

## Aluminum Capacitors Power Eurodin Printed Wiring

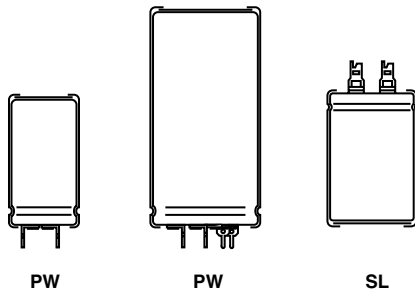
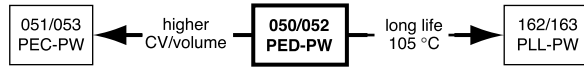


Fig.1 Component outlines



### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, cylindrical aluminum case, insulated with a blue sleeve
- Provided with keyed polarity
- 050 series also available in solder-lug (SL) versions
- Very long useful life: 15 000 hours at 85 °C
- Low ESR, high ripple current capability
- High resistance to shock and vibration



**RoHS**  
COMPLIANT

### APPLICATIONS

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

### MARKING

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

- Rated capacitance (in  $\mu\text{F}$ )
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (Q for - 10/+ 30 %)
- Rated voltage (in V)
- Date code (YYMM)
- Name of manufacturer
- Code for factory of origin
- Polarity of the terminals and '-' sign to indicate the negative terminal, visible from the top and/or side of the capacitor
- Code number
- Climatic category in accordance with IEC 60068

### QUICK REFERENCE DATA

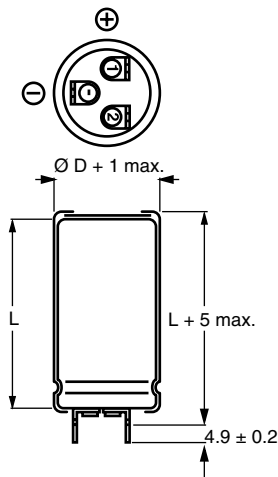
DESCRIPTION	VALUE	
	050	052
Nominal case size ( $\varnothing$ D x L in mm)	25 x 30 to 40 x 100	
Rated capacitance range (E6 series), $C_R$	470 to 68 000 $\mu\text{F}$	47 to 1000 $\mu\text{F}$
Tolerance on $C_R$	- 10 to + 30 %	
Rated voltage range, $U_R$	10 to 100 V	250 to 400 V
Category temperature range	- 40 to - 85 °C	
Endurance test at 85 °C	5000 hours	
Useful life at 85 °C	15 000 hours	
Useful life at 40 °C, 1.4 x $I_R$ applied	250 000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/085/56	

### SELECTION CHART FOR $C_R$ , $U_R$ AND RELEVANT NOMINAL CASE SIZES FOR 050 SERIES ( $\varnothing$ D x L in mm)

$C_R$ ( $\mu\text{F}$ )	$U_R$ (V)					
	10	16	25	40	63	100
470	-	-	-	-	-	25 x 30
680	-	-	-	-	-	25 x 40
1000	-	-	-	-	25 x 30	30 x 40
1500	-	-	-	25 x 30	25 x 40	35 x 40
2200	-	-	25 x 30	25 x 40	30 x 40	35 x 50
3300	-	-	-	-	-	40 x 40
3300	-	25 x 30	25 x 40	30 x 40	35 x 40	40 x 50
4700	25 x 30	25 x 40	30 x 40	35 x 40	35 x 50	40 x 70
4700	-	-	-	-	40 x 40	-
6800	25 x 40	30 x 40	35 x 40	35 x 50	40 x 50	40 x 100
6800	-	-	-	40 x 40	-	-
10 000	30 x 40	35 x 40	35 x 50	40 x 50	40 x 70	-
10 000	-	-	40 x 40	-	-	-
15 000	35 x 40	35 x 50	40 x 50	40 x 70	40 x 100	-
15 000	-	40 x 40	-	-	-	-
22 000	35 x 50	40 x 50	40 x 70	40 x 100	-	-
22 000	40 x 40	-	-	-	-	-
33 000	40 x 50	40 x 70	40 x 100	-	-	-
47 000	40 x 70	40 x 100	-	-	-	-
68 000	40 x 100	-	-	-	-	-

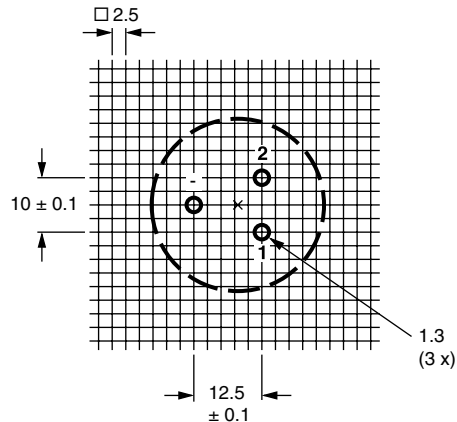
<b>SELECTION CHART FOR <math>C_R</math>, <math>U_R</math> AND RELEVANT NOMINAL CASE SIZES FOR 052 SERIES (<math>\varnothing D \times L</math>)</b>			
$C_R$ ( $\mu F$ )	$U_R$ (V)		
	250	385	400
47	-	25 x 30	25 x 30
68	-	25 x 40	25 x 40
100	25 x 30	30 x 40	30 x 40
150	25 x 40	35 x 40	35 x 40
220	30 x 40	35 x 50	35 x 50
	-	40 x 40	40 x 40
330	35 x 40	40 x 50	40 x 50
470	35 x 50	40 x 70	40 x 70
	40 x 40	-	-
680	40 x 50	-	40 x 100
1000	40 x 70	-	-

