

DATA SHEET

050/052 PED-PW

Aluminum electrolytic capacitors
Power Eurodin Printed Wiring

Product specification
Supersedes data of 18th January 2000
File under BCcomponents, BC01

2001 Nov 14

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

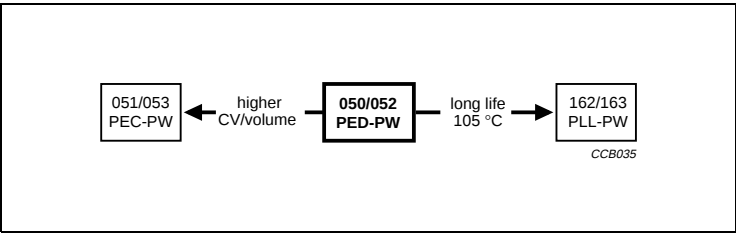
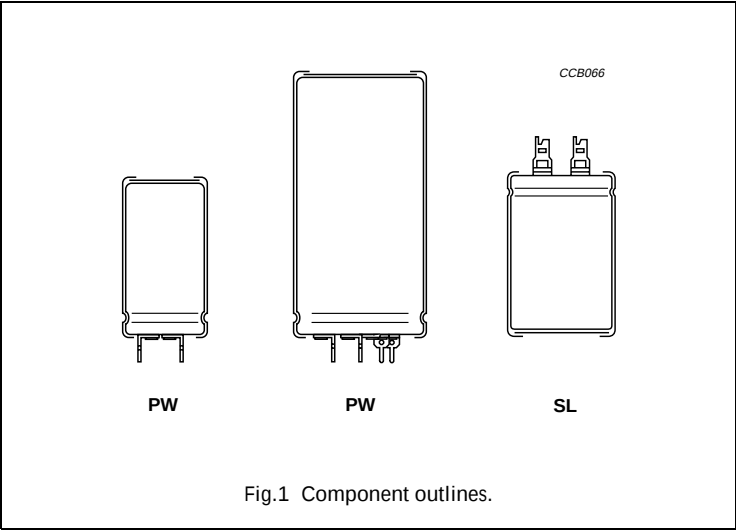
050/052 PED-PW

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: 15000 hours at 85 °C
- Low ESR, high ripple current capability
- High resistance to shock and vibration.

APPLICATIONS

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



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	050	052
Case size ($\varnothing D_{nom} \times L_{nom}$ in mm)	25 × 30 to 40 × 100	
Rated capacitance range (E6 series), C_R	470 to 68000 μF	47 to 1000 μF
Tolerance on C_R	-10 to +30%	
Rated voltage range, U_R	10 to 100 V	250 to 400 V
Category temperature range	-40 to +85 °C	
Endurance test at 85 °C	5000 hours	
Useful life at 85 °C	15000 hours	
Useful life at 40 °C and $1.4 \times I_R$ applied	250000 hours	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/085/56	

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW
Selection chart for C_R , U_R and relevant nominal case sizes ($\varnothing D \times L$ in mm) for 050 series

 Preferred types in **bold**.

C_R (μF)	U_R (V)					
	10	16	25	40	63	100
470	–	–	–	–	–	25 × 30
680	–	–	–	–	–	25 × 40
1000	–	–	–	–	25 × 30	30 × 40
1500	–	–	–	25 × 30	25 × 40	35 × 40
2200	–	–	25 × 30	25 × 40	30 × 40	35 × 50
	–	–	–	–	–	40 × 40
3300	–	25 × 30	25 × 40	30 × 40	35 × 40	40 × 50
4700	25 × 30	25 × 40	30 × 40	35 × 40	35 × 50	40 × 70
	–	–	–	–	40 × 40	–
6800	25 × 40	30 × 40	35 × 40	35 × 50	40 × 50	40 × 100
	–	–	–	40 × 40	–	–
10000	30 × 40	35 × 40	35 × 50	40 × 50	40 × 70	–
	–	–	40 × 40	–	–	–
15000	35 × 40	35 × 50	40 × 50	40 × 70	40 × 100	–
	–	40 × 40	–	–	–	–
22000	35 × 50	40 × 50	40 × 70	40 × 100	–	–
	40 × 40	–	–	–	–	–
33000	40 × 50	40 × 70	40 × 100	–	–	–
47000	40 × 70	40 × 100	–	–	–	–
68000	40 × 100	–	–	–	–	–

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

 Preferred types in **bold**.

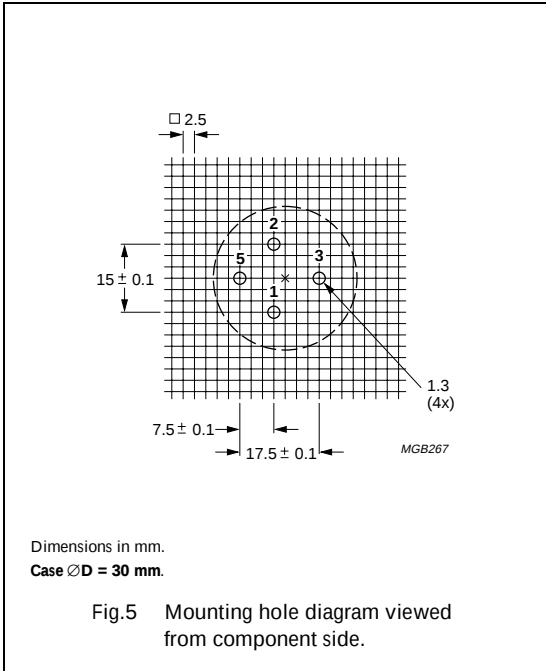
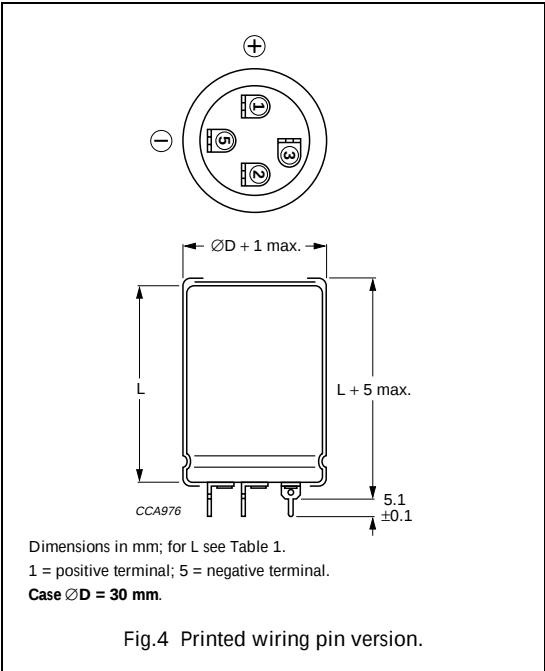
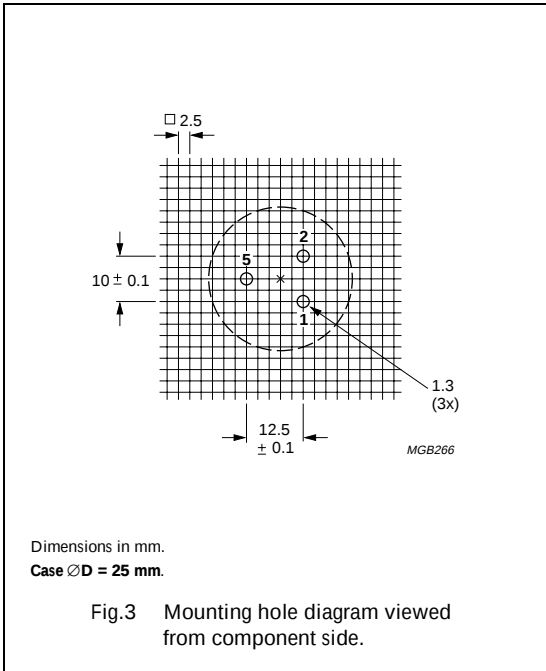
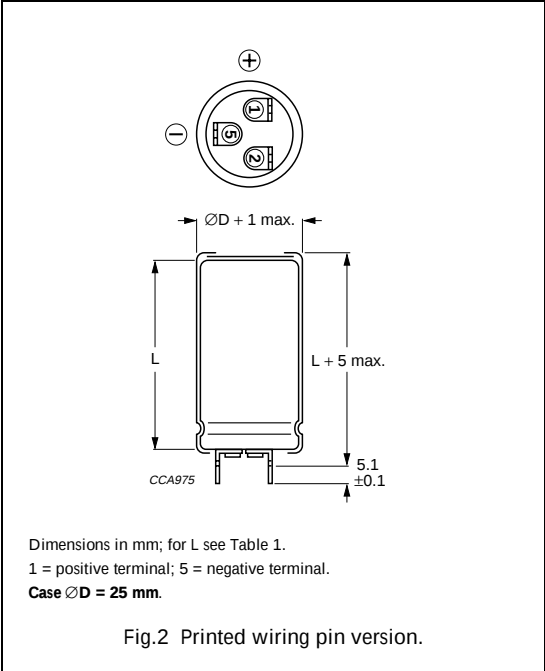
C_R (μF)	U_R (V)		
	250	385	400
47	–	25 × 30	25 × 30
68	–	25 × 40	25 × 40
100	25 × 30	30 × 40	30 × 40
150	25 × 40	35 × 40	35 × 40
220	30 × 40	35 × 50	35 × 50
	–	40 × 40	40 × 40
330	35 × 40	40 × 50	40 × 50
470	35 × 50	40 × 70	40 × 70
	40 × 40	–	–
680	40 × 50	–	40 × 100
1000	40 × 70	–	–

