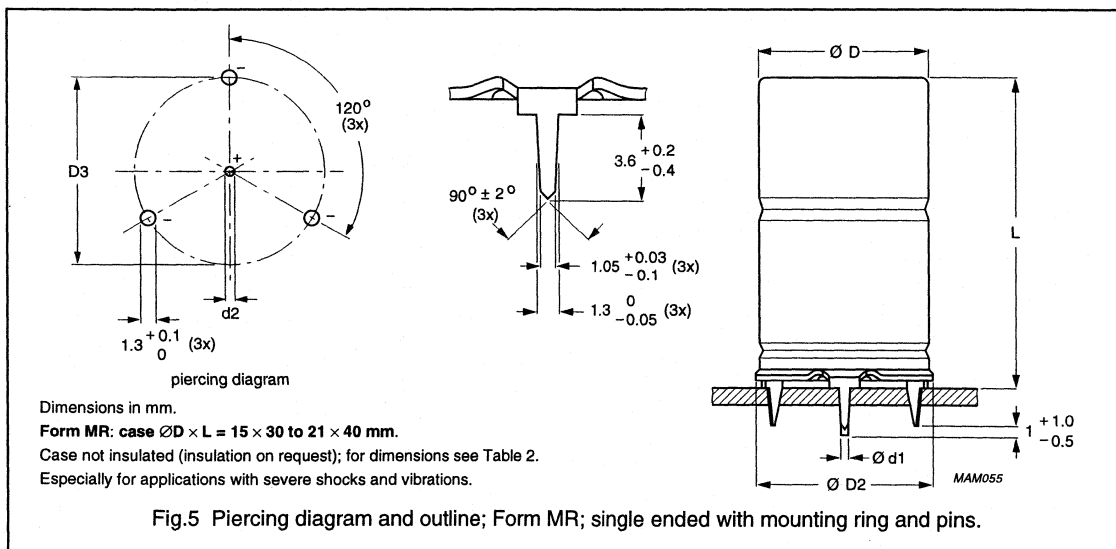


Table 2 Single ended; physical dimensions, mass and packaging quantities; see Fig. 5

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	SINGLE ENDED WITH MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		Ød ₁ (mm)	Ød ₂ (mm)	ØD _{max} (mm)	ØD _{2max} (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

Non-solid Al - electrolytic capacitors

Axial Miniature Long-Life

AML 138

ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 3, 5, 7 and 9 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, 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 $\tan \delta_{max}$ 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 $\varnothing \times L$ (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 × 25	520	64	24	0.2	0.32	0.20	0.16
	1500	10 × 30	560	94	34	0.26	0.27	0.18	0.15
	2200	12.5 × 30	750	140	48	0.27	0.14	0.13	0.12
	3300	15 × 30	990	200	70	0.28	0.10	0.1	0.094
	4700	18 × 30	1200	290	98	0.31	0.083	0.088	0.083
	6800	18 × 40	1700	410	140	0.32	0.056	0.049	0.069
	10000	18 × 40	1900	600	200	0.37	0.048	0.042	0.065
15000	21 × 40	2200	900	300	0.51	0.044	0.038	0.063	
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

Non-solid Al - electrolytic capacitors

Axial Miniature Long-Life

AML 138

ORDERING INFORMATION**Ordering example**

Electrolytic capacitor AML 138

470 $\mu\text{F}/10\text{ V}$; $\pm 20\%$ Nominal case size: $\varnothing 8 \times 18$; 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 $\varnothing D \times L$ (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
6.3	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	–
	2200	10×25	7	–	138 23222	138 33222	–
10	150	7.7×12.7	(3)	–	138 24151	138 34151	–
	220	6.5×18	4	–	138 24221	138 34221	–
	470	8×18	5	–	138 24471	138 34471	–
	1000	10×25	7	–	138 24102	138 34102	–
	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	–	138 44332
	4700	18×30	03	138 14472	–	–	138 44472
	6800	18×40	04	138 14682	–	–	138 44682
	10000	18×40	04	138 14103	–	–	138 44103
	15000	21×40	05	138 14153	–	–	138 44153
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	–
	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	–	138 45222
	3300	18×30	03	138 15332	–	–	138 45332

Non-solid Al - 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 $\varnothing D \times L$ (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)
16	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

Non-solid Al - electrolytic capacitors

Axial Miniature Long-Life

AML 138

ORDERING INFORMATION (continued)

Table 6 Ordering information continued; preferred types in bold

U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
16	4700	18 × 30	03	138 15472	—	—	138 45472
	6800	18 × 40	04	138 15682	—	—	138 45682
	10000	21 × 40	05	138 15103	—	—	138 45103
25	10	6.3 × 12.7	(2)	—	138 26109	138 36109	—
	22	6.3 × 12.7	(2)	—	138 26229	138 36229	—
	33	6.3 × 12.7	(2)	—	138 26339	138 36339	—
	47	7.7 × 12.7	(3)	—	138 26479	138 36479	—
	100	6.5 × 18	4	—	138 26101	138 36101	—
	220	10 × 18	6	—	138 26221	138 36221	—
	470	10 × 25	7	—	138 26471	138 36471	—
	680	10 × 30	00	138 16681	138 26681	—	—
	1000	12.5 × 30	02	138 16102	138 26102	—	—
	1500	15 × 30	03	138 16152	138 26152	—	138 46152
	2200	18 × 30	04	138 16222	—	—	138 46222
	3300	18 × 40	04	138 16332	—	—	138 46332
	4700	18 × 40	05	138 16472	—	—	138 46472
	6800	21 × 40	02	138 16682	—	—	138 46682
40	33	7.7 × 12.7	(3)	—	138 27339	138 37339	—
	47	6.5 × 18	4	—	138 27479	138 37479	—
	100	8 × 18	5	—	138 27101	138 37101	—
	220	10 × 25	7	—	138 27221	138 37221	—
	330	10 × 30	00	138 17331	138 27331	—	—
	470	12.5 × 30	01	138 17471	138 27471	—	—
	680	12.5 × 30	01	138 17681	138 27681	—	—
	1000	15 × 30	02	138 17102	138 27102	—	138 47102
	1500	18 × 30	03	138 17152	—	—	138 47152
	2200	18 × 40	04	138 17222	—	—	138 47222
	3300	21 × 40	05	138 17332	—	—	138 47332
50	10	6.3 × 12.7	(2)	—	138 21109	138 31109	—
	22	7.7 × 12.7	(3)	—	138 21229	138 31229	—
	100	10 × 18	6	—	138 21101	138 31101	—

A

Non-solid Al - electrolytic capacitors

Axial Miniature Long-Life

AML 138

ELECTRICAL DATA (continued)**Table 7** Electrical data continued; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing \times L$ (mm)	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)	Z 100 kHz (Ω)
63	4.7	6.3 × 12.7	35	9	4.6	0.09	30	17	5
	10	7.7 × 12.7	59	16	5.3	0.08	13	8	1.8
	22	6.5 × 18	100	12	6.8	0.07	5.1	3.6	0.85
	47	8 × 18	150	22	9.9	0.07	2.4	1.7	0.50
	100	10 × 25	280	42	17	0.07	1.1	0.8	0.27
	150	10 × 30	340	61	23	0.11	0.73	0.41	0.31
	220	12.5 × 30	470	88	32	0.11	0.50	0.28	0.22
	330	12.5 × 30	570	130	46	0.12	0.37	0.22	0.18
	470	15 × 30	730	180	63	0.12	0.26	0.15	0.14
	680	18 × 30	930	260	90	0.12	0.19	0.12	0.11
	1000	18 × 40	1300	380	130	0.12	0.13	0.08	0.09
1500	21 × 40	1600	570	190	0.13	0.10	0.07	0.08	
100	1.0	6.3 × 12.7	16	5	4.2	0.09	140	55	10
	2.2	6.3 × 12.7	24	7	4.4	0.09	65	25	8
	4.7	7.7 × 12.7	40	12	4.9	0.08	27	17	5
	10	6.5 × 18	67	10	6.0	0.07	11	8	2.4
	22	8 × 18	100	17	8.4	0.07	5.1	3.6	1.4
	47	10 × 25	190	32	13	0.07	2.4	1.7	0.67
	68	10 × 30	220	45	18	0.07	1.7	1.1	0.97
	100	12.5 × 30	290	64	24	0.07	1.1	0.77	0.67
	150	15 × 30	390	94	34	0.07	0.78	0.52	0.46
	220	15 × 30	470	140	48	0.07	0.54	0.37	0.33
	330	18 × 30	620	200	70	0.08	0.38	0.27	0.24
	470	18 × 40	840	290	98	0.08	0.27	0.19	0.17
	680	21 × 40	1100	410	140	0.09	0.21	0.14	0.14

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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	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
63	4.7	6.3 × 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	–	–
	330	12.5 × 30	01	138 18331	138 28331	–	–
	470	15 × 30	02	138 18471	138 28471	–	138 48471
	680	18 × 30	03	138 18681	–	–	138 48681
	1000	18 × 40	04	138 18102	–	–	138 48102
	1500	21 × 40	05	138 18152	–	–	138 48152
	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	–	138 49151
220		15 × 30	02	138 19221	138 29221	–	138 49221
330		18 × 30	03	138 19331	–	–	138 49331
470		18 × 40	04	138 19471	–	–	138 49471
680		21 × 40	05	138 19681	–	–	138 49681

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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 :		
	case $\varnothing D \times L = 6.3 \times 12.7$ and 7.7×12.7 mm	$I_{L1} \leq 0.02C_R \times U_R + 3 \mu\text{A}$	
	case $\varnothing D \times L = 6.5 \times 18$ to 21×40 mm	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$	
	after 5 minutes at U_R :	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$	
Inductance			
Equivalent series inductance (ESL)	case $\varnothing D \times L$ mm:		
	6.3 × 12.7	typ. 20 nH	–
	7.7 × 12.7	typ. 30 nH	–
	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

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).

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ELECTRICAL DATA (continued)

Capacitance (C)

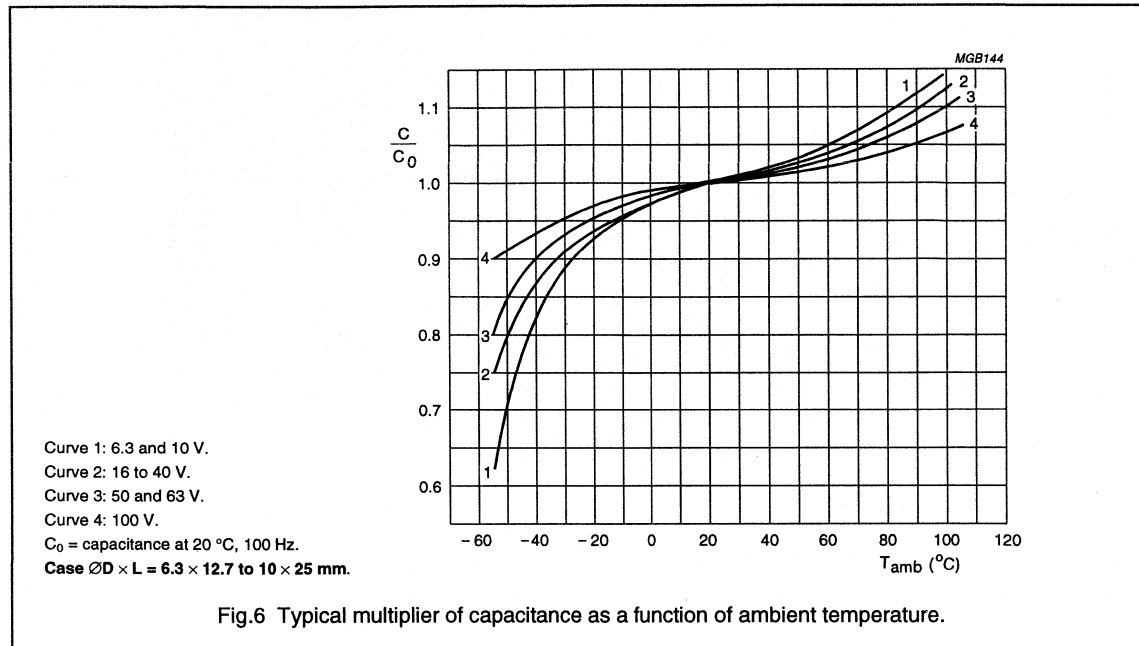


Fig.6 Typical multiplier of capacitance as a function of ambient temperature.

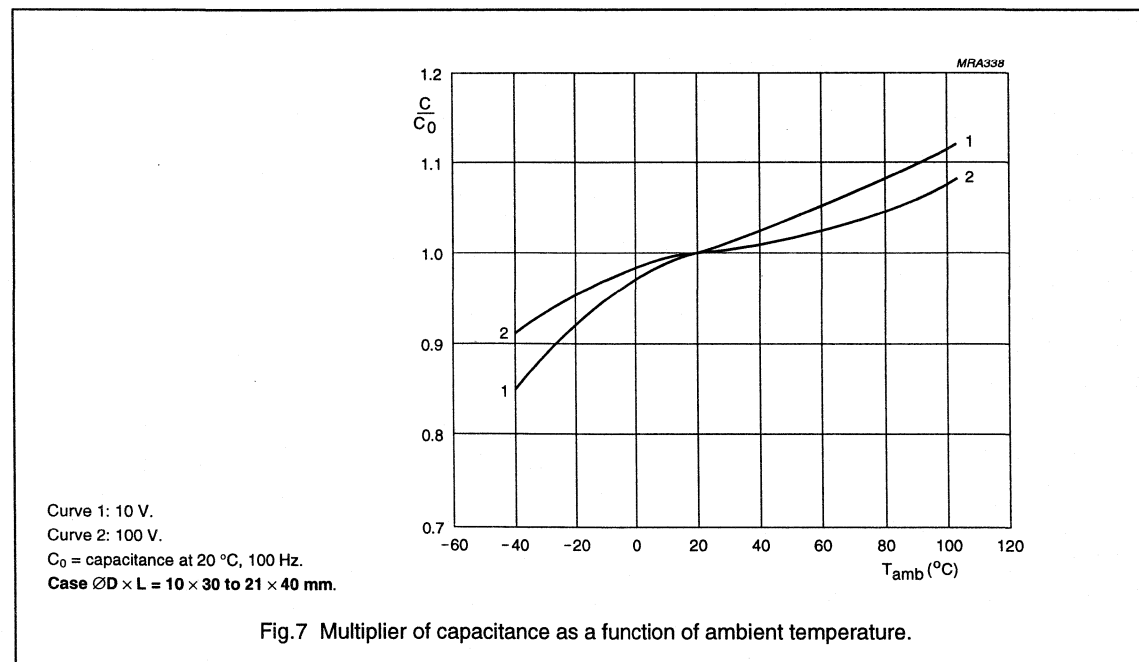
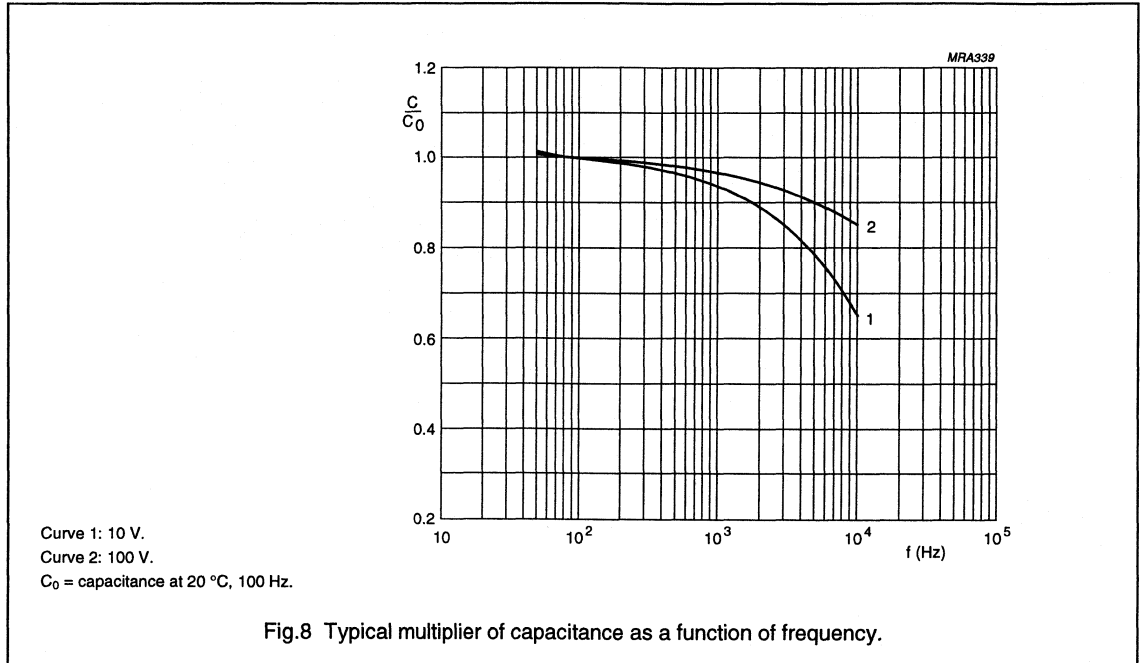


Fig.7 Multiplier of capacitance as a function of ambient temperature.

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Non-solid Al - electrolytic capacitors
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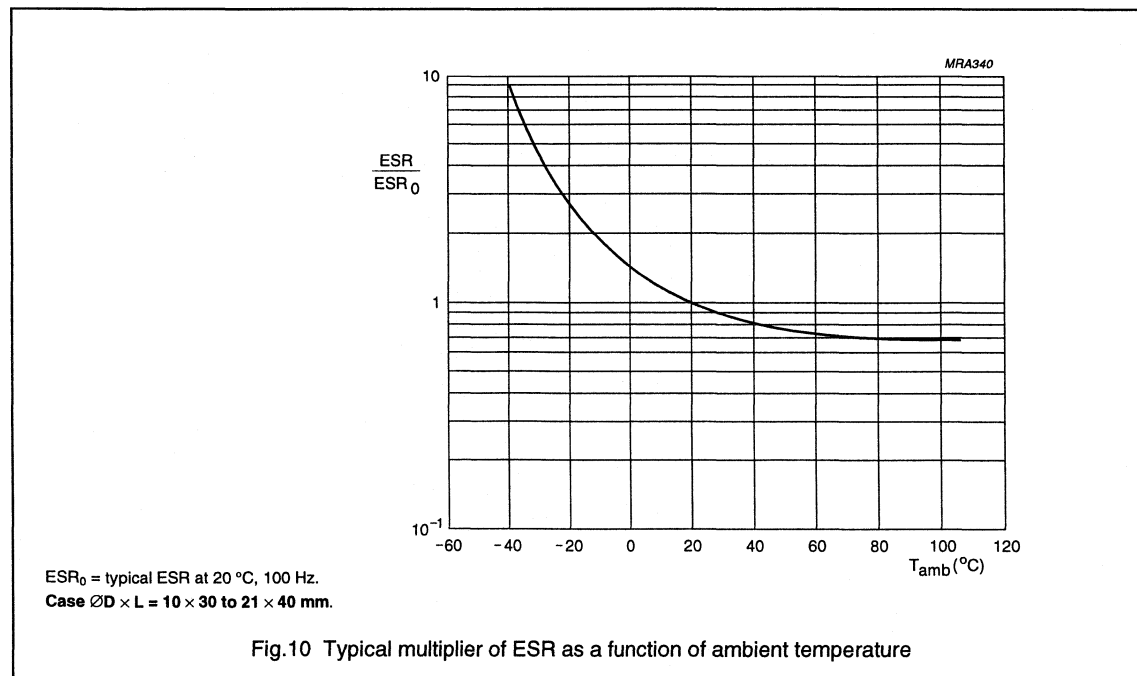
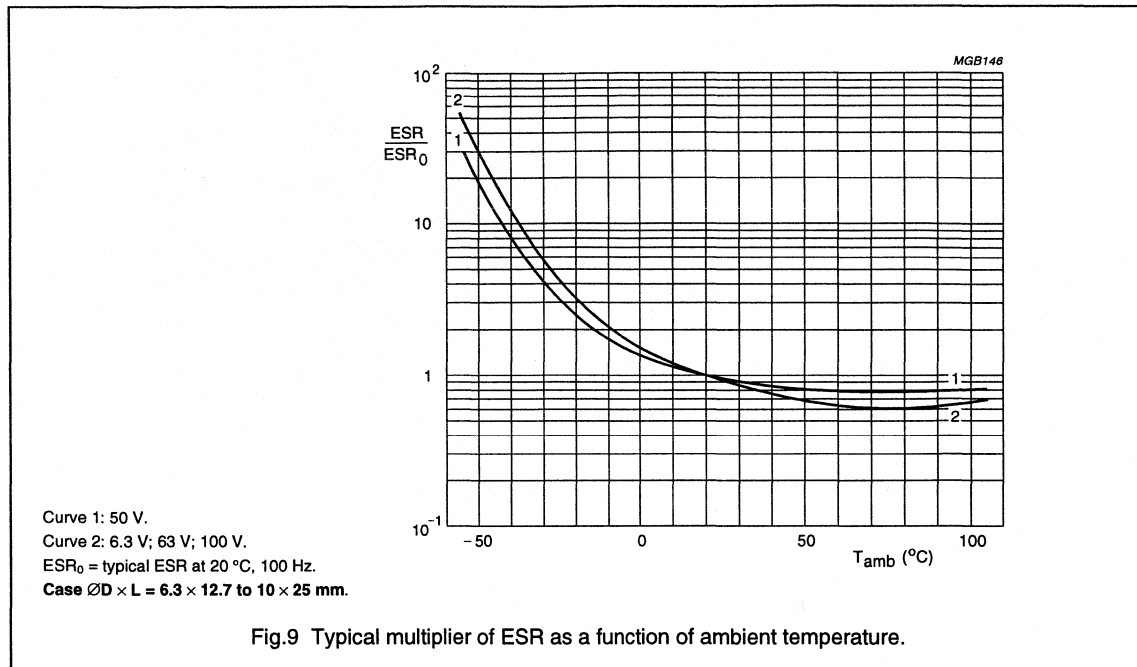
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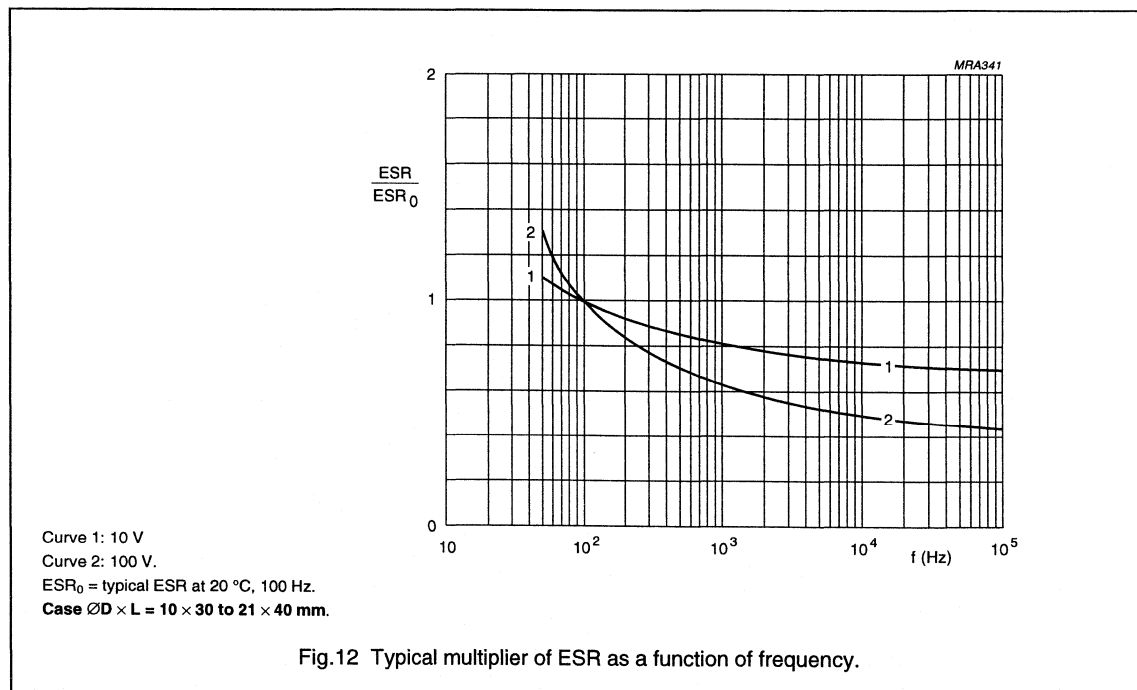
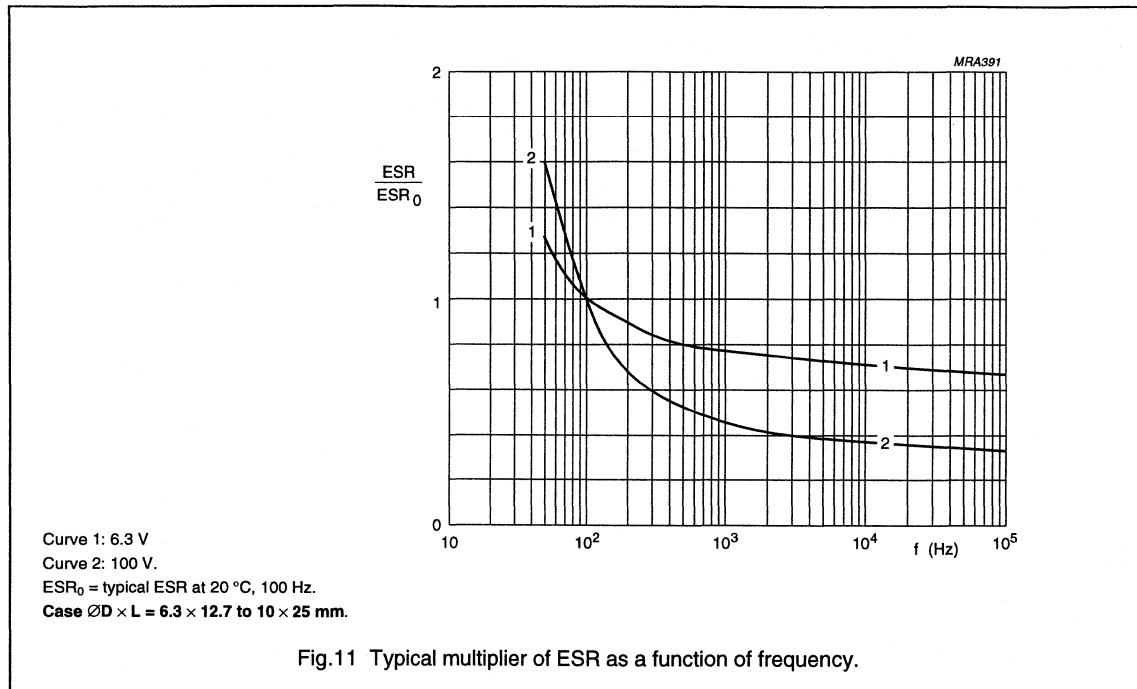
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Equivalent series resistance (ESR)



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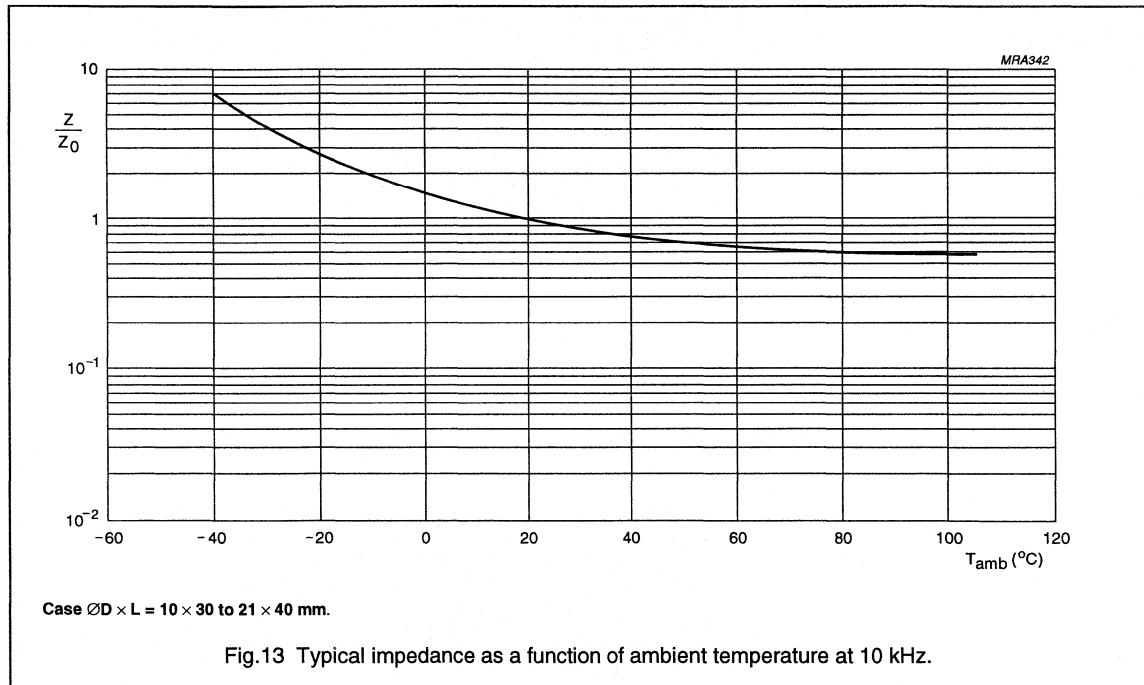
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Impedance (Z)**Table 9** Impedance \times capacitance values (case $\varnothing D \times L = 6.3 \times 12.7$ to 10×25 mm)

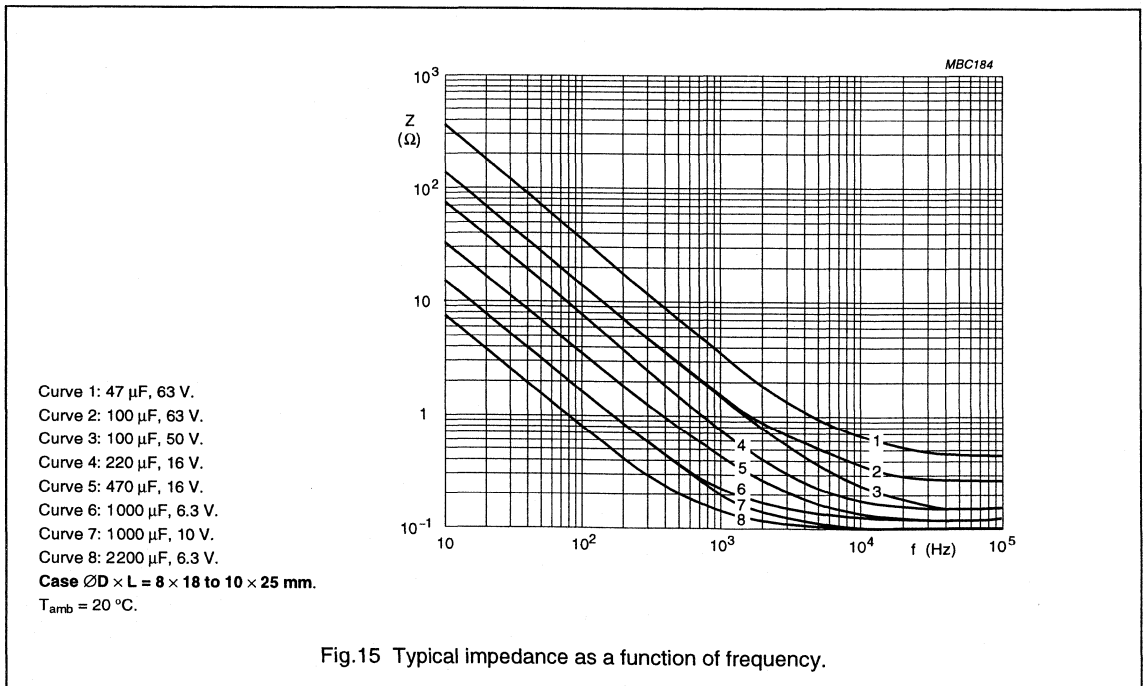
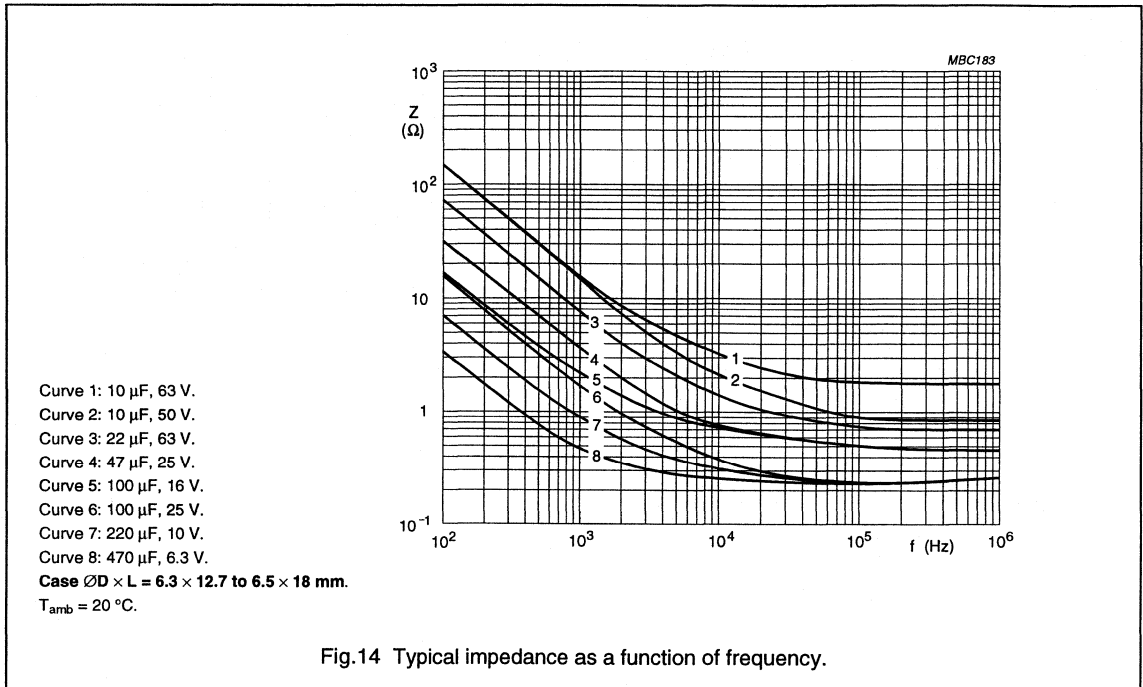
T_{amb}	$Z = Z \times C_R (\Omega \mu F)$ at 10 kHz							
	6.3 V	10 V	16 V	25 V	40 V	50 V	63 V	100 V
+20 °C	≤ 300	≤ 200	≤ 160	≤ 120	≤ 90	≤ 70	≤ 80	≤ 80
-25 °C	≤ 2000	≤ 1200	≤ 750	≤ 560	≤ 450	≤ 300	≤ 550	≤ 550
-40 °C	≤ 5500	≤ 3200	≤ 2000	≤ 1500	≤ 1200	≤ 900	≤ 1500	≤ 1500



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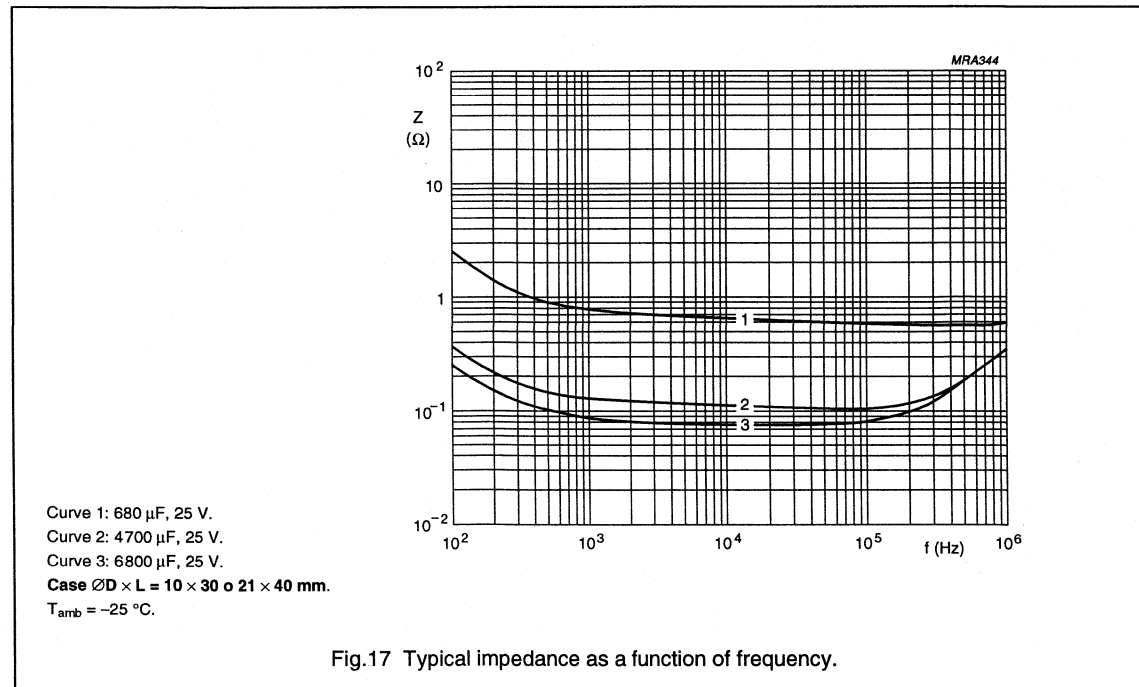
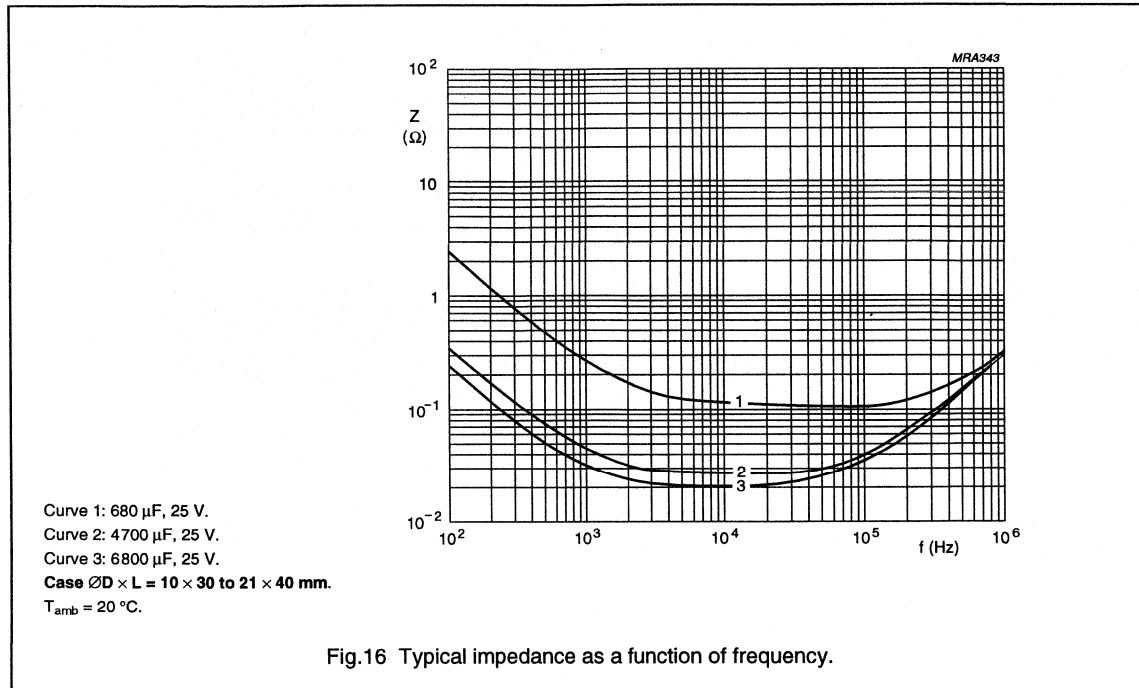
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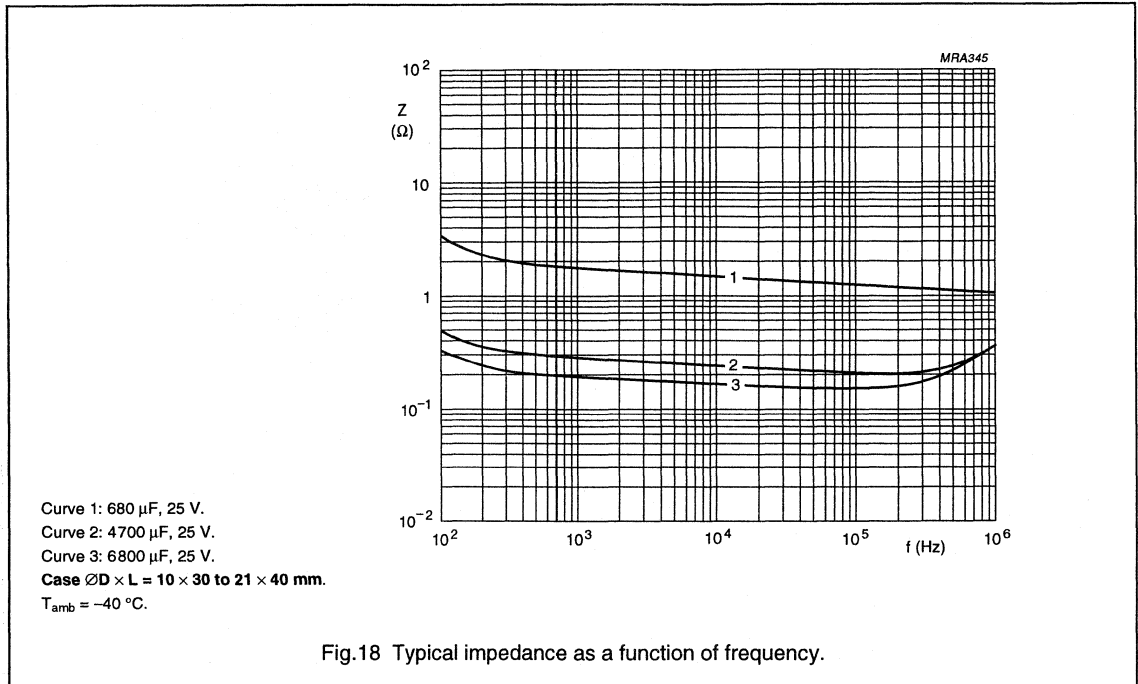
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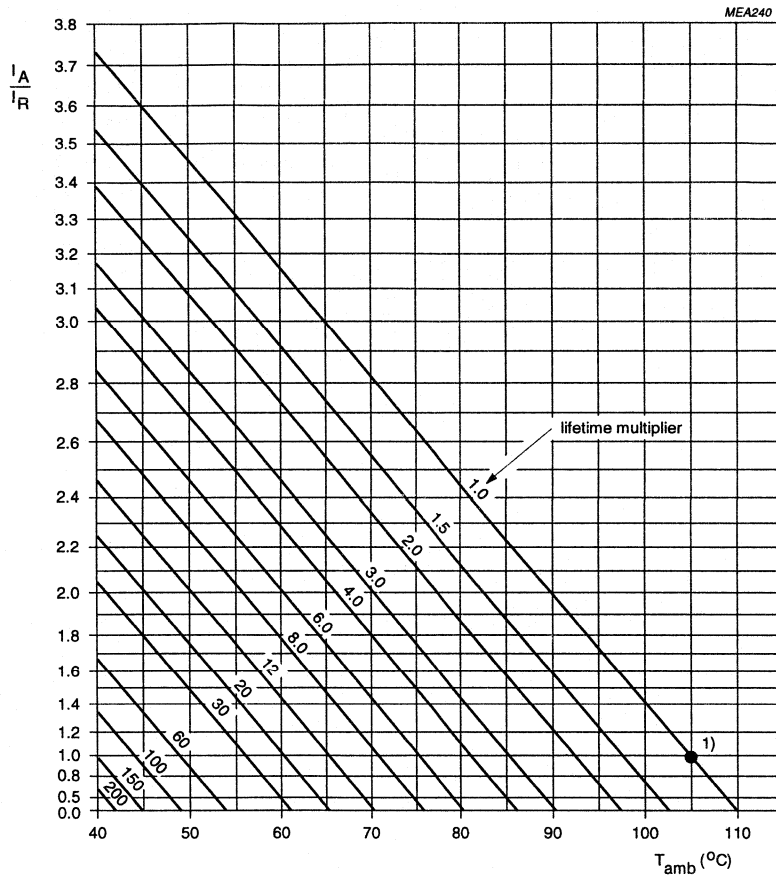
RIPPLE CURRENT AND USEFUL LIFE

Table 10 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_R = ripple current at 105 °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
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥ 10000	1.2	1.3	1.4

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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 $\varnothing D \times L = 6.3 \times 12.7$ to 10×25 mm: 2000 hours

case $\varnothing D \times L = 10 \times 30$ to 21×40 mm: 5000 hours.

Fig.19 Multiplier of useful life as a function of ambient temperature and ripple current load; see Table 10.

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Non-solid Al - electrolytic capacitors

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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	$T_{amb} = 105\text{ °C}$; U_R applied; case $\varnothing D \times L$: 6.3 × 12.7 to 10 × 25 mm: 1000 hours 10 × 30 to 21 × 40 mm: 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	$T_{amb} = 105\text{ °C}$; U_R and I_R applied; case $\varnothing D \times L$: 6.3 × 12.7 to 10 × 25 mm: 2000 hours 10 × 30 to 21 × 40 mm: 5000 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	$T_{amb} = 105\text{ °C}$; 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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NOTES



Non-solid Al - electrolytic capacitors

Axial Long Life, DIN-based

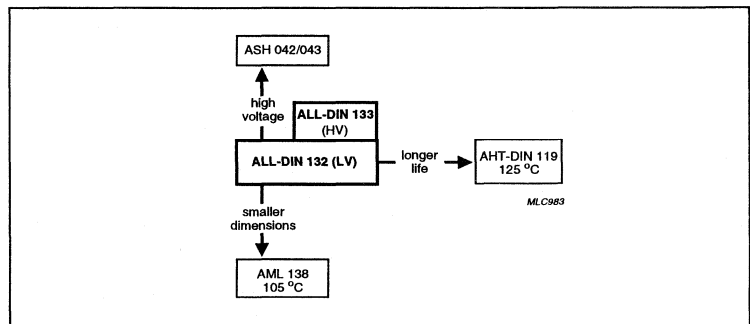
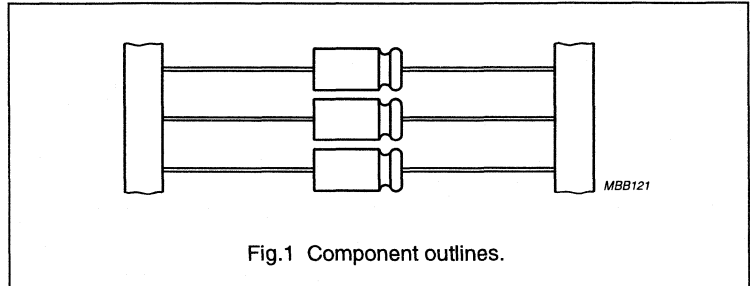
ALL-DIN 132-133

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case $\varnothing 10 \times 30$ 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 ($\varnothing D_{nom} \times L_{nom}$ 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	-
Endurance test at 85 °C	6000 hours	8000 hours	8000 hours
Useful life at 105 °C	3000 hours	3000 hours	-
Useful life at 85 °C	10000 hours	15000 hours	15000 hours
Useful life at 40 °C, $1.8 \times I_R$ applied	160000 hours	240000 hours	240000 hours
Shelf life at 0 V, 85 °C	500 hours		
Based on sectional specification	IEC 384-4/CECC 30300, LL grade		
Detail specification	DIN 45910-T 123, former DIN 41257, UTE C031/C033 (without approval)		
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)		
Approvals	CECC 30301-056		-

Non-solid Al - electrolytic capacitors

Axial Long Life, DIN-based

ALL-DIN 132-133

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	250	350
1.0	–	–	–	–	–	6.5 × 18	–	–	6.5 × 18
2.2	–	–	–	–	–	6.5 × 18	6.5 × 18	8 × 18	8 × 18
4.7	–	–	–	–	6.5 × 18	6.5 × 18	8 × 18	10 × 18	10 × 18
10	–	–	–	–	6.5 × 18	8 × 18	10 × 18	10 × 25	12.5 × 30 ⁽¹⁾
	–	–	–	–	–	–	–	10 × 30 ⁽¹⁾	–
22	–	–	6.5 × 18	–	8 × 18	10 × 18	10 × 25	12.5 × 30 ⁽¹⁾	15 × 30 ⁽¹⁾
	–	–	–	–	–	–	10 × 30 ⁽¹⁾	–	–
47	–	6.5 × 18	–	8 × 18	10 × 18	10 × 25	15 × 30 ⁽¹⁾	18 × 30 ⁽¹⁾	18 × 40 ⁽¹⁾
	–	–	–	–	–	10 × 30	–	–	–
68	–	–	–	–	10 × 30	12.5 × 30	15 × 30 ⁽¹⁾	18 × 40 ⁽¹⁾	21 × 40 ⁽¹⁾
100	–	8 × 18	–	10 × 18	10 × 30	15 × 30	18 × 30 ⁽¹⁾	21 × 40 ⁽¹⁾	–
150	–	–	–	12.5 × 30	15 × 30	18 × 30	18 × 40 ⁽¹⁾	–	–
220	8 × 18	10 × 18	10 × 25	12.5 × 30	15 × 30	18 × 40	21 × 40 ⁽¹⁾	–	–
	–	–	12.5 × 30	–	–	–	–	–	–
330	–	10 × 25	12.5 × 30	15 × 30	18 × 30	18 × 40	–	–	–
	–	12.5 × 30	–	–	–	–	–	–	–
470	12.5 × 30	10 × 25	12.5 × 30	15 × 30	18 × 40	21 × 40	–	–	–
	–	12.5 × 30	–	–	–	–	–	–	–
680	12.5 × 30	15 × 30	18 × 30	18 × 30	21 × 40	–	–	–	–
1000	15 × 30	15 × 30	18 × 30	18 × 40	21 × 40	–	–	–	–
1500	18 × 30	18 × 30	18 × 40	21 × 40	–	–	–	–	–
2200	18 × 30	18 × 40	21 × 40	21 × 40	–	–	–	–	–
3300	18 × 40	21 × 40	–	–	–	–	–	–	–
4700	21 × 40	21 × 40	–	–	–	–	–	–	–

Note

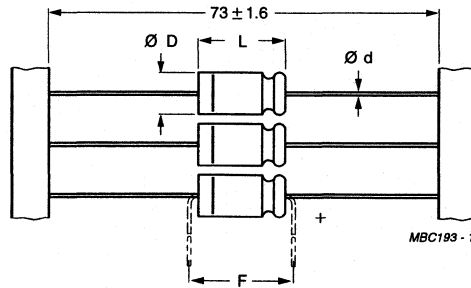
- For these CV-values see "ASH 041-043 series".

Non-solid Al - electrolytic capacitors

Axial Long Life, DIN-based

ALL-DIN 132-133

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.

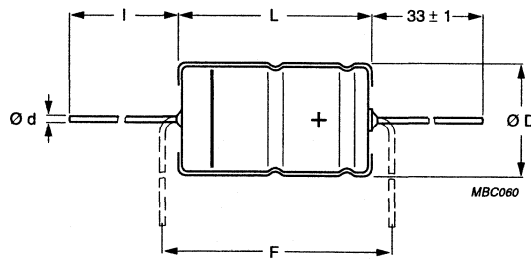
Form BA: Taped in box (ammopack),

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

For dimensions see Table 1.

Fig.3 Dimensional outline; Form AA.

Non-solid Al - electrolytic capacitors

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

NOMINAL CASE SIZE ØD × L	CASE CODE	AXIAL: FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		Ød (mm)	l (mm)	ØD _{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	–	–

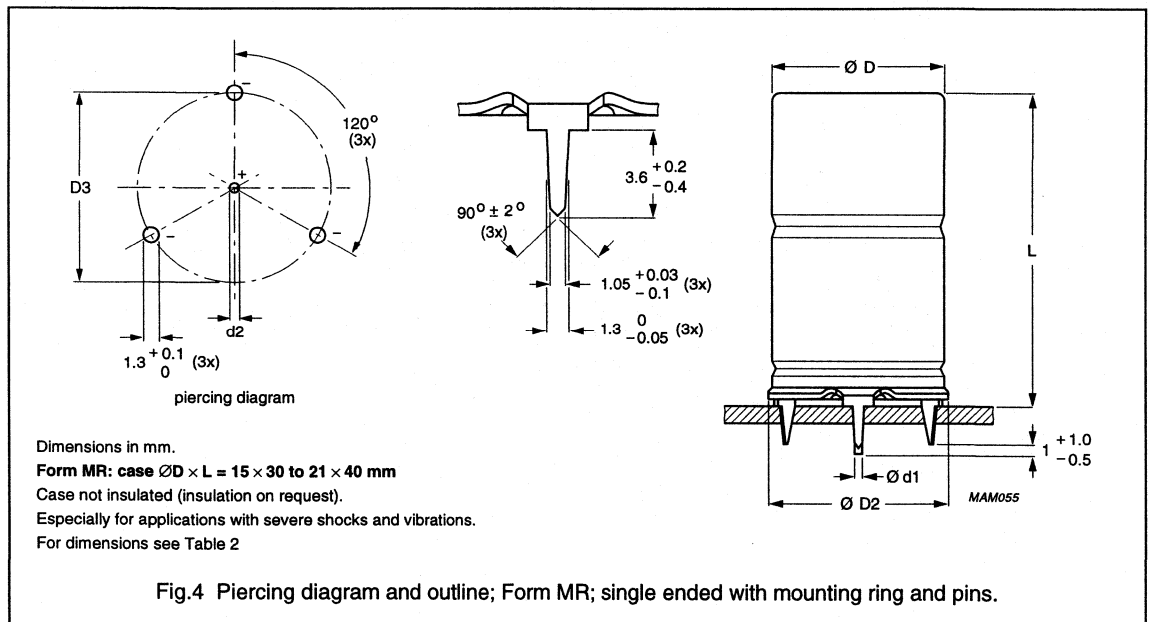


Table 2 Single ended; physical dimensions, mass and packaging quantities; see Fig. 4

NOMINAL CASE SIZE ØD × L	CASE CODE	SINGLE ENDED WITH MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		ØD ₁ (mm)	ØD ₂ (mm)	ØD _{max} (mm)	ØD _{2max} (mm)	D ₃ (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

Non-solid Al - electrolytic capacitors

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 3, 5, 7 and 9 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 -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
$\tan \delta$	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 or 100 kHz

Table 3 Electrical data; 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)
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
	1000	15 × 30	640	64	20	0.18	0.28	0.12	–
	1500	18 × 30	800	94	30	0.22	0.23	0.10	–
	2200	18 × 30	1100	140	44	0.22	0.16	0.09	–
	3300	18 × 40	1300	200	66	0.27	0.13	0.05	–
	4700	21 × 40	1800	290	94	0.27	0.09	0.05	–
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
	330	12.5 × 30	320	36	10.6	0.14	0.67	0.36	0.60
	470	10 × 25	450	78	19	0.14	0.47	0.26	0.26
	470	12.5 × 30	450	49	15	0.14	0.47	0.26	0.40
	680	15 × 30	550	69	22	0.14	0.33	0.14	–
	1000	15 × 30	780	100	32	0.14	0.22	0.12	–
	1500	18 × 30	950	150	48	0.15	0.16	0.10	–
	2200	15 × 40	1300	220	70	0.15	0.11	0.06	–
	3300	21 × 40	1600	320	110	0.15	0.07	0.05	–
	4700	21 × 40	2300	460	150	0.15	0.05	0.05	–

Non-solid Al - electrolytic capacitors

Axial Long Life, DIN-based

ALL-DIN 132-133

ORDERING INFORMATION**Ordering example**

Electrolytic capacitor ALL-DIN 132

100 μ F/40 V; -10/+50%Nominal case size: \varnothing 10 \times 18; Form BR

Catalogue number: 2222 132 27101.

Table 4 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	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
10	220	8 \times 18	5	-	132 24221	132 34221	-
	470	12.5 \times 30	01	132 14471	132 24471	-	-
	680	12.5 \times 30	01	132 14681	132 24681	-	-
	1000	15 \times 30	02	132 14102	132 24102	-	132 44102
	1500	18 \times 30	03	132 14152	-	-	132 44152
	2200	18 \times 30	03	132 14222	-	-	132 44222
	3300	18 \times 40	04	132 14332	-	-	132 44332
	4700	21 \times 40	05	132 14472	-	-	132 44472
	16	47	6.5 \times 18	4	-	132 25479	132 35479
100		8 \times 18	5	-	132 25101	132 35101	-
220		10 \times 18	6	-	132 25221	132 35221	-
330		10 \times 25	7	-	132 90508	132 90509	-
330		12.5 \times 30	01	132 15331	132 25331	-	-
470		10 \times 25	7	-	132 90507	132 90502	-
470		12.5 \times 30	01	132 15471	132 25471	-	-
680		15 \times 30	02	132 15681	132 25681	-	132 45681
1000		15 \times 30	02	132 15102	132 25102	-	132 45102
1500		18 \times 30	03	132 15152	-	-	132 45152
2200		15 \times 40	04	132 15222	-	-	132 45222
3300		21 \times 40	05	132 15332	-	-	132 45332
4700		21 \times 40	05	132 15472	-	-	132 45472

Non-solid Al - electrolytic capacitors

Axial Long Life, DIN-based

ALL-DIN 132-133

ELECTRICAL DATA (continued)**Table 5** Electrical data continued

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	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)	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	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	–

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

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			SINGLE ENDED
				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	47	8 × 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

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Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

ELECTRICAL DATA (continued)

Table 7 Electrical data continued

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	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)	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
	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	21 × 40	1600	380	130	0.07	0.11	0.06	—	
100	1	6.5 × 18	20	4.0	4.0	0.06	95	45	6
	2.2	6.5 × 18	30	5.2	4.4	0.06	43	20	5
	4.7	6.5 × 18	48	7.7	4.9	0.06	20	9.6	4
	10	8 × 18	73	13	6	0.06	9.5	4.5	2.8
	22	10 × 18	130	25	8.4	0.06	4.3	2	1.3
	47	10 × 25	220	50	13.4	0.06	2.0	1	0.90
	47	10 × 30	220	32	9.4	0.06	2.0	1	0.90
	68	12.5 × 30	250	45	13.5	0.06	1.4	0.80	—
	100	15 × 30	380	64	20	0.06	0.95	0.50	—
	150	18 × 30	400	94	30	0.06	0.64	0.35	—
	220	18 × 40	660	140	44	0.06	0.43	0.20	—
	330	18 × 40	700	200	66	0.06	0.29	0.15	—
	470	21 × 40	1200	290	94	0.06	0.20	0.10	—

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

ORDERING INFORMATION (continued)

Table 8 Ordering information continued; preferred types in bold

U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
63	4.7	6.5 × 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 × 30	00	132 18689	132 28689	–	–
	100	10 × 30	00	132 18101	132 28101	–	–
	150	15 × 30	02	132 18151	132 28151	–	132 48151
	220	15 × 30	02	132 18221	132 28221	–	132 48221
	330	18 × 30	03	132 18331	–	–	132 48331
	470	18 × 40	04	132 18471	–	–	132 48471
	680	21 × 40	05	132 18681	–	–	132 48681
	1000	21 × 40	05	132 18102	–	–	132 48102
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	05	132 19471	–	–	132 49471

A

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

ELECTRICAL DATA (continued)**Table 9** Electrical data continued

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 δ 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

Non-solid Al - electrolytic capacitors

Axial Long Life, DIN-based

ALL-DIN 132-133

ORDERING INFORMATION (continued)**Table 10** Ordering information continued; preferred types in bold

U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × L (mm)	CASE CODE	CATALOGUE NUMBER 2222			
				AXIAL			SINGLE ENDED
				IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
160	2.2	6.5 × 18	4	–	133 21228	133 31228	–
	4.7	8 × 18	5	–	133 21478	133 31478	–
	10	10 × 18	6	–	133 21109	133 31109	–
	22	10 × 25	7	–	133 90502	133 90503	–
250	2.2	8 × 18	5	–	133 23228	133 33228	–
	4.7	10 × 18	6	–	133 23478	133 33478	–
	10	10 × 25	7	–	133 23109	133 33109	–
350	1	6.5 × 18	4	–	133 25108	133 35108	–
	2.2	8 × 18	5	–	133 25228	133 35228	–
	4.7	10 × 18	6	–	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.

A

Non-solid Al - electrolytic capacitors

Axial Long Life, DIN-based

ALL-DIN 132-133

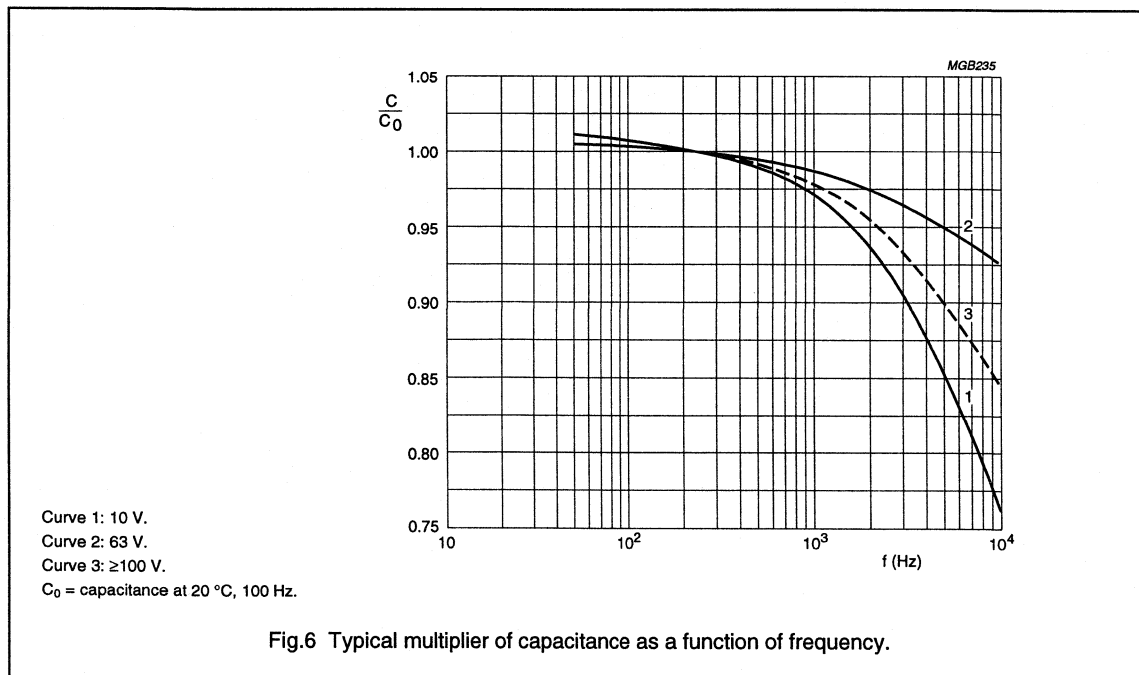
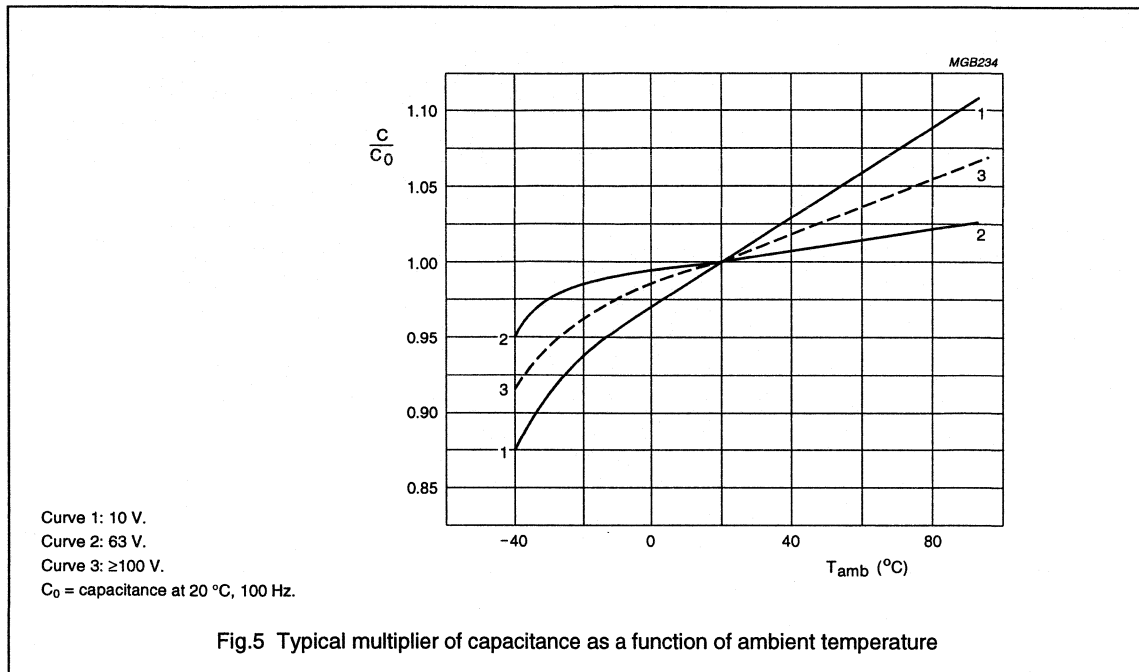
ELECTRICAL DATA (continued)**Additional electrical data**

PARAMETER	CONDITIONS	VALUE	
		AXIAL	SINGLE ENDED
Voltage			
Surge voltage for short periods	$U_R = 10$ to 250 V	$U_s \leq 1.15 \times U_R$	
	$U_R = 350$ V	$U_s \leq 1.1 \times U_R$	
Reverse voltage		$U_{rev} \leq 1$ V	
Current			
Leakage current	after 1 minute: case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm $U_R = 10$ to 100 V $U_R = 160$ to 350 V case $\varnothing D \times L = 10 \times 30$ to 21×40 mm $U_R = 10$ to 100 V	$I_{L1} \leq 0.01 C_R \times U_R + 3 \mu A$ $I_{L1} \leq 50 \mu A$ $I_{L1} \leq 0.006 C_R \times U_R + \mu A$	
	after 5 minutes: case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm $U_R = 10$ to 100 V $U_R = 160$ to 350 V case $\varnothing D \times L = 10 \times 30$ to 21×40 mm $U_R = 10$ to 100 V	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu A$ $I_{L5} \leq 20 \mu A$ $I_{L5} \leq 0.002 C_R \times U_R \mu A$	
Inductance			
Equivalent series inductance (ESL)	case $\varnothing D \times L$ 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

Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

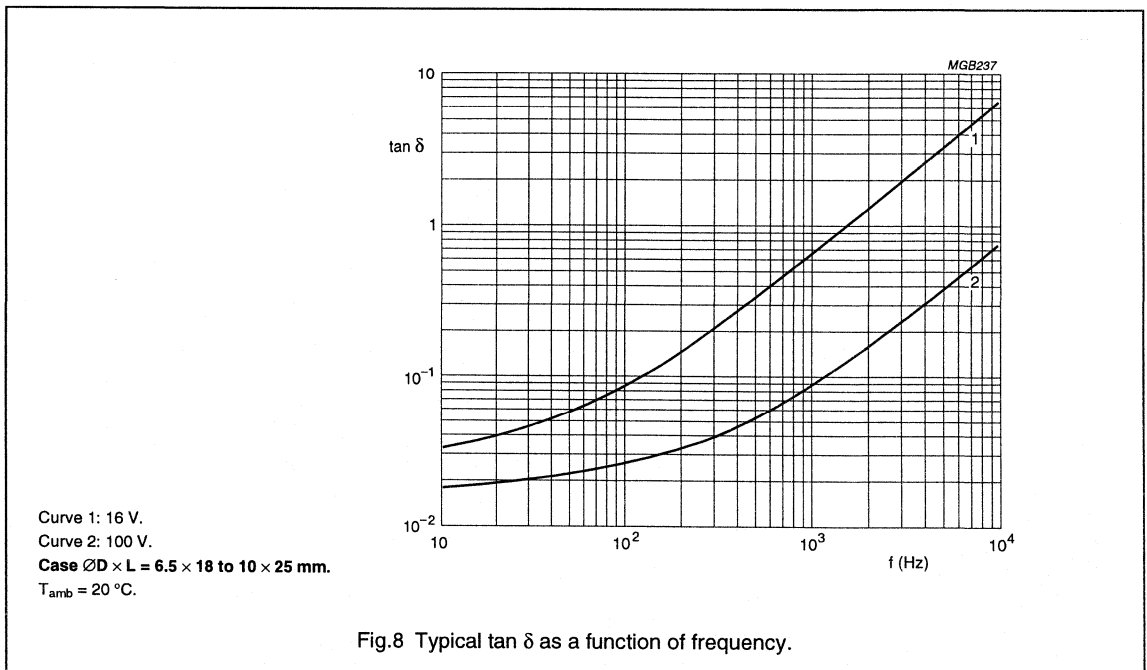
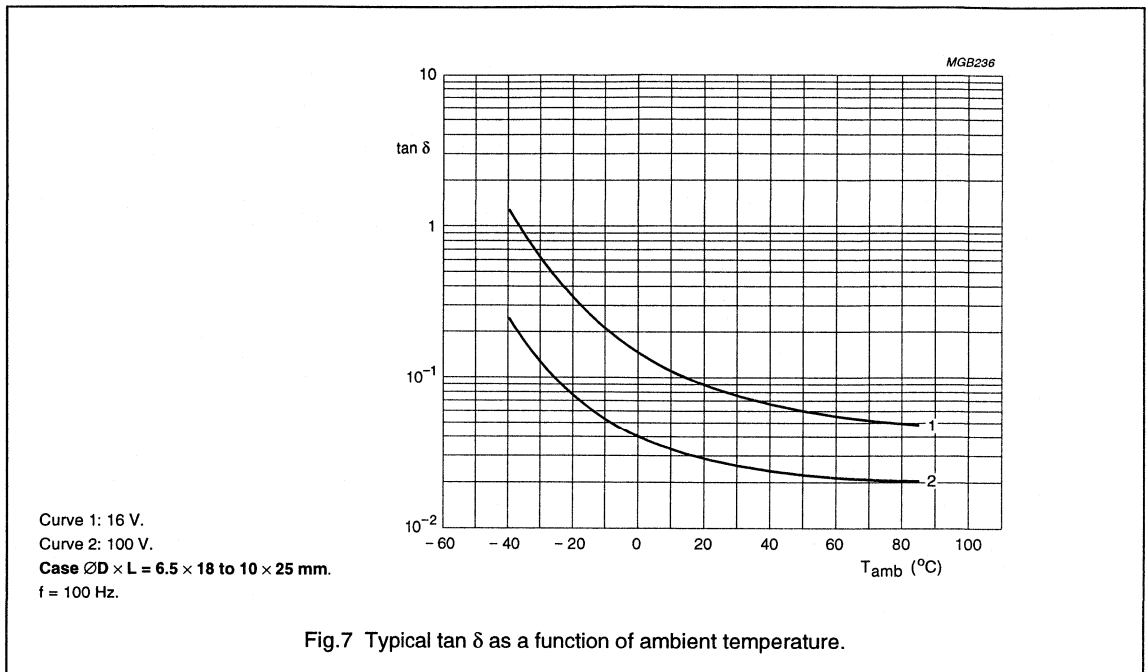
Capacitance (C)



Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

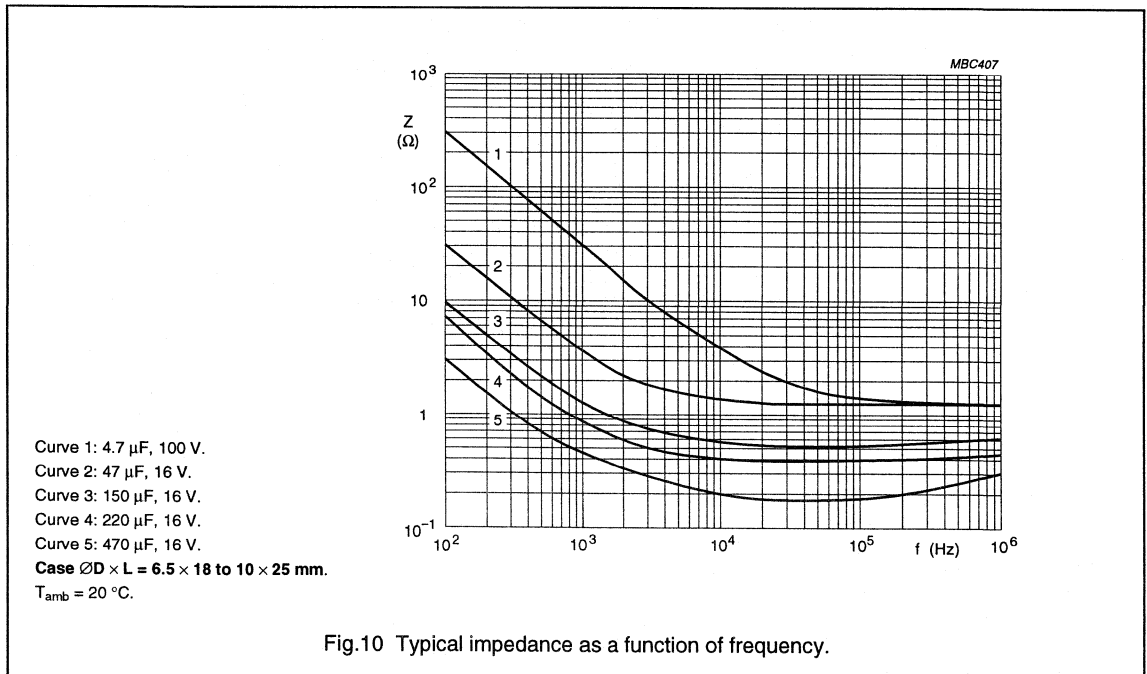
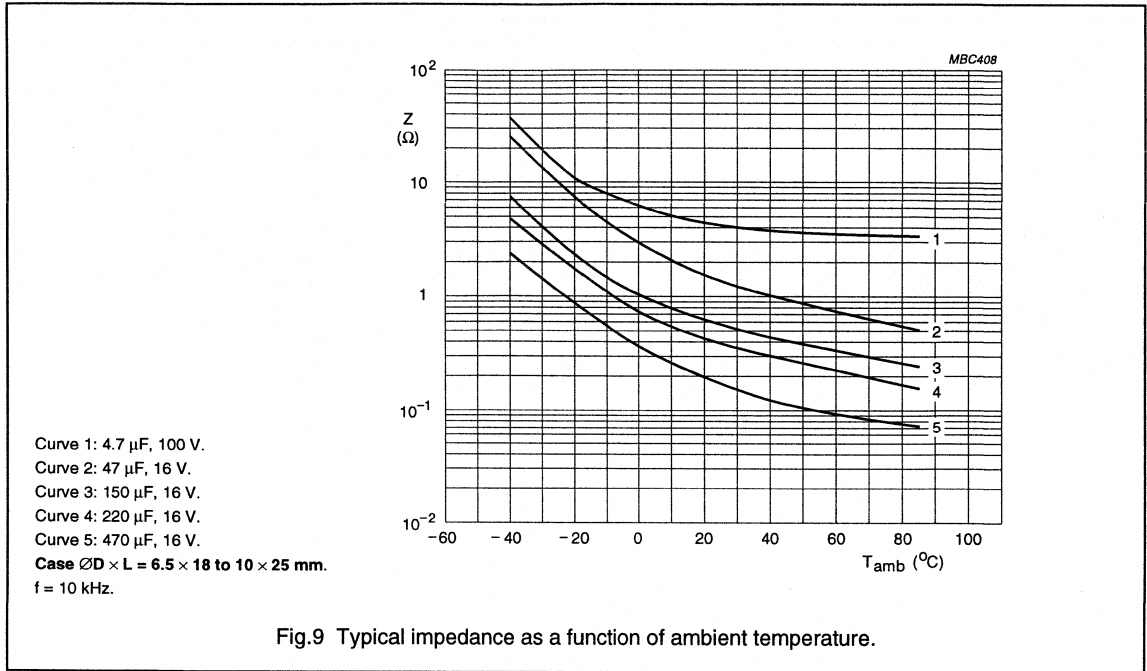
Dissipation factor ($\tan \delta$)



Non-solid Al - electrolytic capacitors
Axial Long Life, DIN-based

ALL-DIN 132-133

Impedance (Z)



Non-solid Al - electrolytic capacitors

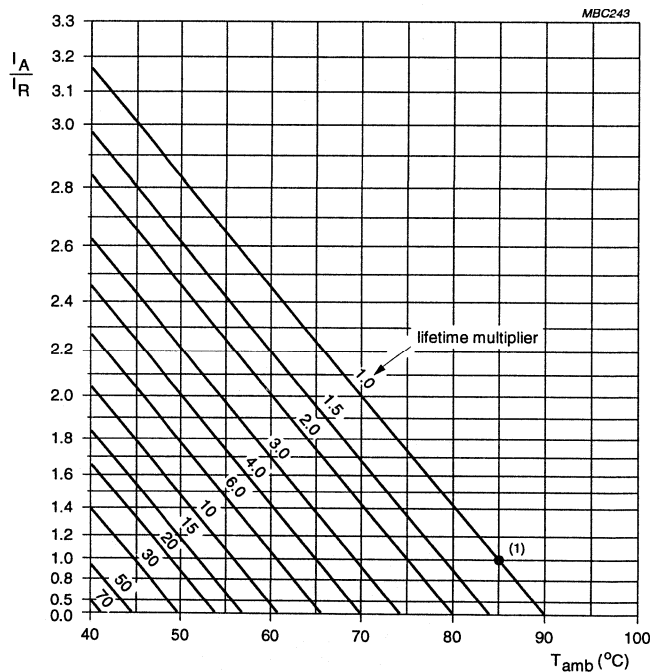
Axial Long Life, DIN-based

ALL-DIN 132-133

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
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 $\varnothing D \times L = 6.5 \times 18$ and 8×18 mm: 10000 hours

case $\varnothing D \times L = 10 \times 18$ to 21×40 mm: 15000 hours.

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

Non-solid Al - electrolytic capacitors

Axial Long Life, DIN-based

ALL-DIN 132-133

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	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; case $\varnothing D \times L = 6.5 \times 18$ and 8×18 mm: 6000 hours; case $\varnothing D \times L = 10 \times 18$ to 21×40 mm: 8000 hours	$U_R = 10$ to 160 V; $\Delta C/C: \pm 15\%$ $U_R = 250$ to 350 V; $\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; case $\varnothing D \times L = 6.5 \times 18$ and 8×18 mm: 10000 hours; case $\varnothing D \times L = 10 \times 18$ to 21×40 mm: 15000 hours	$U_R = 10$ to 160 V; $\Delta C/C: \pm 45\%$ $U_R = 250$ to 350 V; $\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ 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 $I_{L5} \leq 2 \times \text{spec. limit}$

A

Non-solid Al - electrolytic capacitors

Axial High Temperature

AHT 118

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case $\varnothing 10 \times 30$ mm to $\varnothing 21 \times 40$ 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: 4000 hours at 125 °C, high reliability
- Extended temperature range: 125 °C (usable up to 150 °C)
- Miniaturized, high CV-product per unit volume.

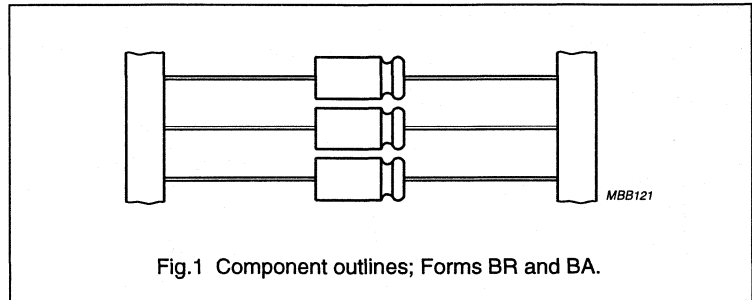
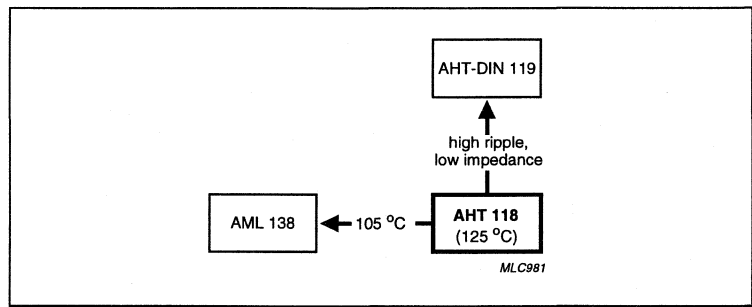


Fig.1 Component outlines; Forms BR and BA.

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 ($\varnothing D_{nom} \times L_{nom}$ in mm)	6.5 × 18 to 10 × 25	10 × 30 to 21 × 40
Rated capacitance range, C_R	1 to 10000 μF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	6.3 to 200 V	
Category temperature range	-40 to +125 °C	-55 to +125 °C
Endurance test at 150 °C, with no I_R applied	500 hours	1000 hours
Endurance test at 125 °C	2000 hours	3000 hours
Useful life at 125 °C	4000 hours	4000 hours
Useful life at 40 °C, $1.8 \times I_R$ applied	500000 hours	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, LL grade	
Climatic category IEC 68 (DIN 40040)	40/125/56 (GKD)	55/125/56 (FKD)

Non-solid Al - electrolytic capacitors

Axial High Temperature

AHT 118

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

Preferred types in **bold**.

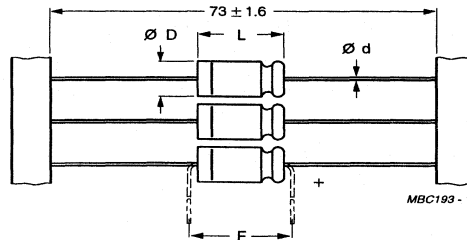
C_R (μF)	U_R (V)							
	6.3	10	16	25	40	63	100	200
1.0	-	-	-	-	-	6.5 × 18	-	-
2.2	-	-	-	-	-	6.5 × 18	-	6.5 × 18
4.7	-	-	-	-	-	6.5 × 18	6.5 × 18	8 × 18
10	-	-	-	-	-	6.5 × 18	6.5 × 18	10 × 25
15	-	-	-	-	-	-	-	10 × 30
22	-	-	-	-	-	6.5 × 18	8 × 18	12.5 × 30
33	-	-	-	-	-	-	10 × 25	15 × 30
47	-	-	-	-	6.5 × 18	8 × 18	10 × 25	18 × 30
	-	-	-	-	-	-	10 × 30	-
68	-	-	-	-	-	-	12.5 × 30	18 × 40
100	-	-	-	6.5 × 18	8 × 18	10 × 25	12.5 × 30	21 × 40
	-	-	-	-	-	10 × 30	-	-
150	-	-	-	-	10 × 18	12.5 × 30	15 × 30	-
220	-	6.5 × 18	8 × 18	10 × 18	10 × 25	12.5 × 30	18 × 30	-
	-	-	-	-	10 × 30	-	-	-
330	-	8 × 18	10 × 18	10 × 25	12.5 × 30	15 × 30	18 × 40	-
470	-	8 × 18	10 × 18	10 × 25	12.5 × 30	18 × 30	21 × 40	-
	-	-	-	10 × 30	-	-	-	-
680	-	-	10 × 30	12.5 × 30	15 × 30	18 × 40	-	-
1000	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	-	-	-
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	-	-	-	-	-	-

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

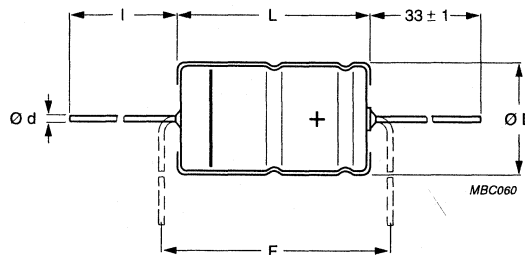
Form BR: Taped on reel,
case $\varnothing D \times L = 6.5 \times 18$ to 15×30 mm.

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 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.

Fig.3 Dimensional outline; Form AA.

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

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	AXIAL: FORM AA, BA and BR					MASS (g)	PACKAGING QUANTITIES		
		Ød (mm)	L (mm)	ØD _{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	–	–

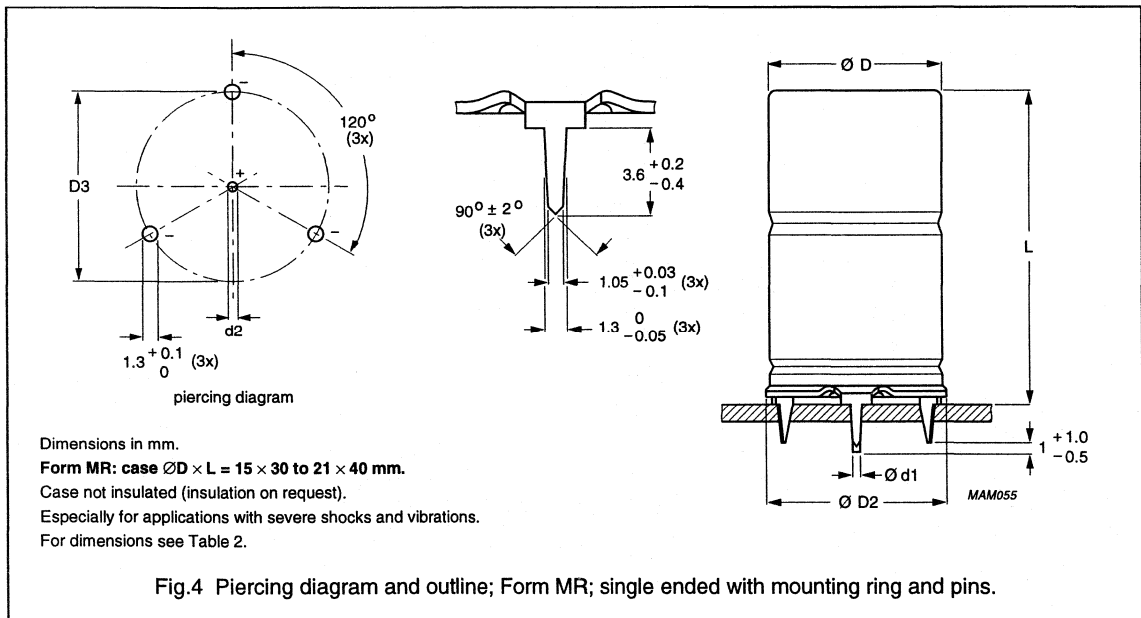


Table 2 Single ended; physical dimensions, mass and packaging quantities; see Fig.4

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	SINGLE ENDED WITH MOUNTING RING: FORM MR					MASS (g)	PACKAGING QUANTITIES	
		Ød ₁ (mm)	Ød ₂ (mm)	ØD _{max} (mm)	ØD _{2max} (mm)	D ₃ (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 AHT 118
1000 $\mu\text{F}/10\text{ V}$; $\pm 20\%$
Nominal case size: $\varnothing 10 \times 30$; Form BR
Catalogue number: 2222 118 24102.

ELECTRICAL DATA AND ORDERING INFORMATION

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

C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, 125 $^\circ\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
Tan 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 $\varnothing D \times L$ (mm)	I_R 100 Hz 125 $^\circ\text{C}$ (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				
									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 x 18 10 x 25	6 7	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 1000 1500 2200 3300 4700 6800 10000	6.5 x 18 8 x 18 8 x 18 10 x 25 10 x 30 12.5 x 30 12.5 x 30 15 x 30 18 x 30 18 x 40 21 x 40	4 5 5 7 00 01 01 02 03 04 05	20 24 32 64 64 94 136 202 286 412 604	8.4 11 13 24 24 34 48 70 98 140 200	0.35 0.35 0.35 0.35 0.32 0.32 0.40 0.40 0.46 0.53 0.53	2.53 1.69 1.19 0.56 0.505 0.285 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 - - - - - -	- - - - - - - - - - -	- - - - - - - - - - -

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CATALOGUE NUMBER 2222														
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × 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	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	-	118 46152	
1500		15 × 30	02	691	229	79	0.25	0.263	0.22	118 16152	118 26152	-	118 46222	
2200		18 × 30	03	919	334	110	0.26	0.185	0.17	118 16222	-	-	118 46332	
3300		18 × 40	04	1280	499	170	0.26	0.12	0.11	118 16332	-	-	118 46472	
4700	21 × 40	05	1464	709	240	0.28	0.095	0.10	118 16472	-	-	118 46472		

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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	
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	0.33	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							SINGLE ENDED							
UR (V)	CR 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	IR 100 Hz 125 °C (mA)	IL1 1 min (μA)	IL5 5 min (μA)		AXIAL						
							IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR				
100	4.7	6.5 × 18	4	36	20	4.9	0.07	24	19	118 29478	118 39478	118 39478	-	
	10	6.5 × 18	4	52	20	6.0	0.07	11	9.0	118 29109	118 39109	118 39109	-	
	22	8 × 18	5	91	20	8.4	0.07	5.1	4.0	118 29229	118 39229	118 39229	-	
	33	10 × 25	7	140	24	11	0.07	3.4	2.7	118 29339	118 39339	118 39339	-	
	47	10 × 25	7	170	33	13	0.07	2.6	2.0	118 90535	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	118 90538	-
		4.7	8 × 18	5	46	20	5.9	0.06	21	11	118 90539	118 90541	118 90541	-
		10	10 × 25	7	85	20	8.0	0.06	9.4	5.0	118 90542	118 90543	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	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	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$ or $20 \mu\text{A}$ (whichever is greater)	
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$	
Inductance			
Equivalent series inductance (ESL)	case $\varnothing D \times L$ 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	

Table 4 Uprating values at reduced ambient temperature; note 1

SYMBOL	CONDITIONS	VALUES								UNIT
		6.3	10	16	25	40	63	100	200	
U_R	$T_{amb} > 85$ to $125 \text{ }^\circ\text{C}$	6.3	10	16	25	40	63	100	200	V
U_{R2}	$T_{amb} \leq 85 \text{ }^\circ\text{C}$	10	16	25	40	63	100	125	250	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} .