**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**



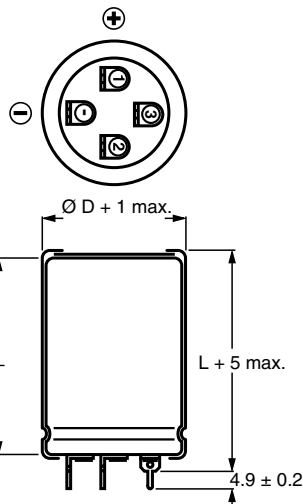
Case  $\varnothing D = 25$  mm

Fig. 2 Printed wiring pin version



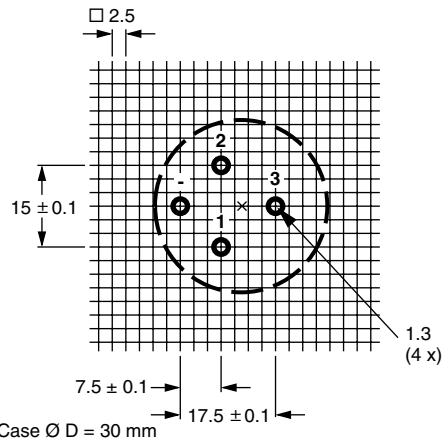
Case  $\varnothing D = 25$  mm

Fig. 3 Mounting hole diagram viewed from component side



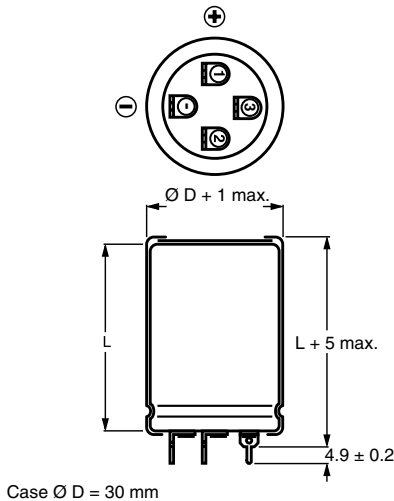
Case  $\varnothing D = 30$  mm

Fig. 4 Printed wiring pin version



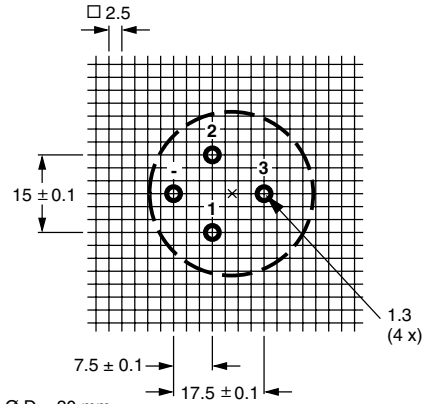
Case  $\varnothing D = 30$  mm

Fig. 5 Mounting hole diagram viewed from component side



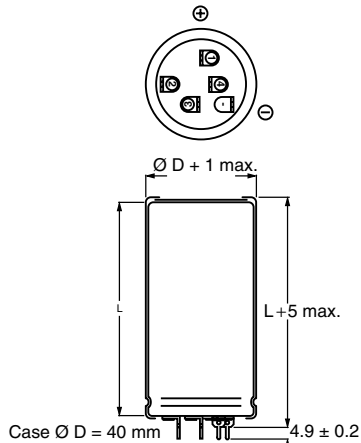
Case  $\varnothing D = 30 \text{ mm}$

Fig. 6 Printed wiring pin version



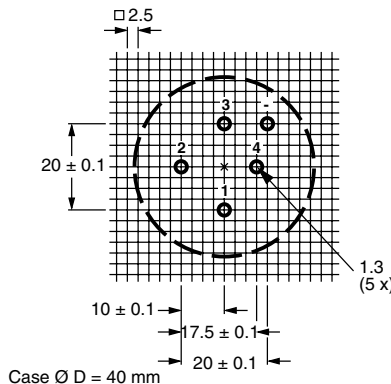
Case  $\varnothing D = 30 \text{ mm}$

Fig. 7 Mounting hole diagram viewed from component side



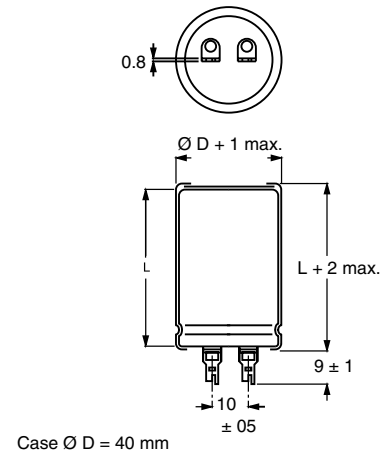
Case  $\varnothing D = 40 \text{ mm}$

Fig. 8 Printed wiring pin version



Case  $\varnothing D = 40 \text{ mm}$

Fig. 9 Mounting hole diagram viewed from component outside



Case  $\varnothing D = 40 \text{ mm}$

Fig. 10 Solder-lug version (SL):  
only available in 050 series

## 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.**

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES						
NOMINAL CASE SIZE $\varnothing D \times L$	$\varnothing D_{\text{max.}}$	$L_{\text{max.}}$ SL VERSIONS	$L_{\text{max.}}$ PW VERSIONS	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS L x W x H
25 x 30	26	32	35	≈ 24	100	290 x 280 x 50
25 x 40	26	42	45	≈ 28	100	290 x 280 x 60
30 x 40	31	42	45	≈ 38	100	340 x 330 x 60
35 x 40	36	42	45	≈ 51	50	390 x 198 x 60
35 x 50	36	52	55	≈ 66	50	390 x 198 x 70
40 x 40 <sup>(1)</sup>	41	-	45	≈ 78	50	440 x 223 x 60
40 x 50	41	52	55	≈ 82	50	440 x 223 x 70
40 x 70	41	72	75	≈ 110	25	230 x 230 x 90
40 x 100	41	102	105	≈ 176	25	230 x 230 x 120

