

Aluminum Capacitors Power Long Life Printed Wiring

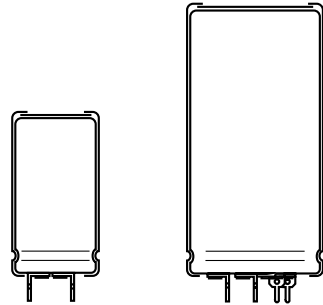
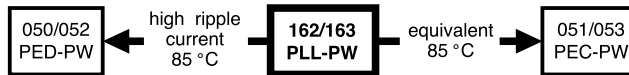


Fig.1 Component outlines



QUICK REFERENCE DATA		
DESCRIPTION	VALUE	
	162	163
Nominal case size (Ø D x L in mm)	25 x 30 to 40 x 100	
Rated capacitance range (E6 series), C _R	470 to 150 000 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 x I _R applied	150 000 hours	
Shelf life at 0 V, 105 °C	500 hours	
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/105/56	

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, minimized dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Provided with keyed polarity
- 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


**RoHS
COMPLIANT**
APPLICATIONS

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

MARKING

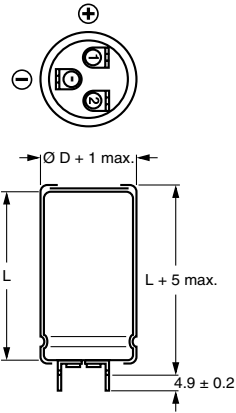
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- 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

SELECTION CHART FOR C _R , U _R AND RELEVANT NOMINAL CASE SIZES FOR 162 SERIES (Ø D x L in mm)						
C _R (µF)	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 40	35 x 40
2200	-	-	-	25 x 30	30 x 40	35 x 50
3300	-	-	-	25 x 40	35 x 40	40 x 40
4700	-	-	25 x 30	30 x 40	35 x 50	40 x 70
6800	-	25 x 30	25 x 40	35 x 40	40 x 50	40 x 100
10 000	25 x 30	25 x 40	30 x 40	35 x 50	40 x 70	-
15 000	25 x 40	30 x 40	35 x 40	40 x 50	40 x 100	-
22 000	30 x 40	35 x 40	35 x 50	40 x 70	-	-
33 000	35 x 40	35 x 50	40 x 50	40 x 100	-	-
47 000	35 x 50	40 x 50	40 x 70	-	-	-
68 000	40 x 50	40 x 70	40 x 100	-	-	-
100 000	40 x 70	40 x 100	-	-	-	-
150 000	40 x 100	-	-	-	-	-

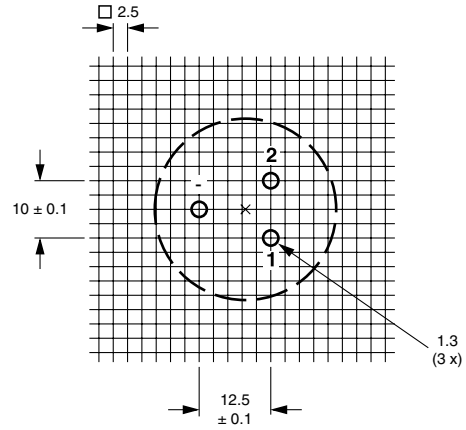
C _R (μF)	U _R (V)			
	200	250	385	400
68	-	-	25 x 30	25 x 30
100	-	25 x 30	25 x 40	25 x 40
150	25 x 30	25 x 40	30 x 40	30 x 40
220	25 x 40	30 x 40	35 x 40	35 x 40
330	30 x 40	35 x 40	35 x 50	35 x 50
	-	-	40 x 40	40 x 40
470	35 x 40	35 x 50	40 x 50	40 x 50
	-	40 x 40	-	-
680	35 x 50	40 x 50	40 x 70	40 x 70
	40 x 50	-	-	-
1000	40 x 50	40 x 70	40 x 100	40 x 100
1500	40 x 70	40 x 100	-	-
2200	40 x 100	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**