MARKING

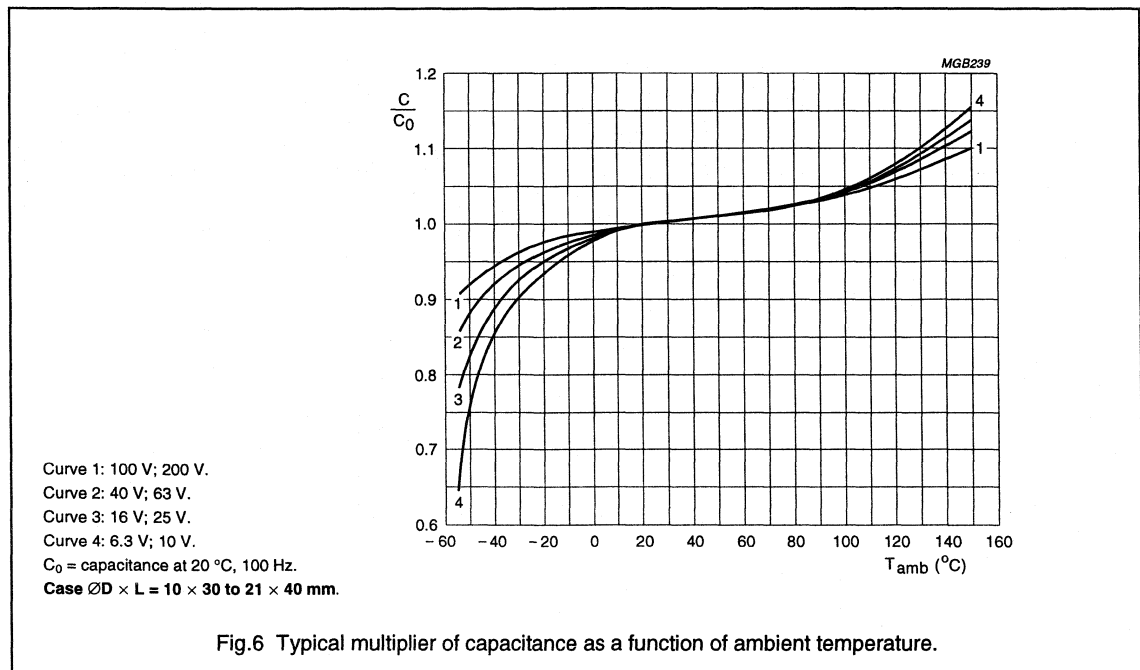
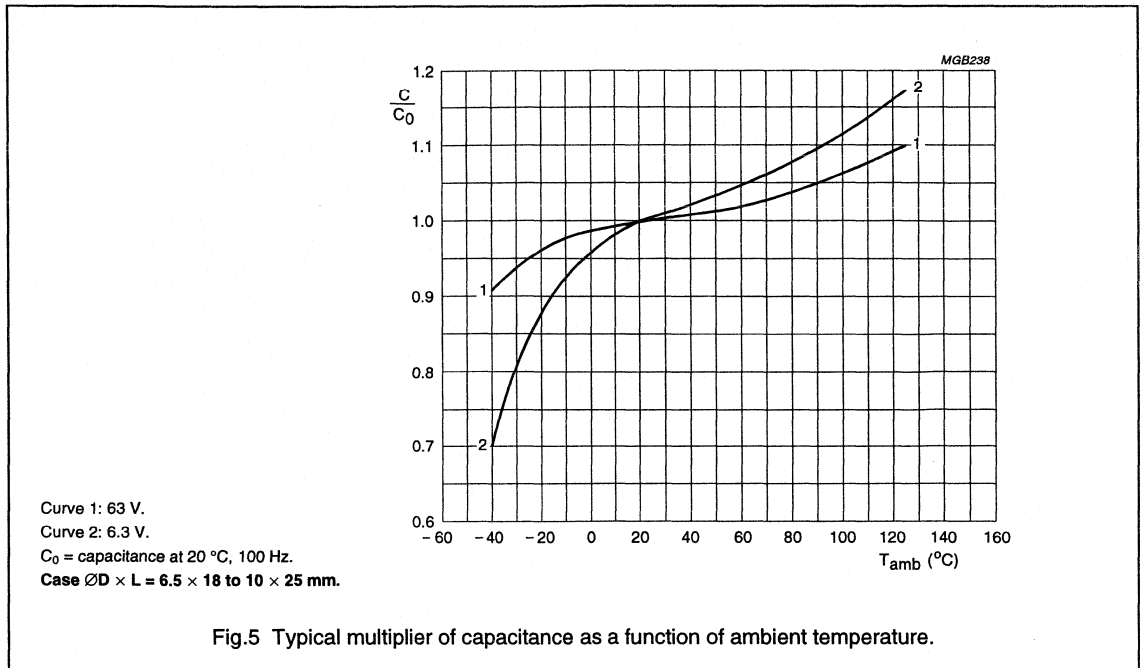
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in μF)
- Tolerance on rated capacitance, code letter in accordance with "IEC 62"
- Rated voltage (in V) at $125 \text{ }^\circ\text{C}$ and $85 \text{ }^\circ\text{C}$
- 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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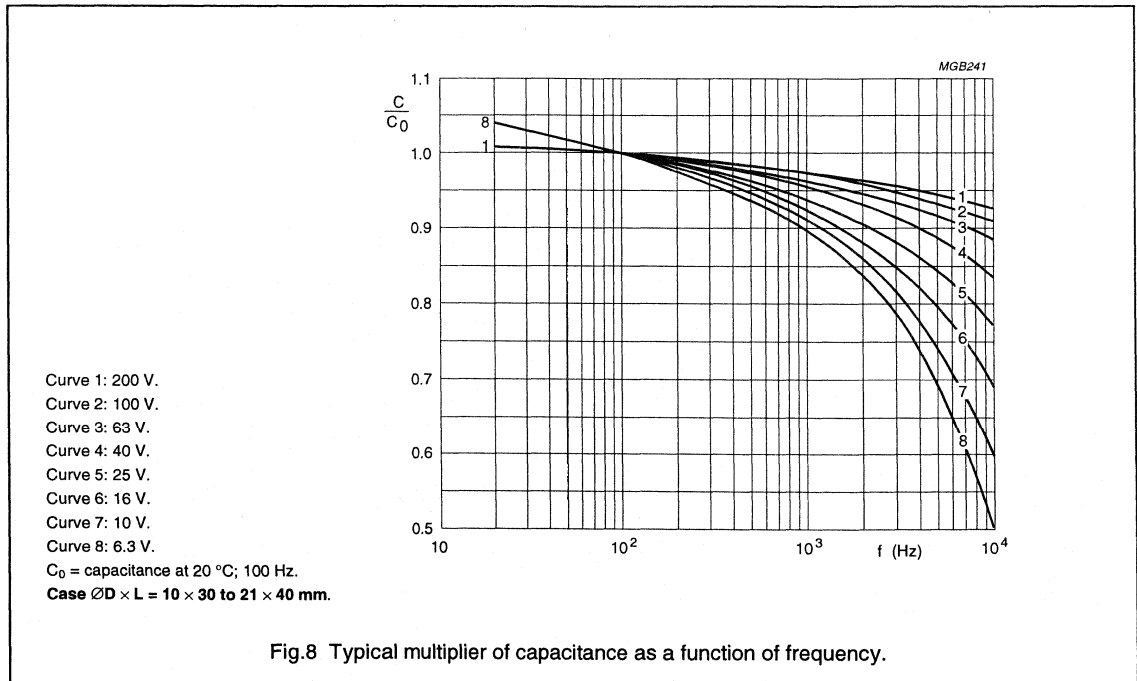
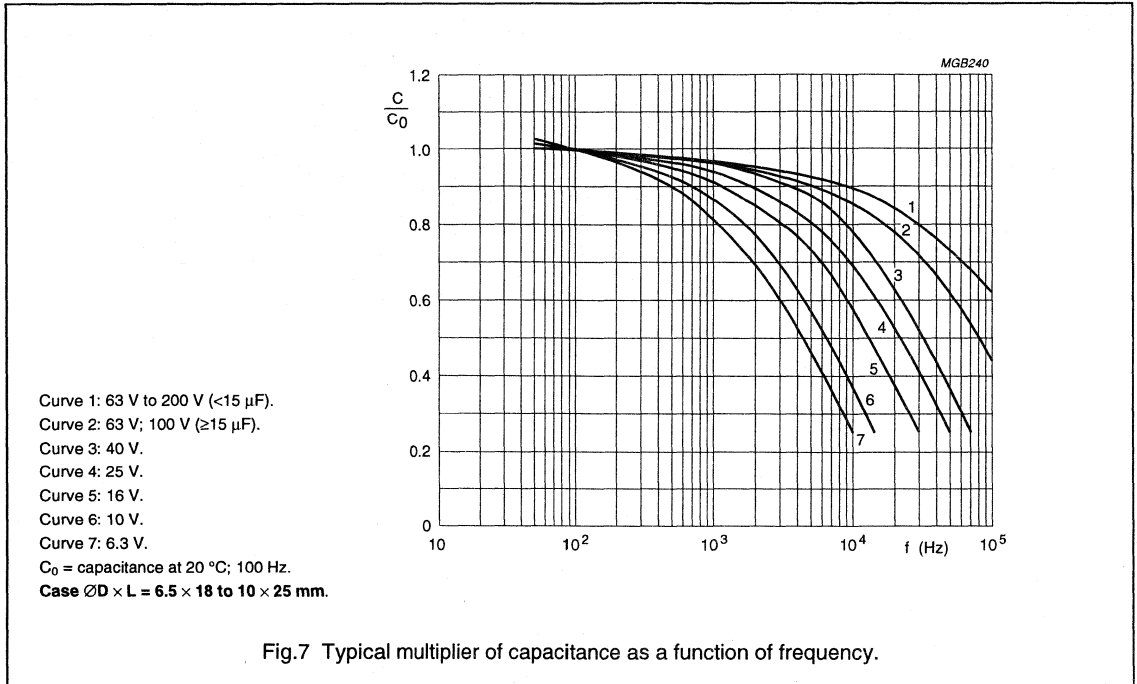
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Capacitance (C)



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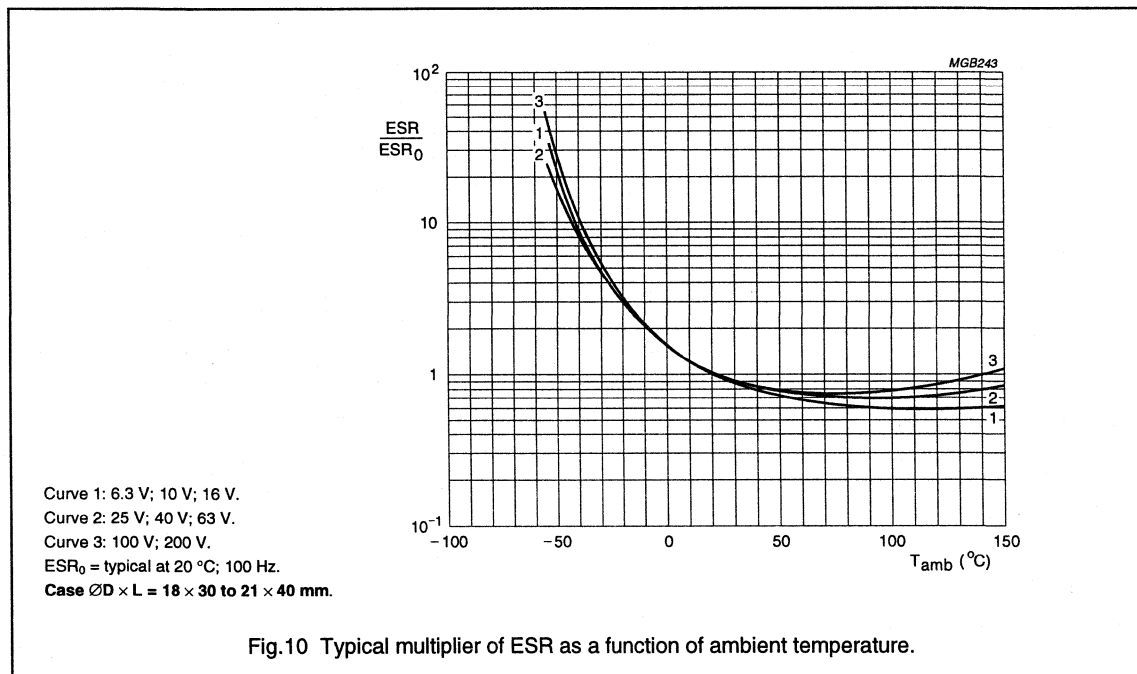
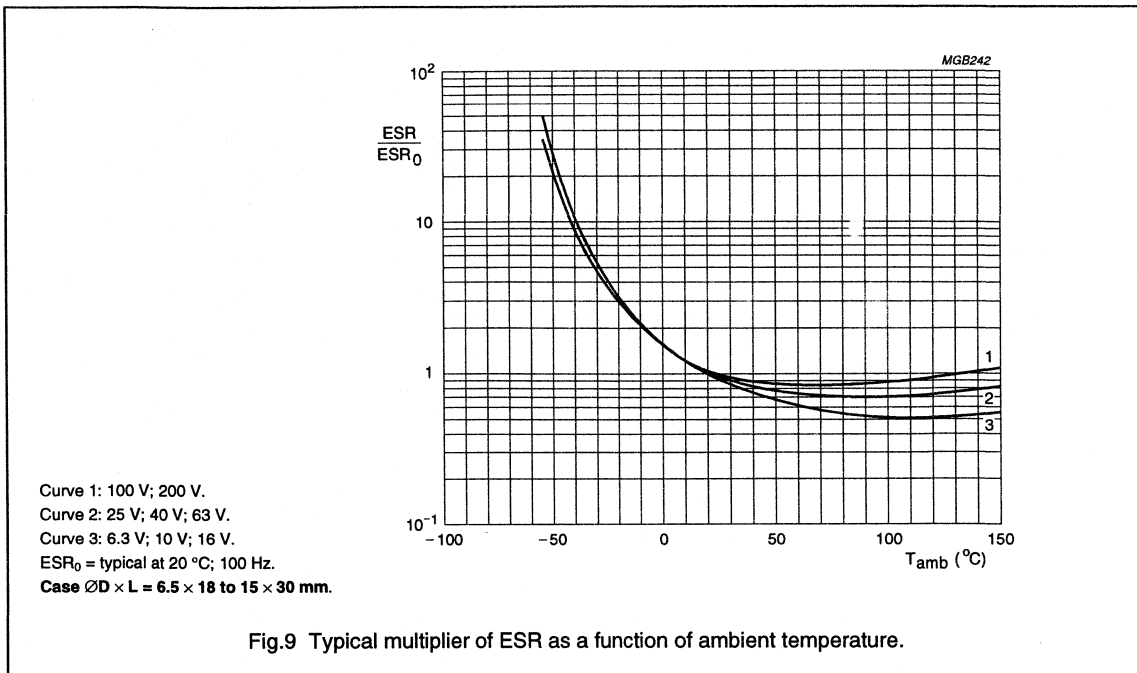
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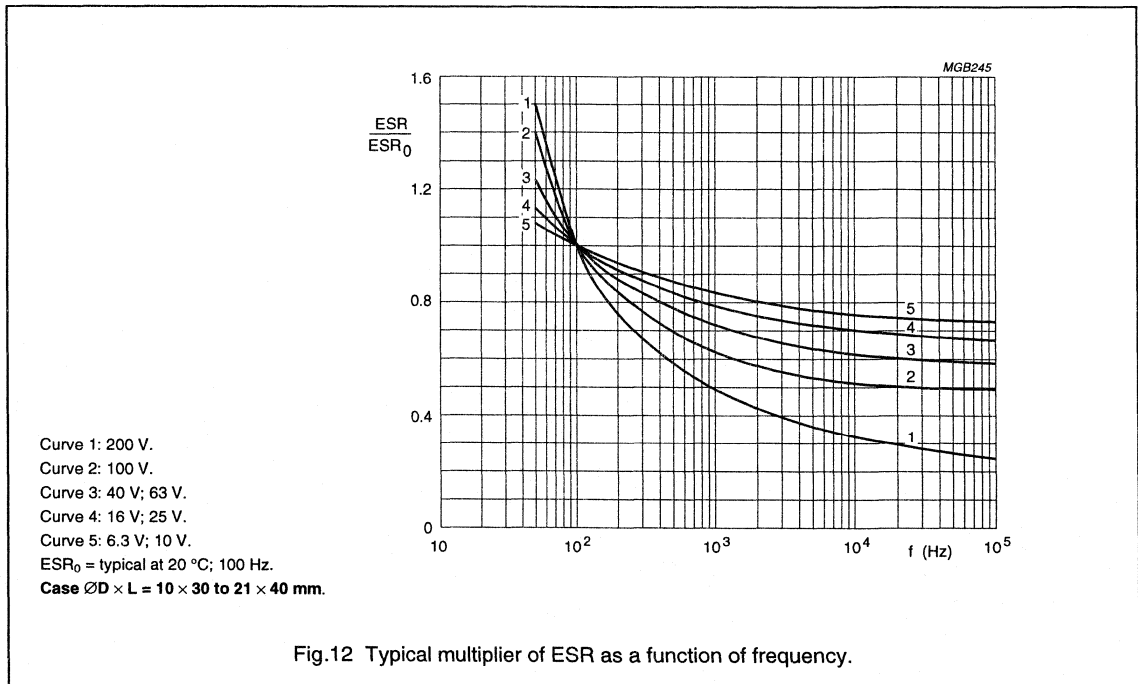
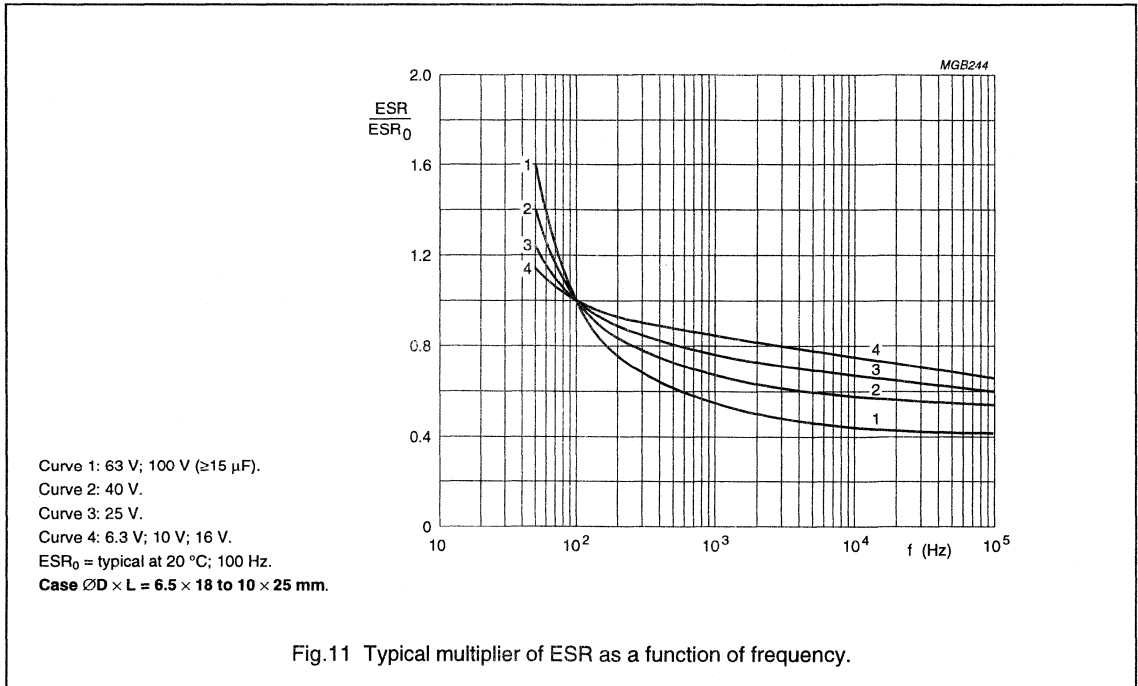
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Equivalent series resistance (ESR)



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Impedance (Z)

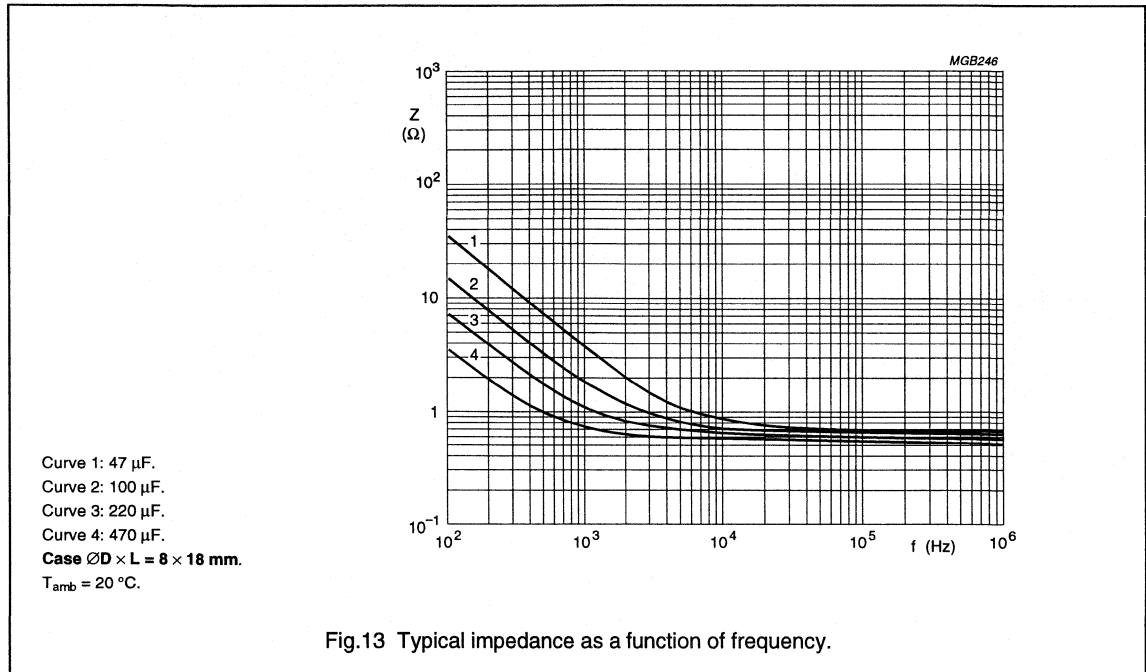


Fig.13 Typical impedance as a function of frequency.

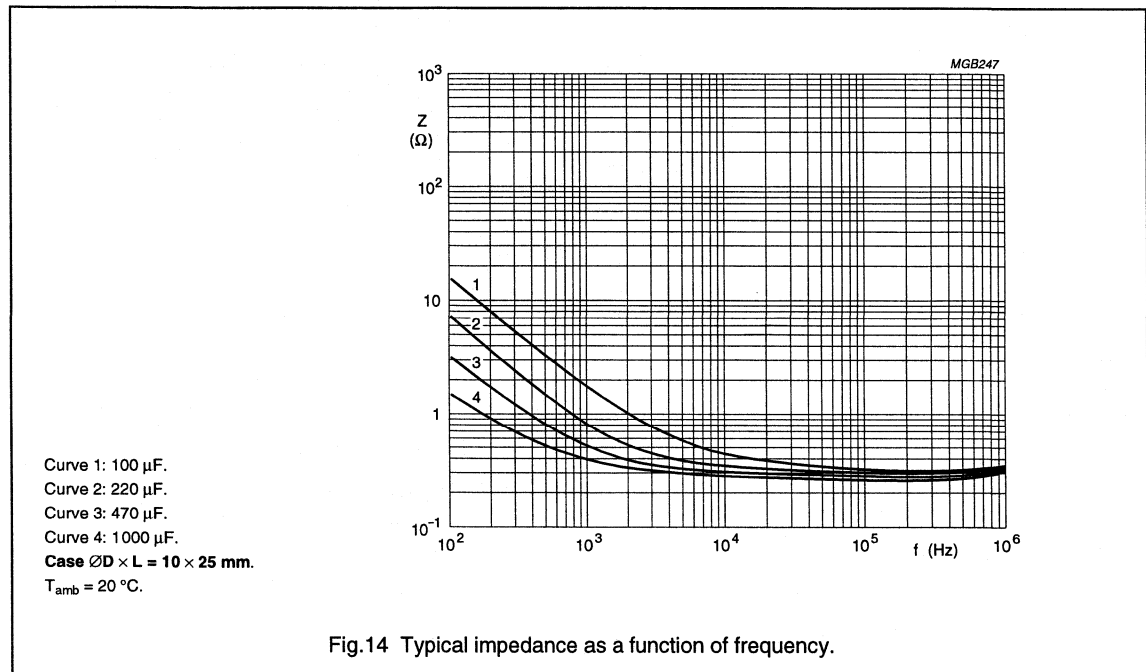


Fig.14 Typical impedance as a function of frequency.

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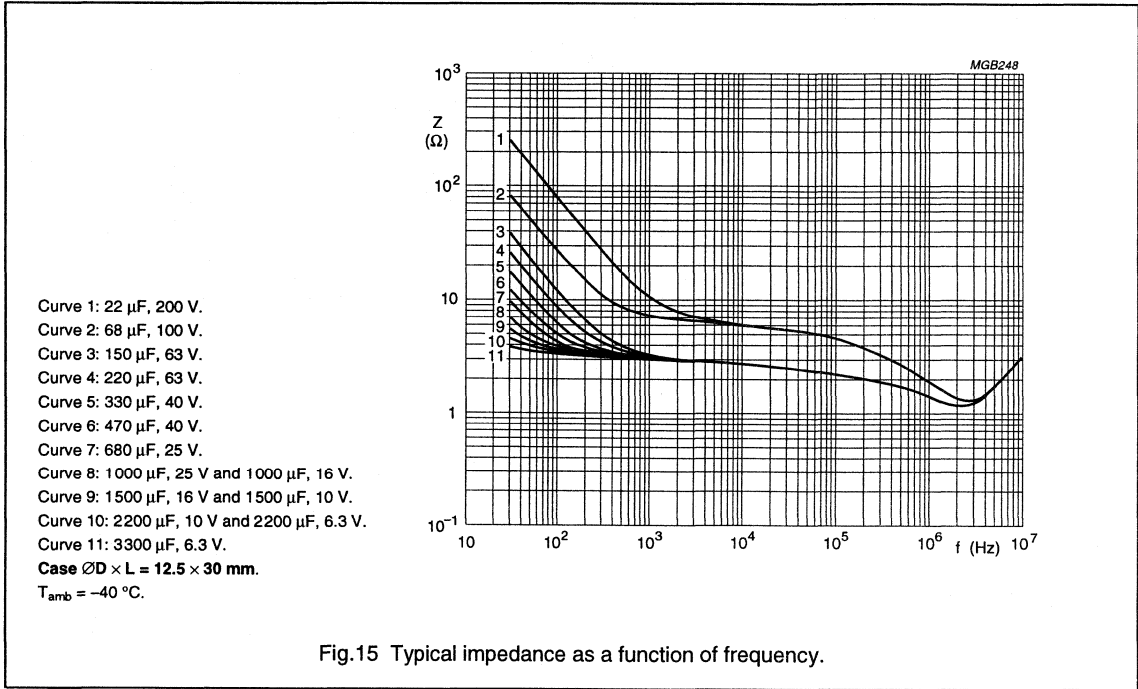


Fig.15 Typical impedance as a function of frequency.

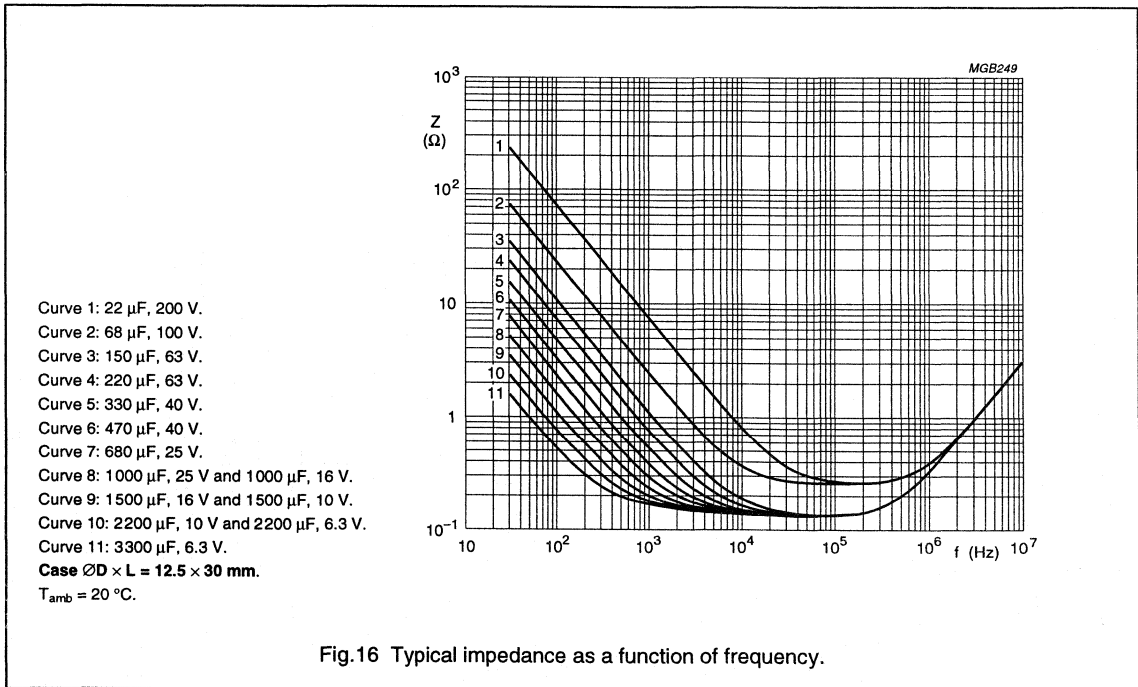
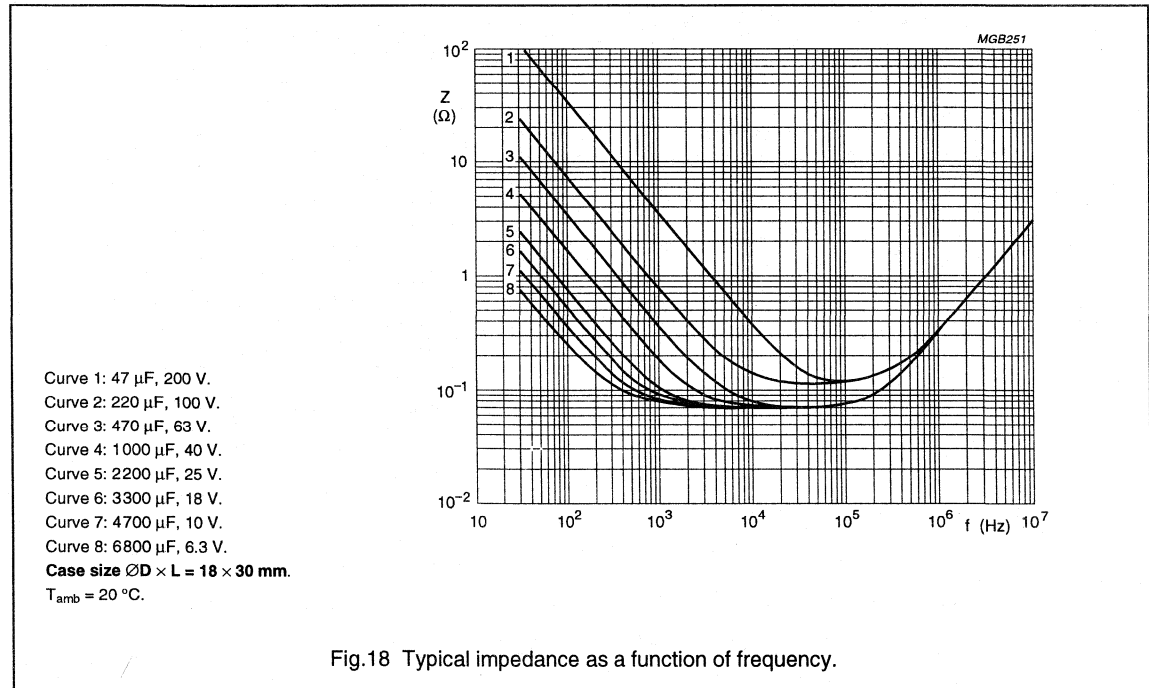
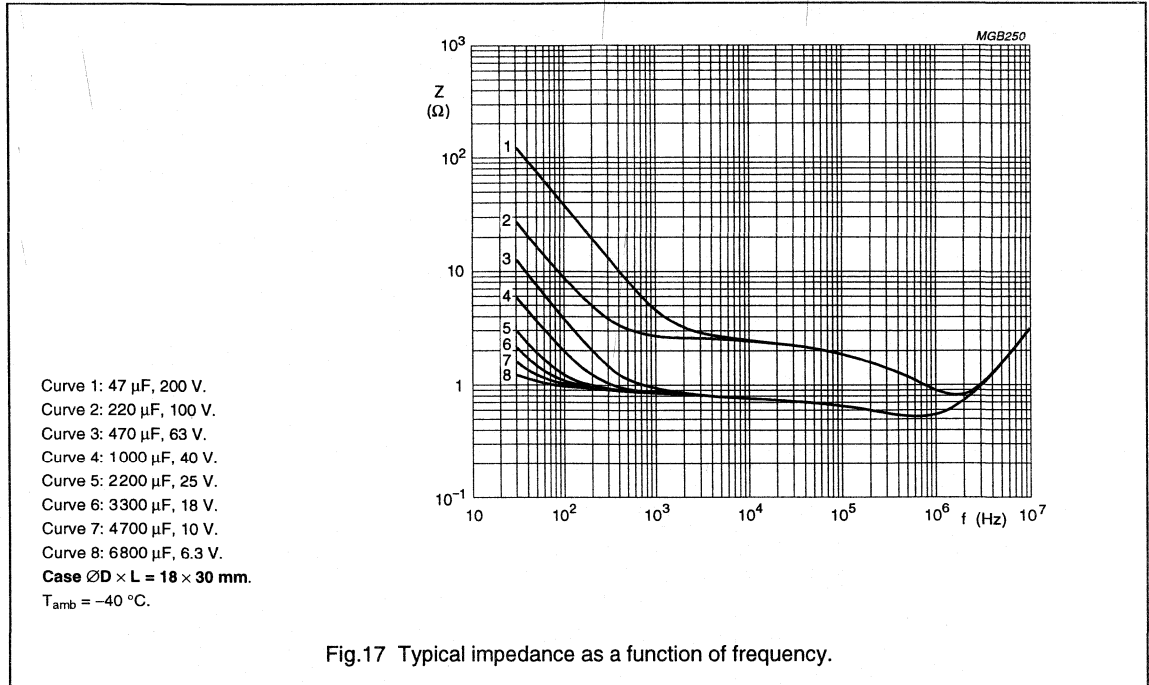


Fig.16 Typical impedance as a function of frequency.

Non-solid Al - electrolytic capacitors

Axial High Temperature

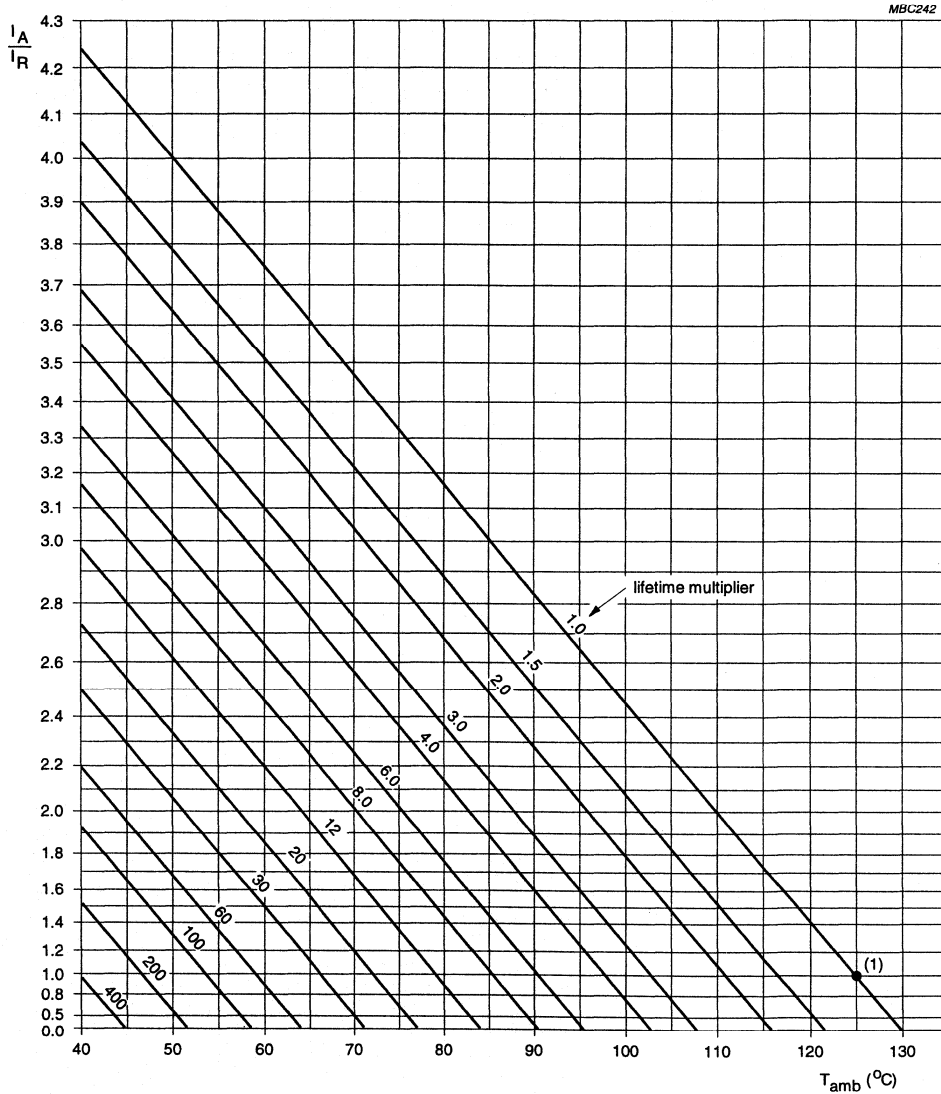
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Non-solid Al - electrolytic capacitors Axial High Temperature

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RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz.
 I_R = rated ripple current at 100 Hz, 125 °C.
 (1) Useful life at 125 °C and I_R applied: 4000 hours.

Fig.19 Multiplier of useful life as a function of ambient temperature and ripple current load; see Table 5.

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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	$U_R = 100$ to 200 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥ 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	$T_{amb} = 125$ °C; U_R applied; case sizes: 6.5 × 18 to 10 × 25 mm: 2000 hours 10 × 30 to 21 × 40 mm: 3000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: +15/-30% $U_R > 6.3$ V; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times$ spec. limit $Z \leq 2 \times$ spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 125$ °C; U_R and I_R applied; 4000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: +45/-50% $U_R > 6.3$ V; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times$ spec. limit $Z \leq 3 \times$ spec. limit $I_{L5} \leq$ 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	$T_{amb} = 125$ °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 $I_{L5} \leq 2 \times$ spec. limit
Reverse voltage	IEC 384-4/ CECC 30300 subclause 4.15	$T_{amb} = 125$ °C: 125 hours at $U = -1$ V followed by 125 hours at U_R	$\Delta C/C$: $\pm 20\%$ $\tan \delta \leq$ spec. limit $I_{L5} \leq$ spec. limit

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FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case $\varnothing 10 \times 30$ 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.

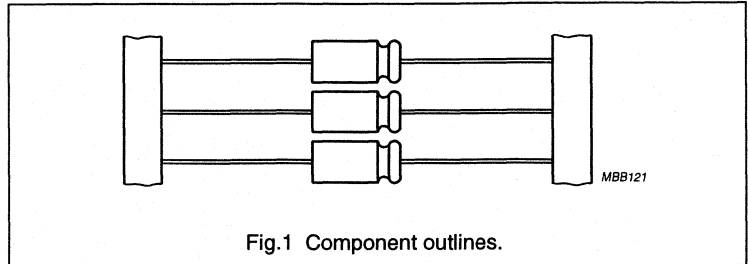
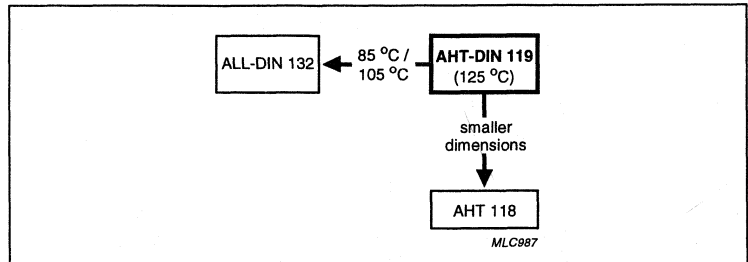


Fig.1 Component outlines.



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 ($\varnothing D_{nom} \times L_{nom}$ in mm)	6.5 × 18 to 10 × 25	10 × 30 to 21 × 40
Rated capacitance range, C_R	4.7 to 4700 μF	
Tolerance on C_R	-10/+50%	
Rated voltage range, U_R	10 to 200 V	
Category temperature range	-55 to +125 °C	
Endurance test at 150 °C, with no I_R applied	500 hours	1000 hours
Endurance test at 125 °C	2000 hours	4000 hours; 100 V: 3000 hours
Useful life at 125 °C	4000 hours	5000 hours; 100 V: 4000 hours
Useful life at 40 °C, 1.8 I_R applied	500000 hours	500000 hours
Shelf life at 0 V, 125 °C		
$U_R = 10$ to 63 V	500 hours	
$U_R = 100$ and 200 V	100 hours	
Based on sectional specification	IEC 384-4/CECC 30300, LL grade	
Detail specification	similar to DIN 45910-T123 (without approval), former DIN 41257	
Climatic category IEC 68 (DIN 40040)	55/125/56 (FKD)	
Approvals	CECC 30301-055 (values $\geq 4.7 \mu\text{F}$)	UTE CO31/CO33

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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	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	–
47	–	6.5 × 18	–	8 × 18	10 × 18	10 × 25	–
	–	–	–	–	–	10 × 30	–
68	–	–	–	–	10 × 30	12.5 × 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	–	–	–	–
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 × 40	21 × 40	–
	12.5 × 30	–	–	–	–	–	–
680	12.5 × 30	15 × 30	18 × 30	18 × 30	21 × 40	–	–
1000	15 × 30	15 × 30	18 × 30	18 × 40	21 × 40	–	–
1500	18 × 30	18 × 30	18 × 40	21 × 40	–	–	–
2200	18 × 30	18 × 40	21 × 40	21 × 40	–	–	–
3300	18 × 40	21 × 40	–	–	–	–	–
4700	21 × 40	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 (119)
- 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.

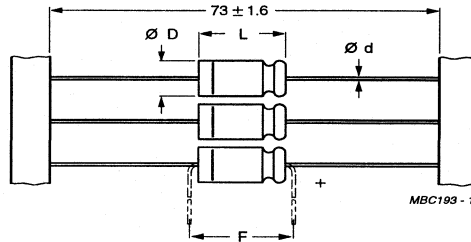
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Non-solid Al - electrolytic capacitors

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

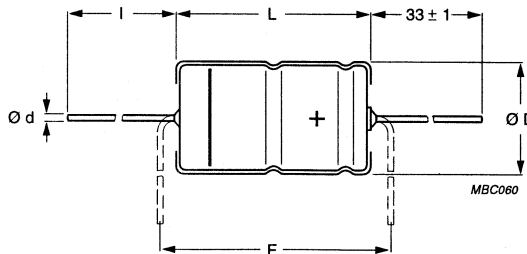
Form BR: Taped on reel,
case $\varnothing D \times L = 6.5 \times 18$ to 15×30 mm.

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 case sizes 18×30 and 21×40 mm, the stated L_{max} may be exceeded by 0.7 mm.

For dimensions see Table 1.

Fig.3 Dimensional outline; Form AA.

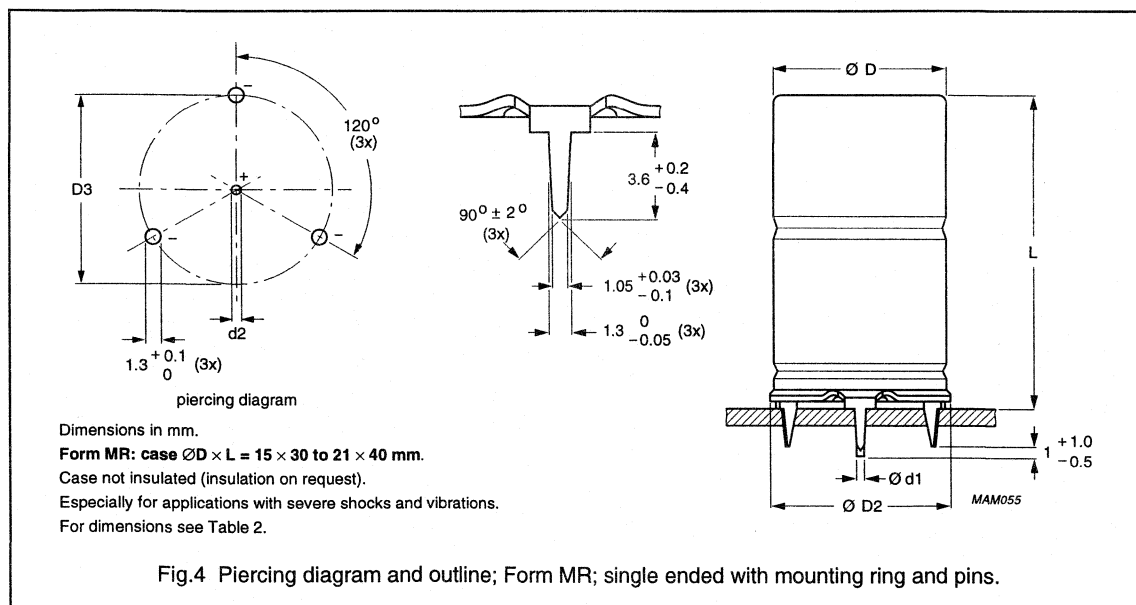
Non-solid Al - electrolytic capacitors

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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		
		$\varnothing d$	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	–	–

**Fig. 4** Piercing diagram and outline; Form MR; single ended with mounting ring and pins.**Table 2** Single ended; 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
		$\varnothing d_1$ (mm)	$\varnothing d_2$ (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

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Ordering example

Electrolytic capacitor AHT-DIN 119
470 $\mu\text{F}/16\text{ V}$; $-10/+50\%$
Nominal case size: $\varnothing 12.5 \times 30$; Form BR
Catalogue number: 2222 119 25471.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 apply at $T_{\text{amb}} = 20^\circ\text{C}$,
 $P = 86$ to 106 kPa , $\text{RH} = 45$ 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
$\text{Tan } \delta$	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 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 °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			
										AXIAL		SINGLE ENDED	
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
10	100	6.5 x 18	4	130	10	6	0.2	3.5	2.2	-	119 24101	119 34101	-
	220	10 x 18	6	240	17	8.4	0.18	1.3	1.0	-	119 24221	119 34221	-
	470	10 x 25	7	380	32	13	0.18	0.61	0.49	-	119 90501	119 90502	-
	470	12.5 x 30	01	550	32	13	0.16	0.54	0.38	119 14471	119 24471	-	-
	680	12.5 x 30	01	590	45	18	0.20	0.47	0.38	119 14681	119 24681	-	-
	1000	15 x 30	02	715	64	24	0.20	0.32	0.24	119 14102	119 24102	-	119 44102
	1500	18 x 30	03	945	94	34	0.22	0.23	0.17	119 14152	-	-	119 44152
	2200	18 x 30	03	1025	136	48	0.26	0.19	0.17	119 14222	-	-	119 44222
	3300	18 x 40	04	1405	202	70	0.27	0.13	0.10	119 14332	-	-	119 44332
	4700	21 x 40	05	1700	286	90	0.30	0.10	0.09	119 14472	-	-	119 44472
16	47	6.5 x 18	4	110	10	5.5	0.13	4.4	2.2	-	119 25479	119 35479	-
	100	8 x 18	5	170	14	7.2	0.13	2.1	1.3	-	119 25101	119 35101	-
	220	10 x 25	7	300	25	11	0.13	0.94	0.55	-	119 25221	119 35221	-
	330	12.5 x 30	01	510	36	15	0.13	0.63	0.38	119 15331	119 25331	-	-
	470	12.5 x 30	01	565	50	19	0.15	0.51	0.38	119 15471	119 25471	-	-

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × 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			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	
16	680 1000 1500 2200 3300 4700	15 × 30 15 × 30 18 × 30 18 × 40 21 × 40 21 × 40	02 02 03 04 05 05	680 735 970 1310 1650 1700	69 100 148 215 321 455	26 36 52 74 110 154	0.15 0.19 0.20 0.20 0.22 0.28	0.35 0.30 0.21 0.14 0.11 0.09	0.24 0.24 0.17 0.10 0.09 0.09	119 15681 119 15102 119 15152 119 15222 119 15332 119 15472	119 25681 119 25102 - - - -	- - - - - -	119 45681 119 45102 119 45152 119 45222 119 45332 119 45472
25	22 100 220 220 330 470 680 1000 1500 2200	6.5 × 18 10 × 18 10 × 25 12.5 × 30 12.5 × 30 12.5 × 30 18 × 30 18 × 30 18 × 40 21 × 40	4 6 7 01 01 01 03 03 04 05	85 210 350 500 555 610 810 980 1345 1640	10 19 37 37 54 75 106 154 229 334	5.1 9 15 15 21 28 38 54 79 114	0.10 0.10 0.10 0.09 0.11 0.13 0.13 0.13 0.13 0.13	7.2 1.6 0.72 0.65 0.53 0.44 0.30 0.21 0.14 0.11	3.2 1.0 0.58 0.38 0.38 0.38 0.17 0.17 0.10 0.09	- - - 119 16221 119 16331 119 16471 119 16681 - - - 119 16222	119 26229 119 36229 119 36101 119 90504 - - - - - -	119 46681 119 46102 119 46152 119 46222	
40	47 100 150 220 330 470 680 1000 1500 2200	8 × 18 10 × 25 12.5 × 30 12.5 × 30 15 × 30 15 × 30 18 × 30 18 × 40 21 × 40 21 × 40	5 7 01 01 02 02 03 04 05 05	150 260 440 500 615 630 845 1140 1400 12	15 28 40 57 83 117 167 244 364 20	7.8 12 16 22 30 42 58 84 124 4.1	0.08 0.08 0.08 0.09 0.09 0.12 0.12 0.12 0.14 0.07	2.7 1.3 0.85 0.65 0.43 0.41 0.28 0.19 0.15 110	1.5 0.7 0.51 0.48 0.37 0.37 0.22 0.12 0.12 22.0	119 27479 119 37479 119 37101 119 27101 119 27151 119 27221 119 27331 119 27471 - - - -	119 47479 119 47102 119 47152 119 47222	119 47331 119 47471 119 47681 119 47102 119 47152 119 47222	

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × 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				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	91	20	5.9	0.07	7.4	3.7	-	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	-		
	220	15 × 30	02	530	87	32	0.08	0.58	0.37	119 18221	119 28221	119 48151		
	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		
	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		
100	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		
	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	266	98	0.10	0.34	0.28	119 19471	-	119 49471		
200	4.7	10 × 18	6	52	20	10	0.08	27	10	-	119 90507	119 90508	-	
	10	10 × 25	7	82	20	10	0.08	13	5.0	-	119 90509	119 90511	-	

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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: $U_R = 10 \text{ to } 40 \text{ V}$ $U_R = 63 \text{ V to } 200 \text{ V}$	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$, or $10 \mu\text{A}$ (whichever is greater)	
	after 5 minutes: $U_R = 10 \text{ to } 63 \text{ V}$ $U_R = 100 \text{ and } 200 \text{ V}$	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$ $I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$, or $10 \mu\text{A}$ (whichever is greater)	
Inductance			
Equivalent series inductance (ESL)	case $\varnothing D \times L$ 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	

Table 4 Up-rating values at reduced ambient temperature; note 1

SYMBOL	CONDITIONS	VALUES							UNIT
		10	16	25	40	63	100	200	
U_R	$T_{amb} > 85 \text{ to } 125 \text{ }^\circ\text{C}$	10	16	25	40	63	100	200	V
U_{R2}	$T_{amb} \leq 85 \text{ }^\circ\text{C}$	16	25	40	63	100	125	250	V

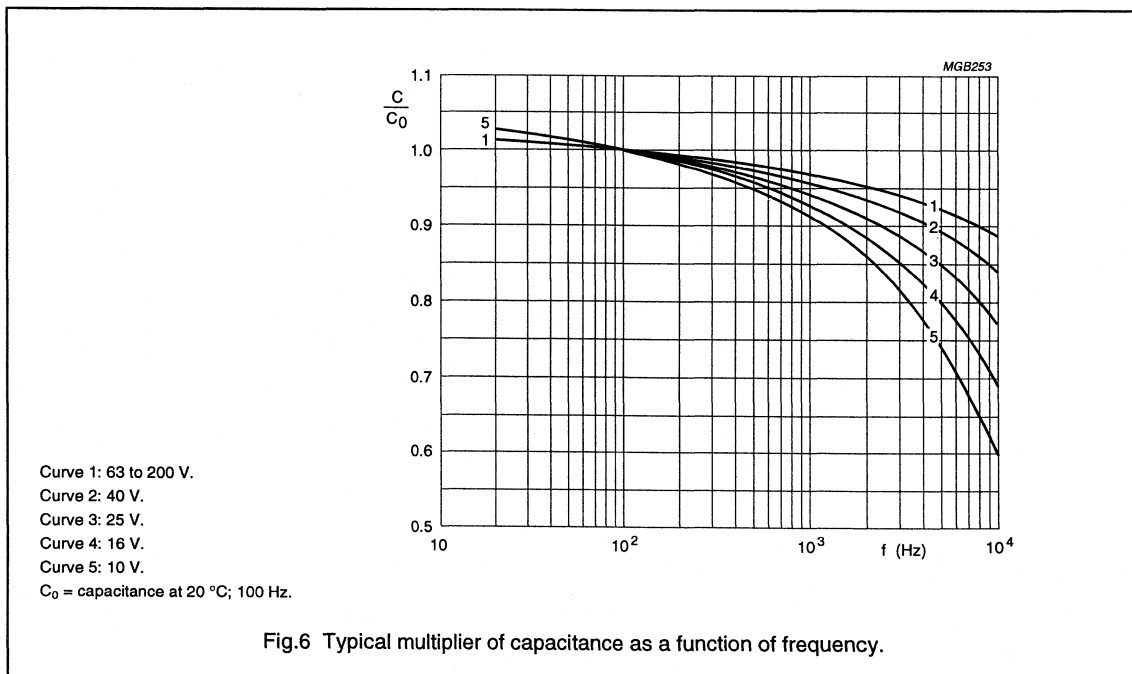
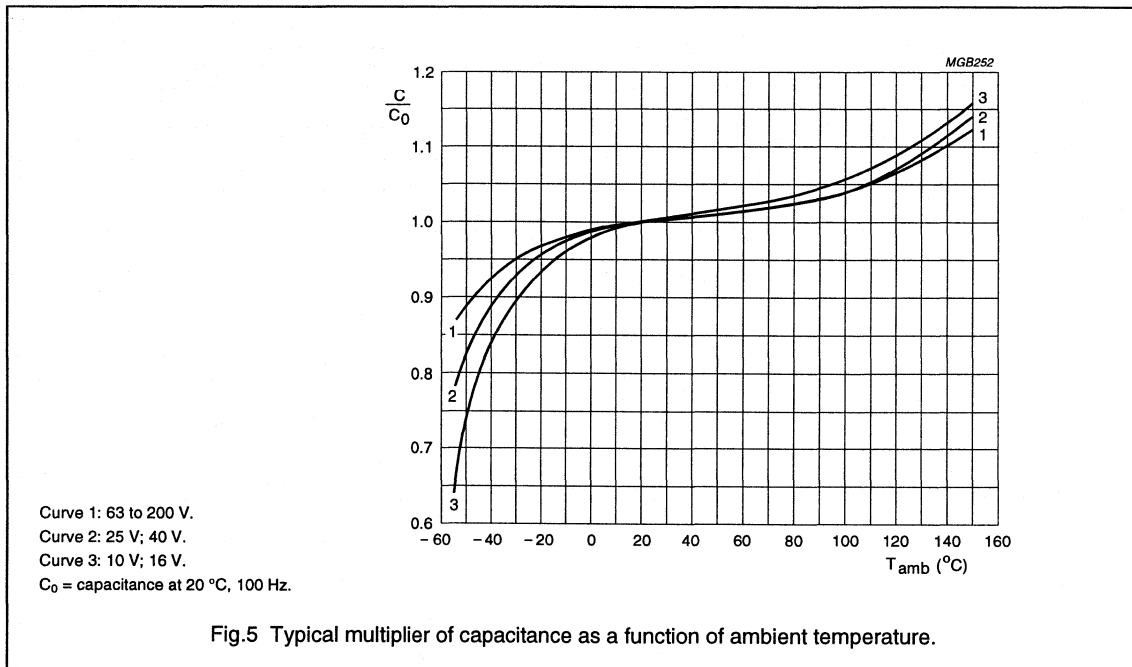
Note

- For applications at ambient temperatures of $\leq 85 \text{ }^\circ\text{C}$, the rated voltage (U_R) may be raised to U_{R2} .

Non-solid Al - electrolytic capacitors Axial High Temperature, DIN-based

AHT-DIN 119

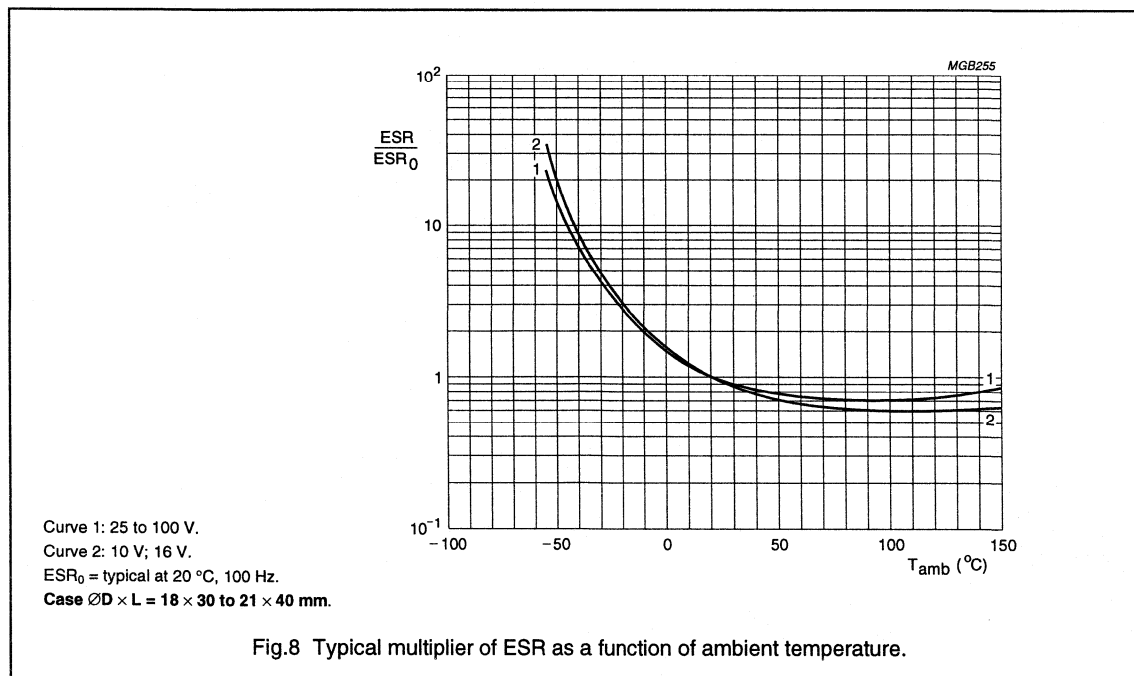
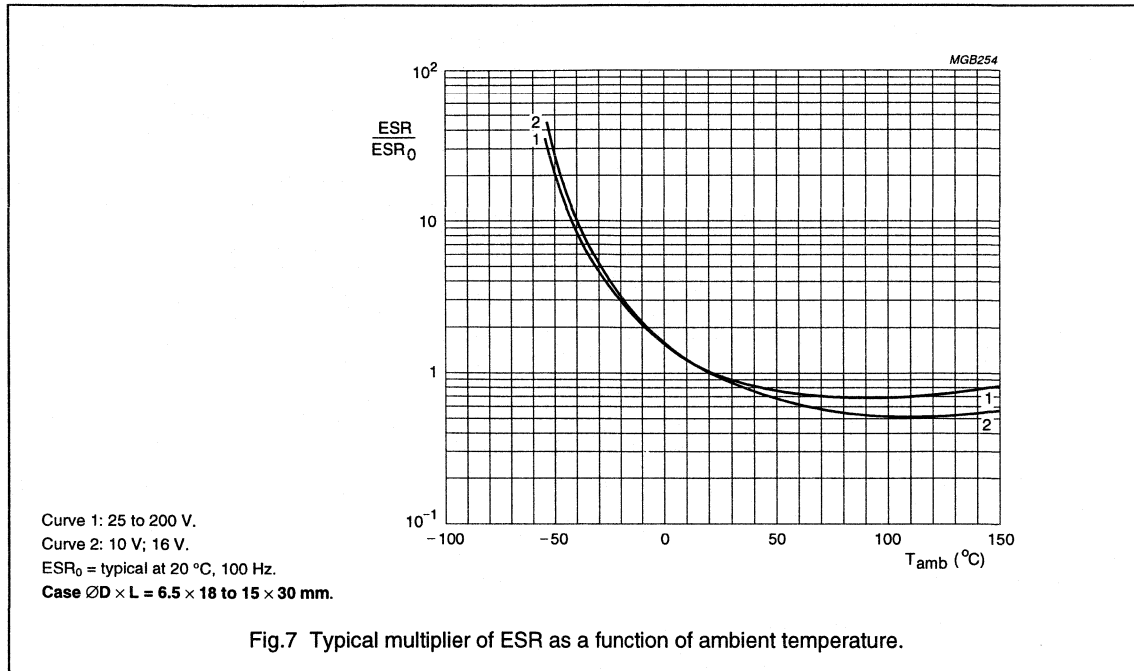
Capacitance (C)



Non-solid Al - electrolytic capacitors
Axial High Temperature, DIN-based

AHT-DIN 119

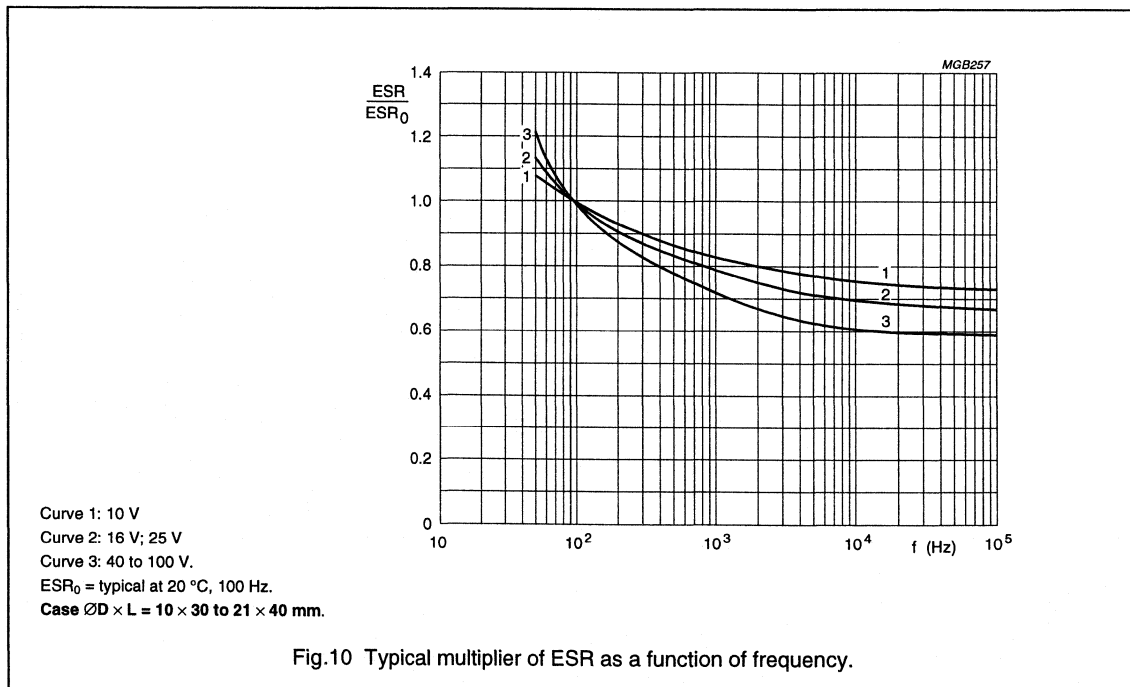
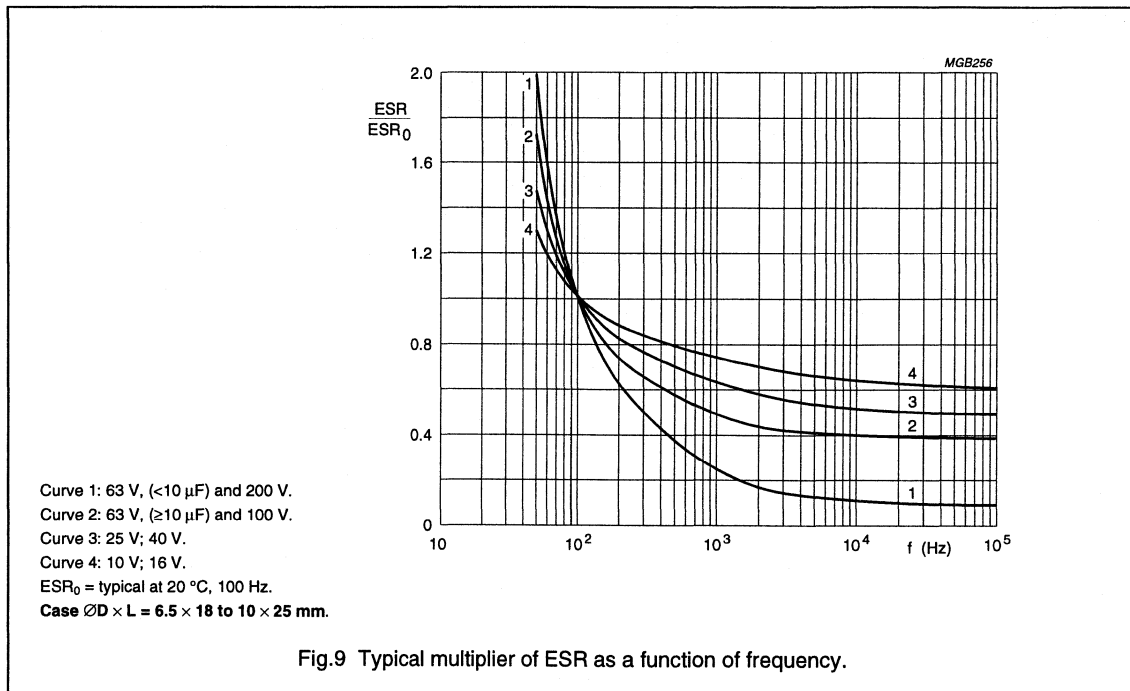
Equivalent series resistance (ESR)



A

Non-solid Al - electrolytic capacitors
Axial High Temperature, DIN-based

AHT-DIN 119



Non-solid Al - electrolytic capacitors

Axial High Temperature, DIN-based

AHT-DIN 119

Impedance (Z)

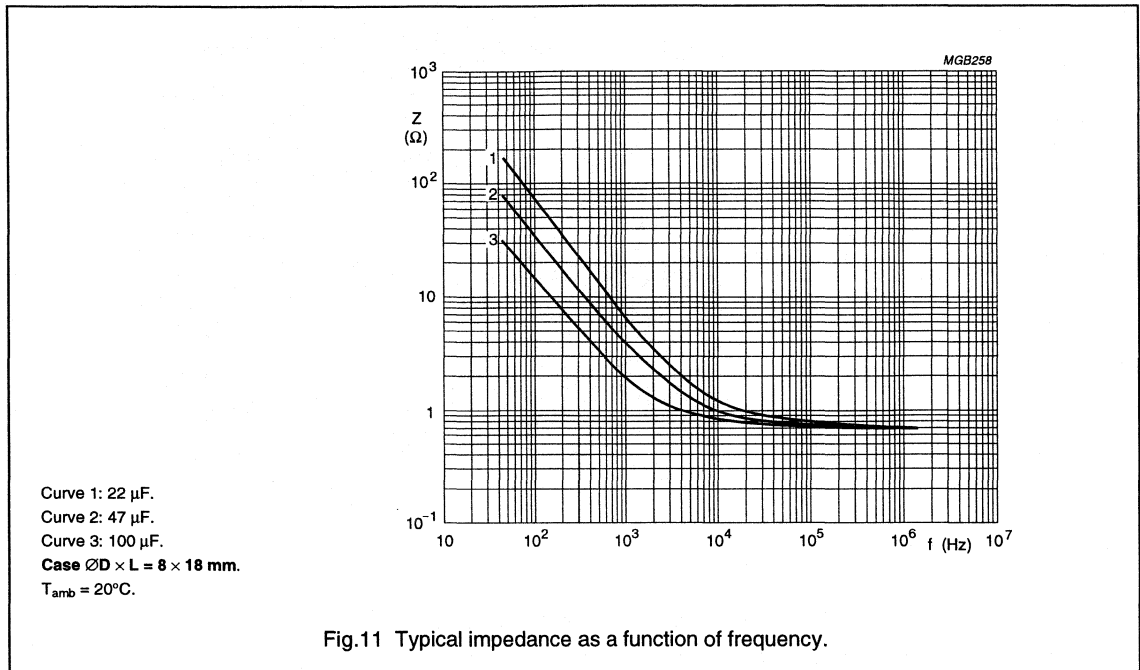


Fig.11 Typical impedance as a function of frequency.

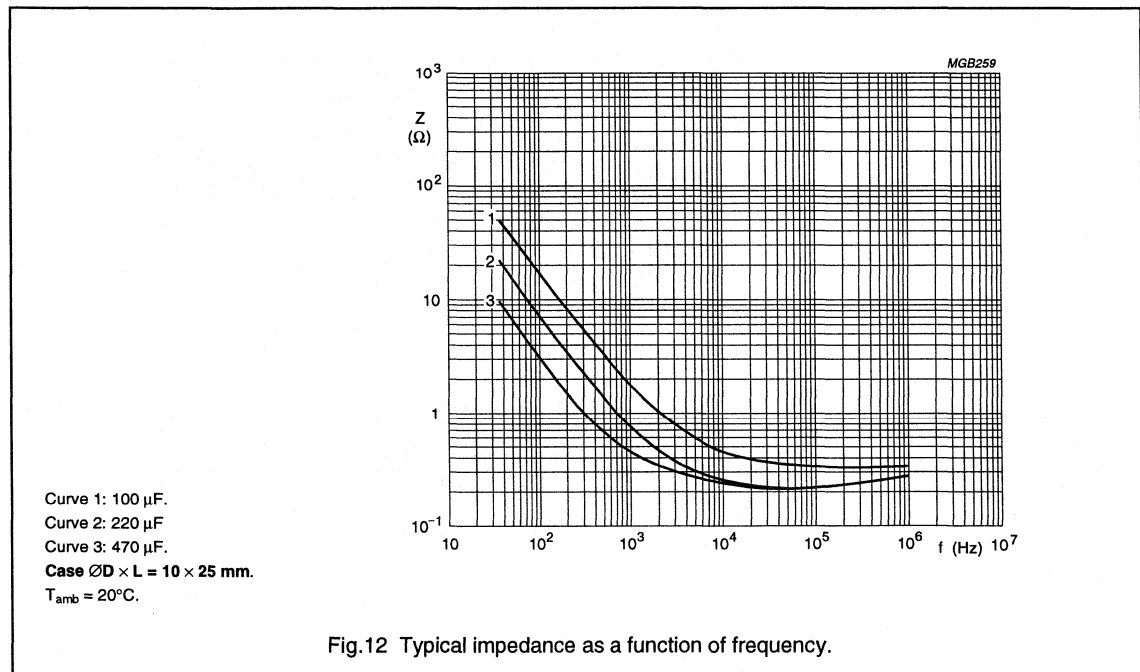
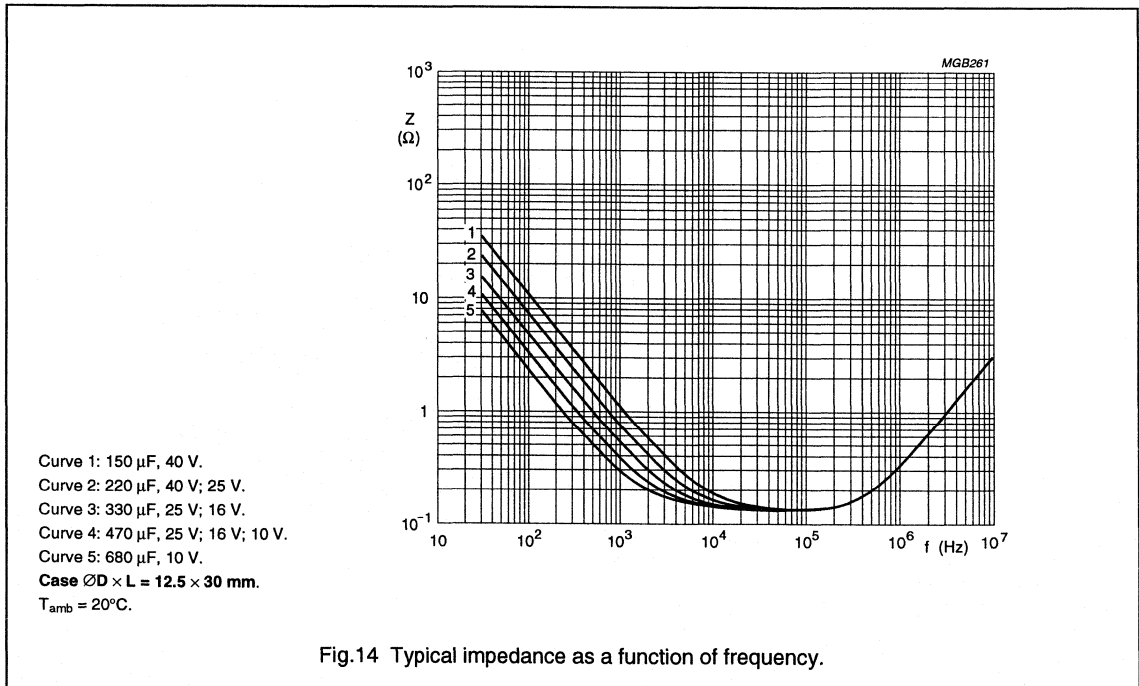
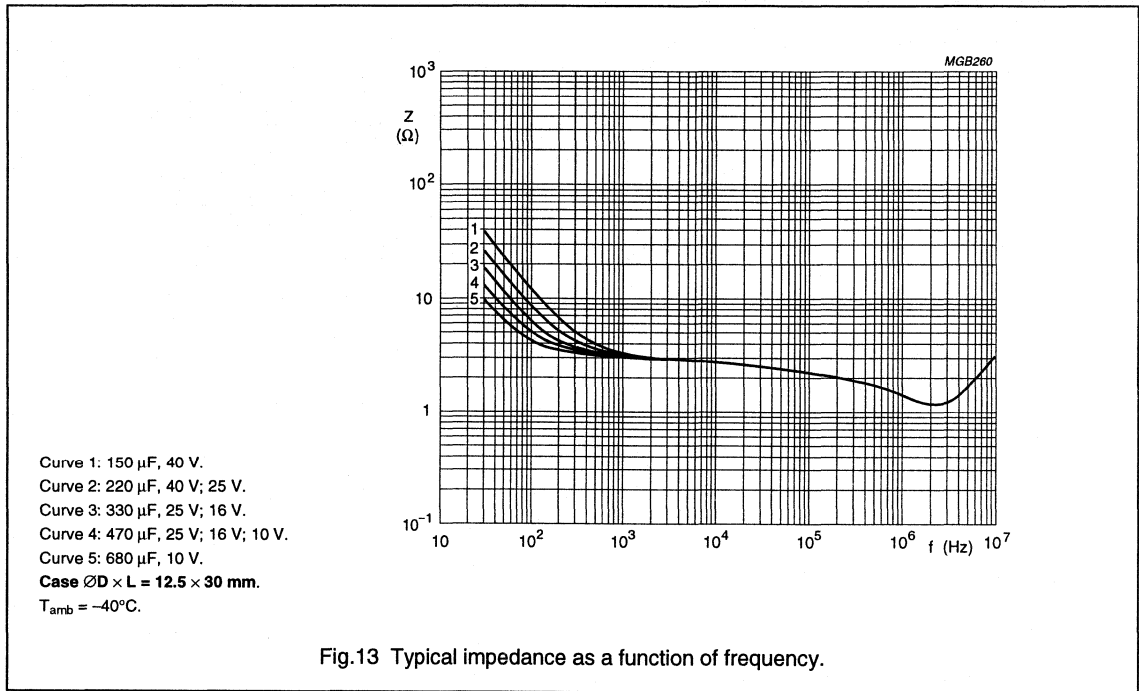


Fig.12 Typical impedance as a function of frequency.

Non-solid Al - electrolytic capacitors
Axial High Temperature, DIN-based

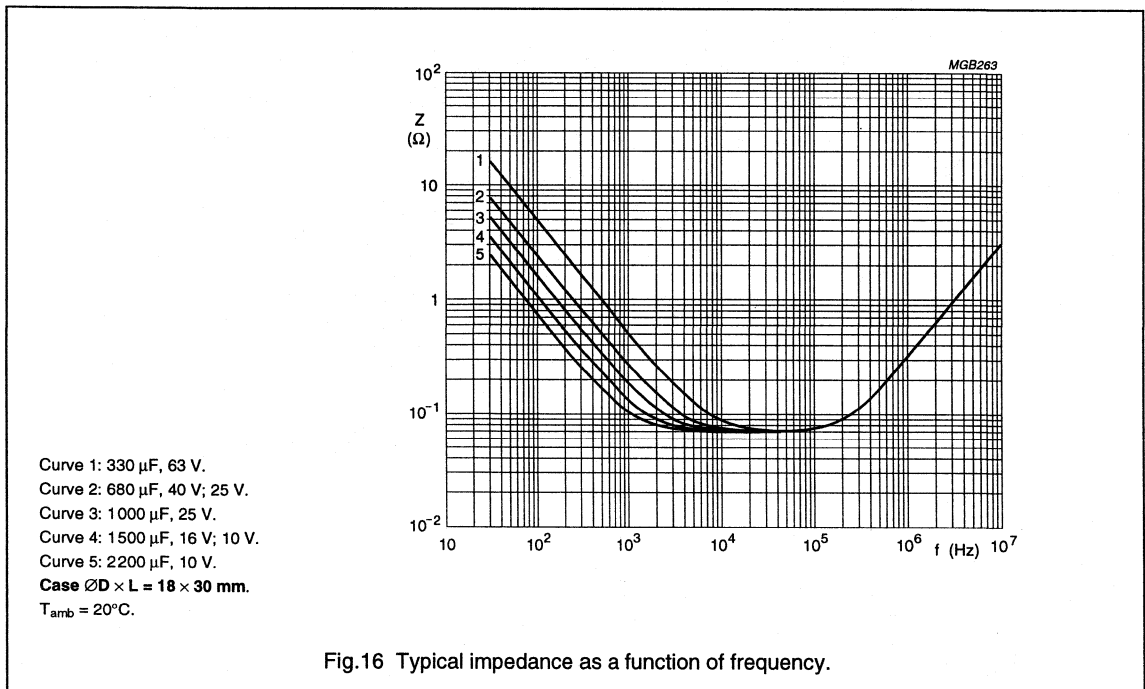
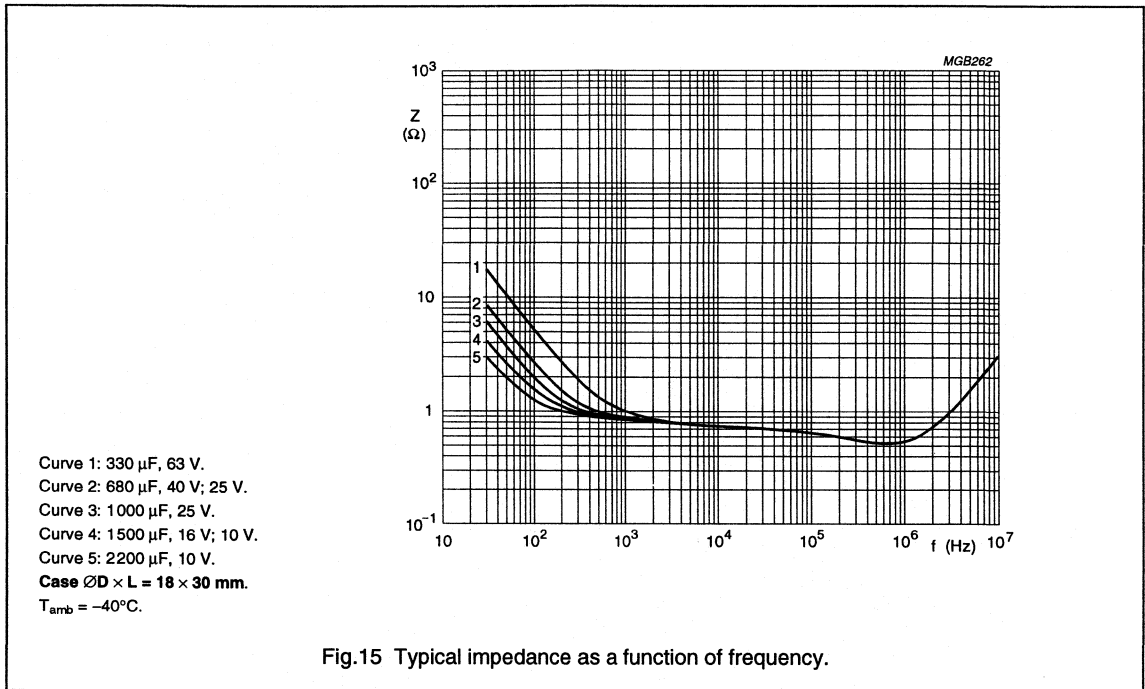
AHT-DIN 119



Non-solid Al - electrolytic capacitors

Axial High Temperature, DIN-based

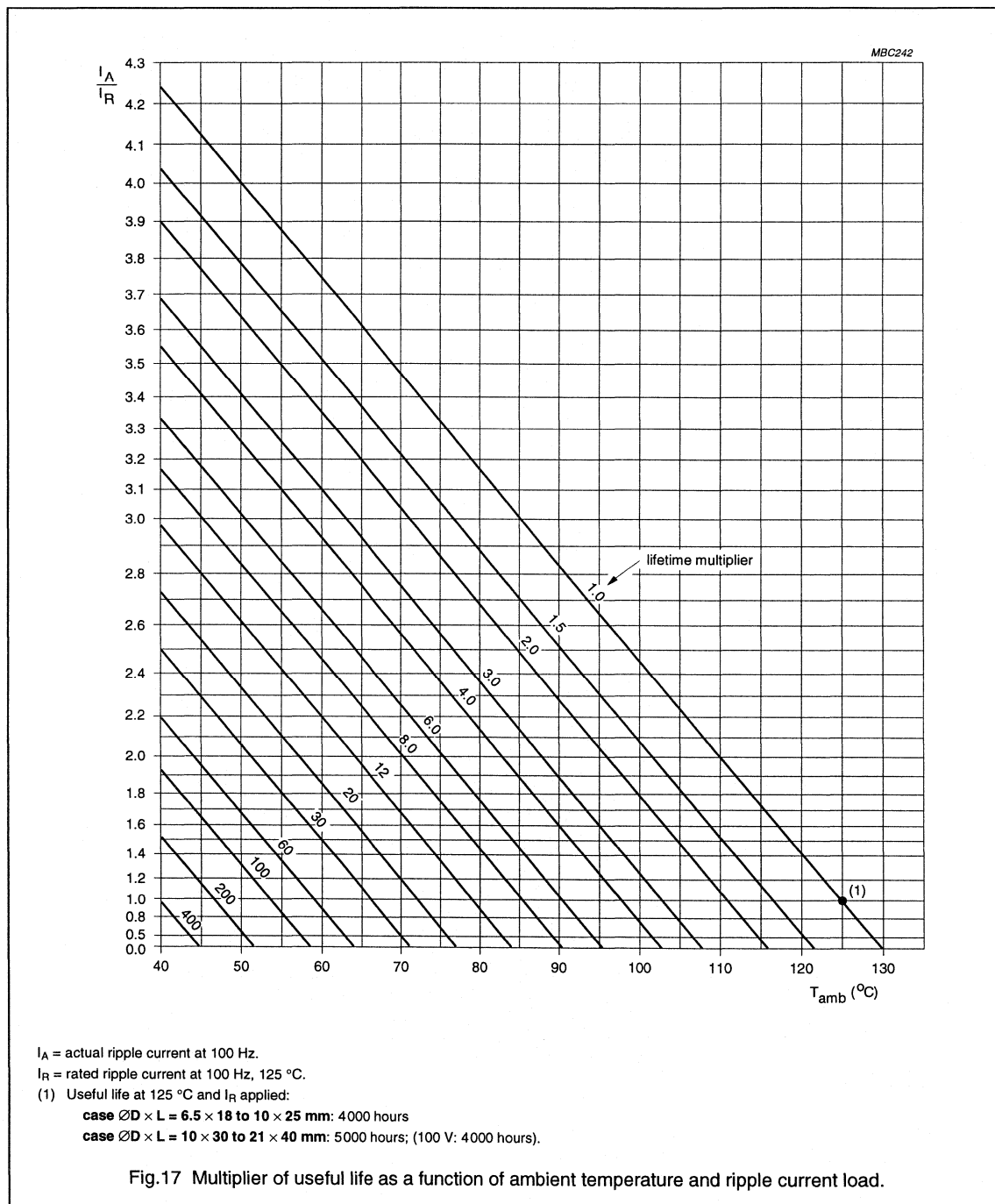
AHT-DIN 119



Non-solid Al - electrolytic capacitors Axial High Temperature, DIN-based

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RIPPLE CURRENT AND USEFUL LIFE



Non-solid Al - electrolytic capacitors

Axial High Temperature, DIN-based

AHT-DIN 119

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	$U_R = 63$ V to 200 V
50	0.95	0.9	0.85
100	1.0	1.0	1.0
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥ 10000	1.2	1.3	1.4

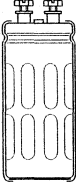



SPECIFIC TESTS AND REQUIREMENTS

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	$T_{amb} = 125$ °C; U_R applied; case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm: 2000 hours; case $\varnothing D \times L = 10 \times 30$ to 21×40 mm: 4000 hours, (100 V: 3000 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	$T_{amb} = 125$ °C; U_R and I_R applied; case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm: 4000 hours; case $\varnothing D \times L = 10 \times 30$ to 21×40 mm: 5000 hours, (100 V: 4000 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	$T_{amb} = 125$ °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	$T_{amb} = 125$ °C: 125 hours at $U = -1$ V followed by 125 hours at U_R	$\Delta C/C: \pm 20\%$ $\tan \delta \leq \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$

POWER ELECTROLYTIC CAPACITORS

	ECONOMY	EURO-DIN	LONG-LIFE
   	<p style="text-align: center;">10 000-12 000 hours 85 °C</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; text-align: center;"> PEC-ST PEC-STB 154-155 <i>page 525</i> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; text-align: center;"> PEC-PW 051-053 <i>page 475</i> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; text-align: center;"> PSM-SI 056-057 <i>page 428</i> </div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> PSM-4TSI 166-167 <i>page 461</i> </div>	<p style="text-align: center;">15-20 000 hours 85 °C</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; text-align: center;"> PED-ST PED-STB 114-115 <i>page 534</i> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; text-align: center;"> PED-PW 050-052 <i>page 493</i> </div>	<p style="text-align: center;">5-10 000 hours 105 °C</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; text-align: center;"> PLL-PW 162-163 <i>page 514</i> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; text-align: center;"> PLL-SI 058-059 <i>page 445</i> </div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> PLL-4TSI 168-169 <i>page 488</i> </div>

Non-solid Al - electrolytic capacitors Power Standard Miniature Snap-in

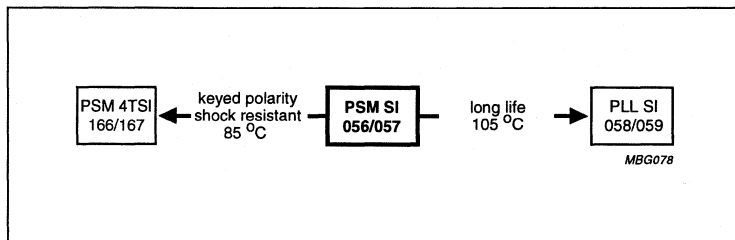
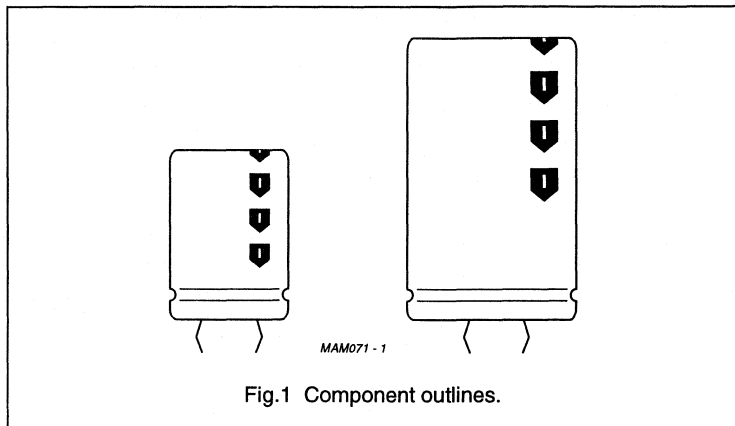
PSM-SI 056/057

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Pressure relief on the top of the aluminium case
- Charge and discharge proof
- Long useful life: 12000 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.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	056	057
Case size ($\varnothing D_{nom} \times L_{nom}$ 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 $1.4 \times I_R$ applied	210000 hours (450 V: 90000 hours)	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4/CECC 30300, LL grade	
Detail specification	CECC 30301-806 (in preparation)	
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)	

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-in

PSM-SI 056/057

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	63	100
470	-	-	-	-	-	22 × 25
680	-	-	-	-	-	22 × 30
1000	-	-	-	-	22 × 25	25 × 30
	-	-	-	-	-	22 × 40
1500	-	-	-	-	22 × 30	30 × 30
	-	-	-	-	-	25 × 40
2200	-	-	-	22 × 25	25 × 30	30 × 40
	-	-	-	-	22 × 40	25 × 50
3300	-	-	22 × 25	22 × 30	30 × 30	35 × 40
	-	-	-	-	25 × 40	30 × 50
4700	-	22 × 25	22 × 30	25 × 30	30 × 40	35 × 50
	-	-	-	22 × 40	25 × 50	-
6800	22 × 25	22 × 30	25 × 30	30 × 30	35 × 40	-
	-	-	22 × 40	25 × 40	30 × 50	-
10000	22 × 30	25 × 30	30 × 30	30 × 40	35 × 50	-
	-	22 × 40	25 × 40	25 × 50	-	-
15000	25 × 30	30 × 30	30 × 40	35 × 40	-	-
	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	-	-	-	-	-

Non-solid Al - electrolytic capacitors

Power Standard Miniature Snap-in

PSM-SI 056/057

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	450
47	–	–	22 × 25	22 × 25	22 × 30
68	–	–	22 × 30	22 × 30	22 × 30
100	–	22 × 25	25 × 30	25 × 30	30 × 30
	–	–	22 × 35	22 × 35	25 × 35
	–	–	22 × 40	–	–
150	22 × 25	22 × 30	30 × 30	30 × 30	25 × 50
	–	–	25 × 40	25 × 40	30 × 35
220	22 × 30	25 × 30	25 × 50	25 × 50	35 × 40
	–	22 × 40	30 × 35	30 × 35	30 × 45
	–	–	30 × 40	–	–
330	25 × 30	30 × 30	30 × 45	35 × 40	35 × 50
	22 × 40	25 × 40	35 × 35	30 × 50	35 × 45
470	30 × 30	30 × 40	35 × 50	35 × 50	–
	25 × 40	25 × 50	35 × 45	–	–
680	30 × 40	35 × 40	–	–	–
	25 × 50	30 × 50	–	–	–
1000	35 × 40	35 × 50	–	–	–
	30 × 50	–	–	–	–
1500	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
- '-' 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".

Non-solid Al - electrolytic capacitors

Power Standard Miniature Snap-in

PSM-SI 056/057

MECHANICAL DATA AND PACKAGING QUANTITIES

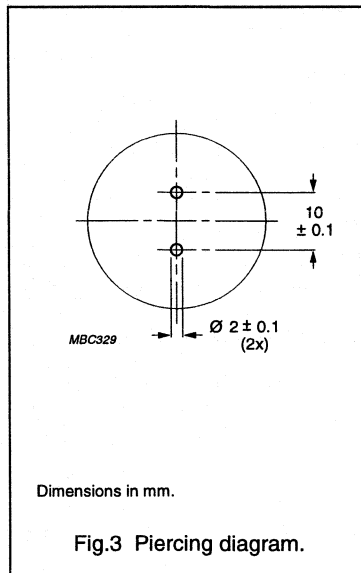
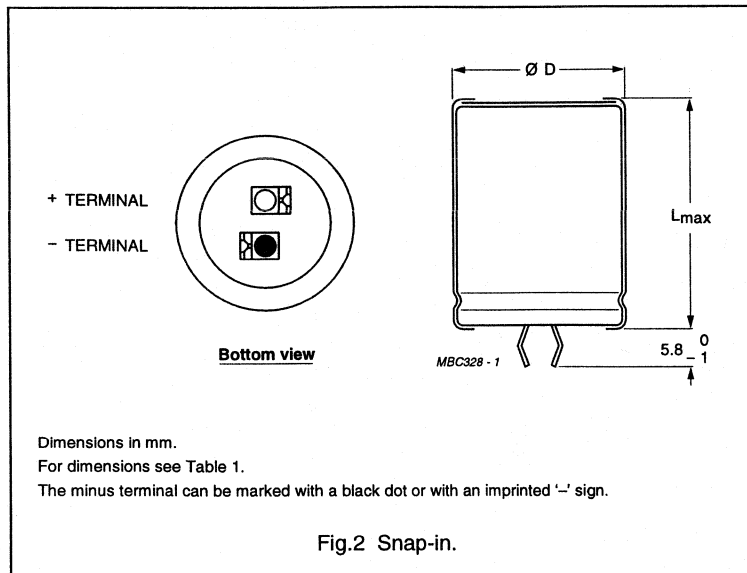


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	ØD _{max} (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	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

Non-solid Al - electrolytic capacitors

Power Standard Miniature Snap-in

PSM-SI 056/057

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 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 or $\geq 10\text{ kHz}$ 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

Ordering example

Electrolytic capacitor
 PSM-SI 056

10 000 $\mu\text{F}/25\text{ V}$; $\pm 20\%$

Nominal case size: $\varnothing 25 \times 40\text{ mm}$

Catalogue number: 2222 056 46103.