### Note

<sup>(1)</sup> Not available in SL versions

ELECTRICAL DATA	
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

**Note**

1. Unless otherwise specified, all electrical values in Tables 2 and 3 apply at  $T_{amb} = 20\text{ °C}$ ,  $P = 86\text{ to }106\text{ kPa}$ ,  $RH = 45\text{ to }75\%$ .

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION FOR 050 SERIES										
$U_R$ (V)	$C_R$ 100 Hz ( $\mu\text{F}$ )	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 $\Omega$ )	Z 10 kHz (m $\Omega$ )	ORDERING CODE SL MAL2050.....	ORDERING CODE PW MAL2050.....
10	4700	25 x 30	2.4	4.6	0.28	0.10	74	50	14472E3	54472E3
	6800	25 x 40	3.2	6.1	0.41	0.14	51	37	14682E3	54682E3
	10 000	30 x 40	3.8	7.2	0.60	0.20	39	29	14103E3	54103E3
	15 000	35 x 40	4.1	7.8	0.90	0.30	35	26	14153E3	54153E3
	22 000	35 x 50	5.0	9.5	1.32	0.44	27	21	14223E3	54223E3
	22 000	40 x 40	4.2	8.0	1.32	0.44	36	27	not available	44223E3
	33 000	40 x 50	5.0	9.5	1.98	0.66	29	22	14333E3	54333E3
	47 000	40 x 70	6.8	12.9	2.82	0.94	20	17	14473E3	54473E3
68 000	40 x 100	9.2	17.5	4.08	1.36	15	14	14683E3	54683E3	
16	3300	25 x 30	2.4	4.6	0.32	0.11	75	50	15332E3	55332E3
	4700	25 x 40	3.1	5.9	0.45	0.15	52	37	15472E3	55472E3
	6800	30 x 40	3.7	7.0	0.65	0.22	40	30	15682E3	55682E3
	10 000	35 x 40	4.1	7.8	0.96	0.32	36	27	15103E3	55103E3
	15 000	35 x 50	5.0	9.5	1.44	0.48	28	21	15153E3	55153E3
	15 000	40 x 40	4.2	8.0	1.44	0.48	36	27	not available	45153E3
	22 000	40 x 50	5.0	9.5	2.12	0.71	29	22	15223E3	55223E3
	33 000	40 x 70	6.7	12.7	3.17	1.06	20	17	15333E3	55333E3
47 000	40 x 100	9.1	17.3	4.51	1.51	15	14	15473E3	55473E3	
25	2200	25 x 30	2.3	4.4	0.33	0.11	78	52	16222E3	56222E3
	3300	25 x 40	3.1	5.9	0.49	0.17	53	38	16332E3	56332E3
	4700	30 x 40	3.7	7.0	0.70	0.24	42	31	16472E3	56472E3
	6800	35 x 40	4.1	7.8	1.02	0.34	37	28	16682E3	56682E3
	10 000	35 x 50	5.0	9.5	1.50	0.50	28	21	16103E3	56103E3
	10 000	40 x 40	4.2	8.0	1.50	0.50	36	27	not available	46103E3
	15 000	40 x 50	5.0	9.5	2.25	0.75	29	22	16153E3	56153E3
	22 000	40 x 70	6.8	12.9	3.30	1.10	20	17	16223E3	56223E3
33 000	40 x 100	9.2	17.5	4.95	1.65	15	14	16333E3	56333E3	
40	1500	25 x 30	2.0	3.8	0.36	0.12	112	68	17152E3	57152E3
	2200	25 x 40	2.7	5.1	0.53	0.18	76	51	17222E3	57222E3
	3300	30 x 40	3.3	6.3	0.79	0.27	57	41	17332E3	57332E3
	4700	35 x 40	3.8	7.2	1.13	0.38	48	35	17472E3	57472E3
	6800	35 x 50	4.7	8.9	1.64	0.55	36	27	17682E3	57682E3
	6800	40 x 40	4.1	7.8	1.64	0.55	45	33	not available	47682E3
	10 000	40 x 50	4.9	9.3	2.40	0.80	35	27	17103E3	57103E3
	15 000	40 x 70	6.6	12.5	3.60	1.20	25	20	17153E3	57153E3
22 000	40 x 100	9.0	17.1	5.28	1.76	18	16	17223E3	57223E3	