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

MECHANICAL DATA AND PACKAGING QUANTITIES



Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

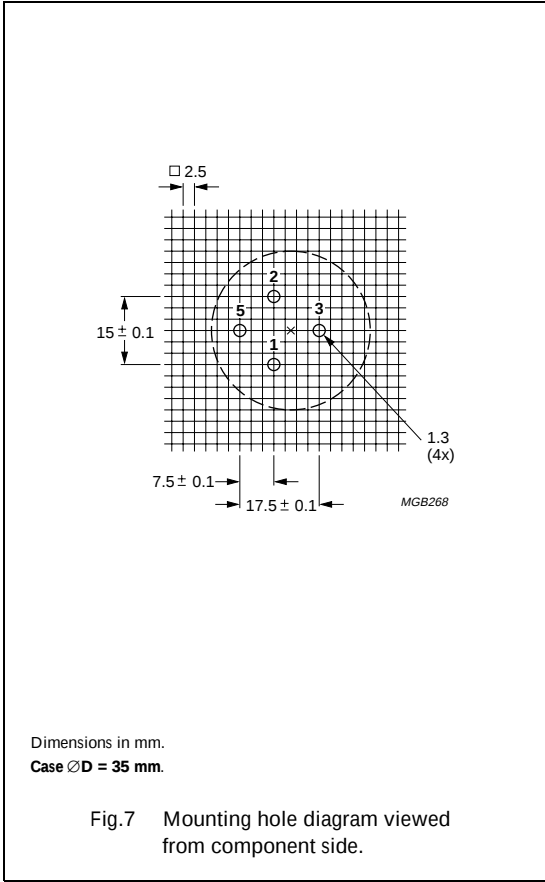
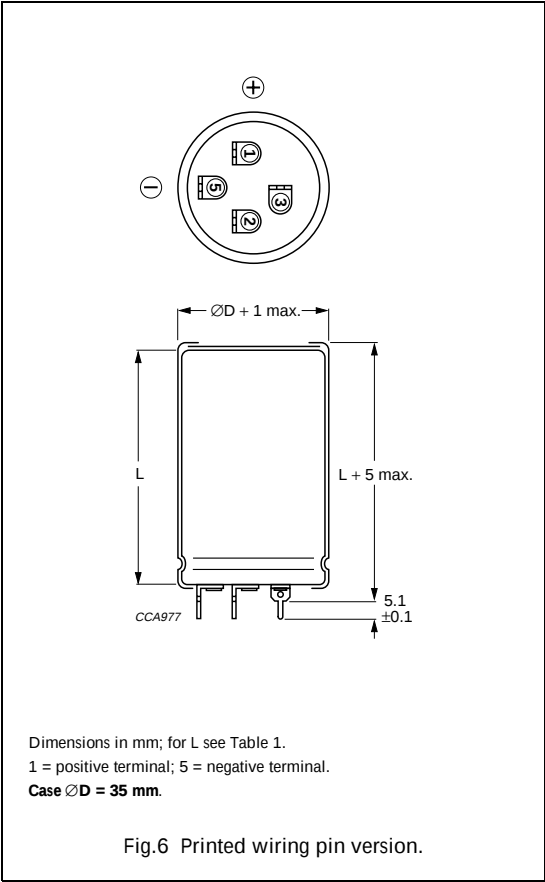
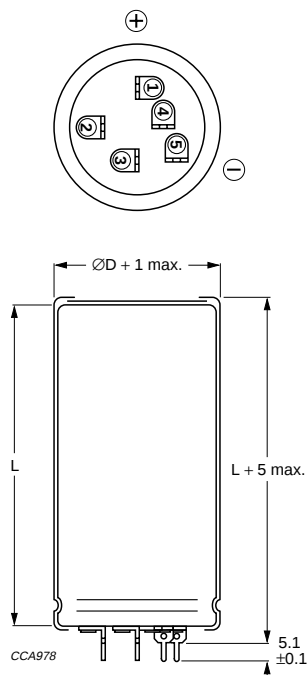


Table 1 PW versions; physical dimensions, mass and packaging information; see Figs 2, 4, 6 and 8

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	$\varnothing D_{\max}$ (mm)	$L_{\max}$ (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS $l \times w \times h$ (mm)
25 × 30	26	35	≈24	100	290 × 280 × 50
25 × 40	26	45	≈28	100	290 × 280 × 60
30 × 40	31	45	≈38	100	340 × 330 × 60
35 × 40	36	45	≈51	50	390 × 198 × 60
35 × 50	36	55	≈66	50	390 × 198 × 70
40 × 40	41	45	≈78	50	440 × 223 × 60
40 × 50	41	55	≈82	50	440 × 223 × 70
40 × 70	41	75	≈110	50	440 × 223 × 90
40 × 100	41	105	≈176	50	440 × 223 × 120

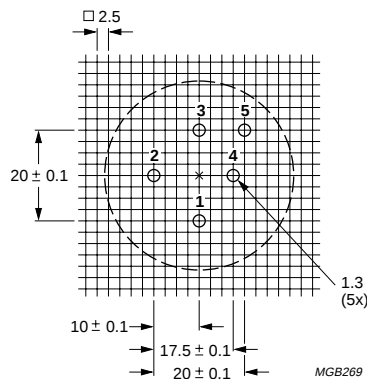
Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW


Dimensions in mm; for L see Table 1.
 1 = positive terminal; 5 = negative terminal.
Case $\varnothing D = 40$ mm.

Fig.8 Printed wiring pin version.



Dimensions in mm.
Case $\varnothing D = 40$ mm.

Fig.9 Mounting hole diagram viewed from component side.