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 $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 °C (A)	I_R $\geq 10\text{ kHz}$ 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
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	

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-in

PSM-SI 056/057

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (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
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	1024	344	54	41	056 56682
	6800	22 × 40	2240	3.16	3.73	1024	344	47	38	056 46682
	10000	30 × 30	3030	3.25	3.84	1504	504	50	38	056 56103
	10000	25 × 40	2540	3.73	4.40	1504	504	39	30	056 46103
	15000	30 × 40	3040	4.73	5.58	2254	754	30	28	056 56153
	15000	25 × 50	2550	3.92	4.63	2254	754	43	39	056 46153
	22000	35 × 40	3540	4.48	5.29	3304	1104	40	28	056 56223
	22000	30 × 50	3050	4.96	5.85	3304	1104	36	23	056 46223
	33000	35 × 50	3550	4.98	5.88	4954	1654	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	1132	380	82	70	056 57472
	4700	22 × 40	2240	3.10	3.78	1132	380	49	38	056 47472
	6800	30 × 30	3030	3.16	3.85	1636	548	53	38	056 57682
	6800	25 × 40	2540	3.06	3.73	1636	548	58	50	056 47682
	10000	30 × 40	3040	4.20	5.12	2404	804	38	28	056 57103
	10000	25 × 50	2550	3.88	4.73	2404	804	44	39	056 47103
	15000	35 × 40	3540	4.05	4.94	3604	1204	49	41	056 57153
	15000	30 × 50	3050	4.45	4.43	3604	1204	41	34	056 47153
	22000	35 × 50	3550	4.86	5.93	5284	1764	40	33	056 57223
63	1000	22 × 25	2225	1.46	1.78	382	130	148	104	056 58102
	1500	22 × 30	2230	1.87	2.28	571	193	105	72	056 58152
	2200	25 × 30	2530	2.32	2.83	836	281	79	59	056 58222
	2200	22 × 40	2240	2.54	3.10	836	281	73	53	056 48222
	3300	30 × 30	3030	2.87	3.50	1251	420	64	50	056 58332
	3300	25 × 40	2540	3.14	3.83	1251	420	55	44	056 48332
	4700	30 × 40	3040	3.67	4.48	1780	596	50	38	056 58472
	4700	25 × 50	2550	3.71	4.53	1780	596	48	38	056 48472
	6800	35 × 40	3540	4.33	5.28	2574	861	43	38	056 58682
	6800	30 × 50	3050	4.75	5.80	2574	861	42	37	056 48682
	10000	35 × 50	3550	5.26	6.42	3784	1264	35	30	056 58103

Non-solid Al - electrolytic capacitors

Power Standard Miniature Snap-in

PSM-SI 056/057

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (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
100	470	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
	1000	25 × 30	2530	1.27	1.55	604	204	265	235	056 59102
	1000	22 × 40	2240	1.35	1.65	604	204	260	225	056 49102
	1500	30 × 30	3030	1.67	2.04	904	304	190	170	056 59152
	1500	25 × 40	2540	1.75	2.14	904	304	180	160	056 49152
	2200	30 × 40	3040	2.27	2.77	1324	444	130	120	056 59222
	2200	25 × 50	2550	2.30	2.80	1324	444	125	110	056 49222
	3300	35 × 40	3540	2.84	3.46	1984	664	100	95	056 59332
	3300	30 × 50	3050	2.97	3.62	1984	664	92	85	056 49332
4700	35 × 50	3550	3.59	4.38	2824	677	75	70	056 59472	

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 $\varnothing D \times L$ (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
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
	1500	35 × 50	3550	3.66	1804	604	120	105	057 52152
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
	1000	35 × 50	3550	3.12	1504	504	160	105	057 53102

Non-solid Al - electrolytic capacitors

Power Standard Miniature Snap-in

PSM-SI 056/057

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (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	47	22 × 25	2225	0.50	112	40	3000	1400	057 58479
	68	22 × 30	2230	0.63	161	56	2100	1000	057 58689
	100	22 × 35	2235	0.84	235	81	1400	780	057 38101
	100	25 × 30	2530	0.86	235	81	1400	780	057 58101
	100	22 × 40	2240	0.86	235	81	1400	780	057 48101
	150	30 × 30	3030	1.16	350	119	950	520	057 58151
	150	25 × 40	2540	1.16	350	119	950	520	057 48151
	220	30 × 35	3035	1.50	512	173	650	400	057 38221
	220	25 × 50	2550	1.57	512	173	650	400	057 48221
	220	30 × 40	3040	1.57	512	173	650	400	057 58221
	330	30 × 45	3045	1.75	766	258	480	280	057 38331
	330	35 × 35	3535	1.73	766	258	480	280	057 68331
	470	35 × 45	3545	2.29	1089	366	340	220	057 48471
	470	35 × 50	3550	2.76	1089	366	340	220	057 58471
400	47	22 × 25	2225	0.50	117	42	3000	1400	057 56479
	68	22 × 30	2230	0.63	167	58	2100	1000	057 56689
	100	22 × 35	2235	0.84	240	84	1400	780	057 36101
	100	25 × 30	2530	0.86	244	84	1400	780	057 56101
	150	30 × 30	3030	1.16	364	124	950	520	057 56151
	150	25 × 40	2540	1.16	364	124	950	520	057 46151
	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 × 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	2.76	1132	380	340	220	057 56471	
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	25 × 35	2535	0.46	274	94	2600	2100	057 37101
	100	30 × 30	3030	0.48	274	94	2600	2100	057 57101
	150	25 × 50	2550	0.70	409	140	1600	1300	057 47151
	150	30 × 35	3035	0.66	409	140	1600	1300	057 37151
	220	30 × 45	3045	0.73	598	202	1100	900	057 37221
	220	35 × 40	3540	0.92	598	202	1100	900	057 57221
	330	35 × 45	3545	1.20	895	301	700	600	057 47331
330	35 × 50	3550	1.26	895	301	700	600	057 57331	

Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-in

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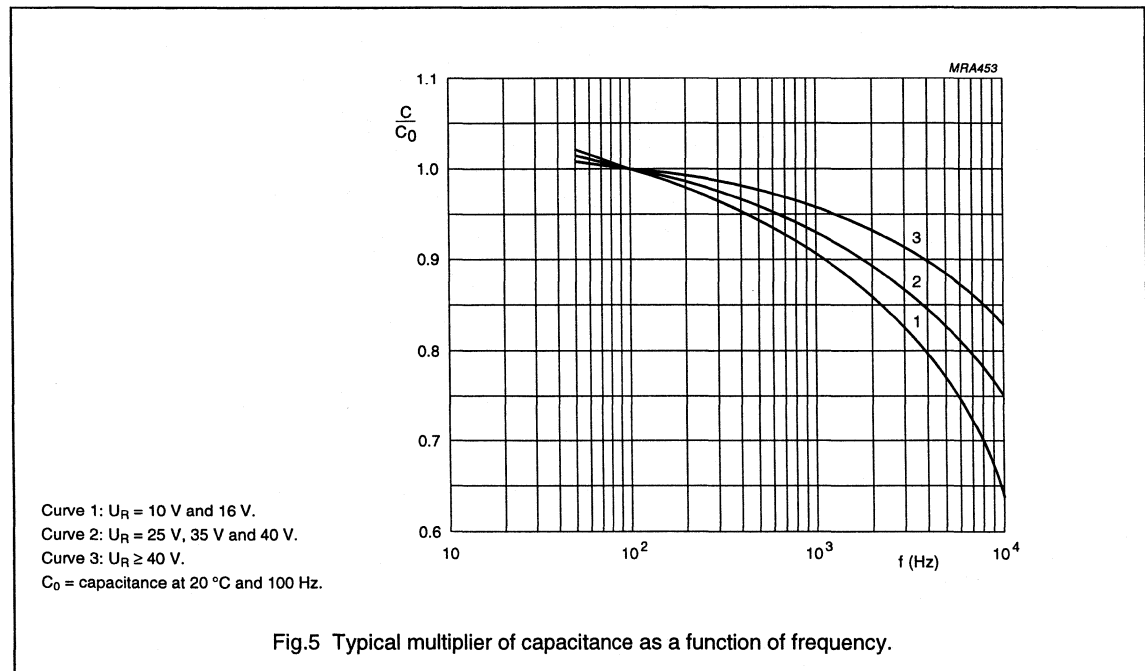
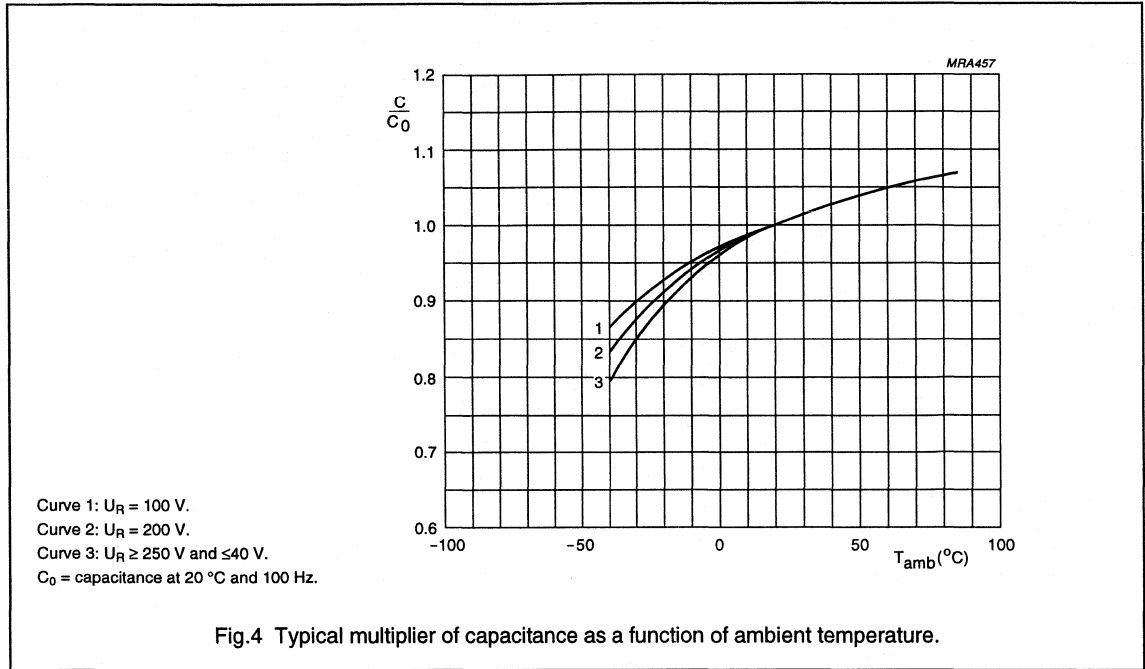
Additional electrical data

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	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	all case sizes	typ. 19 nH
		max. 25 nH

Non-solid Al - electrolytic capacitors
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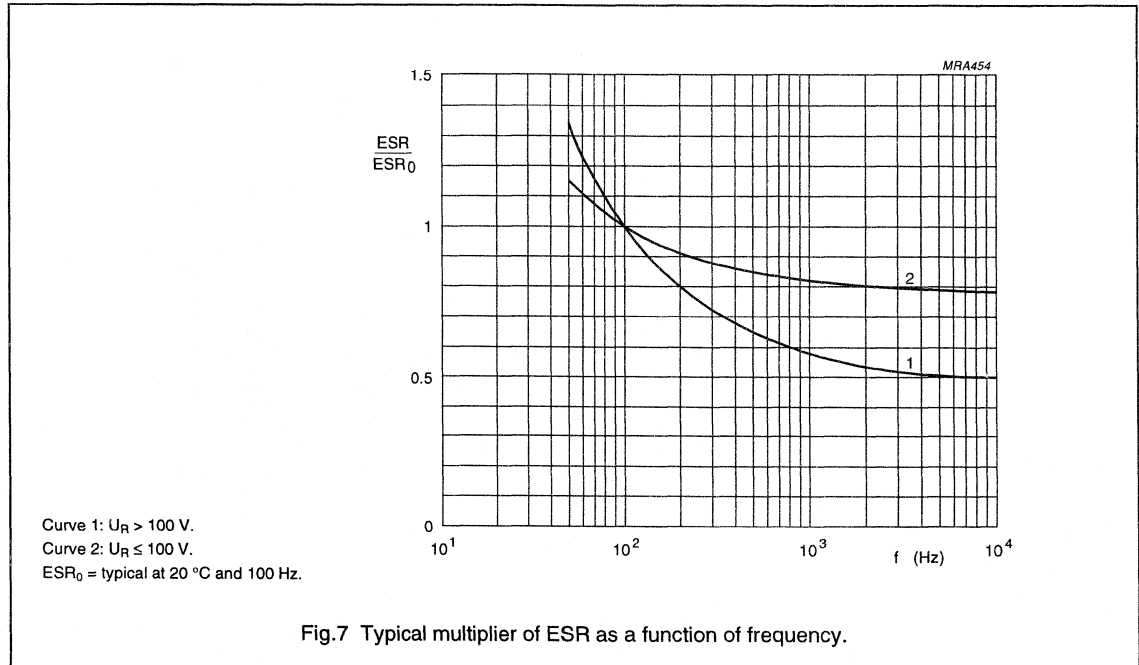
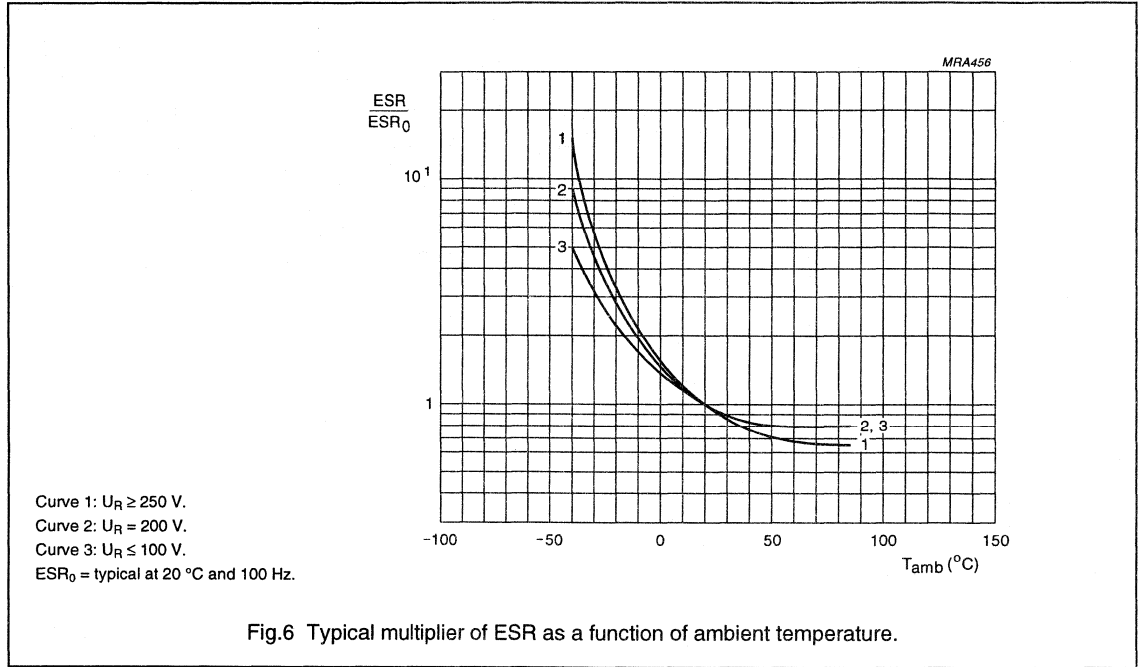
Capacitance (C)



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Power Standard Miniature Snap-in

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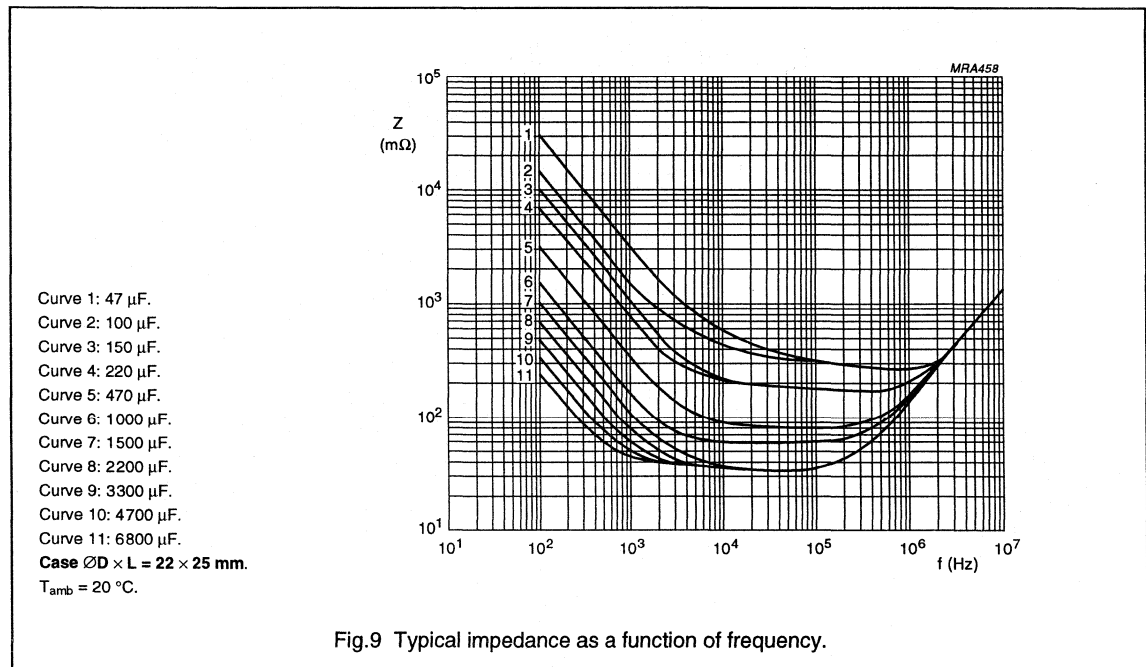
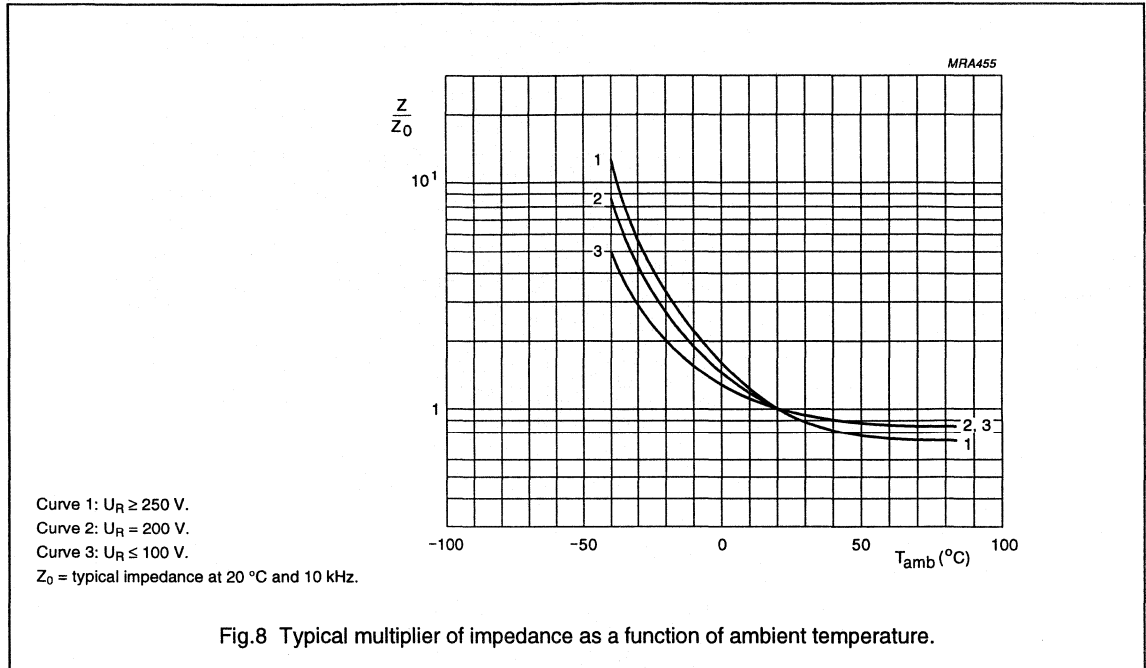
Equivalent series resistance (ESR)



Non-solid Al - electrolytic capacitors
Power Standard Miniature Snap-in

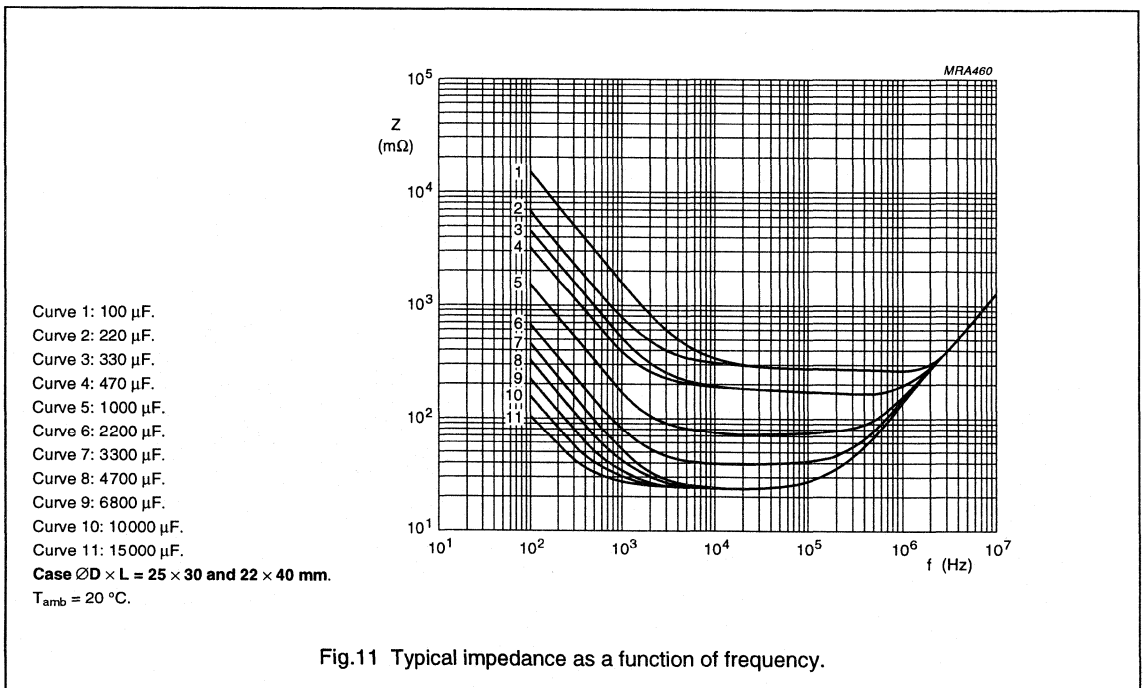
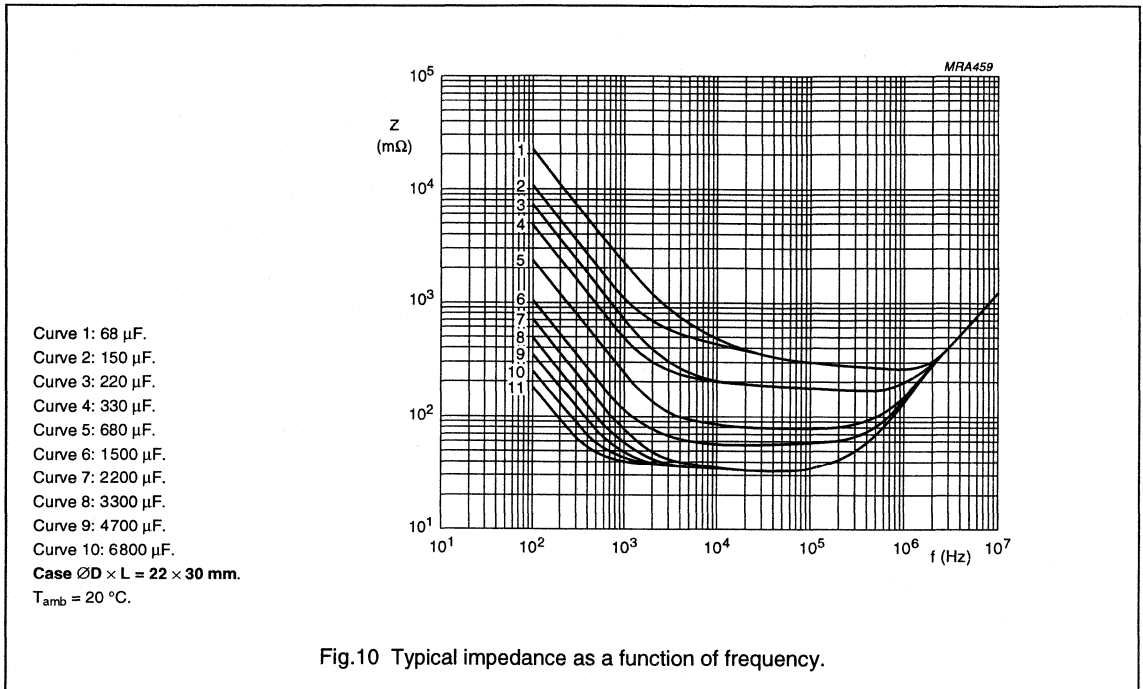
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Impedance (Z)



Non-solid Al - electrolytic capacitors
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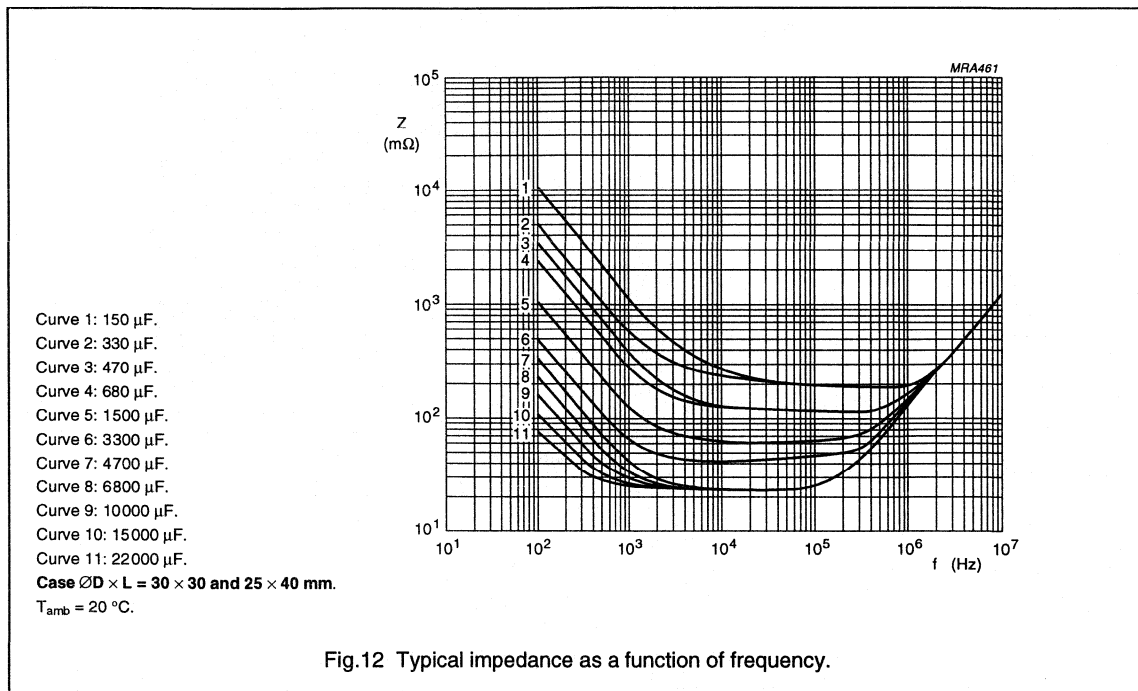


Fig.12 Typical impedance as a function of frequency.

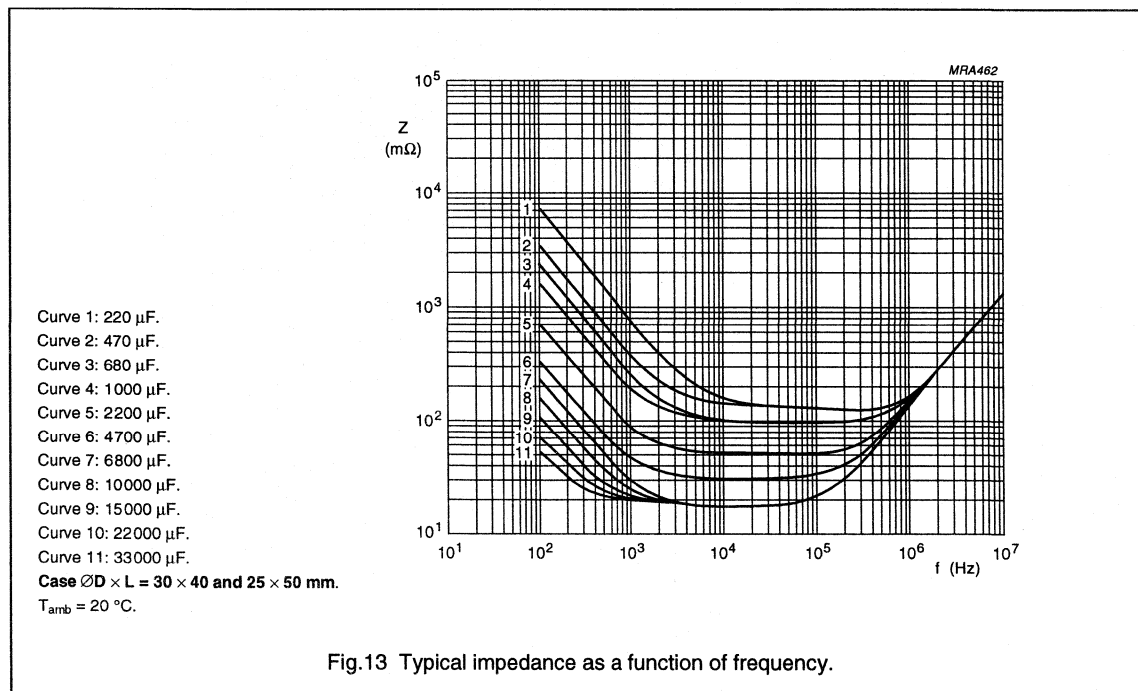


Fig.13 Typical impedance as a function of frequency.



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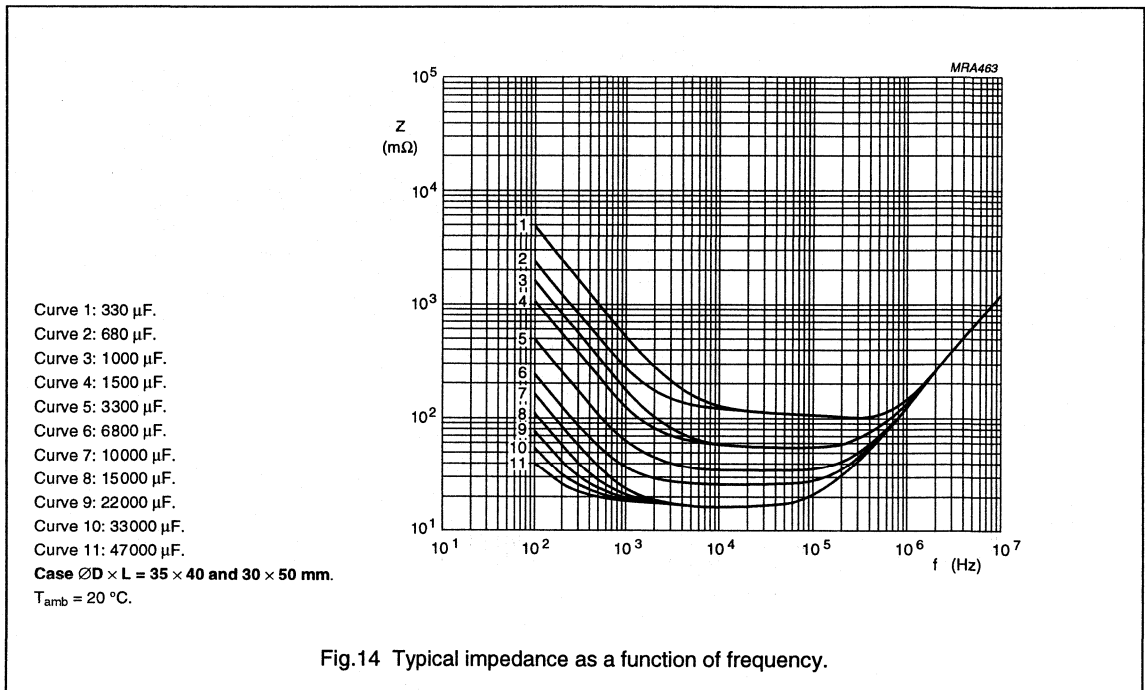


Fig.14 Typical impedance as a function of frequency.

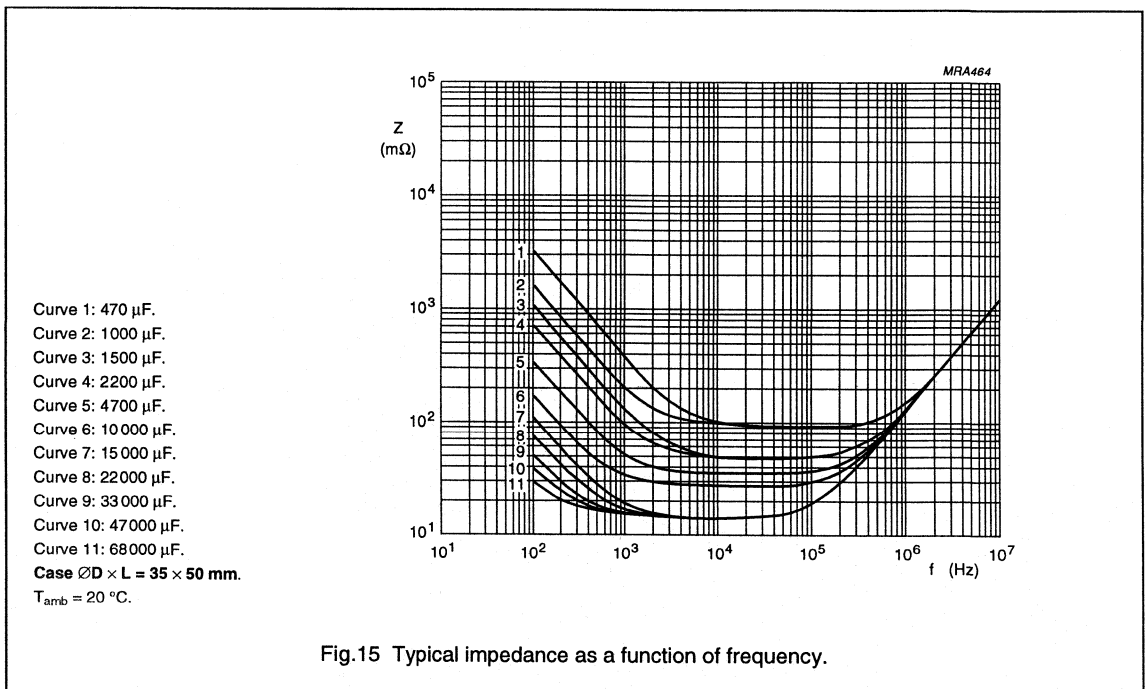


Fig.15 Typical impedance as a function of frequency.

Non-solid Al - electrolytic capacitors

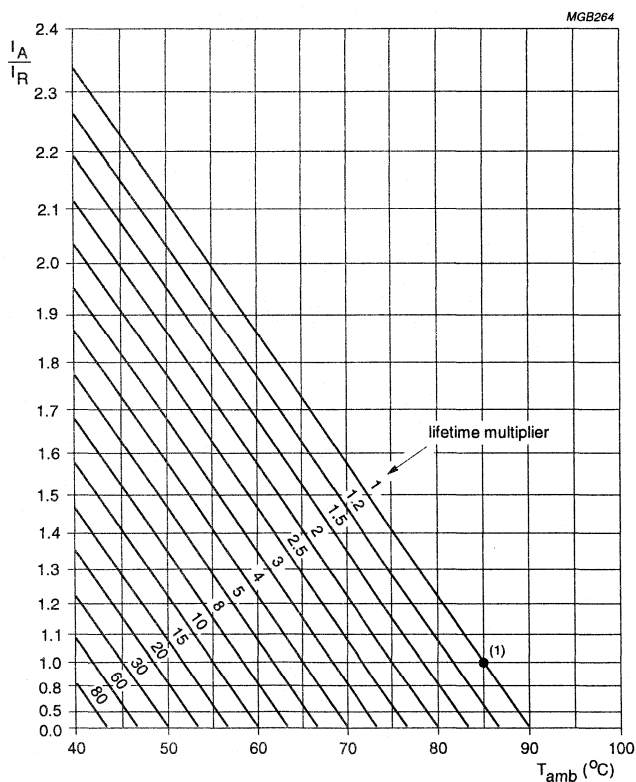
Power Standard Miniature Snap-in

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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		
	$U_R = 10$ to 25 V	$U_R = 40$ to 100 V	$U_R > 100$ V
50	0.93	0.91	0.86
100	1.00	1.00	1.00
200	1.04	1.05	1.13
400	1.07	1.09	1.21
1000	1.11	1.13	1.29
2000	1.13	1.15	1.32
4000	1.15	1.18	1.35
≥ 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.

Non-solid Al - 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

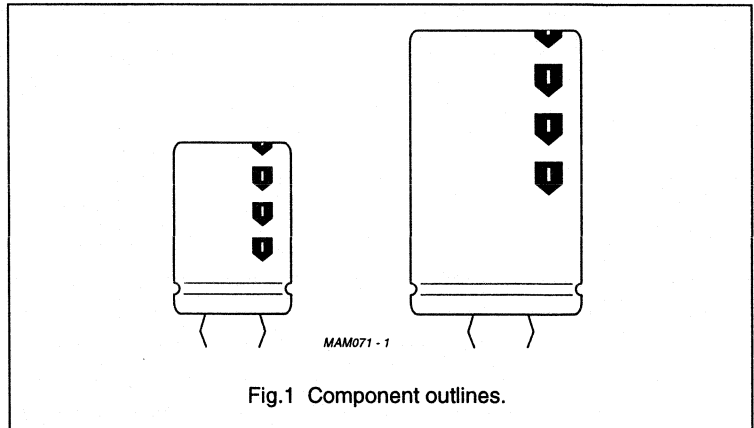
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ °C}$; U_R applied; 5000 hours (450 V types: 2000 hours)	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
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	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Non-solid Al - electrolytic capacitors Power Long Life Snap-in

PLL-SI 058/059

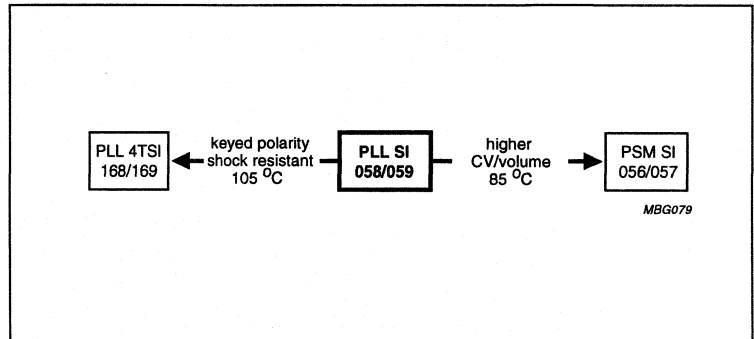
FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Pressure relief in the top of the aluminium case
- Charge and discharge proof
- Very long useful life: up to 10 000 hours at 105 °C
- Extended temperature range: 105 °C
- Low ESR, high ripple current capability.



APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering applications
- Standard and switched mode power supplies
- Energy storage in pulse systems.



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 47 000 μF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	10 to 100 V	200 to 400 V
Category temperature range	-40 to +105 °C	
Endurance test at 105 °C	≤40 V: 2000 hours; ≥63 V: 5000 hours	
Useful life at 105 °C	≤40 V: 5000 hours; ≥63 V: 10000 hours	
Useful life at 40 °C and $1.9 \times I_R$ applied	≤40 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, LL grade	
Detail specification	CECC 30301-807 (in preparation)	
Climatic category IEC 68 (DIN 40040)	40/105/56 (GMF)	

Non-solid Al - electrolytic capacitors

Power Long Life Snap-in

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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	63	100
330	-	-	-	-	-	22 × 25
470	-	-	-	-	-	22 × 30
680	-	-	-	-	22 × 25	25 × 30
	-	-	-	-	-	22 × 40
1000	-	-	-	-	22 × 30	30 × 30
	-	-	-	-	-	25 × 40
1500	-	-	-	22 × 25	25 × 30	30 × 40
	-	-	-	-	22 × 40	25 × 50
2200	-	-	22 × 25	22 × 30	30 × 30	35 × 40
	-	-	-	-	25 × 40	30 × 50
3300	-	22 × 25	22 × 30	25 × 30	30 × 40	35 × 50
	-	-	-	22 × 40	25 × 50	-
4700	22 × 25	22 × 30	25 × 30	30 × 30	35 × 40	-
	-	-	22 × 40	25 × 40	30 × 50	-
6800	22 × 30	25 × 30	30 × 30	30 × 40	35 × 50	-
	-	22 × 40	25 × 40	25 × 50	-	-
10000	25 × 30	30 × 30	30 × 40	35 × 40	-	-
	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	-	-	-	-	-

Non-solid Al - electrolytic capacitors

Power Long Life Snap-in

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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
- '–' 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".



Non-solid Al - electrolytic capacitors

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MECHANICAL DATA AND PACKAGING QUANTITIES

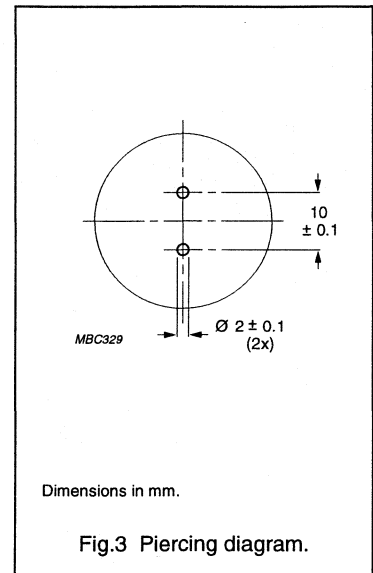
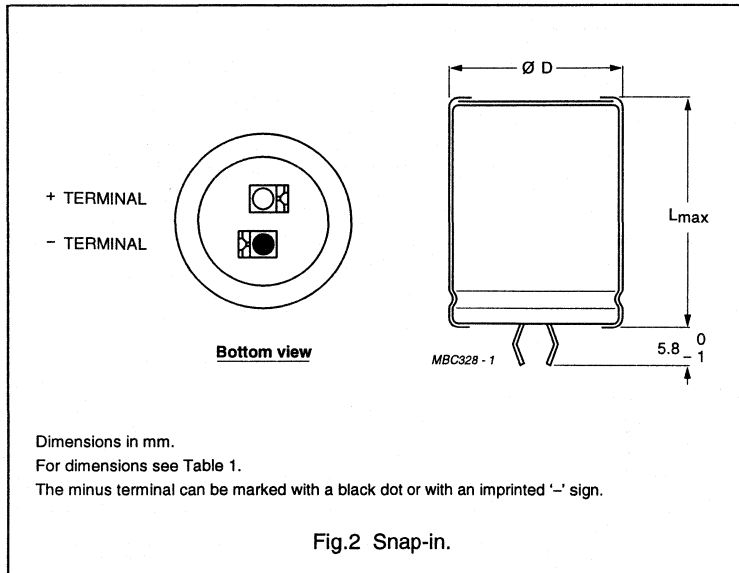


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$\varnothing D_{max}$ (mm)	L_{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	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 × 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

Non-solid Al - electrolytic capacitors

Power Long Life Snap-in

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 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 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
 PLL-SI 058

10000 $\mu\text{F}/25\text{ V}$; $\pm 20\%$

Nominal case size: $\text{Ø}30 \times 40\text{ mm}$

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 $\text{ØD} \times \text{L}$ (mm)	CASE CODE	I_R 100 Hz $105\text{ }^{\circ}\text{C}$ (A)	I_R $\geq 10\text{ kHz}$ $105\text{ }^{\circ}\text{C}$ (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 × 25	2225	1.95	2.30	286	98	82	57	058 54472	
	6800	22 × 30	2230	2.44	2.88	412	140	61	44	058 54682	
	10000	25 × 30	2530	2.81	3.32	604	204	54	42	058 54103	
	10000	22 × 40	2240	3.29	3.88	604	204	43	32	058 44103	
	15000	30 × 30	3030	3.53	4.17	904	304	42	34	058 54153	
	15000	25 × 40	2540	3.78	4.46	904	304	38	30	058 44153	
	22000	30 × 40	3040	4.62	5.45	1324	444	31	25	058 54223	
	22000	25 × 50	2550	4.68	5.52	1324	444	31	24	058 44223	
	33000	35 × 40	3540	5.15	6.08	1984	664	30	24	058 54333	
	33000	30 × 50	3050	5.70	6.73	1984	664	24	21	058 44333	
	47000	35 × 50	3550	6.23	7.35	2824	944	24	21	058 54473	
16	3300	22 × 25	2225	1.90	2.24	321	110	86	57	058 55332	
	4700	22 × 30	2230	2.36	2.78	455	154	65	44	058 55472	
	6800	25 × 30	2530	2.75	3.25	657	222	56	42	058 55682	
	6800	22 × 40	2240	3.18	3.75	657	222	46	32	058 45682	
	10000	30 × 30	3030	3.44	4.06	964	324	44	34	058 55103	
	10000	25 × 40	2540	3.66	4.32	964	324	40	30	058 45103	
	15000	30 × 40	3040	4.55	5.37	1444	484	32	25	058 55153	
	15000	25 × 50	2550	4.55	5.37	1444	484	32	24	058 45153	
	22000	35 × 40	3540	5.07	5.98	2116	708	31	24	058 55223	
	22000	30 × 50	3050	5.67	6.69	2116	708	25	21	058 45223	
		33000	35 × 50	3550	6.23	7.35	3172	1060	25	21	058 55333

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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 (A)	I_R ≥ 10 kHz 105 °C (A)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	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
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

Non-solid Al - electrolytic capacitors

Power Long Life Snap-in

PLL-SI 058/059

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 (A)	I_R ≥ 10 kHz 105 °C (A)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
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

Table 3 Electrical data and ordering information for 059 series; 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 105 °C (A)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	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
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

Non-solid Al - electrolytic capacitors

Power Long Life Snap-in

PLL-SI 058/059

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 (A)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER 2222
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
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

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	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	all case sizes	typ. 19 nH
		max. 25 nH

Non-solid Al - electrolytic capacitors

Power Long Life Snap-in

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Capacitance (C)

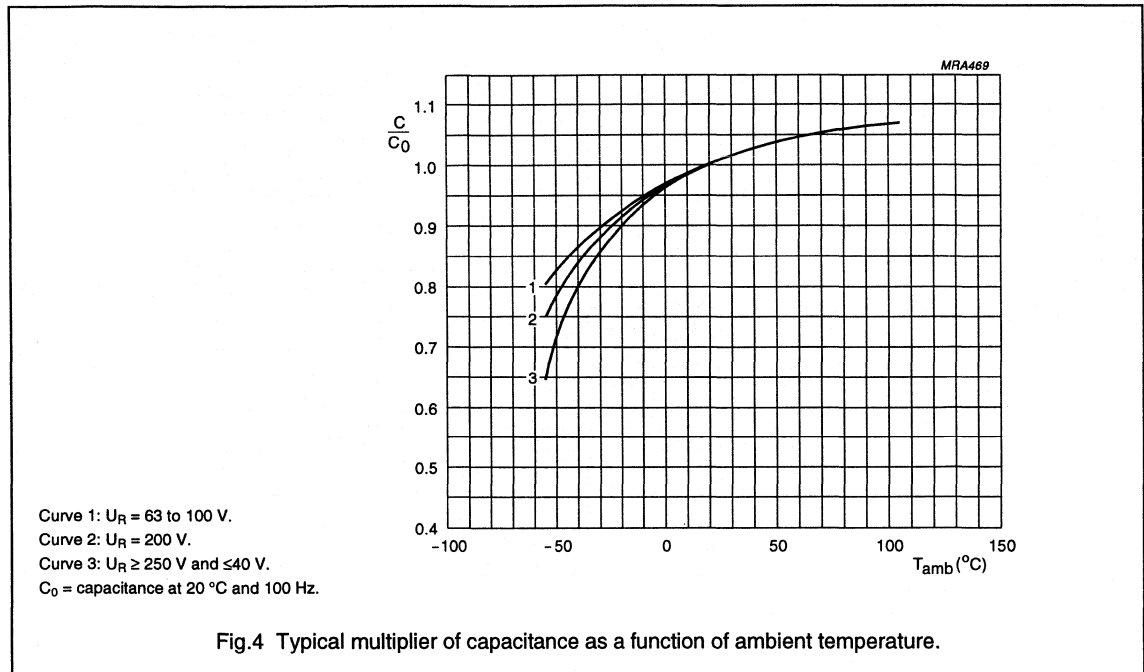


Fig.4 Typical multiplier of capacitance as a function of ambient temperature.

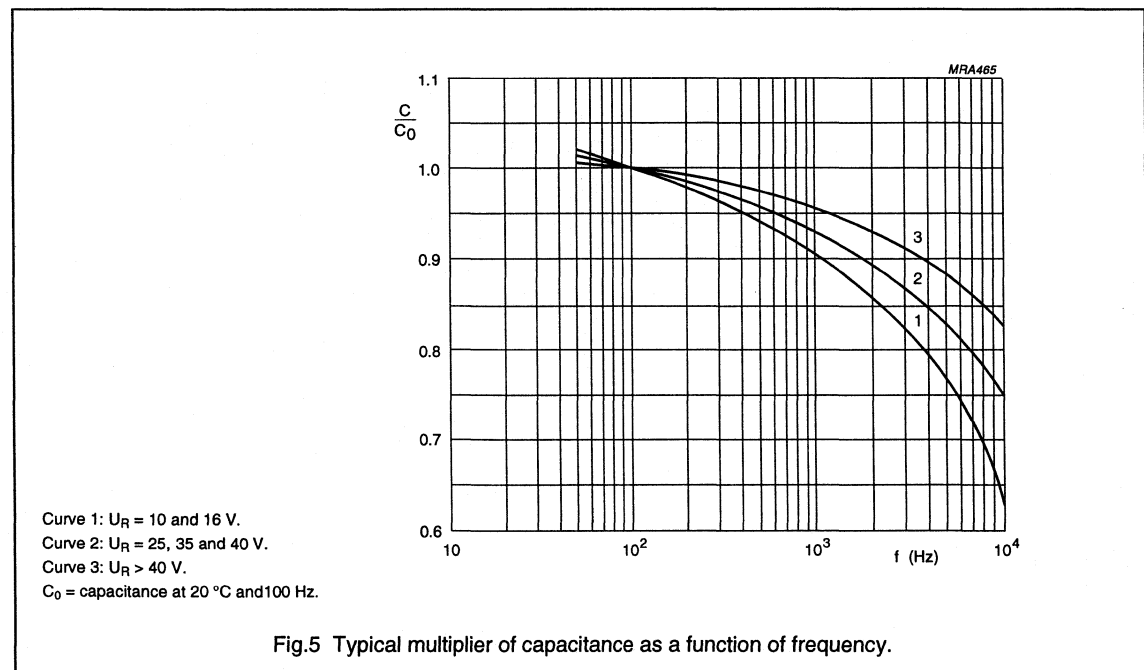
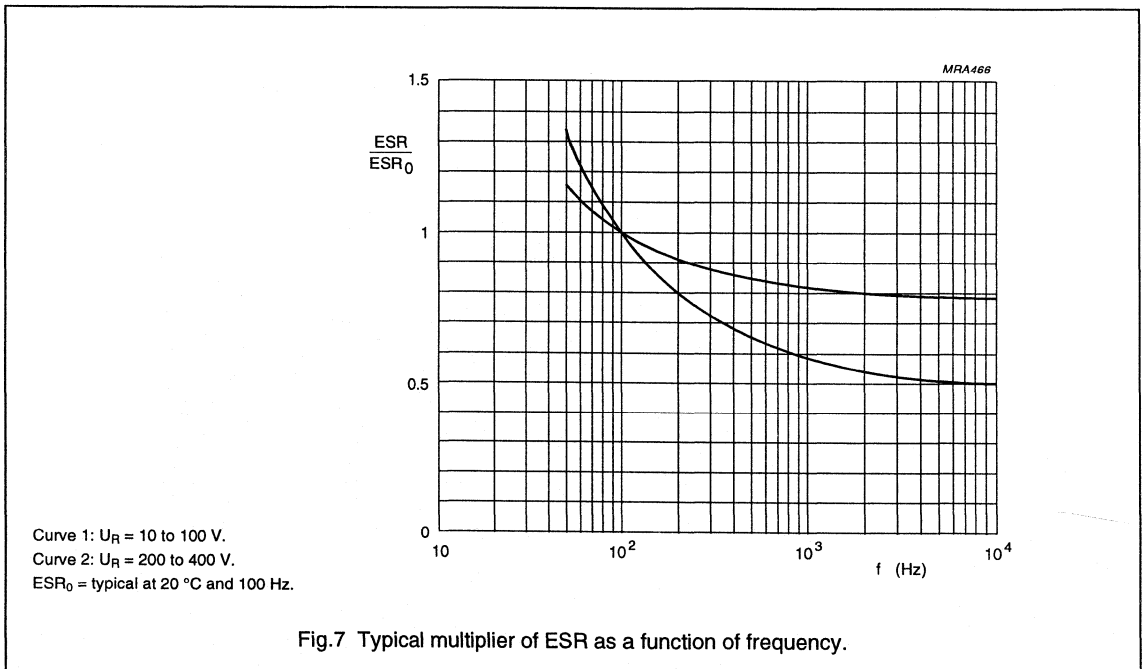
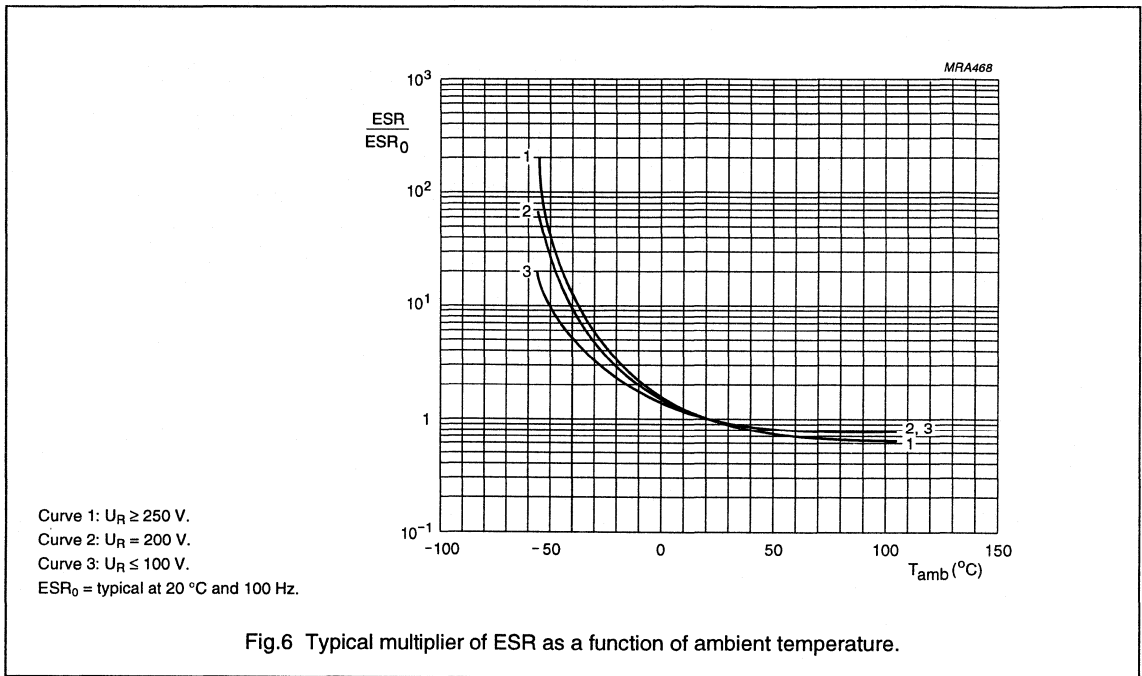


Fig.5 Typical multiplier of capacitance as a function of frequency.

Non-solid Al - electrolytic capacitors
Power Long Life Snap-in

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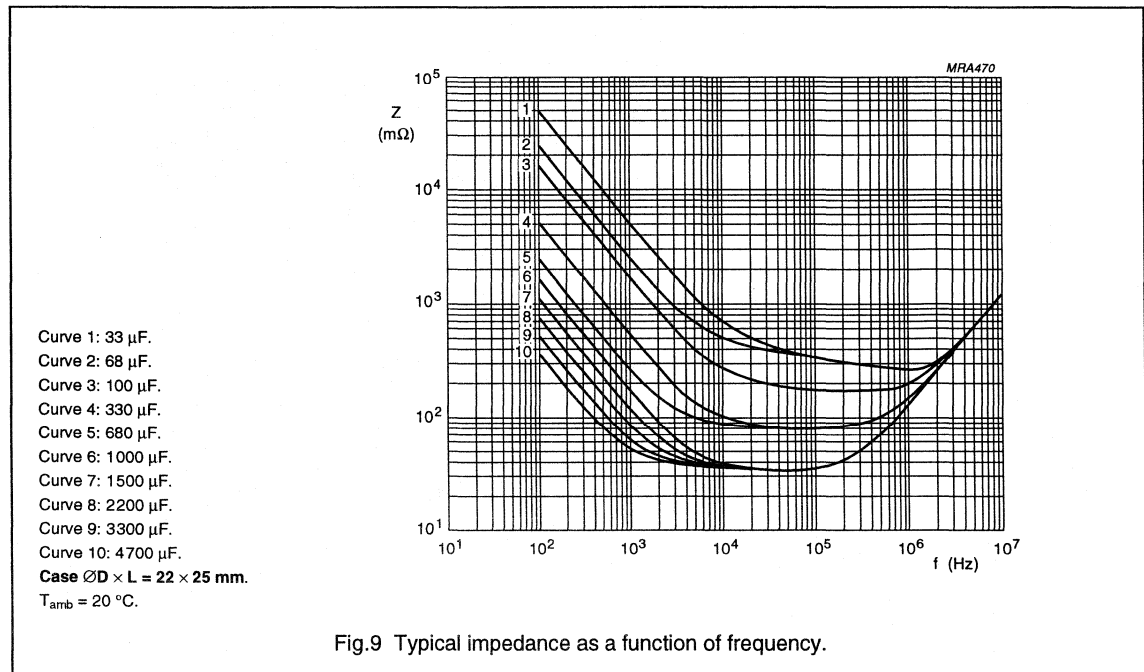
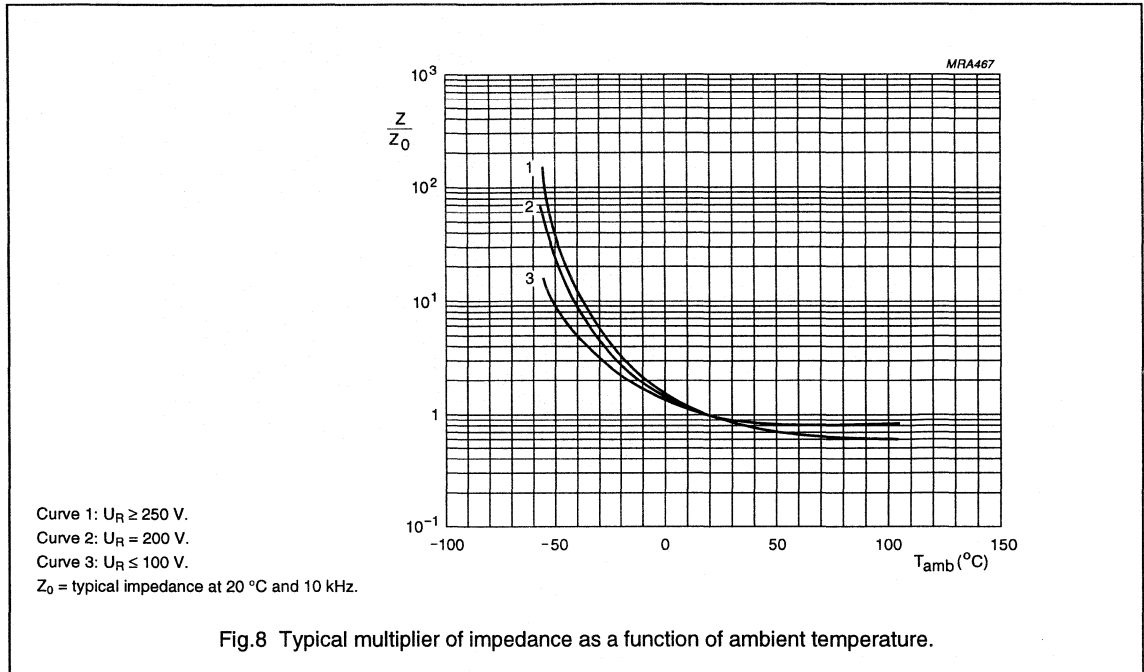
Equivalent series resistance (ESR)



Non-solid Al - electrolytic capacitors
Power Long Life Snap-in

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Impedance (Z)



Non-solid Al - electrolytic capacitors
Power Long Life Snap-in

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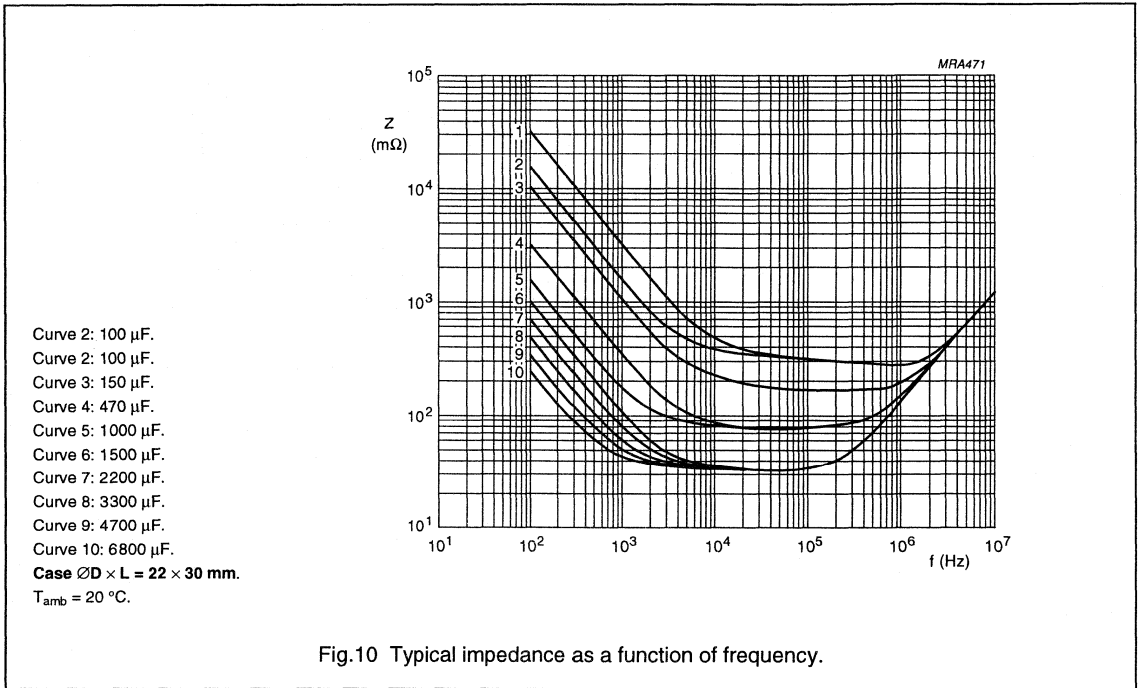


Fig.10 Typical impedance as a function of frequency.

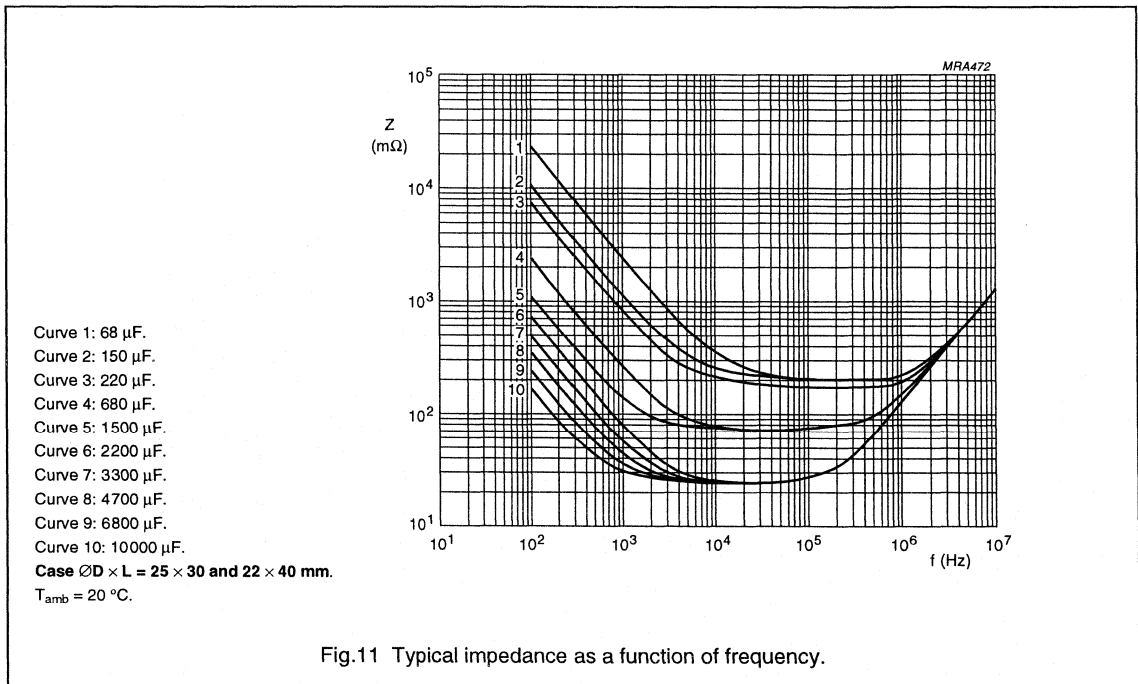


Fig.11 Typical impedance as a function of frequency.

Non-solid Al - electrolytic capacitors

Power Long Life Snap-in

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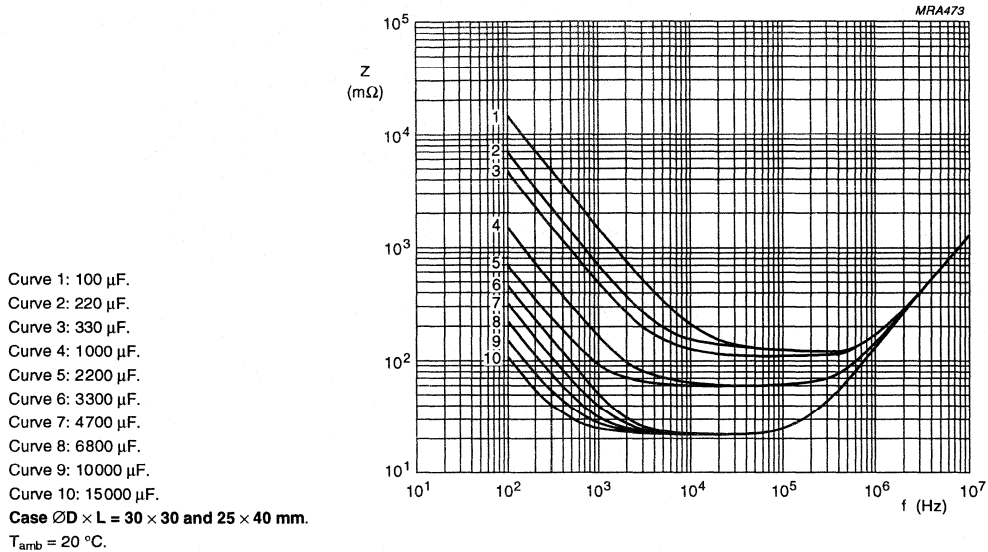


Fig.12 Typical impedance as a function of frequency.

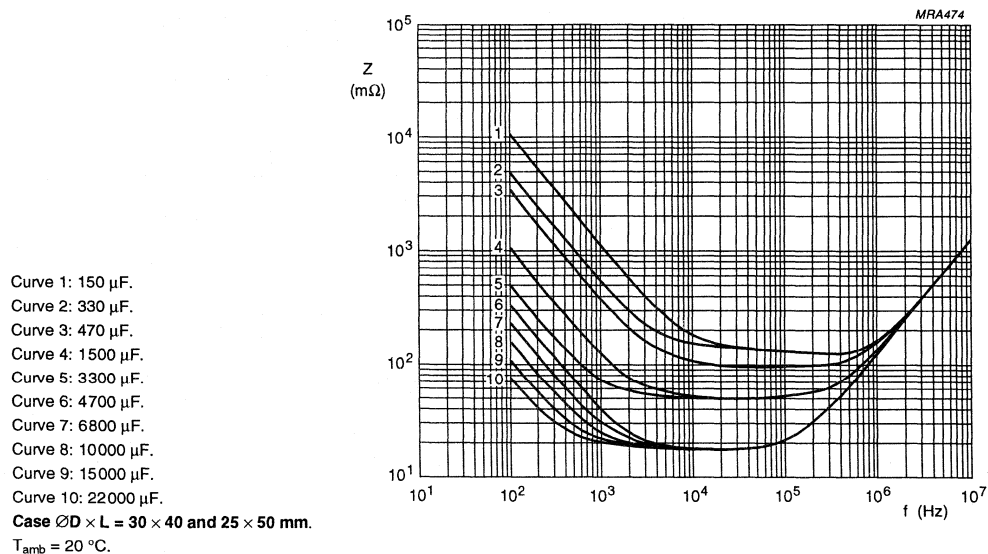
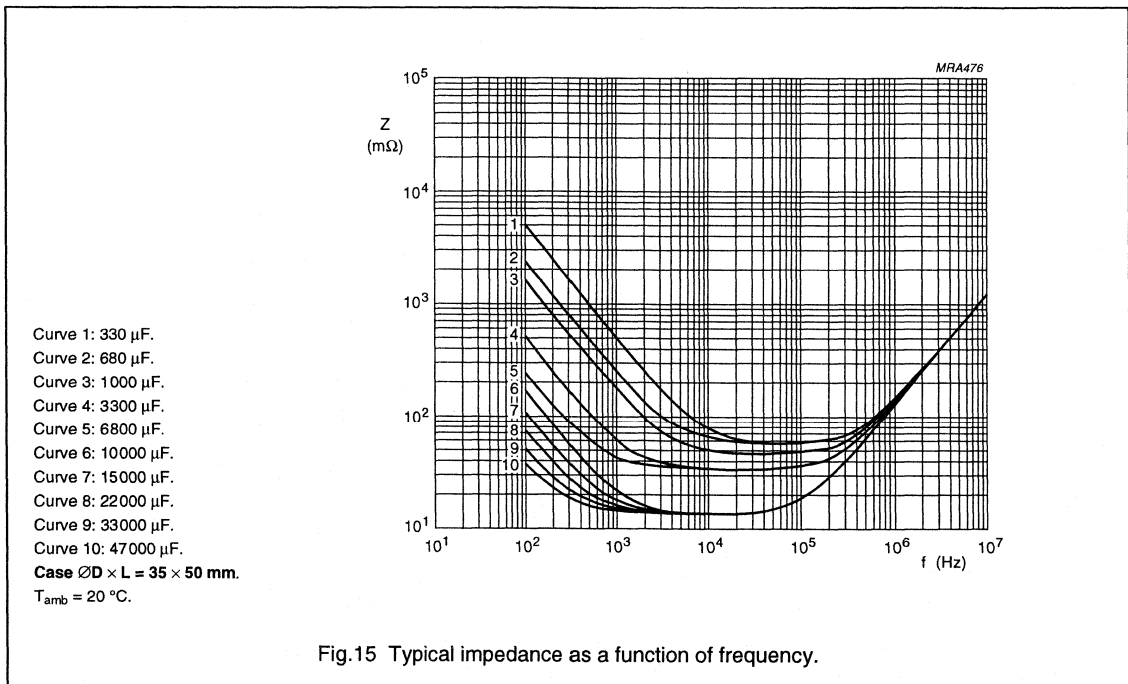
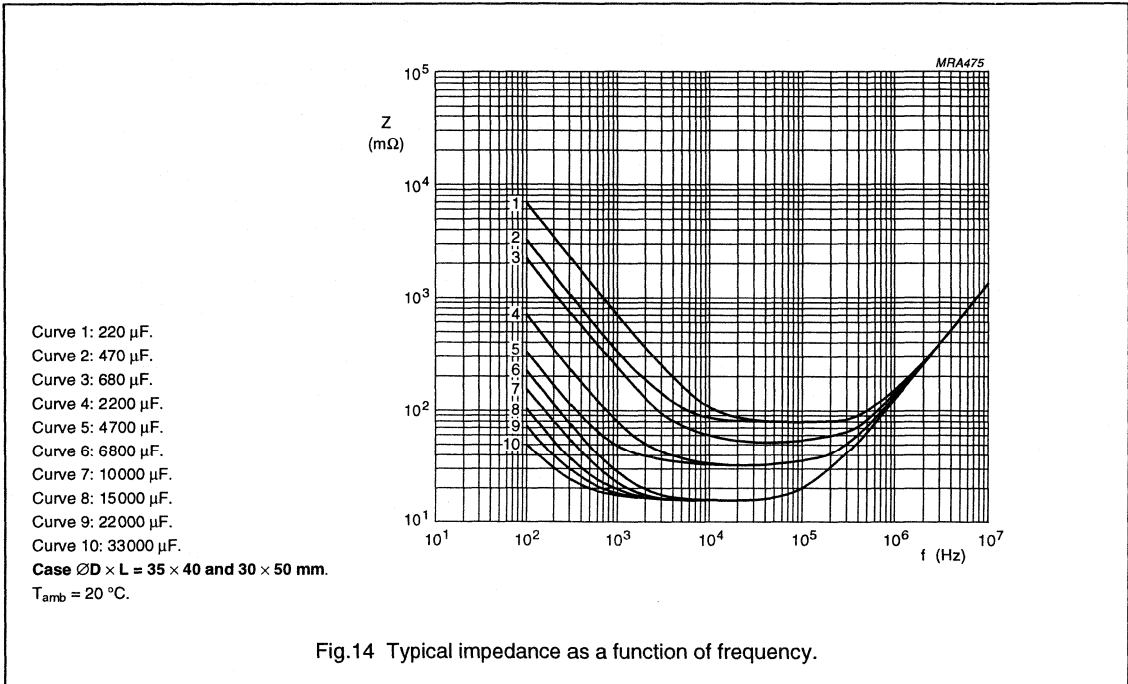


Fig.13 Typical impedance as a function of frequency.

Non-solid Al - electrolytic capacitors
Power Long Life Snap-in

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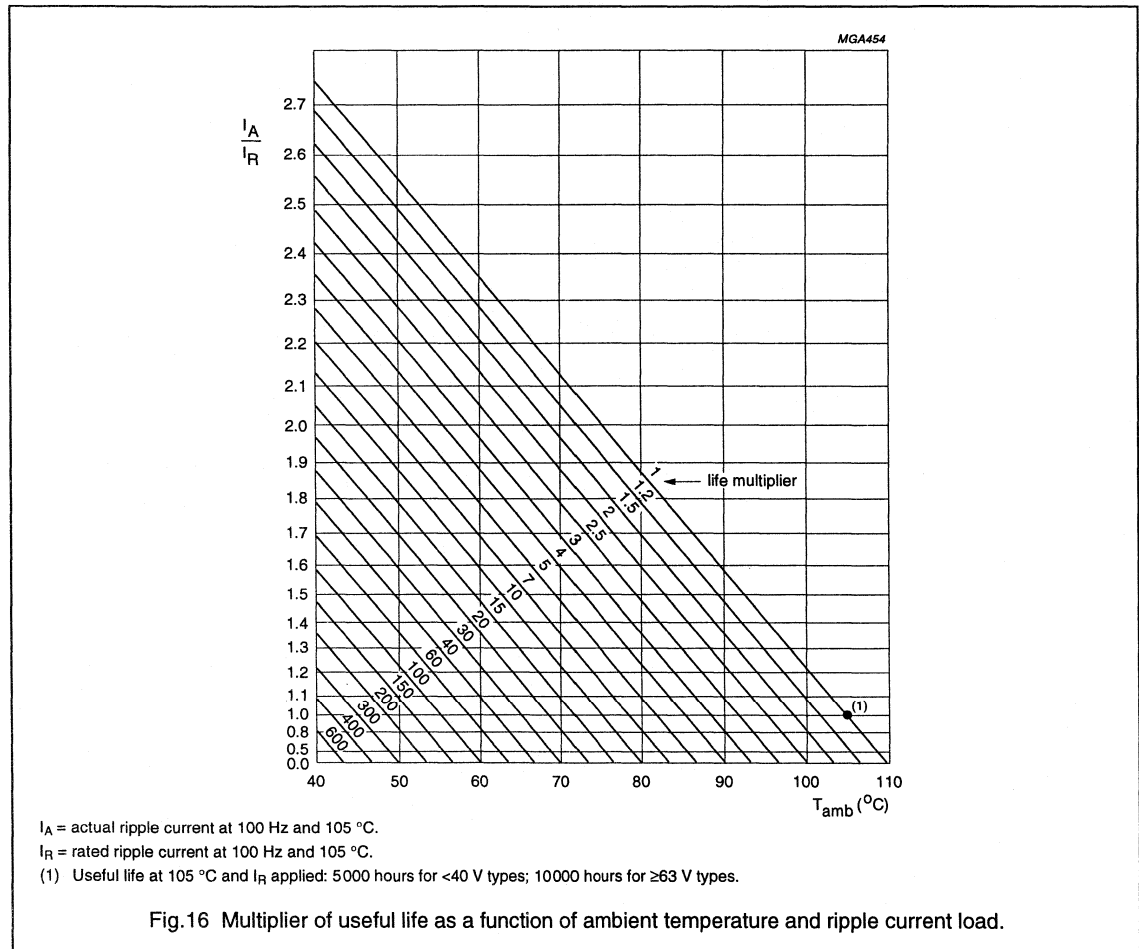
Non-solid Al - electrolytic capacitors Power Long Life Snap-in

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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		
	$U_R = 10$ to 25 V	$U_R = 40$ to 100 V	$U_R > 100$ V
50	0.93	0.91	0.86
100	1.00	1.00	1.00
200	1.04	1.05	1.13
400	1.07	1.09	1.21
1000	1.11	1.13	1.29
2000	1.13	1.15	1.32
4000	1.15	1.18	1.35
≥ 10000	1.18	1.22	1.40



Non-solid Al - electrolytic capacitors

Power Long Life Snap-in

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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; $\leq 40\text{ V}$ 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	$T_{amb} = 105\text{ °C}$; U_R and I_R applied; $\leq 40\text{ V}$ 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	$T_{amb} = 105\text{ °C}$; no voltage applied; 500 hours; after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Non-solid Al - electrolytic capacitors Power Standard Miniature 4-Terminal Snap-in

PSM-4TSI 166/167

FEATURES

- Keyed polarity obtained by 4 snap-in terminals
- Extremely high shock and vibration capability
- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Pressure relief on the top of the aluminium case
- Charge and discharge proof
- Long useful life:
10000 hours at 85 °C
- High ripple current capability.

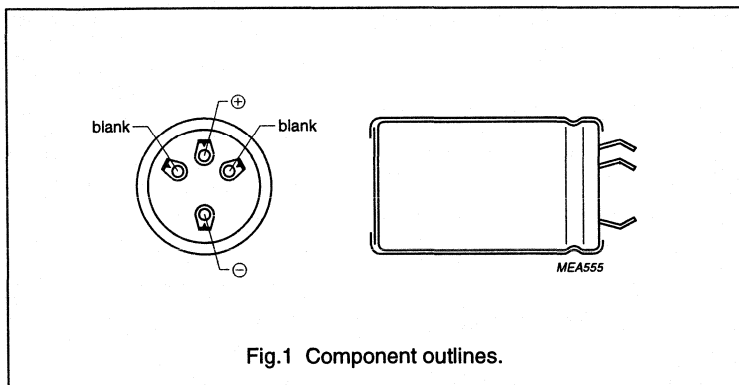
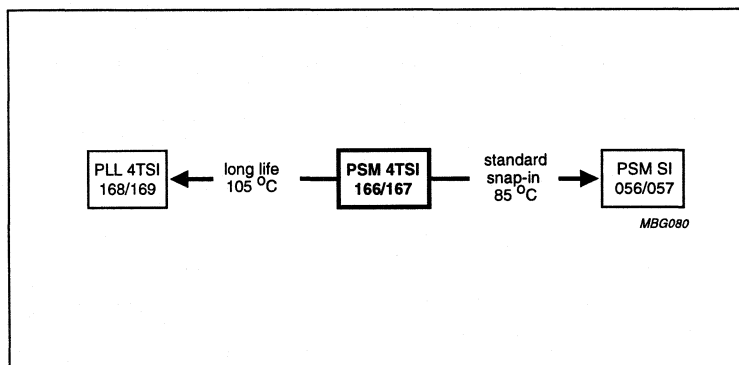


Fig.1 Component outlines.

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.



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, LL grade	
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)	

Non-solid Al - electrolytic capacitors
Power Standard Miniature 4-Terminal Snap-in

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Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 166 series

Preferred 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 series

Preferred types in **bold**.

C_R (μF)	U_R (V)			
	$U_R = 200 V$	$U_R = 250 V$	$U_R = 385 V$	$U_R = 400 V$
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	–	–	–

Non-solid Al - electrolytic capacitors

Power Standard Miniature 4-Terminal Snap-in

PSM-4TSI 166/167

MECHANICAL DATA AND PACKAGING QUANTITIES

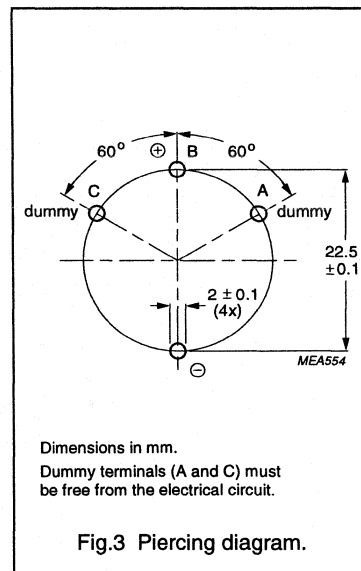
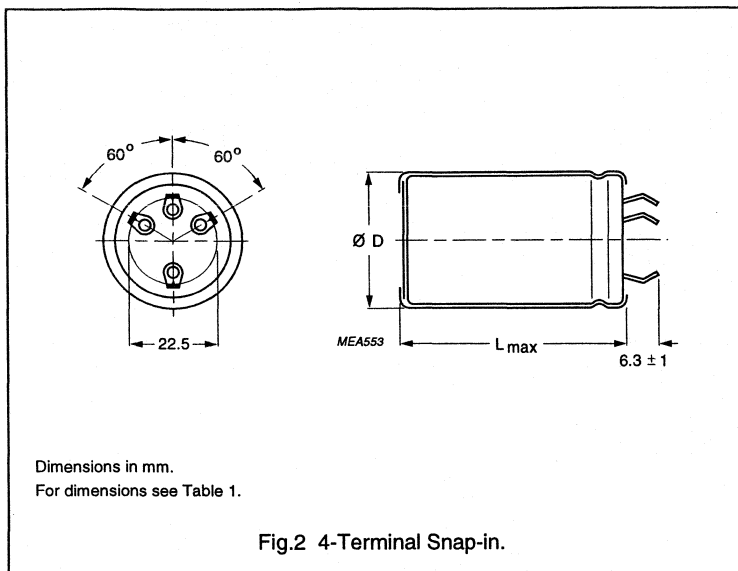


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	ØD _{max} (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	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".

Non-solid Al - electrolytic capacitors

Power Standard Miniature 4-Terminal Snap-in

PSM-4TSI 166/167

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 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 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
 PSM-4TSI 166

15000 $\mu\text{F}/40\text{ V}$; $\pm 20\%$

Nominal case size: $\varnothing 35 \times 40\text{ mm}$

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

Non-solid Al - electrolytic capacitors
Power Standard Miniature 4-Terminal Snap-in

PSM-4TSI 166/167

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	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	all case sizes	typ. 19 nH
		max. 25 nH

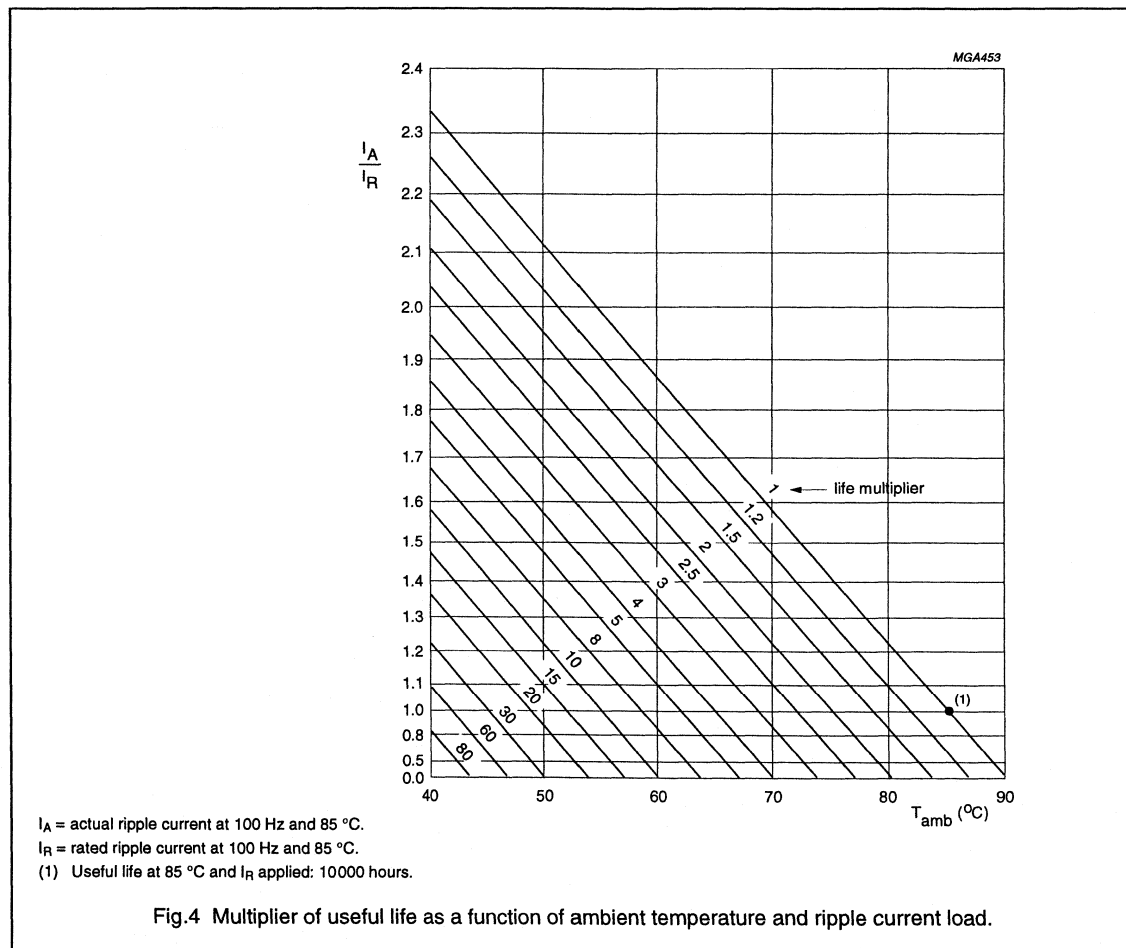
Non-solid Al - electrolytic capacitors Power Standard Miniature 4-Terminal Snap-in

PSM-4TSI 166/167

RIPPLE CURRENT AND USEFUL LIFE

Table 3 Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10$ to 25 V	$U_R = 40$ to 100 V	$U_R > 100$ V
50	0.93	0.91	0.86
100	1.00	1.00	1.00
200	1.04	1.05	1.13
400	1.07	1.09	1.21
1000	1.11	1.13	1.29
2000	1.13	1.15	1.32
4000	1.15	1.18	1.35
≥ 10000	1.18	1.22	1.40



Non-solid Al - electrolytic capacitors

Power Standard Miniature 4-Terminal Snap-in

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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	$T_{amb} = 85\text{ °C}$; 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	$T_{amb} = 85\text{ °C}$; 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	$T_{amb} = 85\text{ °C}$ no voltage applied; 500 hours; after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Non-solid Al - electrolytic capacitors

Power Long Life 4-Terminal Snap-in

PLL-4TSI 168/169

FEATURES

- Keyed polarity obtained by 4 snap-in terminals
- Extremely high shock and vibration capability
- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Pressure relief on the top of the aluminium case
- Charge and discharge proof
- Very long useful life: 5000 hours at 105 °C
- Temperature range up to 105 °C
- Low ESR, high ripple current capability.

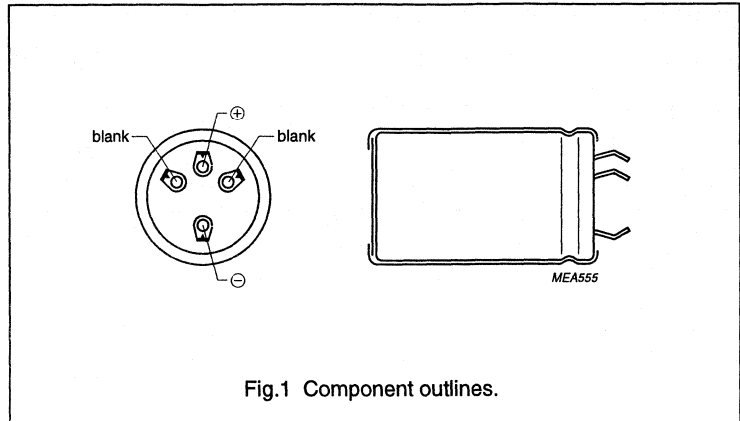
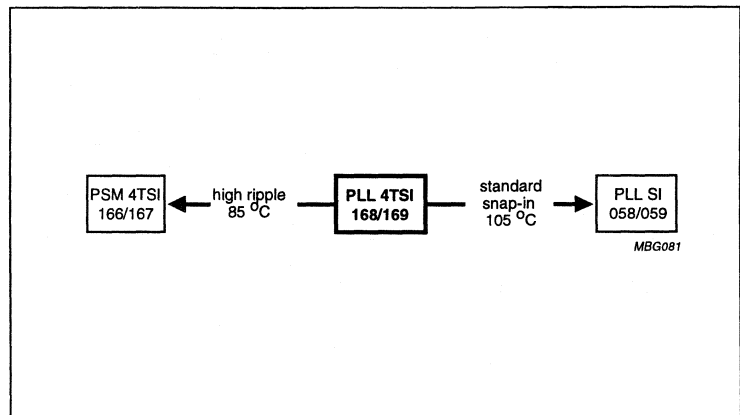


Fig.1 Component outlines.

APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering applications
- Standard and switched mode power supplies
- Energy storage in pulse systems
- 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	±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, LL grade	
Climatic category IEC 68 (DIN 40040)	40/105/56 (GMF)	

Non-solid Al - electrolytic capacitors
Power Long Life 4-Terminal Snap-in

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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	-	-	-

Non-solid Al - electrolytic capacitors Power Long Life 4-Terminal Snap-in

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MECHANICAL DATA AND PACKAGING QUANTITIES

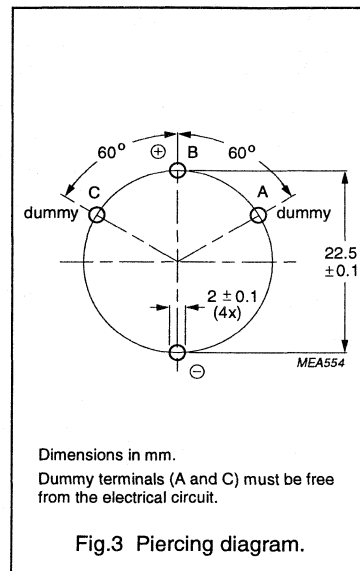
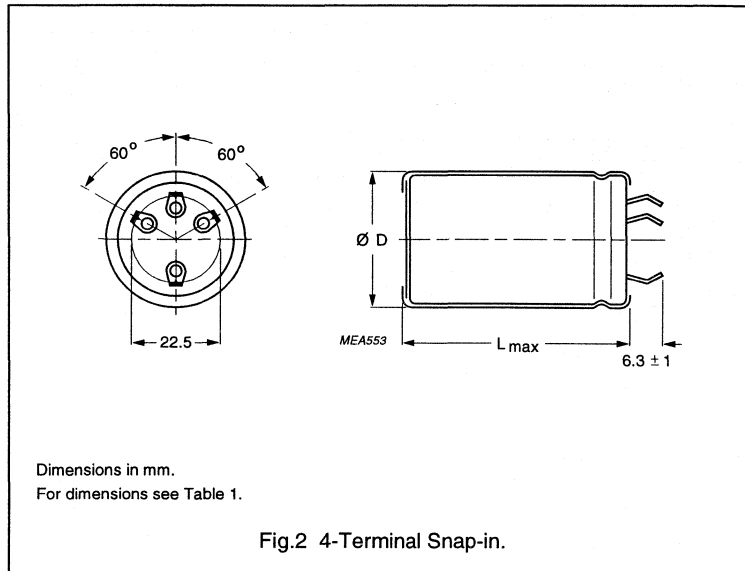


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	ØD _{max} (mm)	L _{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	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".