**ORDERING EXAMPLE**

Electrolytic capacitor 050 series

10 000  $\mu\text{F}/25\text{ V}$ ; - 10/+ 30 %

Nominal case size:  $\varnothing 35 \times 50\text{ mm}$ ; PW version

Ordering code: MAL205056103E3

Former 12NC: 222205056103



<b>ELECTRICAL DATA AND ORDERING INFORMATION FOR 050 SERIES</b>										
$U_R$ (V)	$C_R$ 100 Hz ( $\mu$ F)	NOMINAL CASE SIZE $\varnothing$ D x L (mm)	$I_R$ 100 Hz 85 °C (A)	$I_R$ 20 kHz 70 °C (A)	$I_{L1}$ 1 min (mA)	$I_{L5}$ 5 min (mA)	ESR 100 Hz (m $\Omega$ )	Z 10 kHz (m $\Omega$ )	ORDERING CODE SL MAL2050.....	ORDERING CODE PW MAL2050.....
63	1000	25 x 30	1.8	3.4	0.38	0.13	122	74	18102E3	58102E3
	1500	25 x 40	2.5	4.7	0.57	0.19	83	54	18152E3	58152E3
	2200	30 x 40	3.1	5.9	0.83	0.28	57	41	18222E3	58222E3
	3300	35 x 40	3.6	6.8	1.25	0.42	48	35	18332E3	58332E3
	4700	35 x 50	4.4	8.3	1.78	0.60	36	27	18472E3	58472E3
	4700	40 x 40	3.8	7.2	1.78	0.60	45	33	not available	48472E3
	6800	40 x 50	4.7	8.9	2.57	0.86	35	27	18682E3	58682E3
	10 000	40 x 70	6.2	11.8	3.78	1.26	25	20	18103E3	58103E3
	15 000	40 x 100	8.5	16.1	5.67	1.89	18	16	18153E3	58153E3
100	470	25 x 30	1.4	2.7	0.28	0.10	247	172	19471E3	59471E3
	680	25 x 40	1.9	3.6	0.41	0.14	170	116	19681E3	59681E3
	1000	30 x 40	2.5	4.7	0.60	0.20	123	88	19102E3	59102E3
	1500	35 x 40	3.1	5.8	0.90	0.30	94	71	19152E3	59152E3
	2200	35 x 50	3.9	7.4	1.32	0.44	69	55	19222E3	59222E3
	2200	40 x 40	3.6	6.8	1.32	0.44	81	65	not available	49222E3
	3300	40 x 50	4.6	8.7	1.98	0.66	59	48	19332E3	59332E3
	4700	40 x 70	6.2	11.7	2.82	0.94	42	36	19472E3	59472E3
	6800	40 x 100	8.2	15.5	4.08	1.36	32	28	19682E3	59682E3

Table 3

<b>ELECTRICAL DATA AND ORDERING INFORMATION FOR 052 SERIES</b>										
$U_R$ (V)	$C_R$ 100 Hz ( $\mu$ F)	NOMINAL CASE SIZE $\varnothing$ D x L (mm)	$I_R$ 100 Hz 85 °C (A)	$I_R$ 20 kHz 70 °C (A)	$I_{L1}$ 1 min (mA)	$I_{L5}$ 5 min (mA)	ESR 100 Hz (m $\Omega$ )	Z 10 kHz (m $\Omega$ )	ORDERING CODE MAL2052.....	
250	100	25 x 30	0.6	1.15	0.15	0.05	1800	1300	53101E3	
	150	25 x 40	0.8	1.5	0.23	0.08	1100	850	53151E3	
	220	30 x 40	1.0	1.9	0.33	0.11	750	550	53221E3	
	330	35 x 40	1.4	2.65	0.49	0.17	500	400	53331E3	
	470	35 x 50	1.8	3.4	0.70	0.24	360	290	53471E3	
	470	40 x 40	1.8	3.4	0.70	0.24	420	350	43471E3	
	680	40 x 50	2.3	4.4	1.02	0.34	250	190	53681E3	
	1000	40 x 70	3.0	5.7	1.50	0.50	170	140	53102E3	
385	47	25 x 30	0.5	0.94	0.11	0.04	2370	1550	58479E3	
	68	25 x 40	0.67	1.27	0.16	0.06	1640	1100	58689E3	
	100	30 x 40	0.84	1.59	0.23	0.08	1275	950	58101E3	
	150	35 x 40	1.13	2.14	0.34	0.11	850	635	58151E3	
	220	35 x 50	1.48	2.8	0.50	0.17	580	430	58221E3	
	220	40 x 40	1.48	2.8	0.50	0.17	580	430	48221E3	
	330	40 x 50	1.97	3.73	0.75	0.25	385	300	58331E3	
470	40 x 70	2.7	5.11	1.06	0.36	270	215	58471E3		
400	47	25 x 30	0.47	0.89	0.11	0.04	2700	2125	56479E3	
	68	25 x 40	0.63	1.29	0.16	0.06	1875	1470	56689E3	
	100	30 x 40	0.84	1.59	0.24	0.08	1275	1000	56101E3	
	150	35 x 40	1.13	2.14	0.36	0.12	850	665	56151E3	
	220	35 x 50	1.41	2.67	0.52	0.17	650	450	56221E3	
	220	40 x 40	1.41	2.67	0.52	0.17	650	450	46221E3	
	330	40 x 50	1.86	3.52	0.79	0.26	435	315	56331E3	
	470	40 x 70	2.54	4.81	1.12	0.37	305	225	56471E3	
680	40 x 100	3.56	6.75	1.63	0.54	210	155	56681E3		



ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage	≤ 250 V versions	$U_s = 1.15 \times U_R$
	≥ 385 V versions	$U_s = 1.1 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
<b>Current</b>		
Leakage current	After 1 minute at $U_R$	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$
	After 5 minutes at $U_R$	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$
<b>Inductance</b>		
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)**