Mounting

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

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

Aluminum electrolytic capacitors
Power Eurodin Printed Wiring

050/052 PED-PW

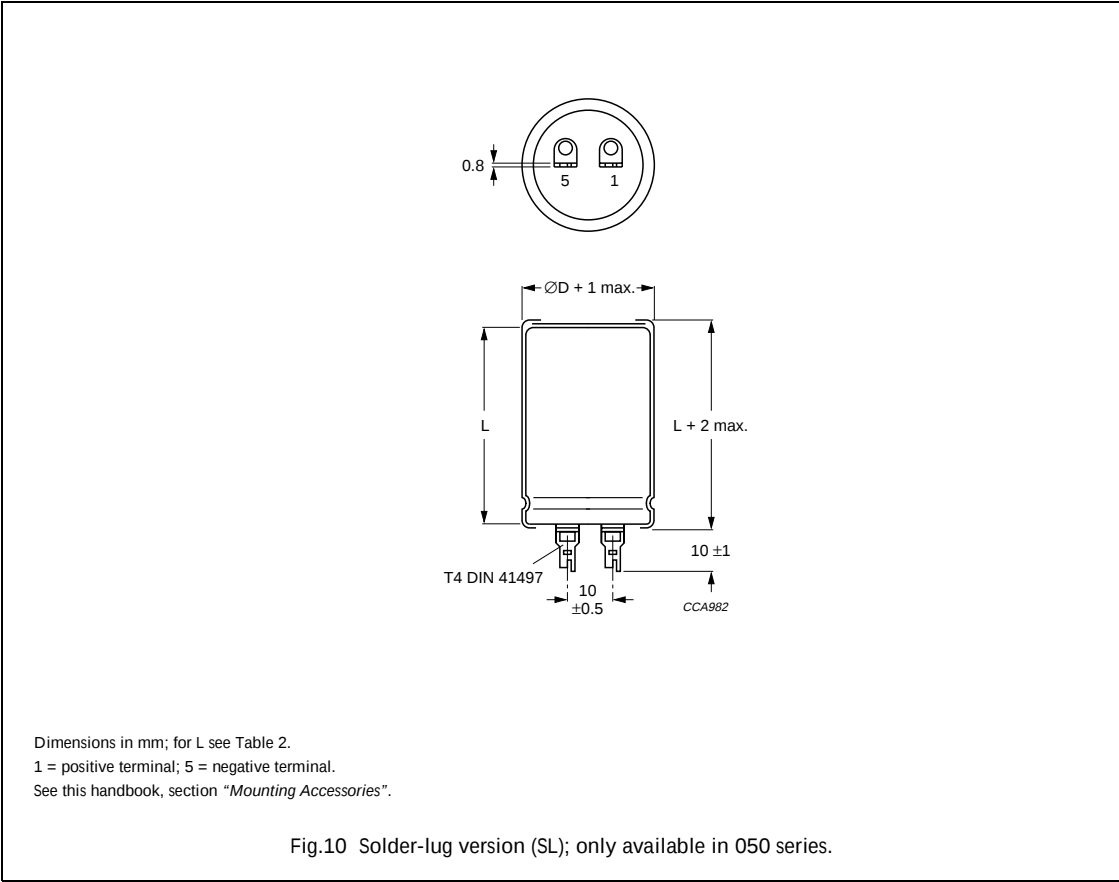


Table 2 SL versions (050 series only); physical dimensions, mass and packaging information; see Fig.10

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	$\varnothing D_{\text{max}}$ (mm)	L_{max} (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS $l \times w \times h$ (mm)
25 × 30	26	32	≈24	100	290 × 280 × 50
25 × 40	26	42	≈28	100	290 × 280 × 60
30 × 40	31	42	≈38	100	340 × 330 × 60
35 × 40	36	42	≈51	50	390 × 198 × 60
35 × 50	36	52	≈66	50	390 × 198 × 70
40 × 50	41	52	≈82	50	440 × 223 × 70
40 × 70	41	72	≈110	50	440 × 223 × 90
40 × 100	41	102	≈176	50	440 × 223 × 120

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW
ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Tables 3 and 4 apply at
 $T_{amb} = 20\text{ }^{\circ}\text{C}$, $P = 86\text{ to }106\text{ kPa}$, $RH = 45\text{ to }75\%$.

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz
I_R	rated RMS ripple current at 100 Hz, $85\text{ }^{\circ}\text{C}$ or at 20 kHz, $70\text{ }^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	max. equivalent series resistance at 100 Hz
Z	max. impedance at 10 kHz

Ordering example

Electrolytic capacitor 050 series

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

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

Catalogue number: 2222 050 56103.

Table 3 Electrical data and ordering information for **050** series; preferred types in **bold**

U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	I _R 100 Hz 85 °C (A)	I _R 20 kHz 70 °C (A)	I _{L1} 1 min (mA)	I _{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOGUE NUMBER (note 1) 2222
10	4700	25 × 30	2.4	4.6	0.28	0.10	74	50	050 54472
	6800	25 × 40	3.2	6.1	0.41	0.14	51	37	050 54682
	10000	30 × 40	3.8	7.2	0.60	0.20	39	29	050 54103
	15000	35 × 40	4.1	7.8	0.90	0.30	35	26	050 54153
	22000	35 × 50	5.0	9.5	1.32	0.44	27	21	050 54223
	22000	40 × 40	4.2	8.0	1.32	0.44	36	27	050 44223
	33000	40 × 50	5.0	9.5	1.98	0.66	29	22	050 54333
	47000	40 × 70	6.8	12.9	2.82	0.94	20	17	050 54473
68000	40 × 100	9.2	17.5	4.08	1.36	15	14	050 54683	
16	3300	25 × 30	2.4	4.6	0.32	0.11	75	50	050 55332
	4700	25 × 40	3.1	5.9	0.45	0.15	52	37	050 55472
	6800	30 × 40	3.7	7.0	0.65	0.22	40	30	050 55682
	10000	35 × 40	4.1	7.8	0.96	0.32	36	27	050 55103
	15000	35 × 50	5.0	9.5	1.44	0.48	28	21	050 55153
	15000	40 × 40	4.2	8.0	1.44	0.48	36	27	050 45153
	22000	40 × 50	5.0	9.5	2.12	0.71	29	22	050 55223
	33000	40 × 70	6.7	12.7	3.17	1.06	20	17	050 55333
	47000	40 × 100	9.1	17.3	4.51	1.51	15	14	050 55473
25	2200	25 × 30	2.3	4.4	0.33	0.11	78	52	050 56222
	3300	25 × 40	3.1	5.9	0.49	0.17	53	38	050 56332
	4700	30 × 40	3.7	7.0	0.70	0.24	42	31	050 56472
	6800	35 × 40	4.1	7.8	1.02	0.34	37	28	050 56682
	10000	35 × 50	5.0	9.5	1.50	0.50	28	21	050 56103
	10000	40 × 40	4.2	8.0	1.50	0.50	36	27	050 46103
	15000	40 × 50	5.0	9.5	2.25	0.75	29	22	050 56153
	22000	40 × 70	6.8	12.9	3.30	1.10	20	17	050 56223
	33000	40 × 100	9.2	17.5	4.95	1.65	15	14	050 56333

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

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 × 30	2.0	3.8	0.36	0.12	112	68	050 57152
	2200	25 × 40	2.7	5.1	0.53	0.18	76	51	050 57222
	3300	30 × 40	3.3	6.3	0.79	0.27	57	41	050 57332
	4700	35 × 40	3.8	7.2	1.13	0.38	48	35	050 57472
	6800	35 × 50	4.7	8.9	1.64	0.55	36	27	050 57682
	6800	40 × 40	4.1	7.8	1.64	0.55	45	33	050 47682
	10000	40 × 50	4.9	9.3	2.40	0.80	35	27	050 57103
	15000	40 × 70	6.6	12.5	3.60	1.20	25	20	050 57153
	22000	40 × 100	9.0	17.1	5.28	1.76	18	16	050 57223
63	1000	25 × 30	1.8	3.4	0.38	0.13	122	74	050 58102
	1500	25 × 40	2.5	4.7	0.57	0.19	83	54	050 58152
	2200	30 × 40	3.1	5.9	0.83	0.28	57	41	050 58222
	3300	35 × 40	3.6	6.8	1.25	0.42	48	35	050 58332
	4700	35 × 50	4.4	8.3	1.78	0.60	36	27	050 58472
	4700	40 × 40	3.8	7.2	1.78	0.60	45	33	050 48472
	6800	40 × 50	4.7	8.9	2.57	0.86	35	27	050 58682
	10000	40 × 70	6.2	11.8	3.78	1.26	25	20	050 58103
	15000	40 × 100	8.5	16.1	5.67	1.89	18	16	050 58153
100	470	25 × 30	1.4	2.7	0.28	0.10	247	172	050 59471
	680	25 × 40	1.9	3.6	0.41	0.14	170	116	050 59681
	1000	30 × 40	2.5	4.7	0.60	0.20	123	88	050 59102
	1500	35 × 40	3.1	5.8	0.90	0.30	94	71	050 59152
	2200	35 × 50	3.9	7.4	1.32	0.44	69	55	050 59222
	2200	40 × 40	3.6	6.8	1.32	0.44	81	65	050 49222
	3300	40 × 50	4.6	8.7	1.98	0.66	59	48	050 59332
	4700	40 × 70	6.2	11.7	2.82	0.94	42	36	050 59472
	6800	40 × 100	8.2	15.5	4.08	1.36	32	28	050 59682