Non-solid Al - electrolytic capacitors

Power Long Life 4-Terminal Snap-in

PLL-4TSI 168/169

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 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 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
 PLL-4TSI 168

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	35 × 40	3540	5.15	1984	664	30	24	168 54333
	47000	35 × 50	3550	6.23	2824	944	24	21	168 54473
16	22000	35 × 40	3540	5.07	2116	708	31	24	168 55223
	33000	35 × 50	3550	6.23	3172	1060	25	21	168 55333
25	15000	35 × 40	3540	4.91	2254	754	33	24	168 56153
	22000	35 × 50	3550	6.07	3304	1104	27	21	168 56223
40	10000	35 × 40	3540	4.18	2404	804	46	29	168 57103
	15000	35 × 50	3550	5.21	3604	1204	36	24	168 57153
63	4700	35 × 40	3540	3.65	1781	596	60	45	168 58472
	6800	35 × 50	3550	4.58	2574	861	46	35	168 58682
100	2200	35 × 40	3540	3.05	1324	444	86	65	168 59222
	3300	35 × 50	3550	3.84	1984	664	64	50	168 59332
200	680	35 × 40	3540	1.91	820	276	235	155	169 52681
	820	35 × 45	3545	2.18	988	332	195	150	169 42821
	1000	35 × 50	3550	2.45	1204	404	160	125	169 52102
250	470	35 × 40	3540	1.82	709	239	270	155	169 53471
	680	35 × 45	3545	2.25	1024	344	190	125	169 43681
	680	35 × 50	3550	2.30	1024	344	190	125	169 53681
385	220	35 × 40	3540	1.31	512	173	580	465	169 58221
	270	35 × 45	3545	1.52	627	212	475	385	169 48271
	330	35 × 50	3550	1.75	766	258	390	320	169 58331
400	220	35 × 40	3540	0.94	532	180	930	760	169 56221
	270	35 × 45	3545	1.07	652	220	770	630	169 46271
	330	35 × 50	3550	1.25	796	260	620	510	169 56331

Non-solid Al - electrolytic capacitors
Power Long Life 4-Terminal Snap-in

PLL-4TSI 168/169

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	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	all case sizes	typ. 19 nH
		max. 25 nH

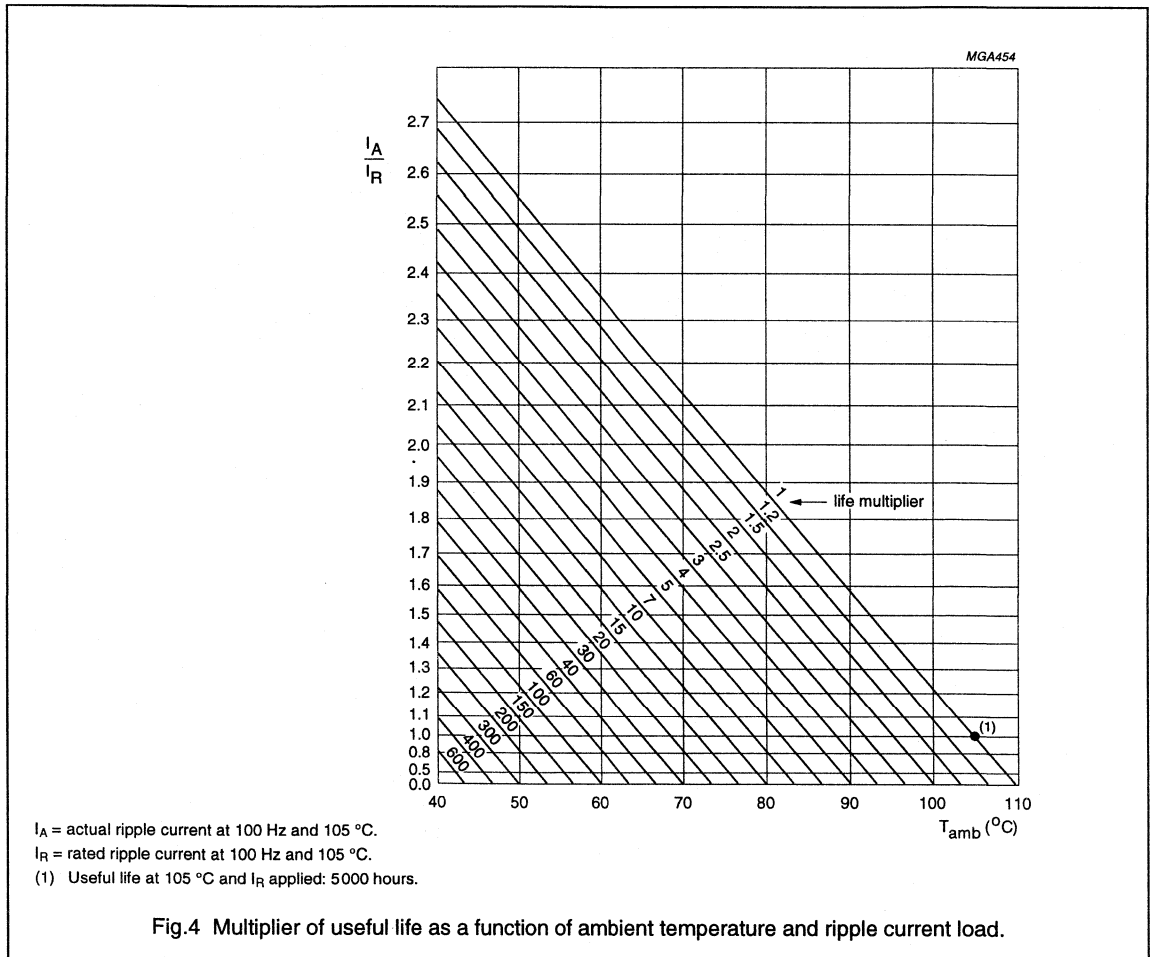
Non-solid Al - electrolytic capacitors Power Long Life 4-Terminal Snap-in

PLL-4TSI 168/169

RIPPLE CURRENT AND USEFUL LIFE

Table 3 Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10$ to 25 V	$U_R = 40$ to 100 V	$U_R > 100$ V
50	0.93	0.91	0.86
100	1.00	1.00	1.00
200	1.04	1.05	1.13
400	1.07	1.09	1.21
1000	1.11	1.13	1.29
2000	1.13	1.15	1.32
4000	1.15	1.18	1.35
≥ 10000	1.18	1.22	1.40



Non-solid Al - electrolytic capacitors

Power Long Life 4-Terminal Snap-in

PLL-4TSI 168/169

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	$T_{amb} = 105\text{ °C}$; 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	$T_{amb} = 105\text{ °C}$; 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	$T_{amb} = 105\text{ °C}$; no voltage applied; 500 hours; after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

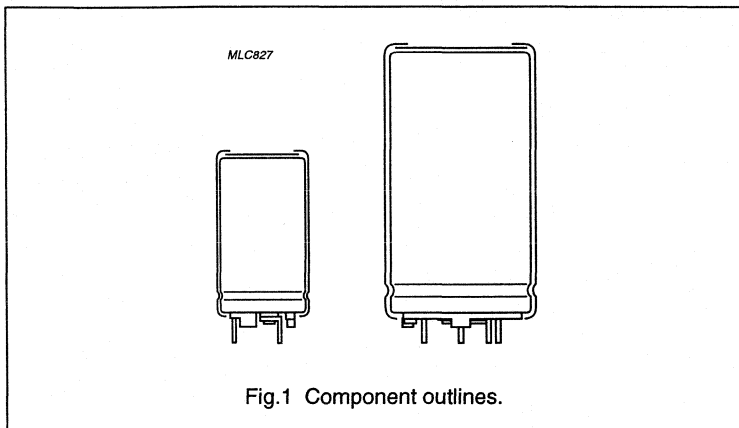
Non-solid Al - electrolytic capacitors

Power Economic Printed Wiring

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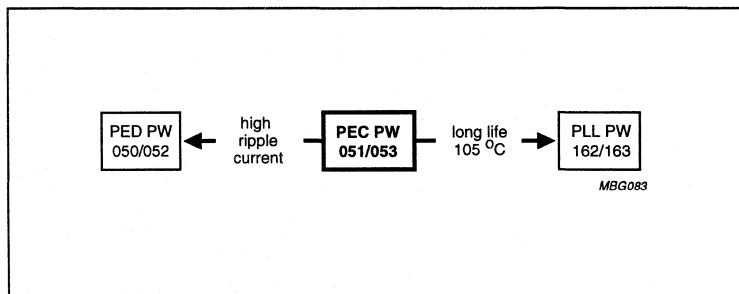
FEATURES

- 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 achieved by a special internal construction.



APPLICATIONS

- General purpose, industrial and audio/video systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	051	053
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	25 × 35 to 40 × 105	
Rated capacitance range (E6 series), C_R	680 to 150000 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	200000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 384-4, CECC 30300, LL grade	
Detail specification	DIN 45910-T129 (without approval) former DIN 41238	
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)	
Approvals	France: liste LNZ 44-04	

Non-solid Al - electrolytic capacitors

Power Economic Printed Wiring

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

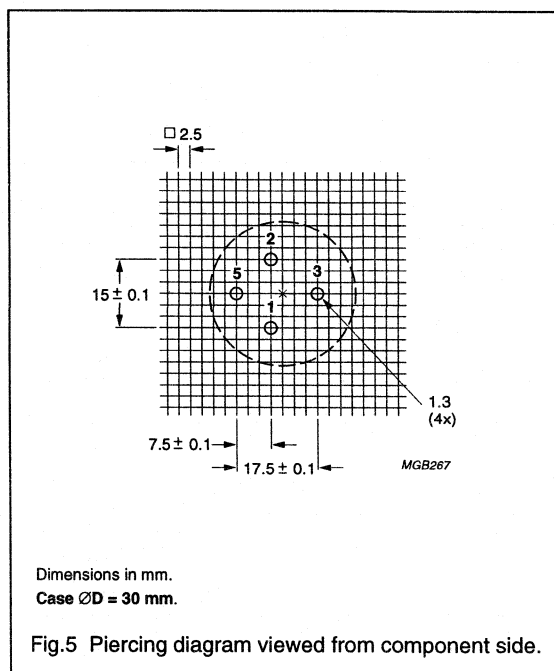
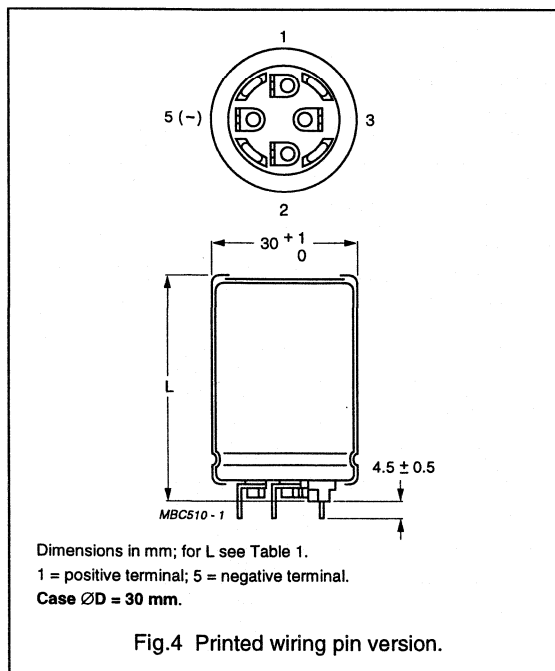
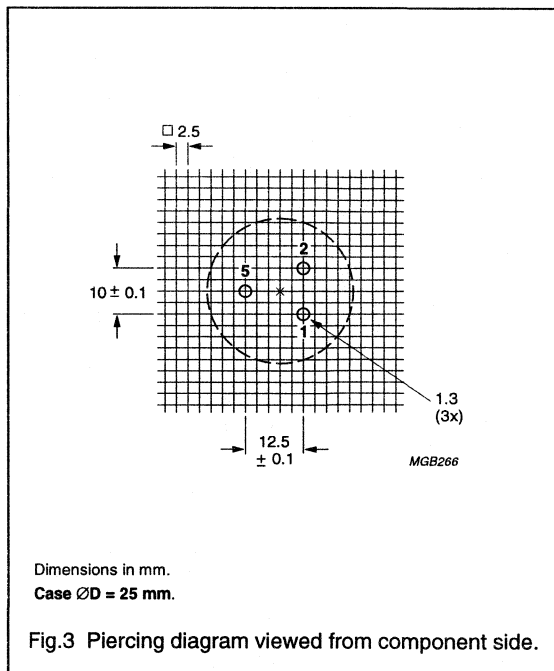
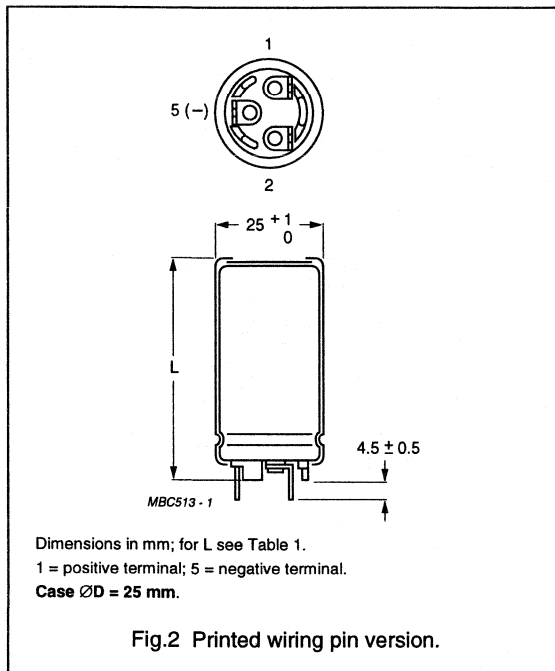
Preferred types in bold.

C_R (μF)	U_R (V)								
	10	16	25	40	63	100	200	385	400
68	-	-	-	-	-	-	-	25 × 35	25 × 35
100	-	-	-	-	-	-	-	25 × 45	25 × 45
150	-	-	-	-	-	-	25 × 35	30 × 45	30 × 45
220	-	-	-	-	-	-	25 × 45	35 × 45	35 × 45
330	-	-	-	-	-	-	30 × 45	35 × 55	35 × 55
	-	-	-	-	-	-	-	40 × 45	40 × 45
470	-	-	-	-	-	-	35 × 45	40 × 55	40 × 55
680	-	-	-	-	-	25 × 35	35 × 55	40 × 75	40 × 75
	-	-	-	-	-	-	40 × 45	-	-
1000	-	-	-	-	-	25 × 45	40 × 55	40 × 105	40 × 105
1500	-	-	-	-	-	30 × 45	40 × 75	-	-
2200	-	-	-	-	25 × 35	35 × 45	40 × 105	-	-
3300	-	-	-	25 × 35	25 × 45	35 × 55	-	-	-
	-	-	-	-	-	40 × 45	-	-	-
4700	-	-	25 × 35	25 × 45	30 × 45	40 × 55	-	-	-
6800	-	25 × 35	25 × 45	30 × 45	35 × 45	40 × 75	-	-	-
10000	25 × 35	25 × 45	30 × 45	35 × 45	35 × 55	40 × 105	-	-	-
	-	-	-	-	40 × 45	-	-	-	-
15000	25 × 45	30 × 45	35 × 45	35 × 55	40 × 75	-	-	-	-
	-	-	-	40 × 45	-	-	-	-	-
22000	30 × 45	35 × 45	35 × 55	40 × 55	40 × 105	-	-	-	-
	-	-	40 × 45	-	-	-	-	-	-
33000	35 × 45	35 × 55	40 × 55	40 × 75	-	-	-	-	-
	-	40 × 45	-	-	-	-	-	-	-
47000	35 × 55	40 × 55	40 × 75	40 × 105	-	-	-	-	-
	40 × 45	-	-	-	-	-	-	-	-
68000	40 × 55	40 × 75	40 × 105	-	-	-	-	-	-
100000	40 × 75	40 × 105	-	-	-	-	-	-	-
150000	40 × 105	-	-	-	-	-	-	-	-

Non-solid Al - electrolytic capacitors Power Economic Printed Wiring

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MECHANICAL DATA AND PACKAGING QUANTITIES



Non-solid Al - electrolytic capacitors
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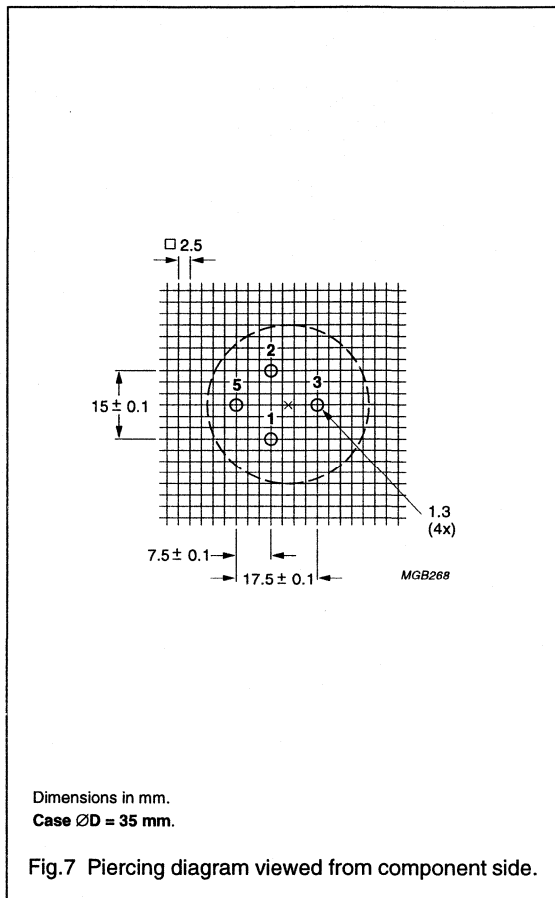
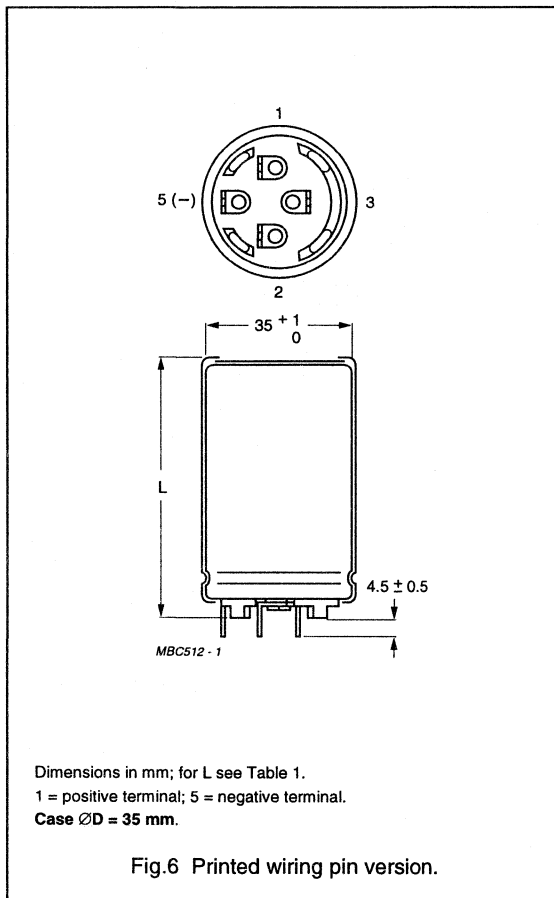


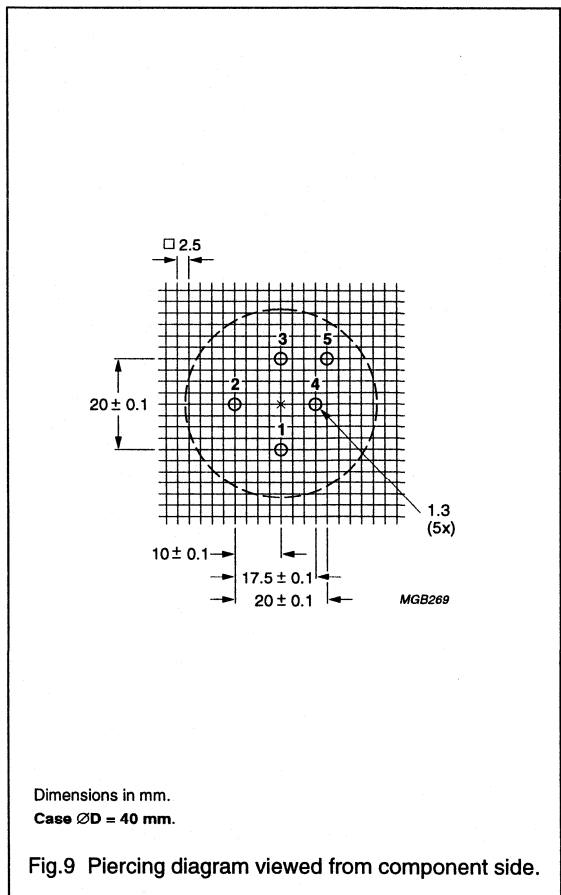
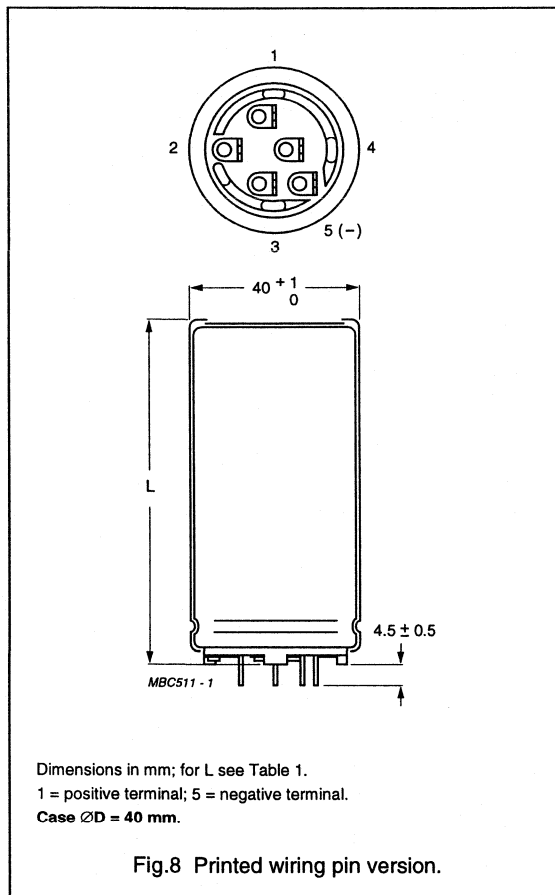
Table 1 Physical dimensions, mass and packaging information; see Figs 2, 4, 6 and 8

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	BOX DIMENSIONS $l \times w \times h$ (mm)
25 × 35	26	39.3	≈24	100	290 × 280 × 49
25 × 45	26	49.3	≈28	100	290 × 280 × 59
30 × 45	31	49.3	≈38	100	340 × 330 × 59
35 × 45	36	49.3	≈51	50	390 × 198 × 59
35 × 55	36	59.3	≈66	50	390 × 198 × 69
40 × 45	41	49.3	≈78	50	440 × 223 × 59
40 × 55	41	59.3	≈82	50	440 × 223 × 69
40 × 75	41	79.3	≈110	50	440 × 223 × 89
40 × 105	41	109.3	≈176	50	440 × 223 × 119

Non-solid Al - electrolytic capacitors

Power Economic Printed Wiring

PEC-PW 051/053



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".

Non-solid Al - electrolytic capacitors

Power Economic Printed Wiring

PEC-PW 051/053

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 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 or at 20 kHz, 70 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	max. equivalent series resistance at 100 Hz
Z	max. impedance at 10 kHz

Ordering example

Electrolytic capacitor
 PEC-PW 051

10000 $\mu\text{F}/25\text{ V}$; $\pm 20\%$

Nominal case size: $\varnothing 30 \times 45\text{ mm}$

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 °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
10	10000	25 × 35	3.1	5.9	0.60	0.20	51	40	051 54103
	15000	25 × 45	4.1	7.8	0.90	0.30	37	30	051 54153
	22000	30 × 45	5.0	9.5	1.32	0.44	30	25	051 54223
	33000	35 × 45	5.5	10.4	1.98	0.66	28	24	051 54333
	47000	35 × 55	6.8	12.9	2.82	0.94	23	20	051 54473
	47000	40 × 45	5.8	10.4	2.82	0.94	29	22	051 44473
	68000	40 × 55	7.1	13.5	4.08	1.36	24	20	051 54683
	100000	40 × 75	9.2	17.4	6.00	2.00	19	16	051 54104
150000	40 × 105	12.0	22.7	9.00	3.00	16	14	051 54154	
16	6800	25 × 35	3.1	5.9	0.65	0.22	53	42	051 55682
	10000	25 × 45	4.0	7.6	0.96	0.32	39	34	051 55103
	15000	30 × 45	5.0	9.5	1.44	0.48	31	27	051 55153
	22000	35 × 45	5.5	10.4	2.12	0.71	29	26	051 55223
	33000	35 × 55	6.7	12.7	3.17	1.06	23	21	051 55333
	33000	40 × 45	5.7	10.8	3.17	1.06	30	24	051 45333
	47000	40 × 55	7.0	13.3	4.52	1.51	24	20	051 55473
	68000	40 × 75	9.2	17.4	6.53	2.18	19	16	051 55683
100000	40 × 105	12.0	22.7	9.60	3.20	16	14	051 55104	
25	4700	25 × 35	2.9	5.5	0.71	0.24	60	42	051 56472
	6800	25 × 45	3.9	7.4	1.02	0.34	42	34	051 56682
	10000	30 × 45	4.8	9.1	1.50	0.50	34	27	051 56103
	15000	35 × 45	5.3	10.0	2.25	0.75	30	26	051 56153
	22000	35 × 55	6.5	12.3	3.30	1.10	24	21	051 56223
	22000	40 × 45	5.7	10.8	3.30	1.10	31	24	051 46223
	33000	40 × 55	7.0	13.3	4.95	1.65	25	20	051 56333
	47000	40 × 75	9.2	17.4	7.05	2.35	19	16	051 56473
68000	40 × 105	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 × 35	2.9	5.5	0.80	0.27	87	63	051 57332
	4700	25 × 45	3.8	7.2	1.13	0.38	62	47	051 57472
	6800	30 × 45	4.7	8.9	1.64	0.55	49	38	051 57682
	10000	35 × 45	5.2	9.8	2.40	0.80	48	37	051 57103
	15000	35 × 55	6.3	11.9	3.60	1.20	37	28	051 57153
	15000	40 × 45	5.6	10.6	3.60	1.20	50	35	051 47153
	22000	40 × 55	5.8	11.0	5.28	1.76	39	28	051 57223
	33000	40 × 75	7.8	14.8	7.92	2.64	28	21	051 57333
	47000	40 × 105	10.4	19.7	11.28	3.76	22	17	051 57473
63	2200	25 × 35	2.5	4.7	0.84	0.28	83	62	051 58222
	3300	25 × 45	3.3	6.2	1.25	0.42	58	42	051 58332
	4700	30 × 45	4.1	7.8	1.78	0.60	49	38	051 58472
	6800	35 × 45	4.5	8.5	2.57	0.86	48	37	051 58682
	10000	35 × 55	5.4	10.2	3.78	1.26	37	28	051 58103
	10000	40 × 45	4.6	8.7	3.78	1.26	52	37	051 48103
	15000	40 × 75	7.5	14.2	5.67	1.89	29	24	051 58153
	22000	40 × 105	10.0	19.0	8.32	2.77	22	19	051 58223
100	680	25 × 35	1.74	3.30	0.41	0.14	190	130	051 59681
	1000	25 × 45	2.34	4.44	0.60	0.20	130	90	051 59102
	1500	30 × 45	2.95	5.59	0.90	0.30	95	67	051 59152
	2200	35 × 45	3.69	7.00	1.32	0.44	71	53	051 59222
	3300	35 × 55	4.37	8.29	1.98	0.66	55	41	051 59332
	3300	40 × 45	4.16	7.89	1.98	0.66	64	48	051 49332
	4700	40 × 55	5.21	9.88	2.82	0.94	49	38	051 59472
	6800	40 × 75	6.97	13.22	4.08	1.36	35	28	051 59682
	10000	40 × 105	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 × 35	0.70	1.33	0.18	0.06	1000	770	053 52151
	220	25 × 45	0.94	1.78	0.26	0.09	680	525	053 52221
	330	30 × 45	1.27	2.41	0.40	0.14	460	360	053 52331
	470	35 × 45	1.66	3.15	0.57	0.19	320	250	053 52471
	680	35 × 55	2.19	4.15	0.82	0.28	220	170	053 52681
	680	40 × 45	2.17	4.11	0.82	0.28	220	170	053 42681
	1000	40 × 55	2.86	5.42	1.20	0.40	150	115	053 52102
	1500	40 × 75	3.81	7.22	1.80	0.60	110	85	053 52152
	2200	40 × 105	5.20	9.86	2.64	0.88	80	60	053 52222
385	68	25 × 35	0.47	0.89	0.16	0.06	2200	1480	053 58689
	100	25 × 45	0.64	1.21	0.23	0.08	1500	1020	053 58101
	150	30 × 45	0.90	1.71	0.35	0.12	1000	700	053 58151
	220	35 × 45	1.15	2.18	0.51	0.17	680	480	053 58221
	330	35 × 55	1.53	2.90	0.77	0.26	450	340	053 58331
	330	40 × 45	1.52	2.88	0.77	0.26	450	340	053 48331
	470	40 × 55	1.96	3.72	1.09	0.36	320	260	053 58471
	680	40 × 75	2.70	5.12	1.58	0.53	220	190	053 58681
	1000	40 × 105	3.70	7.02	2.31	0.78	180	140	053 58102
400	68	25 × 35	0.54	1.02	0.16	0.06	2100	1000	053 56689
	100	25 × 45	0.73	1.38	0.24	0.08	1400	780	053 56101
	150	30 × 45	0.98	1.86	0.36	0.12	950	520	053 56151
	220	35 × 45	1.28	2.43	0.52	0.17	650	400	053 56221
	330	35 × 55	1.67	3.17	0.79	0.26	480	280	053 56331
	330	40 × 45	1.67	3.17	0.79	0.26	480	280	053 46331
	470	40 × 55	2.12	4.02	1.12	0.37	340	220	053 56471
	680	40 × 75	2.90	5.50	1.63	0.54	235	155	053 56681
	1000	40 × 105	4.05	7.68	2.40	0.80	160	110	053 56102

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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		$U_{rev} \leq 1$ 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 $\varnothing D = 25$ mm	max. 25 nH
	case $\varnothing D = 30$ and 35 mm	max. 30 nH
	case $\varnothing D = 40$ mm	max. 35 nH

Capacitance (C)

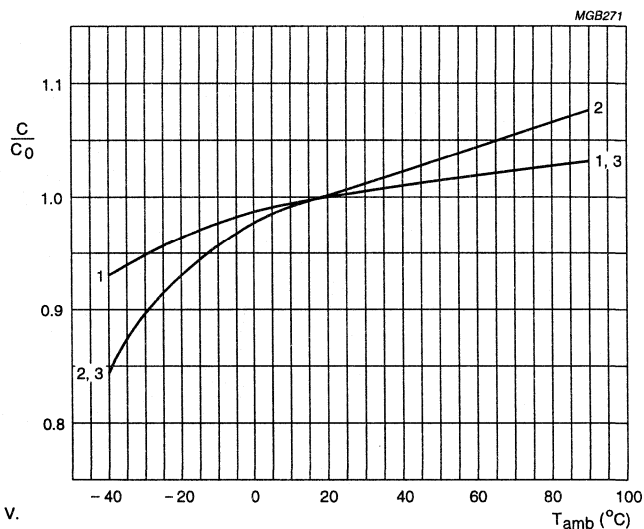
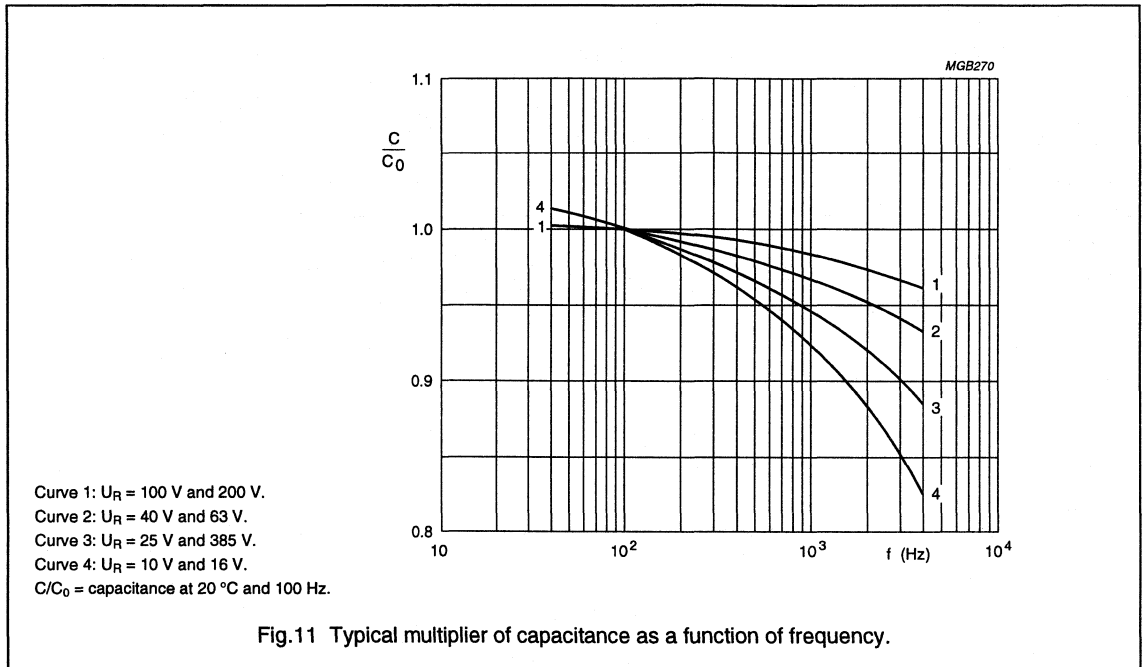
Curve 1: $U_R = 100$ V and 200 V.Curve 2: $U_R = 10$ V, 16 V, 25 V, 40 V and 63 V.Curve 3: $U_R = 385$ V. C/C_0 = capacitance at 20 °C and 100 Hz.

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

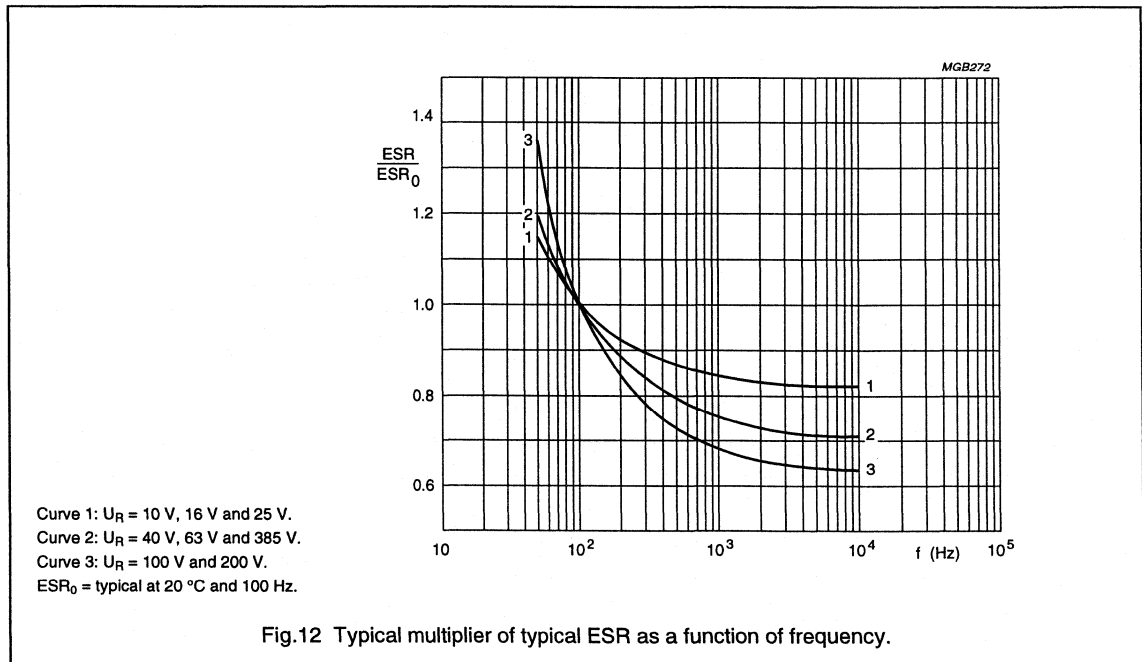
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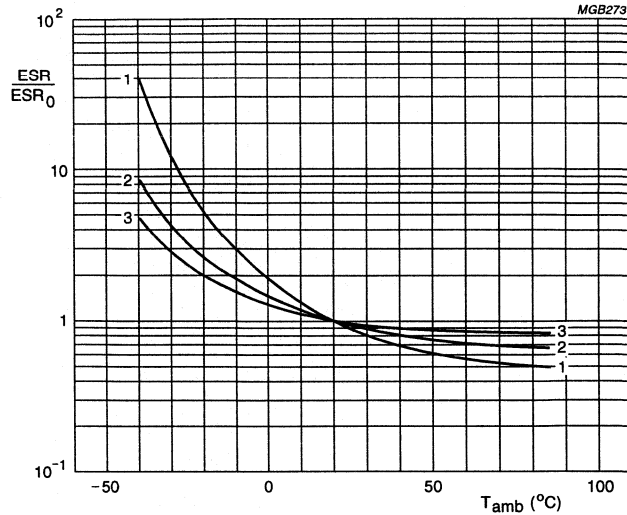
Equivalent series resistance (ESR)



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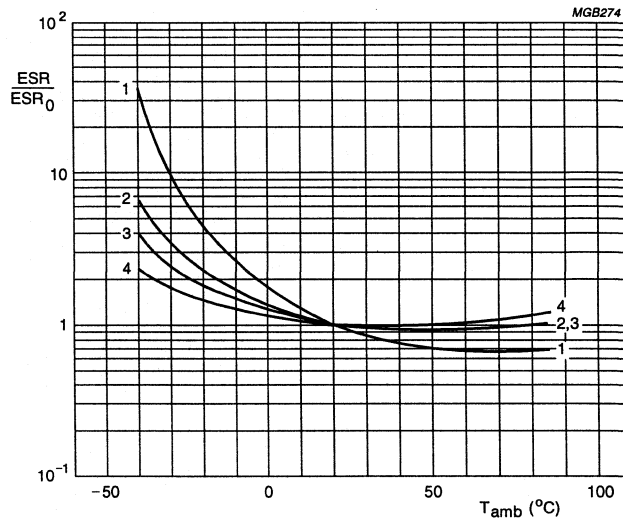
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Curve 1: $U_R = 385$ V.
 Curve 2: $U_R = 100$ V and 200 V.
 Curve 3: $U_R = 10$ V to 63 V.
 ESR_0 = typical at 20 $^{\circ}C$ and 100 Hz.
 Case $\varnothing D \times L = 25 \times 35, 25 \times 45, 30 \times 45$ and 35×45 mm.

Fig.13 Typical multiplier of ESR as a function of ambient temperature.



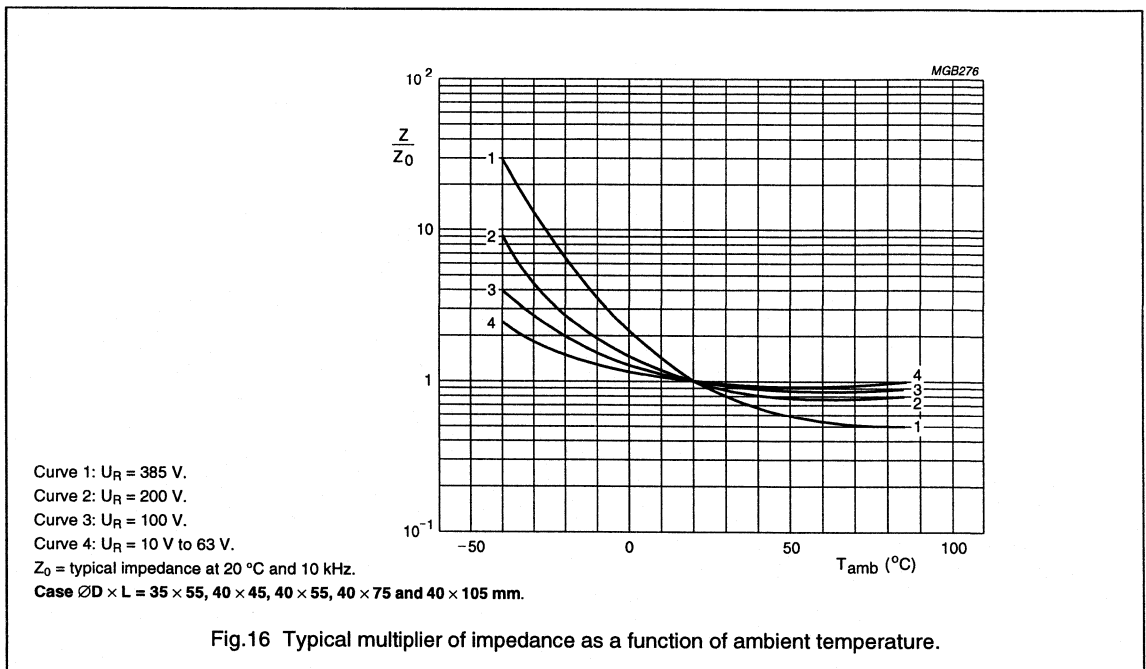
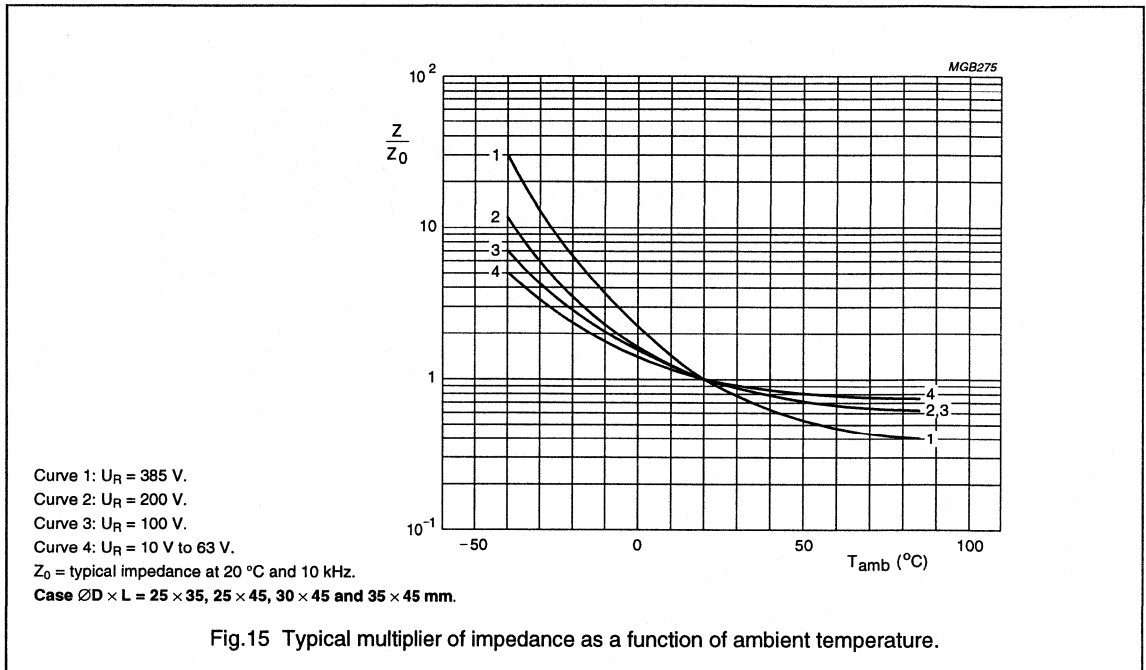
Curve 1: $U_R = 385$ V.
 Curve 2: $U_R = 200$ V.
 Curve 3: $U_R = 100$ V.
 Curve 4: $U_R = 10$ V to 63 V.
 ESR_0 = typical at 20 $^{\circ}C$ and 100 Hz.
 Case $\varnothing D \times L = 35 \times 55, 40 \times 45, 40 \times 55, 40 \times 75$ and 40×105 mm.

Fig.14 Typical multiplier of ESR as a function of ambient temperature.

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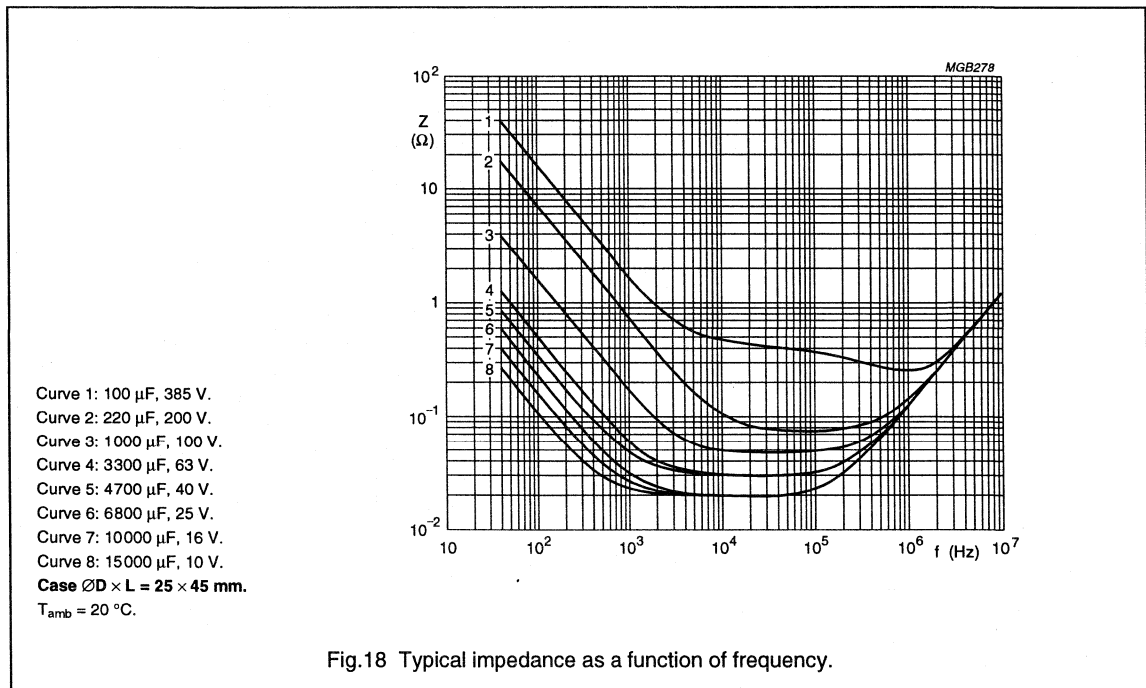
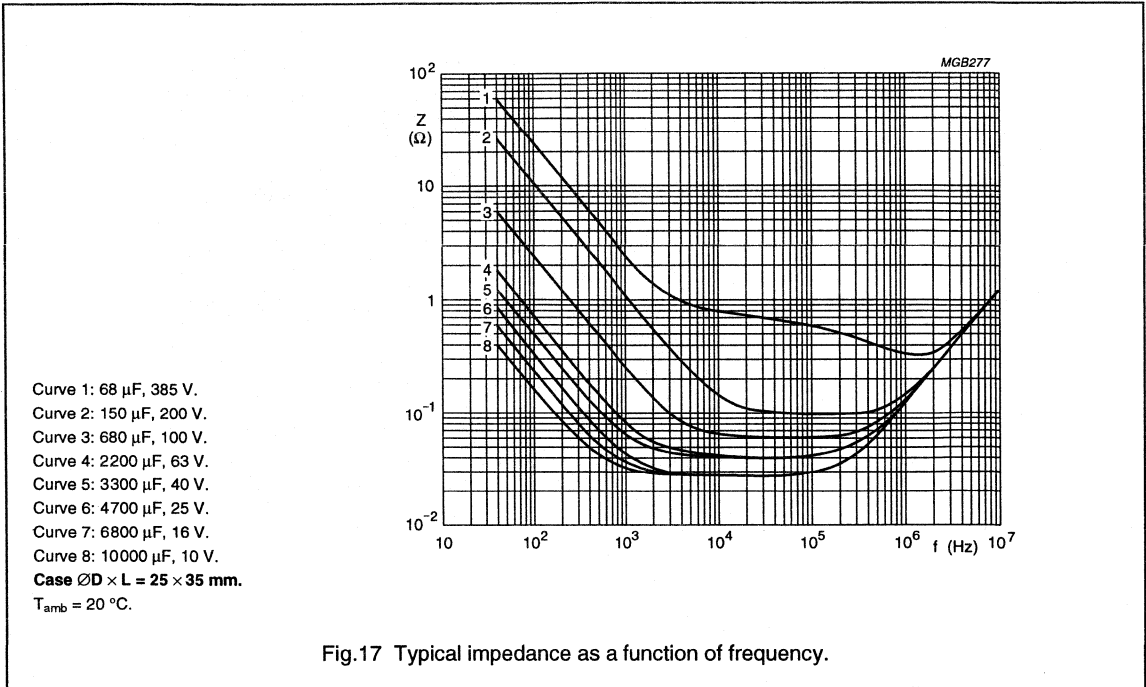
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Impedance (Z)



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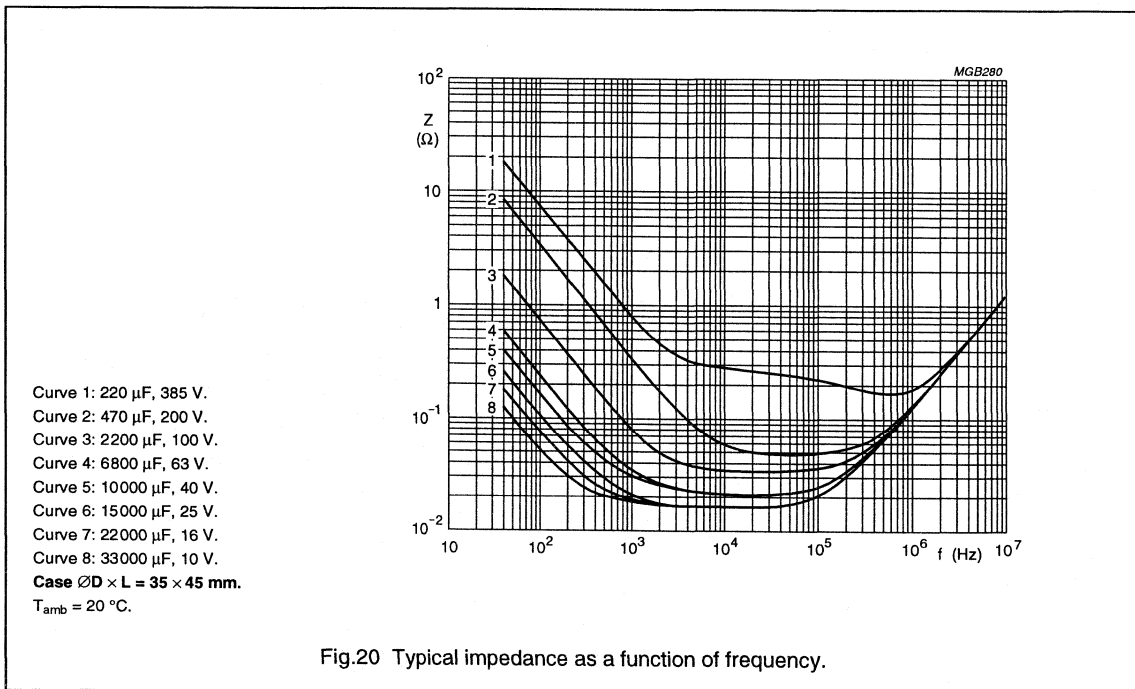
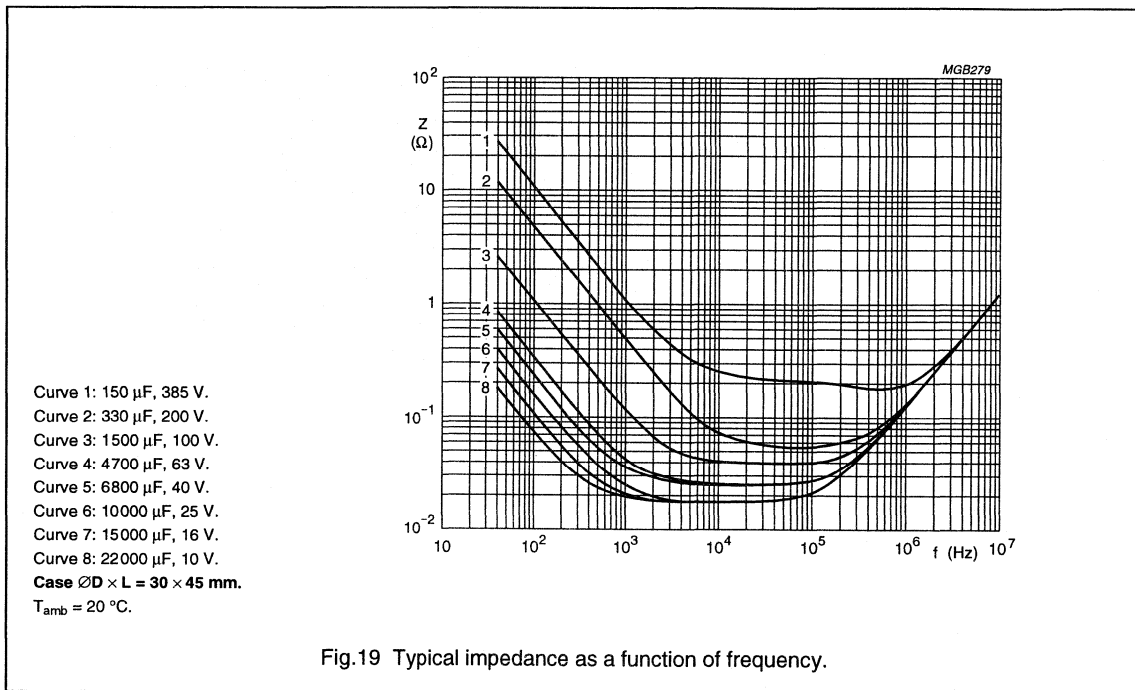
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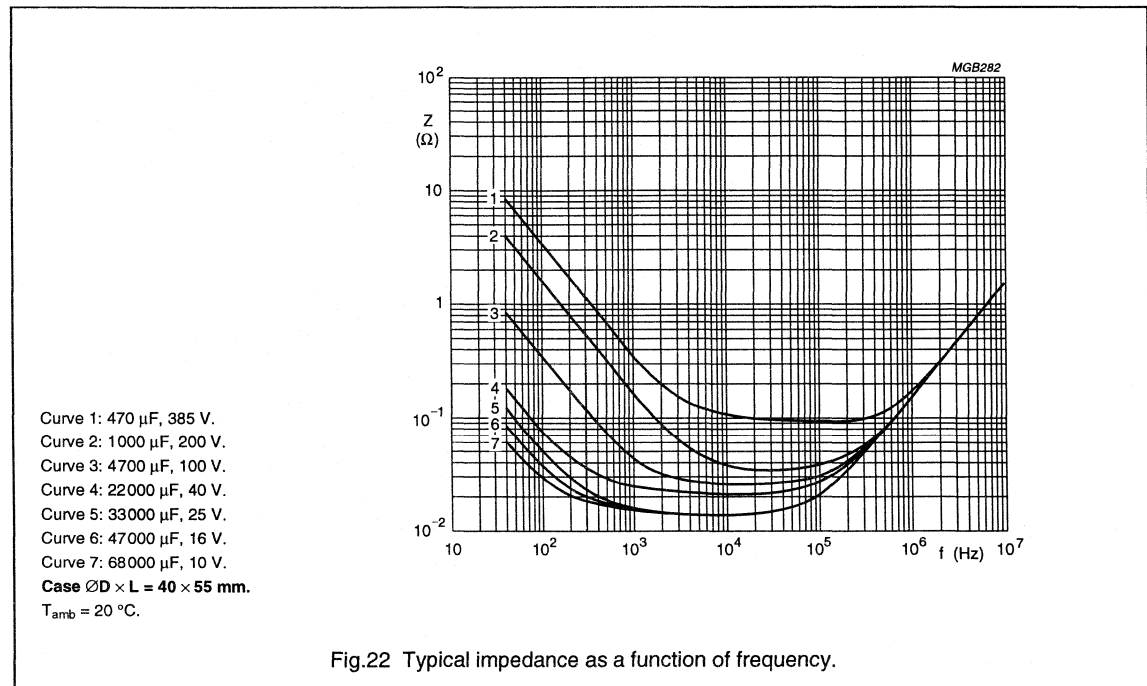
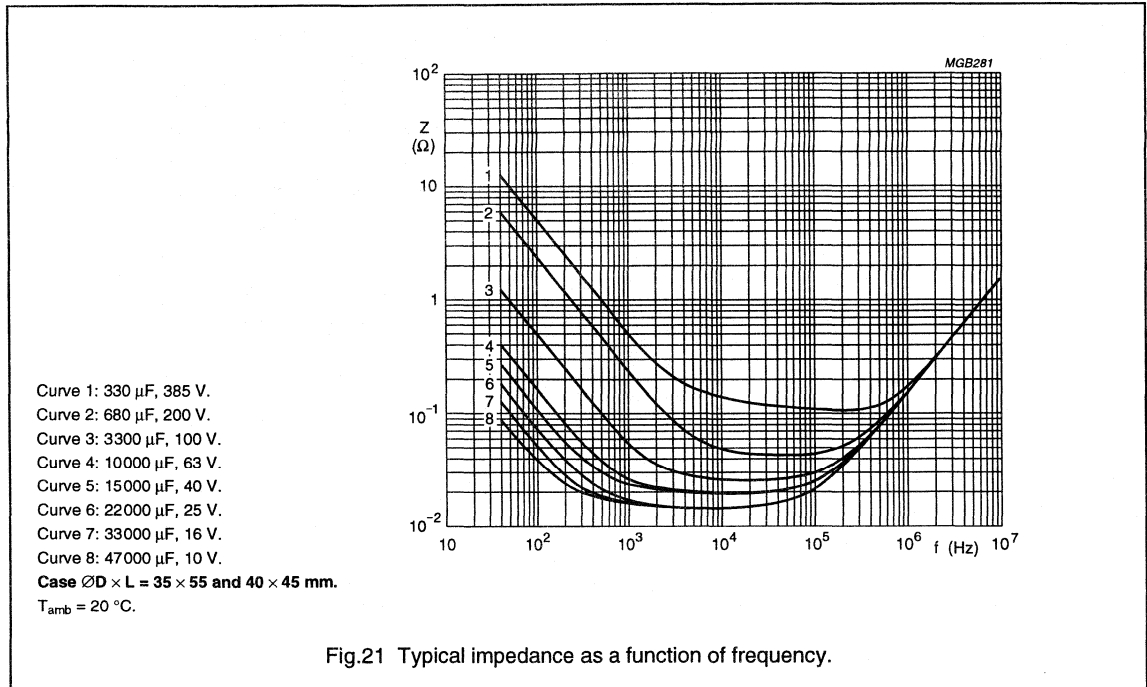
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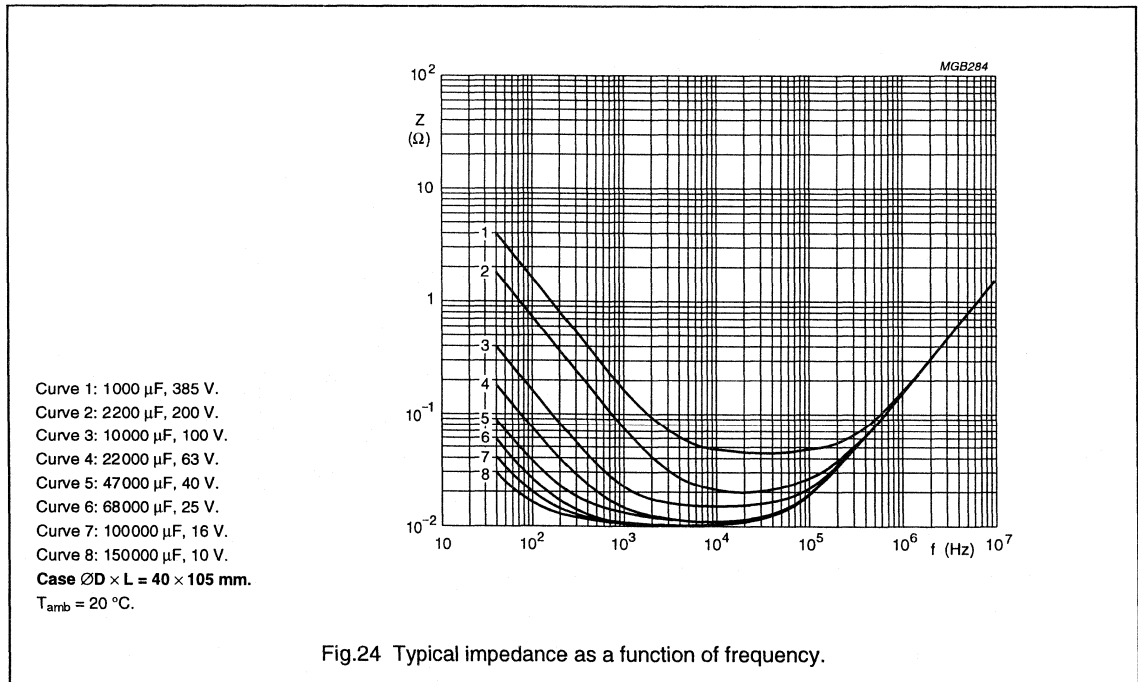
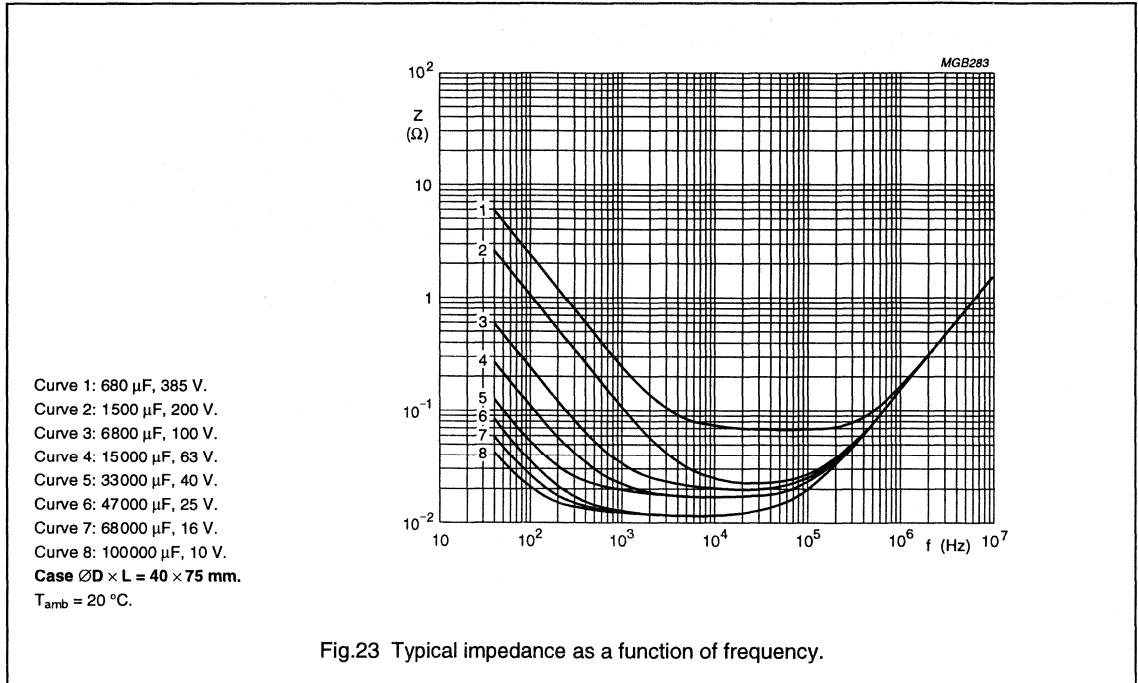
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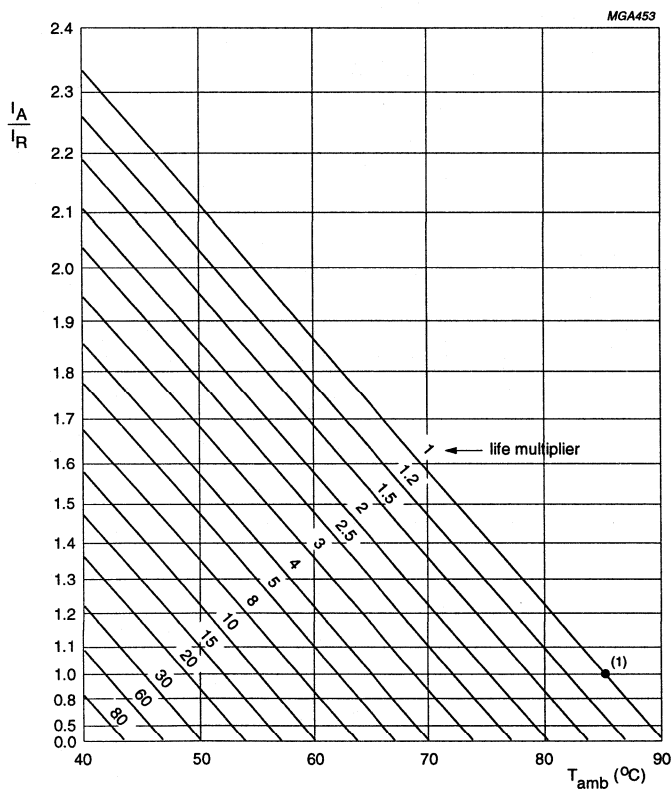
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RIPPLE CURRENT AND USEFUL LIFE

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.

Non-solid Al - 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

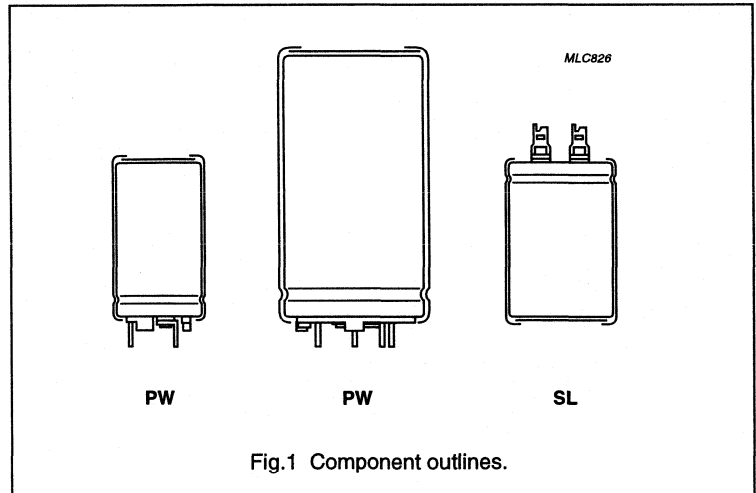
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 5000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 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	$\Delta C/C$: $\pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

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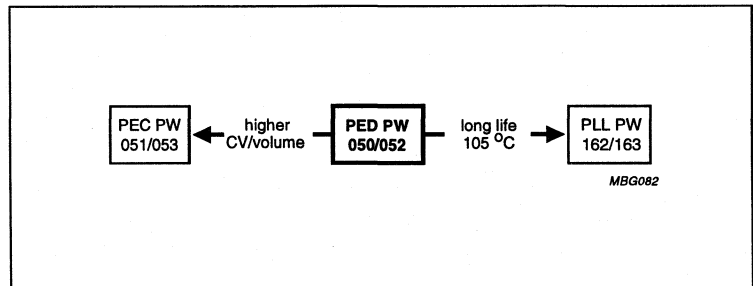
FEATURES

- 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 (PED-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 achieved by a special internal construction.



APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	050	052
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	25 × 35 to 40 × 105	
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, LL grade	
Detail specification	DIN 45910-T129 former DIN 41238	
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)	
Approvals	France: Liste LNZ 4404	

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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 × 35
680	–	–	–	–	–	25 × 45
1000	–	–	–	–	25 × 35	30 × 45
1500	–	–	–	25 × 35	25 × 45	35 × 45
2200	–	–	25 × 35	25 × 45	30 × 45	35 × 55
	–	–	–	–	–	40 × 45
3300	–	25 × 35	25 × 45	30 × 45	35 × 45	40 × 55
4700	25 × 35	25 × 45	30 × 45	35 × 45	35 × 55	40 × 75
	–	–	–	–	40 × 45	–
6800	25 × 45	30 × 45	35 × 45	35 × 55	40 × 55	40 × 105
	–	–	–	40 × 45	–	–
10000	30 × 45	35 × 45	35 × 55	40 × 55	40 × 75	–
	–	–	40 × 45	–	–	–
15000	35 × 45	35 × 55	40 × 55	40 × 75	40 × 105	–
	–	40 × 45	–	–	–	–
22000	35 × 55	40 × 55	40 × 75	40 × 105	–	–
	40 × 45	–	–	–	–	–
33000	40 × 55	40 × 75	40 × 105	–	–	–
47000	40 × 75	40 × 105	–	–	–	–
68000	40 × 105	–	–	–	–	–

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 052 series

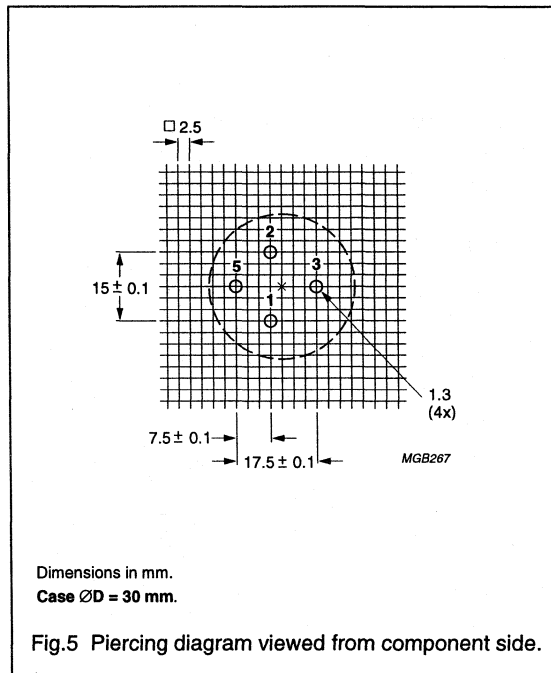
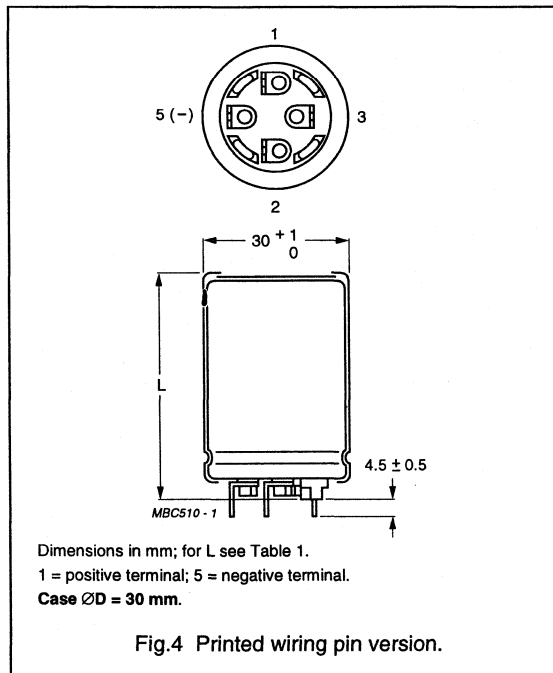
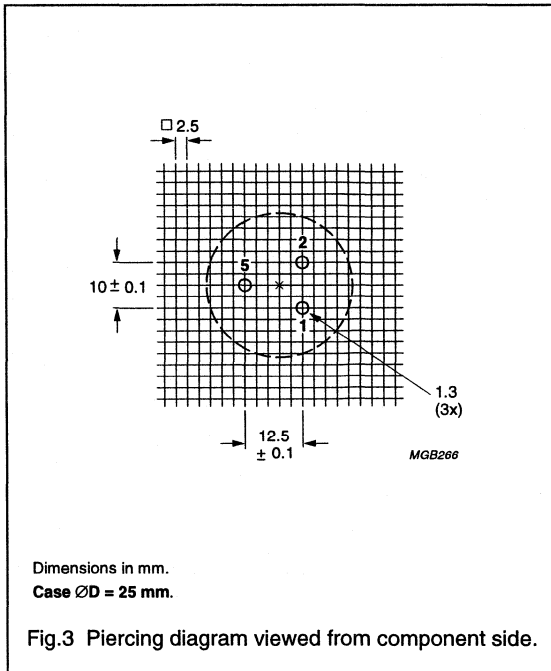
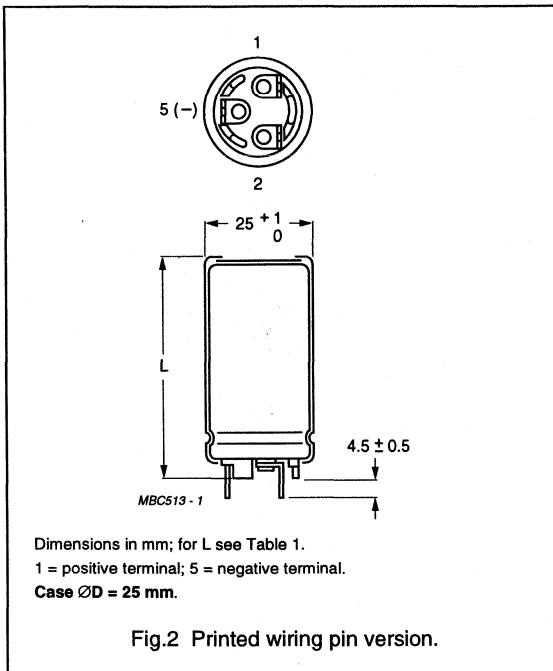
Preferred types in **bold**.

C_R (μF)	U_R (V)		
	250	385	400
47	–	25 × 35	25 × 35
68	–	25 × 45	25 × 45
100	25 × 35	30 × 45	30 × 45
150	25 × 45	35 × 45	35 × 45
220	30 × 45	35 × 55	35 × 55
	–	40 × 45	40 × 45
330	35 × 45	40 × 55	40 × 55
470	35 × 55	40 × 75	40 × 75
	40 × 45	–	–
680	40 × 55	–	40 × 105
1000	40 × 75	–	–

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MECHANICAL DATA AND PACKAGING QUANTITIES



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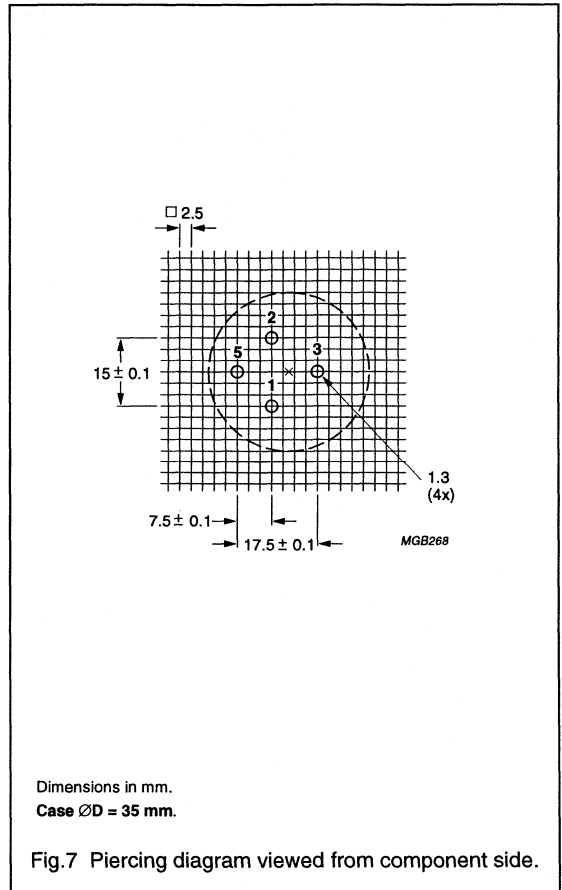
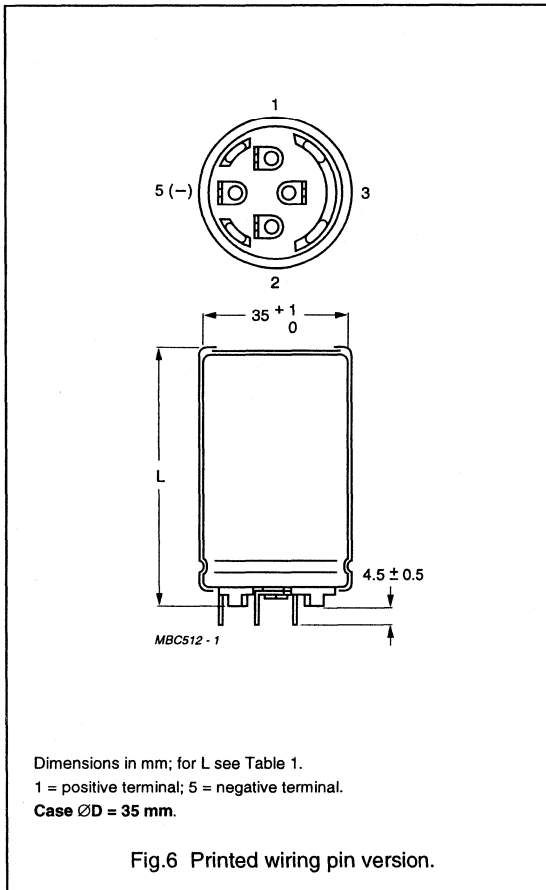
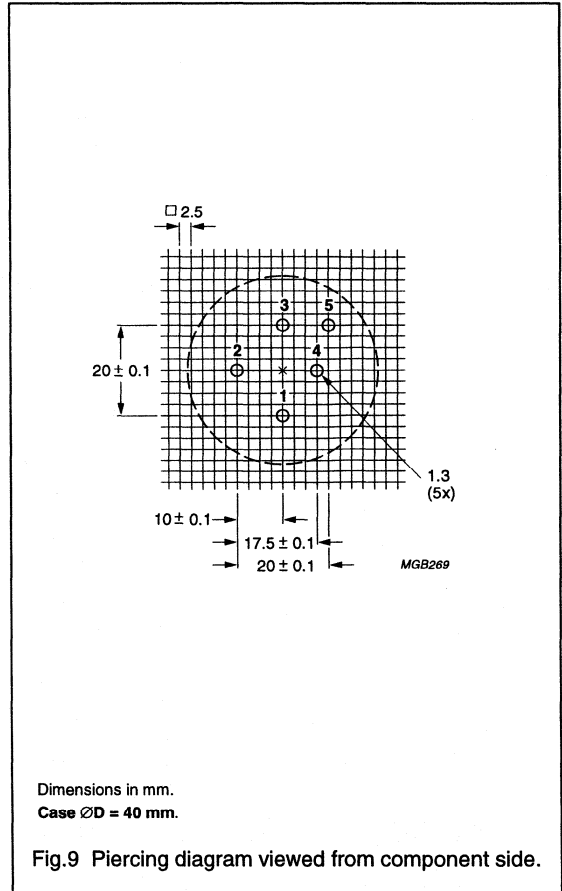
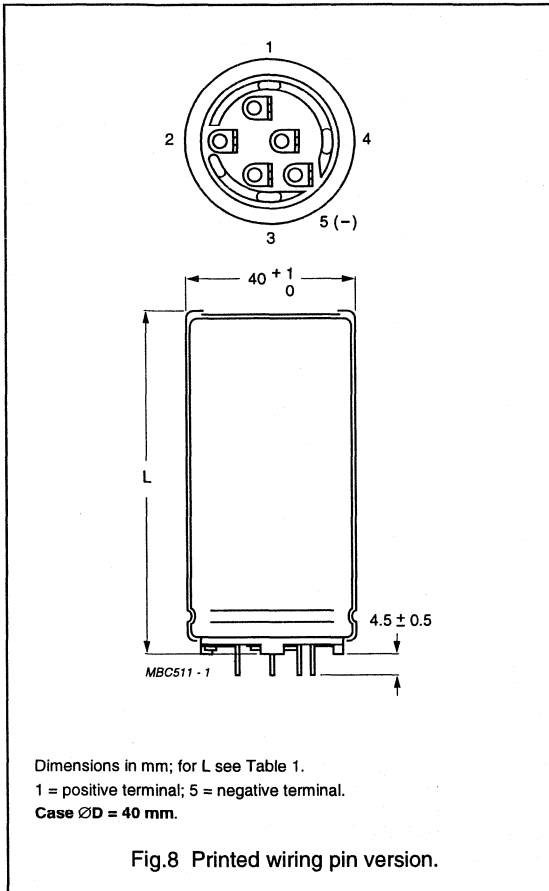


Table 1 PW versions; physical dimensions, mass and packaging information; see Figs 2, 4, 6 and 8

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	BOX DIMENSIONS $l \times w \times h$ (mm)
25 × 35	26	39.3	≈24	100	290 × 280 × 49
25 × 45	26	49.3	≈28	100	290 × 280 × 59
30 × 45	31	49.3	≈38	100	340 × 330 × 59
35 × 45	36	49.3	≈51	50	390 × 198 × 59
35 × 55	36	59.3	≈66	50	390 × 198 × 69
40 × 45	41	49.3	≈78	50	440 × 223 × 59
40 × 55	41	59.3	≈82	50	440 × 223 × 69
40 × 75	41	79.3	≈110	50	440 × 223 × 89
40 × 105	41	109.3	≈176	50	440 × 223 × 119

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Mounting

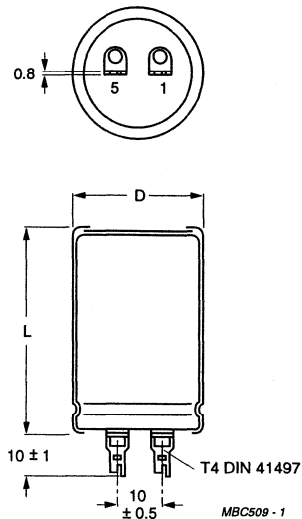
When a number of capacitors are connected in a bank, they must not be closer together than 15 mm, when no derating of ripple current and/or temperature is applied.

Pin numbers 2, 3 and 4 (if present) must be free from the electrical circuit.

Non-solid Al - electrolytic capacitors

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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 $\varnothing D \times L$ (mm)	$\varnothing D_{\max}$ (mm)	L_{\max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	BOX DIMENSIONS $l \times w \times h$ (mm)
25 × 35	26	36.3	≈24	100	290 × 280 × 69
25 × 45	26	46.3	≈28	100	290 × 280 × 79
30 × 45	31	46.3	≈38	100	340 × 330 × 79
35 × 45	36	46.3	≈51	50	390 × 198 × 79
35 × 55	36	56.3	≈66	50	390 × 198 × 89
40 × 55	41	56.3	≈82	50	440 × 223 × 89
40 × 75	41	76.3	≈110	50	440 × 223 × 109
40 × 105	41	106.3	≈176	50	440 × 223 × 139

Non-solid Al - electrolytic capacitors

Power Eurodin Printed Wiring

PED-PW 050/052

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 3 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
I_R	rated RMS ripple current at 100 Hz, 85 °C or at 20 kHz, 70 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	max. equivalent series resistance at 100 Hz
Z	max. impedance at 10 kHz

Ordering example

Electrolytic capacitor
PED-PW 050

10000 $\mu\text{F}/25\text{ V}$; $-10/+30\%$

Nominal case size: $\varnothing 35 \times 55\text{ mm}$;
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 °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
10	4700	25 × 35	2.4	4.6	0.28	0.10	74	50	050 54472
	6800	25 × 45	3.2	6.1	0.41	0.14	51	37	050 54682
	10000	30 × 45	3.8	7.2	0.60	0.20	39	29	050 54103
	15000	35 × 45	4.1	7.8	0.90	0.30	35	26	050 54153
	22000	35 × 55	5.0	9.5	1.32	0.44	27	21	050 54223
	22000	40 × 45	4.2	8.0	1.32	0.44	36	27	050 44223
	33000	40 × 55	5.0	9.5	1.98	0.66	29	22	050 54333
	47000	40 × 75	6.8	12.9	2.82	0.94	20	17	050 54473
68000	40 × 105	9.2	17.5	4.08	1.36	15	14	050 54683	
16	3300	25 × 35	2.4	4.6	0.32	0.11	75	50	050 55332
	4700	25 × 45	3.1	5.9	0.45	0.15	52	37	050 55472
	6800	30 × 45	3.7	7.0	0.65	0.22	40	30	050 55682
	10000	35 × 45	4.1	7.8	0.96	0.32	36	27	050 55103
	15000	35 × 55	5.0	9.5	1.44	0.48	28	21	050 55153
	15000	40 × 45	4.2	8.0	1.44	0.48	36	27	050 45153
	22000	40 × 55	5.0	9.5	2.12	0.71	29	22	050 55223
	33000	40 × 75	6.7	12.7	3.17	1.06	20	17	050 55333
47000	40 × 105	9.1	17.3	4.51	1.51	15	14	050 55473	
25	2200	25 × 35	2.3	4.4	0.33	0.11	78	52	050 56222
	3300	25 × 45	3.1	5.9	0.49	0.17	53	38	050 56332
	4700	30 × 45	3.7	7.0	0.70	0.24	42	31	050 56472
	6800	35 × 45	4.1	7.8	1.02	0.34	37	28	050 56682
	10000	35 × 55	5.0	9.5	1.50	0.50	28	21	050 56103
	10000	40 × 45	4.2	8.0	1.50	0.50	36	27	050 46103
	15000	40 × 55	5.0	9.5	2.25	0.75	29	22	050 56153
	22000	40 × 75	6.8	12.9	3.30	1.10	20	17	050 56223
33000	40 × 105	9.2	17.5	4.95	1.65	15	14	050 56333	

Non-solid Al - 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 100 Hz (m Ω)	Z 10 kHz (m Ω)	CATALOGUE NUMBER (note 1) 2222
40	1500	25 × 35	2.0	3.8	0.36	0.12	112	68	050 57152
	2200	25 × 45	2.7	5.1	0.53	0.18	76	51	050 57222
	3300	30 × 45	3.3	6.3	0.79	0.27	57	41	050 57332
	4700	35 × 45	3.8	7.2	1.13	0.38	48	35	050 57472
	6800	35 × 55	4.7	8.9	1.64	0.55	36	27	050 57682
	6800	40 × 45	4.1	7.8	1.64	0.55	45	33	050 47682
	10000	40 × 55	4.9	9.3	2.40	0.80	35	27	050 57103
	15000	40 × 75	6.6	12.5	3.60	1.20	25	20	050 57153
	22000	40 × 105	9.0	17.1	5.28	1.76	18	16	050 57223
63	1000	25 × 35	1.8	3.4	0.38	0.13	122	74	050 58102
	1500	25 × 45	2.5	4.7	0.57	0.19	83	54	050 58152
	2200	30 × 45	3.1	5.9	0.83	0.28	57	41	050 58222
	3300	35 × 45	3.6	6.8	1.25	0.42	48	35	050 58332
	4700	35 × 55	4.4	8.3	1.78	0.60	36	27	050 58472
	4700	40 × 45	3.8	7.2	1.78	0.60	45	33	050 48472
	6800	40 × 55	4.7	8.9	2.57	0.86	35	27	050 58682
	10000	40 × 75	6.2	11.8	3.78	1.26	25	20	050 58103
15000	40 × 105	8.5	16.1	5.67	1.89	18	16	050 58153	
100	470	25 × 35	1.4	2.7	0.28	0.10	247	172	050 59471
	680	25 × 45	1.9	3.6	0.41	0.14	170	116	050 59681
	1000	30 × 45	2.5	4.7	0.60	0.20	123	88	050 59102
	1500	35 × 45	3.1	5.8	0.90	0.30	94	71	050 59152
	2200	35 × 55	3.9	7.4	1.32	0.44	69	55	050 59222
	2200	40 × 45	3.6	6.8	1.32	0.44	81	65	050 49222
	3300	40 × 55	4.6	8.7	1.98	0.66	59	48	050 59332
	4700	40 × 75	6.2	11.7	2.82	0.94	42	36	050 59472
6800	40 × 105	8.2	15.5	4.08	1.36	32	28	050 59682	

Note

- Catalogue number applies to the PW versions; for SL versions (not preferred) available in 050 series only (case size $\varnothing 40 \times 45$ mm not available) replace the 8th digit by '1': SL versions: 2222 050 1....

Non-solid Al - electrolytic capacitors

Power Eurodin Printed Wiring

PED-PW 050/052

Table 4 Electrical data and ordering information for 052 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
250	100	25 × 35	0.6	1.15	0.15	0.05	1800	1300	052 53101
	150	25 × 45	0.8	1.5	0.23	0.08	1100	850	052 53151
	220	30 × 45	1.0	1.9	0.33	0.11	750	550	052 53221
	330	35 × 45	1.4	2.65	0.49	0.17	500	400	052 53331
	470	35 × 55	1.8	3.4	0.70	0.24	360	290	052 53471
	470	40 × 45	1.8	3.4	0.70	0.24	420	350	052 43471
	680	40 × 55	2.3	4.4	1.02	0.34	250	190	052 53681
	1000	40 × 75	3.0	5.7	1.50	0.50	170	140	052 53102
385	47	25 × 35	0.5	0.94	0.11	0.04	2370	1550	052 58479
	68	25 × 45	0.67	1.27	0.16	0.06	1640	1100	052 58689
	100	30 × 45	0.84	1.59	0.23	0.08	1275	950	052 58101
	150	35 × 45	1.13	2.14	0.34	0.11	850	635	052 58151
	220	35 × 55	1.48	2.8	0.50	0.17	580	430	052 58221
	220	40 × 45	1.48	2.8	0.50	0.17	580	430	052 48221
	330	40 × 55	1.97	3.73	0.75	0.25	385	300	052 58331
470	40 × 75	2.7	5.11	1.06	0.36	270	215	052 58471	
400	47	25 × 35	0.47	0.89	0.11	0.04	2700	2125	052 56479
	68	25 × 45	0.63	1.29	0.16	0.06	1875	1470	052 56689
	100	30 × 45	0.84	1.59	0.24	0.08	1275	1000	052 56101
	150	35 × 45	1.13	2.14	0.36	0.12	850	665	052 56151
	220	35 × 55	1.41	2.67	0.52	0.17	650	450	052 56221
	220	40 × 45	1.41	2.67	0.52	0.17	650	450	052 46221
	330	40 × 55	1.86	3.52	0.79	0.26	435	315	052 56331
	470	40 × 75	2.54	4.81	1.12	0.37	305	225	052 56471
680	40 × 105	3.56	6.75	1.63	0.54	210	155	052 56681	

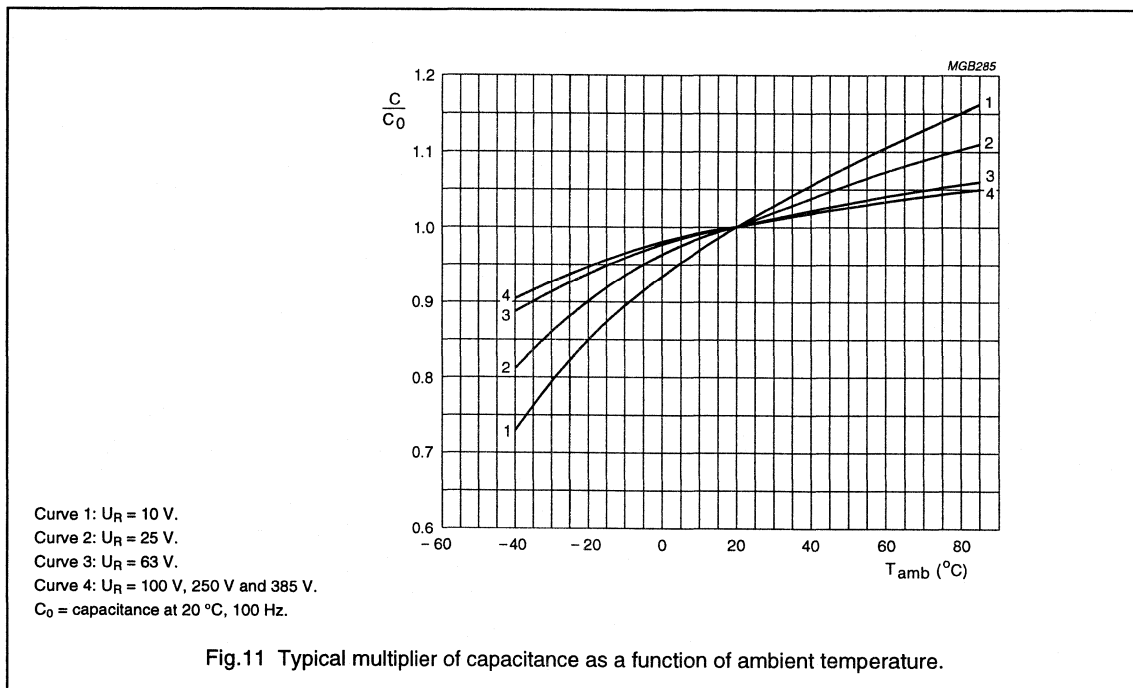
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Additional electrical data

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	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$
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)

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Equivalent series resistance (ESR)

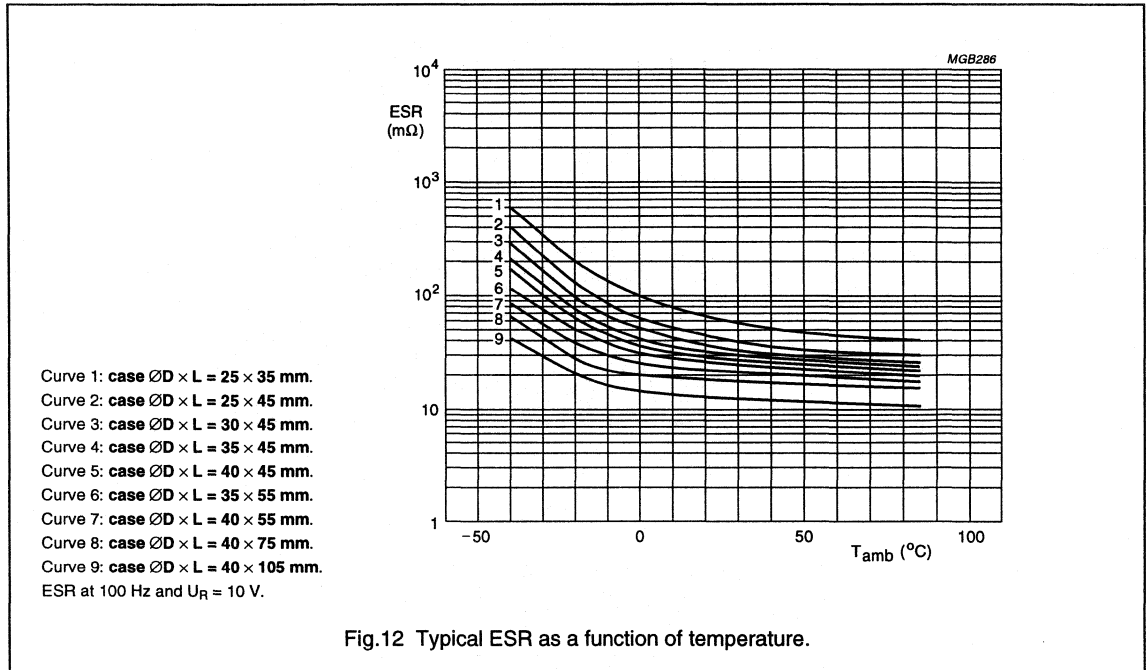


Fig.12 Typical ESR as a function of temperature.