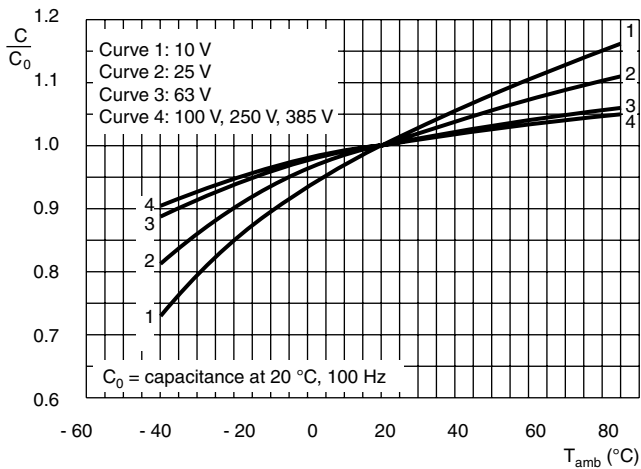


Fig.11 Typical multiplier of capacitance as a function of ambient temperature

**EQUIVALENT SERIES RESISTANCE (ESR)**

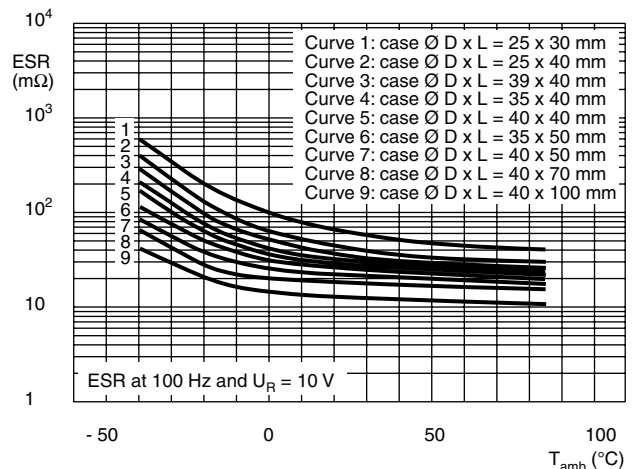


Fig.12 Typical ESR as a function of temperature

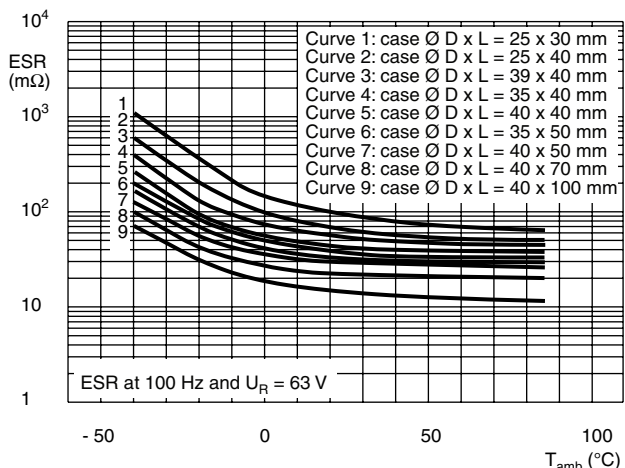


Fig.13 Typical ESR as a function of temperature

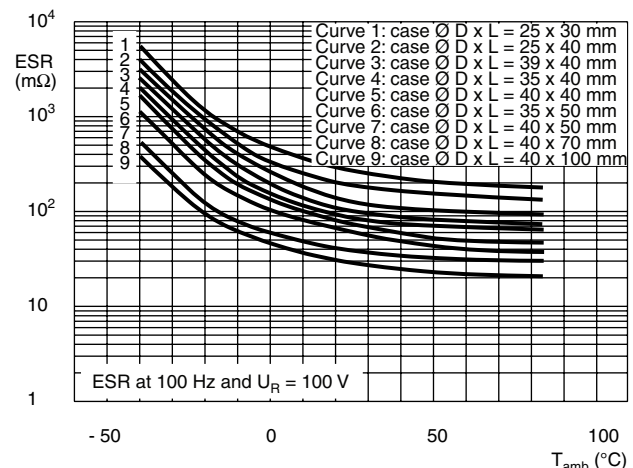


Fig.14 Typical ESR as a function of temperature

**EQUIVALENT SERIES RESISTANCE (ESR)**

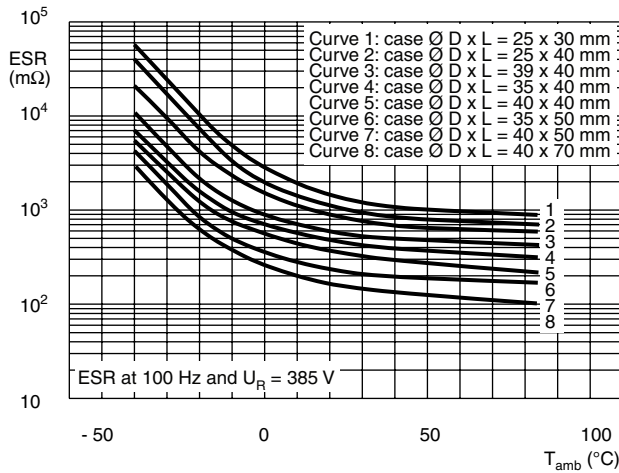


Fig.15 Typical ESR as a function of temperature

**IMPEDANCE (Z)**

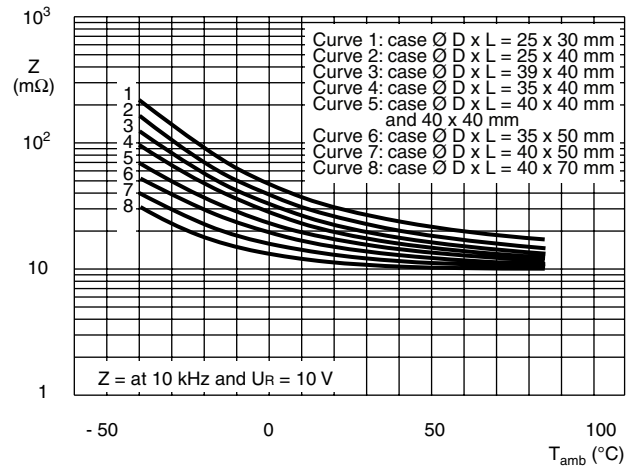


Fig.16 Typical impedance as a function of temperature

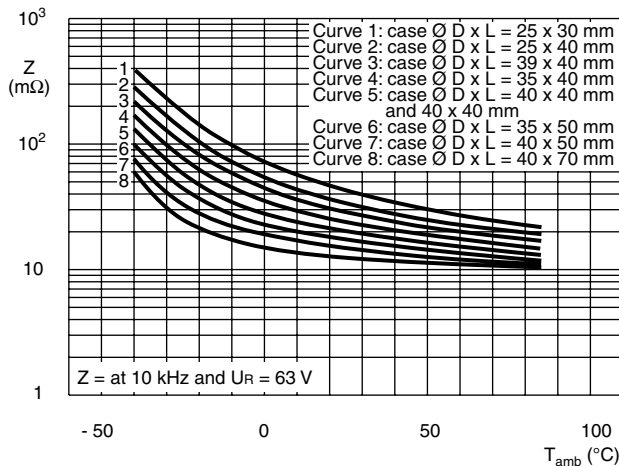


Fig.17 Typical impedance as a function of temperature