Note

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

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW
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 × 30	0.6	1.15	0.15	0.05	1800	1300	052 53101
	150	25 × 40	0.8	1.5	0.23	0.08	1100	850	052 53151
	220	30 × 40	1.0	1.9	0.33	0.11	750	550	052 53221
	330	35 × 40	1.4	2.65	0.49	0.17	500	400	052 53331
	470	35 × 50	1.8	3.4	0.70	0.24	360	290	052 53471
	470	40 × 40	1.8	3.4	0.70	0.24	420	350	052 43471
	680	40 × 50	2.3	4.4	1.02	0.34	250	190	052 53681
	1000	40 × 70	3.0	5.7	1.50	0.50	170	140	052 53102
385	47	25 × 30	0.5	0.94	0.11	0.04	2370	1550	052 58479
	68	25 × 40	0.67	1.27	0.16	0.06	1640	1100	052 58689
	100	30 × 40	0.84	1.59	0.23	0.08	1275	950	052 58101
	150	35 × 40	1.13	2.14	0.34	0.11	850	635	052 58151
	220	35 × 50	1.48	2.8	0.50	0.17	580	430	052 58221
	220	40 × 40	1.48	2.8	0.50	0.17	580	430	052 48221
	330	40 × 50	1.97	3.73	0.75	0.25	385	300	052 58331
	470	40 × 70	2.7	5.11	1.06	0.36	270	215	052 58471
400	47	25 × 30	0.47	0.89	0.11	0.04	2700	2125	052 56479
	68	25 × 40	0.63	1.29	0.16	0.06	1875	1470	052 56689
	100	30 × 40	0.84	1.59	0.24	0.08	1275	1000	052 56101
	150	35 × 40	1.13	2.14	0.36	0.12	850	665	052 56151
	220	35 × 50	1.41	2.67	0.52	0.17	650	450	052 56221
	220	40 × 40	1.41	2.67	0.52	0.17	650	450	052 46221
	330	40 × 50	1.86	3.52	0.79	0.26	435	315	052 56331
	470	40 × 70	2.54	4.81	1.12	0.37	305	225	052 56471
	680	40 × 100	3.56	6.75	1.63	0.54	210	155	052 56681

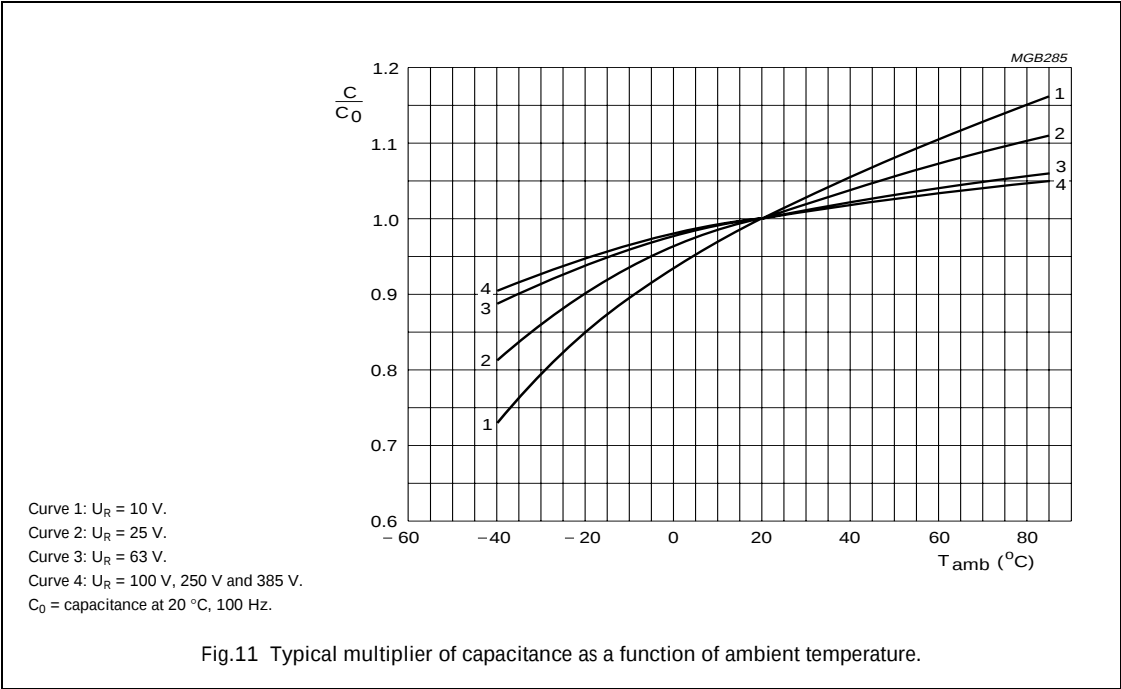
Aluminum electrolytic capacitors
Power Eurodin Printed Wiring

050/052 PED-PW

Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage	≤250 V versions	$U_s = 1.15 \times U_R$
	≥385 V versions	$U_s = 1.1 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006C_R \times U_R + 4 \text{ }\mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.002C_R \times U_R + 4 \text{ }\mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case ØD = 25 mm	max. 25 nH
	case ØD = 30 and 35 mm	max. 30 nH
	case ØD = 40 mm	max. 35 nH

Capacitance (C)

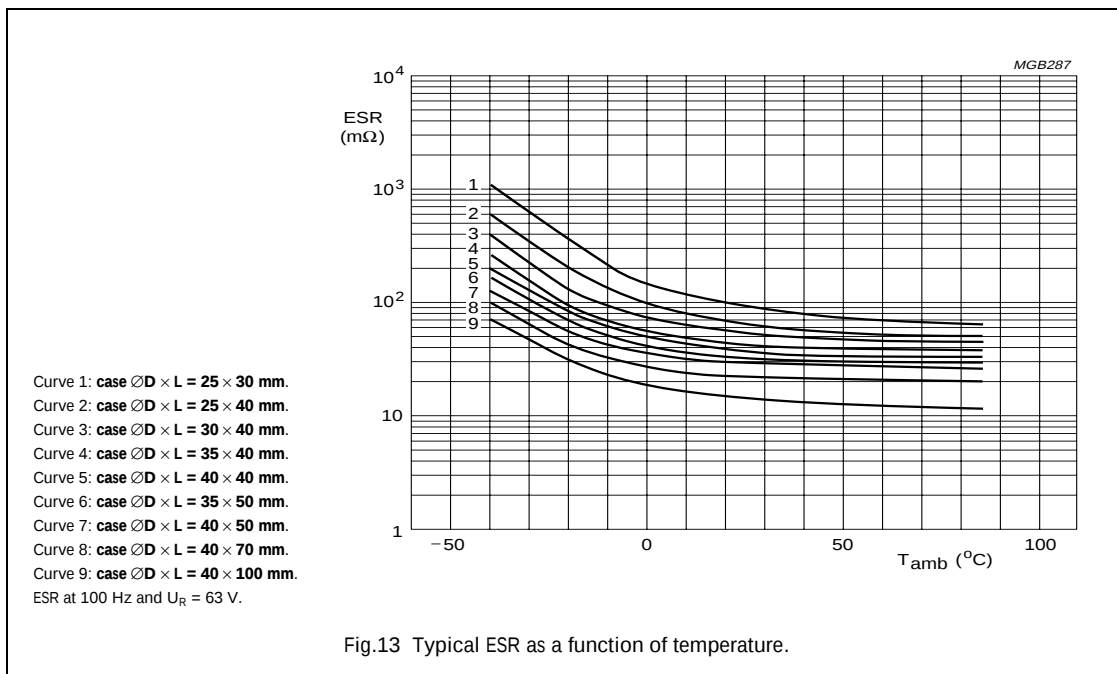
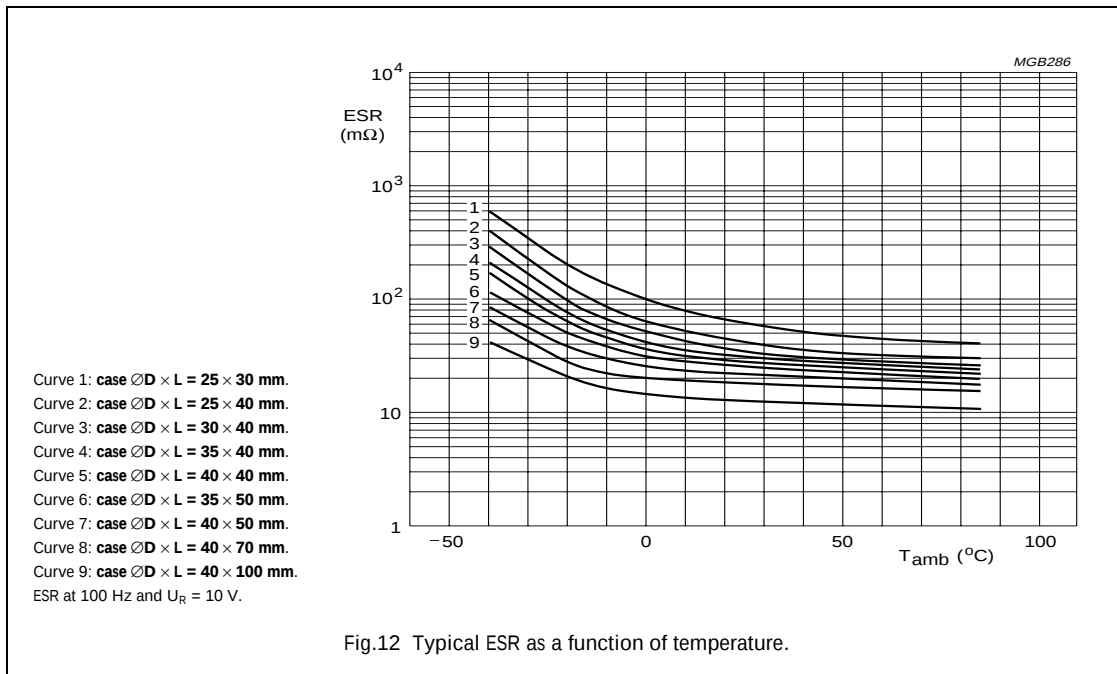


Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

Equivalent series resistance (ESR)



Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

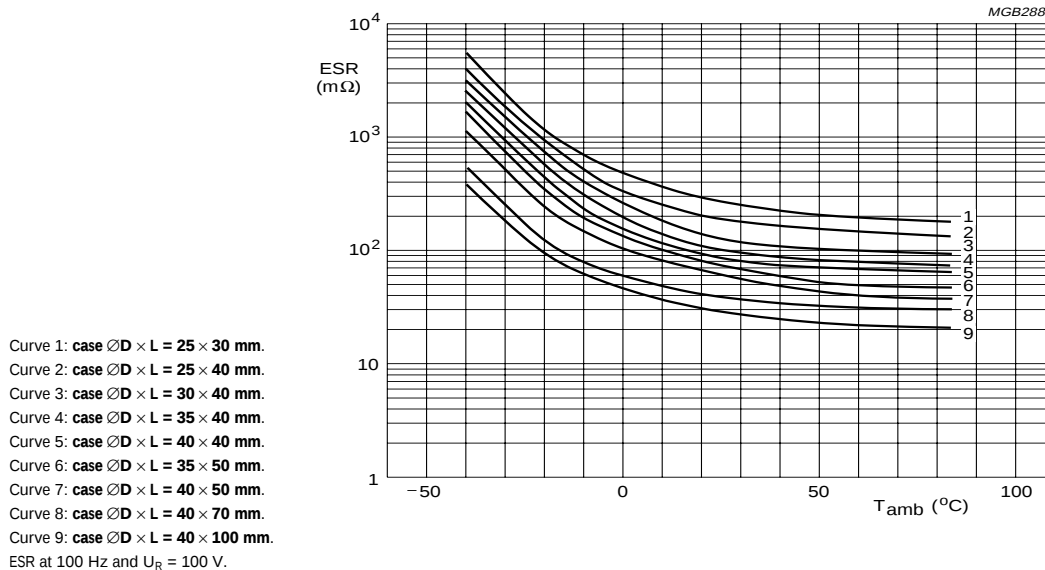
050/052 PED-PW


Fig.14 Typical ESR as a function of temperature.

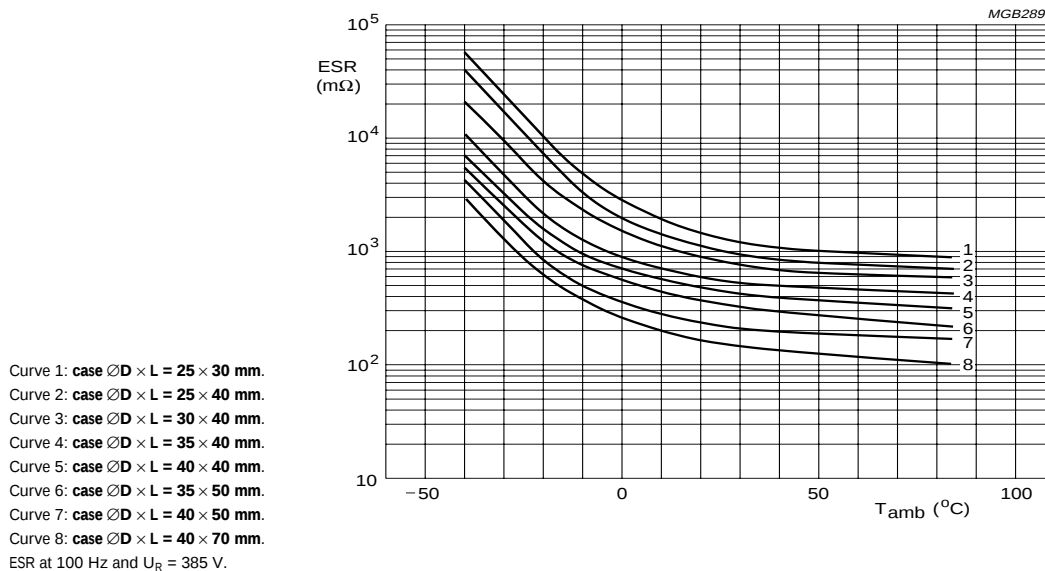


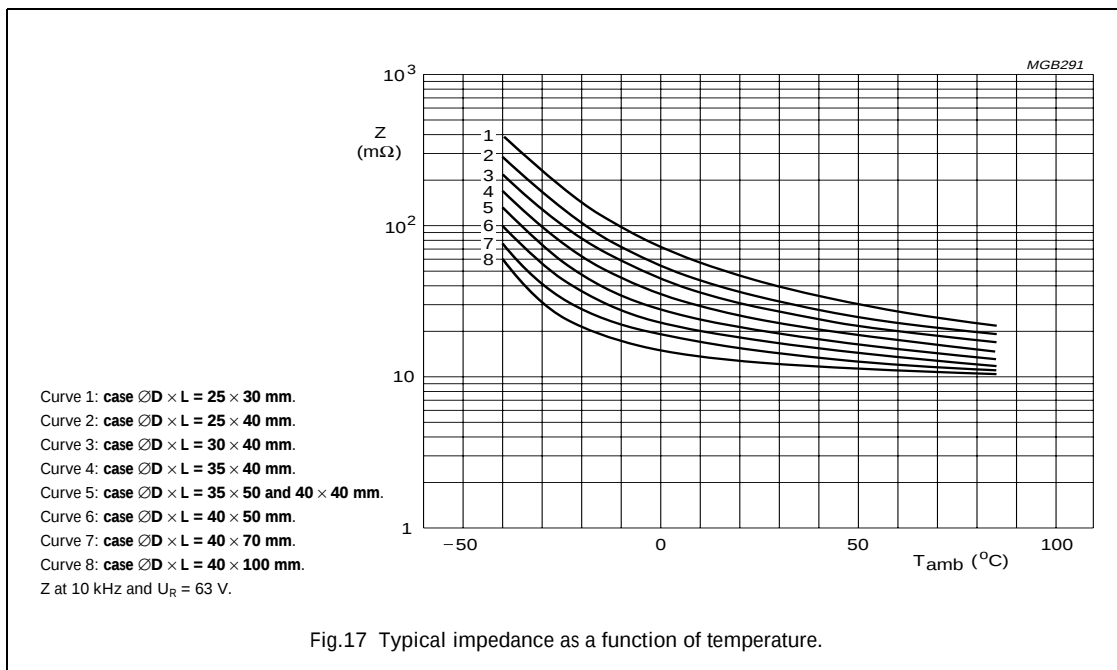
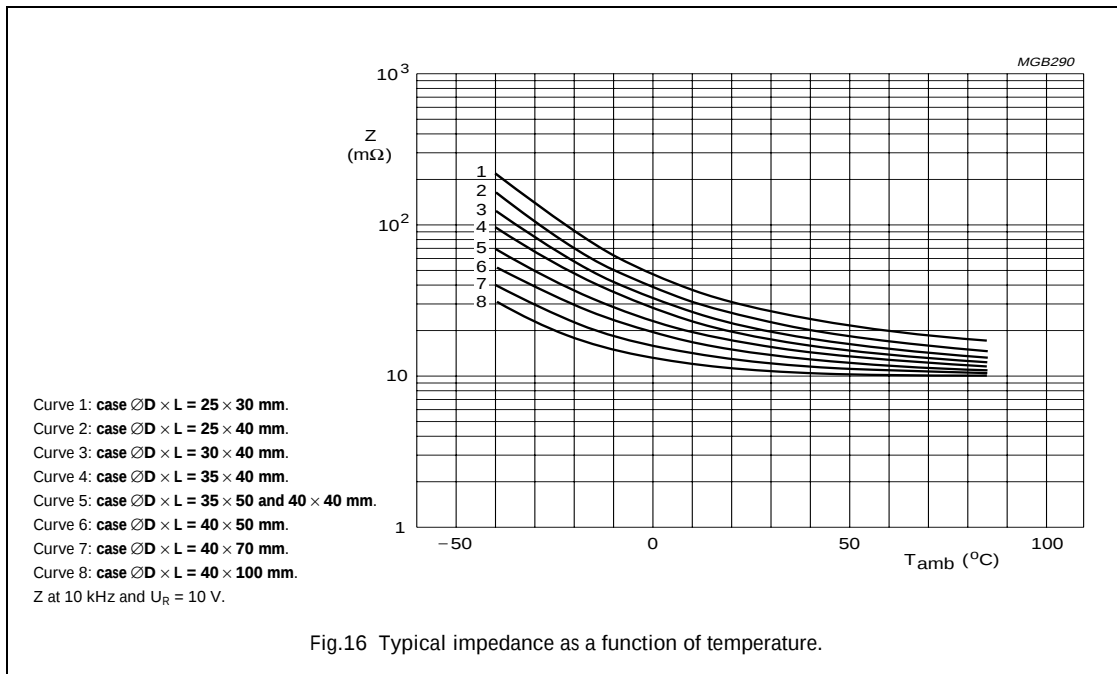
Fig.15 Typical ESR as a function of temperature.

