

## Aluminum Capacitors Power Long Life Snap-In

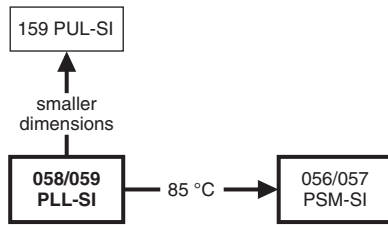


Fig. 1


**RoHS  
COMPLIANT**

### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, minimized dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Very long useful life: up to 10 000 h at 105 °C
- Extended temperature range: 105 °C
- Low ESR, high ripple current capability
- Keyed polarity version available
- Compliant of RoHS Directive 2002/95/EC

### APPLICATIONS

- Computer, telecommunication and industrial systems
- Smoothing and filtering applications
- 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 code on rated capacitance, code letter in accordance with IEC 60062 (M for  $\pm 20\%$ )
- Rated voltage (in V)
- Date code (YYMM)
- Name of manufacturer
- Code for factory of origin
- “-” sign to identify the negative terminal, visible from the top and side of the capacitor
- Code number
- Climatic category in accordance with IEC 60068

### QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	058	059
Nominal case sizes ( $\varnothing D \times L$ in mm)	22 x 25 to 35 x 50	
Rated capacitance range (E6 series), $C_R$	33 $\mu\text{F}$ to 47 000 $\mu\text{F}$	
Tolerance on $C_R$	$\pm 20\%$	
Rated voltage range, $U_R$	10 V to 100 V	200 V to 400 V
Category temperature range	-40 °C to 105 °C	-25 °C to 105 °C
Endurance test at 105 °C	$\leq 50\text{ V}$ : 2000 h; $\geq 63\text{ V}$ : 5000 h	
Useful life at 105 °C	$\leq 50\text{ V}$ : 5000 h; $\geq 63\text{ V}$ : 10 000 h	
Useful life at 40 °C, 1.9 x $I_R$ applied	$\leq 50\text{ V}$ : 125 000 h; $\geq 63\text{ V}$ : 250 000 h	
Shelf life at 0 V, 105 °C	500 h	
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/105/56	25/105/56

### SELECTION CHART FOR $C_R$ , $U_R$ AND RELEVANT NOMINAL CASE SIZES FOR 058 SERIES ( $\varnothing D \times L$ in mm)

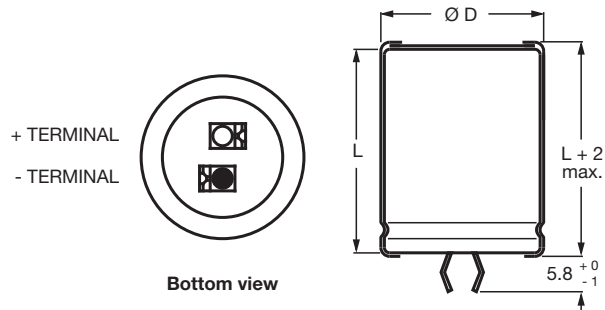
$C_R$ ( $\mu\text{F}$ )	$U_R$ (V)						
	10	16	25	40	50	63	100
330	-	-	-	-	-	-	22 x 25
470	-	-	-	-	-	-	22 x 30
680	-	-	-	-	-	22 x 25	25 x 30
	-	-	-	-	-	-	22 x 40
1000	-	-	-	-	22 x 25	22 x 30	30 x 30
	-	-	-	-	-	-	25 x 40
1500	-	-	-	22 x 25	22 x 30	25 x 30	30 x 40
	-	-	-	-	-	22 x 40	25 x 50

**SELECTION CHART FOR C<sub>R</sub>, U<sub>R</sub> AND RELEVANT NOMINAL CASE SIZES FOR 058 SERIES (∅ D x L in mm)**

C <sub>R</sub> (μF)	U <sub>R</sub> (V)						
	10	16	25	40	50	63	100
2200	-	-	22 x 25	22 x 30	25 x 30	30 x 30	35 x 40
	-	-	-	-	22 x 40	25 x 40	30 x 50
3300	-	22 x 25	22 x 30	25 x 30	30 x 30	30 x 40	35 x 50
	-	-	-	22 x 40	25 x 40	25 x 50	-
4700	22 x 25	22 x 30	25 x 30	30 x 30	30 x 40	35 x 40	-
	-	-	22 x 40	25 x 40	25 x 50	30 x 50	-
6800	22 x 30	25 x 30	30 x 30	30 x 40	35 x 40	35 x 50	-
	-	22 x 40	25 x 40	25 x 50	30 x 50	-	-
10 000	25 x 30	30 x 30	30 x 40	35 x 40	35 x 50	-	-
	22 x 40	25 x 40	25 x 50	30 x 50	-	-	-
15 000	30 x 30	30 x 40	35 x 40	35 x 50	-	-	-
	25 x 40	25 x 50	30 x 50	-	-	-	-
22 000	30 x 40	35 x 40	35 x 50	-	-	-	-
	25 x 50	30 x 50	-	-	-	-	-
33 000	35 x 40	35 x 50	-	-	-	-	-
	30 x 50	-	-	-	-	-	-
47 000	35 x 50	-	-	-	-	-	-