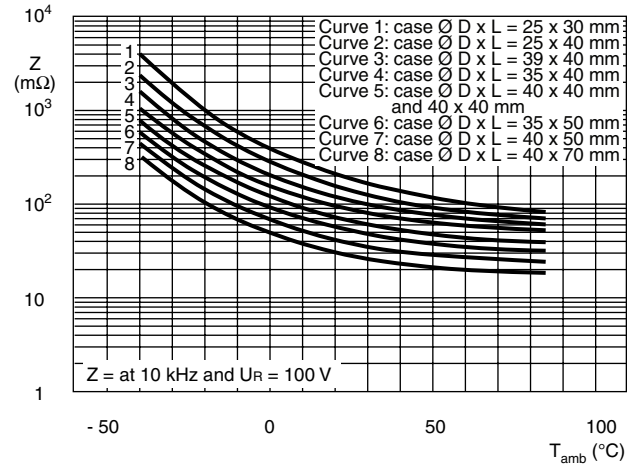


Fig.18 Typical impedance as a function of temperature

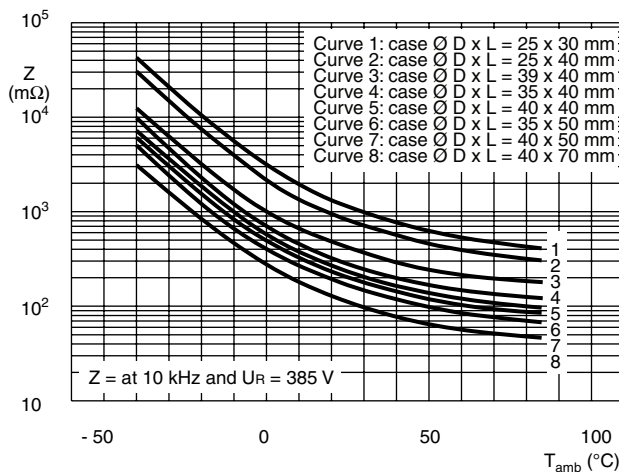


Fig.19 Typical impedance as a function of temperature

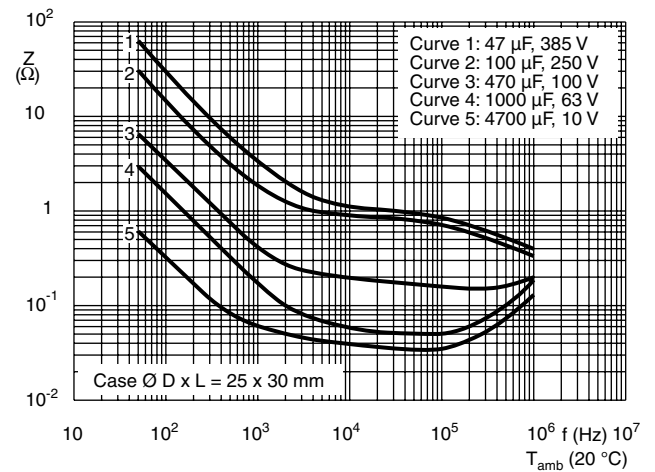


Fig.20 Typical impedance as a function of temperature



**IMPEDANCE (Z)**

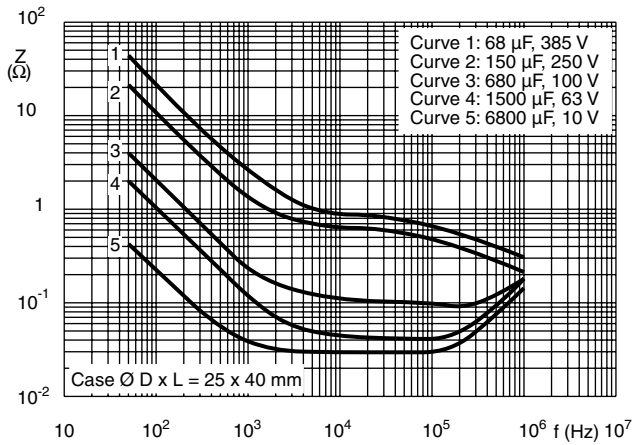


Fig.21 Typical impedance as a function of frequency

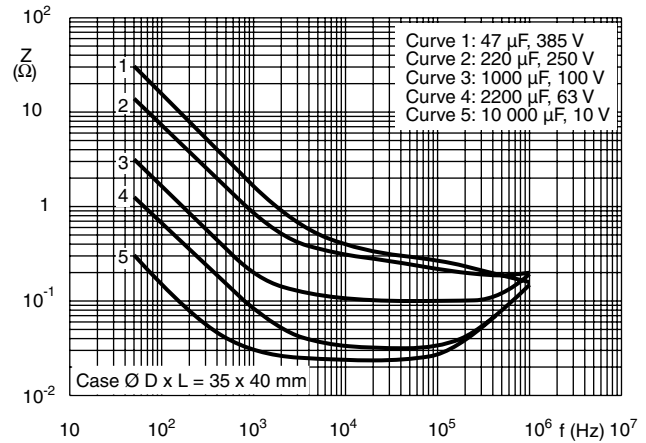


Fig.22 Typical impedance as a function of frequency

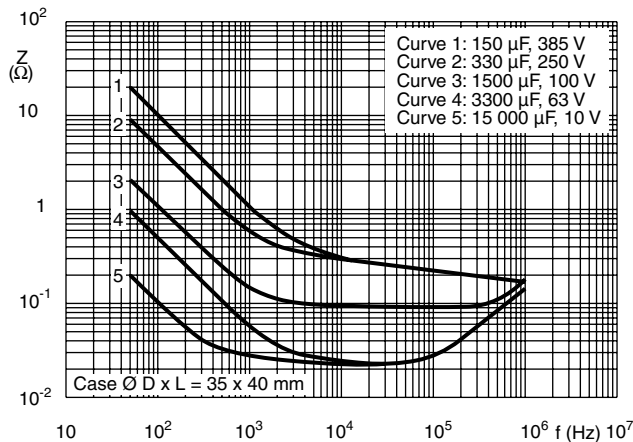


Fig.23 Typical impedance as a function of frequency

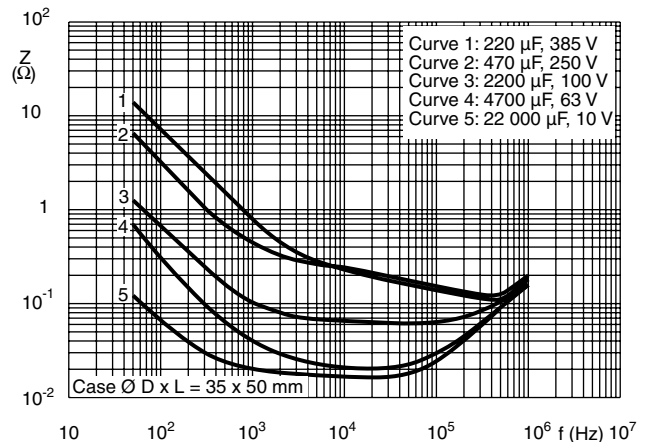


Fig.24 Typical impedance as a function of frequency

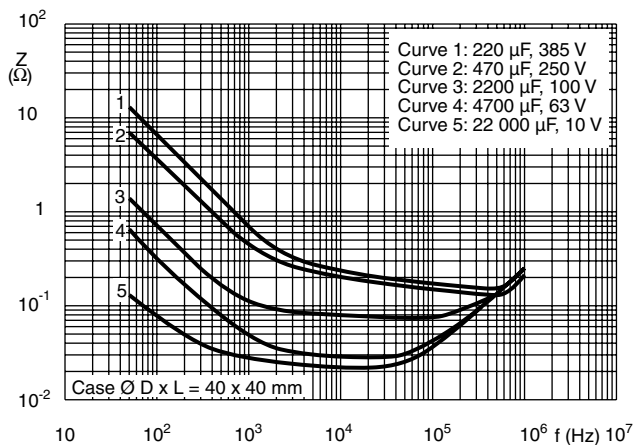