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

Impedance (Z)



Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

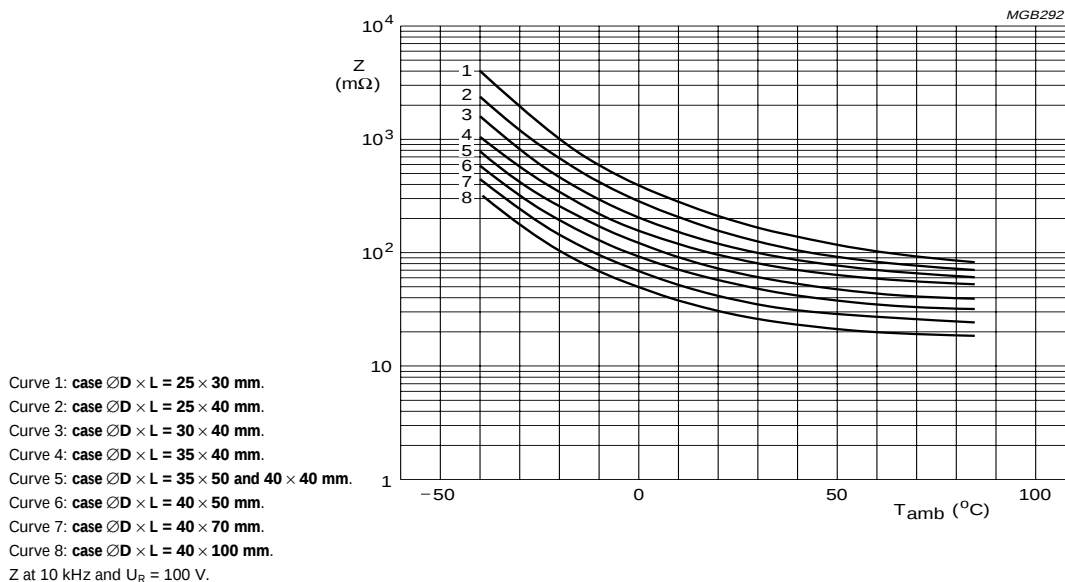


Fig.18 Typical impedance as a function of temperature.

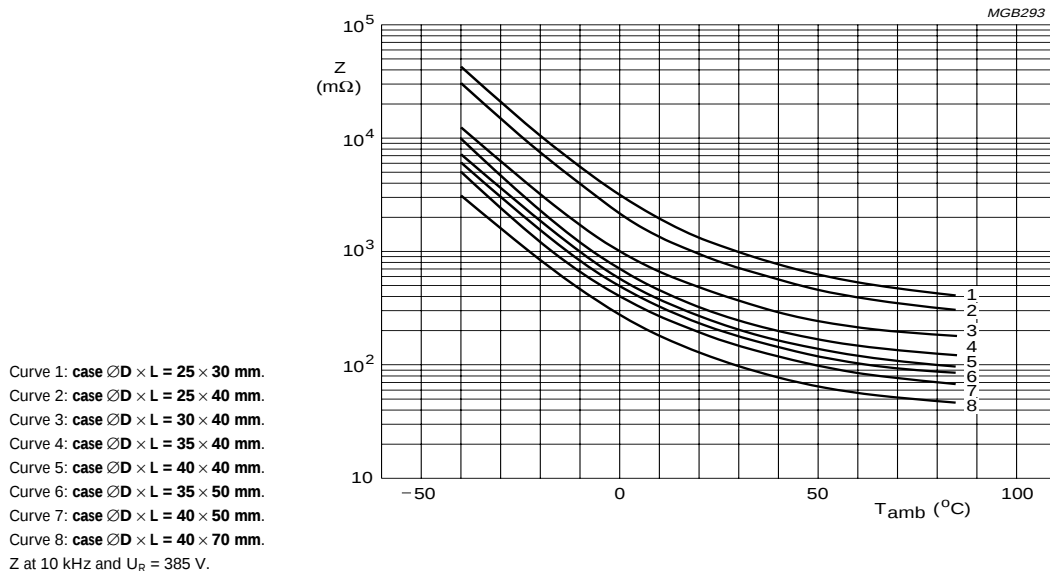


Fig.19 Typical impedance as a function of temperature.

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

Curve 1: 47 μF , 385 V.
 Curve 2: 100 μF , 250 V.
 Curve 3: 470 μF , 100 V.
 Curve 4: 1000 μF , 63 V.
 Curve 5: 4700 μF , 10 V.
Case $\varnothing D \times L = 25 \times 30$ mm.
 $T_{\text{amb}} = 20^\circ\text{C}$.

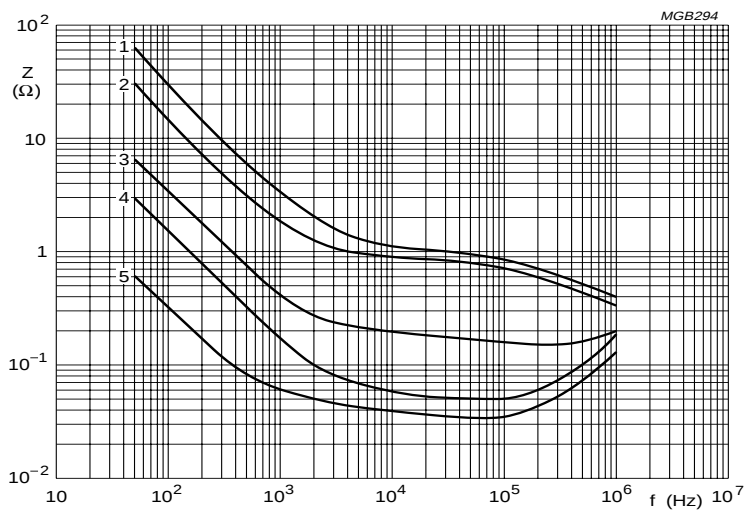


Fig.20 Typical impedance as a function of frequency.

Curve 1: 68 μF , 385 V.
 Curve 2: 150 μF , 250 V.
 Curve 3: 680 μF , 100 V.
 Curve 4: 1500 μF , 63 V.
 Curve 5: 6800 μF , 10 V.
Case $\varnothing D \times L = 25 \times 40$ mm.
 $T_{\text{amb}} = 20^\circ\text{C}$.

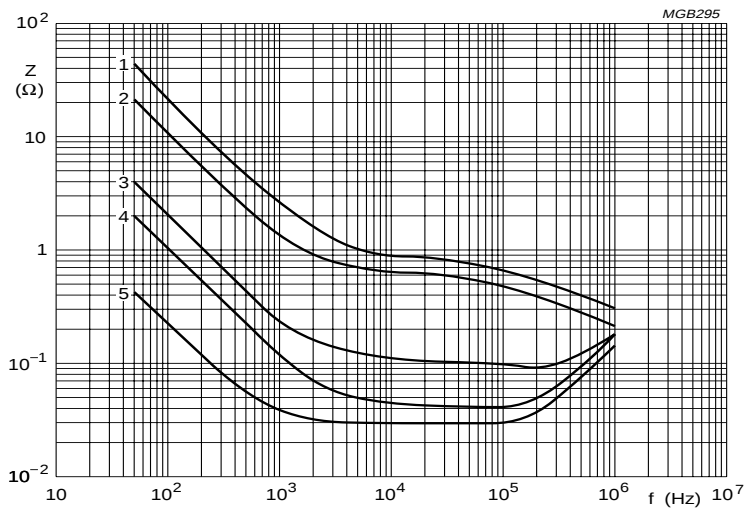


Fig.21 Typical impedance as a function of frequency.