**SELECTION CHART FOR C<sub>R</sub>, U<sub>R</sub> AND RELEVANT NOMINAL CASE SIZES FOR 059 SERIES (∅ D x L in mm)**

C <sub>R</sub> (μF)	U <sub>R</sub> (V)			
	200	250	385	400
33	-	-	22 x 25	-
47	-	-	22 x 30	22 x 30
68	-	22 x 25	22 x 35	22 x 35
	-	-	25 x 30	25 x 30
100	22 x 25	22 x 30	30 x 30	30 x 30
	-	-	25 x 40	25 x 40
150	22 x 30	22 x 35	25 x 50	30 x 35
	-	25 x 30	30 x 40	25 x 50
220	22 x 35	30 x 30	35 x 40	35 x 40
	25 x 30	25 x 35	30 x 50	30 x 50
330	30 x 30	30 x 35	35 x 50	35 x 50
	25 x 40	25 x 50	-	-
470	30 x 35	35 x 35	-	-
	25 x 50	30 x 45	-	-
680	35 x 35	35 x 45	-	-
	30 x 45	-	-	-
1000	35 x 50	-	-	-

**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**
**TWO TERMINAL SNAP-IN**


The minus terminal can be marked with a black dot or with an imprinted "-" sign.

Fig. 2 - Two terminal snap-in

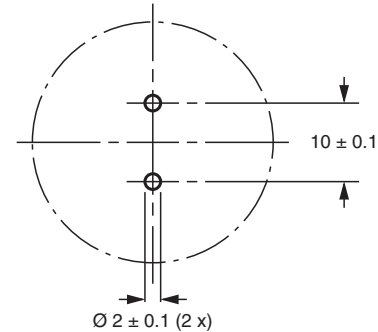
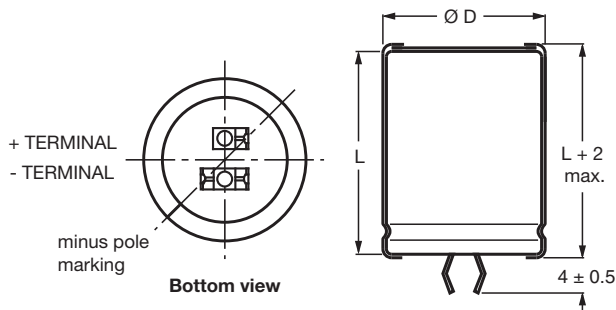
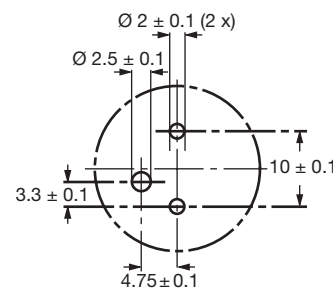


Fig. 3 - Mounting hole diagram

**THREE TERMINAL SNAP-IN**


The negative terminal has **TWO** pins which are **BOTH** electrically connected.

Fig. 4 - Three terminal snap-in



The 10 mm spacing of the 2 pin snap-in is used as the base layout and a third hole is added.

The third hole is closer to the negative primary hole so that polarization is always maintained, together with added mechanical stability.

Fig. 5 - Mounting hole diagram

**Table 1**

<b>DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b>					
<b>NOMINAL CASE SIZE</b> Ø D x L	<b>Ø D<sub>MAX.</sub></b>	<b>L<sub>MAX.</sub></b>	<b>MASS (g)</b>	<b>PACKAGING QUANTITIES (units per box)</b>	<b>CARDBOARD BOX DIMENSIONS L x W x H</b>
22 x 25	23	27	≈ 12	100	260 x 250 x 39
22 x 30	23	32	≈ 16	100	260 x 250 x 44
22 x 35	23	37	≈ 20	100	260 x 250 x 49
22 x 40	23	42	≈ 23	100	260 x 250 x 54
25 x 30	26	32	≈ 22	100	290 x 280 x 44
25 x 35	26	37	≈ 24	100	290 x 280 x 49
25 x 40	26	42	≈ 27	100	290 x 280 x 54
25 x 50	26	52	≈ 38	100	290 x 280 x 64
30 x 30	31	32	≈ 30	100	340 x 330 x 44
30 x 35	31	37	≈ 35	100	340 x 330 x 49
30 x 40	31	42	≈ 40	100	340 x 330 x 54
30 x 45	31	47	≈ 45	100	340 x 330 x 59
30 x 50	31	52	≈ 50	100	340 x 330 x 64
35 x 35	36	37	≈ 48	50	390 x 198 x 49
35 x 40	36	42	≈ 55	50	390 x 198 x 54
35 x 45	36	47	≈ 63	50	390 x 198 x 59
35 x 50	36	52	≈ 72	50	390 x 198 x 64