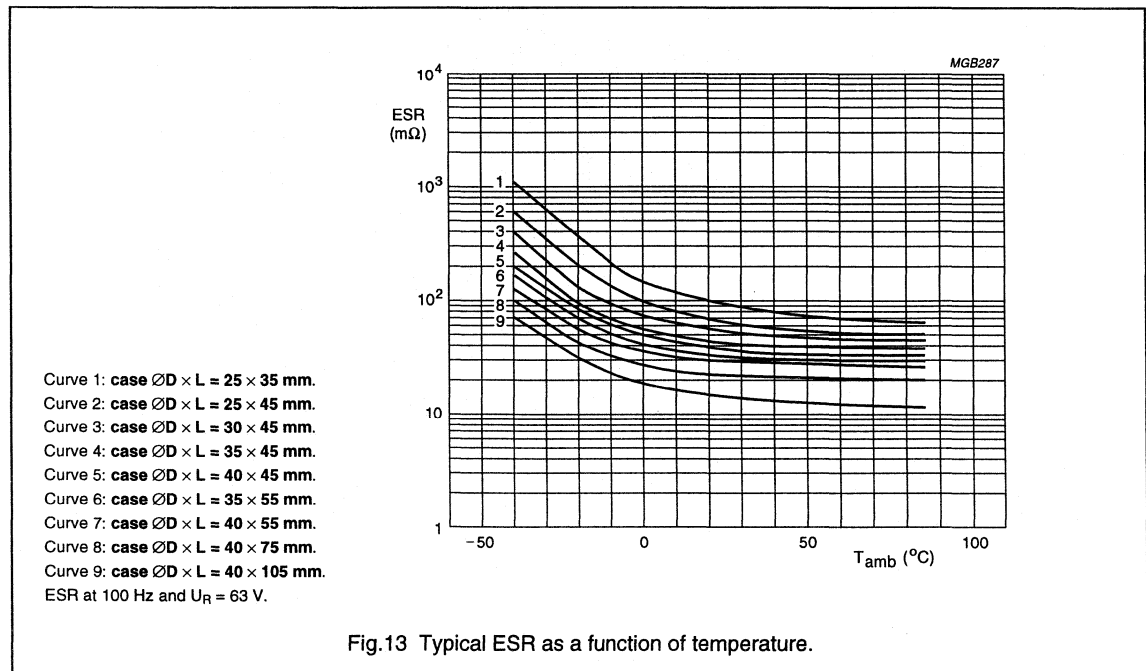
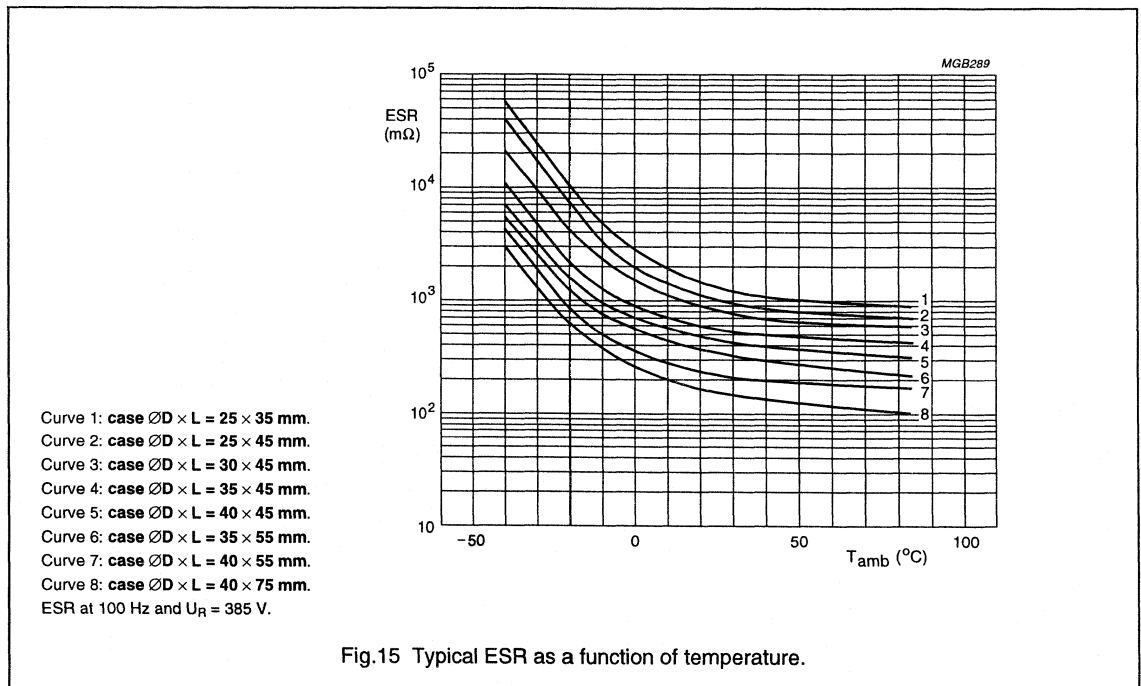
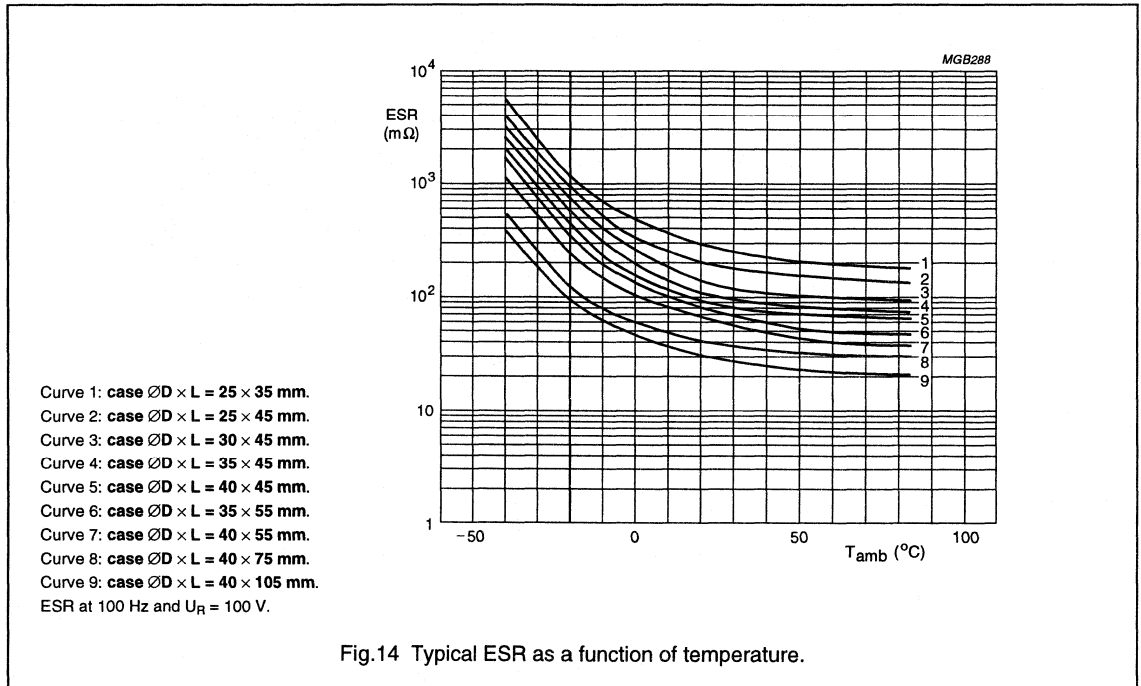


Fig.13 Typical ESR as a function of temperature.

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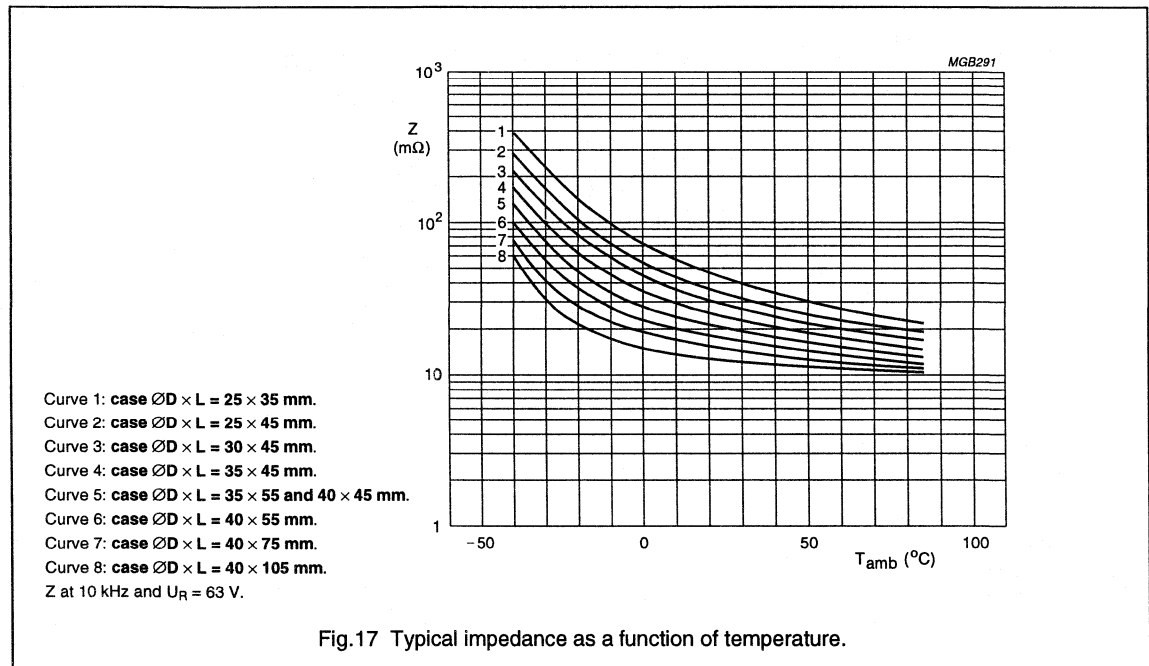
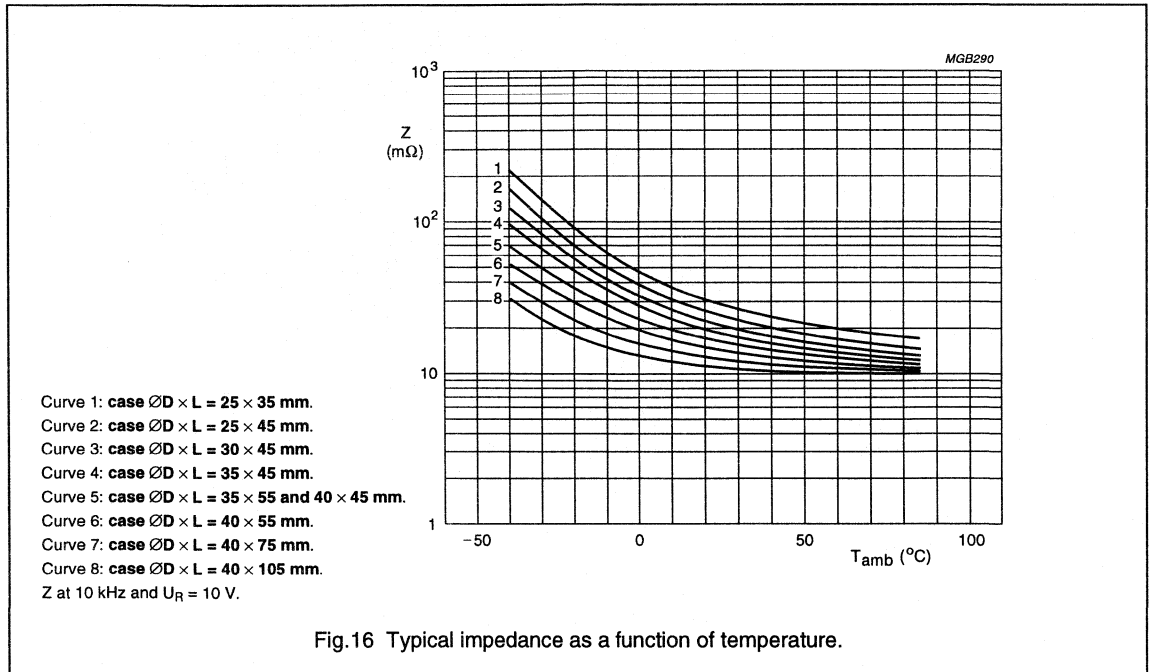


Non-solid Al - electrolytic capacitors

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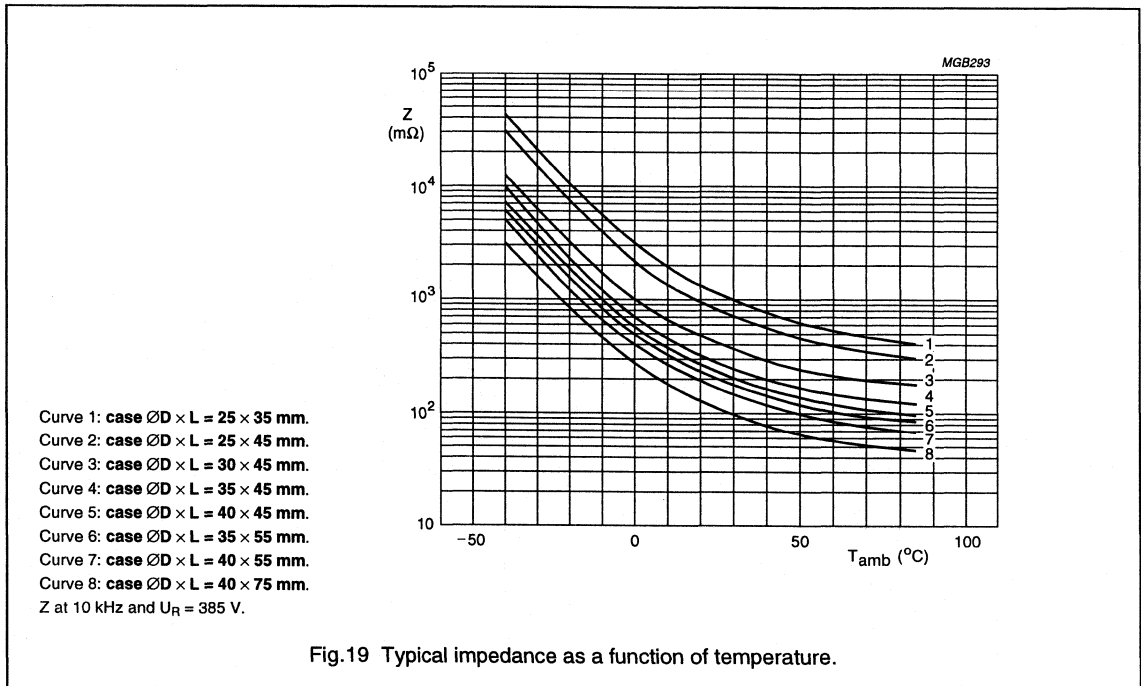
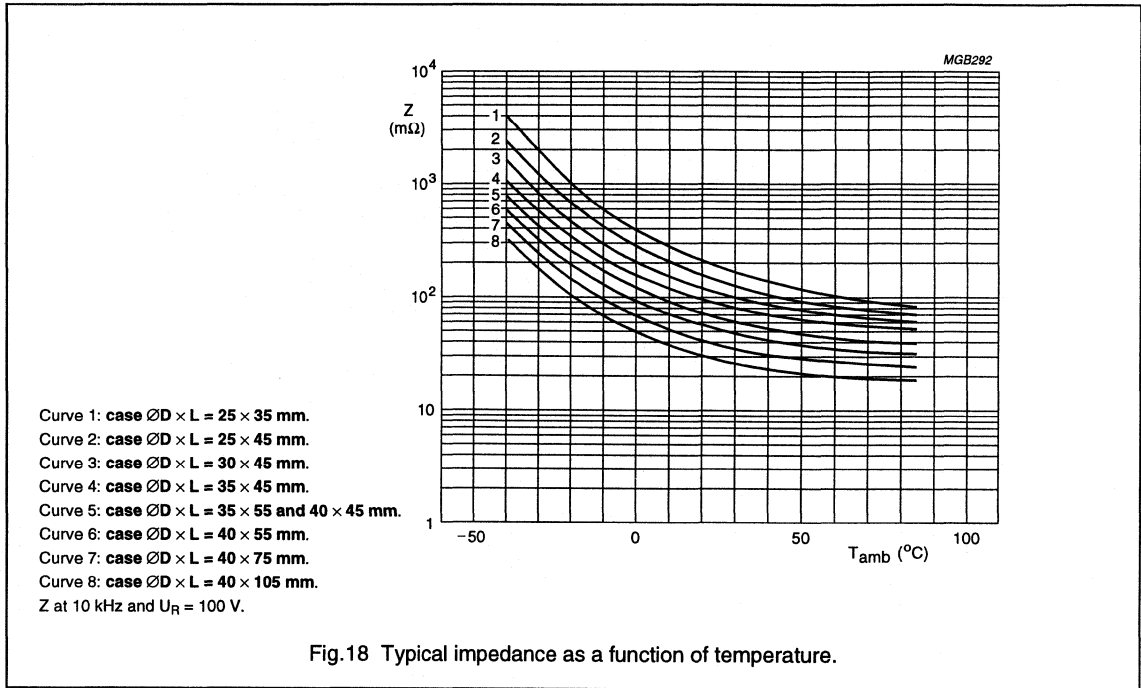
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Impedance (Z)



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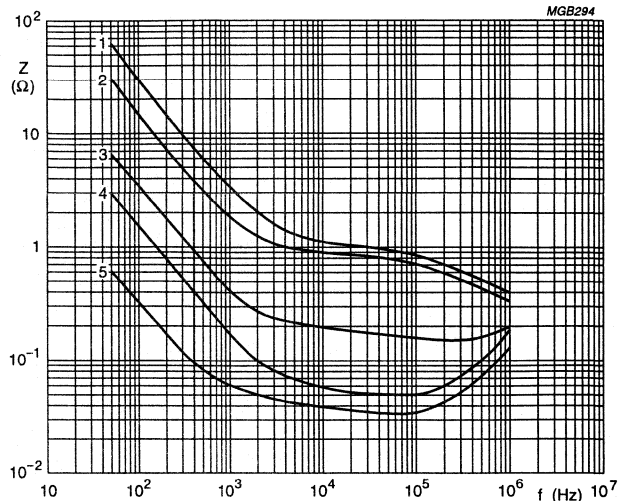
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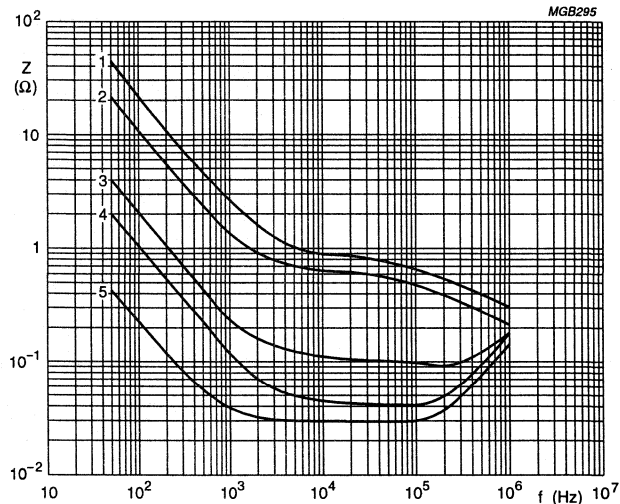
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Curve 1: 47 μ F, 385 V.
 Curve 2: 100 μ F, 250 V.
 Curve 3: 470 μ F, 100 V.
 Curve 4: 1000 μ F, 63 V.
 Curve 5: 4700 μ F, 10 V.
Case \varnothing D \times L = 25 \times 35 mm.
 $T_{amb} = 20$ °C.

Fig.20 Typical impedance as a function of frequency.



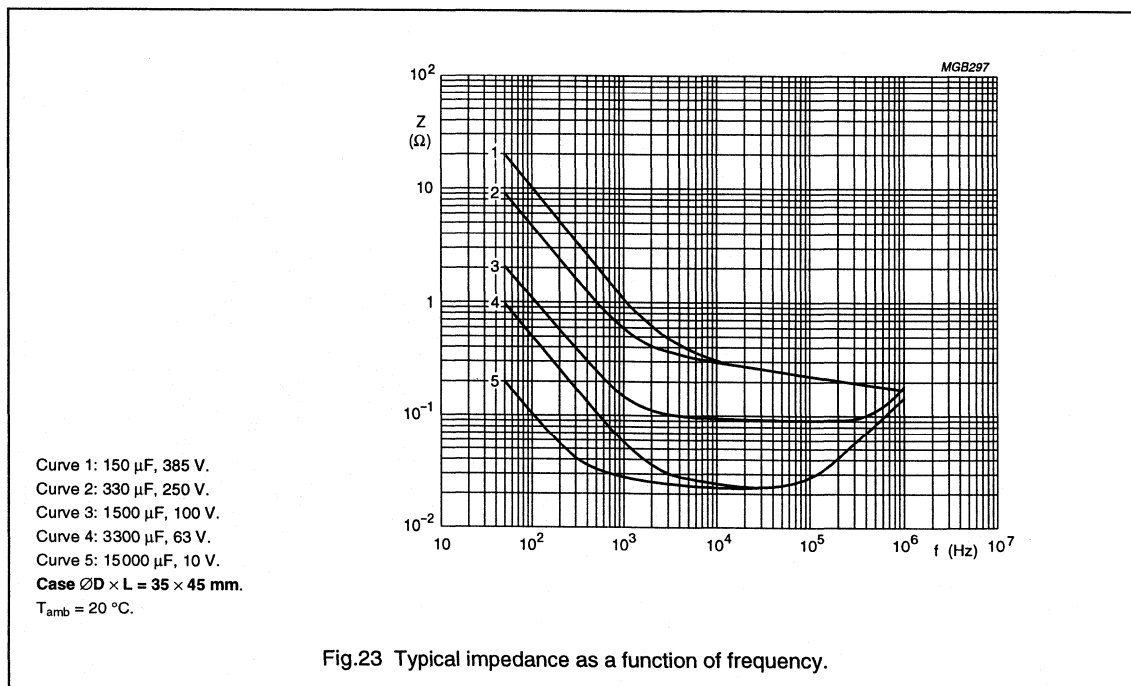
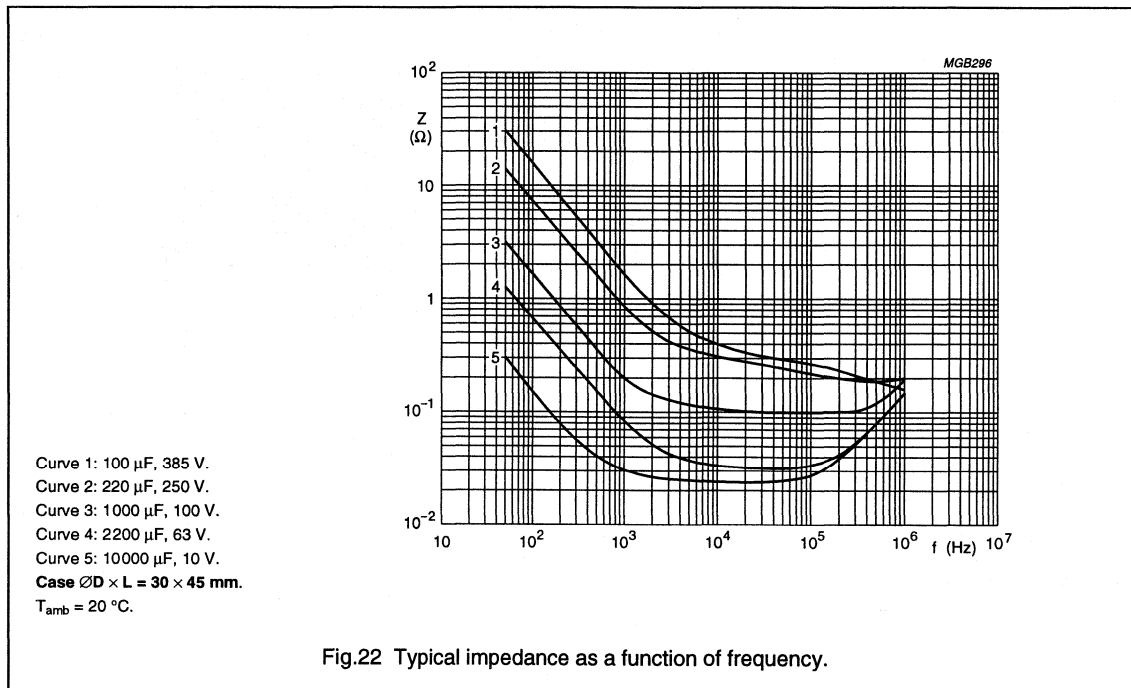
Curve 1: 68 μ F, 385 V.
 Curve 2: 150 μ F, 250 V.
 Curve 3: 680 μ F, 100 V.
 Curve 4: 1500 μ F, 63 V.
 Curve 5: 6800 μ F, 10 V.
Case \varnothing D \times L = 25 \times 45 mm.
 $T_{amb} = 20$ °C.

Fig.21 Typical impedance as a function of frequency.

Non-solid Al - electrolytic capacitors

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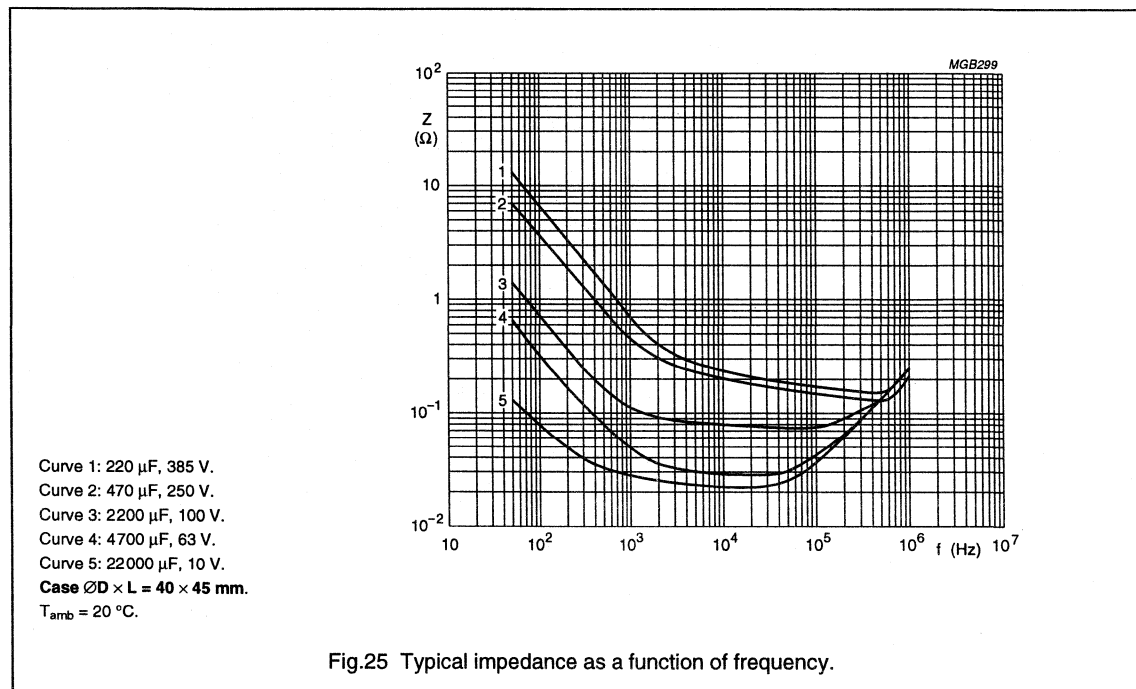
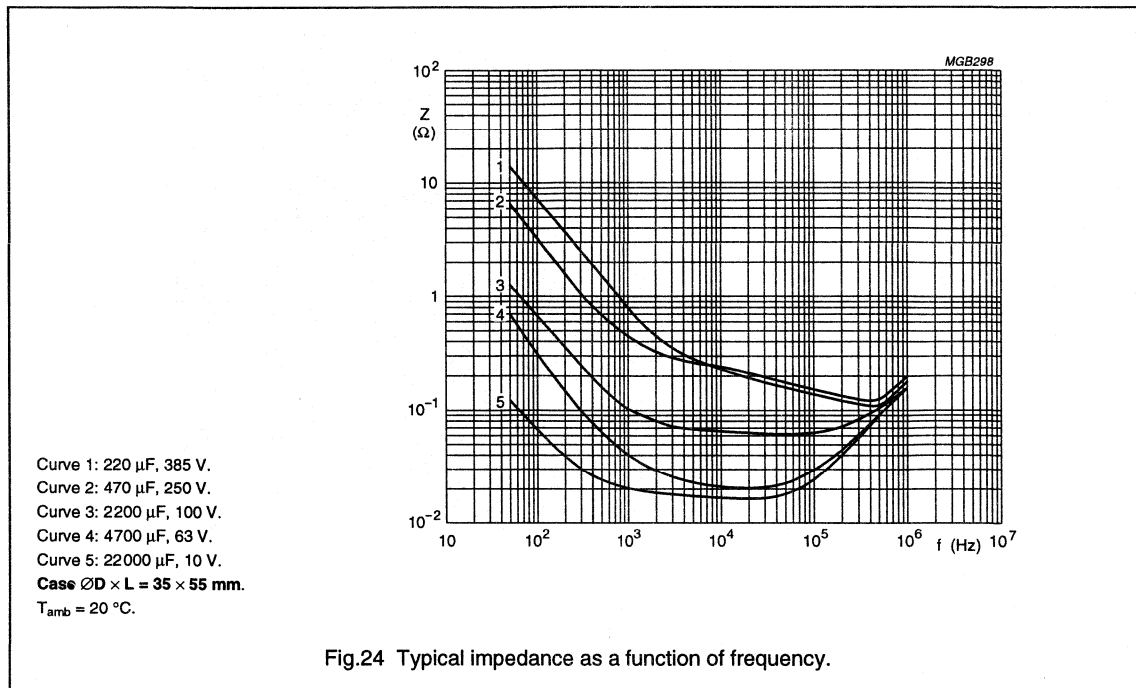
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Non-solid Al - electrolytic capacitors

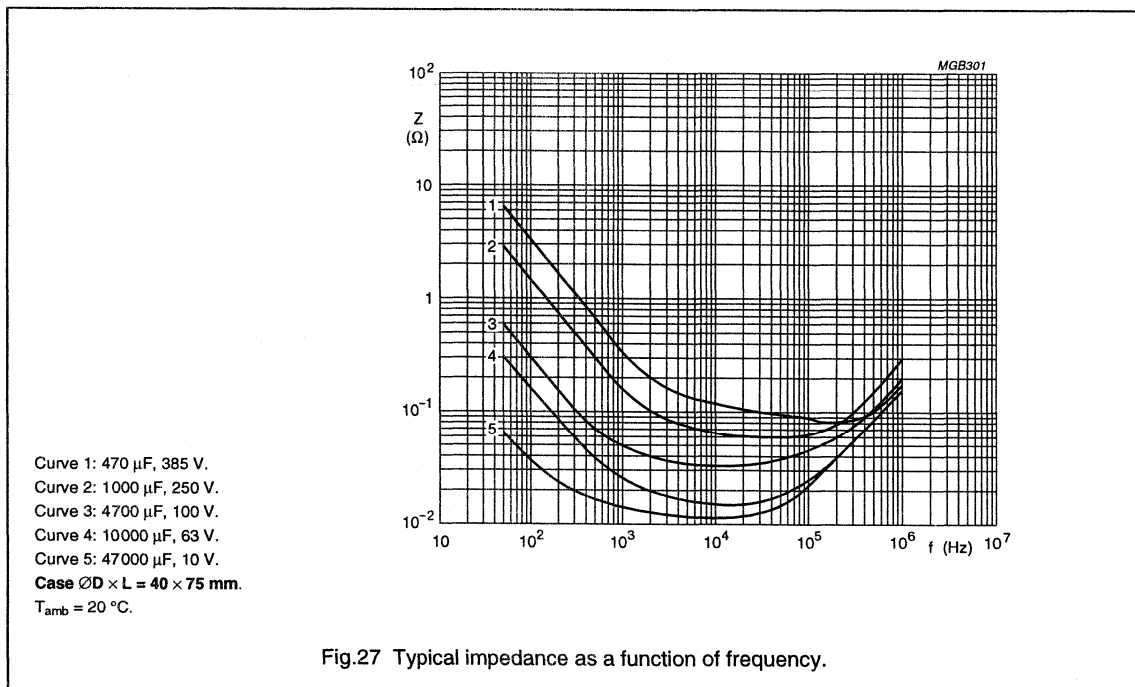
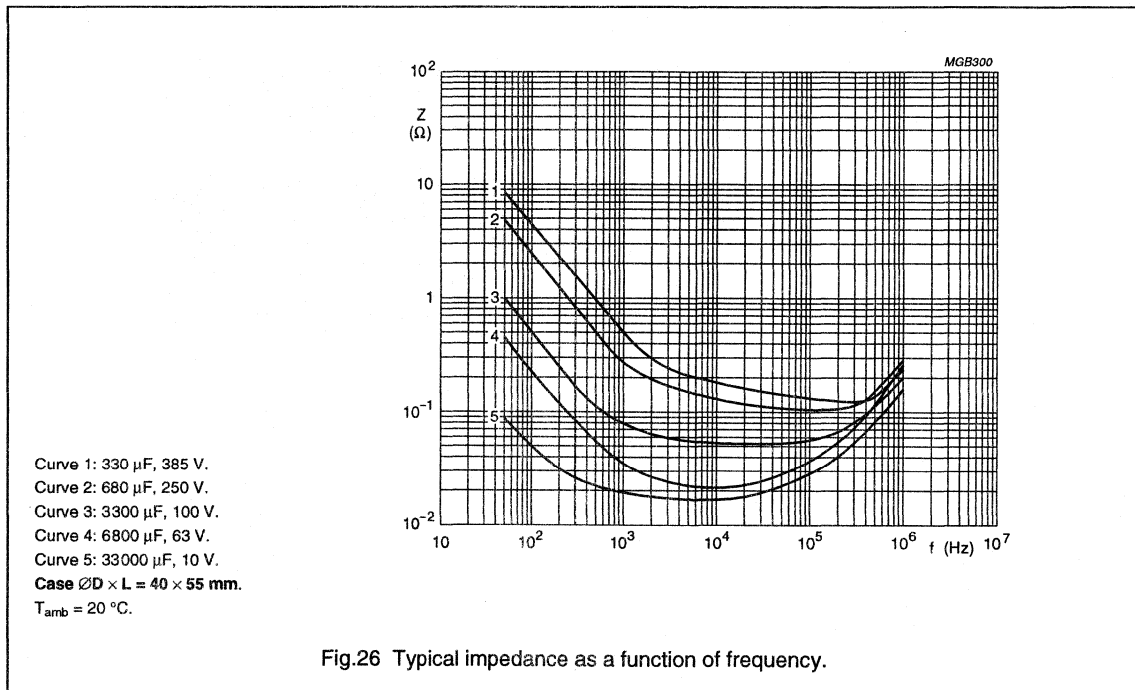
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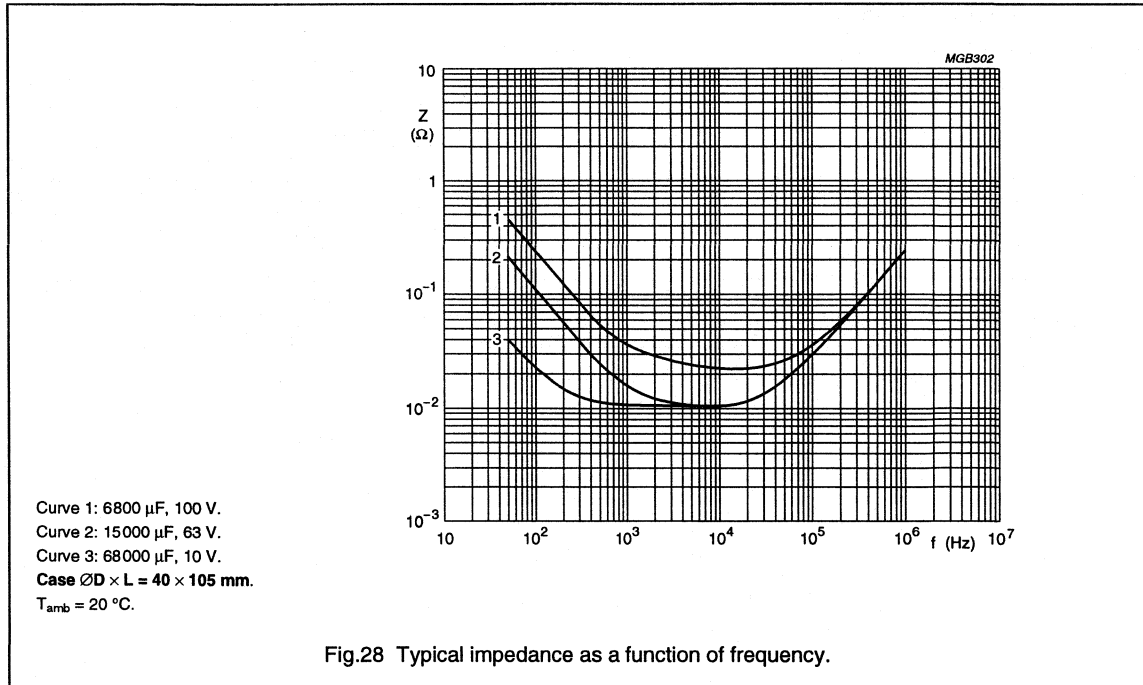
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Non-solid Al - electrolytic capacitors

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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".

P

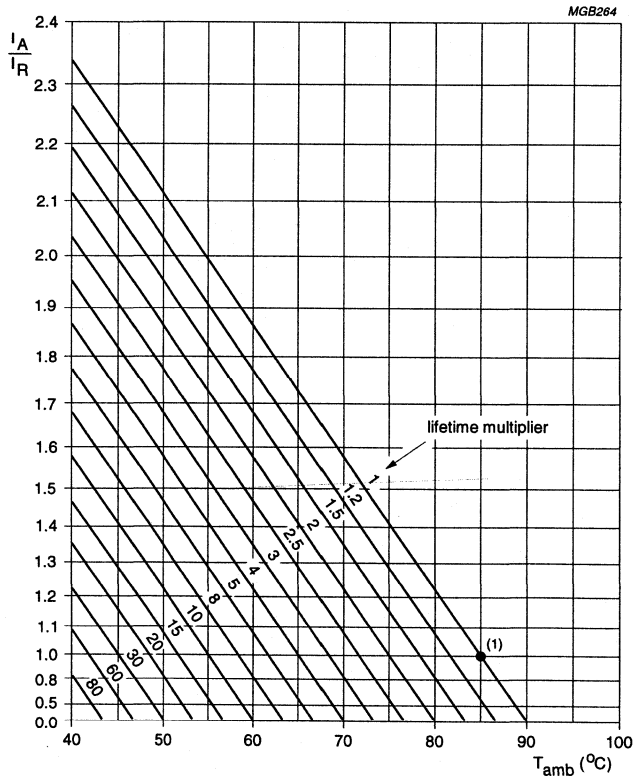
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RIPPLE CURRENT AND USEFUL LIFE

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
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: 15000 hours.

Fig.29 Multiplier of useful life as a function of ambient temperature and ripple current load.

Non-solid Al - electrolytic capacitors

Power Eurodin Printed Wiring

PED-PW 050/052

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	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ °C}$; U_R and I_R applied; 15000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 45\%$ $U_R \leq 100\text{ V}$; $\Delta C/C: \pm 30\%$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ 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	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Non-solid Al - electrolytic capacitors

Power Long Life Printed Wiring

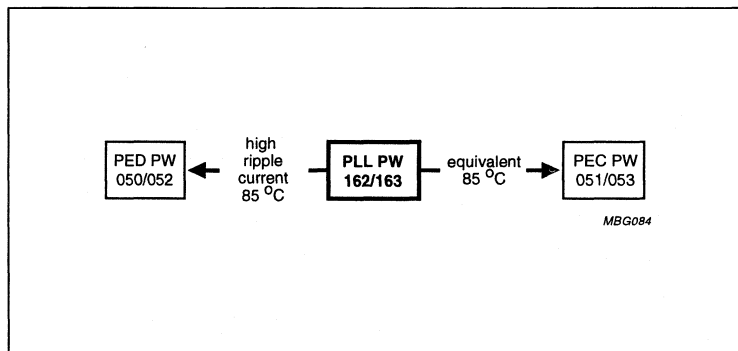
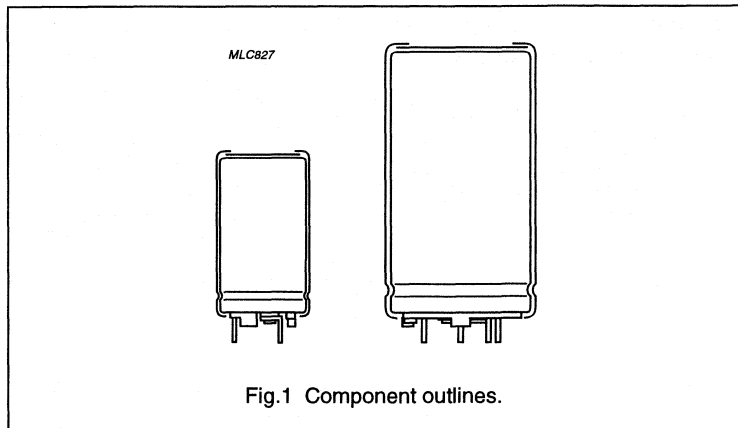
PLL-PW 162/163

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- 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 achieved by a special internal construction.

APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	162	163
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	25 × 35 to 40 × 105	
Rated capacitance range (E6 series), C_R	470 to 150000 μF	68 to 3300 μF
Tolerance on C_R	±20%	
Rated voltage range, U_R	10 to 100 V	200 to 400 V
Category temperature range	-40 to +105 °C	
Endurance test at 105 °C	2000 hours	
Useful life at 105 °C	5000 hours	
Useful life at 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, LL grade	
Detail specification	similar to DIN 45910-T129, former DIN 41238	
Climatic category IEC 68 (DIN 40040)	40/105/56 (GMF)	

Non-solid Al - electrolytic capacitors

Power Long Life Printed Wiring

PLL-PW 162/163

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 × 35
680	–	–	–	–	–	25 × 45
1000	–	–	–	–	25 × 35	30 × 45
1500	–	–	–	–	25 × 45	35 × 45
2200	–	–	–	25 × 35	30 × 45	35 × 55
	–	–	–	–	–	40 × 45
3300	–	–	–	25 × 45	35 × 45	40 × 55
4700	–	–	25 × 35	30 × 45	35 × 55	40 × 75
	–	–	–	–	40 × 45	–
6800	–	25 × 35	25 × 45	35 × 45	40 × 55	40 × 105
10000	25 × 35	25 × 45	30 × 45	35 × 55	40 × 75	–
	–	–	–	40 × 45	–	–
15000	25 × 45	30 × 45	35 × 45	40 × 55	40 × 105	–
22000	30 × 45	35 × 45	35 × 55	40 × 75	–	–
	–	–	40 × 45	–	–	–
33000	35 × 45	35 × 55	40 × 55	40 × 105	–	–
	–	40 × 45	–	–	–	–
47000	35 × 55	40 × 55	40 × 75	–	–	–
	40 × 45	–	–	–	–	–
68000	40 × 55	40 × 75	40 × 105	–	–	–
100000	40 × 75	40 × 105	–	–	–	–
150000	40 × 105	–	–	–	–	–

Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 163 series

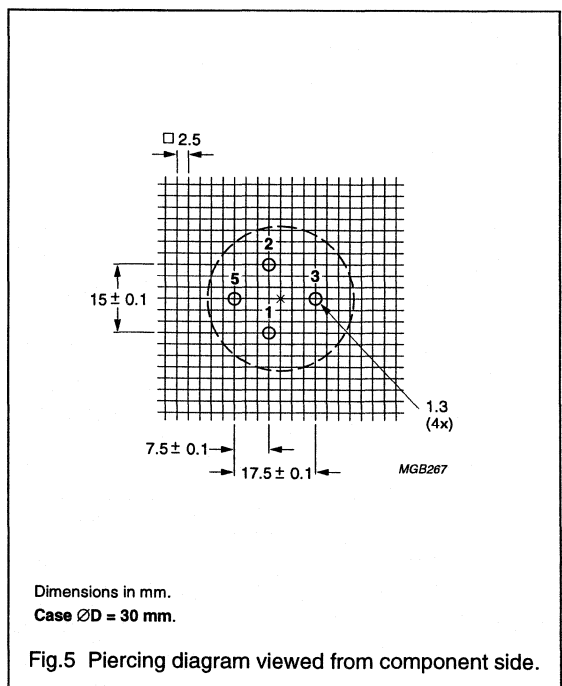
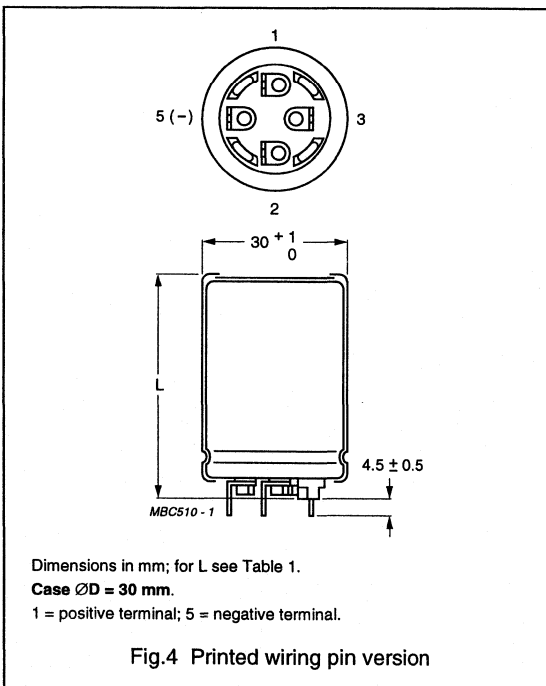
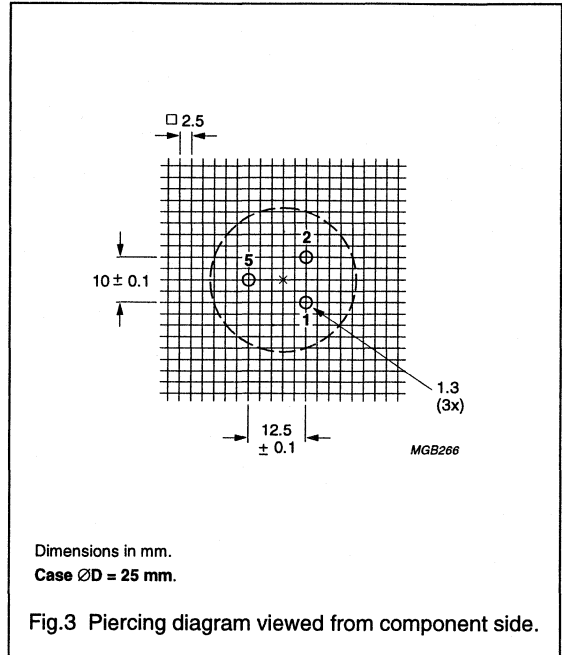
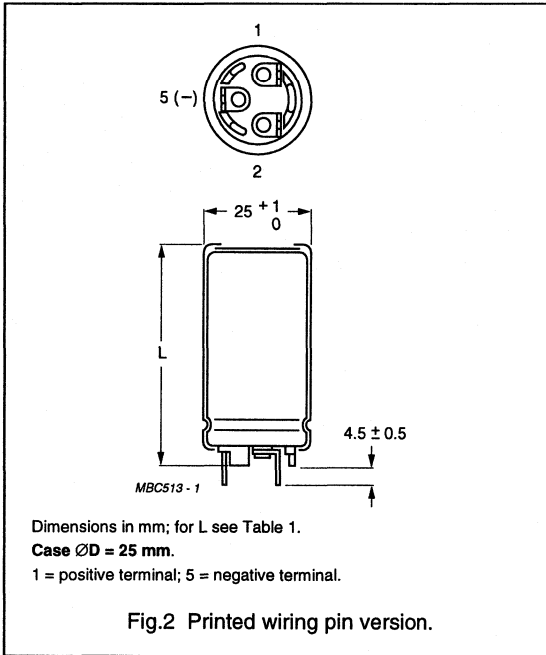
Preferred types in bold.

C_R (μF)	U_R (V)			
	200	250	385	400
68	–	–	25 × 35	25 × 35
100	–	25 × 35	25 × 45	25 × 45
150	25 × 35	25 × 45	30 × 45	30 × 45
220	25 × 45	30 × 45	35 × 45	35 × 45
330	30 × 45	35 × 45	35 × 55	35 × 55
	–	–	40 × 45	40 × 45
470	35 × 45	35 × 55	40 × 55	40 × 55
	–	40 × 45	–	–
680	35 × 55	40 × 55	40 × 75	40 × 75
	40 × 55	–	–	–
1000	40 × 55	40 × 75	40 × 105	40 × 105
1500	40 × 75	40 × 105	–	–
2200	40 × 105	–	–	–

Non-solid Al - electrolytic capacitors Power Long Life Printed Wiring

PLL-PW 162/163

MECHANICAL DATA AND PACKAGING QUANTITIES



Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

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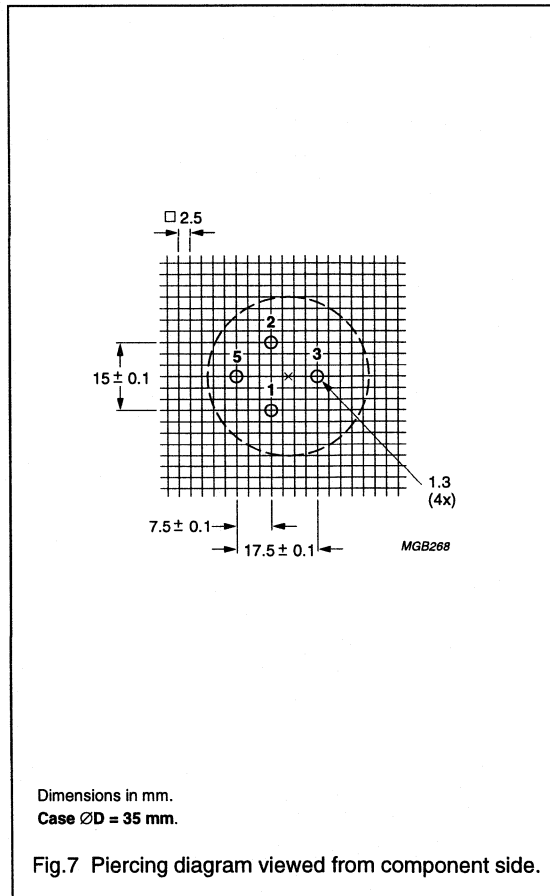
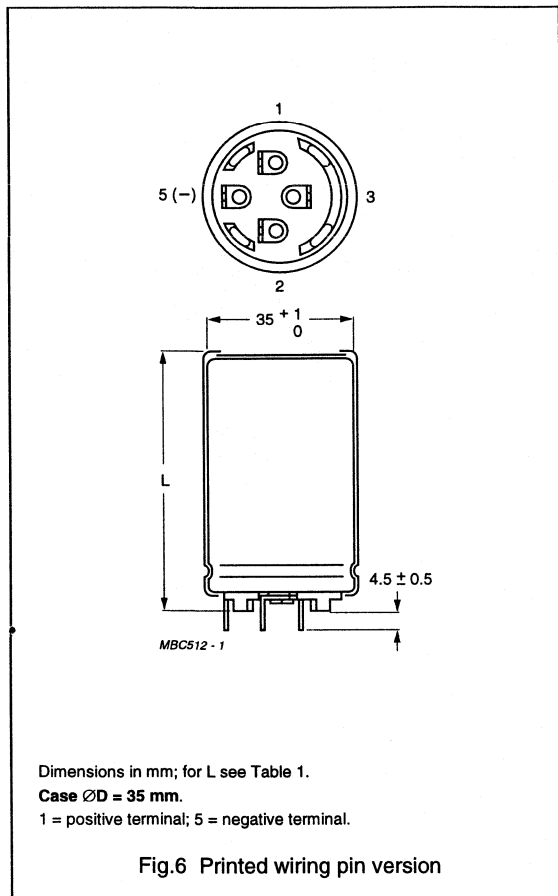


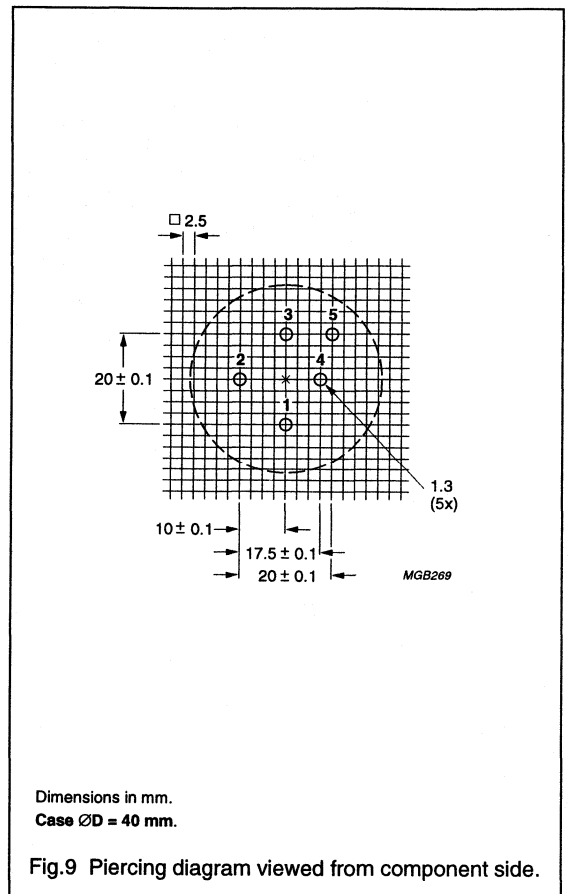
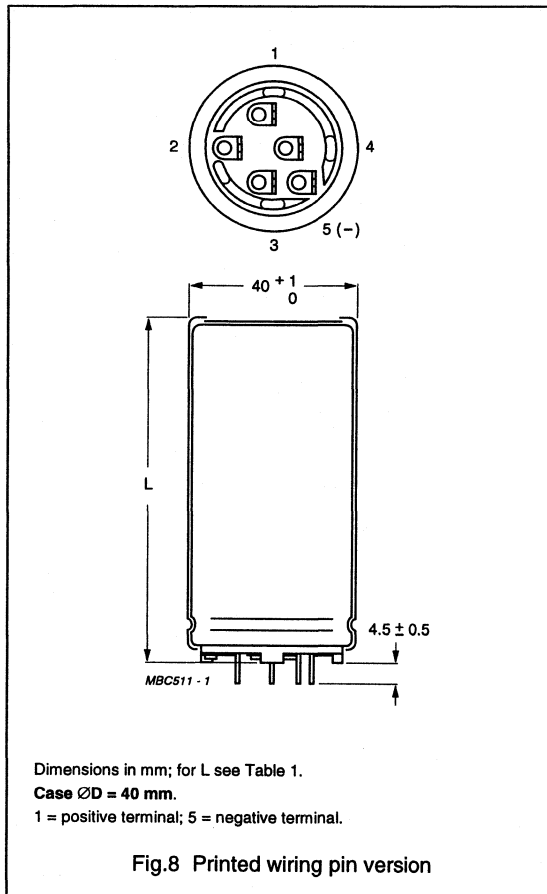
Table 1 Physical dimensions, mass and packaging information; see Figs 2, 4 and 6

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	BOX DIMENSIONS $l \times w \times h$ (mm)
25 x 35	26	39.3	≈24	100	290 x 280 x 49
25 x 45	26	49.3	≈28	100	290 x 280 x 59
30 x 45	31	49.3	≈38	100	340 x 330 x 59
35 x 45	36	49.3	≈51	50	390 x 198 x 59
35 x 55	36	59.3	≈66	50	390 x 198 x 69
40 x 45	41	49.3	≈78	50	440 x 223 x 59
40 x 55	41	59.3	≈82	50	440 x 223 x 69
40 x 75	41	79.3	≈110	50	440 x 223 x 89
40 x 105	41	109.3	≈176	50	440 x 223 x 119

P

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

PLL-PW 162/163



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.

Non-solid Al - electrolytic capacitors

Power Long Life Printed Wiring

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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 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
PLL-PW 162

10000 $\mu\text{F}/25\text{ V}$; $\pm 20\%$

Nominal case size: $\varnothing 30 \times 45\text{ mm}$

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 $85\text{ }^{\circ}\text{C}$ (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 × 35	3.17	0.60	0.20	48	37	162 54103
	15000	25 × 45	4.21	0.90	0.30	34	27	162 54153
	22000	30 × 45	5.05	1.32	0.44	29	23	162 54223
	33000	35 × 45	5.63	1.98	0.66	27	22	162 54333
	47000	35 × 55	6.19	2.82	0.94	26	21	162 54473
	47000	40 × 45	6.19	2.82	0.94	26	21	162 44473
	68000	40 × 55	7.64	4.08	1.36	21	18	162 54683
	100000	40 × 75	10.0	6.00	2.00	16	15	162 54104
	150000	40 × 105	12.9	9.00	3.00	13	12	162 54154
16	6800	25 × 35	3.11	0.65	0.22	50	37	162 55682
	10000	25 × 45	4.09	0.96	0.32	36	27	162 55103
	15000	30 × 45	4.97	1.44	0.48	30	23	162 55153
	22000	35 × 45	5.53	2.12	0.71	29	22	162 55223
	33000	35 × 55	6.08	3.17	1.06	28	21	162 55333
	33000	40 × 45	6.08	3.17	1.06	28	21	162 45333
	47000	40 × 55	7.46	4.52	1.51	22	18	162 55473
	68000	40 × 75	9.70	6.53	2.18	17	15	162 55683
	100000	40 × 105	12.90	9.60	3.20	13	12	162 55104

Non-solid Al - electrolytic capacitors
Power Long Life Printed Wiring

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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_{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 × 35	2.94	0.71	0.24	56	37	162 56472
	6800	25 × 45	3.93	1.02	0.34	39	27	162 56682
	10000	30 × 45	4.81	1.50	0.50	32	23	162 56103
	15000	35 × 45	5.43	2.25	0.75	30	22	162 56153
	22000	35 × 55	5.98	3.30	1.10	29	21	162 56223
	22000	40 × 45	5.98	3.30	1.10	29	21	162 46223
	33000	40 × 55	7.30	4.95	1.65	23	18	162 56333
	47000	40 × 75	9.43	7.05	2.35	18	15	162 56473
	68000	40 × 105	12.44	10.20	3.40	14	12	162 56683
40	2200	25 × 35	2.36	0.53	0.18	87	54	162 57222
	3300	25 × 45	3.17	0.79	0.27	60	38	162 57332
	4700	30 × 45	3.93	1.13	0.38	48	33	162 57472
	6800	35 × 45	4.59	1.63	0.55	42	31	162 57682
	10000	35 × 55	5.03	2.40	0.80	41	29	162 57103
	10000	40 × 45	5.03	2.40	0.80	41	29	162 47103
	15000	40 × 55	6.09	3.60	1.20	33	24	162 57153
	22000	40 × 75	8.34	5.28	1.76	23	18	162 57223
	33000	40 × 105	10.97	7.92	2.64	18	15	162 57333
63	1000	25 × 35	1.55	0.38	0.13	202	155	162 58102
	1500	25 × 45	2.10	0.57	0.19	137	109	162 58152
	2200	30 × 45	2.72	0.83	0.28	100	79	162 58222
	3300	35 × 45	3.44	1.25	0.42	75	61	162 58332
	4700	35 × 55	4.09	1.78	0.60	62	53	162 58472
	4700	40 × 45	4.09	1.78	0.60	62	53	162 48472
	6800	40 × 55	5.10	2.57	0.86	47	40	162 58682
	10000	40 × 75	6.86	3.78	1.26	34	29	162 58103
	15000	40 × 105	9.31	5.67	1.89	25	21	162 58153
100	470	25 × 35	1.42	0.28	0.10	240	155	162 59471
	680	25 × 45	1.90	0.41	0.14	167	109	162 59681
	1000	30 × 45	2.48	0.60	0.20	120	79	162 59102
	1500	35 × 45	3.17	0.90	0.30	88	61	162 59152
	2200	35 × 55	3.79	1.32	0.44	72	53	162 59222
	2200	40 × 45	3.79	1.32	0.44	72	53	162 49222
	3300	40 × 55	4.81	1.98	0.66	53	40	162 59332
	4700	40 × 75	6.49	2.82	0.94	38	29	162 59472
	6800	40 × 105	8.80	4.08	1.36	28	21	162 59682

Non-solid Al - electrolytic capacitors

Power Long Life Printed Wiring

PLL-PW 162/163

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 85 °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 × 35	0.72	0.18	0.06	950	710	163 52151
	220	25 × 45	0.96	0.26	0.09	650	485	163 52221
	330	30 × 45	1.29	0.40	0.14	442	330	163 52331
	470	35 × 45	1.66	0.57	0.19	321	240	163 52471
	680	35 × 55	2.09	0.82	0.28	237	185	163 52681
	680	40 × 45	2.09	0.82	0.28	237	185	163 42681
	1000	40 × 55	2.71	1.20	0.40	167	133	163 52102
	1500	40 × 75	3.75	1.80	0.60	114	90	163 52152
	2200	40 × 105	5.24	2.64	0.88	79	62	163 52222
250	100	25 × 35	0.67	0.15	0.05	1060	710	163 53101
	150	25 × 45	0.92	0.22	0.08	710	485	163 53151
	220	30 × 45	1.28	0.33	0.11	492	330	163 53221
	330	35 × 45	1.65	0.49	0.17	325	240	163 53331
	470	35 × 55	2.01	0.70	0.24	256	185	163 53471
	470	40 × 45	2.01	0.70	0.24	256	185	163 43471
	680	40 × 55	2.59	1.02	0.34	182	133	163 53681
	1000	40 × 75	3.58	1.50	0.50	125	90	163 53102
	1500	40 × 105	5.05	2.25	0.75	85	62	163 53152
385	68	25 × 35	0.61	0.16	0.06	1650	1260	163 58689
	100	25 × 45	0.82	0.23	0.08	1120	855	163 58101
	150	30 × 45	1.10	0.35	0.12	755	580	163 58151
	220	35 × 45	1.44	0.51	0.17	525	405	163 58221
	330	35 × 55	1.84	0.77	0.26	360	280	163 58331
	330	40 × 45	1.84	0.77	0.26	360	280	163 48331
	470	40 × 55	2.37	1.09	0.36	260	205	163 58471
	680	40 × 75	3.24	1.58	0.53	180	140	163 58681
	1000	40 × 105	4.54	2.31	0.78	125	100	163 58102
400	68	25 × 35	0.39	0.16	0.06	3200	2660	163 56689
	100	25 × 45	0.53	0.24	0.08	2180	1810	163 56101
	150	30 × 45	0.72	0.36	0.12	1460	1210	163 56151
	220	35 × 45	0.94	0.52	0.17	1010	830	163 56221
	330	35 × 55	1.24	0.79	0.26	680	570	163 56331
	330	40 × 45	1.24	0.79	0.26	680	570	163 46331
	470	40 × 55	1.59	1.12	0.37	485	407	163 56471
	680	40 × 75	2.18	1.63	0.54	336	282	163 56681
	1000	40 × 105	3.07	2.40	0.80	230	193	163 56102

Non-solid Al - electrolytic capacitors

Power Long Life Printed Wiring

PLL-PW 162/163

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

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".

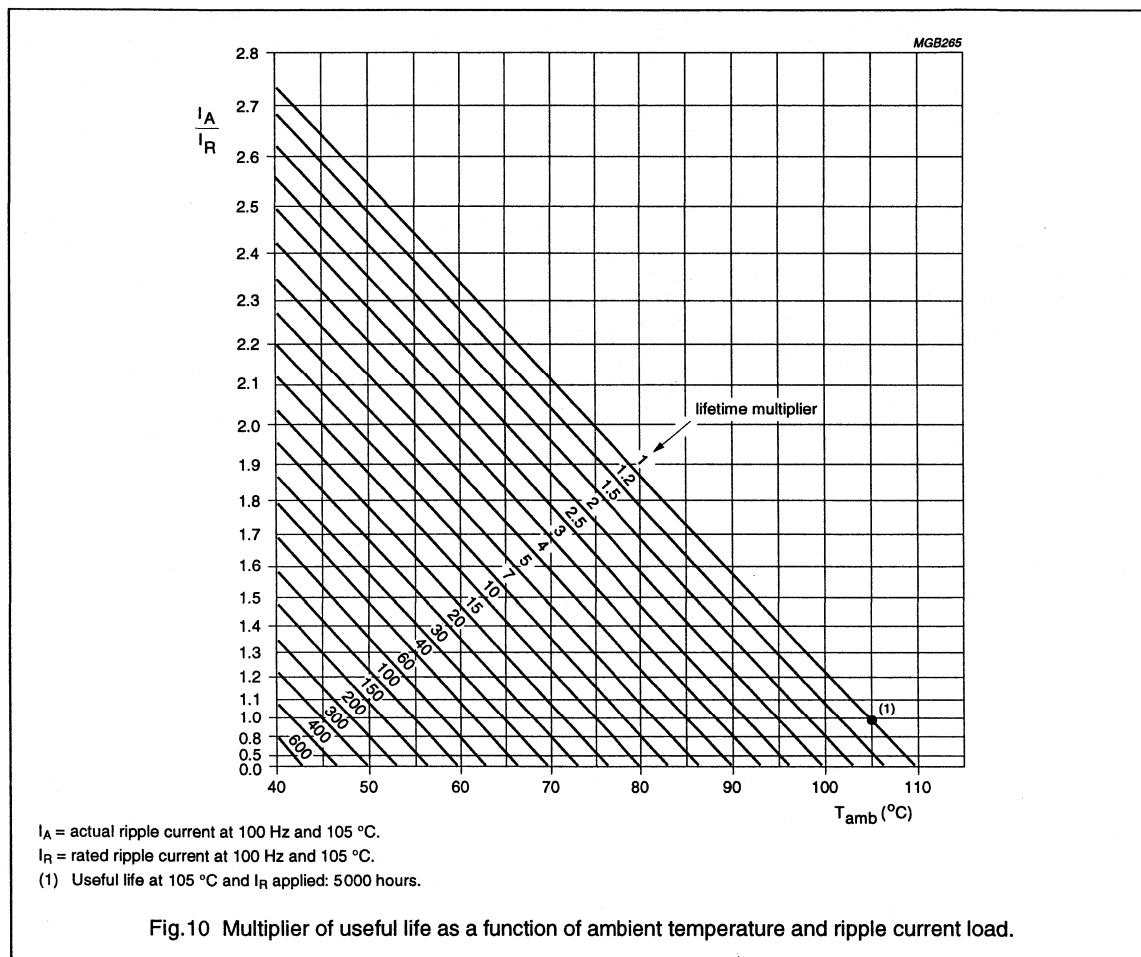
Non-solid Al - electrolytic capacitors Power Long Life Printed Wiring

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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		
	$U_R = 10$ to 25 V	$U_R = 40$ to 100 V	$U_R = 200$ to 400 V
50	0.93	0.91	0.86
100	1.00	1.00	1.00
200	1.04	1.05	1.13
400	1.07	1.09	1.21
1000	1.11	1.13	1.29
2000	1.13	1.15	1.32
4000	1.15	1.18	1.35
≥ 10000	1.18	1.22	1.40



Non-solid Al - electrolytic capacitors

Power Long Life Printed Wiring

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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

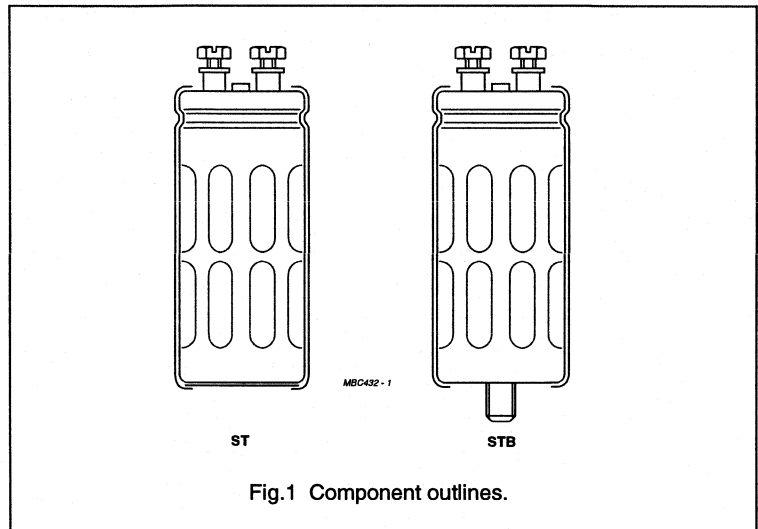
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 10\%$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 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	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Non-solid Al - electrolytic capacitors Power Economic Screw Terminals

PEC-ST 154/155

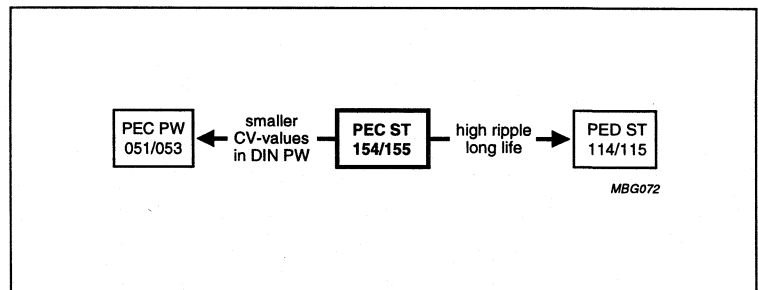
FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, minimized dimensions, cylindrical aluminium case, insulated with a blue sleeve
- Also available in bolt version (PEC-STB)
- Pressure relief in the sealing
- Charge and discharge proof
- Long useful life:
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, LL grade	
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)	

Non-solid Al - electrolytic capacitors

Power Economic Screw Terminals

PEC-ST 154/155

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	–	–	–

Non-solid Al - electrolytic capacitors

Power Economic Screw Terminals

PEC-ST 154/155

MECHANICAL DATA AND PACKAGING QUANTITIES

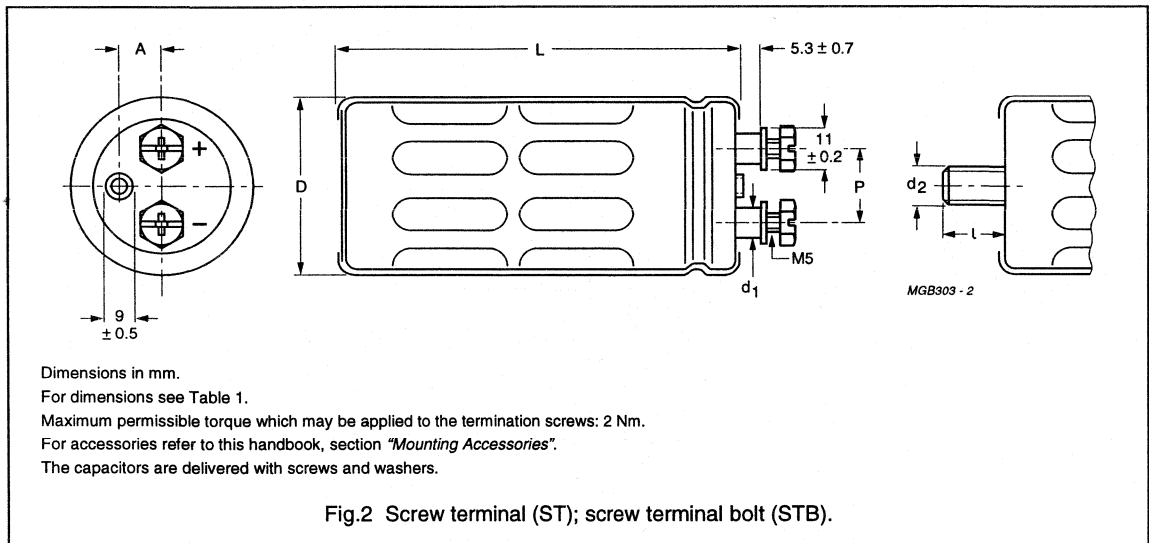


Table 1 Physical dimensions, mass and packaging information; see Fig.2

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)	OUTER 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".

Non-solid Al - electrolytic capacitors

Power Economic Screw Terminals

PEC-ST 154/155

Ordering ExampleElectrolytic capacitor
PEC-ST 15410000 μ F/63 V; $\pm 20\%$ Nominal case size: $\varnothing 35 \times 80$ 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 $T_{amb} = 20^\circ\text{C}$,
 $P = 86$ 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 °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 (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 Table 3 note 1) 2222
10	47000	35 x 60	8.4	15.9	2.82	0.94	14	0.48	11	16.5	154 14473
	68000	35 x 80	8.7	16.5	4.08	1.36	11	0.88	9	13.5	154 14683
	100000	35 x 105	10.7	20.3	6.00	2.00	10.5	0.92	8	12	154 14104
	150000	50 x 80	13.2	25.0	9.00	3.00	8	1.03	8	12	154 14154
	220000	50 x 105	16.5	31.4	13.20	4.40	6.5	1.26	7	10.5	154 14224
	330000	65 x 105	20.8	39.5	19.80	6.60	5.5	1.59	7	10.5	154 14334
	470000	75 x 105	22.6	42.9	28.20	9.40	5.5	2.21	7	10.5	154 14474
16	33000	35 x 60	8.4	15.9	3.17	1.06	14	0.32	10	15	154 15333
	47000	35 x 80	8.7	16.5	4.51	1.51	11	0.32	9	13.5	154 15473
	68000	35 x 105	12.2	23.2	6.53	2.18	8	0.45	8	12	154 15683
	100000	50 x 80	13.2	25.0	9.60	3.20	8	0.70	8	12	154 15104
	150000	50 x 105	14.9	28.3	14.40	4.80	8	0.88	7	10.5	154 15154
	220000	65 x 105	20.8	39.5	21.10	7.04	5.5	1.07	7	10.5	154 15224
	330000	75 x 105	22.6	42.9	31.70	10.60	5.5	1.58	7	10.5	154 15334

Non-solid Al - electrolytic capacitors

Power Economic Screw Terminals

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × 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... ..	
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	
63	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	
	100	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	

Non-solid Al - electrolytic capacitors
Power Economic Screw Terminals

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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 ∅D × 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 (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	
385	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	
	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	

Non-solid Al - electrolytic capacitors

Power Economic Screw Terminals

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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 (note 1) 2222
400	220	35 x 60	1.0	2.0	0.53	0.18	650	0.15	475	955	155 16221
	330	35 x 80	1.5	2.9	0.79	0.27	430	0.15	320	635	155 16331
	470	35 x 80	1.8	3.4	1.13	0.38	300	0.15	220	445	155 16471
	680	35 x 105	2.4	4.6	1.63	0.54	210	0.15	150	310	155 16681
	1000	50 x 80	3.4	6.5	2.40	0.80	125	0.15	90	210	155 16102
	1500	50 x 105	4.7	8.9	3.60	1.20	85	0.15	60	140	155 16152
	2200	65 x 105	6.5	12.4	5.28	1.76	58	0.15	40	95	155 16222
	3300	75 x 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

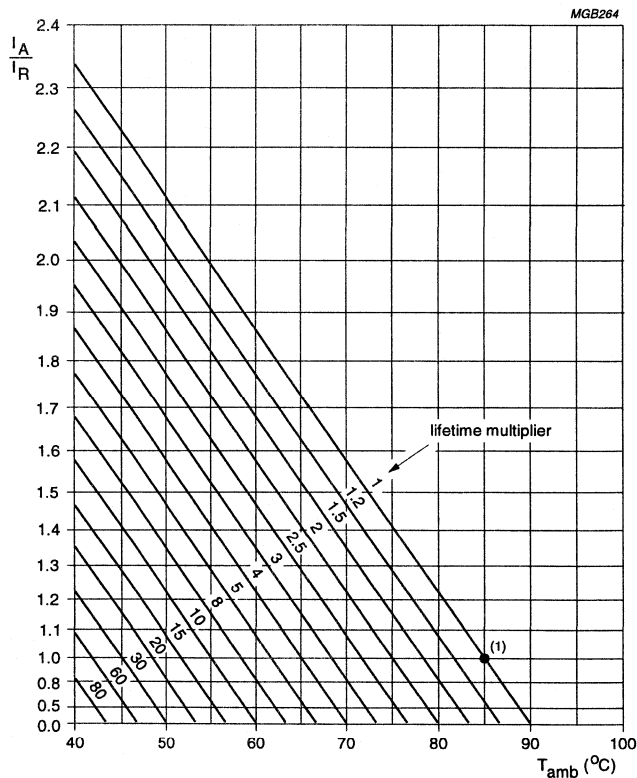
Non-solid Al - electrolytic capacitors
Power Economic Screw Terminals

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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 °C.

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

With an absolute maximum of 50 A.

(1) Useful life at 85 °C and I_R applied: 12000 hours; (5000 hours for 400 V types).

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

Non-solid Al - 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 (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	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Non-solid Al - electrolytic capacitors

Power Eurodin Screw Terminals

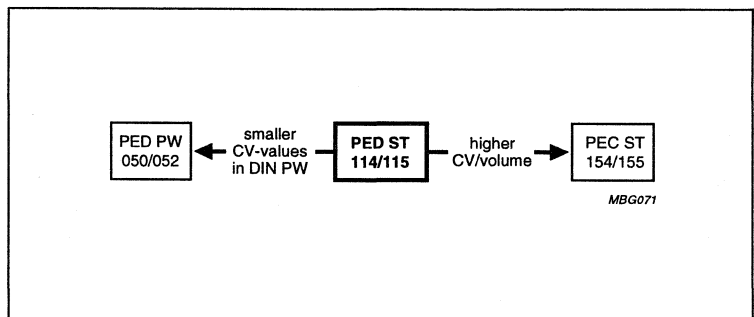
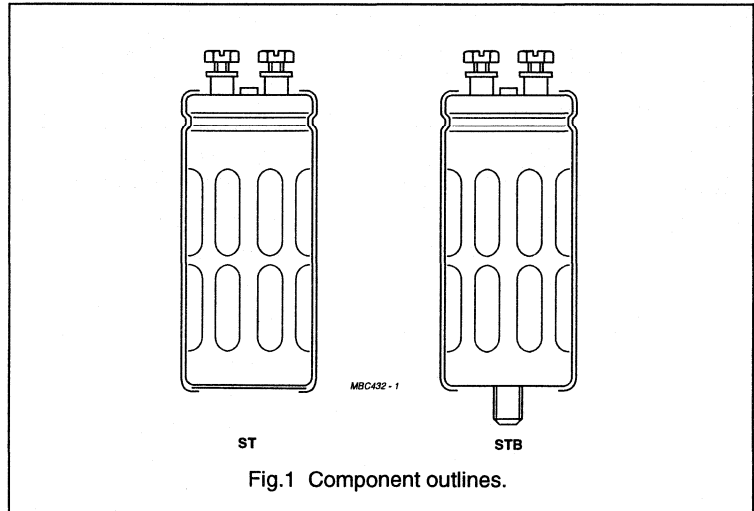
PED-ST 114/115

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Large types, cylindrical aluminium case, insulated with a blue sleeve
- Also available in bolt version (PED-STB)
- Pressure relief in the sealing
- Charge and discharge proof
- Extremely low ESR and ESL allowing very high ripple current load, achieved by a special construction with multiple internal anode and cathode connections
- Very long useful life: 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.



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 μ F	
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 384-4-1/CECC 30300, LL grade	
Climatic category IEC 68 (DIN 40040; NF C93-001)	40/085/56 (GPF; 554)	

Non-solid Al - electrolytic capacitors

Power Eurodin 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 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	-	-	-

Non-solid Al - electrolytic capacitors

Power Eurodin Screw Terminals

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MECHANICAL DATA AND PACKAGING QUANTITIES

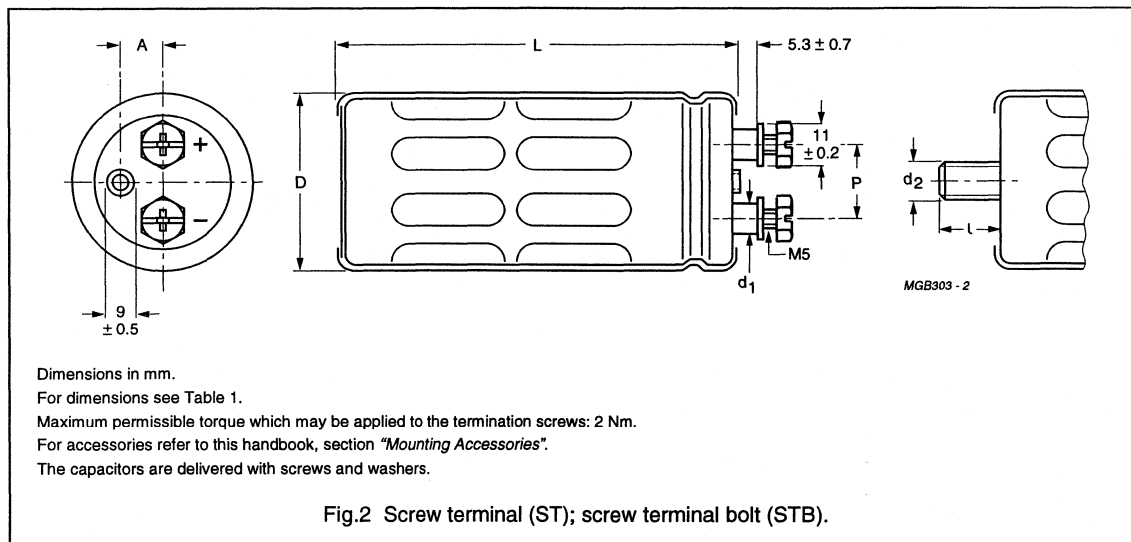


Table 1 Physical dimensions, mass and packaging information; see Fig.2

NOMINAL CASE SIZE ∅D × L (mm)	∅D _{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)	OUTER 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".

Non-solid Al - electrolytic capacitors
Power Eurodin Screw Terminals

PED-ST 114/115

Ordering example

Electrolytic capacitor PED-ST 114
10000 µF/25 V; -10/+30%
Nominal case size: Ø35 x 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 °C, P = 86 to 106 kPa, RH = 45 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 x L (mm)	I _R 100 Hz 85 °C (A)	I _R 20 kHz 70 °C (A)	I _{L1} 1 min (mA)	I _{L5} 5 min (mA)	ESR 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 x 60	6	11.4	0.90	0.30	20	0.32	13	20	114 14153	
	22000	35 x 80	7.5	14.2	1.32	0.43	14	0.33	9.5	14	114 14223	
	33000	35 x 105	10	19	1.98	0.66	10	0.35	7.5	10	114 14333	
	47000	50 x 80	14	26.5	2.82	0.94	7.5	0.36	5.0	9.5	114 14473	
	68000	50 x 105	18	34	4.08	1.36	5.5	0.38	4.0	8.0	114 14683	
	100000	65 x 105	30	50	6.00	2.00	3.5	0.34	3.0	5.0	114 14104	
	150000	65 x 105	30	50	9.00	3.00	3.0	0.45	3.0	5.0	114 14154	
	220000	75 x 105	37	50	13.20	4.40	2.0	0.45	2.5	4.0	114 14224	
	16	10000	35 x 60	6	11.4	0.96	0.32	22	0.22	13	20	114 15103
		15000	35 x 80	7.5	14.2	1.44	0.40	15	0.23	9.5	14	114 15153
22000		35 x 105	10	19	2.12	0.71	11	0.25	7.0	10	114 15223	
33000		50 x 80	13	24.6	3.17	1.06	7.5	0.26	5.0	9.5	114 15333	
47000		50 x 105	18	34	4.52	1.51	5.5	0.27	4.0	8.0	114 15473	
68000		65 x 105	28	50	6.53	2.18	3.5	0.24	3.0	5.0	114 15683	
100000	65 x 105	28	50	9.60	3.20	3.0	0.31	3.0	5.0	114 15104		
150000	75 x 105	37	50	14.40	4.80	2.0	0.31	2.5	4.0	114 15154		

Non-solid Al - electrolytic capacitors

Power Eurodin Screw Terminals

PED-ST 114/115

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 Table 3 note 1) 2222
25	4700	35 x 60	5.2	10	0.71	0.24	30	0.14	15	23	114 16472
	6800	35 x 60	5.2	10	1.02	0.34	25	0.18	14	21	114 16682
	10000	35 x 80	6.7	12.7	1.50	0.50	18	0.18	10	15	114 16103
	15000	35 x 105	9.7	18.4	2.25	0.75	12	0.19	7.5	11	114 16153
	22000	50 x 80	12.5	23.7	3.30	1.10	8.5	0.19	5.5	9.5	114 16223
	33000	50 x 105	18	34	4.95	1.65	6.0	0.21	4.0	8.0	114 16333
	47000	65 x 105	27	50	7.05	2.35	4.0	0.18	3.0	5.0	114 16473
	68000	65 x 105	27	50	10.20	3.40	3.5	0.23	3.0	5.0	114 16683
	100000	75 x 105	37	50	15.00	5.0	2.5	0.23	2.5	4.0	114 16104
	40	3300	35 x 60	4.5	8.5	0.80	0.27	37	0.13	21	32
63	4700	35 x 60	4.5	8.5	1.13	0.38	35	0.17	22	33	114 17472
	6800	35 x 80	6	11.4	1.64	0.55	25	0.17	15	23	114 17682
	10000	35 x 105	7.5	14.2	2.40	0.80	17	0.18	11	17	114 17103
	15000	50 x 80	10	19	3.60	1.20	11	0.17	7.5	13	114 17153
	22000	50 x 105	15	28.5	5.28	1.76	8.0	0.18	5.5	10.5	114 17223
	33000	65 x 105	21	40	7.92	2.64	5.0	0.16	3.5	6.0	114 17333
	47000	65 x 105	22	42	11.28	3.76	4.5	0.21	3.5	6.0	114 17473
	68000	75 x 105	30	50	16.32	5.44	3.0	0.21	3.0	4.5	114 17683
	2200	35 x 60	3.7	7	0.84	0.28	39	0.09	22	33	114 18222
	3300	35 x 60	3.7	7	1.25	0.42	32	0.11	20	30	114 18332
4700	35 x 80	5.2	10	1.78	0.66	23	0.11	14	21	114 18472	
6800	35 x 105	7.5	14.2	2.57	0.86	17	0.11	10	15	114 18682	
10000	50 x 80	9.5	18	3.78	1.26	12	0.12	7.5	14	114 18103	
15000	50 x 105	13.5	25.6	5.67	1.89	8.5	0.13	5.5	10.5	114 18153	
22000	65 x 105	21	40	8.32	2.77	5.0	0.11	3.5	6.0	114 18223	
33000	65 x 105	22	42	12.48	4.16	4.5	0.14	3.5	6.0	114 18333	
47000	75 x 105	30	50	17.77	5.92	3.0	0.14	3.0	4.5	114 18473	

Non-solid Al - 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_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 1500 2200 3300 4700 6800 10000 15000 22000	35 x 60 35 x 60 35 x 80 35 x 105 50 x 80 50 x 105 65 x 105 65 x 105 75 x 105	3.0 3.3 4.6 6.5 7.4 9.9 15.0 15.8 20.5	5.7 6.3 8.7 12.3 14.0 18.8 28.5 30.0 38.9	0.60 0.90 1.32 1.98 2.82 4.08 6.00 9.00 13.20	0.20 0.30 0.41 0.66 0.94 1.36 2.00 3.00 4.40	85 65 45 30 27 19 11 10 7	0.09 0.10 0.10 0.10 0.11 0.11 0.11 0.12 0.12	45 40 28 19 17 12 7 6 5	67 60 42 28 25 18 11 10 8	114 19102 114 19152 114 19222 114 19332 114 19472 114 19682 114 19103 114 19153 114 19223

Table 3 Electrical data and ordering information for the 115 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 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	330 470 680 1000 1500 2200 3300 4700	35 x 60 35 x 80 35 x 105 50 x 80 50 x 105 65 x 105 65 x 105 75 x 105	1.8 2.5 3.5 4.2 6.3 8.8 10.5 14	3.4 4.7 6.6 8 12 16.7 20 26.5	0.50 0.71 1.02 1.50 2.25 3.30 4.95 7.05	0.17 0.24 0.34 0.50 0.75 1.10 1.65 2.35	300 250 180 110 60 45 30 25	0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15	275 140 125 60 40 30 25 20	500 375 300 130 100 60 50 40	115 13331 115 13471 115 13681 115 13102 115 13152 115 13222 115 13332 115 13472
350	680 1000 3300	50 x 80 50 x 105 75 x 105	3.9 5.4 10.8	7.0 9.7 19.4	1.47 2.14 6.93	0.48 0.71 2.31	140 65 30	0.10 0.10 0.12	60 50 20	130 100 45	115 15681 115 15102 115 15332

Non-solid Al - electrolytic capacitors

Power Eurodin Screw Terminals

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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 x 60	1.0	1.8	0.34	0.12	730	0.12	450	935	115 18151
	220	35 x 80	1.4	2.6	0.50	0.17	520	0.12	310	630	115 18221
	330	35 x 105	1.9	3.6	0.75	0.25	340	0.12	210	425	115 18331
	470	50 x 80	2.7	5.1	1.06	0.36	200	0.12	140	300	115 18471
	680	50 x 105	3.6	6.9	1.53	0.51	140	0.12	100	205	115 18681
	1000	65 x 105	5.1	9.7	2.25	0.75	95	0.12	65	125	115 18102
	1500	65 x 105	5.7	10.6	3.38	1.13	80	0.12	45	95	115 18152
400	2200	75 x 105	7.3	13.8	4.95	1.65	55	0.12	40	75	115 18222
	150	35 x 60	1.0	1.8	0.36	0.12	730	0.12	450	935	115 16151
	220	35 x 80	1.4	2.6	0.53	0.18	520	0.12	310	630	115 16221
	330	35 x 105	1.9	3.6	0.79	0.26	340	0.12	210	425	115 16331
	470	50 x 80	2.7	5.1	1.13	0.38	200	0.12	140	300	115 16471
	680	50 x 105	3.6	6.9	1.63	0.54	140	0.12	100	205	115 16681
1000	1500	65 x 105	5.1	9.7	2.40	0.80	95	0.12	65	125	115 16102
	2200	65 x 105	5.7	10.6	3.60	1.20	80	0.12	45	95	115 16152
1000	1500	65 x 105	5.7	10.6	3.60	1.20	80	0.12	45	95	115 16152
	2200	75 x 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.....).