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

Curve 1: 100 μF , 385 V.
 Curve 2: 220 μF , 250 V.
 Curve 3: 1000 μF , 100 V.
 Curve 4: 2200 μF , 63 V.
 Curve 5: 10000 μF , 10 V.
Case $\varnothing D \times L = 30 \times 40$ mm.
 $T_{\text{amb}} = 20^\circ\text{C}$.

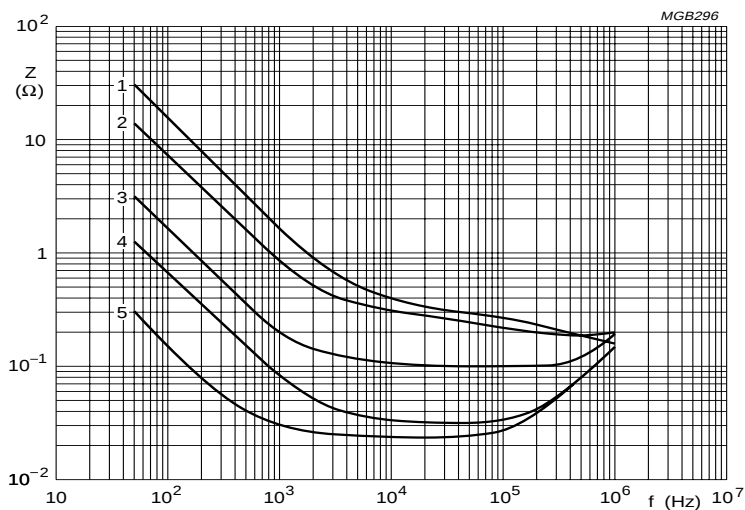


Fig.22 Typical impedance as a function of frequency.

Curve 1: 150 μF , 385 V.
 Curve 2: 330 μF , 250 V.
 Curve 3: 1500 μF , 100 V.
 Curve 4: 3300 μF , 63 V.
 Curve 5: 15000 μF , 10 V.
Case $\varnothing D \times L = 35 \times 40$ mm.
 $T_{\text{amb}} = 20^\circ\text{C}$.

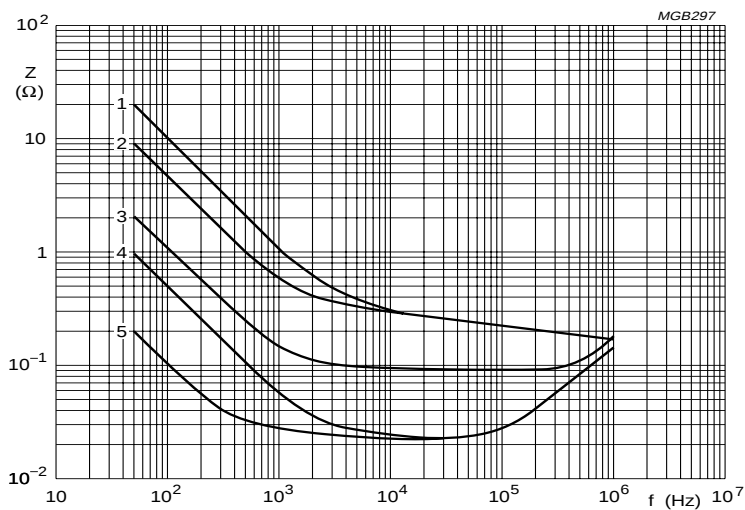


Fig.23 Typical impedance as a function of frequency.

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

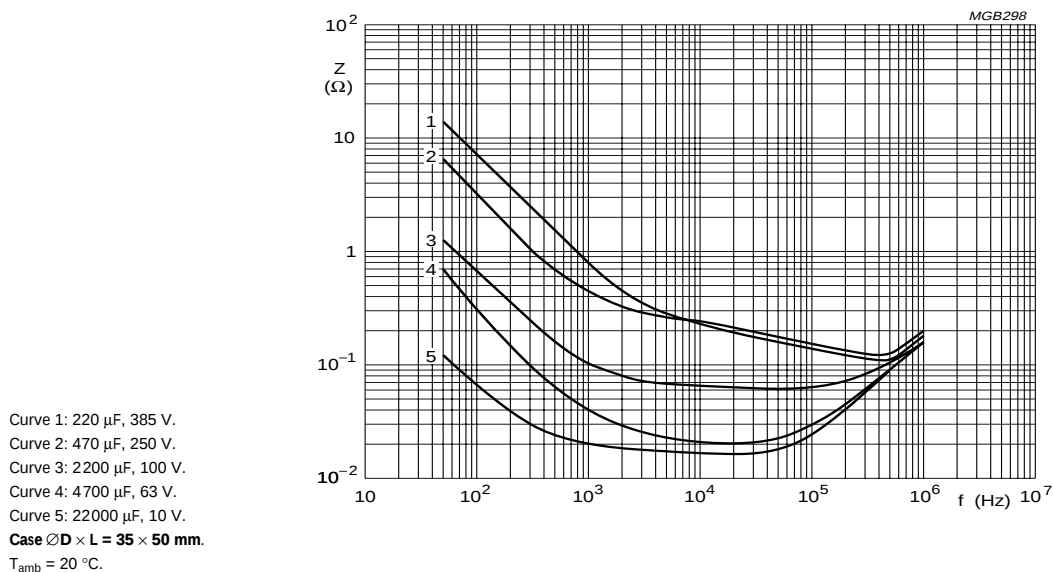
050/052 PED-PW


Fig.24 Typical impedance as a function of frequency.

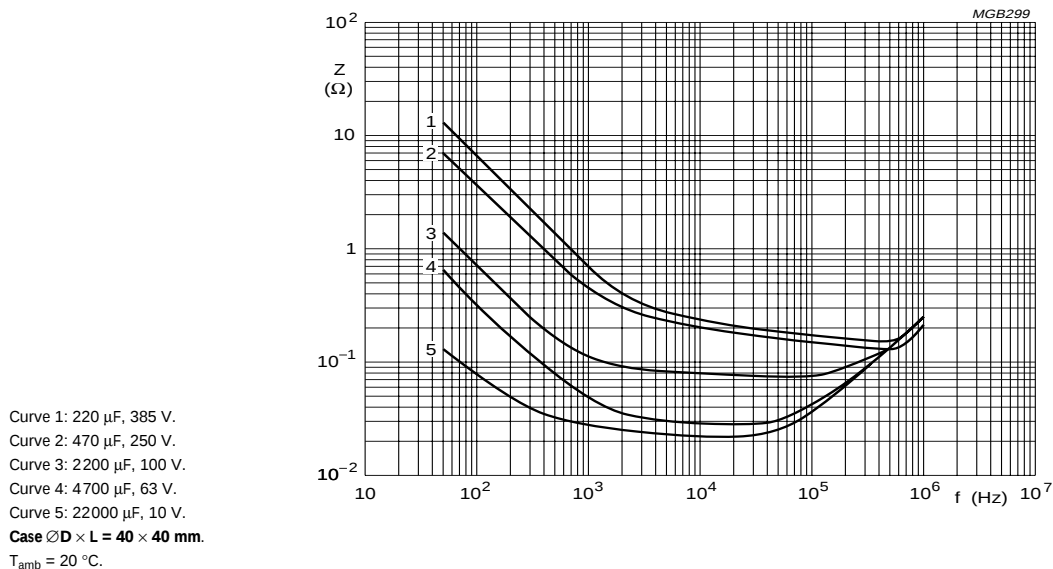


Fig.25 Typical impedance as a function of frequency.

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

Curve 1: 330 μ F, 385 V.
 Curve 2: 680 μ F, 250 V.
 Curve 3: 3300 μ F, 100 V.
 Curve 4: 6800 μ F, 63 V.
 Curve 5: 33000 μ F, 10 V.
Case $\varnothing D \times L = 40 \times 50$ mm.
 $T_{amb} = 20$ °C.

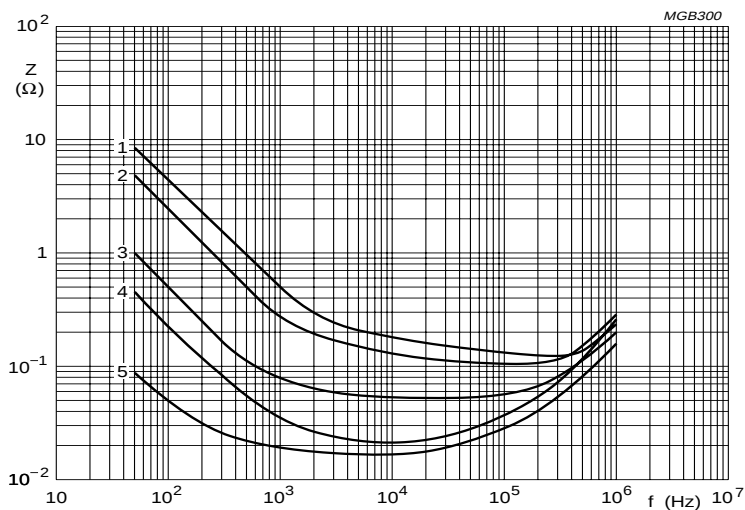


Fig.26 Typical impedance as a function of frequency.