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
$C_R$	rated capacitance at 100 Hz
$I_R$	rated RMS ripple current at 100 Hz or $\geq 10$ kHz and 105 °C
$I_{L1}$	max. leakage current after 1 min at $U_R$
$I_{L5}$	max. leakage current after 5 min at $U_R$
ESR	max. equivalent series resistance at 100 Hz
Z	max. impedance at 10 kHz

**Note**

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

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION FOR 058 SERIES ( $\varnothing$ D x L in mm)										
$U_R$ (V)	$C_R$ 100 Hz ( $\mu$ F)	NOMINAL CASE SIZE $\varnothing$ D x L (mm)	$I_R$ 100 Hz 105 °C (A)	$I_R$ $\geq 10$ kHz 105 °C (A)	$I_{L1}$ 1 min ( $\mu$ A)	$I_{L5}$ 5 min ( $\mu$ A)	ESR 100 Hz (m $\Omega$ )	Z 10 kHz (m $\Omega$ )	ORDERING CODE MAL2058.....	
									2-TERM.	3-TERM.
10	4700	22 x 25	1.95	2.30	286	98	82	57	54472E3	74472E3
	6800	22 x 30	2.44	2.88	412	140	61	44	54682E3	74682E3
	10 000	25 x 30	2.81	3.32	604	204	54	42	54103E3	74103E3
	10 000	22 x 40	3.29	3.88	604	204	43	32	44103E3	24103E3
	15 000	30 x 30	3.53	4.17	904	304	42	34	54153E3	74153E3
	15 000	25 x 40	3.78	4.46	904	304	38	30	44153E3	24153E3
	22 000	30 x 40	4.62	5.45	1324	444	31	25	54223E3	74223E3
	22 000	25 x 50	4.68	5.52	1324	444	31	24	44223E3	24223E3
	33 000	35 x 40	5.15	6.08	1984	664	30	24	54333E3	74333E3
	33 000	30 x 50	5.70	6.73	1984	664	24	21	44333E3	24333E3
47 000	35 x 50	6.23	7.35	2824	944	24	21	54473E3	74473E3	
16	3300	22 x 25	1.90	2.24	321	110	86	57	55332E3	75332E3
	4700	22 x 30	2.36	2.78	455	154	65	44	55472E3	75472E3
	6800	25 x 30	2.75	3.25	657	222	56	42	55682E3	75682E3
	6800	22 x 40	3.18	3.75	657	222	46	32	45682E3	25682E3
	10 000	30 x 30	3.44	4.06	964	324	44	34	55103E3	75103E3
	10 000	25 x 40	3.66	4.32	964	324	40	30	45103E3	25103E3
	15 000	30 x 40	4.55	5.37	1444	484	32	25	55153E3	75153E3
	15 000	25 x 50	4.55	5.37	1444	484	32	24	45153E3	25153E3
	22 000	35 x 40	5.07	5.98	2116	708	31	24	55223E3	75223E3
	22 000	30 x 50	5.67	6.69	2116	708	25	21	45223E3	25223E3
33 000	35 x 50	6.23	7.35	3172	1060	25	21	55333E3	75333E3	
25	2200	22 x 25	1.76	2.08	334	114	100	57	56222E3	76222E3
	3300	22 x 30	2.23	2.63	499	169	73	44	56332E3	76332E3
	4700	25 x 30	2.60	3.07	709	239	62	42	56472E3	76472E3
	4700	22 x 40	3.00	3.54	709	239	52	32	46472E3	26472E3
	6800	30 x 30	3.26	3.85	1024	344	49	34	56682E3	76682E3
	6800	25 x 40	3.49	4.12	1024	344	44	30	46682E3	26682E3
	10 000	30 x 40	4.37	5.16	1504	504	35	25	56103E3	76103E3
	10 000	25 x 50	4.37	5.16	1504	504	35	24	46103E3	26103E3
	15 000	35 x 40	4.91	5.79	2254	754	33	24	56153E3	76153E3
	15 000	30 x 50	5.43	6.41	2254	754	27	21	46153E3	26153E3
22 000	35 x 50	6.07	7.16	3304	1104	27	21	56223E3	76223E3	
40	1500	22 x 25	1.65	2.01	364	124	114	65	57152E3	77152E3
	2200	22 x 30	2.04	2.49	532	180	87	50	57222E3	77222E3
	3300	25 x 30	2.43	2.99	796	268	71	45	57332E3	77332E3
	3300	22 x 40	2.78	3.39	796	268	60	37	47332E3	27332E3
	4700	30 x 30	2.96	3.61	1132	380	59	40	57472E3	77472E3
	4700	25 x 40	3.26	3.90	1132	380	51	32	47472E3	27472E3
	6800	30 x 40	3.94	4.81	1636	548	42	29	57682E3	77682E3
	6800	25 x 50	4.10	5.00	1636	548	39	26	47682E3	27682E3
	10 000	35 x 40	4.18	5.10	2404	804	46	29	57103E3	77103E3
	10 000	30 x 50	4.98	6.08	2404	804	36	24	47103E3	27103E3
15 000	35 x 50	5.21	6.36	3604	1204	36	24	57153E3	77153E3	