Non-solid Al - electrolytic capacitors
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Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods	≤250 V versions	$U_s = 1.15 \times U_R$
	≥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	$I_{L1} \leq 0.006C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 35 \text{ mm}$	typ. 13 nH
	case $\varnothing D = 50 \text{ mm}$	typ. 16 nH
	case $\varnothing D = 65 \text{ mm}$	typ. 19 nH
	case $\varnothing D = 75 \text{ mm}$	typ. 20 nH

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Equivalent series resistance (ESR)

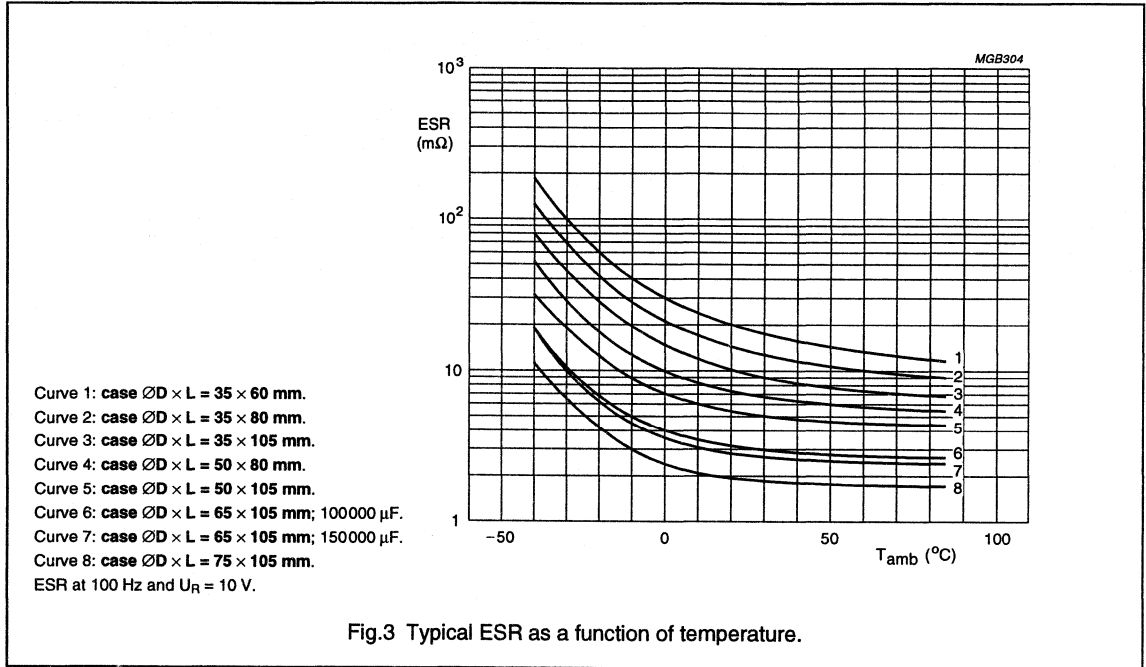


Fig.3 Typical ESR as a function of temperature.

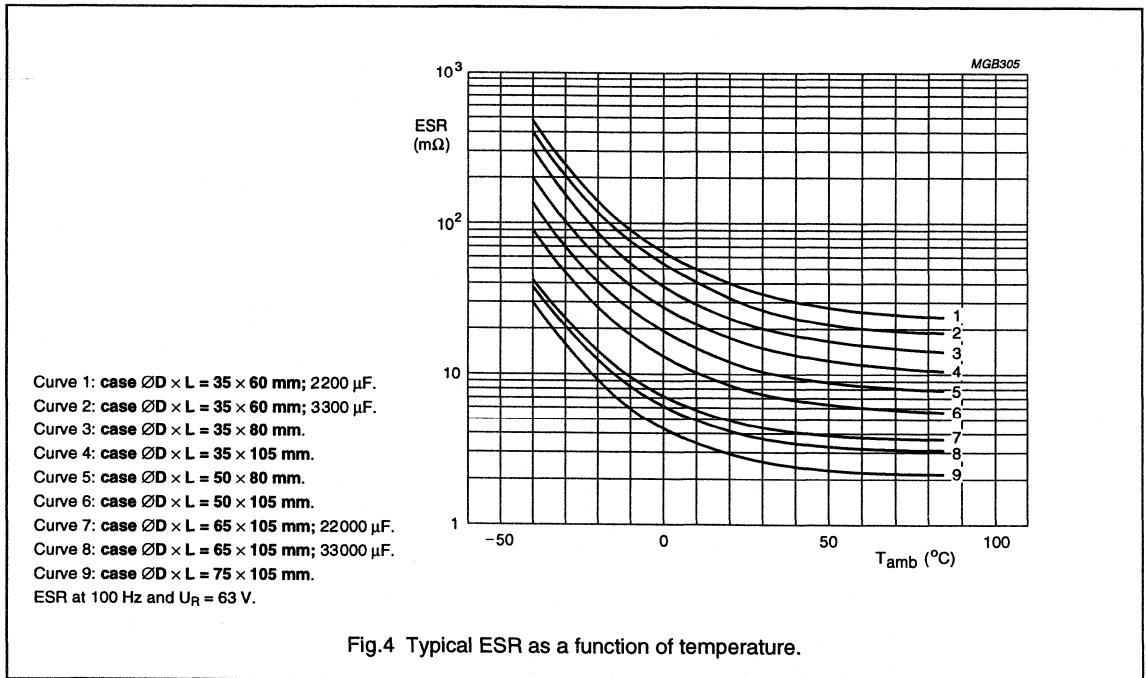
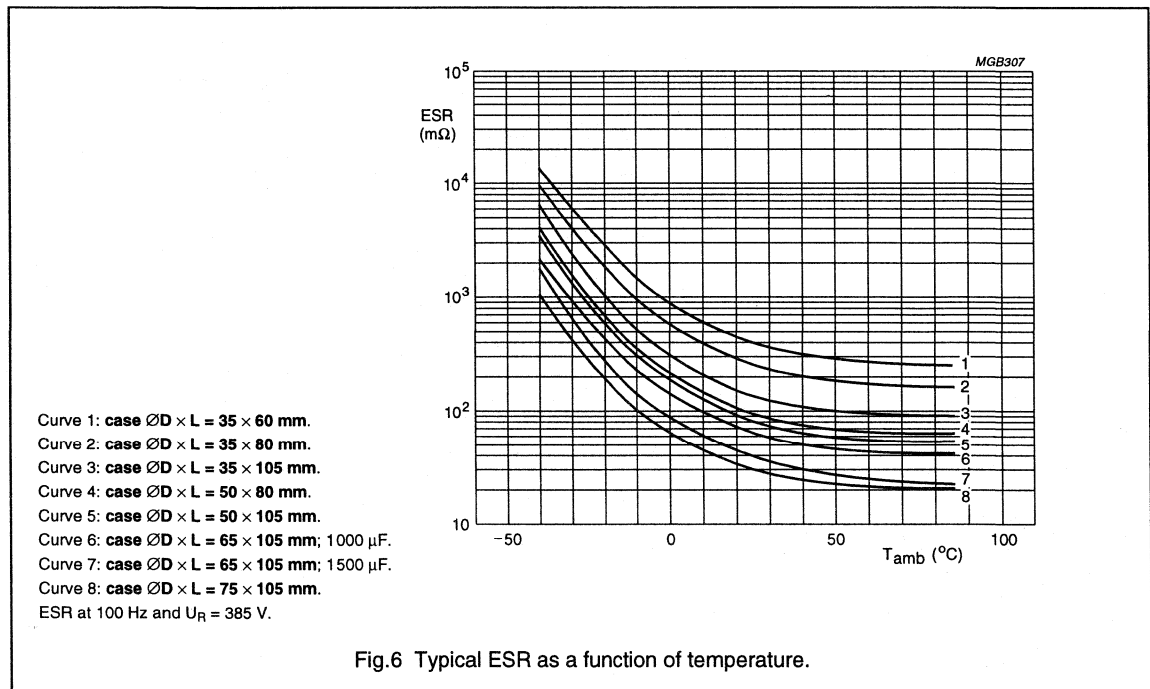
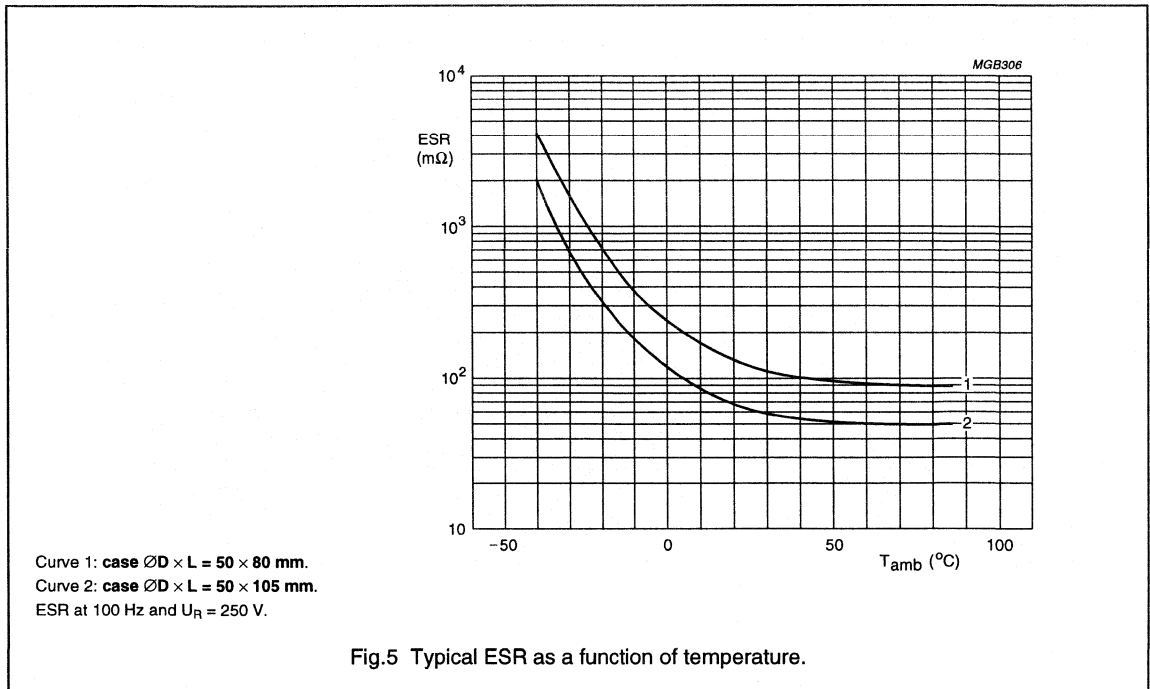


Fig.4 Typical ESR as a function of temperature.

Non-solid Al - electrolytic capacitors
Power Eurodin Screw Terminals

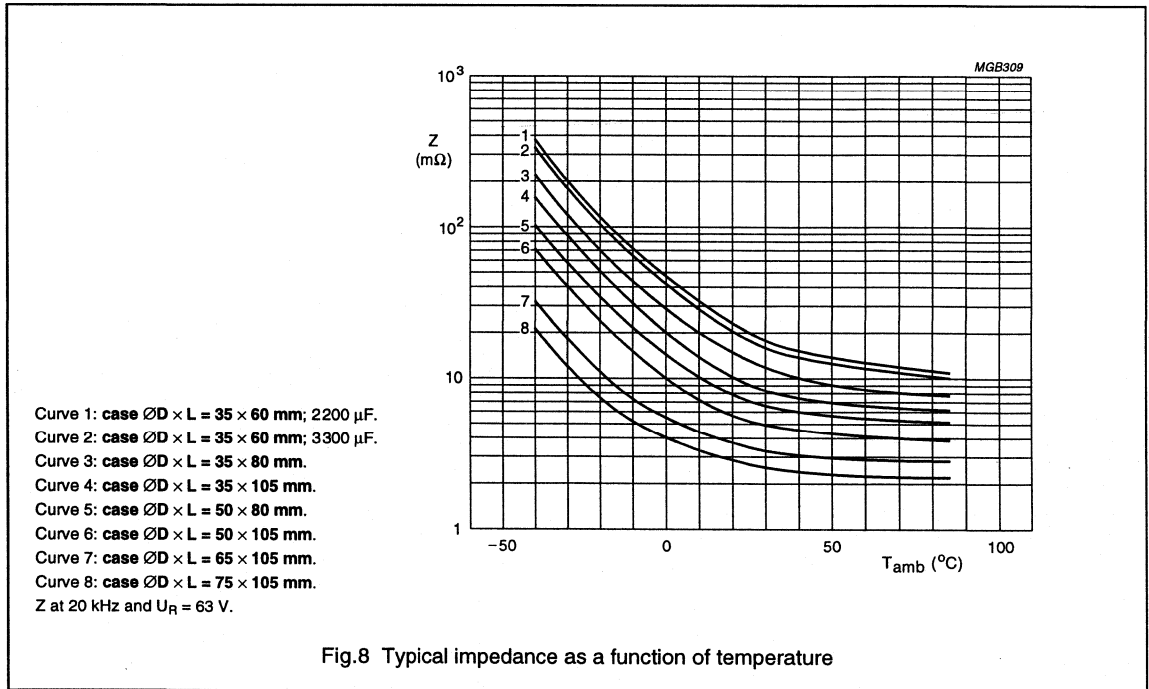
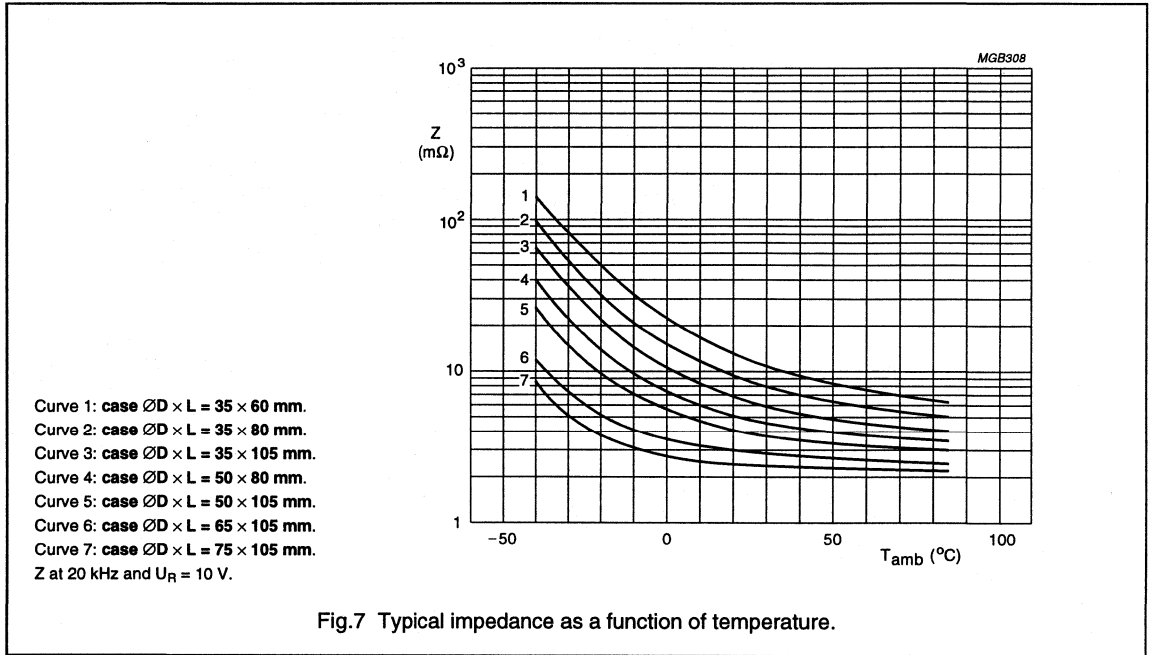
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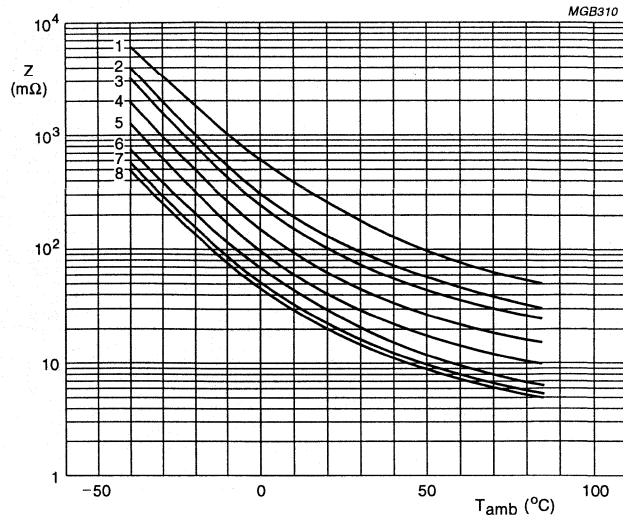
Impedance (Z)



Non-solid Al - electrolytic capacitors

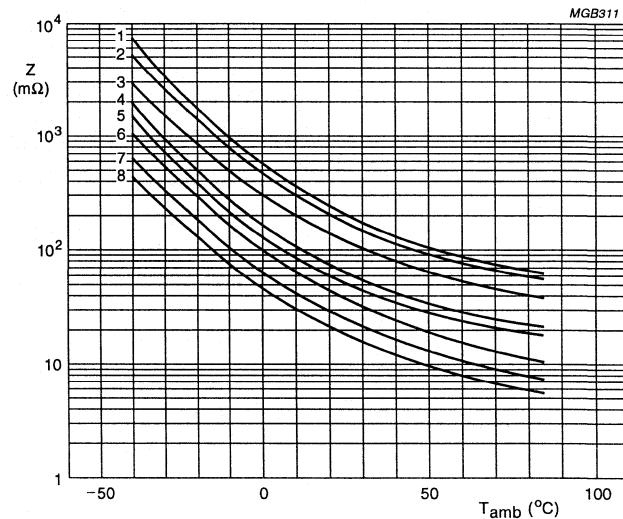
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Curve 1: case $\varnothing D \times L = 35 \times 60$ mm.
 Curve 2: case $\varnothing D \times L = 35 \times 80$ mm.
 Curve 3: case $\varnothing D \times L = 35 \times 105$ mm.
 Curve 4: case $\varnothing D \times L = 50 \times 80$ mm.
 Curve 5: case $\varnothing D \times L = 50 \times 105$ mm.
 Curve 6: case $\varnothing D \times L = 65 \times 105$ mm; 2200 μ F.
 Curve 7: case $\varnothing D \times L = 65 \times 105$ mm; 3300 μ F.
 Curve 8: case $\varnothing D \times L = 75 \times 105$ mm.
 Z at 20 kHz and $U_R = 250$ V.

Fig.9 Typical impedance as a function of temperature.

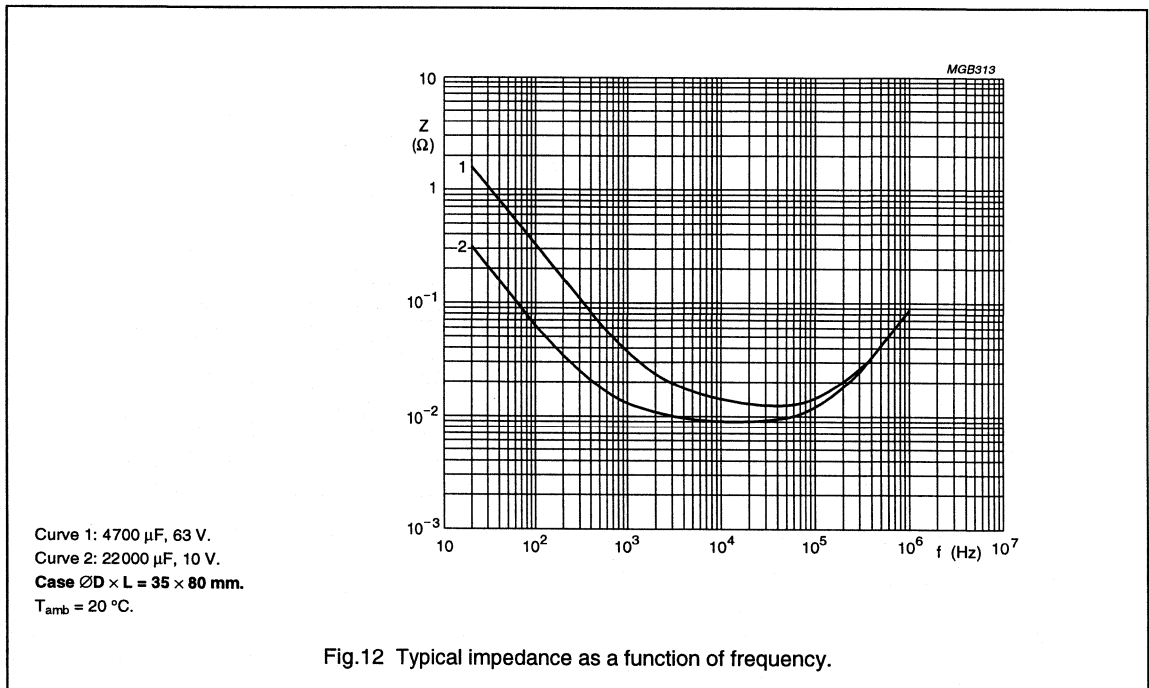
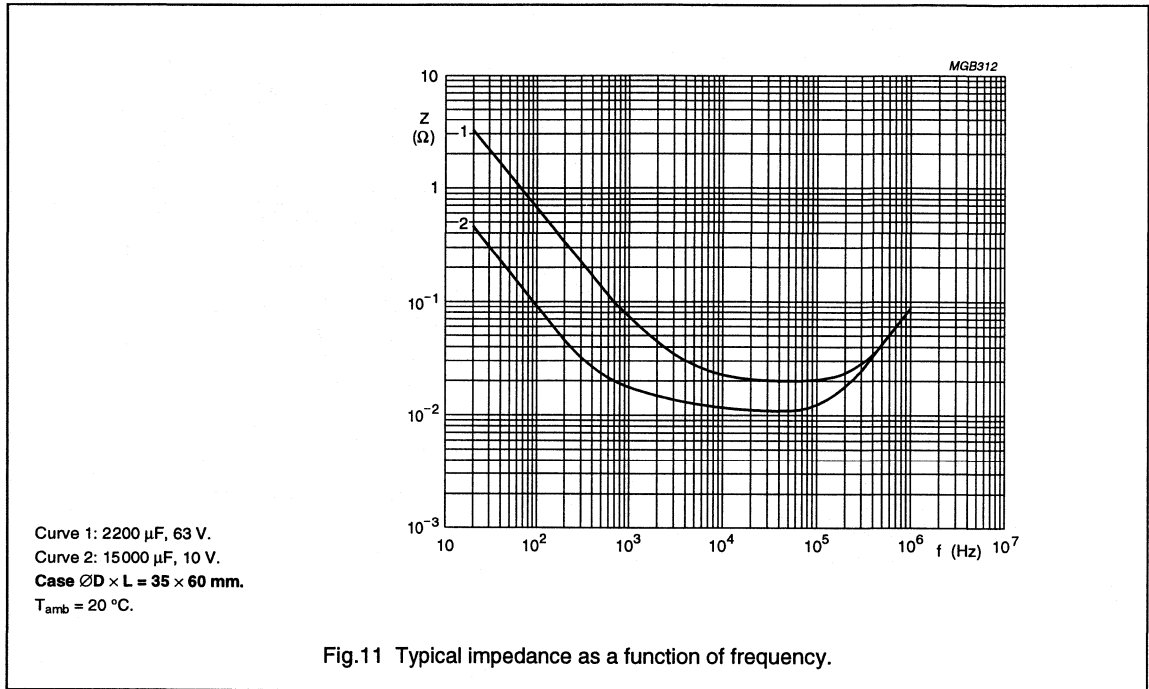


Curve 1: case $\varnothing D \times L = 35 \times 60$ mm.
 Curve 2: case $\varnothing D \times L = 35 \times 80$ mm.
 Curve 3: case $\varnothing D \times L = 35 \times 105$ mm.
 Curve 4: case $\varnothing D \times L = 50 \times 80$ mm.
 Curve 5: case $\varnothing D \times L = 50 \times 105$ mm.
 Curve 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.
 Z at 20 kHz and $U_R = 385$ V.

Fig.10 Typical impedance as a function of temperature.

Non-solid Al - electrolytic capacitors
 Power Eurodin Screw Terminals

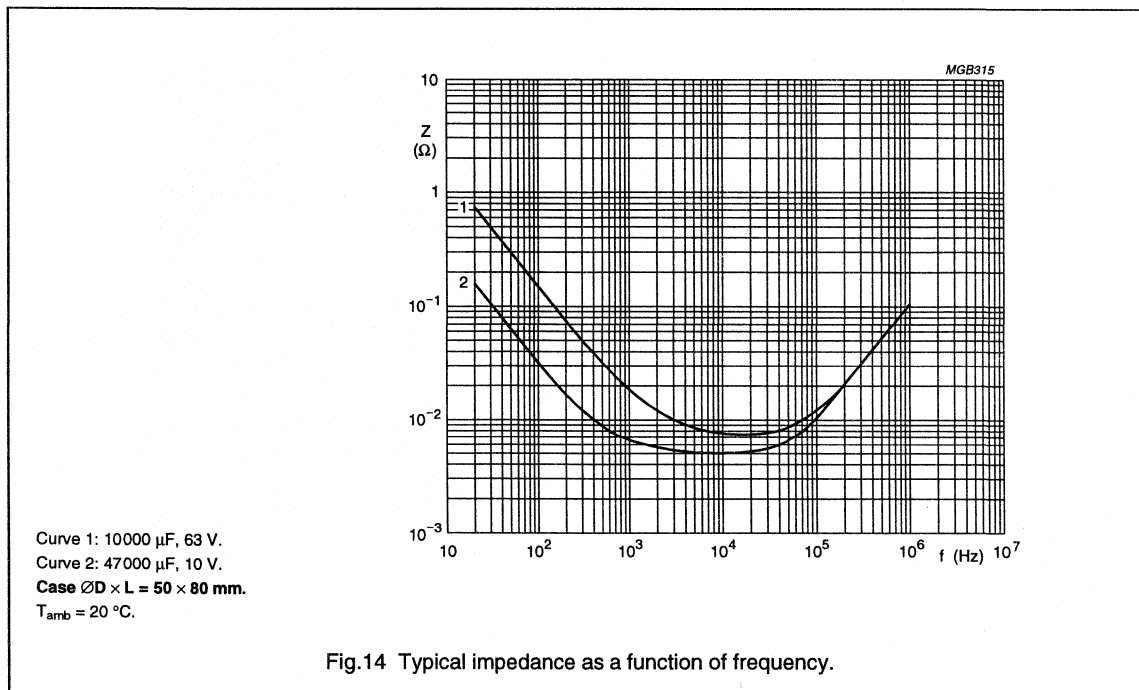
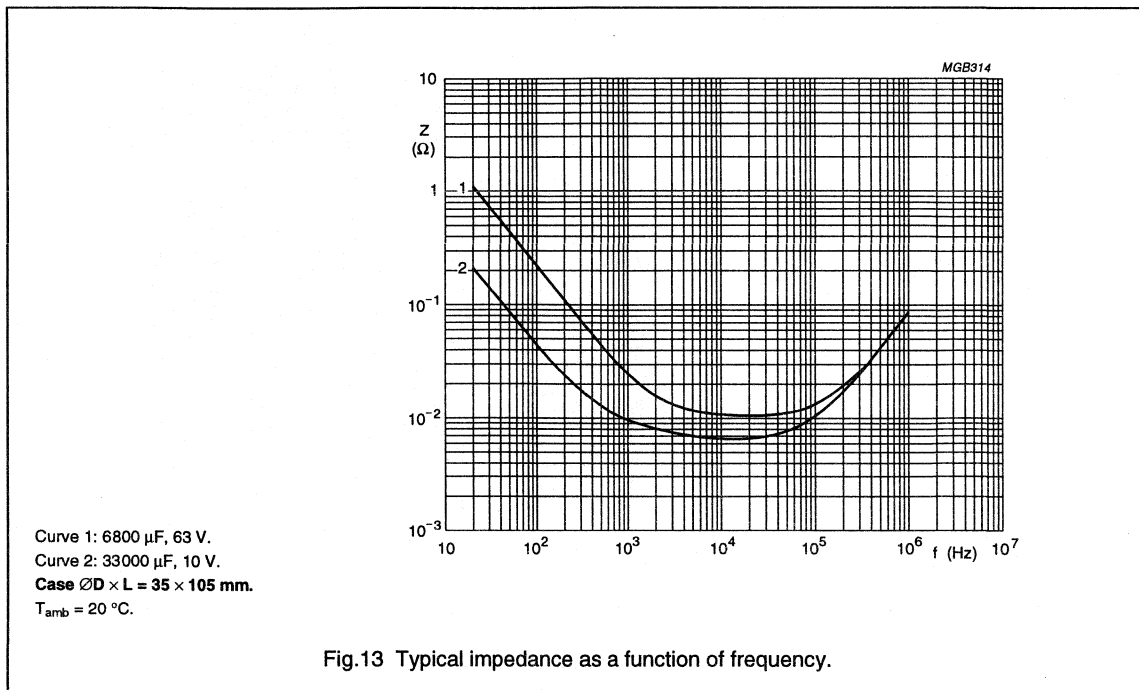
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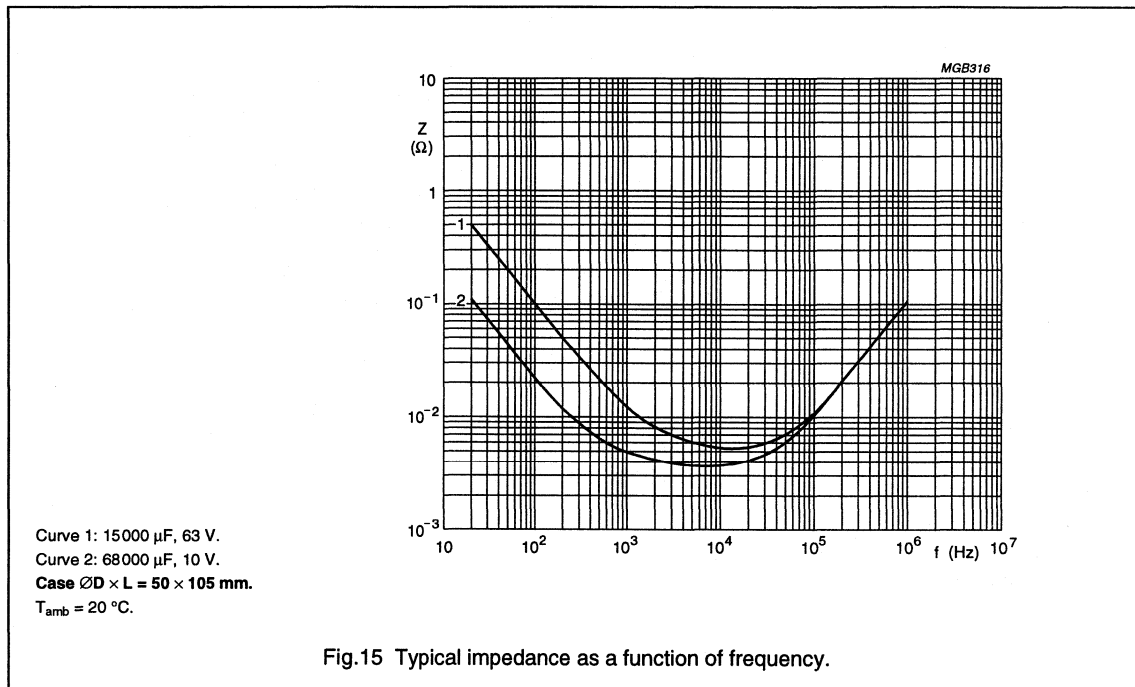


Fig.15 Typical impedance as a function of frequency.

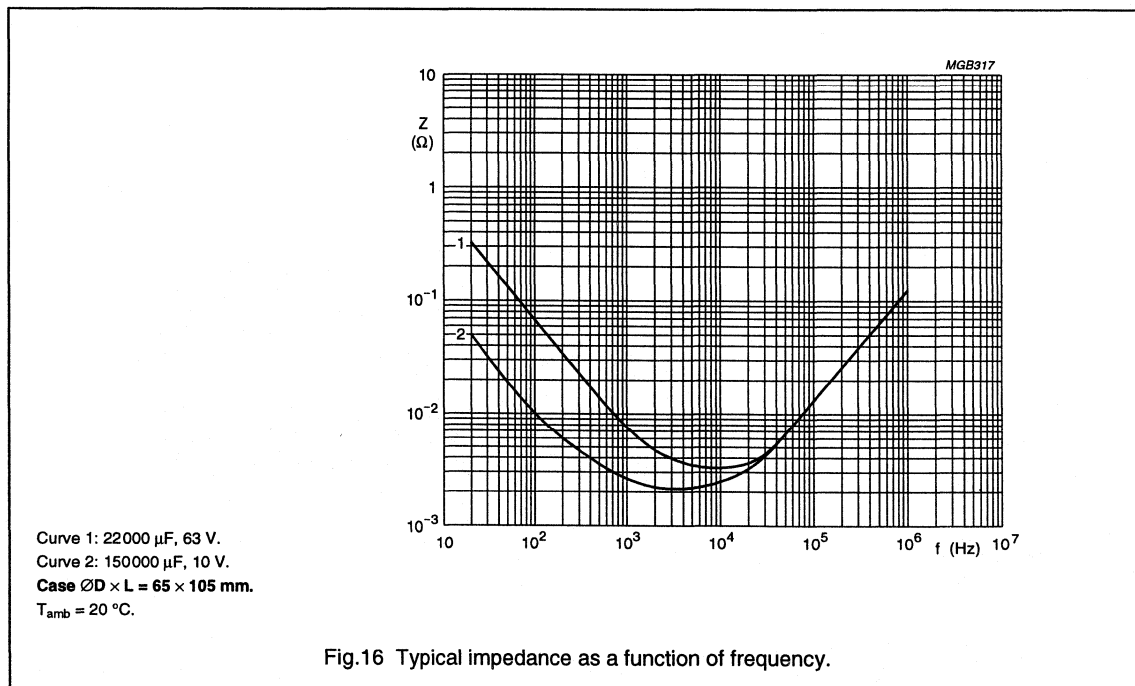
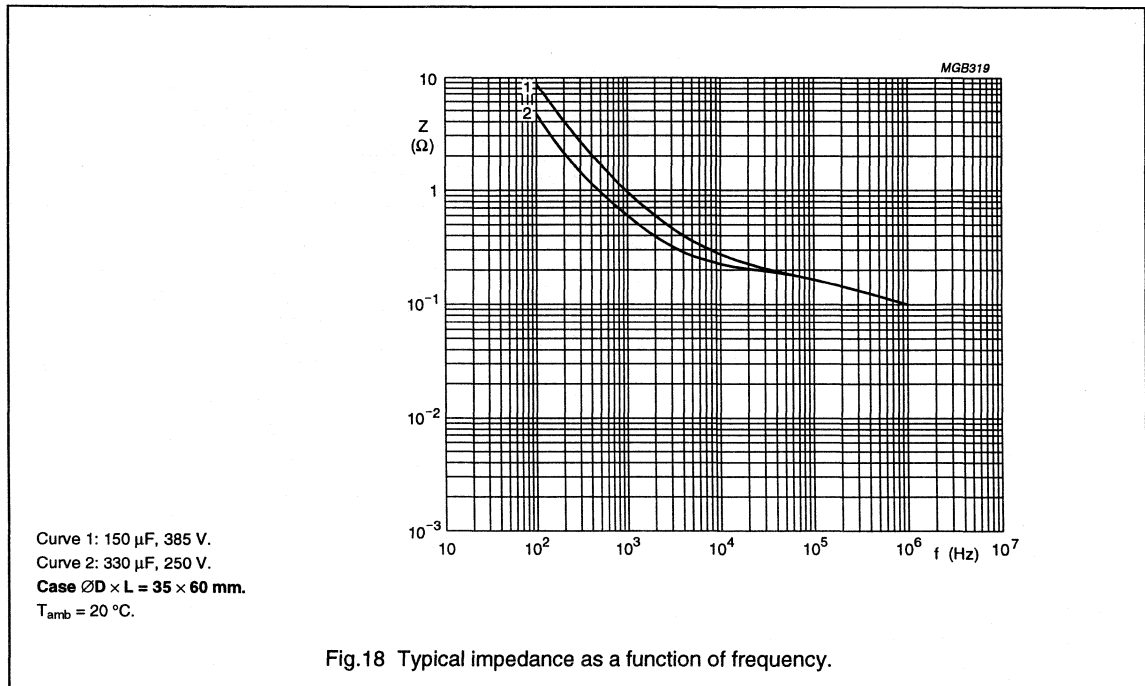
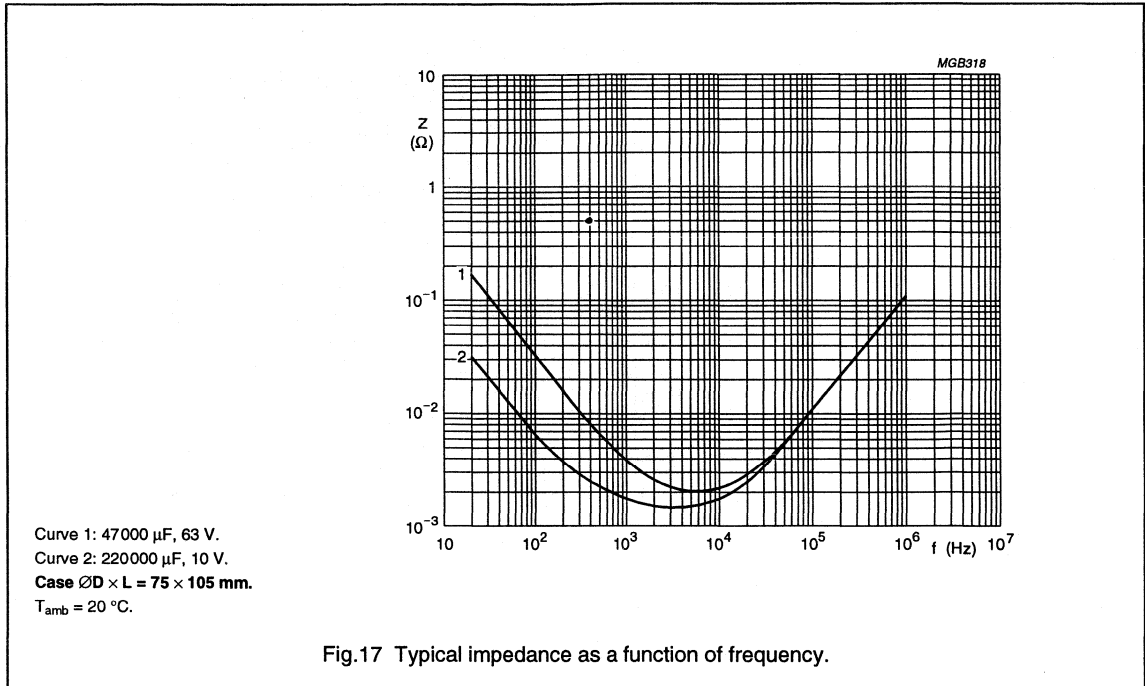


Fig.16 Typical impedance as a function of frequency.

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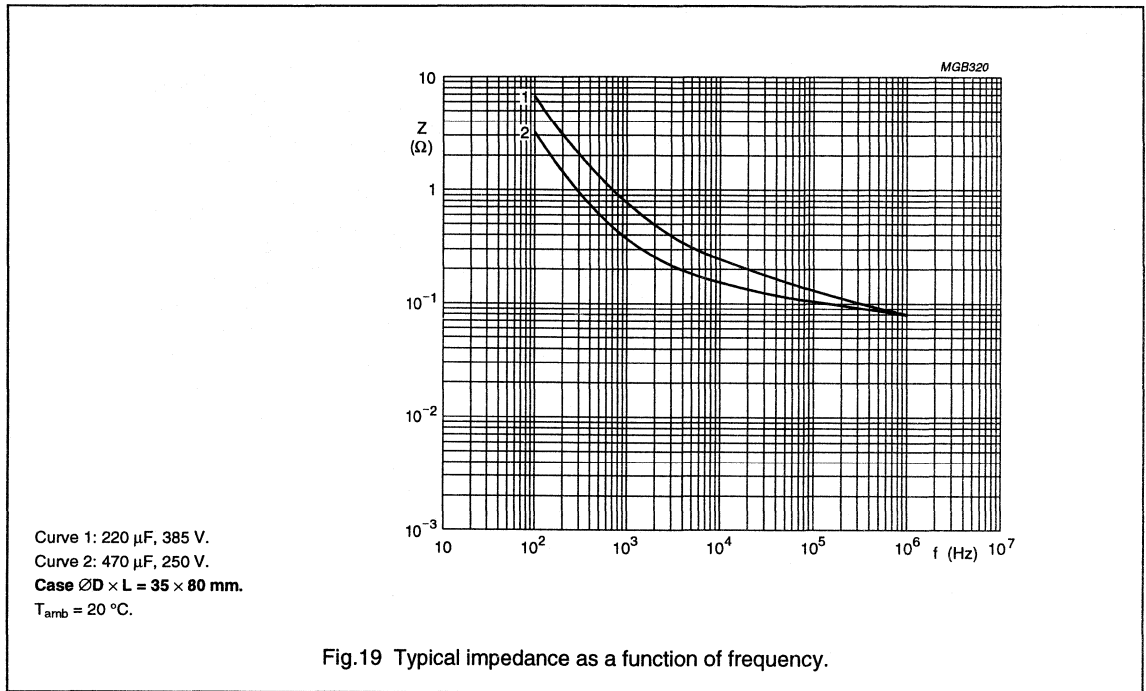


Fig.19 Typical impedance as a function of frequency.

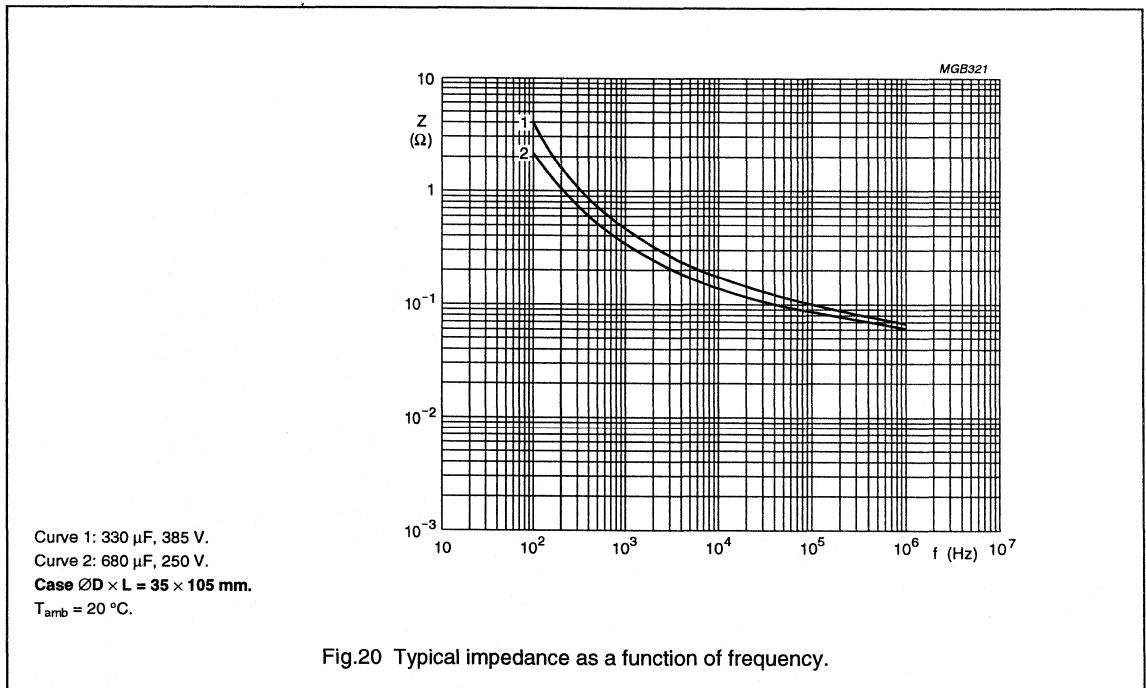
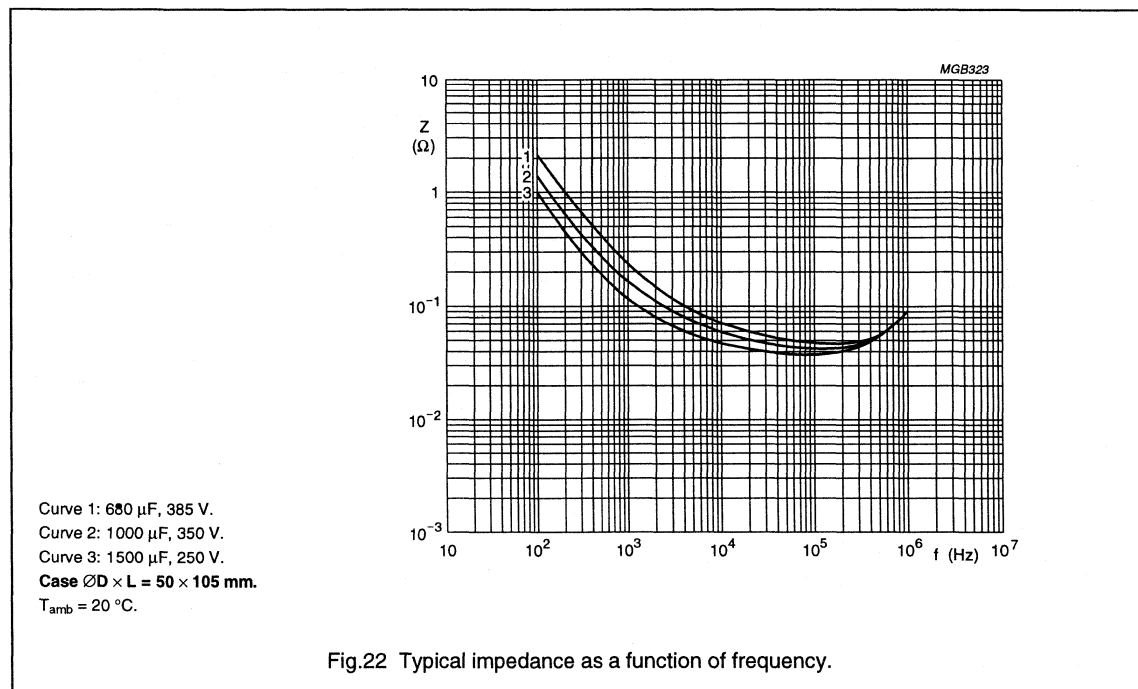
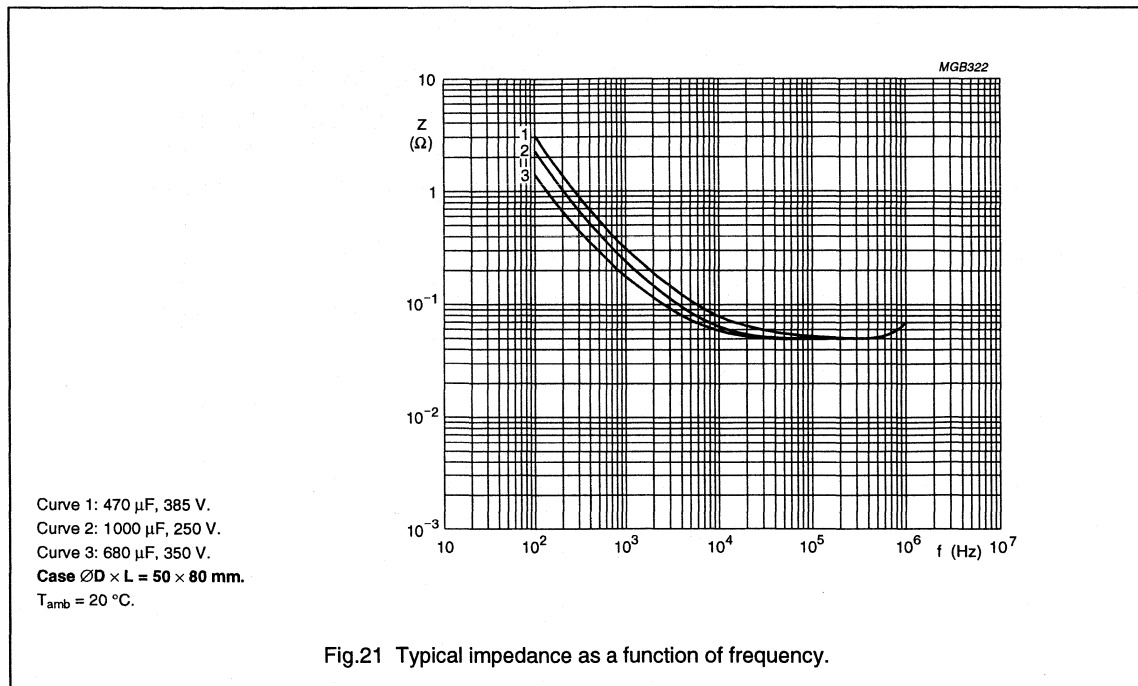


Fig.20 Typical impedance as a function of frequency.

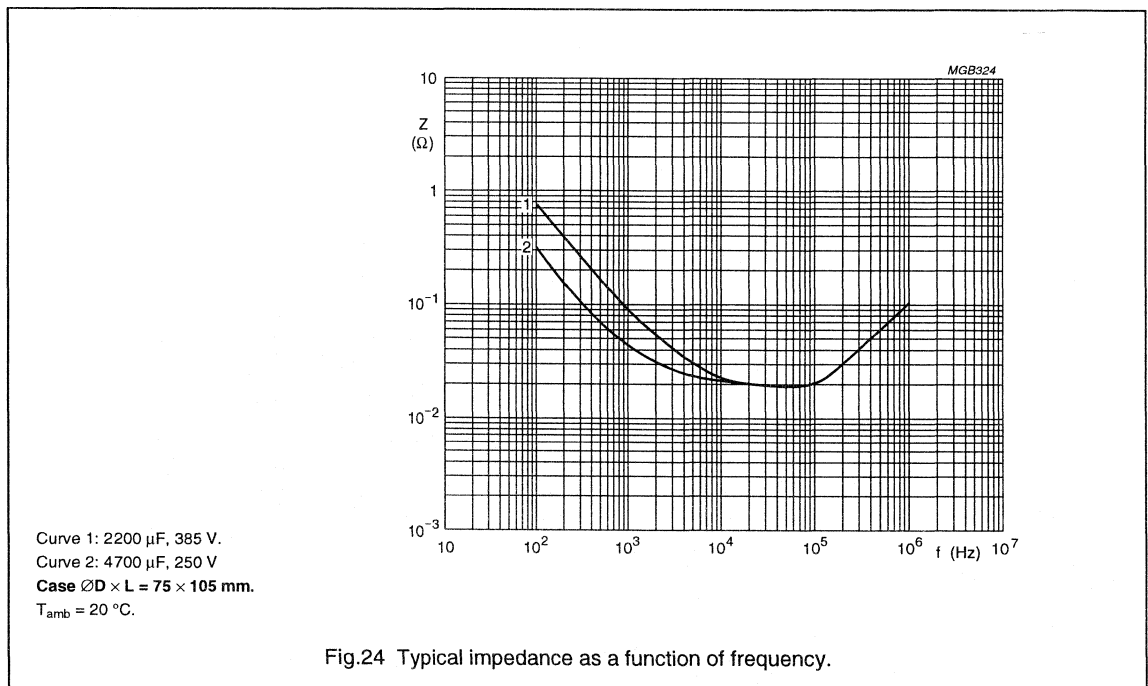
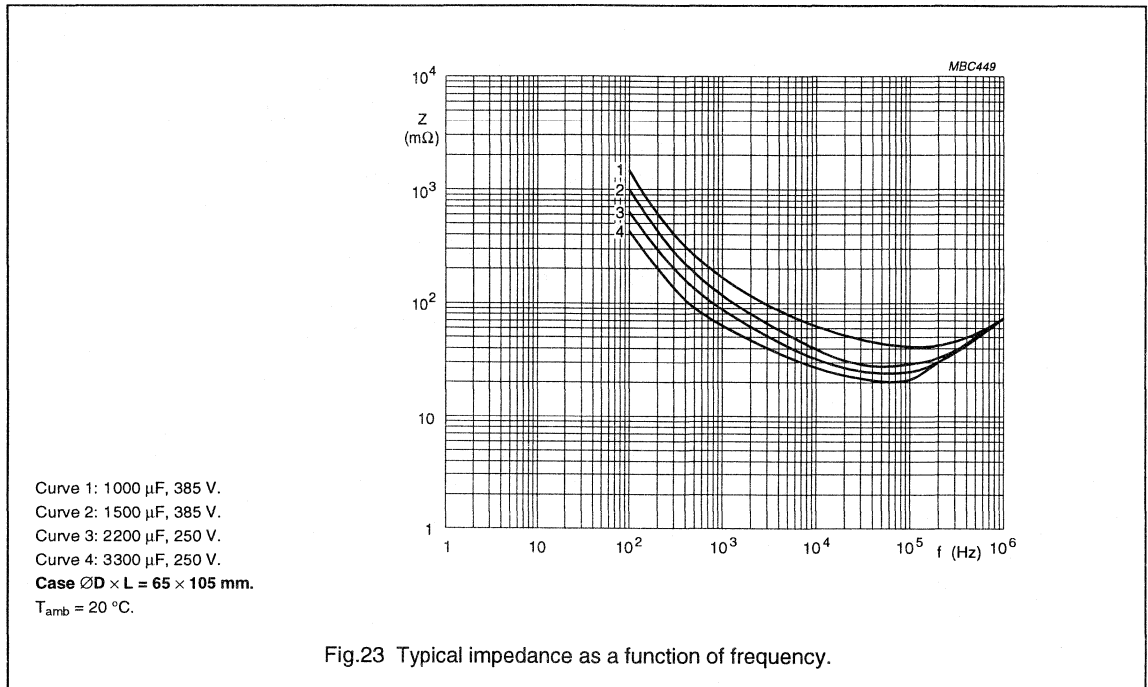
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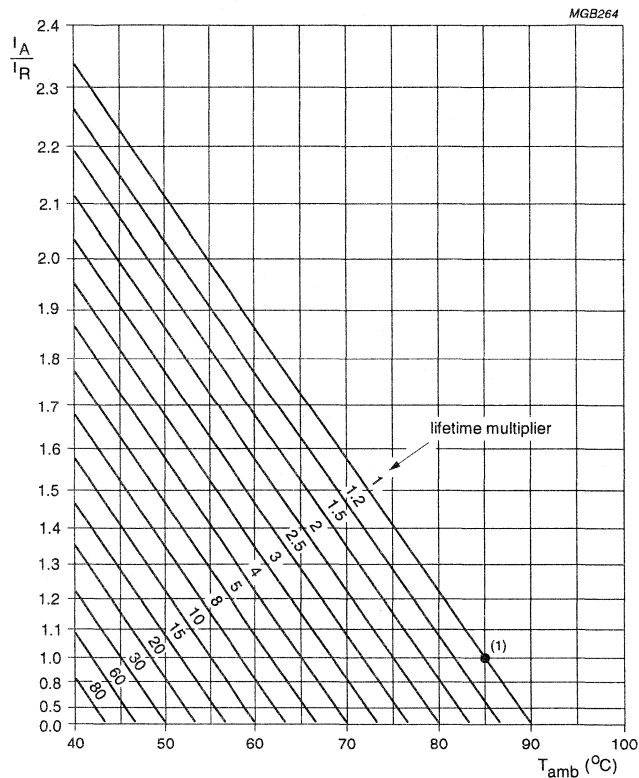
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RIPPLE CURRENT AND USEFUL LIFE

Table 4 Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER
50	0.83
100	1.00
200	1.10
400	1.15
1000	1.19
≥ 2000	1.20



I_A = actual ripple current at 100 Hz and 85 °C.
 I_R = rated ripple current at 100 Hz and 85 °C.
 With an absolute maximum of 50 A.

(1) Useful life at 85 °C and I_R applied: 20000 hours; (5000 hours for 400 V types).

Fig.25 Multiplier of useful life as a function of ambient temperature and ripple current load.

Non-solid Al - 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	$T_{amb} = 85\text{ °C}$; 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	$T_{amb} = 85\text{ °C}$; 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	$T_{amb} = 85\text{ °C}$; no voltage applied; 500 hours; after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 10\%$ $I_{L5} \leq 2 \times \text{spec. limit}$

Non-solid Al - electrolytic capacitors

Mounting Accessories

MECHANICAL DATA

Clamps for ST - versions, $\varnothing D = 35, 50, 65$ and 75 mm

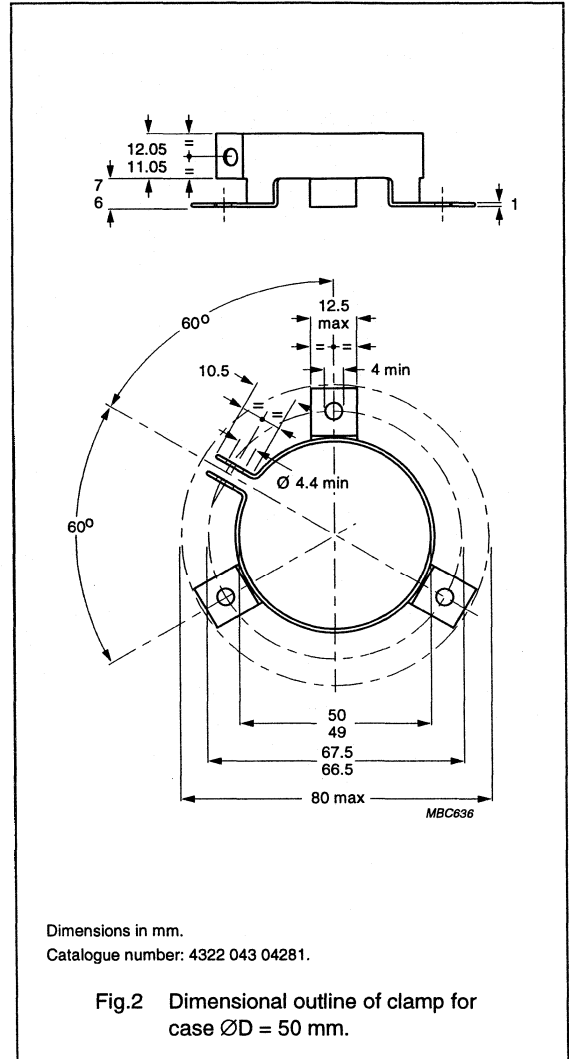
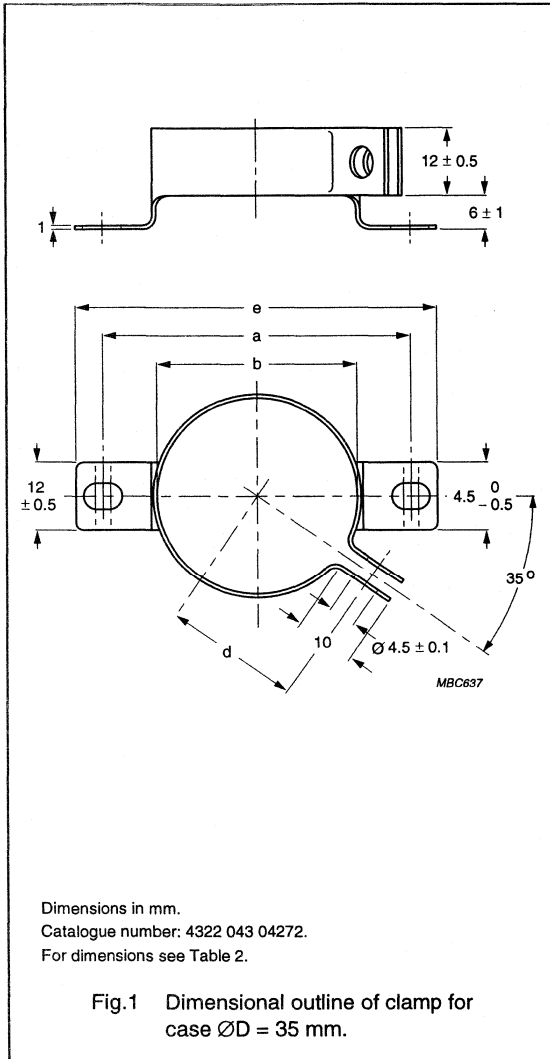
To facilitate vertical mounting, a series of rigid clamps made of zinc plated steel are available.

The clamps have either two or three mounting lugs, may be easily slipped over the capacitor and then clamped with

a nut and bolt. Four types of clamps are available, one for each case diameter.

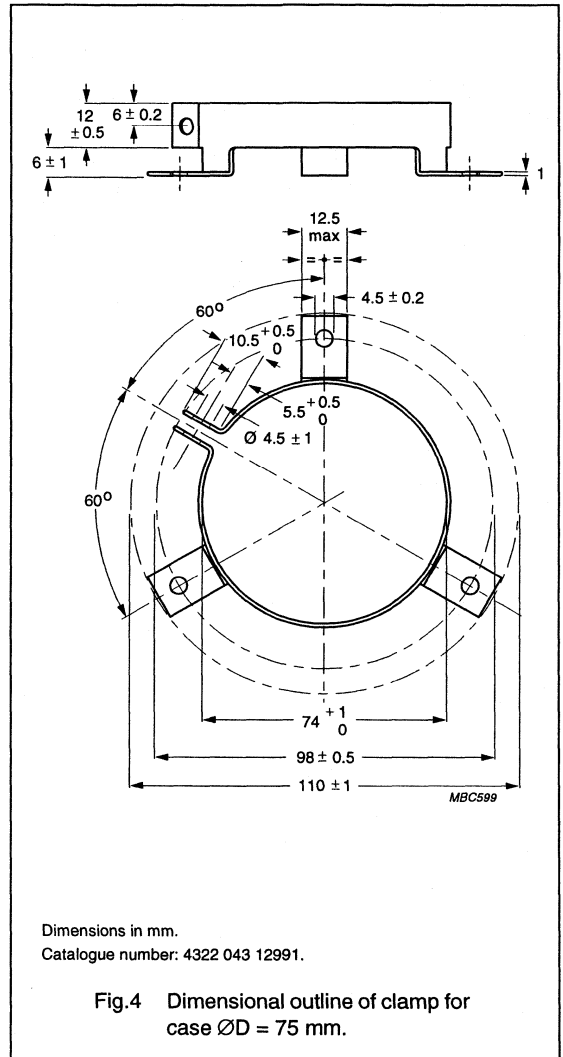
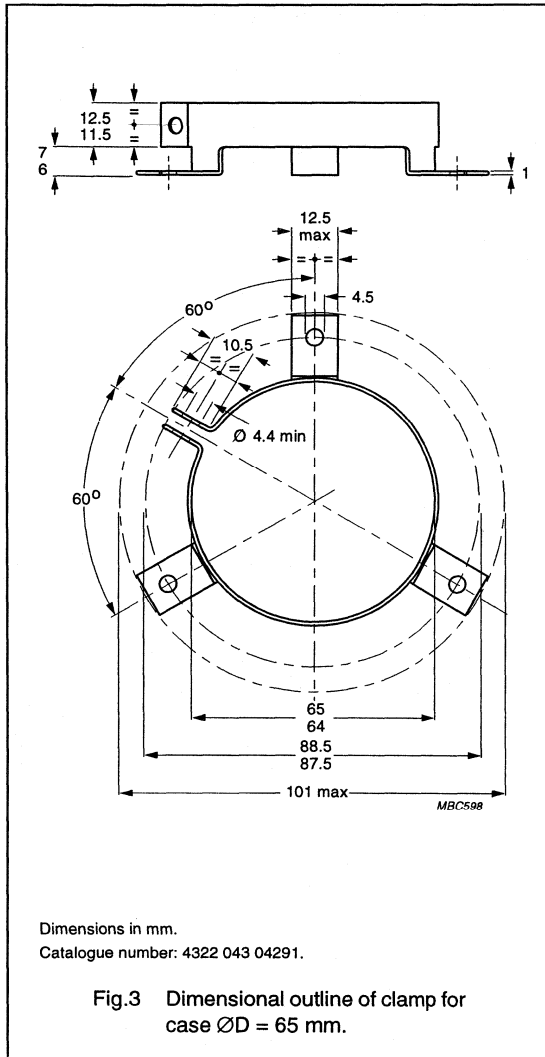
They are delivered without nuts or bolts.

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



Non-solid Al - electrolytic capacitors

Mounting Accessories



Non-solid Al - 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).

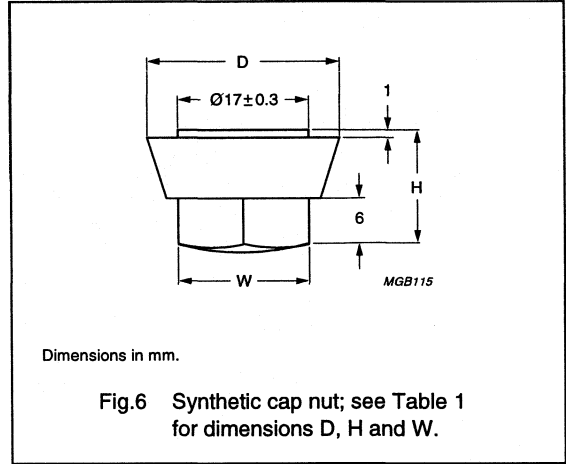
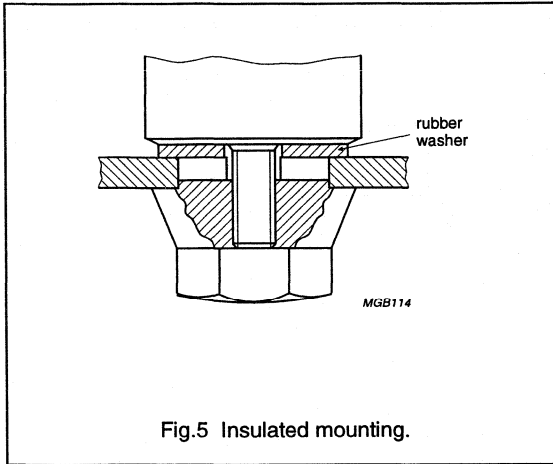
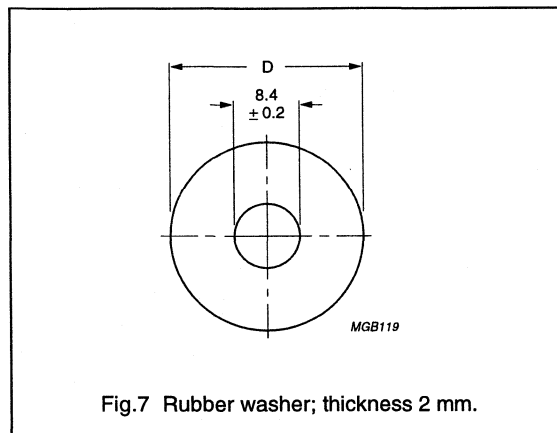


Table 1 Dimensions of synthetic cap nut; see Fig.6

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

Note

1. Dimension W is measured across flats.



Rubber washer ordering codes

D (mm)	D (mm)	CATALOGUE NUMBER
34	8.4	4322 043 05591
49	13	4322 043 05531
64	13	4322 043 05521
74	13	4322 043 13001

Non-solid Al - electrolytic capacitors

Mounting Accessories

Clamps for SL - versions, $\varnothing D = 25, 30, 35$ 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.

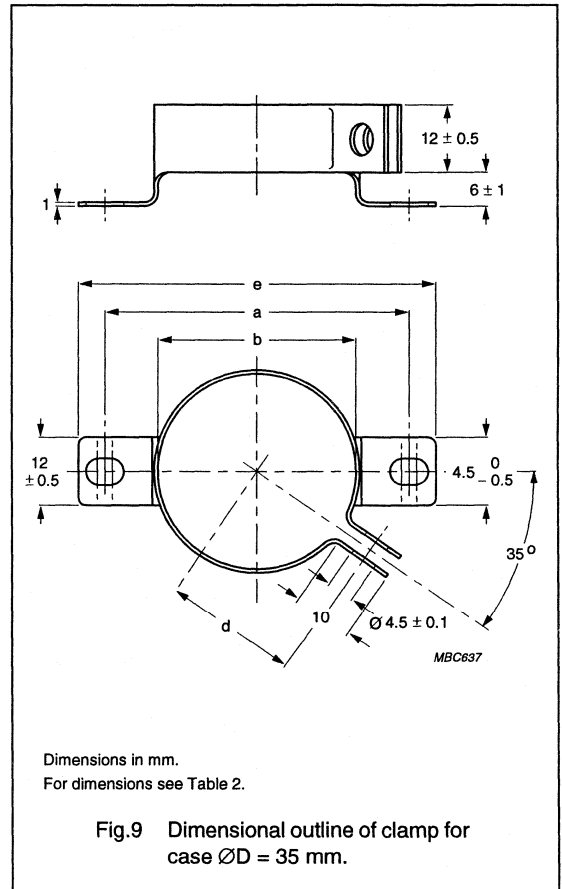
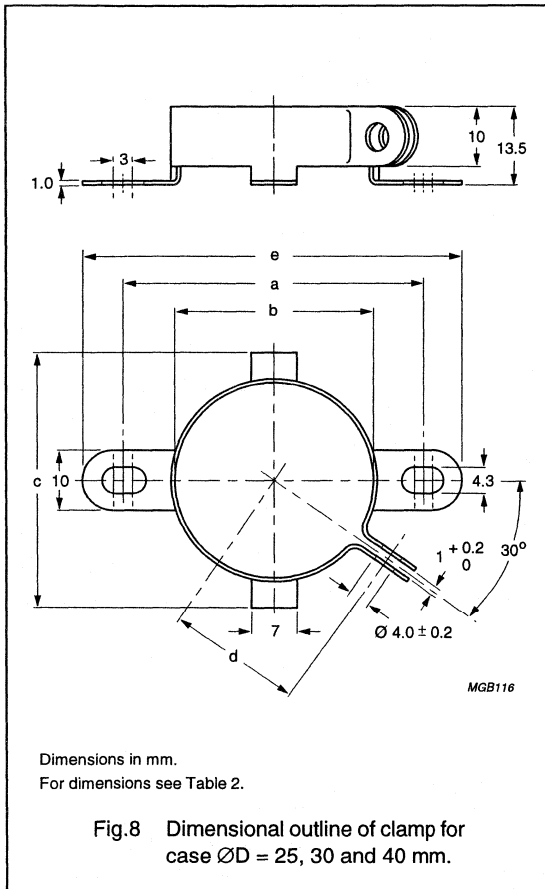
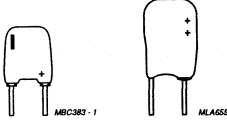


Table 2 Clamp dimensions; see Figs 1, 8 and 9


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

**RADIAL
(pearl)**



AXIAL



PROFESSIONAL
20 000 hours / 125 °C

SAL- RPM128 H: 9 mm page 560	SAL- RP122 H: 12 mm page 579
SAL- A123 page 597	

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Solid Al - electrolytic capacitors

Solid Al, Radial Pearl Miniature

SAL-RPM 128

FEATURES

- Polarized aluminium electrolytic capacitors, solid electrolyte MnO_2
- Radial leads, max. height 9.5 mm, resin dipped, orange coloured
- Extremely long useful life, 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.

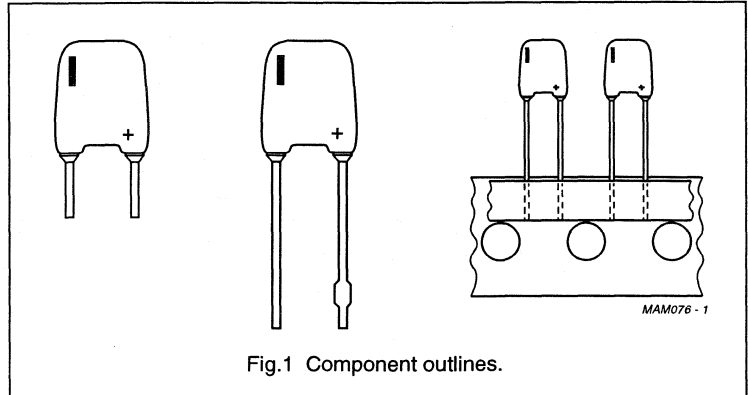
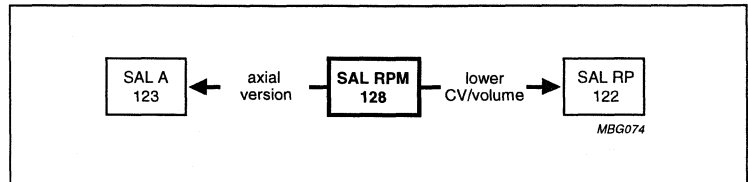


Fig.1 Component outlines.



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 × 7 × 3 to 9.5 × 8 × 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 (DIN 40040; NF C20-600)	55/125/56 (FKD; 434)

Solid Al - electrolytic capacitors
Solid Al, Radial Pearl Miniature

SAL-RPM 128

Selection chart for C_R , U_R , U_C and relevant maximum case sizes ($H \times W \times T$ in mm)

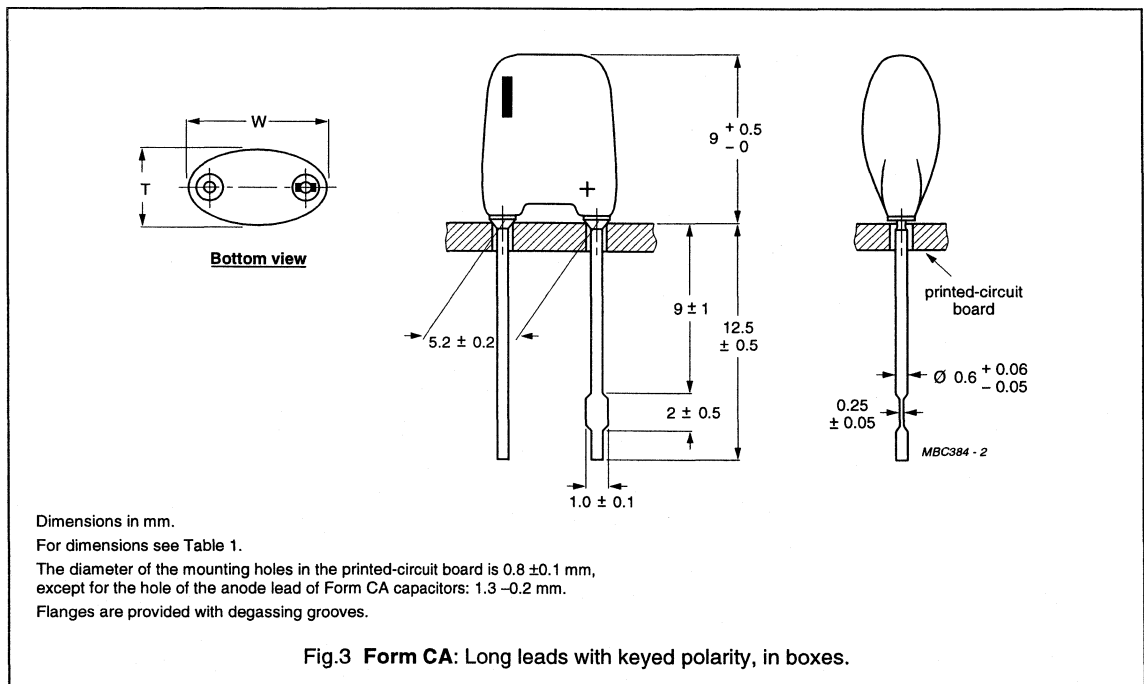
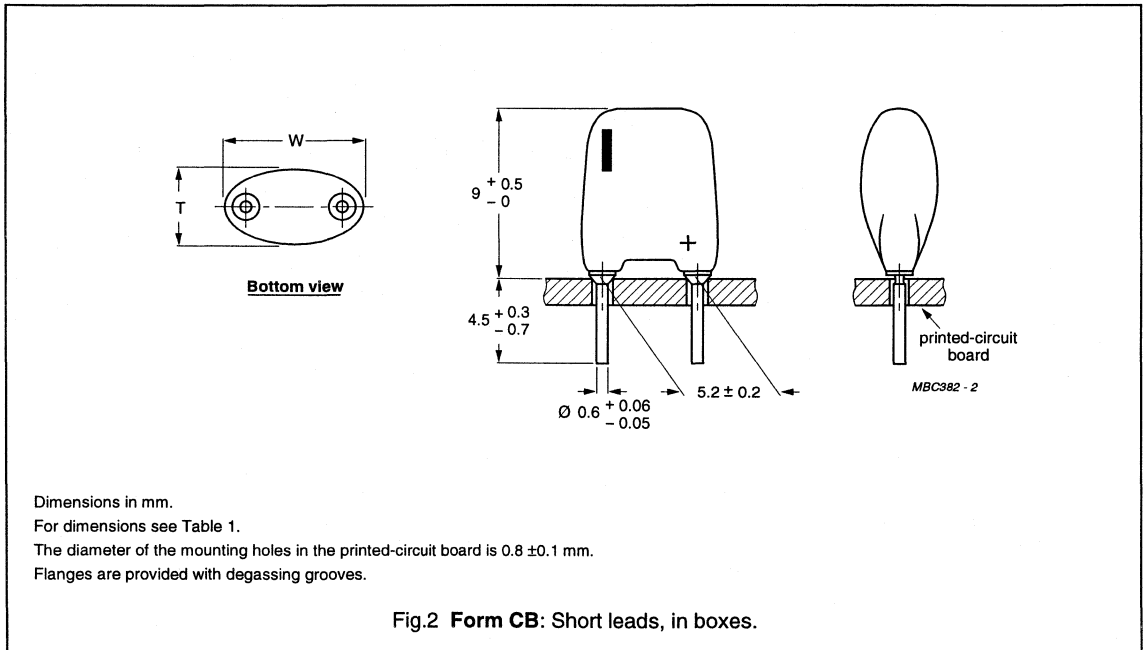
Preferred types in **bold**.

C_R (μF)	U_R (V) at $T_{\text{amb}} = 85^\circ\text{C}$					
	6.3	10	16	25	35	40
	U_C (V) at $T_{\text{amb}} = 125^\circ\text{C}$					
	6.3	10	16	25	25	25
0.1	–	–	–	–	–	9.5 × 7 × 3
0.15	–	–	–	–	–	9.5 × 7 × 3
0.22	–	–	–	–	–	9.5 × 7 × 3.5
0.33	–	–	–	–	9.5 × 7 × 3.5	9.5 × 7 × 4
0.47	–	–	–	–	9.5 × 7 × 4	9.5 × 7 × 5
0.68	–	–	–	9.5 × 7 × 3.5	9.5 × 7 × 4	9.5 × 7 × 5
1	–	–	–	9.5 × 7 × 3.5	9.5 × 7 × 5	9.5 × 8 × 5
1.5	–	–	–	9.5 × 7 × 3.5	9.5 × 8 × 5	9.5 × 8 × 6
2.2	–	–	9.5 × 7 × 3.5	9.5 × 7 × 4	9.5 × 8 × 6	9.5 × 8 × 6
3.3	–	–	9.5 × 7 × 3.5	9.5 × 7 × 5	9.5 × 8 × 6	–
4.7	–	9.5 × 7 × 3.5	9.5 × 7 × 4	9.5 × 8 × 5	–	–
6.8	–	9.5 × 7 × 3.5	9.5 × 7 × 4	9.5 × 8 × 6	–	–
10	9.5 × 7 × 3.5	9.5 × 7 × 4	9.5 × 7 × 5	9.5 × 8 × 6	–	–
15	–	9.5 × 7 × 4	9.5 × 8 × 5	–	–	–
22	9.5 × 7 × 4	9.5 × 7 × 5	9.5 × 8 × 6	–	–	–
33	9.5 × 7 × 5	9.5 × 8 × 5	–	–	–	–
47	9.5 × 8 × 5	9.5 × 8 × 6	–	–	–	–
68	9.5 × 8 × 6	–	–	–	–	–

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Solid Al - electrolytic capacitors

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

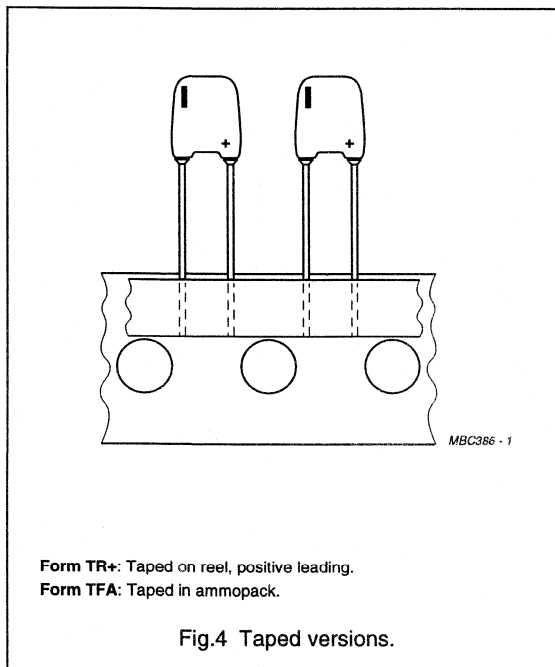
MAXIMUM CASE SIZE H × W × T (mm)	CASE CODE	MASS (g)	PACKAGING QUANTITIES			
			FORM CA (note 1)	FORM CB (note 1)	FORM TR+	FORM TFA
9.5 × 7 × 3	10	≈0.22	1000	1000	2000	2000
9.5 × 7 × 3.5	20	≈0.25	1000	1000	2000	2000
9.5 × 7 × 4	30	≈0.30	1000	1000	2000	2000
9.5 × 7 × 5	40	≈0.35	1000	1000	1000	1000
9.5 × 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
- '-' 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 Al - electrolytic capacitors

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SAL-RPM 128

Ordering example

Electrolytic capacitors SAL-RPM

10 $\mu\text{F}/16 \text{ V}; \pm 20\%$ Maximum case size: $9.5 \times 7 \times 5$, Form CB

Catalogue number: 2222 128 55109.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at $T_{\text{amb}} = 20$ to 25 °C, $P = 86$ to 106 kPa, $RH = 45$ 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 δ	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 kHz 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 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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U _C (V)	U _R (V)	C _R 100 Hz (μF)	MAXIMUM CASE SIZE H × W × T (mm)	CASE CODE	I _R 100 kHz 125 °C (mA)	I _R 10 kHz 85 °C (mA)	I _R 100 kHz 40 °C (mA)	I _{LS} 5 min (μA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222 128....			
												FORM CB	FORM CA	FORM TR+ REEL	FORM 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	235	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
		0.47	9.5 × 7 × 4	30	6.3	90	165	2	0.10	430	20.00	50477	70477	20477	30477
35	35	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
		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
25	25	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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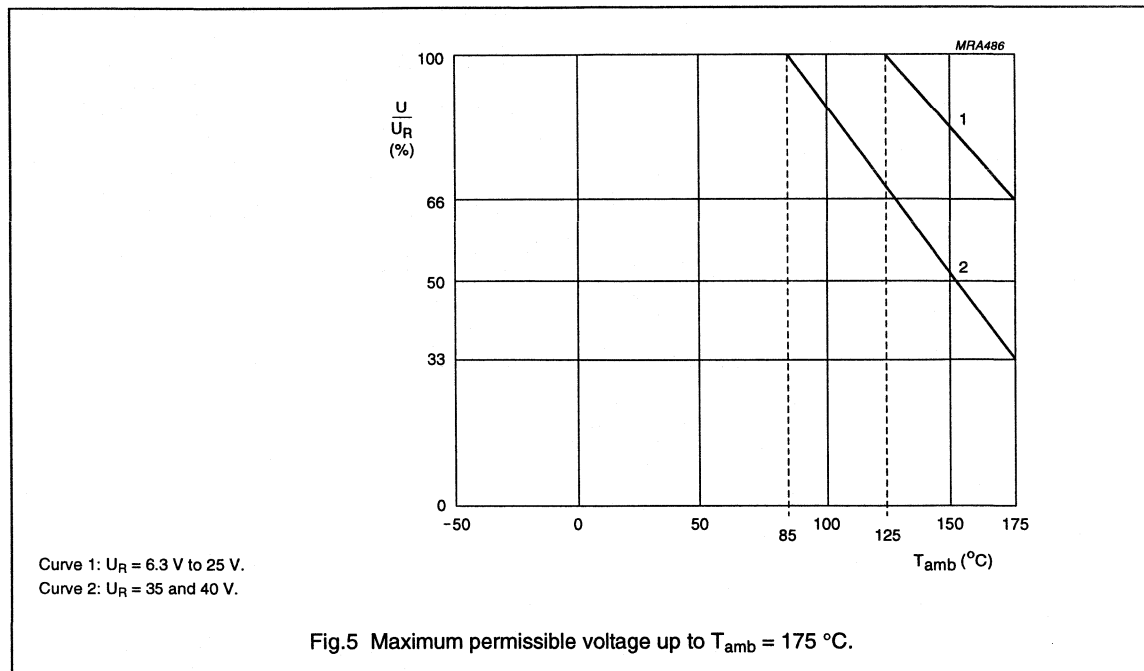
Additional electrical data

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	$\leq 2 V$
Maximum peak AC voltage without reverse voltage applied	$T_{amb} \leq 85^\circ C$	
	at $f \leq 0.1$ Hz	$0.30 \times U_R$
	at $0.1 \text{ Hz} < f \leq 1$ Hz	$0.45 \times U_R$
	at $1 \text{ Hz} < f \leq 10$ Hz	$0.60 \times U_R$
	at $10 \text{ Hz} < f \leq 50$ Hz	$0.65 \times U_R$
	at $f > 50$ Hz	$0.80 \times U_R$
	$85^\circ C < T_{amb} \leq 125^\circ C$	
	at $f \leq 0.1$ Hz	$0.15 \times U_R$
	at $0.1 \text{ Hz} < f \leq 1$ Hz	$0.22 \times U_R$
	at $1 \text{ Hz} < f \leq 10$ Hz	$0.30 \times U_R$
at $10 \text{ Hz} < f \leq 50$ Hz	$0.32 \times U_R$	
at $f > 50$ Hz	$0.40 \times U_R$	
Inductance		
Equivalent series inductance (ESL)	case sizes $9.5 \times 7 \times 3$ to $9.5 \times 7 \times 5$ mm	typ. 9 to 14 nH
	case sizes $9.5 \times 8 \times 5$ and $9.5 \times 8 \times 6$ 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 $9.5 \times 7 \times 5$ mm	$P_{125} = 88 \text{ mW}$
	case sizes $9.5 \times 8 \times 5$ and $9.5 \times 8 \times 6$ mm	$P_{125} = 104 \text{ mW}$
Current		
Maximum leakage current	after 5 minutes at U_R and $T_{amb} = 25^\circ C$	$I_{L5} \leq 0.025C_R \times U_R$ or $2 \mu A$ whichever is greater; see Table 2
Typical leakage current	15 s at U_R and $T_{amb} = 25^\circ C$	
	$U_R = 6.3$ 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



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:

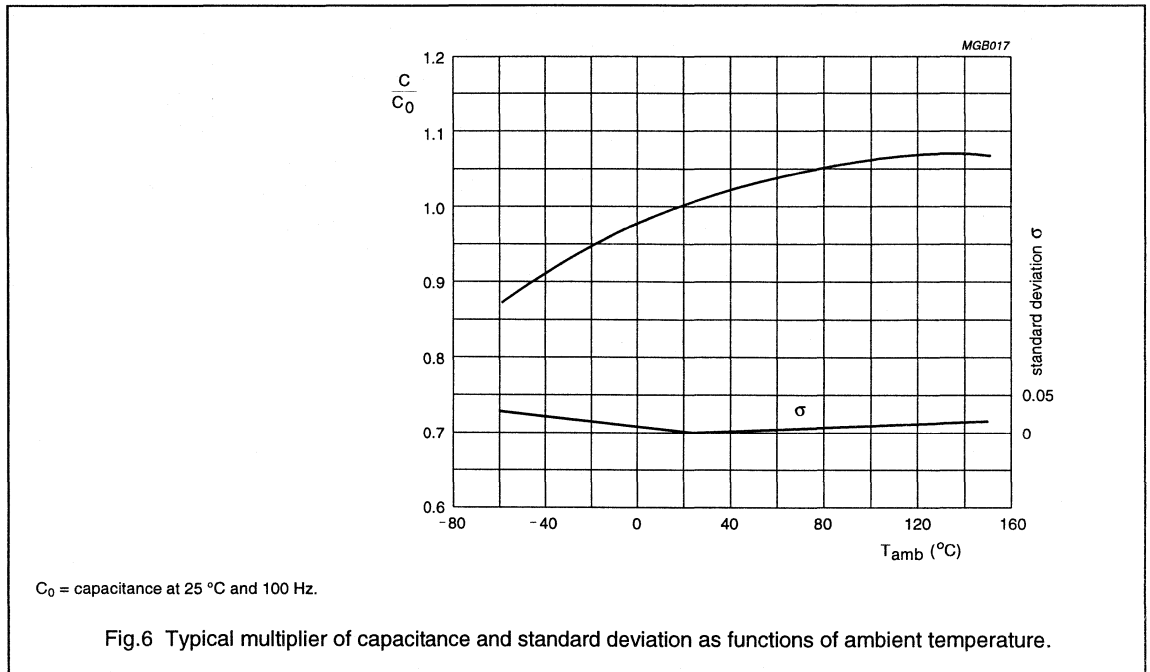
PARAMETER	T_{amb}					
	25 °C	40 °C	65 °C	85 °C	105 °C	125 °C
I_R multiplier	1.1	1.0	0.88	0.75	0.59	0.37



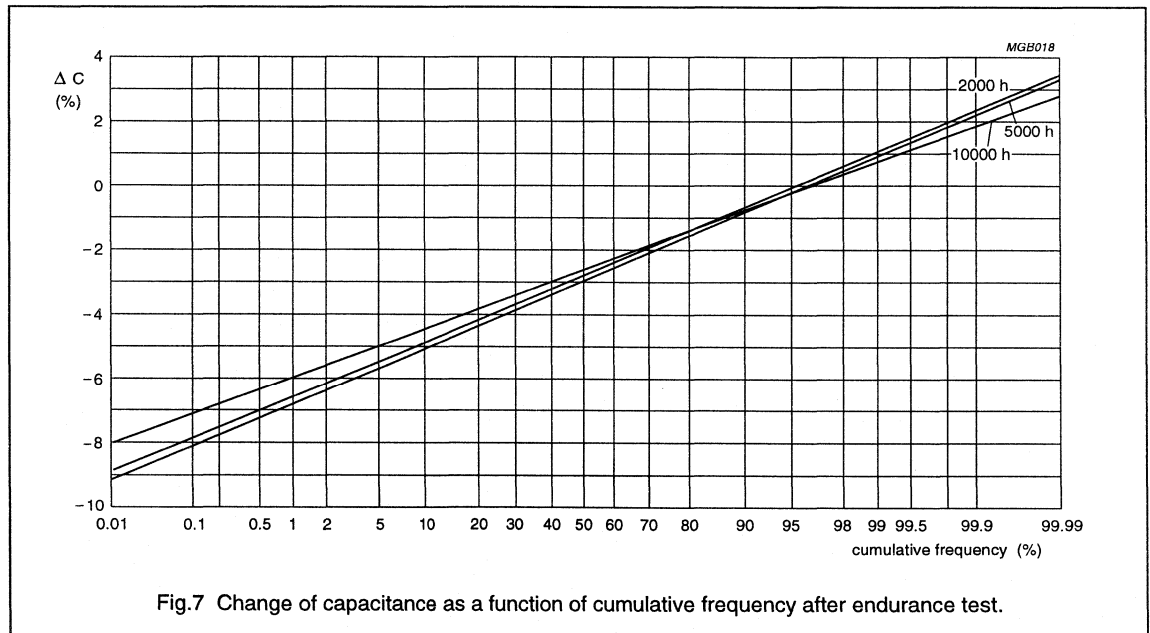
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Capacitance (C)



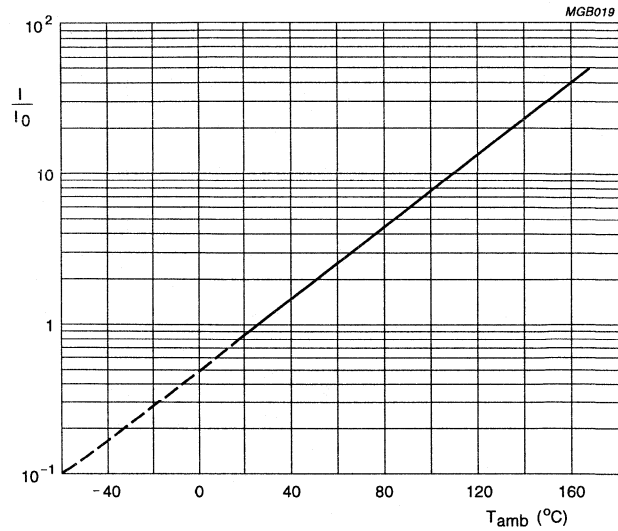
Typical capacitance change after endurance test at $T_{amb} = 125$ °C



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Leakage current



I₀ = leakage current during continuous operation at U_R and T_{amb} = 25 °C.