Curve 1: 470 μ F, 385 V.
 Curve 2: 1000 μ F, 250 V.
 Curve 3: 4700 μ F, 100 V.
 Curve 4: 10000 μ F, 63 V.
 Curve 5: 47000 μ F, 10 V.
Case $\varnothing D \times L = 40 \times 70$ mm.
 $T_{amb} = 20$ °C.

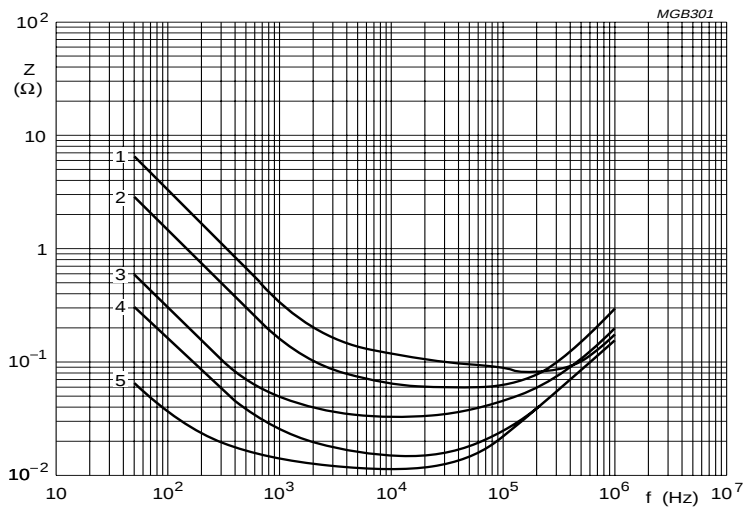


Fig.27 Typical impedance as a function of frequency.

Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

Curve 1: 6800 μF , 100 V.
 Curve 2: 15000 μF , 63 V.
 Curve 3: 68000 μF , 10 V.
 Case $\varnothing D \times L = 40 \times 100 \text{ mm}$.
 $T_{\text{amb}} = 20^\circ\text{C}$.

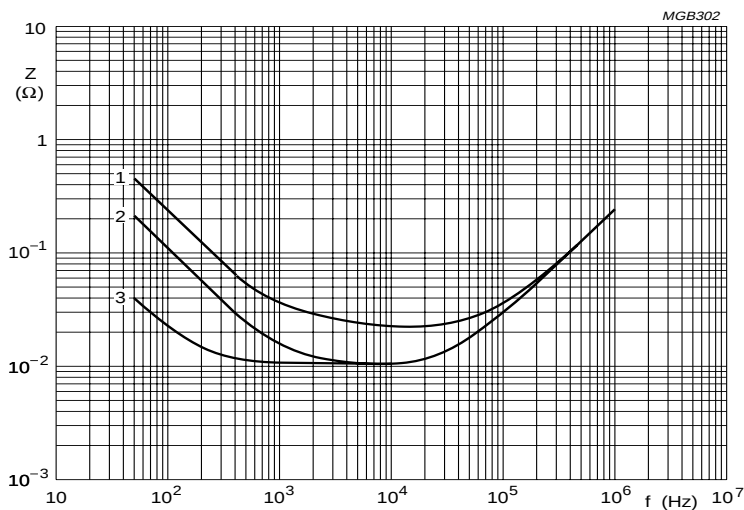


Fig.28 Typical impedance as a function of frequency.

MARKING

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

- Rated capacitance (in μF)
- Tolerance on rated capacitance (Q for $-10/+30\%$)
- Rated voltage (in V)
- Climatic category in accordance with "IEC 60068"
- Date code (year and week) in accordance with "IEC 60062"
- 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.

Aluminum electrolytic capacitors

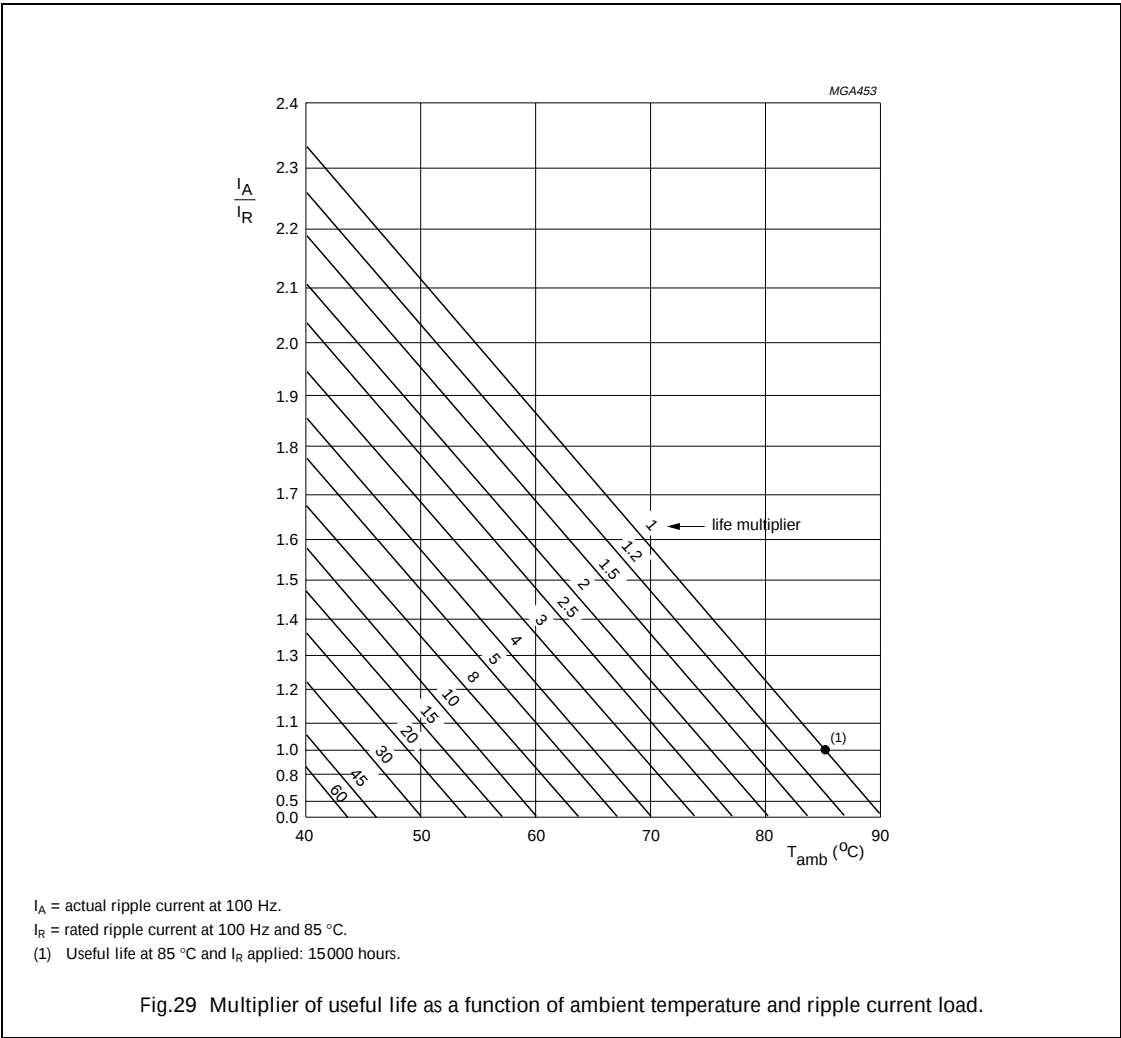
Power Eurodin Printed Wiring

050/052 PED-PW

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



Aluminum electrolytic capacitors

Power Eurodin Printed Wiring

050/052 PED-PW

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in data handbook BC01, section “*Tests and Requirements*”.

Table 6 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 85\text{ °C}$; U_R applied; 5000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 10\%$ $ESR \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ °C}$; U_R and I_R applied; 15000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C$: $\pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C$: $\pm 30\%$ $ESR \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ 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	$T_{amb} = 85\text{ °C}$; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$: $\pm 10\%$ $ESR \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$