**ORDERING EXAMPLE**

Electrolytic capacitor 058 series

10 000  $\mu$ F/25 V;  $\pm 20$  %Nominal case size:  $\varnothing 30$  mm x 40 mm**2-terminal snap-in:**

Ordering code: MAL2 058 56103 E3

Former 12NC: 2222 058 56103

**3-terminal snap-in:**

Ordering code: MAL2 058 76103 E3

Former 12NC: 2222 058 76103



ELECTRICAL DATA AND ORDERING INFORMATION FOR 058 SERIES (Ø D x L in mm)											
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I <sub>R</sub> 100 Hz 105 °C (A)	I <sub>R</sub> ≥ 10 kHz 105 °C (A)	I <sub>L1</sub> 1 min (µA)	I <sub>L5</sub> 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	ORDERING CODE MAL2058.....		
									2-TERM.	3-TERM.	
50	1000	22 x 25	1.50	1.83	304	104	138	69	51102E3	71102E3	
	1500	22 x 30	1.88	2.29	454	154	102	54	51152E3	71152E3	
	2200	25 x 30	2.27	2.77	664	124	82	47	51222E3	71222E3	
	2200	22 x 40	2.55	3.11	664	124	71	38	41222E3	21222E3	
	3300	30 x 30	2.81	3.43	994	334	66	41	51332E3	71332E3	
	3300	25 x 40	3.07	3.75	994	334	57	33	41332E3	21332E3	
	4700	30 x 40	3.77	4.60	1414	474	47	30	51472E3	71472E3	
	4700	25 x 50	3.85	4.70	1414	474	43	27	41472E3	21472E3	
	6800	35 x 40	4.01	4.89	2044	684	49	30	51682E3	71682E3	
	6800	30 x 50	4.74	5.78	2044	684	38	24	41682E3	21682E3	
	10 000	35 x 50	5.04	6.15	3004	1004	38	24	51103E3	71103E3	
63	680	22 x 25	1.17	1.43	261	90	228	150	58681E3	78681E3	
	1000	22 x 30	1.46	1.78	382	130	170	115	58102E3	78102E3	
	1500	25 x 30	1.76	2.15	571	193	137	85	58152E3	78152E3	
	1500	22 x 40	2.00	2.44	571	193	115	85	48152E3	28152E3	
	2200	30 x 30	2.27	2.77	836	281	101	70	58222E3	78222E3	
	2200	25 x 40	2.40	2.93	836	281	94	70	48222E3	28222E3	
	3300	30 x 40	3.07	3.75	1251	420	70	50	58332E3	78332E3	
	3300	25 x 50	3.07	3.75	1251	420	70	50	48332E3	28332E3	
	4700	35 x 40	3.65	4.45	1781	596	60	45	58472E3	78472E3	
	4700	30 x 50	3.88	4.73	1781	596	53	45	48472E3	28472E3	
	6800	35 x 50	4.58	5.59	2574	861	46	35	58682E3	78682E3	
100	330	22 x 25	0.92	1.12	202	70	370	250	59331E3	79331E3	
	470	22 x 30	1.14	1.39	286	98	280	190	59471E3	79471E3	
	680	25 x 30	1.35	1.65	412	140	232	140	59681E3	79681E3	
	680	22 x 40	1.57	1.92	412	140	190	140	49681E3	29681E3	
	1000	30 x 30	1.79	2.40	604	204	163	115	59102E3	79102E3	
	1000	25 x 40	1.85	2.26	604	204	158	115	49102E3	29102E3	
	1500	30 x 40	2.45	2.99	904	304	111	85	59152E3	79152E3	
	1500	25 x 50	2.38	2.90	904	304	116	85	49152E3	29152E3	
	2200	35 x 40	3.05	3.72	1324	444	86	65	59222E3	79222E3	
	2200	30 x 50	3.13	3.82	1324	444	82	65	49222E3	29222E3	
		3300	35 x 50	3.84	4.68	1984	664	64	50	59332E3	79332E3