Fig.25 Typical impedance as a function of frequency

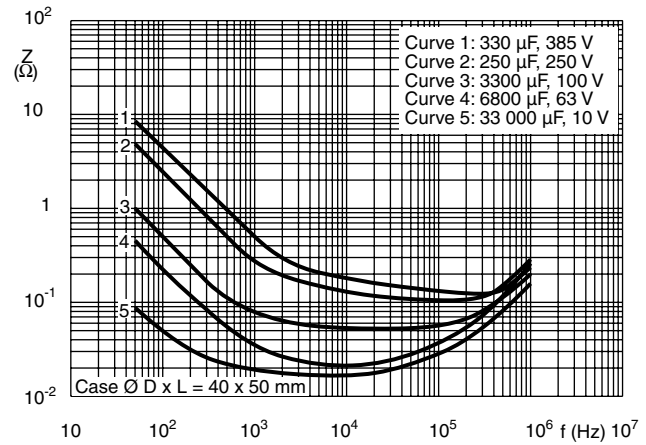


Fig.26 Typical impedance as a function of frequency



**IMPEDANCE (Z)**

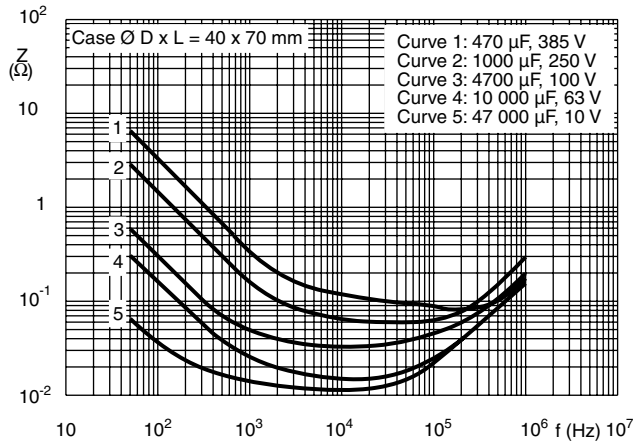


Fig.27 Typical impedance as a function of frequency

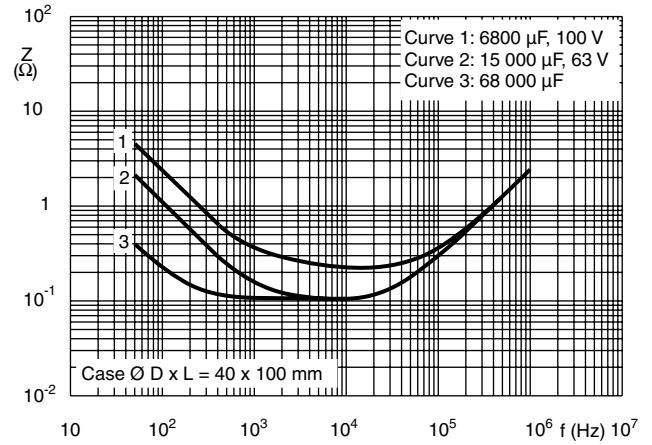
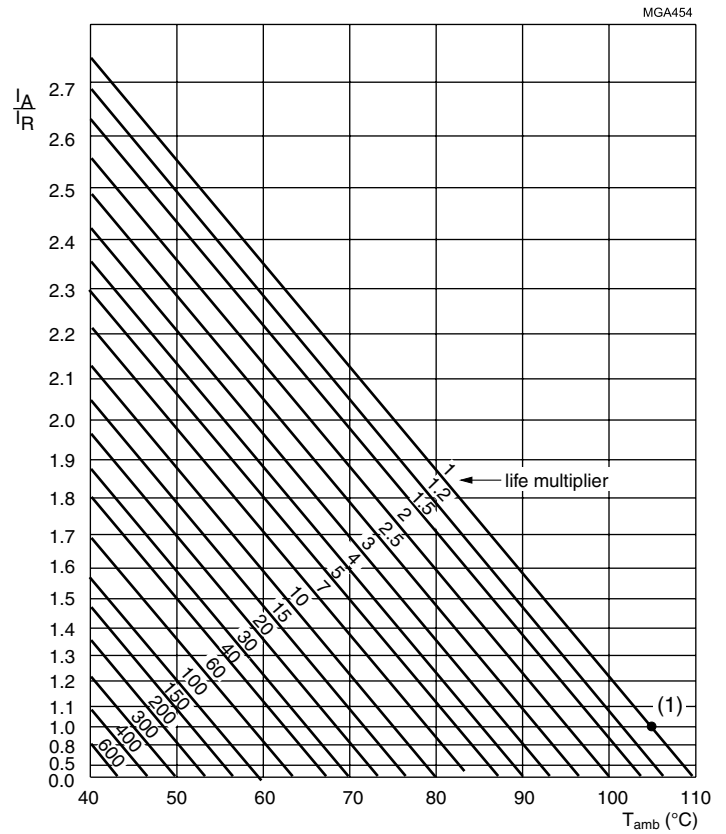


Fig.28 Typical impedance as a function of frequency

**RIPPLE CURRENT AND USEFUL LIFE**



$I_A$  = actual ripple current at 100 Hz  
 $I_R$  = rated ripple current at 100 Hz and 85 °C  
 (1) Useful life at 105 °C and  $I_R$  applied: 15 000 hours

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

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
$\geq 2000$	1.20

Table 5

TEST PROCEDURES AND REQUIREMENT			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 85\text{ }^\circ\text{C}$ ; $U_R$ applied; 5000 hours	$U_R \leq 100\text{ V}$ ; $\Delta C/C: \pm 15\%$ $U_R > 100\text{ V}$ ; $\Delta C/C: \pm 10\%$ $ESR \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^\circ\text{C}$ ; $U_R$ and $I_R$ applied; 15 000 hours	$U_R \leq 100\text{ V}$ ; $\Delta C/C: \pm 45\%$ $U_R > 100\text{ V}$ ; $\Delta C/C: \pm 30\%$ $ESR \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ 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 60384-4/ EN130300 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	$\Delta C/C: \pm 10\%$ $ESR \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$



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