Fig.8 Typical multiplier of leakage current as a function of ambient temperature.

Typical leakage current change after endurance test at T_{amb} = 125 °C

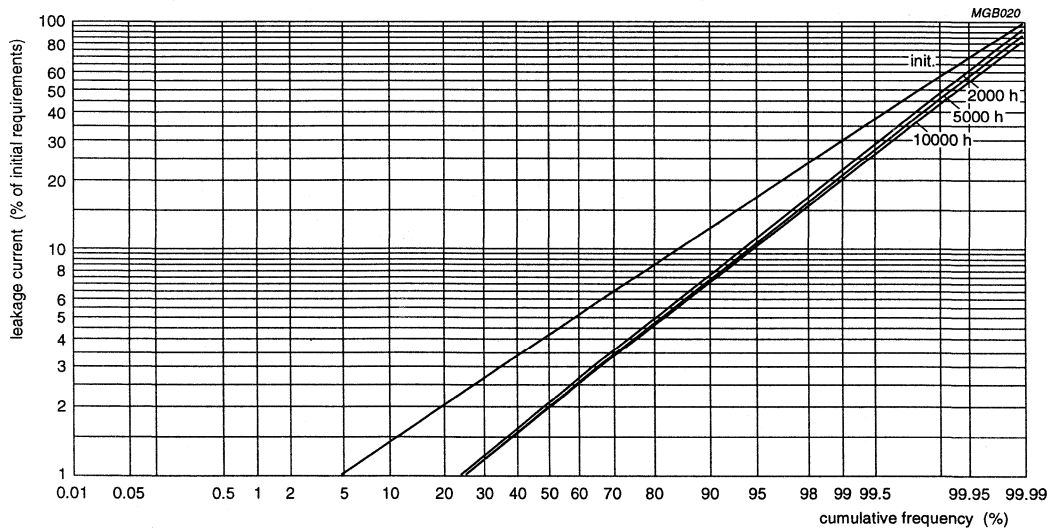


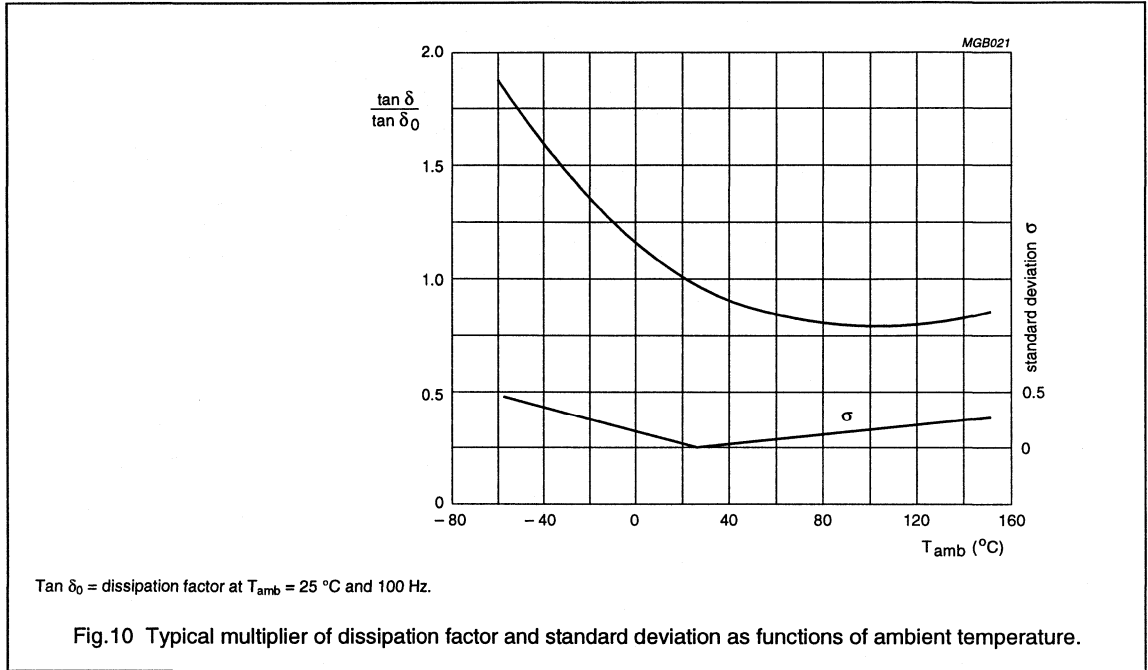
Fig.9 Leakage current change as a function of cumulative frequency after endurance test.



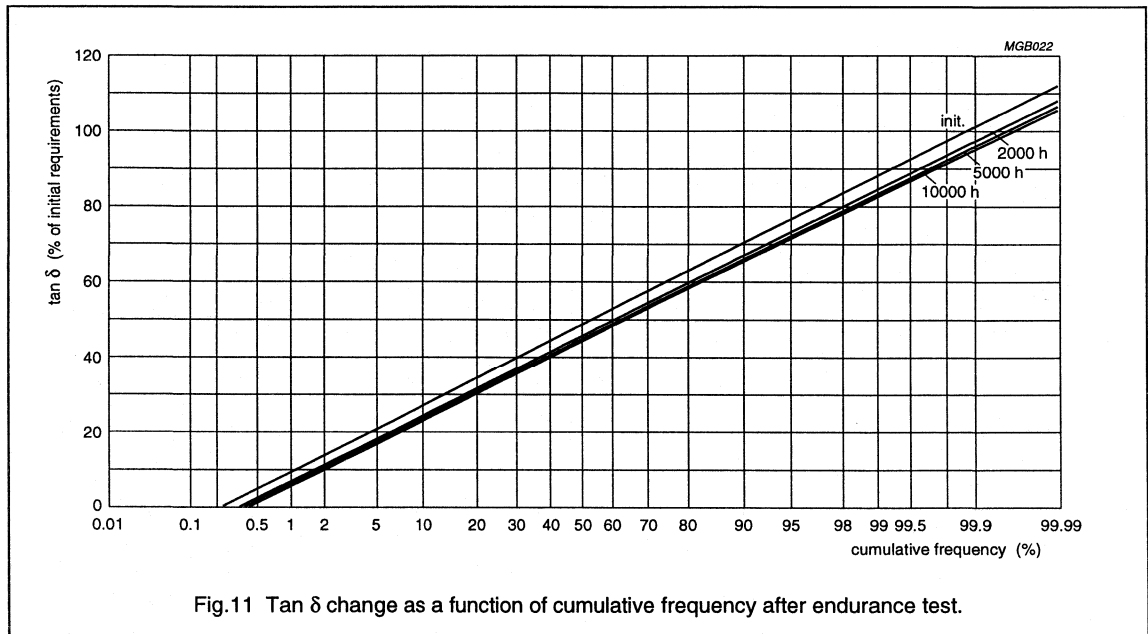
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Dissipation factor ($\tan \delta$)



Typical $\tan \delta$ change after endurance test at $T_{amb} = 125^{\circ}C$



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Equivalent series resistance (ESR)

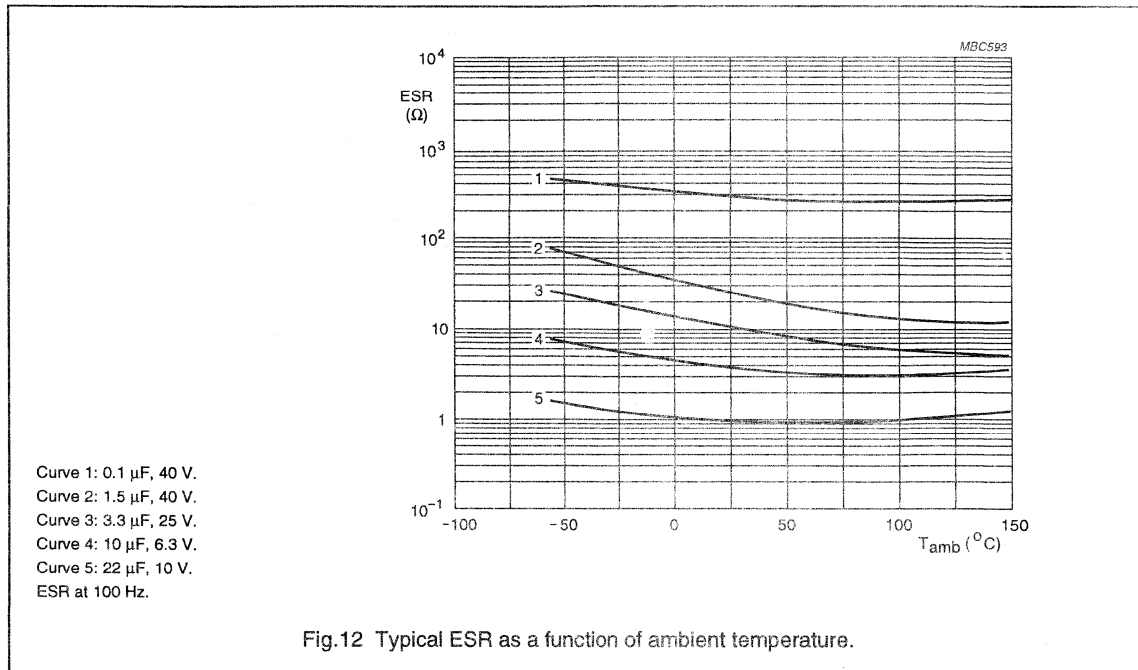


Fig.12 Typical ESR as a function of ambient temperature.

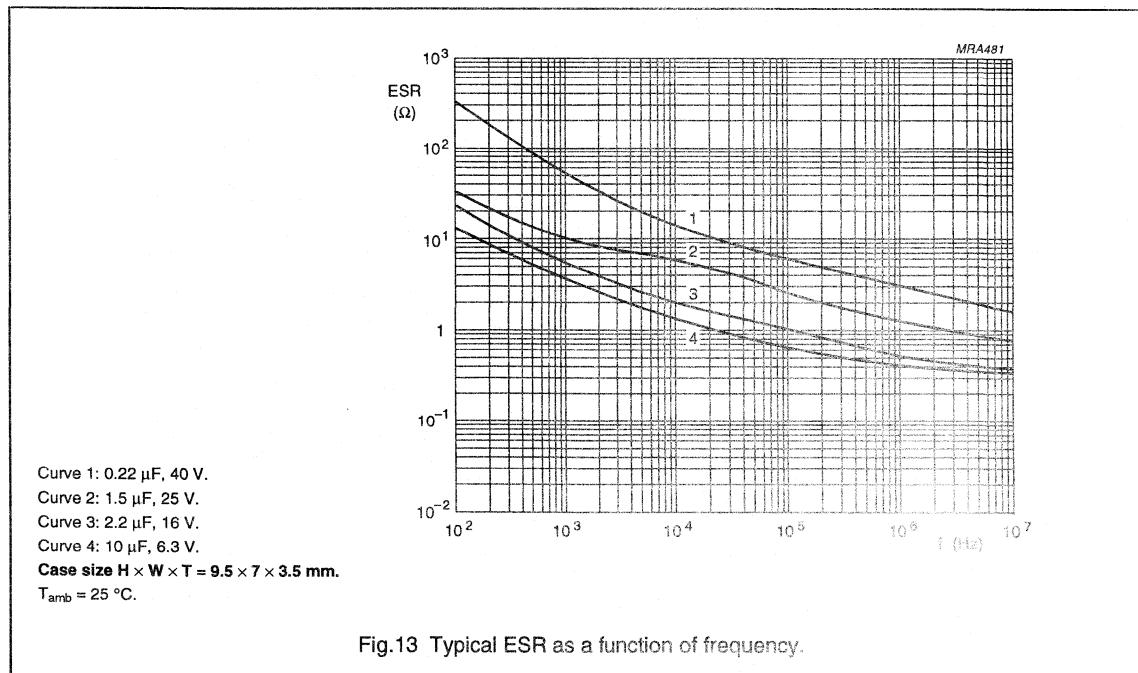
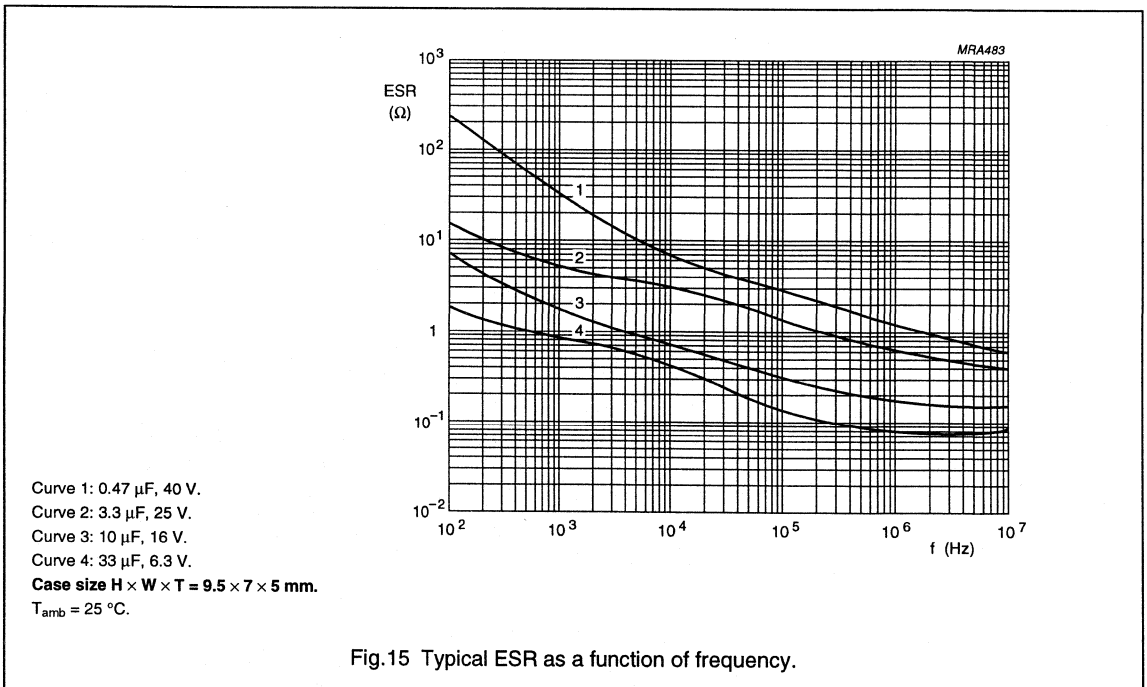
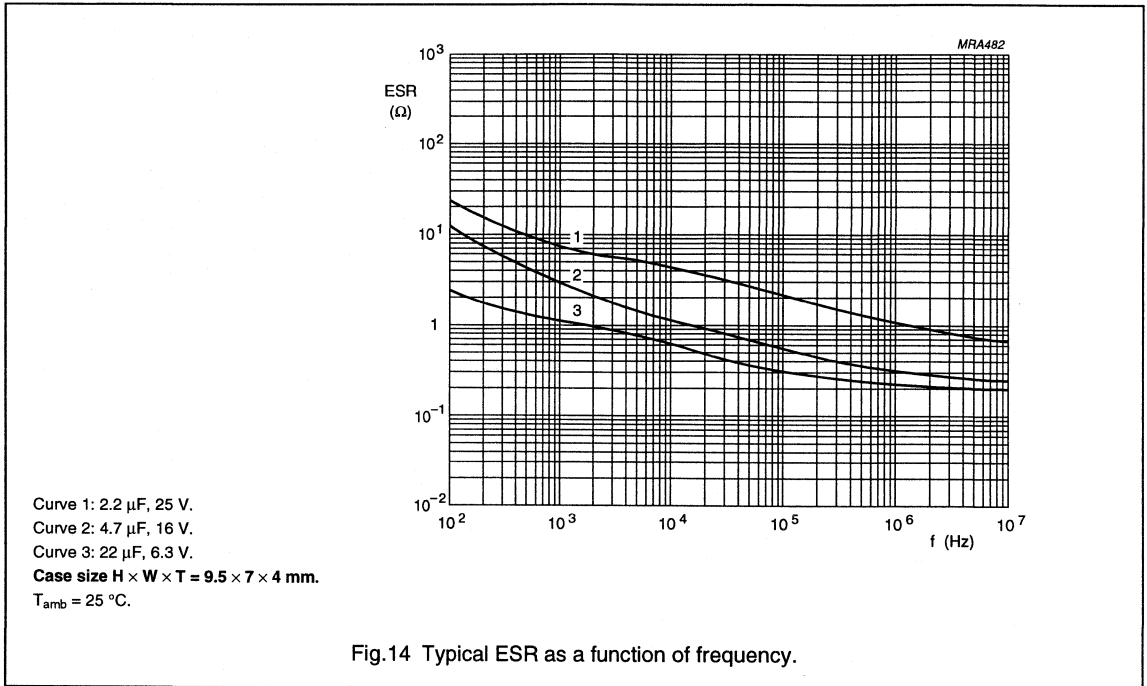


Fig.13 Typical ESR as a function of frequency.

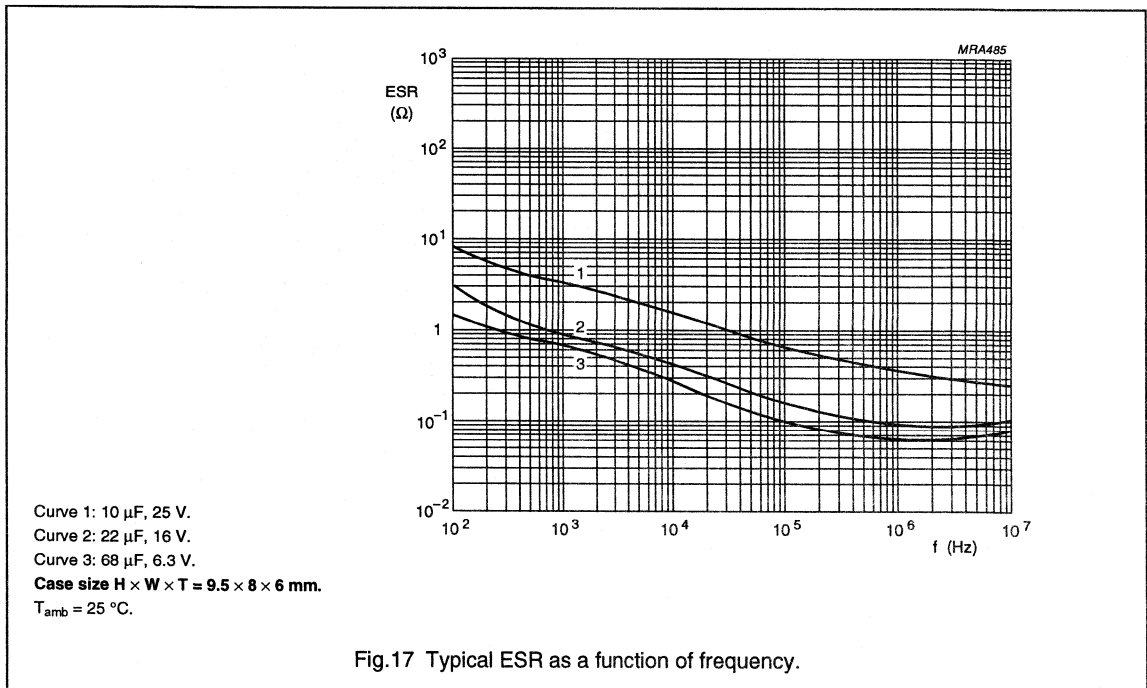
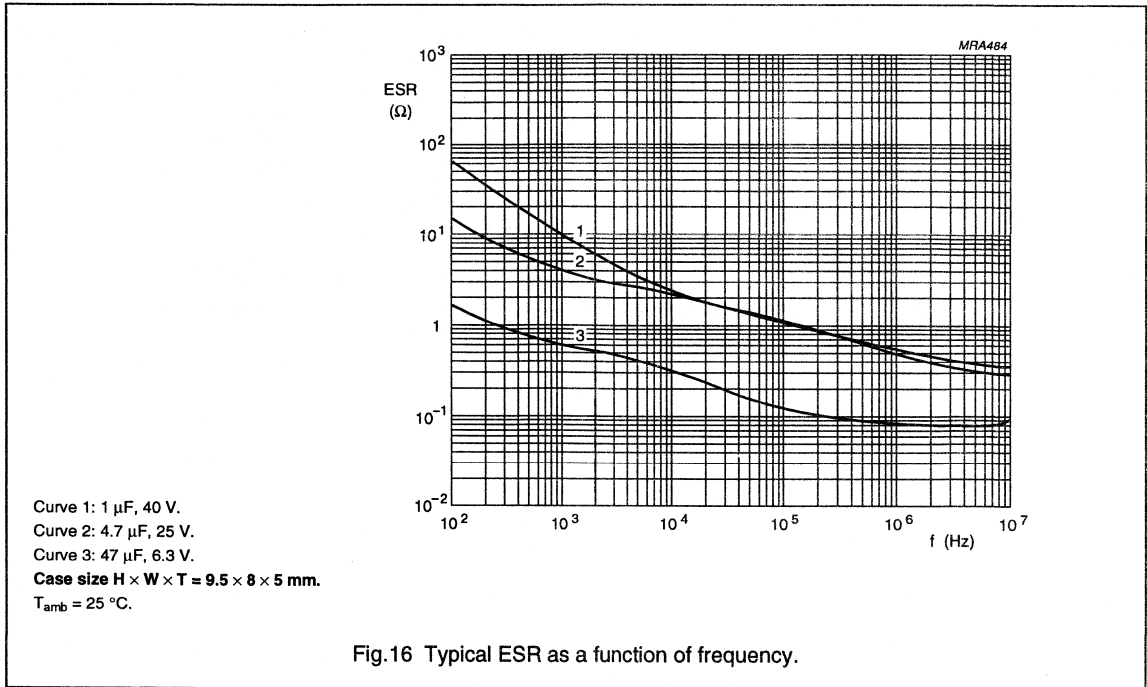
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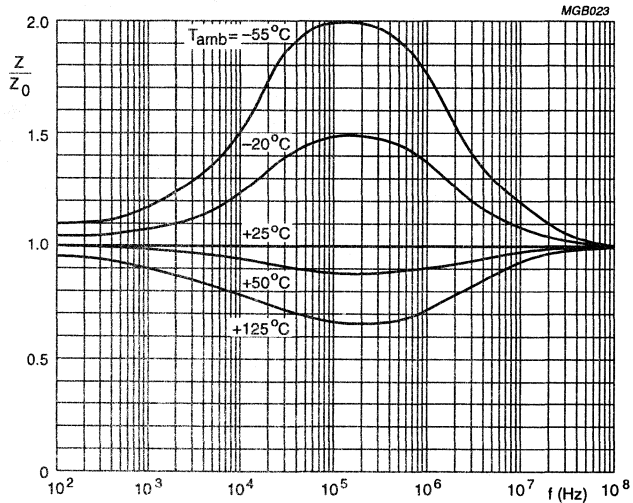
SAL-RPM 128



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 Solid Al, Radial Pearl Miniature

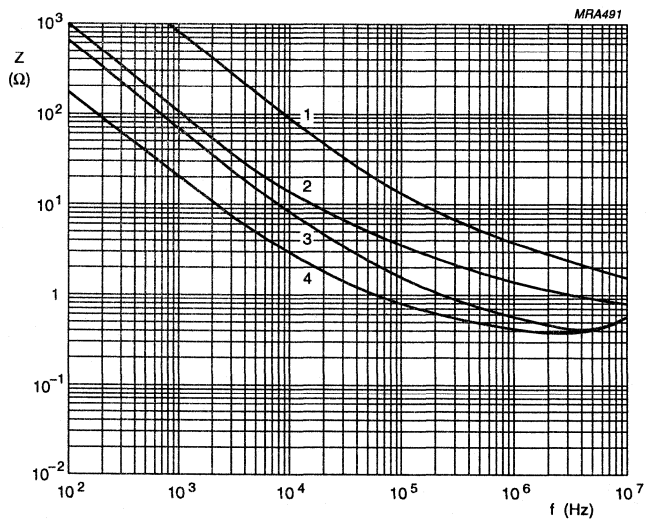
SAL-RPM 128

Impedance (Z)



Z_0 = initial impedance value at $T_{amb} = 25\text{ }^\circ\text{C}$.

Fig.18 Typical multiplier of impedance as a function of frequency at different ambient temperatures.



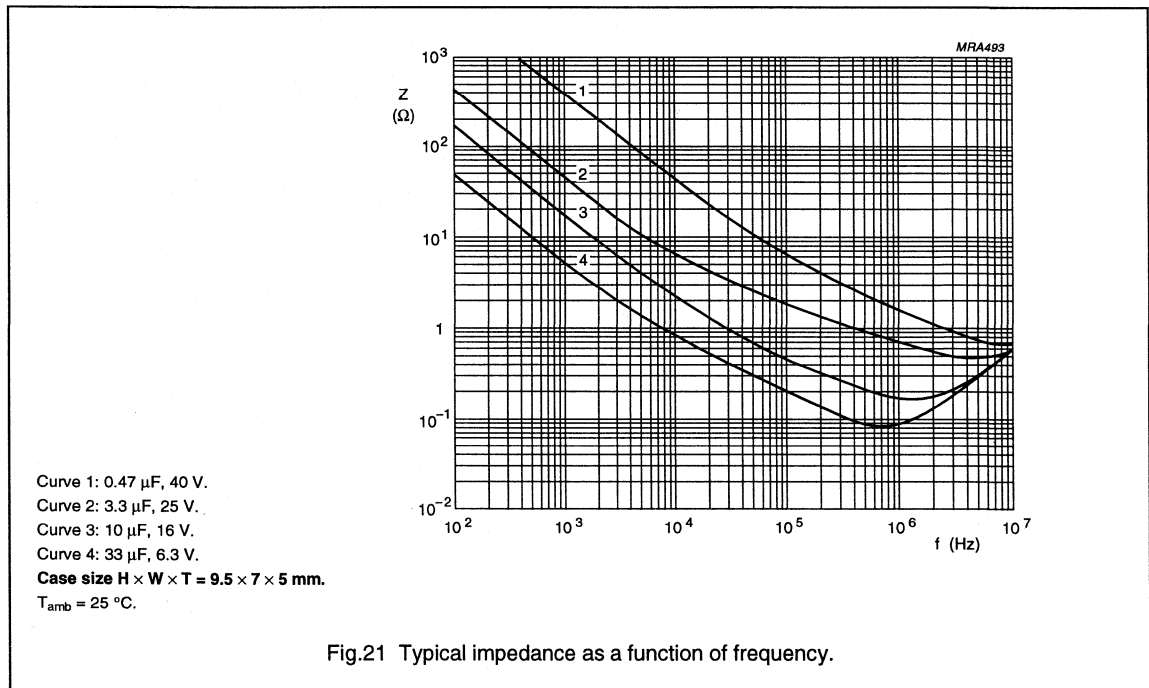
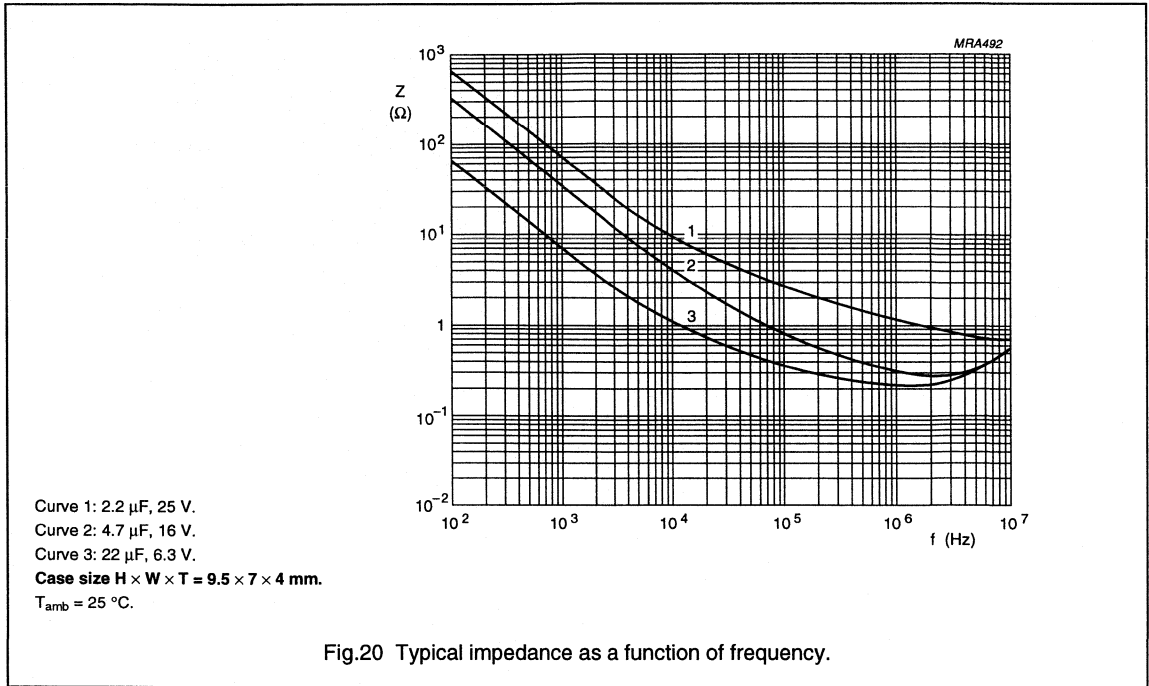
- Curve 1: 0.22 μF , 40 V.
- Curve 2: 1.5 μF , 25 V.
- Curve 3: 2.2 μF , 16 V.
- Curve 4: 10 μF , 6.3 V.

Case size $H \times W \times T = 9.5 \times 7 \times 3.5\text{ mm}$.
 $T_{amb} = 25\text{ }^\circ\text{C}$.

Fig.19 Typical impedance as a function of frequency.

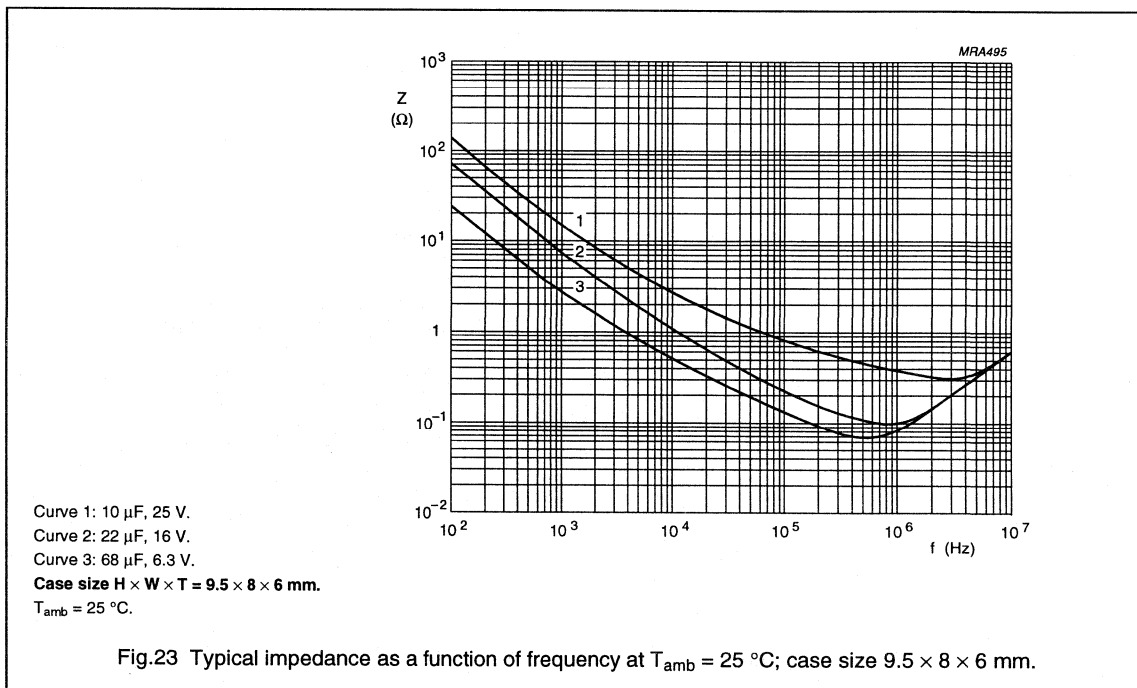
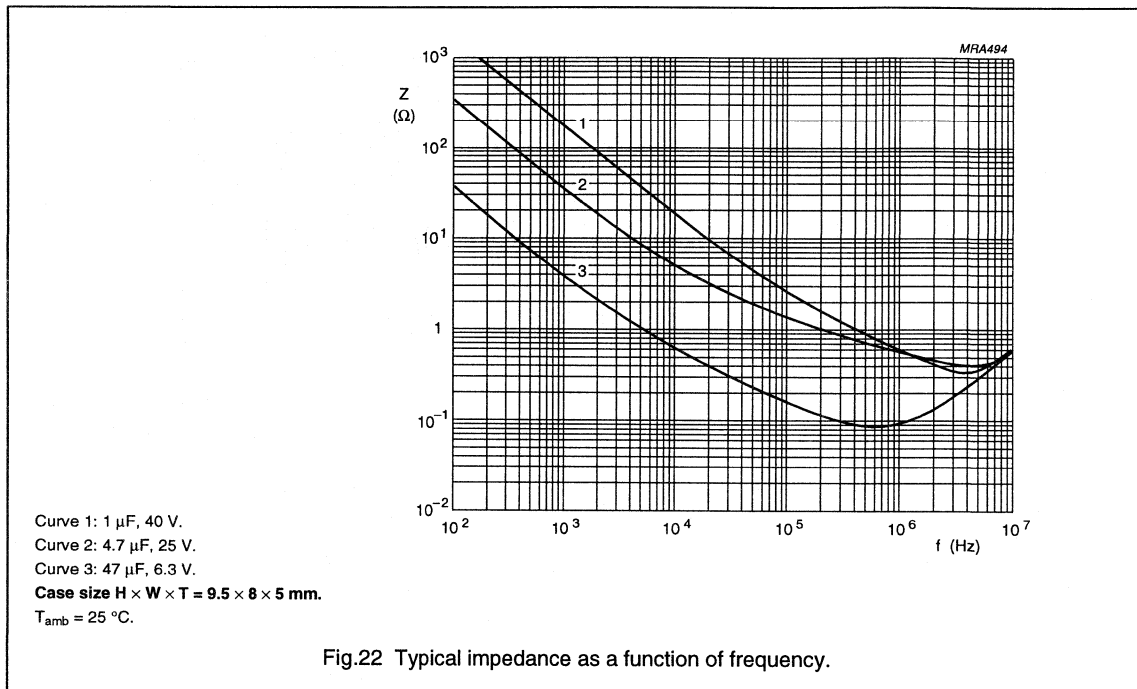
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SPECIFIC TESTS AND REQUIREMENTS

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	$T_{amb} = 125\text{ °C}$; $U_R = 6.3$ 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	$T_{amb} = 125\text{ °C}$; 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	$T_{amb} = 125\text{ °C}$; 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 $55 \pm 5\text{ °C}$ 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; $T_{\text{amb}} = 20$ to 25 °C; test duration = 20 s	after removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s; no burning particles must drop from the sample

Non-solid Al - electrolytic capacitors

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FEATURES

- Polarized aluminium electrolytic capacitors, solid electrolyte MnO₂
- 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.

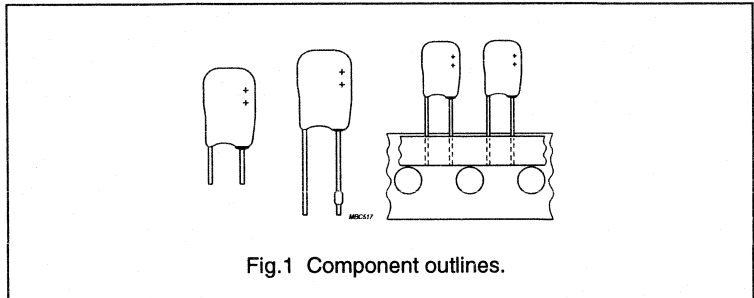
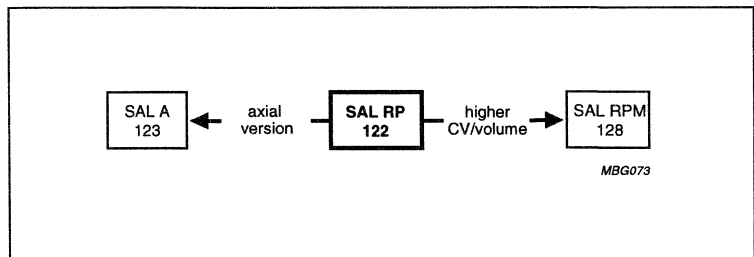


Fig.1 Component outlines.



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%, ±10%
Rated voltage range, U_R	6.3 to 40 V
Category temperature range: $U_C = 6.3$ to 25 V $U_R = 6.3$ to 40 V	-55 to +125 °C -55 to +85 °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 (DIN 40040; NF C20-600)	55/125/56 (FKD; 434)
Approvals	Liste LNZ 44-04 COS-B Gam-t-1

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Selection chart for C_R , U_R , U_C and relevant maximum case sizes (H × W × T in mm)

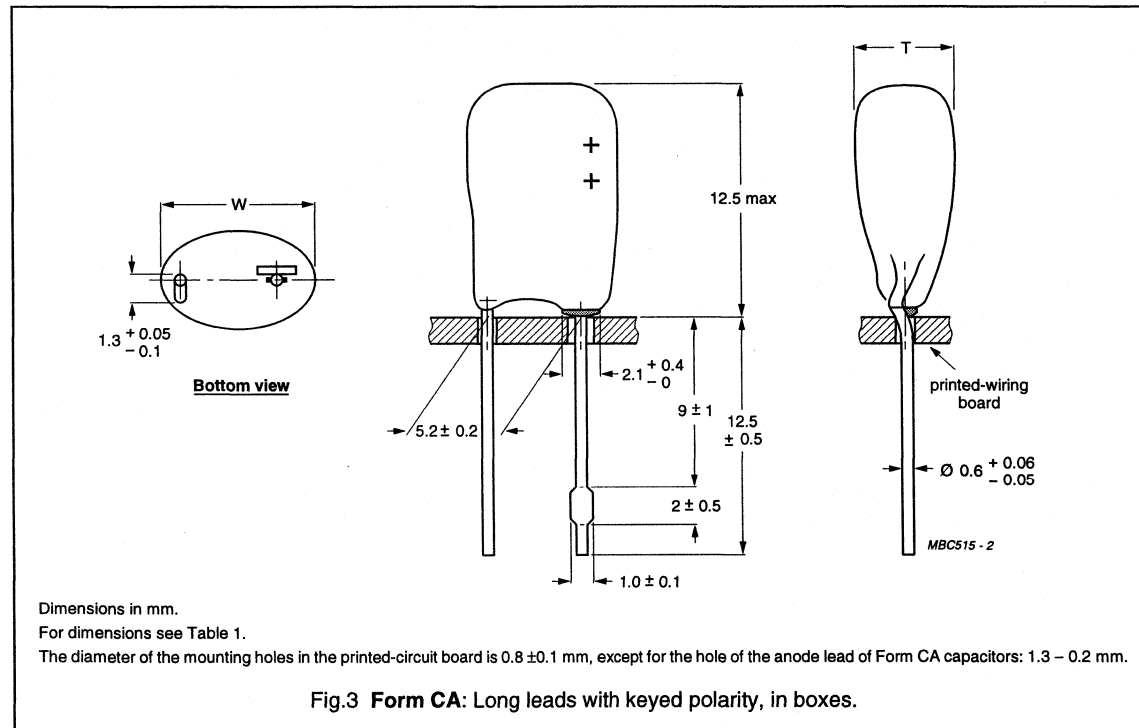
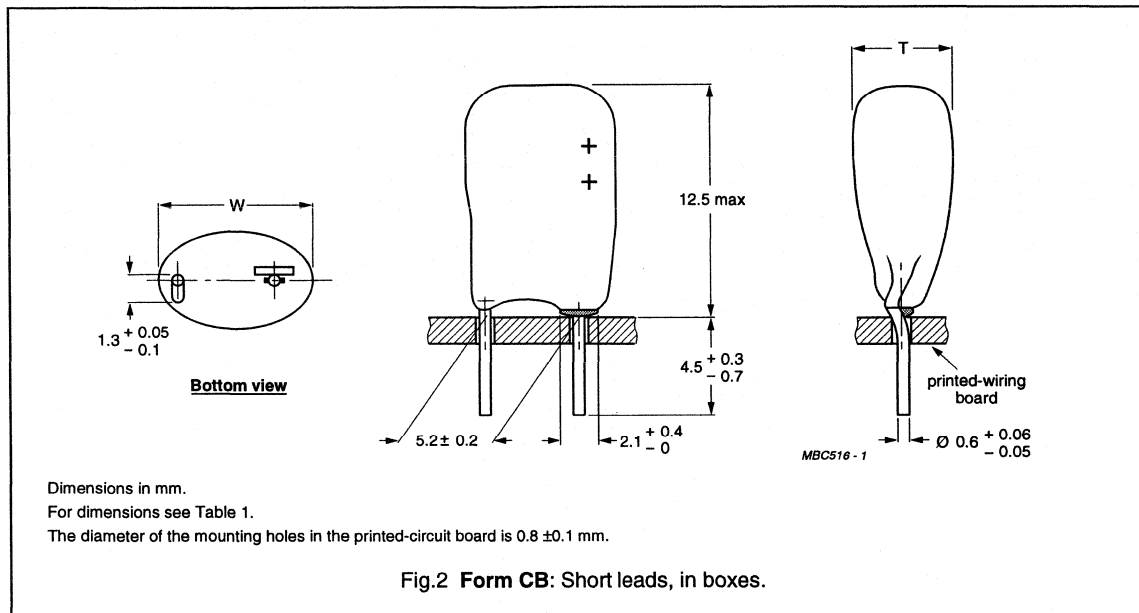
Preferred types in bold.

C_R (μF)	U_R (V) at $T_{\text{amb}} = 85^\circ\text{C}$					
	6.3	10	16	25	35	40
	U_C (V) at $T_{\text{amb}} = 125^\circ\text{C}$					
	6.3	10	16	25	35	40
0.33	–	–	–	–	–	12.5 × 8 × 3.5
0.47	–	–	–	–	–	12.5 × 8 × 4.5
0.68	–	–	–	12.5 × 8 × 3.5	–	12.5 × 8 × 4.5
1.0	–	–	–	12.5 × 8 × 3.5	12.5 × 8 × 4.5	12.5 × 8 × 5
1.5	–	–	–	12.5 × 8 × 3.5	–	12.5 × 8 × 6
2.2	–	–	12.5 × 8 × 3.5	12.5 × 8 × 4.5	–	12.5 × 8 × 6
3.3	–	–	12.5 × 8 × 3.5	12.5 × 8 × 4.5	12.5 × 8 × 6	–
4.7	–	12.5 × 8 × 3.5	12.5 × 8 × 4.5	12.5 × 8 × 5	–	–
6.8	–	12.5 × 8 × 3.5	12.5 × 8 × 4.5	12.5 × 8 × 6	–	–
10	12.5 × 8 × 3.5	12.5 × 8 × 4.5	12.5 × 8 × 5	12.5 × 8 × 6	–	–
15	12.5 × 8 × 4.5	12.5 × 8 × 4.5	12.5 × 8 × 6	–	–	–
22	12.5 × 8 × 4.5	12.5 × 8 × 5	–	–	–	–
33	12.5 × 8 × 5	12.5 × 8 × 6	–	–	–	–
47	12.5 × 8 × 6	–	–	–	–	–
68	12.5 × 8 × 6	–	–	–	–	–

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MECHANICAL DATA AVAILABLE FORMS AND PACKAGING QUANTITIES



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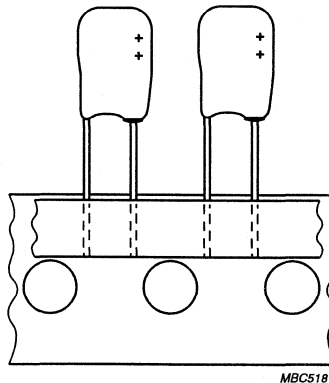
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Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

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

Form TR+: Taped on reel, positive leading.

Form TFA: Taped in ammpack.

Tape dimensions are specified in handbook, section "Packaging".

Fig.4 Taped versions.

Mounting

When bending, cutting or straightening the leads, ensure that the capacitor body is relieved of stress. Bending after soldering must be avoided.

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Ordering example

Electrolytic capacitors SAL-RP

10 μ F/16 V; \pm 20%

Maximum case size: 12.5 x 8 x 5 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_{amb} = 20 to 25 °C,

P = 86 to 106 kPa, 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
Tan δ	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 (μ F)	MAXIMUM CASE SIZE H x W x 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 (μ A)	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
6.3	6.3	10	12.5 x 8 x 3.5	1	9	156	211	3	0.15	30	5	53109	73109	23109	33109
		15	12.5 x 8 x 4.5	2	13	195	264	5	0.15	20	3	53159	73159	23159	33159
		22	12.5 x 8 x 4.5	2	20	234	317	7	0.15	14	1.3	53229	73229	23229	33229
		33	12.5 x 8 x 5	3	30	293	396	11	0.15	9	0.9	53339	73339	23339	33339
		47	12.5 x 8 x 6	4	42	371	502	15	0.15	6.4	0.7	53479	73479	23479	33479
		68	12.5 x 8 x 6	4	61	449	607	22	0.15	4.4	0.5	53689	73689	23689	33689
10	10	4.7	12.5 x 8 x 3.5	1	7	117	158	3	0.15	64	7	54478	74478	24478	34478
		6.8	12.5 x 8 x 3.5	1	10	137	185	4	0.15	44	5	54688	74688	24688	34688
		10	12.5 x 8 x 4.5	2	14	156	211	5	0.15	30	1.5	54109	74109	24109	34109
		15	12.5 x 8 x 4.5	2	21	195	264	8	0.15	20	1	54159	74159	24159	34159
		22	12.5 x 8 x 5	3	31	234	317	11	0.15	14	0.7	54229	74229	24229	34229
		33	12.5 x 8 x 6	4	47	312	422	17	0.15	9	0.5	54339	74339	24339	34339
16	16	2.2	12.5 x 8 x 3.5	1	5	98	132	2	0.10	91	10	55228	75228	25228	35228
		3.3	12.5 x 8 x 3.5	1	8	117	158	3	0.10	61	7	55338	75338	25338	35338
		4.7	12.5 x 8 x 4.5	2	11	137	185	4	0.10	43	2	55478	75478	25478	35478
		6.8	12.5 x 8 x 4.5	2	16	156	211	6	0.10	29.5	1.5	55688	75688	25688	35688
		10	12.5 x 8 x 5	3	23	195	264	8	0.10	20	1	55109	75109	25109	35109
		15	12.5 x 8 x 6	4	34	254	343	12	0.10	13.5	0.7	55159	75159	25159	35159



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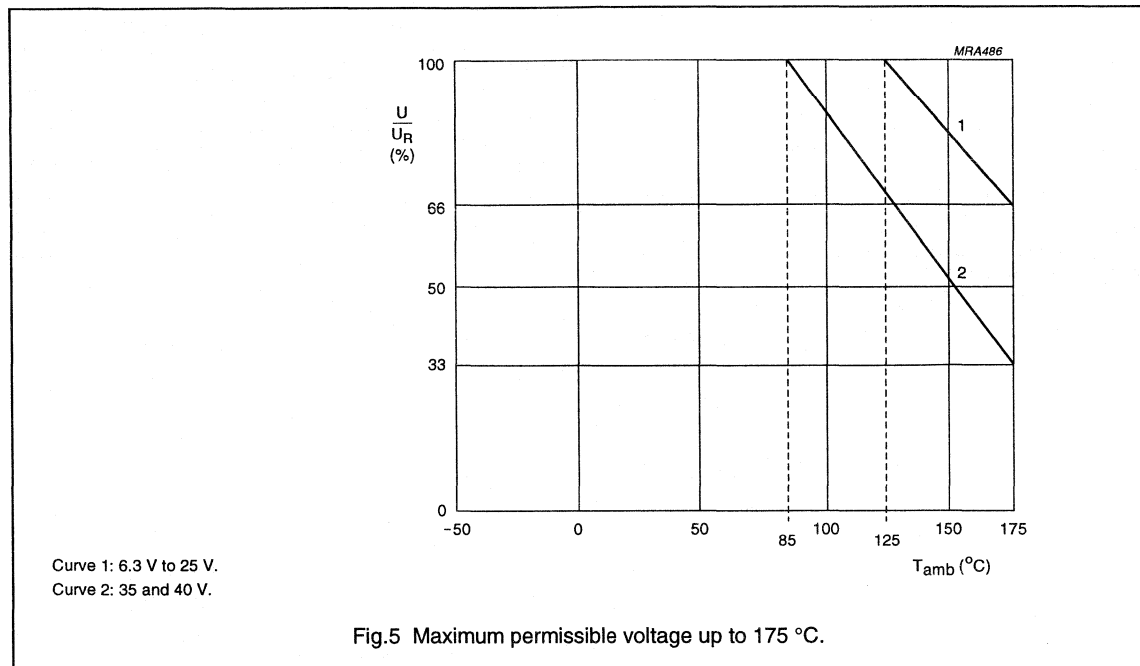
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U _C (V)	U _R (V)	C _R 100 Hz (μF)	MAXIMUM CASE SIZE H × W × T (mm)	CASE CODE	I _R 100 Hz 125 °C (mA)	I _R 10 kHz 85 °C (mA)	I _R 100 kHz 40 °C (mA)	I _{L5} 5 min (μA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222 122			
												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	FORM CB	76687	26687	36687
		1.0	12.5 × 8 × 3.5	1	4	62	85	2	0.10	200	20	FORM CB	56108	26108	36108
		1.5	12.5 × 8 × 3.5	1	5	78	106	2	0.10	135	15	FORM CB	56158	26158	36158
		2.2	12.5 × 8 × 4.5	2	8	98	132	3	0.10	91	10	FORM CB	56228	26228	36228
		3.3	12.5 × 8 × 4.5	2	12	117	158	4	0.10	61	7	FORM CB	56338	26338	36338
		4.7	12.5 × 8 × 5	3	17	137	185	6	0.10	43	5	FORM CB	56478	26478	36478
		6.8	12.5 × 8 × 6	4	24	176	238	9	0.10	29.5	3	FORM CB	56688	26688	36688
		10	12.5 × 8 × 6	4	35	200	238	13	0.15	20	2	FORM CB	56109	26109	36109
		1.0	12.5 × 8 × 4.5	2	3	62	85	2	0.10	200	15	FORM CB	50108	20108	30108
		3.3	12.5 × 8 × 6	4	12	117	132	6	0.10	61	5	FORM CB	50338	20338	30338
25	40	0.33	12.5 × 8 × 3.5	1	1	39	53	2	0.10	610	30	FORM CB	77337	27337	37337
		0.47	12.5 × 8 × 4.5	2	2	47	63	2	0.10	430	20	FORM CB	57477	27477	37477
		0.68	12.5 × 8 × 4.5	2	2	55	74	2	0.10	295	15	FORM CB	57687	27687	37687
		1.0	12.5 × 8 × 5	3	4	62	85	2	0.10	200	10	FORM CB	57108	27108	37108
		1.5	12.5 × 8 × 6	4	5	78	106	3	0.10	135	7	FORM CB	57158	27158	37158
		2.2	12.5 × 8 × 6	4	8	98	132	5	0.10	91	5	FORM CB	57228	27228	37228

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Voltage**MARKING**

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

- Rated capacitance (in μF)
- Tolerance code on rated capacitance (M = $\pm 20\%$, K = $\pm 10\%$)
- 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.

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Non-solid Al - electrolytic capacitors

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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		$U_{rev} < 0.3 \times U_R$
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 $U_R = 25$ to 40 V	$\approx 0.2 \times$ value stated in Table 2 $\approx 0.1 \times$ value stated in Table 2

Ripple current (I_R)

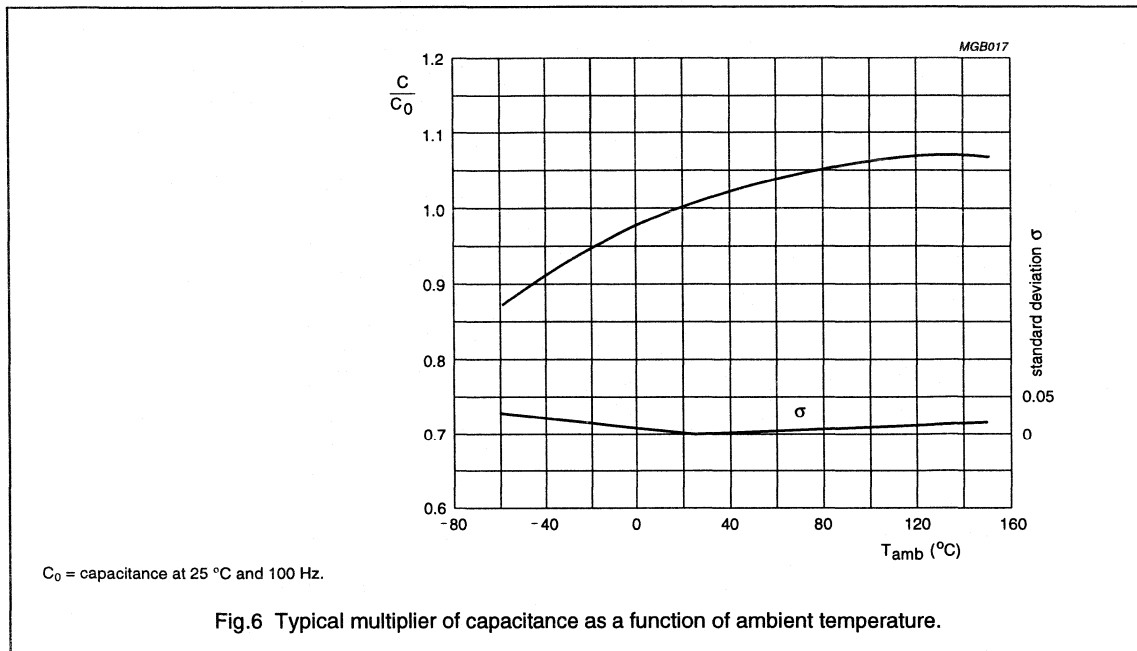
Applying the maximum RMS ripple current given in Table 2 will cause a device temperature of $138 \text{ }^\circ\text{C}$. The 100 kHz values in Table 2 for other temperatures are to be calculated with the following I_R multipliers:

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

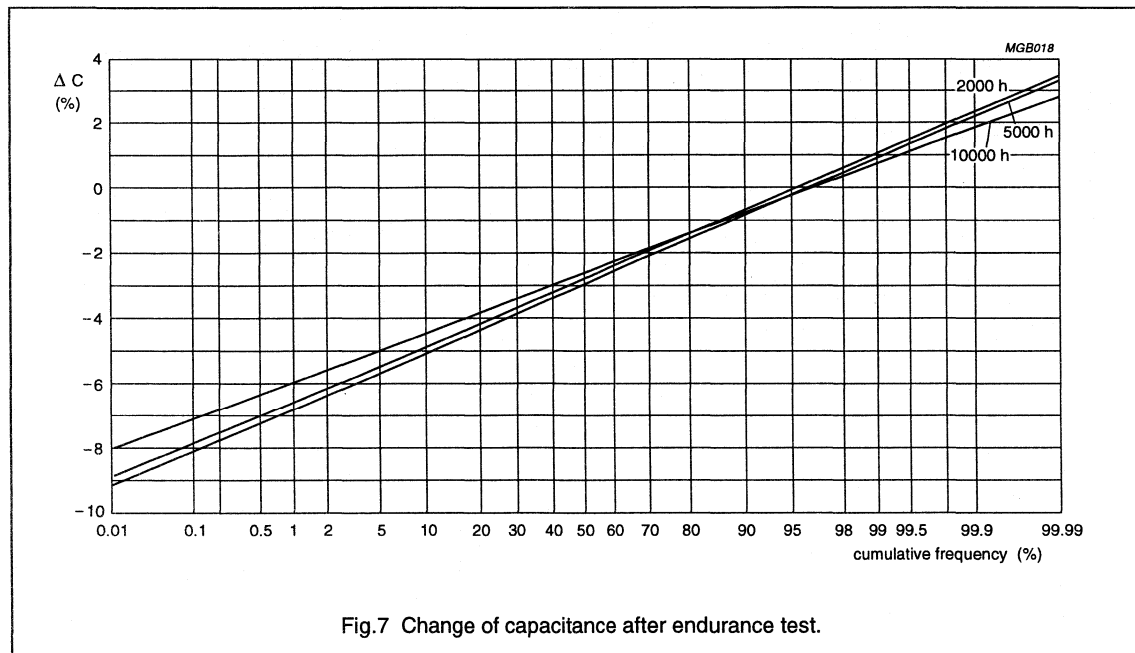
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Capacitance (C)

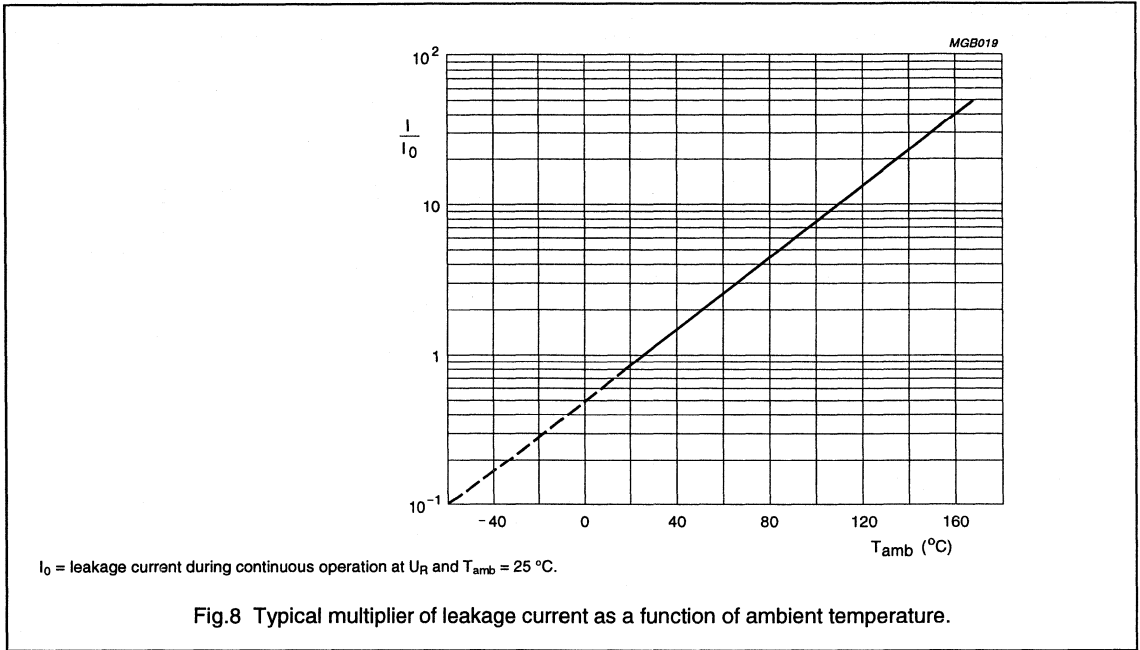


Typical parameter change after endurance test at T_{amb} = 125 °C

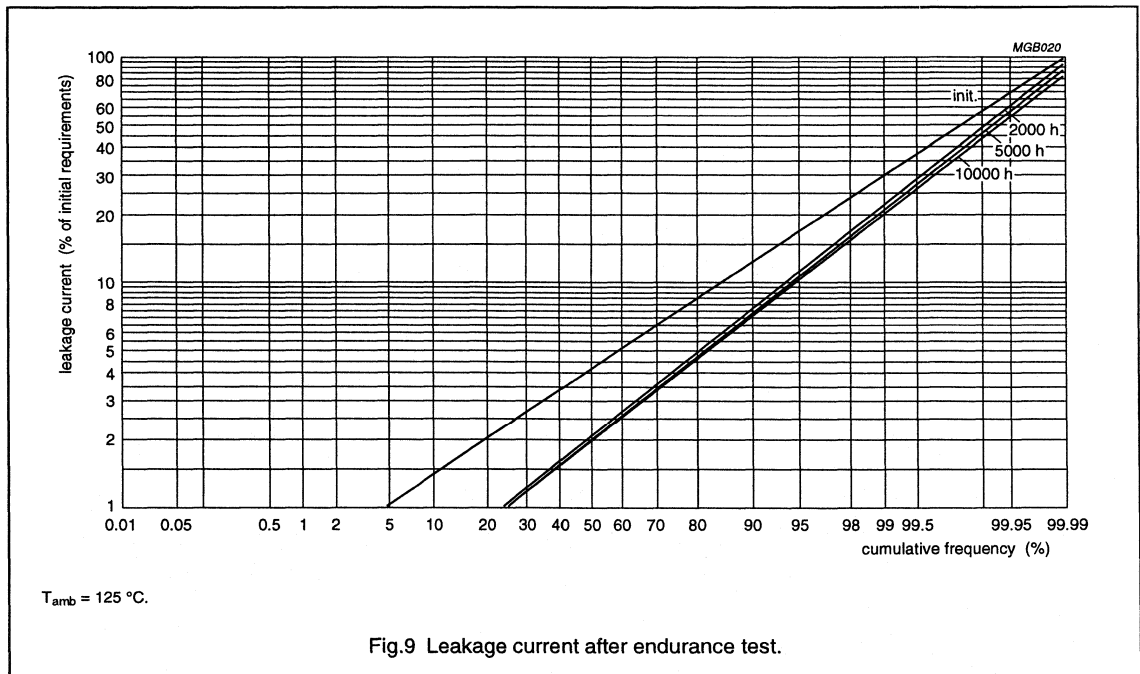


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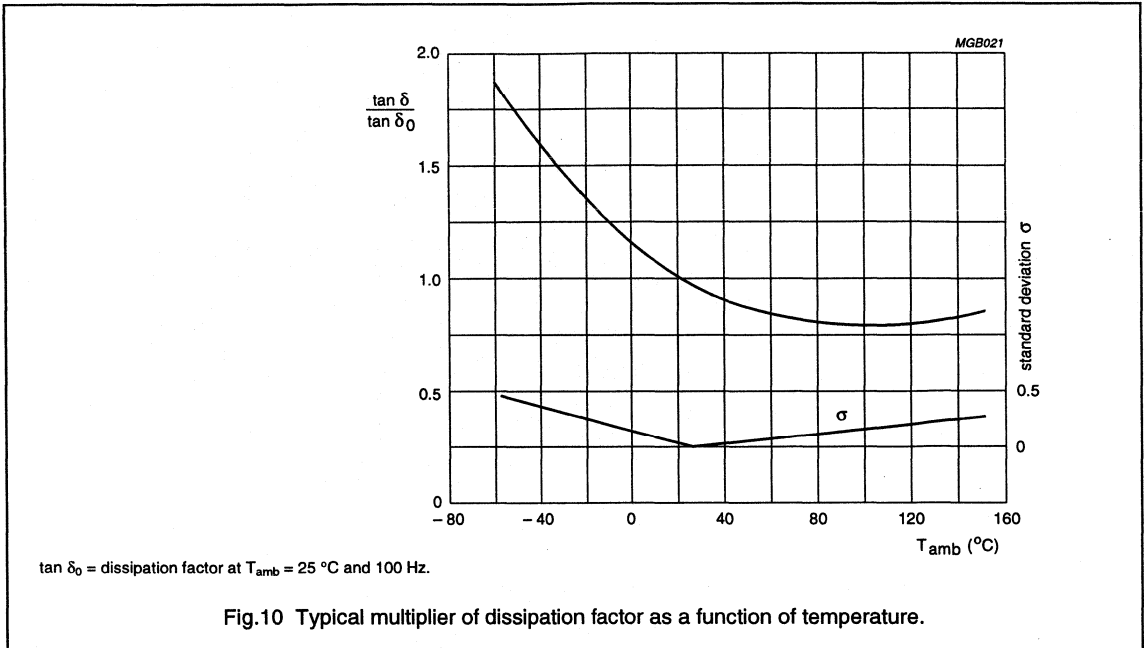
Typical parameter change after endurance test at $T_{amb} = 125^{\circ}C$



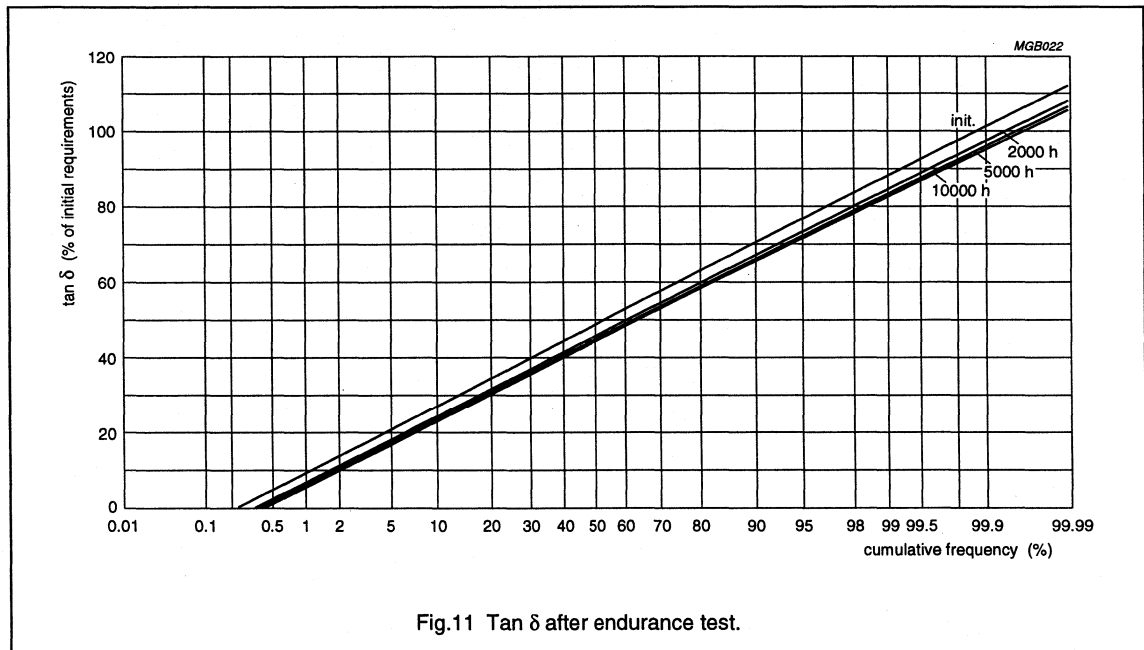
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Dissipation factor ($\tan \delta$)



Typical parameter change after endurance test at $T_{amb} = 125^\circ\text{C}$



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Equivalent series resistance (ESR)

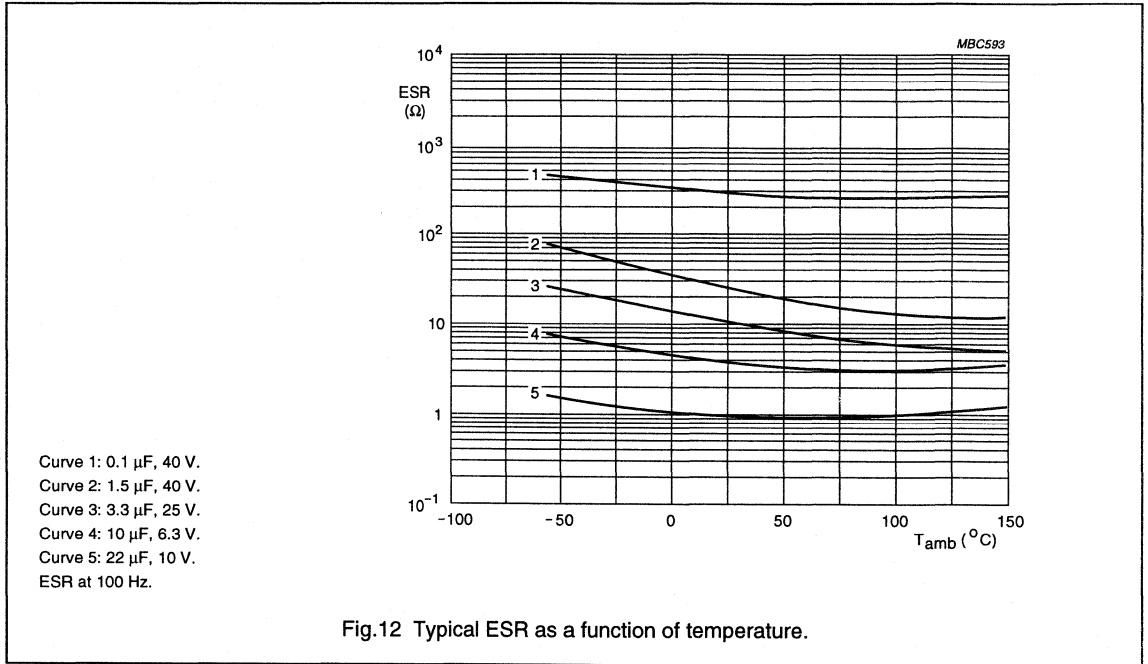


Fig.12 Typical ESR as a function of temperature.

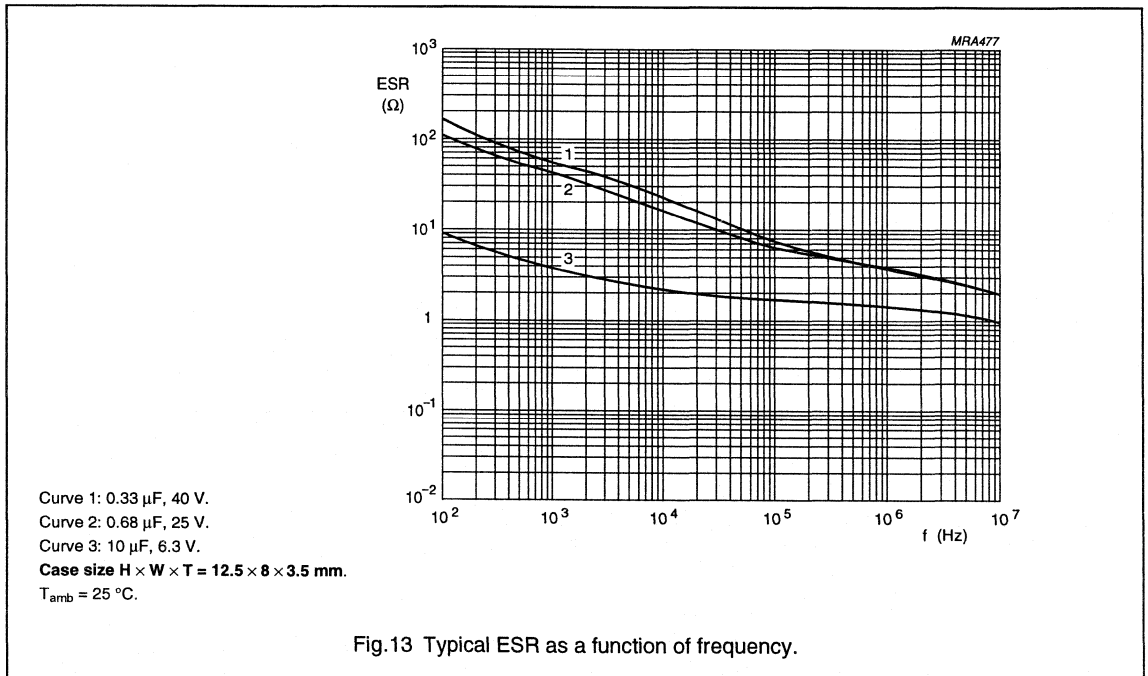
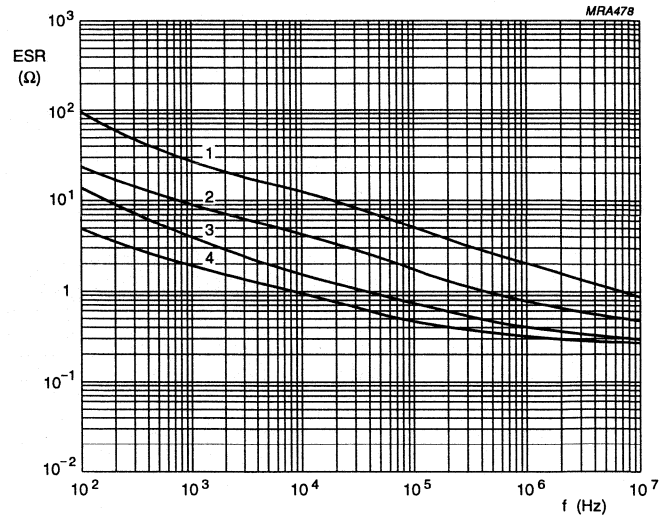


Fig.13 Typical ESR as a function of frequency.

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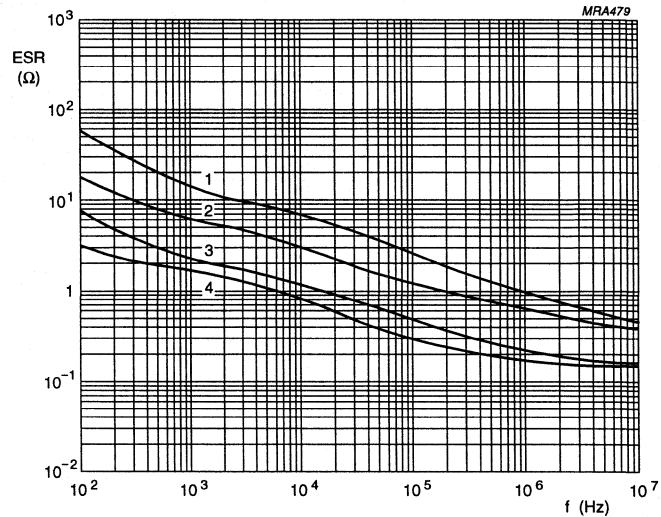
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Case size H × W × T = 12.5 × 8 × 4.5 mm.
 $T_{amb} = 25\text{ }^{\circ}\text{C}.$

Fig.14 Typical ESR as a function of frequency.

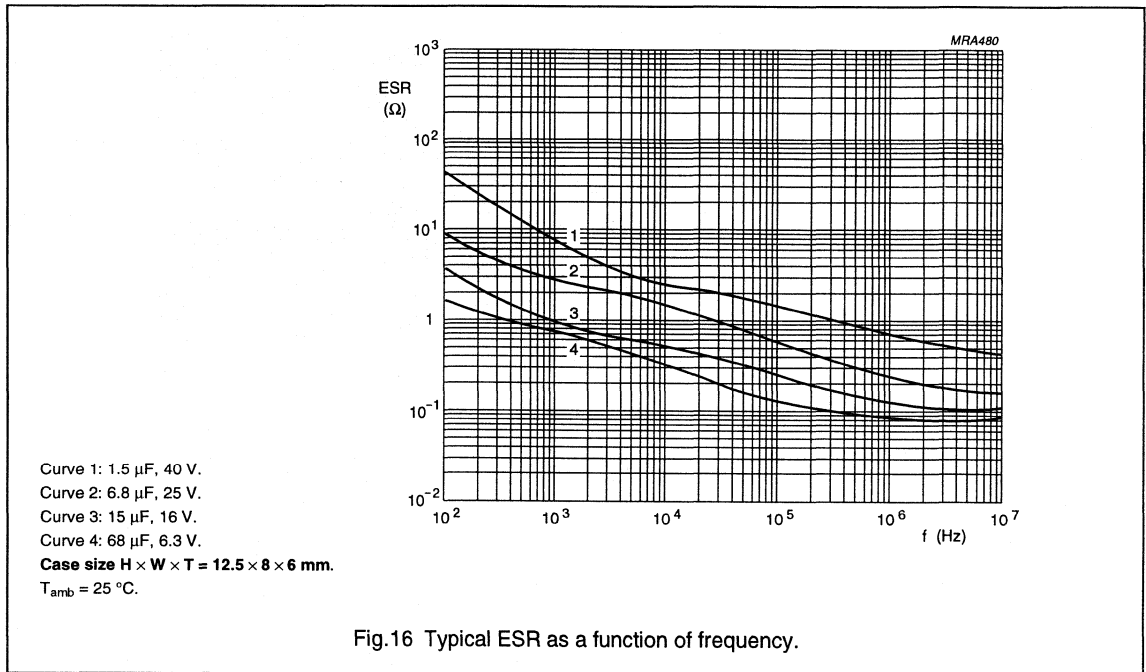


Case size H × W × T = 12.5 × 8 × 5 mm.
 $T_{amb} = 25\text{ }^{\circ}\text{C}.$

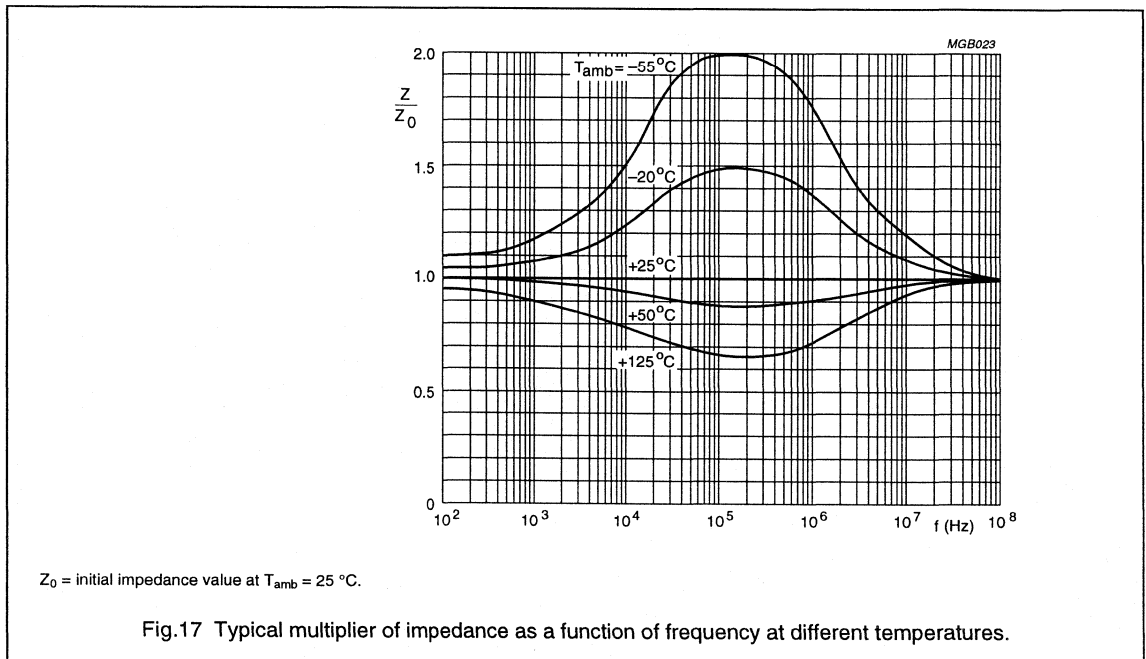
Fig.15 Typical ESR as a function of frequency.

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Solid Al, Radial Pearl

SAL-RP 122

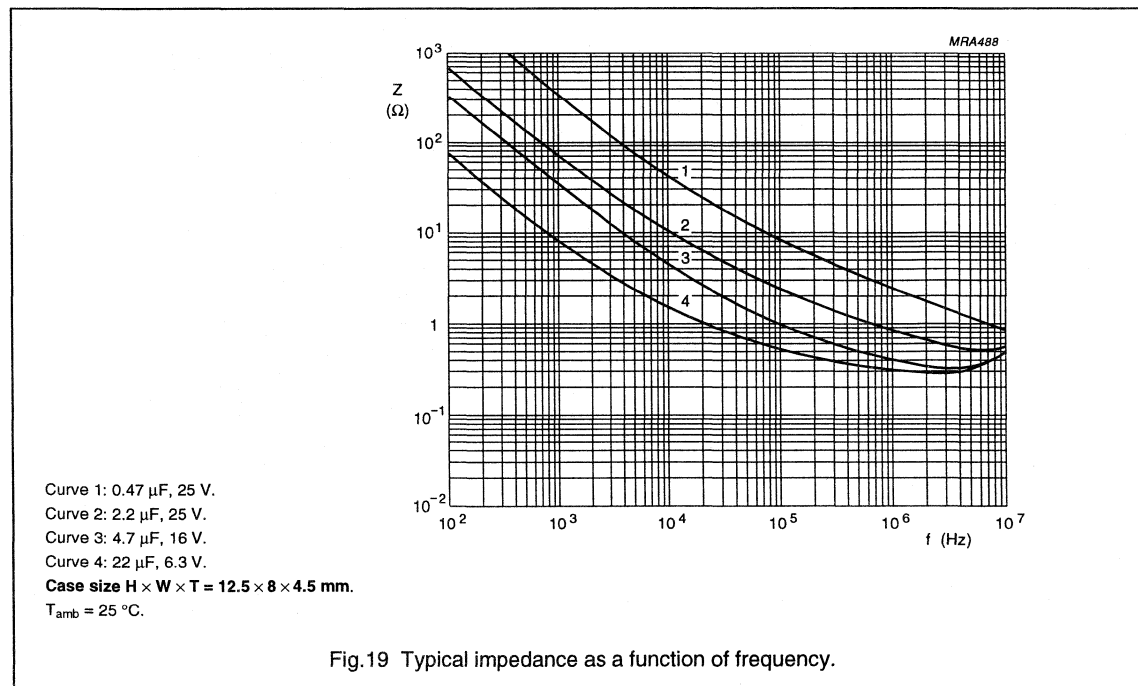
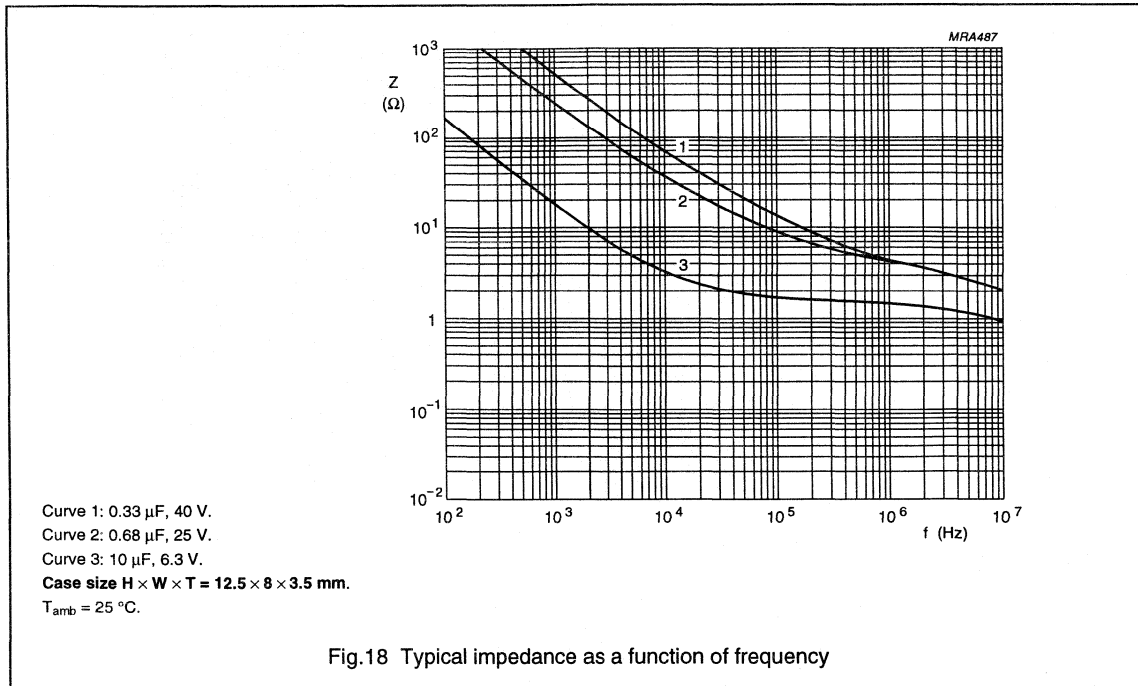


Impedance (Z)



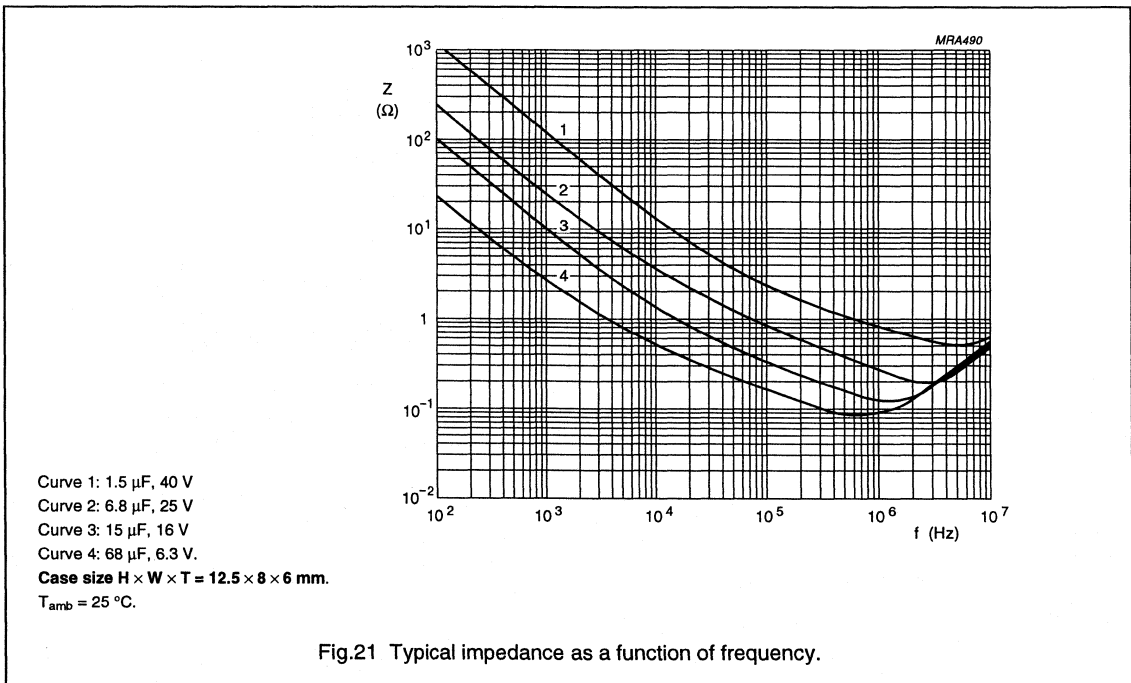
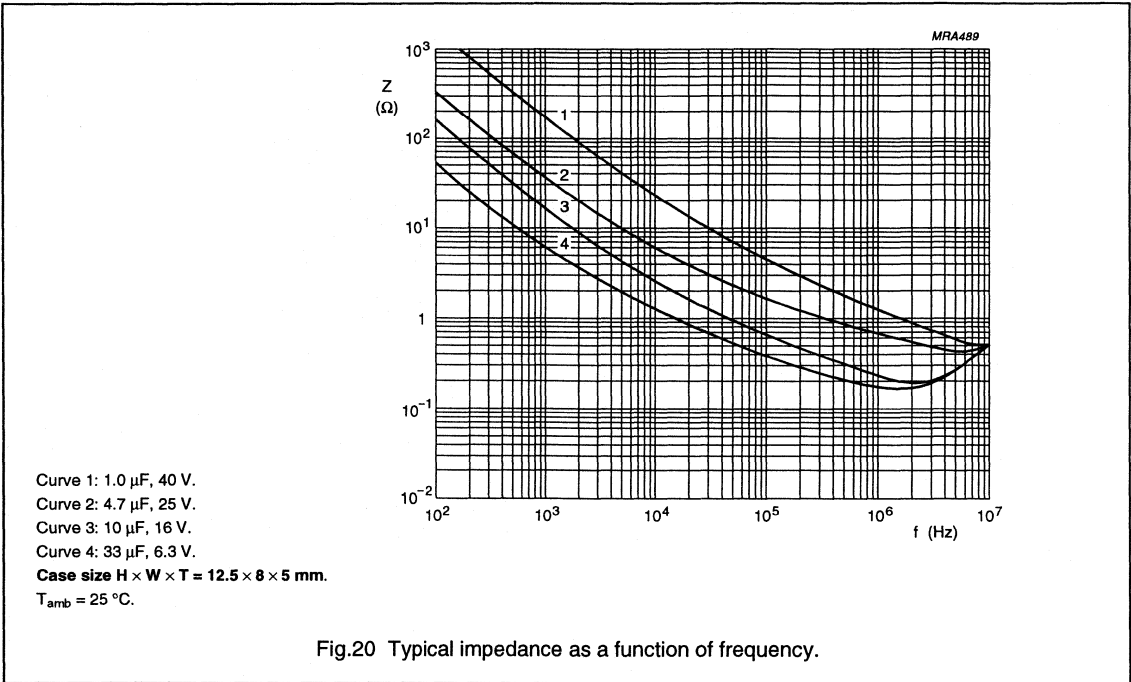
Non-solid Al - electrolytic capacitors
Solid Al, Radial Pearl

SAL-RP 122



Non-solid Al - electrolytic capacitors
Solid Al, Radial Pearl

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Non-solid Al - electrolytic capacitors

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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	$T_{amb} = 125\text{ °C}$; $U_R = 6.3$ 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	$T_{amb} = 125\text{ °C}$; 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	$T_{amb} = 125\text{ °C}$; 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 $55 \pm 5\text{ °C}$ Solvents: demineralized water and/or calgonite solution (20 g/l)	visual appearance not affected

Non-solid Al - electrolytic capacitors

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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; $T_{\text{amb}} = 20$ to 25 °C; test duration = 20 s.	after removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s; no burning particles must drop from the sample

Non-solid Al-electrolytic capacitors

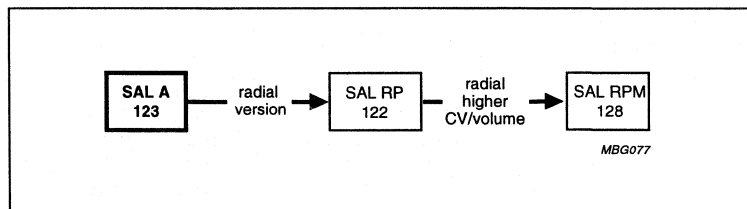
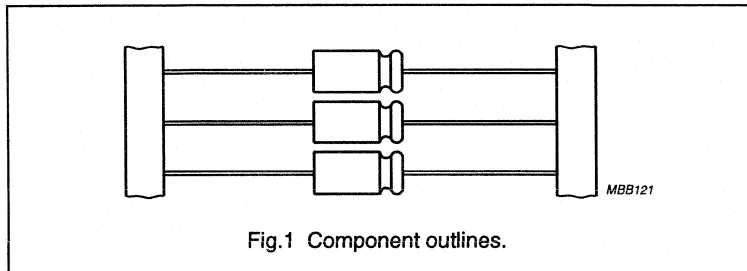
Solid Al, Axial



SAL-A 123

FEATURES

- Polarized aluminium electrolytic capacitors, solid electrolyte MnO_2
- Axial leads, aluminium case, ceramic seal, blue insulation sleeve
- SAL-A: standard version
- SAL-AG: epoxy filled shock-proof version up to 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.



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 ($\varnothing D_{\max} \times L_{\max}$ in mm)	6.7 × 15.3 to 12.9 × 32.0
Rated capacitance range (E6 series), C_R	1.5 to 2200 μF
Tolerance on C_R	$\pm 20\%$; $\pm 10\%$ 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 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
Climatic category IEC 68 (DIN 40040; NF C20-600)	55/125/56 (FKD; 434)
Approvals	CNET LN2 44-04 COS-C (PTT) Gam-t-1(MIL) CECC 30302-003

Non-solid Al-electrolytic capacitors

Solid Al, Axial

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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)					
	6.3	10	16	25	35	40
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	-	-	-	-	-

MARKING

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

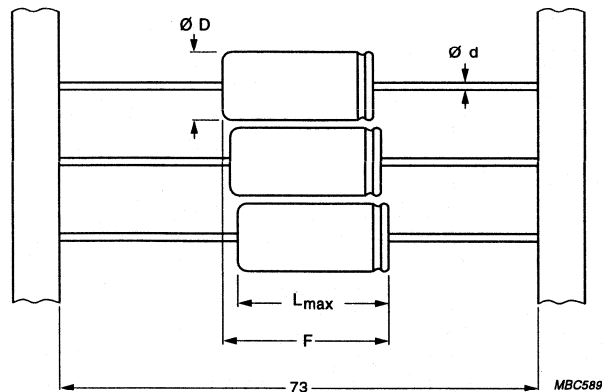
- Rated capacitance (in μF)
- Tolerance code on rated capacitance (M = $\pm 20\%$, K = $\pm 10\%$, in accordance with "IEC 62")
- Rated voltage (in V) at corresponding maximum temperature
- Date code in accordance with "IEC 62"
- Name of manufacturer
- Group number (123)
- Code for factory of origin
- Code for basic specification (in accordance with "IEC 384-4")
- "+" sign to indicate the positive terminal
- A band to identify the negative terminal.