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION FOR 059 SERIES										
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I <sub>R</sub> 100 Hz 105 °C (A)	I <sub>L1</sub> 1 min (µA)	I <sub>L5</sub> 5 min (µA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	ORDERING CODE MAL2059.....		
								2-TERM.	3-TERM.	
200	100	22 x 25	0.53	124	44	1280	730	52101E3	72101E3	
	150	22 x 30	0.67	184	64	850	540	52151E3	72151E3	
	220	22 x 35	0.86	268	92	610	430	32221E3	12221E3	
	220	25 x 30	0.87	268	92	610	430	52221E3	72221E3	
	330	30 x 30	1.12	400	136	435	300	52331E3	72331E3	
	330	25 x 40	1.12	400	136	435	300	42331E3	22331E3	
	470	30 x 35	1.46	568	192	335	225	32471E3	12471E3	
	470	25 x 50	1.25	568	192	335	225	42471E3	22471E3	
	680	30 x 45	1.87	820	276	235	155	32681E3	12681E3	
	680	35 x 35	1.85	820	276	235	155	62681E3	82681E3	
	1000	35 x 50	2.45	1204	404	160	125	52102E3	72102E3	
250	68	22 x 25	0.49	106	38	1640	760	53689E3	73689E3	
	100	22 x 30	0.62	154	54	1110	570	53101E3	73101E3	
	150	22 x 35	0.82	229	79	795	440	33151E3	13151E3	
	150	25 x 30	0.82	229	79	795	440	53151E3	73151E3	
	220	25 x 35	1.03	334	114	540	300	33221E3	13221E3	
	220	30 x 30	1.06	334	114	540	300	53221E3	73221E3	
	330	30 x 35	1.43	499	169	385	225	33331E3	13331E3	
	330	25 x 50	1.40	499	169	385	225	43331E3	23331E3	
	470	30 x 45	1.79	709	239	270	155	33471E3	13471E3	
	470	35 x 35	1.79	709	239	270	155	63471E3	83471E3	
		680	35 x 45	2.25	1024	344	190	125	43681E3	23681E3



ELECTRICAL DATA AND ORDERING INFORMATION FOR 059 SERIES									
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (μF)	NOMINAL CASE SIZE Ø D x L (mm)	I <sub>R</sub> 100 Hz 105 °C (A)	I <sub>L1</sub> 1 min (μA)	I <sub>L5</sub> 5 min (μA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	ORDERING CODE MAL2059.....	
								2-TERM.	3-TERM.
385	33	22 x 25	0.32	80	29	3860	3000	58339E3	78339E3
	47	22 x 30	0.41	113	40	2710	2100	58479E3	78479E3
	68	22 x 35	0.53	161	56	1870	1460	38689E3	18689E3
	68	25 x 30	0.52	161	56	1870	1460	58689E3	78689E3
	100	30 x 30	0.72	235	81	1270	1010	58101E3	78101E3
	100	25 x 40	0.72	235	81	1270	1010	48101E3	28101E3
	150	30 x 40	0.99	351	119	850	675	58151E3	78151E3
	150	25 x 50	0.99	351	119	850	675	48151E3	28151E3
	220	35 x 40	1.31	512	173	580	465	58221E3	78221E3
	220	30 x 50	1.31	512	173	580	465	48221E3	28221E3
	330	35 x 50	1.75	766	258	390	320	58331E3	78331E3
400	47	22 x 30	0.30	117	42	4260	3490	56479E3	76479E3
	68	22 x 35	0.38	167	58	2950	2420	36689E3	16689E3
	68	25 x 30	0.41	167	58	2950	2420	56689E3	76689E3
	100	30 x 30	0.55	244	84	2020	1660	56101E3	76101E3
	100	25 x 40	0.55	244	84	2020	1660	46101E3	26101E3
	150	30 x 35	0.68	364	124	1350	1110	36151E3	16151E3
	150	25 x 50	0.78	364	124	1350	1110	46151E3	26151E3
	220	35 x 40	0.94	532	180	930	760	56221E3	76221E3
	220	30 x 50	0.94	532	180	930	760	46221E3	26221E3
		330	35 x 50	1.25	796	260	620	510	56331E3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage	≤ 250 V versions	U <sub>s</sub> = 1.15 x U <sub>R</sub>
	≥ 385 V versions	U <sub>s</sub> = 1.1 x U <sub>R</sub>
Reverse voltage		U <sub>rev</sub> ≤ 1 V
<b>Current</b>		
Leakage current	After 1 min at U <sub>R</sub>	I <sub>L1</sub> ≤ 0.006 C <sub>R</sub> x U <sub>R</sub> + 4 μA
	After 5 min at U <sub>R</sub>	I <sub>L5</sub> ≤ 0.002 C <sub>R</sub> x U <sub>R</sub> + 4 μA
<b>Inductance</b>		
Equivalent series inductance (ESL)	All case sizes	typ. 19 nH max. 25 nH

**CAPACITANCE (C)**

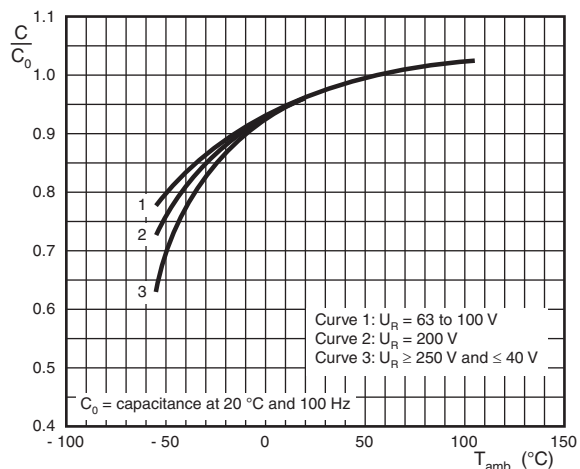


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

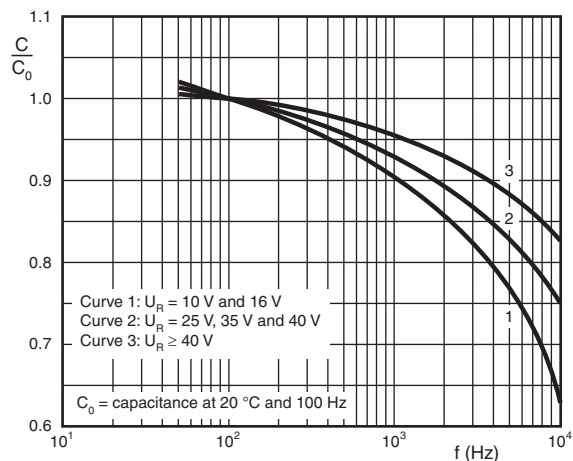


Fig. 7 - Typical multiplier of capacitance as a function of frequency

**EQUIVALENT SERIES RESISTANCE (ESR)**

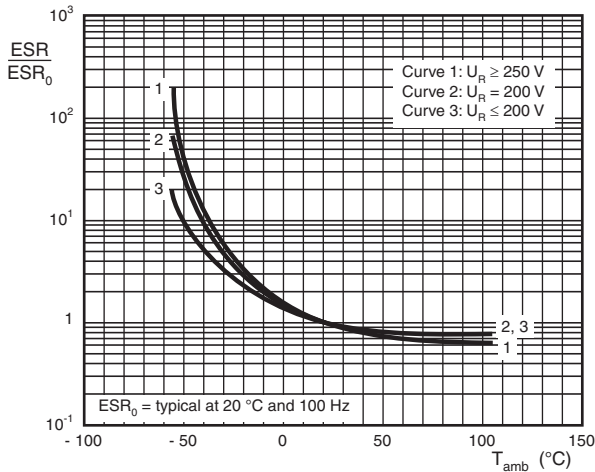


Fig. 8 - Typical multiplier of ESR as a function of ambient temperature

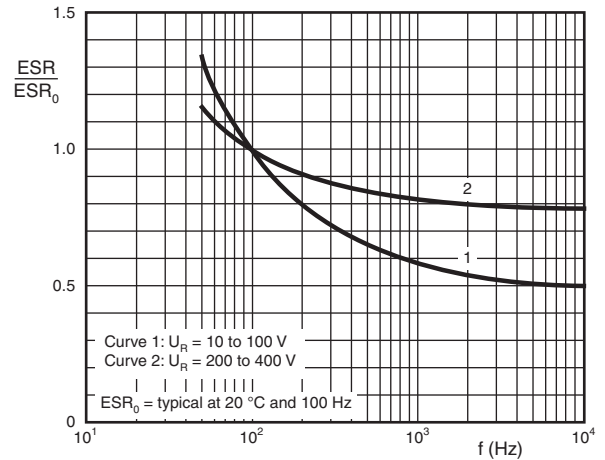


Fig. 9 - Typical multiplier of ESR as a function of frequency

**IMPEDANCE (Z)**

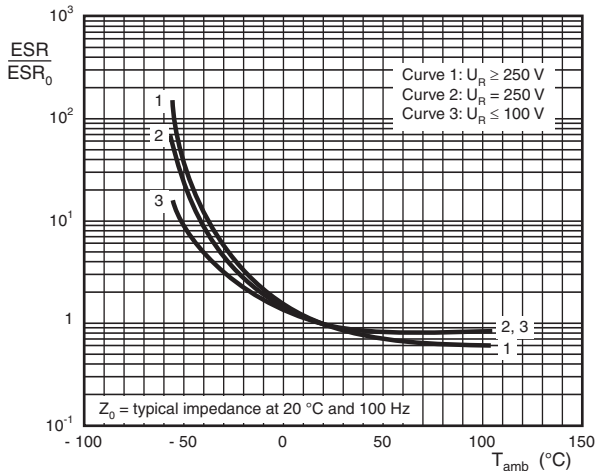


Fig. 10 - Typical multiplier of impedance as a function of ambient temperature

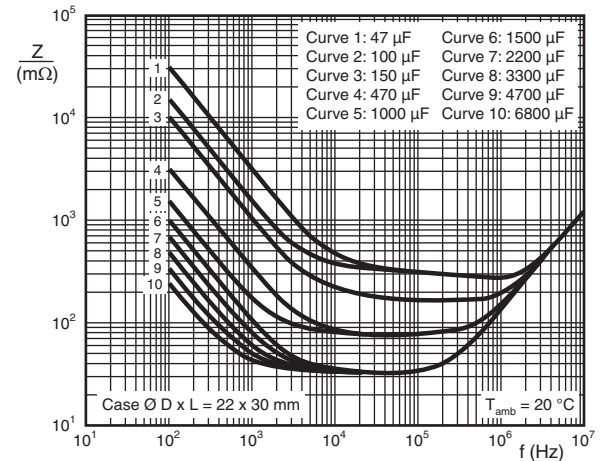


Fig. 12 - Typical impedance as a function of frequency

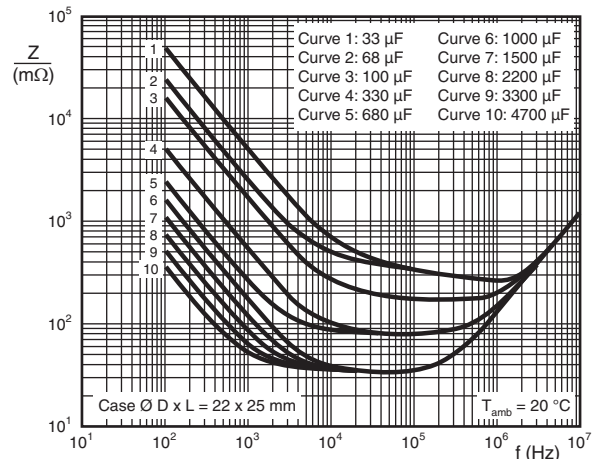


Fig. 11 - Typical impedance as a function of frequency

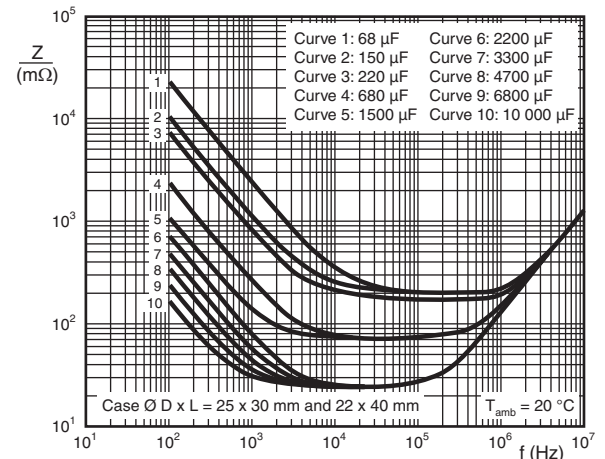


Fig. 13 - Typical impedance as a function of frequency