Non-solid Al-electrolytic capacitors

Solid Al, Axial

SAL-A 123

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

BA: taped in box, (ammopack).

BR: taped on reel.

For dimensions see Table 1.

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

Fig.2 **Forms:** BA and BR.

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

CASE		F _{min} (mm)	Ød (mm)	MASS (g) (note 1)	PACKAGING QUANTITIES	
MAXIMUM SIZE ØD × L (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

Note

1. Add 10% for SAL-AG epoxy-filled versions.

Non-solid Al-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 °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_R (V)	C_R 100 Hz (μ F)	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 (μ A)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
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	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

Non-solid Al-electrolytic capacitors

Solid Al, Axial

SAL-A 123

ORDERING INFORMATION**Ordering example**

Electrolytic capacitors SAL A

10 μ F/16 V; $\pm 20\%$ Maximum case size: 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_R (V)	C_R 100 Hz (μ F)	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 FORM BA tol. $\pm 10\%$ level S	SAL-AG FORM BA tol. $\pm 20\%$
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	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

Non-solid Al-electrolytic capacitors

Solid Al, Axial

SAL-A 123

ELECTRICAL DATA (continued)**Table 4** Electrical data for 123 series continued; preferred types in **bold**

U_R (V)	C_R 100 Hz (μ F)	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 (μ A)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
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	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
	35	1.0	6.7 × 15.3	4	55	80	5	0.12	240
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

Non-solid Al-electrolytic capacitors

Solid Al, Axial

SAL-A 123

ORDERING INFORMATION (continued)**Table 5** Ordering information for 123 series continued; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	MAXIMUM CASE SIZE ∅D × L (mm)	CATALOGUE NUMBER 2222			
			SAL-A FORM BA tol ±20%	SAL-A FORM BR tol ±20%	SAL-AG FORM BA tol. ±10% level S	SAL-AG FORM BA tol. ±20%
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	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
35	1.0	6.7 × 15.3	123 10108	123 20108	123 80108	123 60108
	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

SA

Non-solid Al-electrolytic capacitors

Solid Al, Axial

SAL-A 123

ELECTRICAL DATA (continued)**Table 6** Electrical data for 123 series continued; preferred types in **bold**

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 δ 100 Hz	ESR 100 Hz (Ω)	Z 100 kHz (Ω)
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_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 FORM BA tol. $\pm 10\%$ level S	SAL-AG FORM BA tol. $\pm 20\%$
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

Non-solid Al-electrolytic capacitors

Solid Al, Axial

SAL-A 123

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		$\leq 2 V$
Maximum peak AC voltage, without reverse voltage applied	$T_{amb} \leq 85 \text{ }^\circ\text{C}$	
	at $f \leq 0.1 \text{ Hz}$	$0.30 \times U_R$
	at $0.1 \text{ Hz} < f \leq 1 \text{ Hz}$	$0.45 \times U_R$
	at $1 \text{ Hz} < f \leq 10 \text{ Hz}$	$0.60 \times U_R$
	at $10 \text{ Hz} < f \leq 50 \text{ Hz}$	$0.65 \times U_R$
	at $f > 50 \text{ Hz}$	$0.80 \times U_R$
	$85 \text{ }^\circ\text{C} < T_{amb} \leq 125 \text{ }^\circ\text{C}$	
	at $f \leq 0.1 \text{ Hz}$	$0.15 \times U_R$
	at $0.1 \text{ Hz} < f \leq 1 \text{ Hz}$	$0.22 \times U_R$
	at $1 \text{ Hz} < f \leq 10 \text{ Hz}$	$0.30 \times U_R$
at $10 \text{ Hz} < f \leq 50 \text{ Hz}$	$0.32 \times U_R$	
at $f > 50 \text{ Hz}$	$0.40 \times U_R$	
Current		
Maximum leakage current	after 5 minutes at U_R and $T_{amb} = 25 \text{ }^\circ\text{C}$	$I_{L5} \leq 0.05C_R \times U_R$ 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 $T_{amb} = 25 \text{ }^\circ\text{C}$ $U_R = 6.3 \text{ to } 16 \text{ V}$	approx. $0.2 \times$ value stated in Tables 2, 4 and 6
	$U_R = 25 \text{ to } 40 \text{ V}$	approx. $0.1 \times$ value stated in Tables 2, 4 and 6

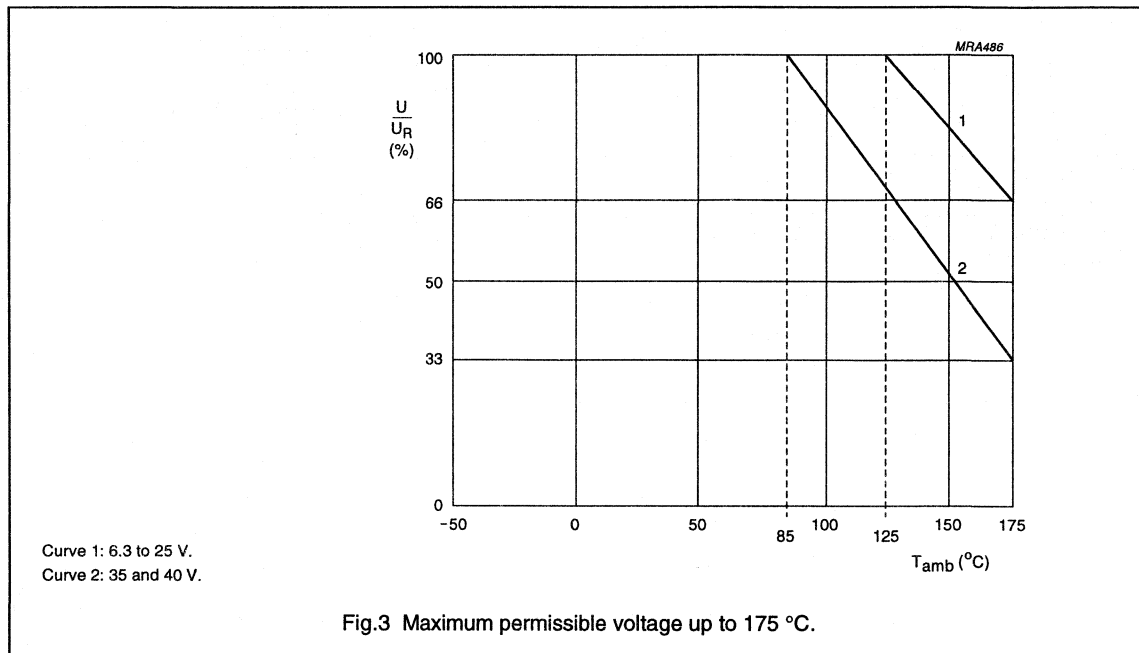
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Non-solid Al-electrolytic capacitors

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Voltage



Ripple current (I_R)

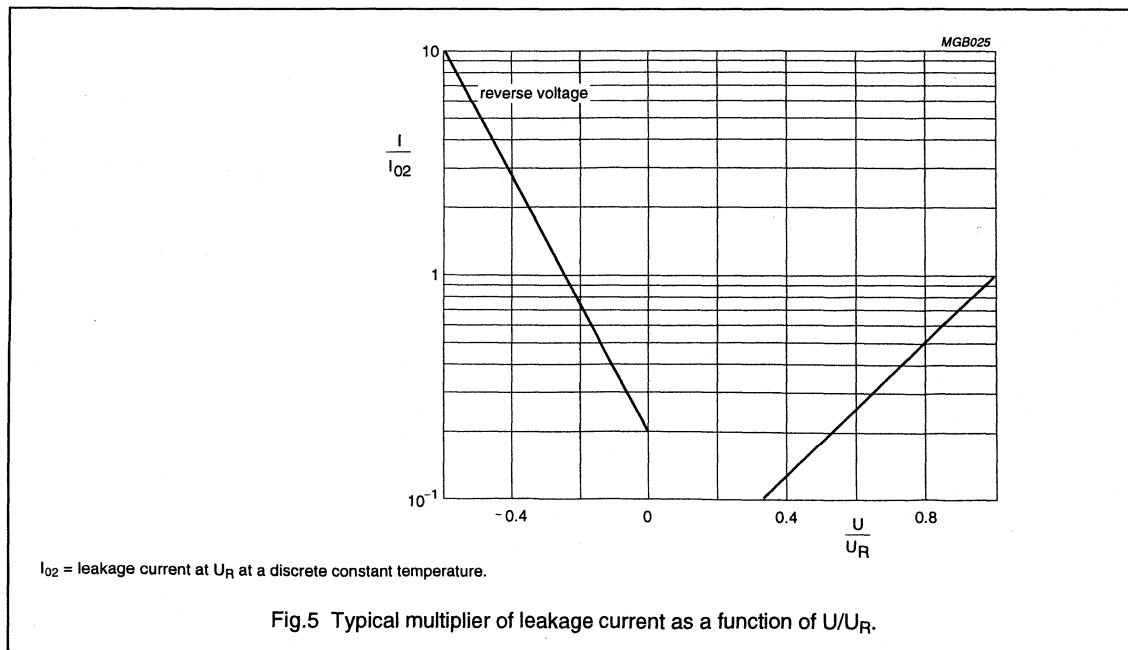
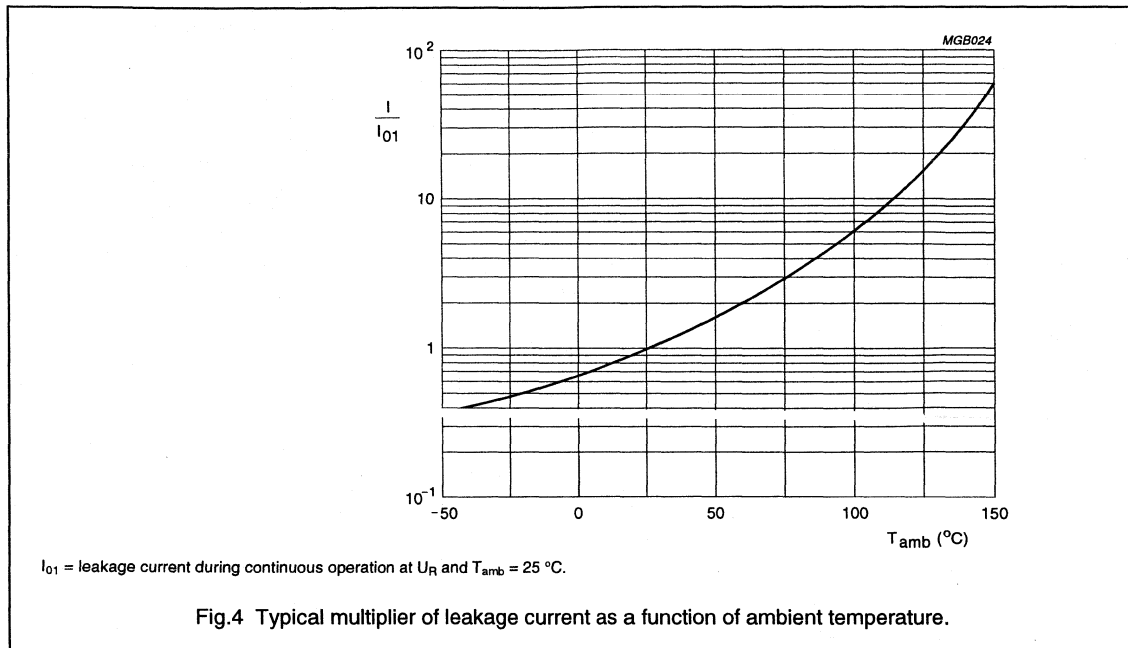
Applying the maximum RMS ripple current given in Tables 2, 4 and 6 will cause a device temperature of 138 °C. The 100 kHz values in Tables 2, 4 and 6 for other temperatures are to be calculated with the following I_R multipliers:

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

Non-solid Al-electrolytic capacitors
Solid Al, Axial

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Leakage current



Non-solid Al-electrolytic capacitors
Solid Al, Axial

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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

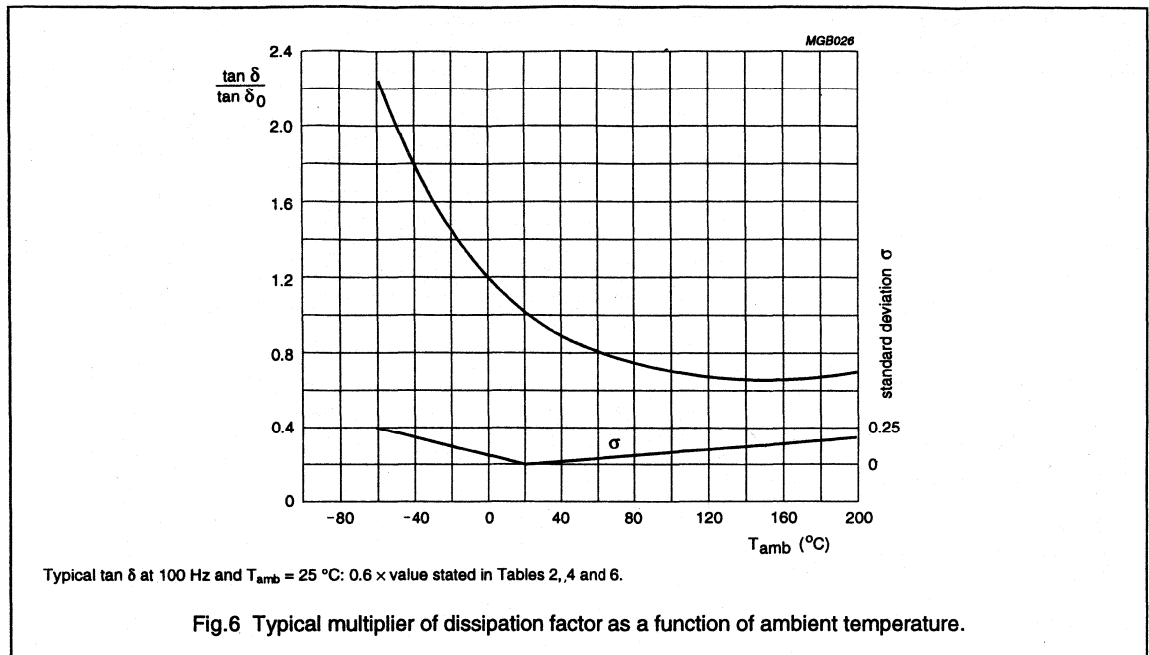
Equivalent series inductance (ESL), $f = 10$ MHz

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

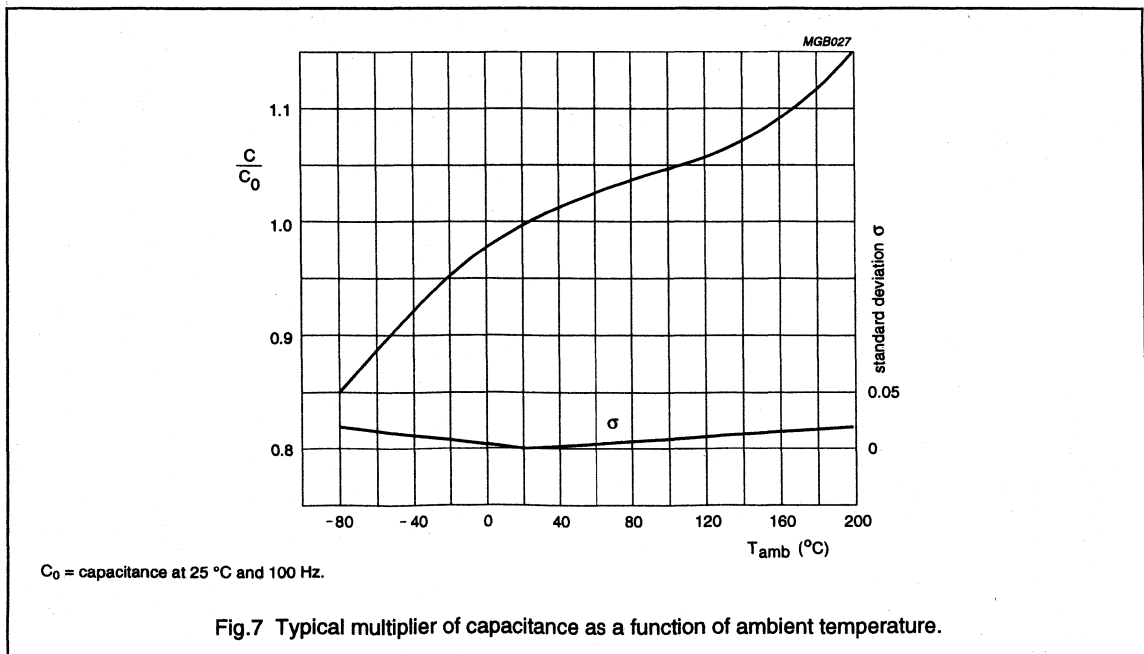
Non-solid Al-electrolytic capacitors
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Dissipation factor ($\tan \delta$)



Capacitance (C)



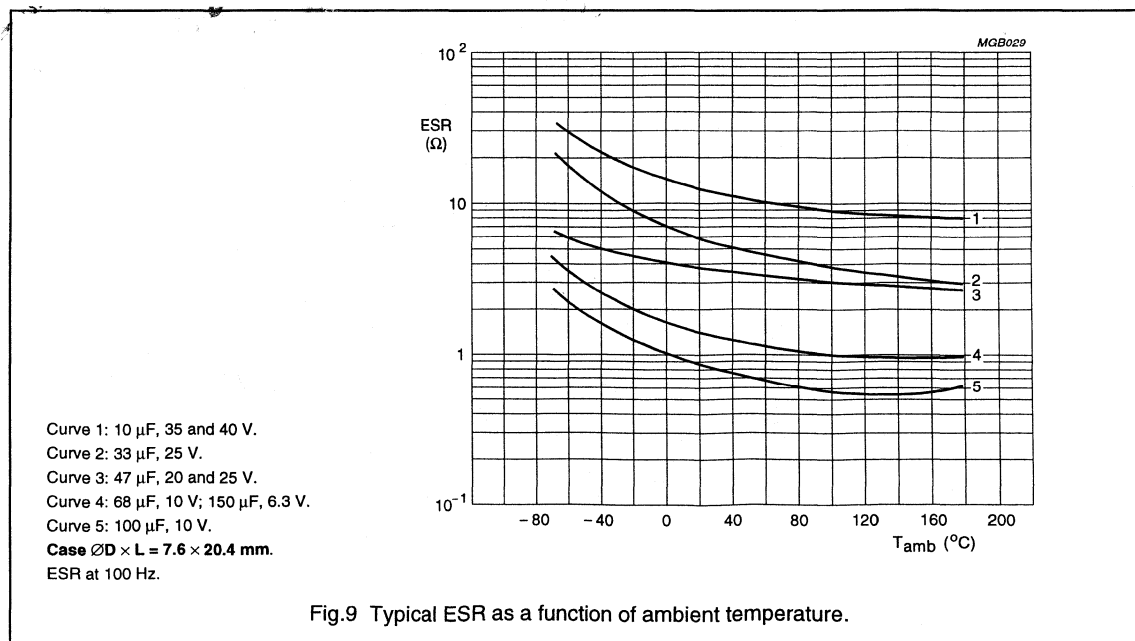
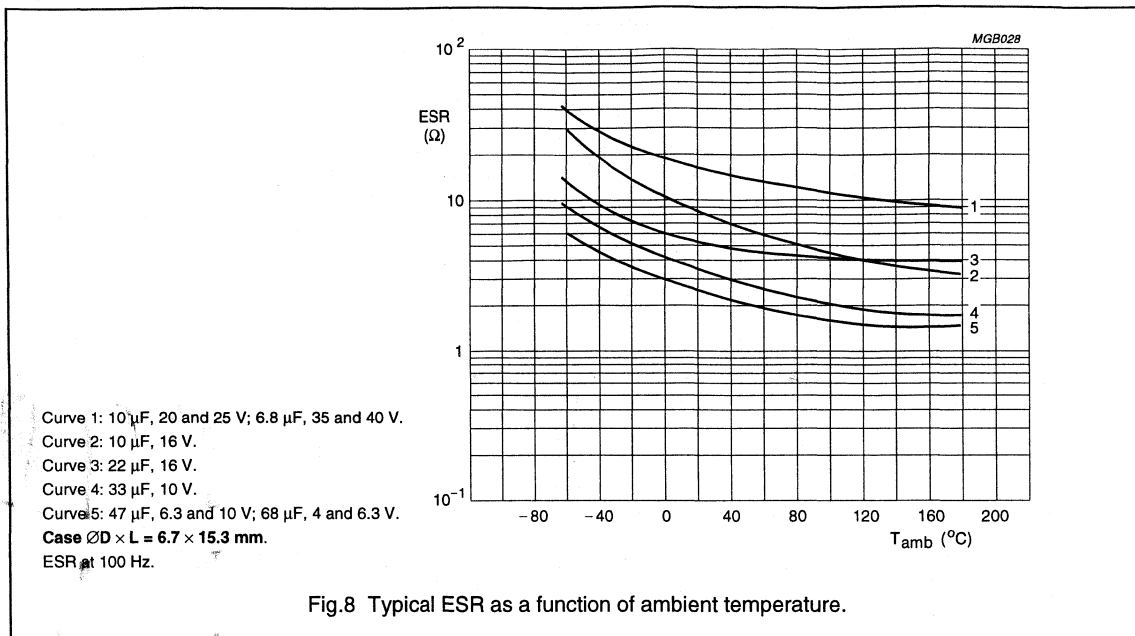
Non-solid Al-electrolytic capacitors

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Equivalent series resistance (ESR)

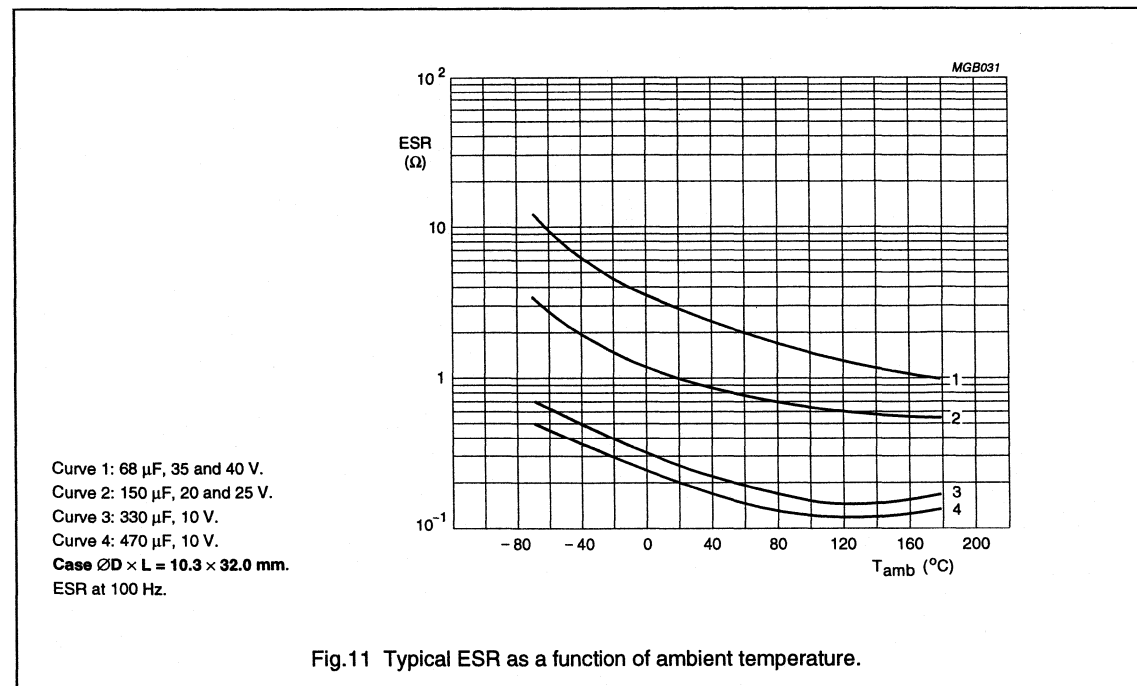
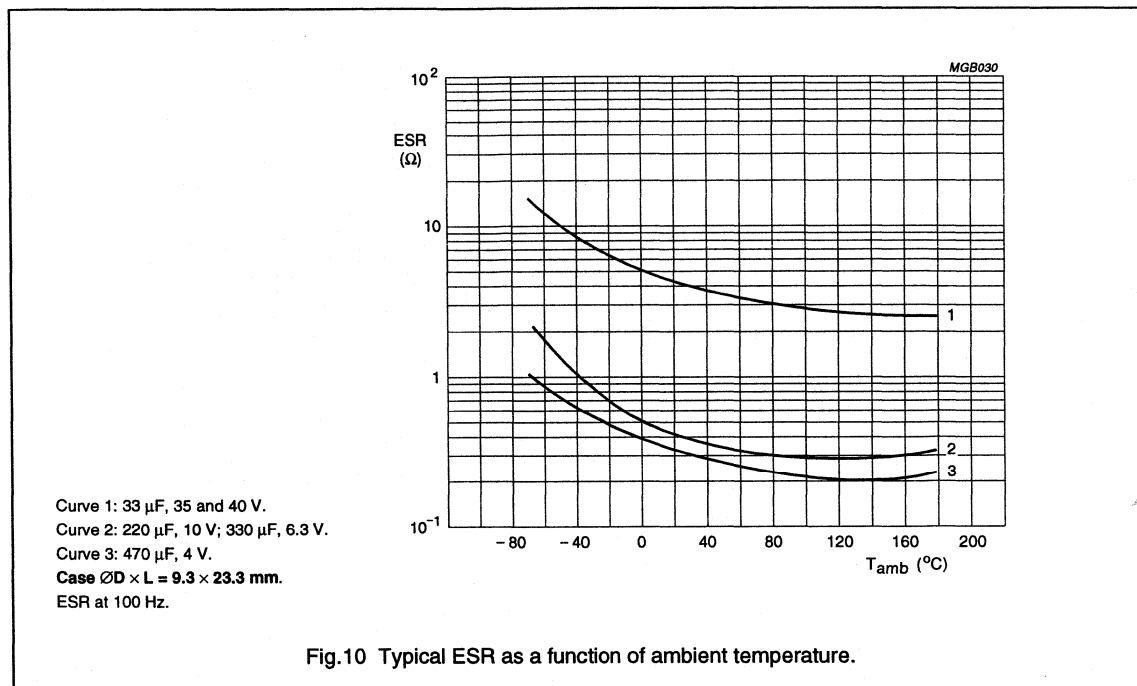
Typical ESR: see Figs 8 to 17; the standard deviation is 20% of each value.



Non-solid Al-electrolytic capacitors

Solid Al, Axial

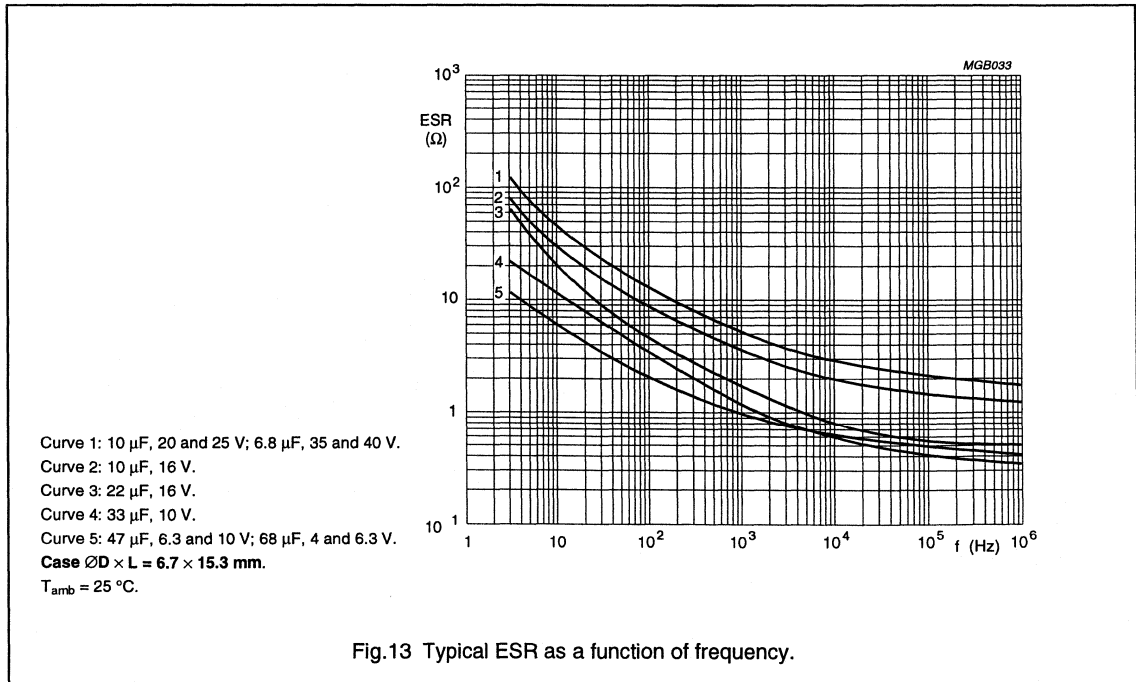
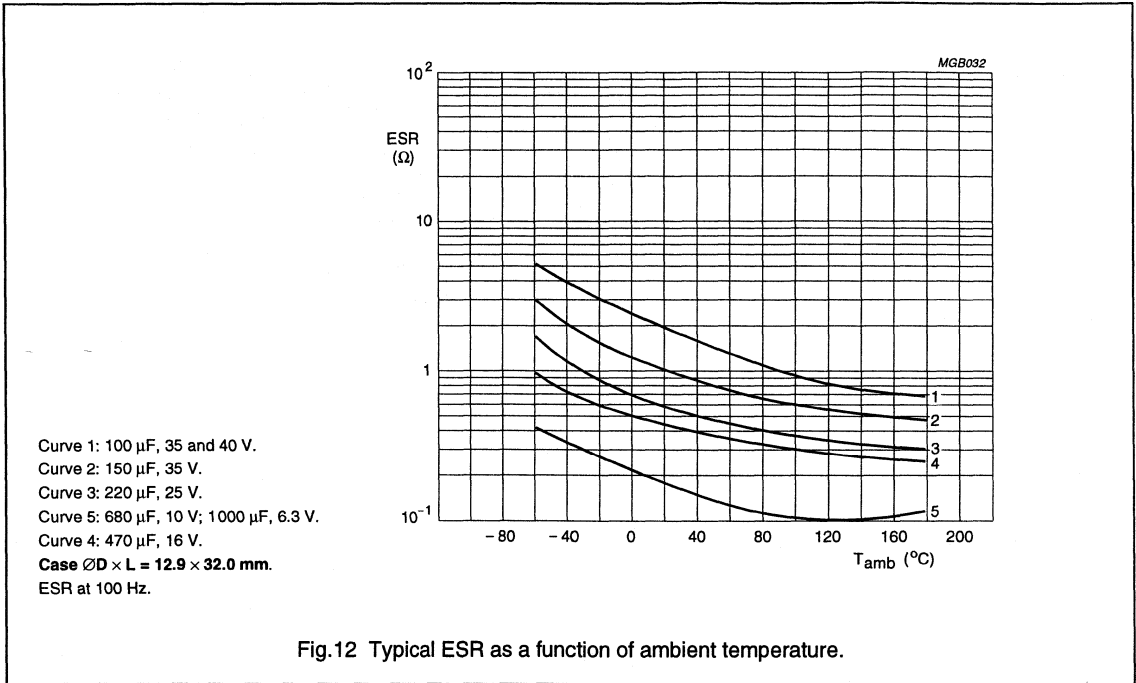
SAL-A 123



Non-solid Al-electrolytic capacitors

Solid Al, Axial

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Non-solid Al-electrolytic capacitors

Solid Al, Axial

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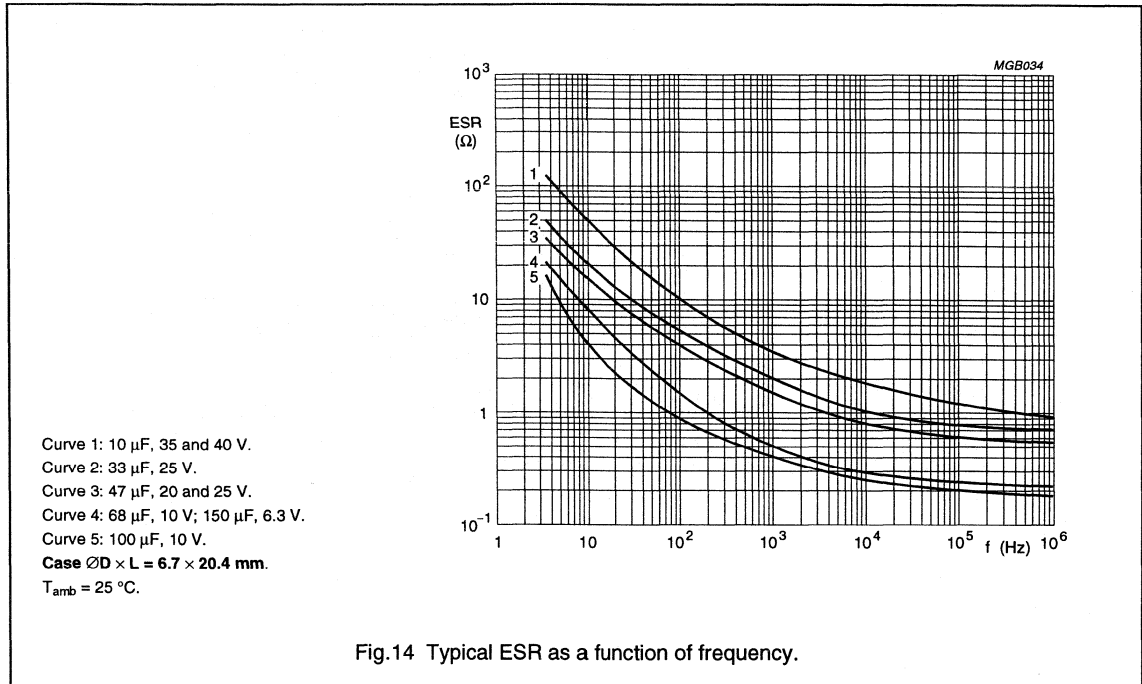


Fig.14 Typical ESR as a function of frequency.

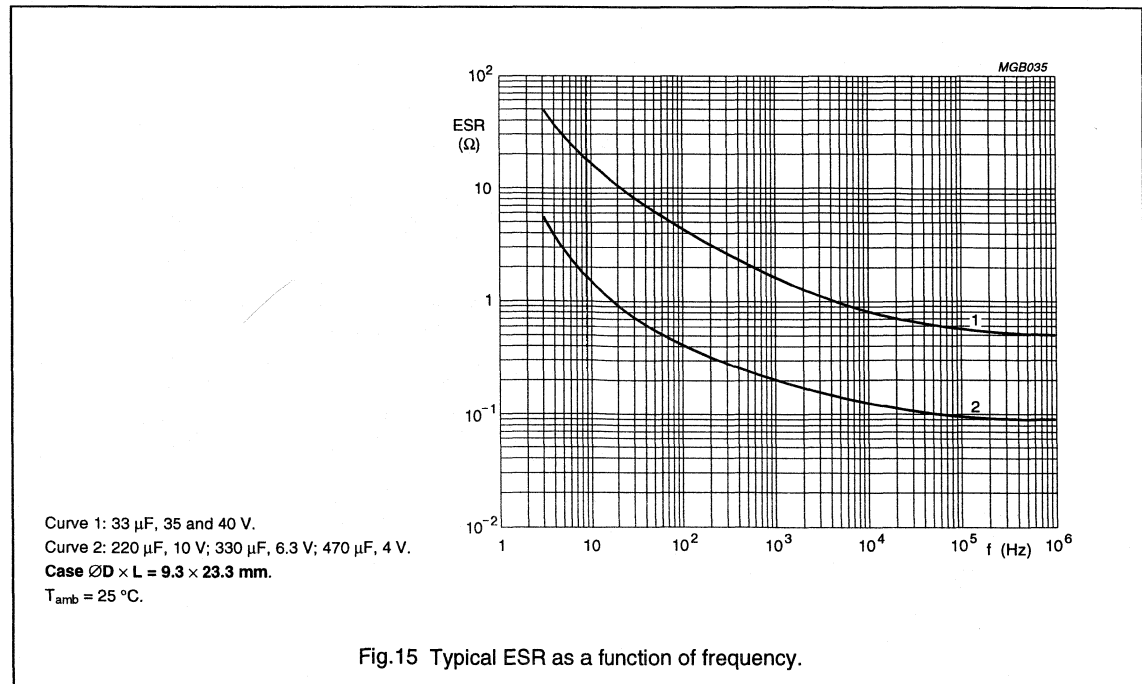


Fig.15 Typical ESR as a function of frequency.

Non-solid Al-electrolytic capacitors

SAL-A 123

Solid Al, Axial

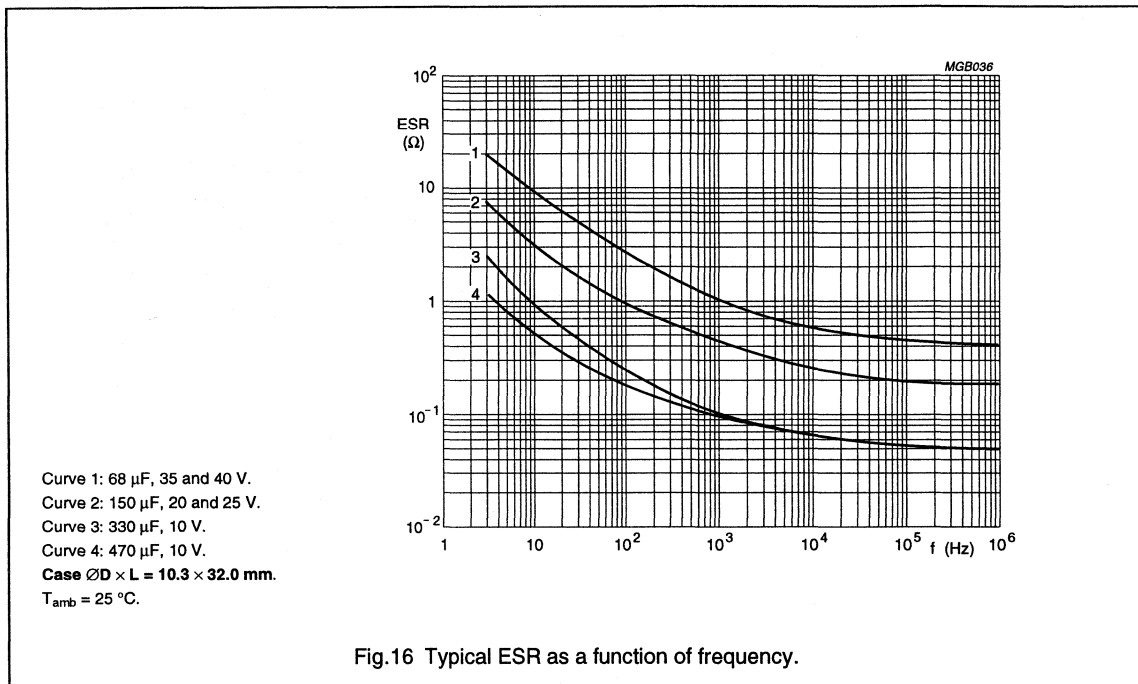


Fig.16 Typical ESR as a function of frequency.

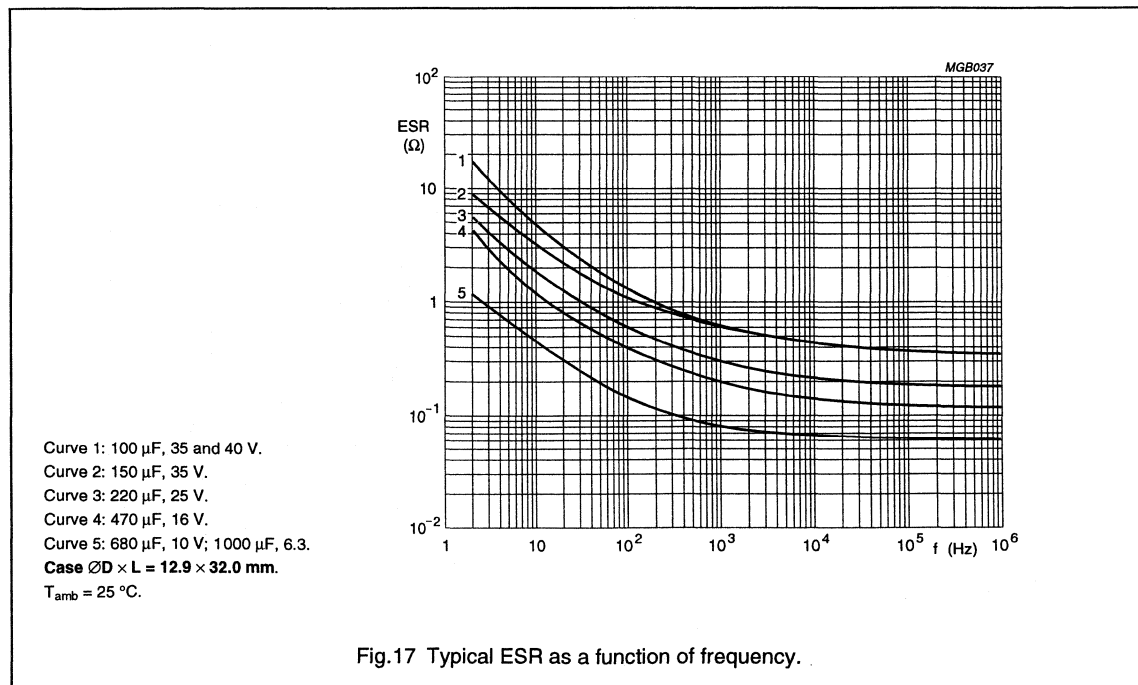


Fig.17 Typical ESR as a function of frequency.

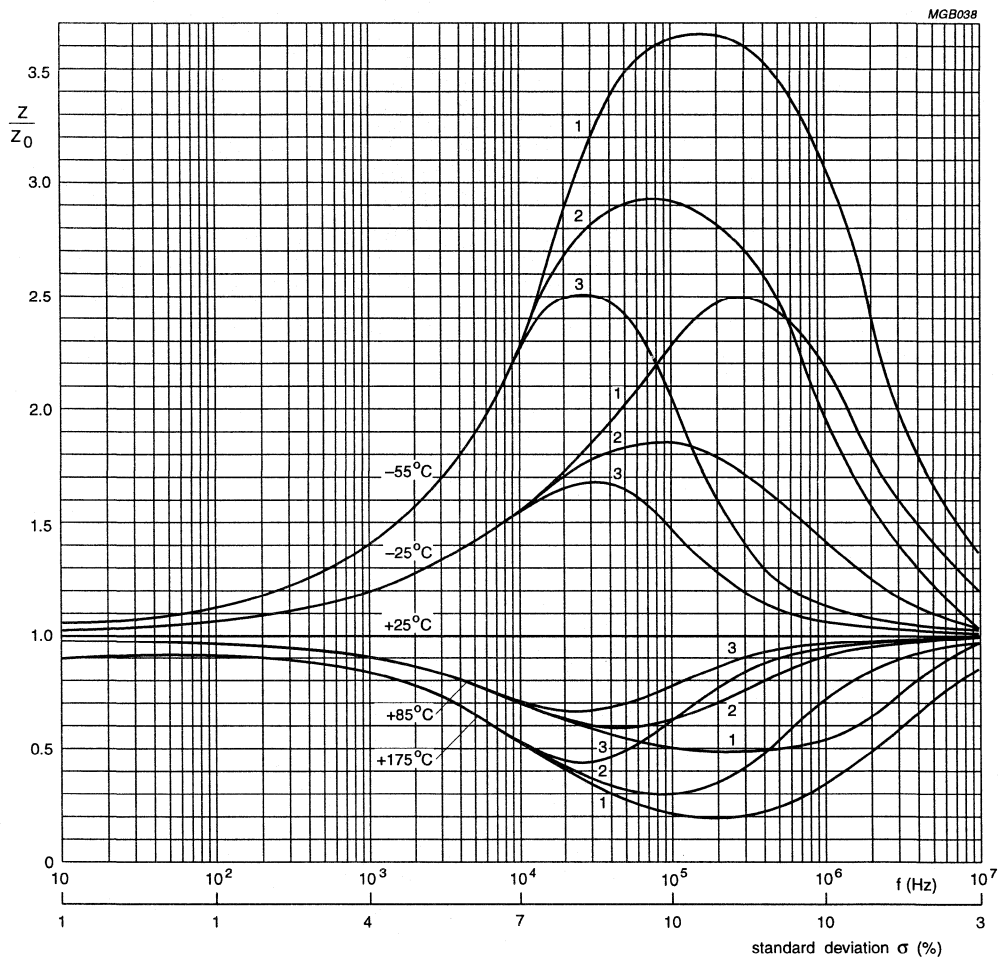
Non-solid Al-electrolytic capacitors

Solid Al, Axial

SAL-A 123

Impedance (Z)

Typical impedance at 100 kHz and $T_{amb} = 25\text{ }^{\circ}\text{C}$: $0.5 \times$ 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; 4 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 $T_{amb} = 25\text{ }^{\circ}\text{C}$.

Fig.18 Typical multiplier of impedance as a function of frequency at different ambient temperatures.

Non-solid Al-electrolytic capacitors
Solid Al, Axial

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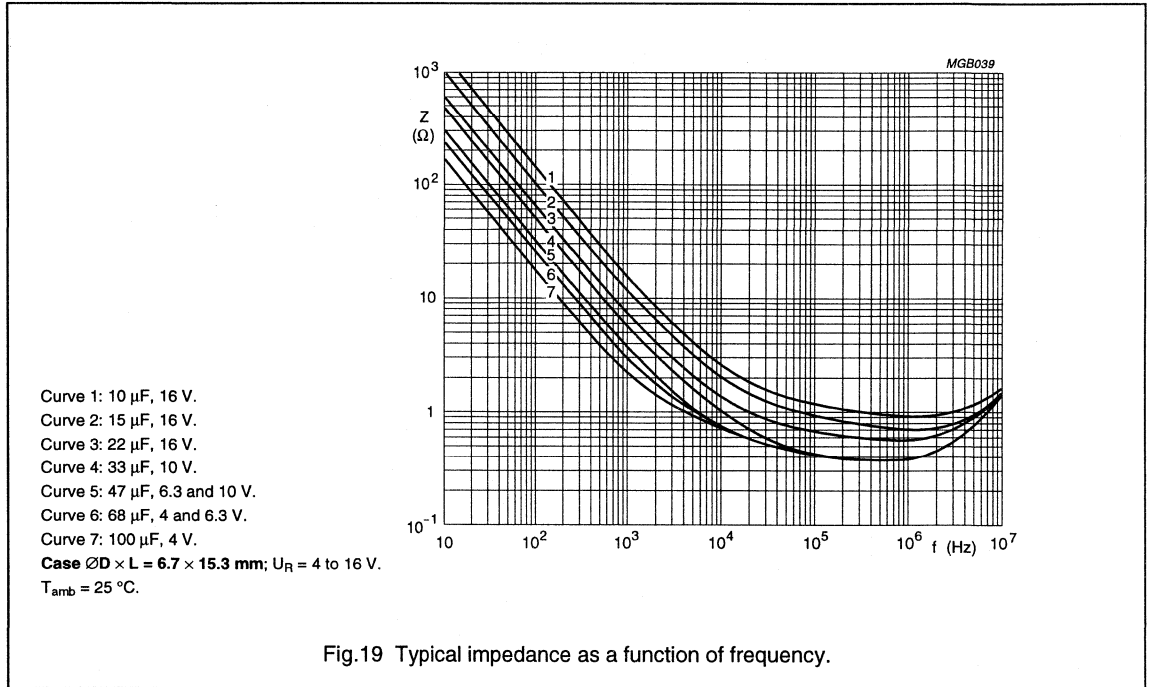


Fig.19 Typical impedance as a function of frequency.

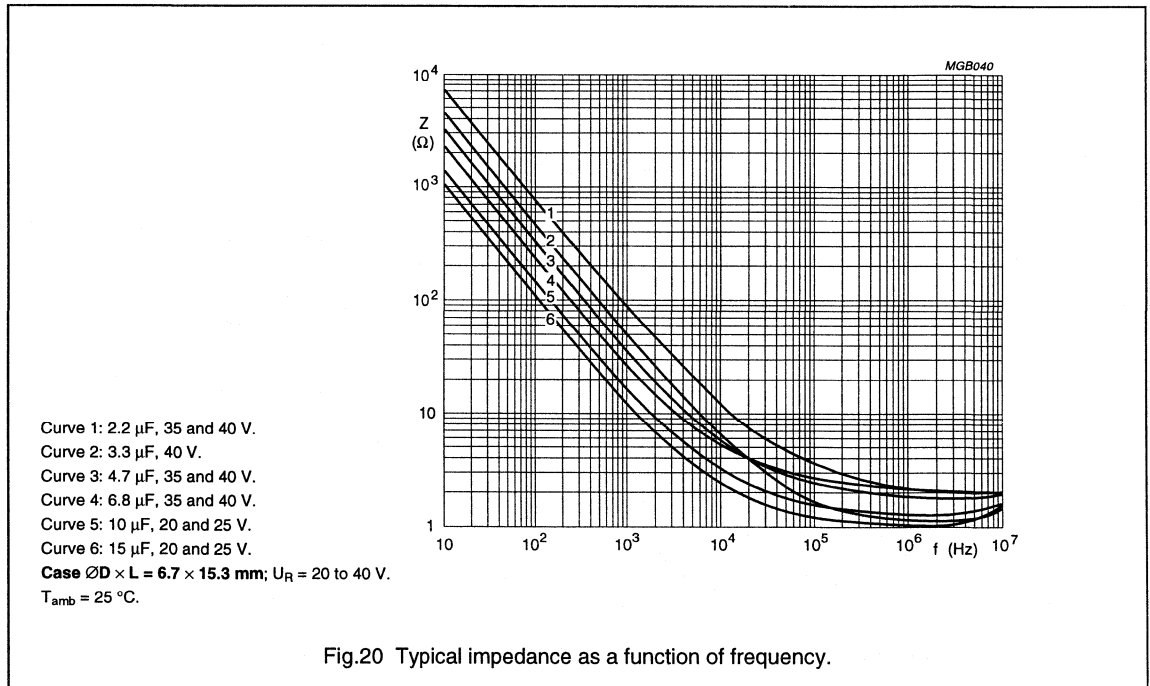
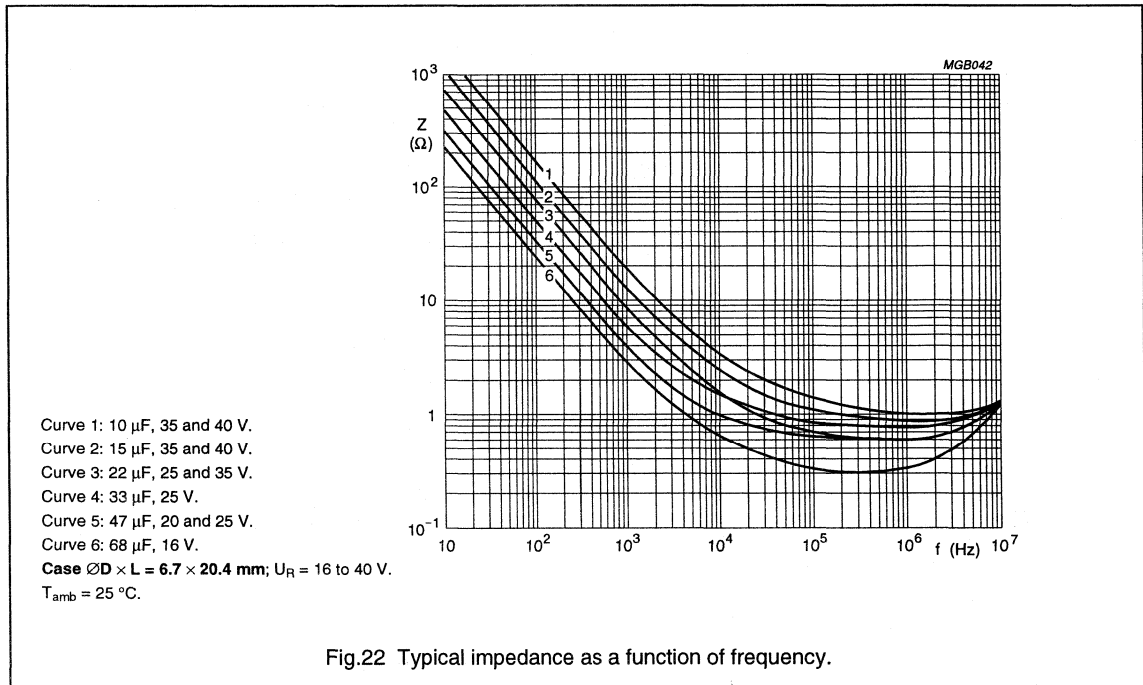
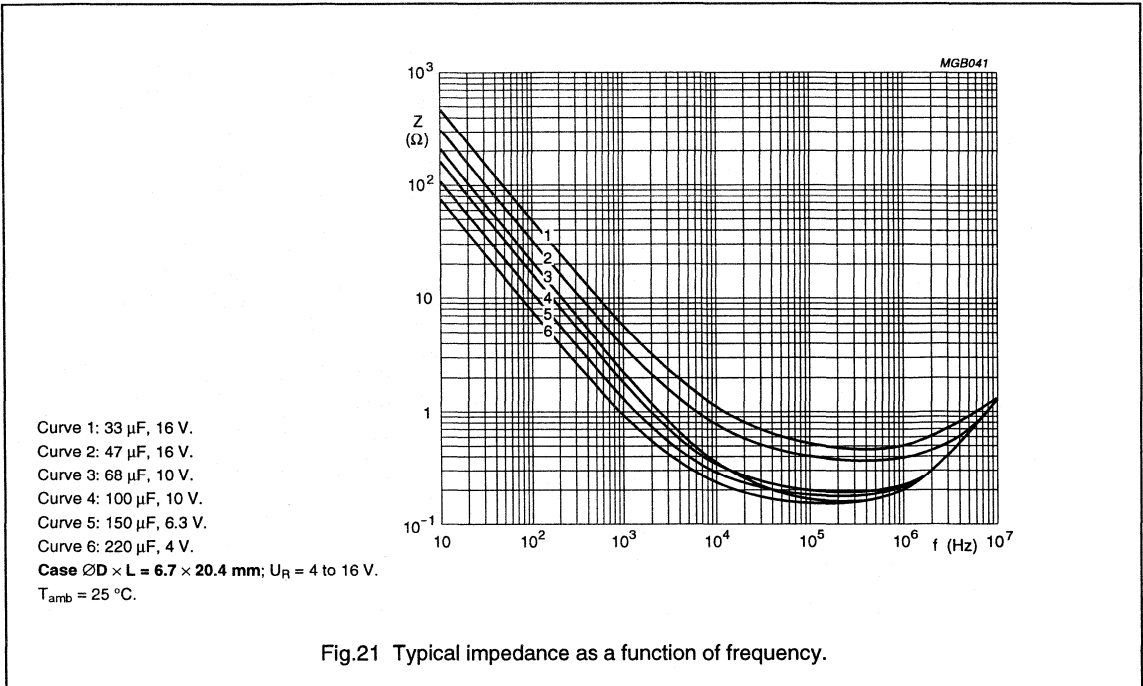


Fig.20 Typical impedance as a function of frequency.

Non-solid Al-electrolytic capacitors
Solid Al, Axial

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Non-solid Al-electrolytic capacitors

Solid Al, Axial

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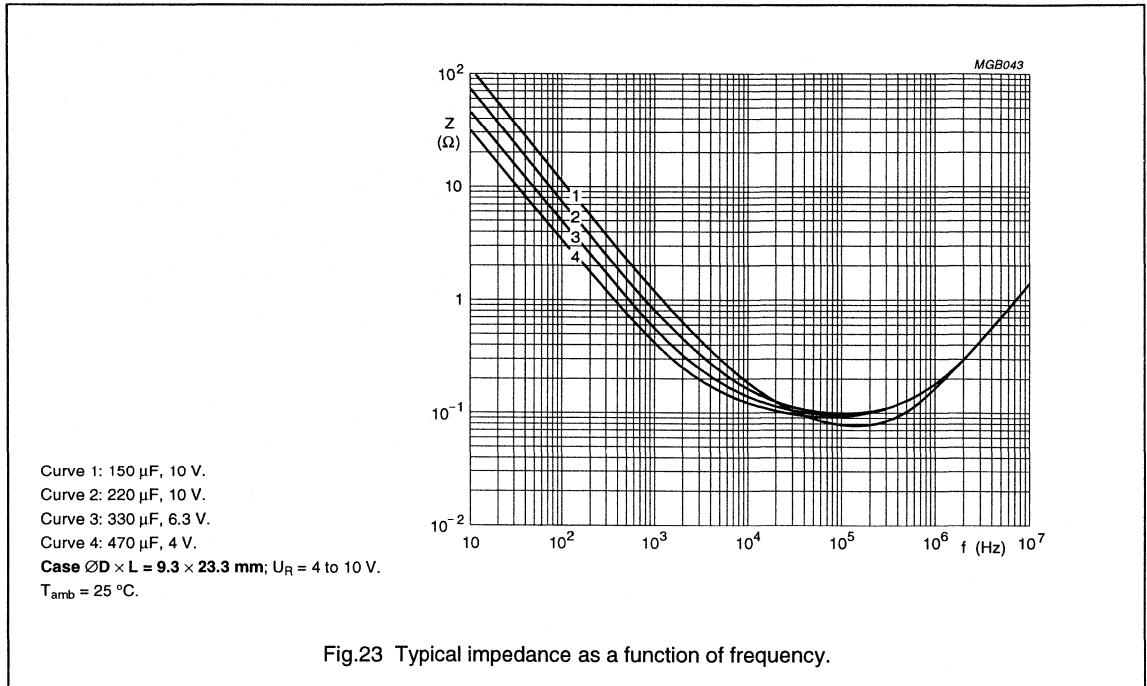


Fig.23 Typical impedance as a function of frequency.

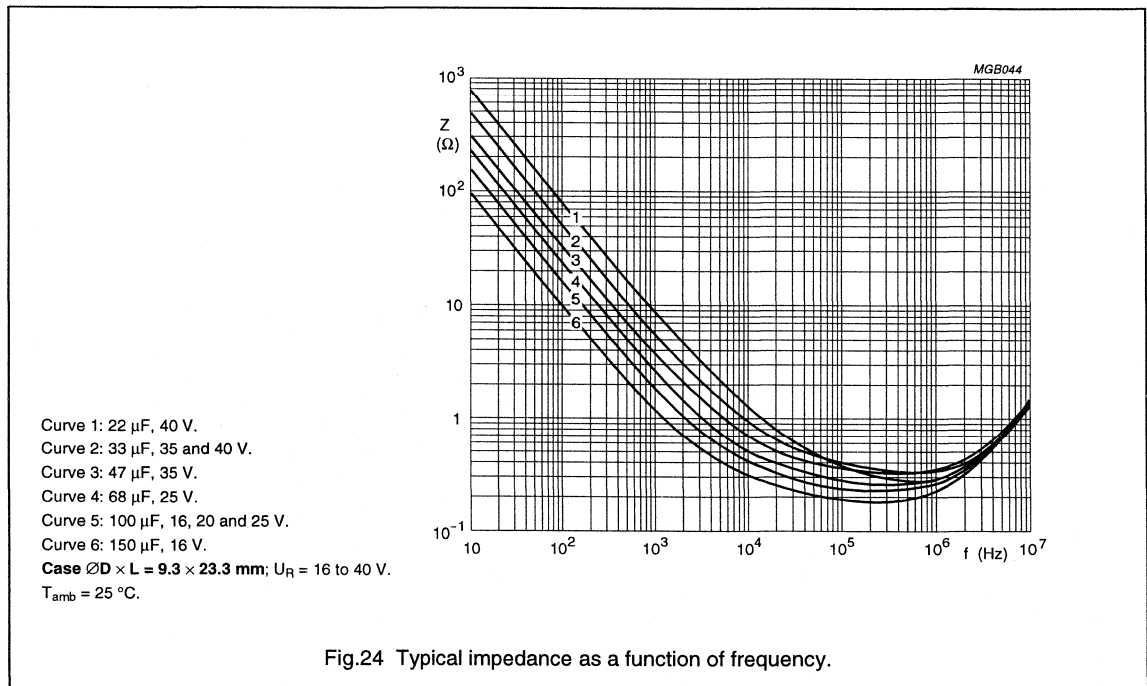
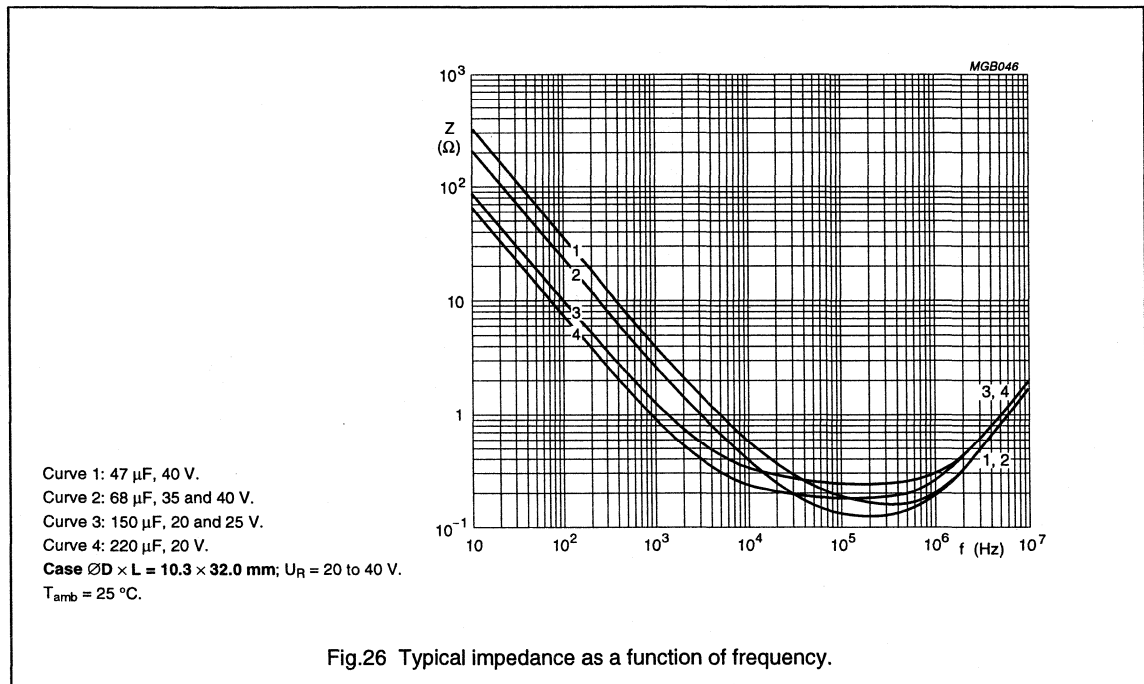
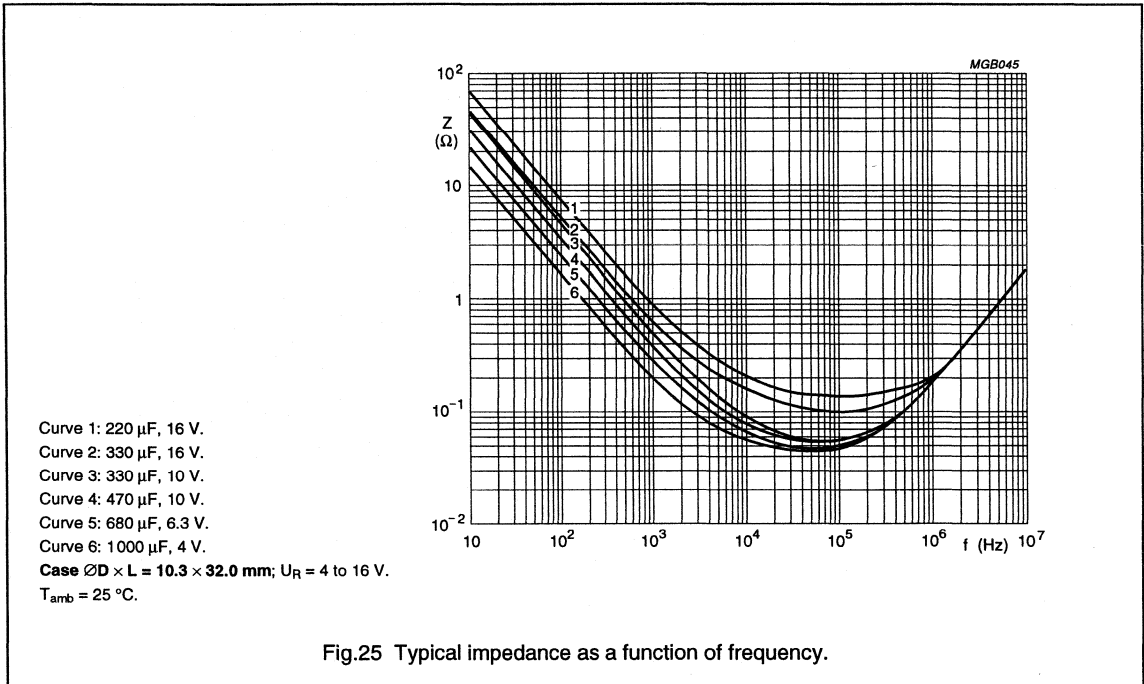


Fig.24 Typical impedance as a function of frequency.

Non-solid Al-electrolytic capacitors
Solid Al, Axial

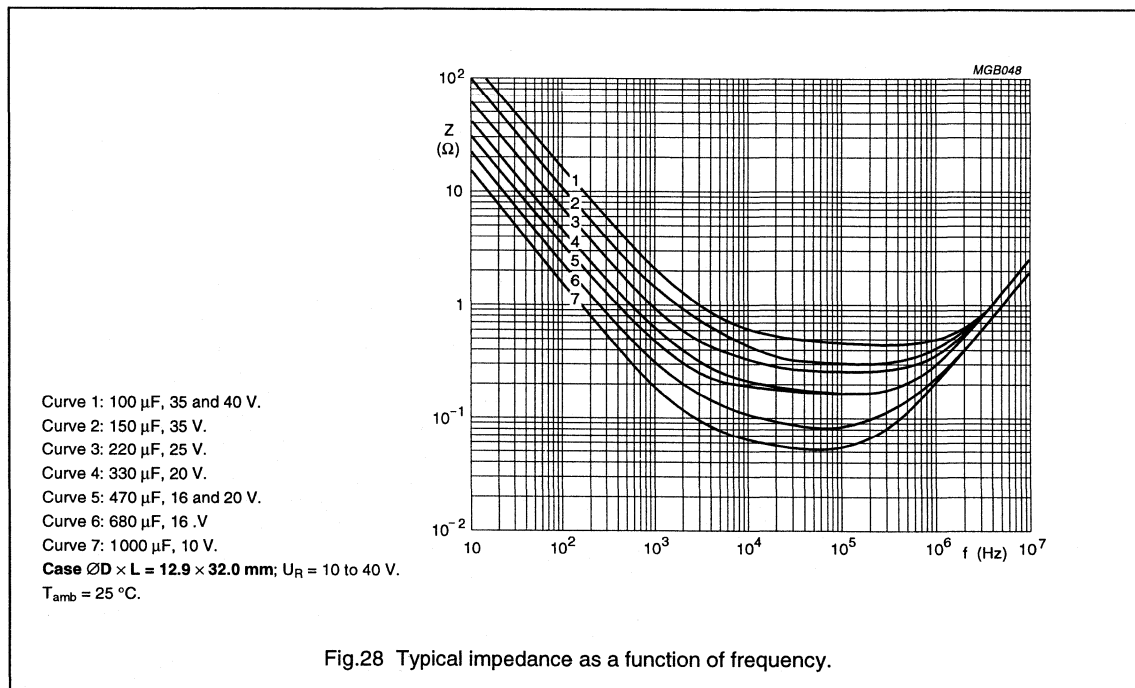
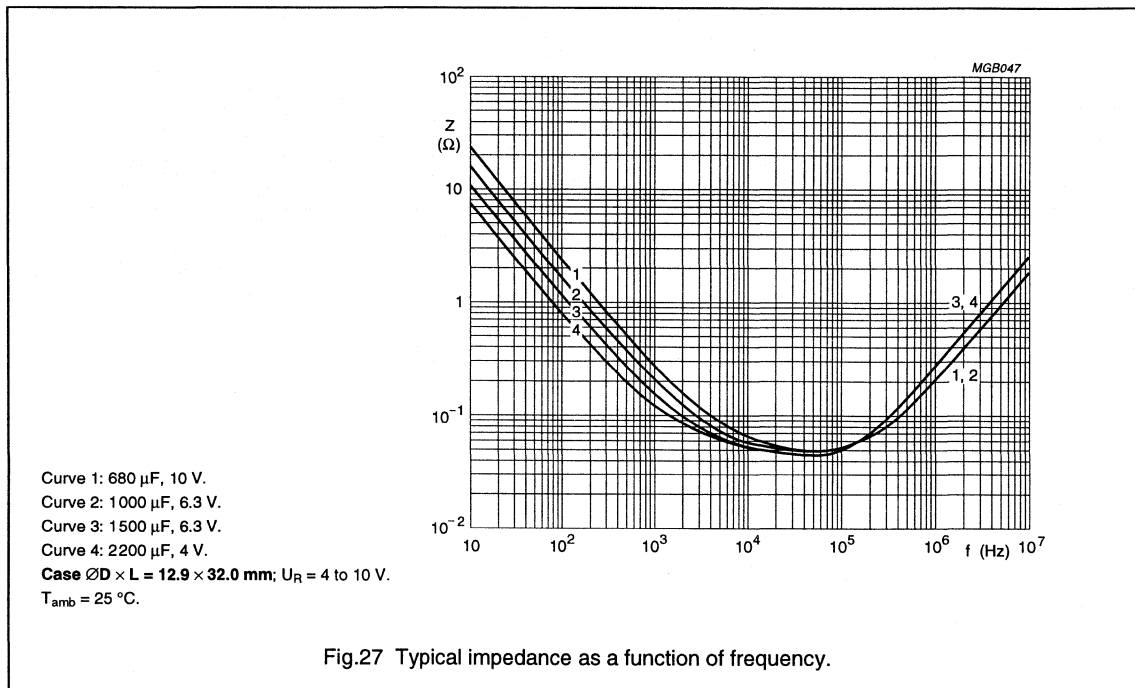
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Non-solid Al-electrolytic capacitors

Solid Al, Axial

SAL-A 123



Non-solid Al-electrolytic capacitors

Solid Al, Axial

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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	$T_{amb} = 125\text{ °C}$; $U_R = 6.3$ 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	$T_{amb} = 125\text{ °C}$; 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	$T_{amb} = 125\text{ °C}$; 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 $\Delta C/C: \pm 5\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $Z \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 1.5 \times \text{spec. limit}$

Non-solid Al-electrolytic capacitors

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Solid Al, Axial

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 $+125\text{ }^{\circ}\text{C}$	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.6 \times \text{spec. limit}$ $Z \leq 1.6 \times \text{spec. limit}$ $I_{L5} \leq 1 \times \text{spec. limit}$
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

Non-solid Al-electrolytic capacitors

Solid Al, Axial

SAL-A 123

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: severity 1	clamping both body and leads frequency range temperature 10 to 3000 Hz; 20-25 °C	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.2 \times$ stated limit $Z \leq 1.4 \times$ stated limit
severity 2	frequency range temperature 50 to 2000 Hz; 125 °C	DC leakage current: \leq stated limit
severity 1 and 2	vibration amplitude: 50 g or 3.5 mm, whichever is less	no intermittent contacts no indication of breakdown
Direction and duration of motion: severity 1	1 octave/minute; 3 directions (mutually perpendicular); 20 sweeps per direction (total 60 sweeps or 18 hours)	no open circuiting no evidence of mechanical damage
severity 2	1 octave/minute; 2 directions (longitudinal and transversal); 3 sweeps per direction (total 6 sweeps or 1 hour)	
Functioning: 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	$\tan \delta \leq 1.2 \times$ stated limit $Z \leq 1.4 \times$ stated limit
severity 1	1500 g; 0.5 ms ("MIL STD-202", method 213, letter F)	DC leakage current: \leq stated limit
severity 2	3000 g; 0.2 ms	no intermittent contacts
severity 3	10000 g; 0.1 ms	no indication of breakdown no open circuiting no evidence of mechanical damage
Direction and number of shocks: severity 1 and 2	3 successive shocks in each direction of 3 mutually perpendicular axes (total 18 shocks)	
severity 3	1 shock in any direction	
Functioning	rated voltage applied	

ENERGY STORAGE CAPACITORS (DOUBLE LAYER)



Double layer capacitors

DLC 196

FEATURES

- Polarized capacitor with high charge density, alternative product to re-chargeable backup batteries
- Dielectric: electric double layer
- Radial leads, cylindrical case, insulated with a blue vinyl sleeve
- Available in both vertical and low-profile version
- Unlimited charge and discharge cycle numbers
- No charge-discharge control circuitry and no series resistor necessary
- Maintenance-free, no periodic replacement or service necessary
- Ecologically beneficial (no Cd, no Li).

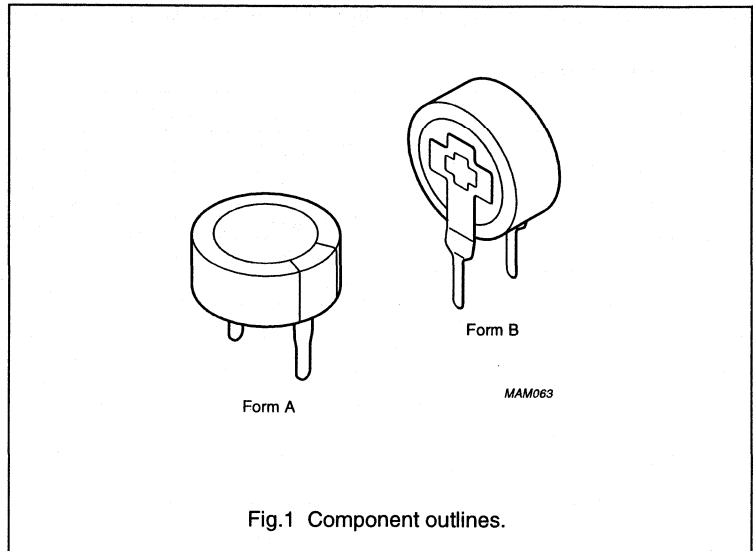


Fig.1 Component outlines.

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 (ØD × L in mm)	13 × 7 and 21 × 7.5 mm	13 × 9 and 21 × 9 mm	13 × 9 and 21 × 9 mm	11.5 × 13 mm (vertical)
Rated capacitance range, C _R	0.047 to 1.0 F	0.047 to 0.68 F	0.047 to 0.68 F	0.047 to 0.33 F
Tolerance on C _R 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	-	-	1000 hours	-
at 70 °C	1000 hours	1000 hours	2800 hours	1000 hours
at 40 °C	8000 hours	8000 hours	23000 hours	8000 hours
at 25 °C	23000 hours	23000 hours	64000 hours	23000 hours
Shelf life at 0 V	1000 hours at upper category temperature			
Climatic category IEC 68	25/070/21	25/070/21	25/085/21	25/070/21

Double layer capacitors

DLC 196

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

DLC 196

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

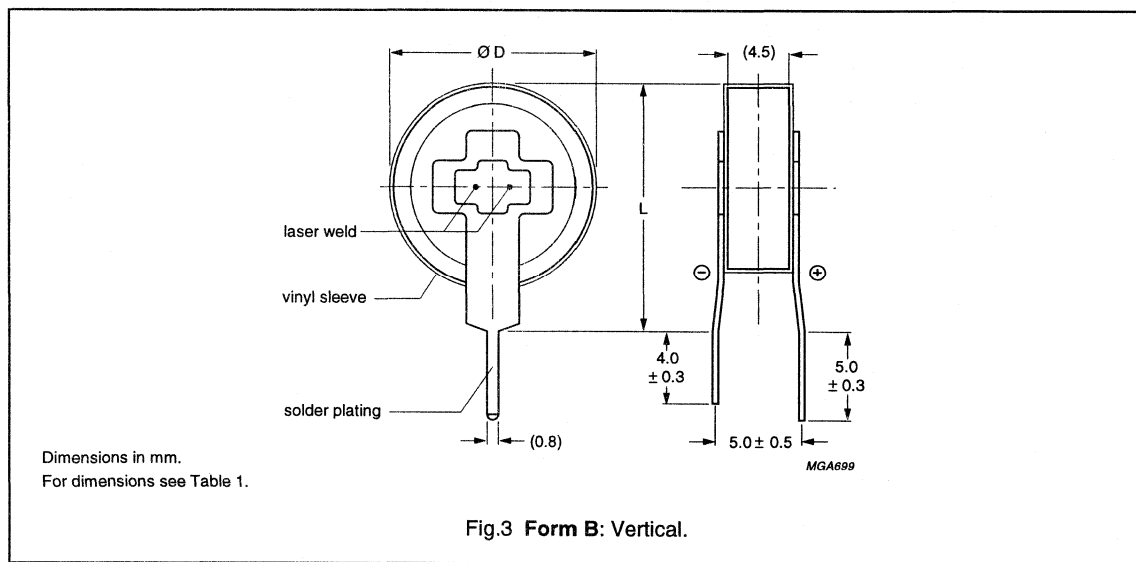
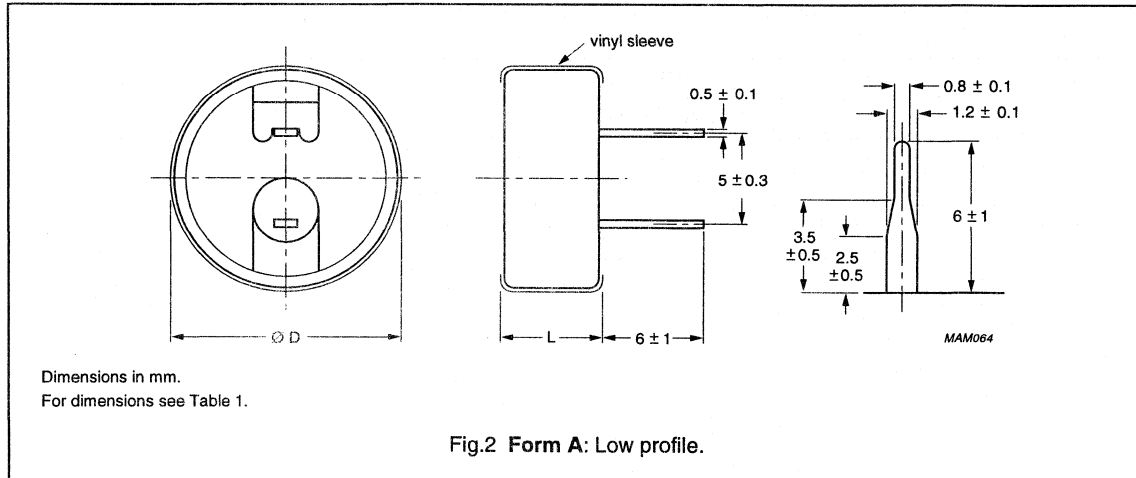


Table 1 Physical dimensions, mass and packaging quantities; see Figs.2 and 3

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	FORM	ØD _{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

DLC 196

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 2 apply at
 $T_{amb} = 20\text{ °C}$, $P = 86$ 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:
 DLC 196 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 (°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

DLC 196

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

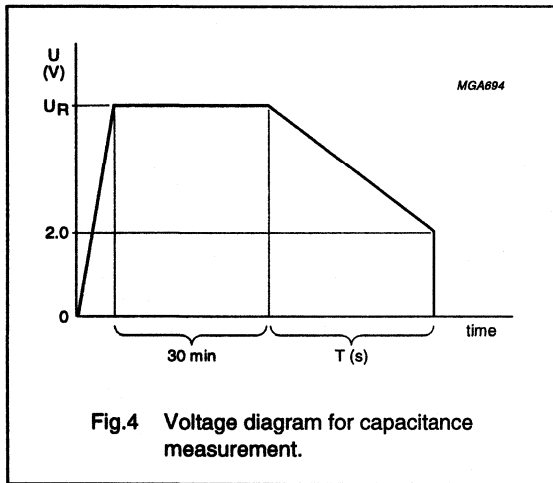


Fig.4 Voltage diagram for capacitance measurement.

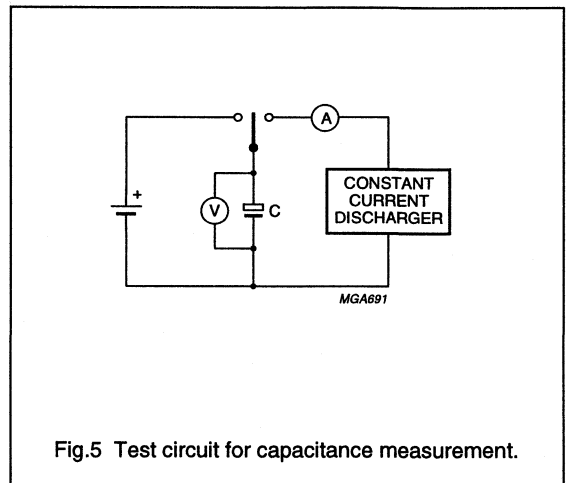


Fig.5 Test circuit for capacitance measurement.

Capacitance value C_R is given by discharge current I_D , time T and rated voltage U_R , according to the following equation:

$$C (F) = \frac{I_D (mA) \times 10^{-3} \times T (s)}{U_R (V) - 2}$$

Internal resistance (R_I) at 1 kHz

$$R_I (\Omega) = \frac{V_C (V)}{10^{-3}}$$

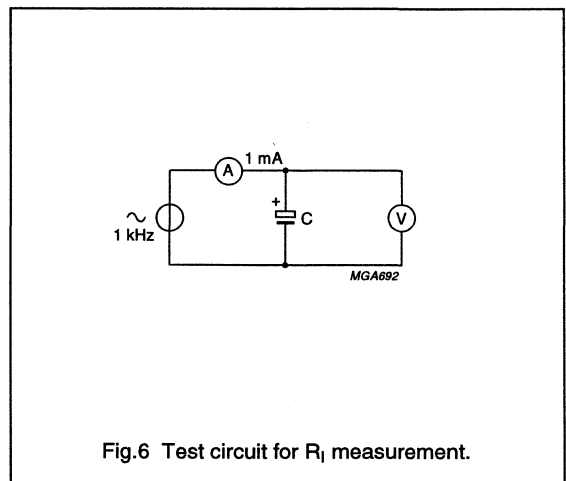


Fig.6 Test circuit for R_I measurement.

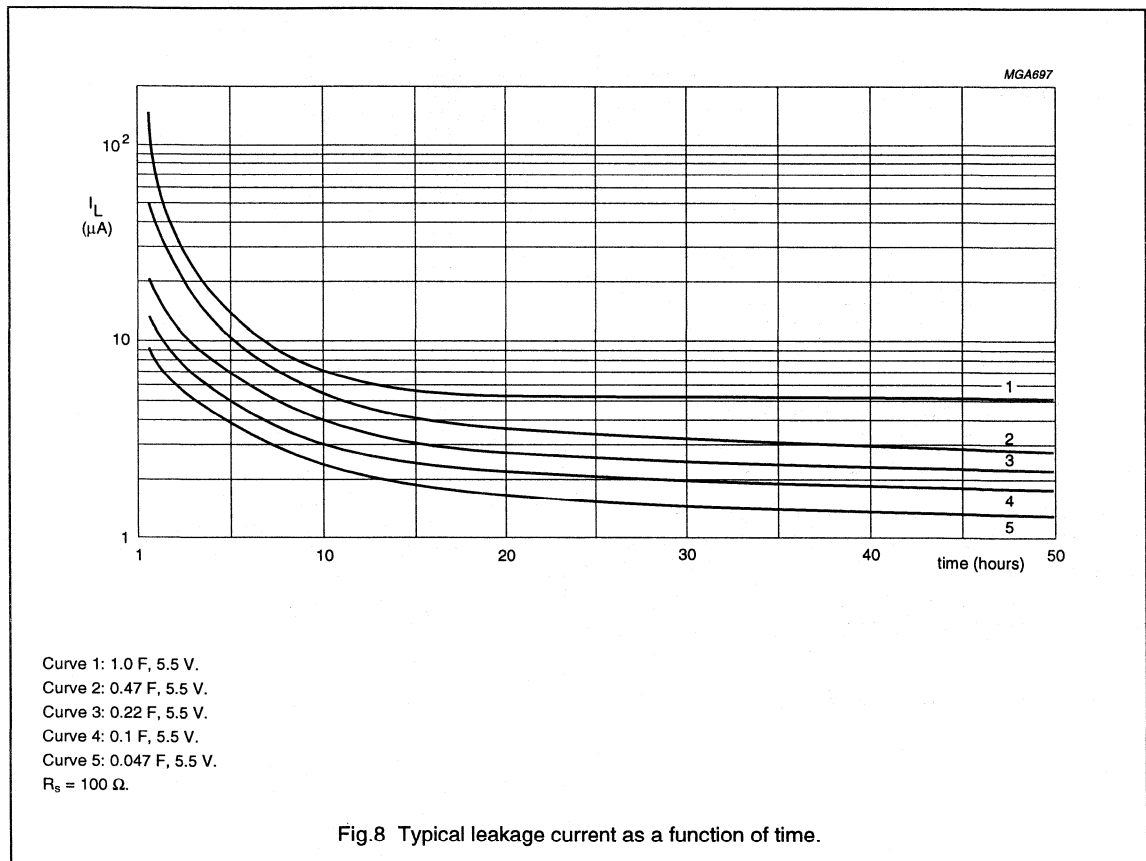
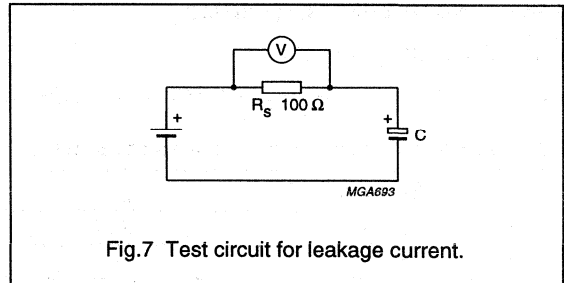
Double layer capacitors

DLC 196

Leakage current (I_L)

Leakage current shall be measured after 30 minutes application of rated voltage U_R .

$$I_L (\mu A) = \frac{V (V)}{10^{-4}}$$



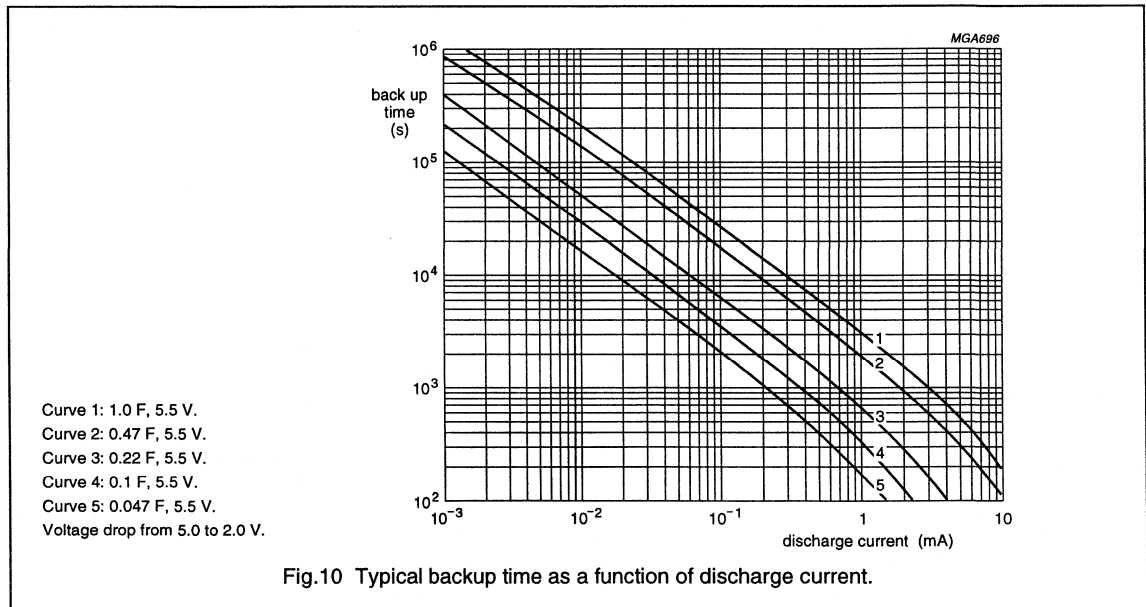
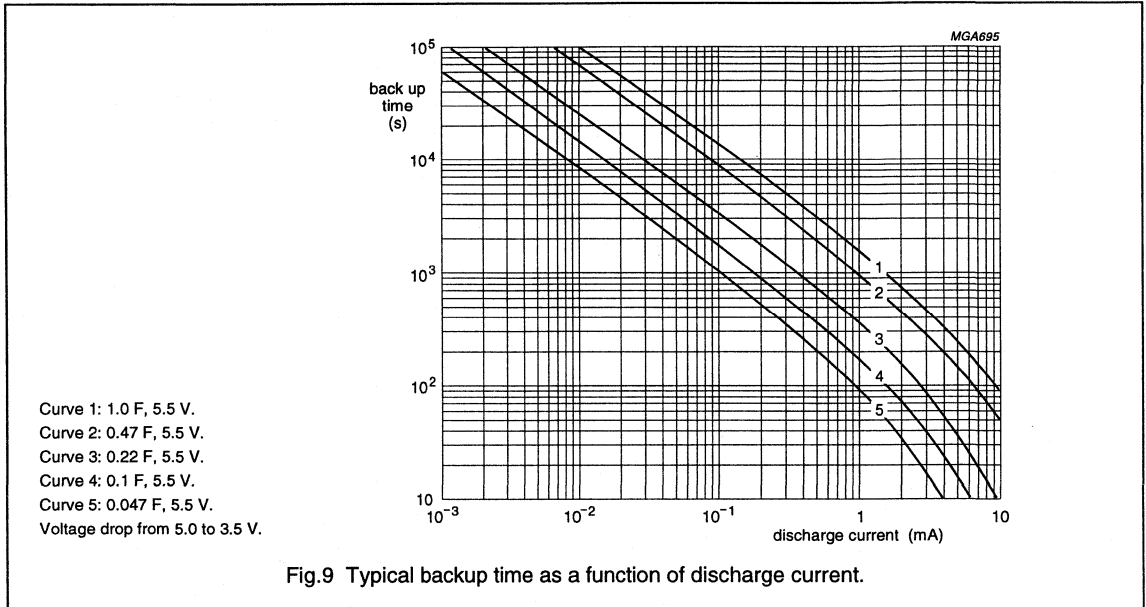
Double layer capacitors

DLC 196

DISCHARGE CHARACTERISTICS

Backup time of DLC 196 capacitors depends on minimum memory holding voltage and discharge current (corresponding with the current consumption of the load).

For minimum backup times of standard and vertical miniaturized series see Figs 9 and 10 (charging time ≥ 24 hours).



Double layer capacitors

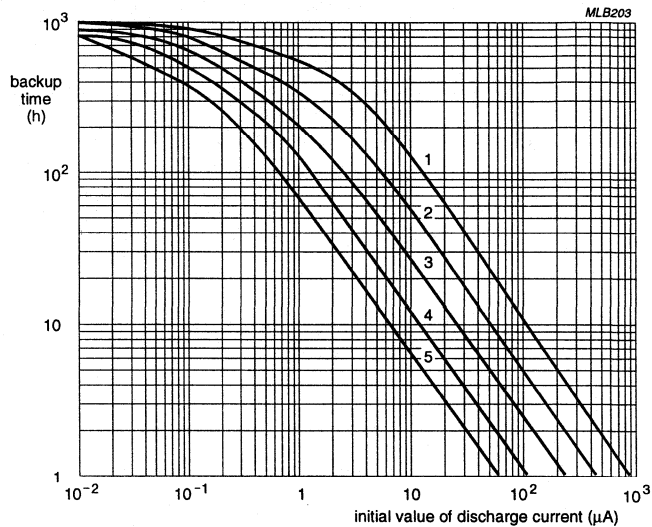
DLC 196

Figure 11 shows the backup time when a 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

DLC 196

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_1 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_1 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	$\Delta C/C: \pm 30\%$ $R_1 \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$
Endurance	4.13	$T_{\text{amb}} = 70 \text{ °C}$; 5.5 V applied; 1 000 hours	$\Delta C/C: \pm 30\%$ $R_1 \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$
Storage at upper category temperature	4.17	$T_{\text{amb}} = 70 \text{ °C}$; no voltage applied; 1 000 hours	$\Delta C/C: \pm 30\%$ $R_1 \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$
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_1 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 $R_1 \leq 5 \times \text{the } +20 \text{ °C value}$ $I_L \leq 4 \times \text{the } +20 \text{ °C value}$

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