**IMPEDANCE (Z)**

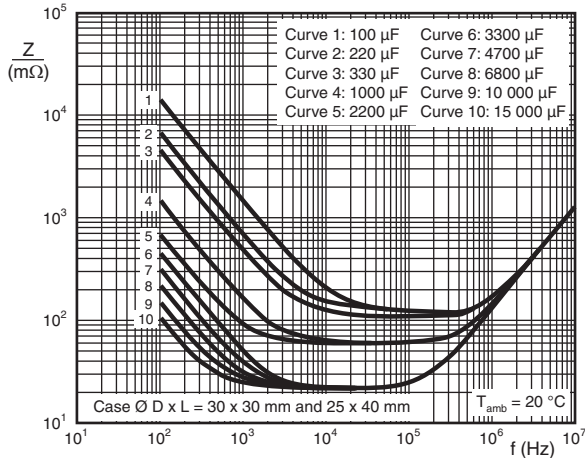


Fig. 14 - Typical impedance as a function of frequency

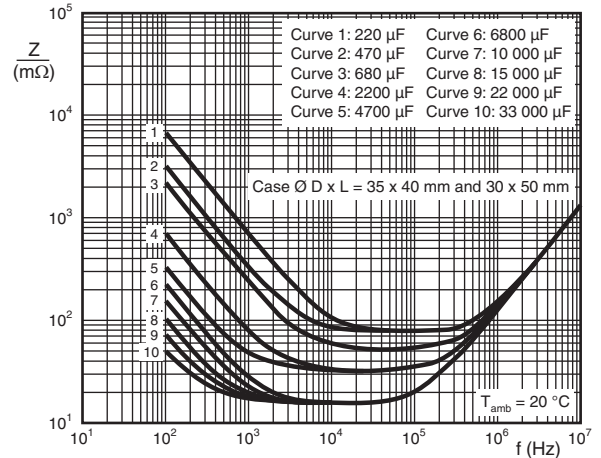


Fig. 16 - Typical impedance as a function of frequency

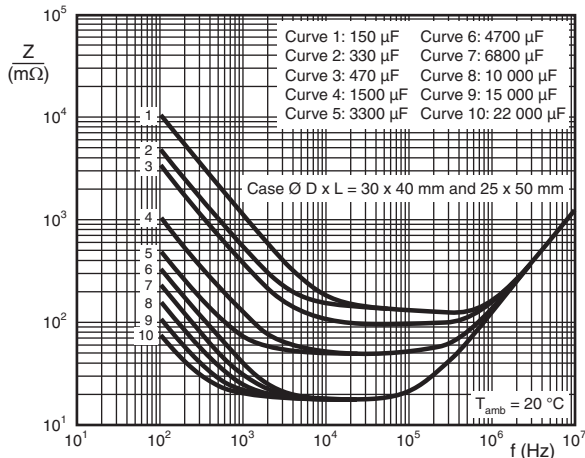


Fig. 15 - Typical impedance as a function of frequency

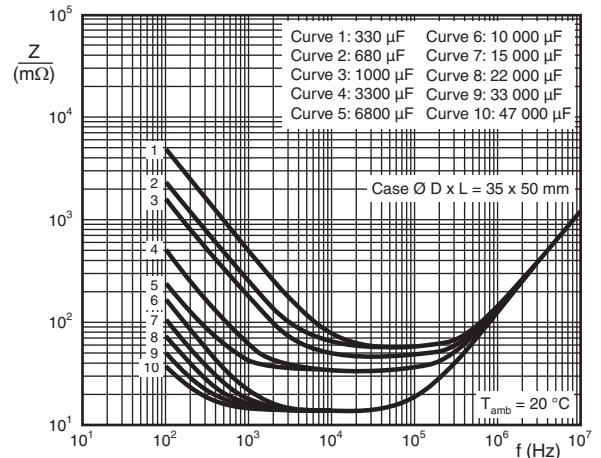
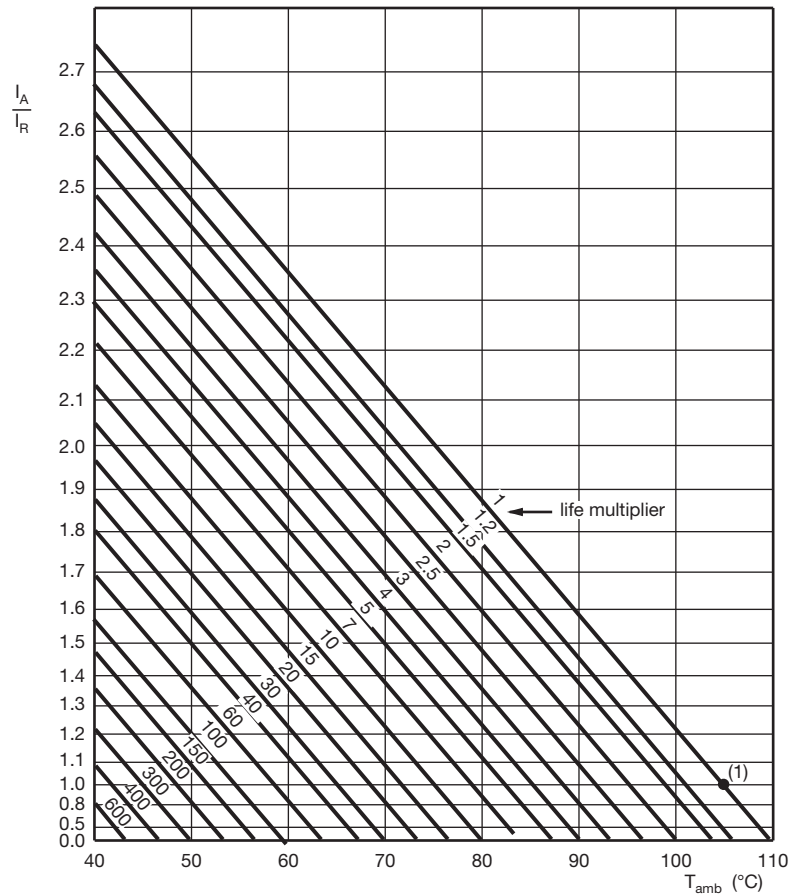


Fig. 17 - Typical impedance as a function of frequency



**RIPPLE CURRENT AND USEFUL LIFE**



$I_A$  = actual ripple current at 100 Hz  
 $I_R$  = rated ripple current at 100 Hz and 105 °C  
 (1) Useful life at 105 °C and  $I_R$  applied:  
 5000 h for  $\leq 50$  V types

Fig. 18 - Multiplier of useful life as a function of ambient temperature and ripple current load

**Table 4**

<b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b>			
<b>FREQUENCY (Hz)</b>	<b><math>I_R</math> MULTIPLIER</b>		
	<b><math>U_R = 10</math> V TO 25 V</b>	<b><math>U_R = 40</math> V TO 100 V</b>	<b><math>U_R &gt; 100</math> V</b>
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
$\geq 10\ 000$	1.18	1.22	1.40

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ applied; $\leq 50\text{ V}$ types: 2000 h; $\geq 63\text{ V}$ types: 5000 h	$U_R \leq 100\text{ V}$ ; $\Delta C/C: \pm 15\%$ $U_R > 100\text{ V}$ ; $\Delta C/C: \pm 10\%$ $ESR \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied; $\leq 50\text{ V}$ types: 5000 h; $\geq 63\text{ V}$ types: 10 000 h	$U_R \leq 100\text{ V}$ ; $\Delta C/C: \pm 45\%$ $U_R > 100\text{ V}$ ; $\Delta C/C: \pm 30\%$ $ESR \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage; $U_R > 100\text{ V}$ : $\leq 3\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$ ; no voltage applied; 500 h After test: $U_R$ to be applied for 30 min 24 h to 48 h 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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