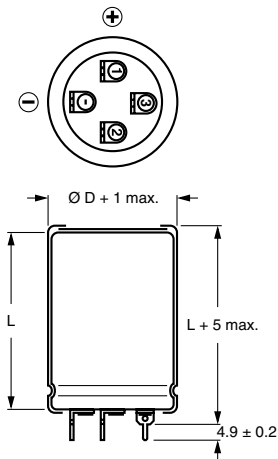
Case Ø D = 25 mm

Fig.2 Printed wiring pin version



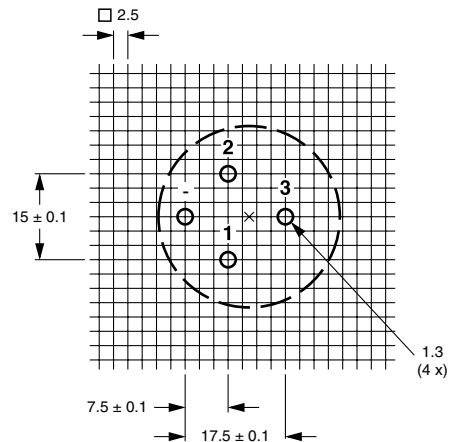
Case Ø D = 25 mm

Fig.3 Mounting hole diagram viewed from component side



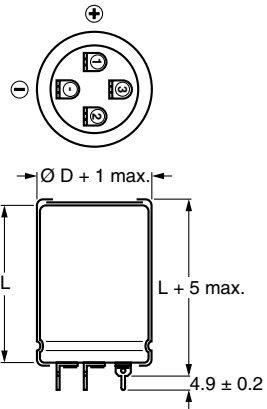
Case Ø D = 30 mm

Fig.4 Printed wiring pin version



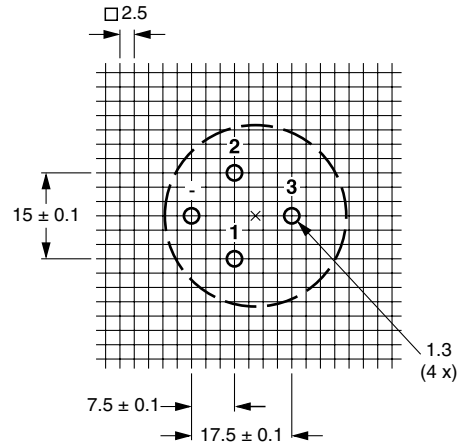
Case Ø D = 30 mm

Fig.5 Mounting hole diagram viewed from component side



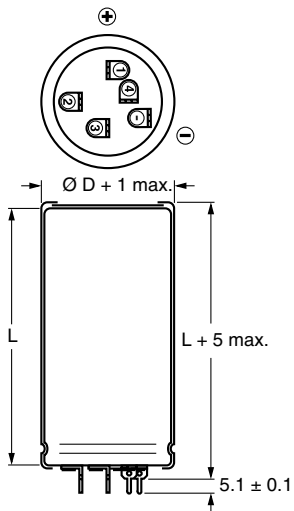
Case $\varnothing D = 35 \text{ mm}$

Fig.6 Printed wiring pin version



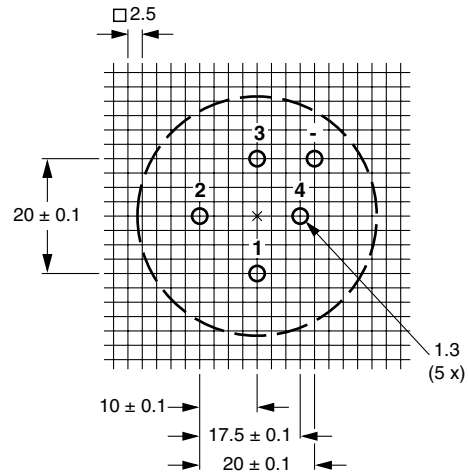
Case $\varnothing D = 35 \text{ mm}$

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 side

Table 1

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

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.



ELECTRICAL DATA	
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

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 162 SERIES								
U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 105 °C (A)	I_{L1} 1 min (mA)	I_{L5} 5 min (mA)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	ORDERING CODE MAL2162.....
10	10 000	25 x 30	3.17	0.60	0.20	48	37	54103E3
	15 000	25 x 40	4.21	0.90	0.30	34	27	54153E3
	22 000	30 x 40	5.05	1.32	0.44	29	23	54223E3
	33 000	35 x 40	5.63	1.98	0.66	27	22	54333E3
	47 000	35 x 50	6.19	2.82	0.94	26	21	54473E3
	47 000	40 x 40	6.19	2.82	0.94	26	21	44473E3
	68 000	40 x 50	7.64	4.08	1.36	21	18	54683E3
	100 000	40 x 70	10.0	6.00	2.00	16	15	54104E3
150 000	40 x 100	12.9	9.00	3.00	13	12	54154E3	
16	6800	25 x 30	3.11	0.65	0.22	50	37	55682E3
	10 000	25 x 40	4.09	0.96	0.32	36	27	55103E3
	15 000	30 x 40	4.97	1.44	0.48	30	23	55153E3
	22 000	35 x 40	5.53	2.12	0.71	29	22	55223E3
	33 000	35 x 50	6.08	3.17	1.06	28	21	55333E3
	33 000	40 x 40	6.08	3.17	1.06	28	21	45333E3
	47 000	40 x 50	7.46	4.52	1.51	22	18	55473E3
	68 000	40 x 70	9.70	6.53	2.18	17	15	55683E3
100 000	40 x 100	12.90	9.60	3.20	13	12	55104E3	
25	4700	25 x 30	2.94	0.71	0.24	56	37	56472E3
	6800	25 x 40	3.93	1.02	0.34	39	27	56682E3
	10 000	30 x 40	4.81	1.50	0.50	32	23	56103E3
	15 000	35 x 40	5.43	2.25	0.75	30	22	56153E3
	22 000	35 x 50	5.98	3.30	1.10	29	21	56223E3
	22 000	40 x 40	5.98	3.30	1.10	29	21	46223E3
	33 000	40 x 40	5.98	3.30	1.10	29	21	56533E3
	47 000	40 x 70	9.43	7.05	2.35	18	15	56473E3
68 000	40 x 100	12.44	10.20	3.40	14	12	56683E3	
40	2200	25 x 30	2.36	0.53	0.18	87	54	57222E3
	3300	25 x 40	3.17	0.79	0.27	60	38	57332E3
	4700	30 x 40	3.93	1.13	0.38	48	33	57472E3
	6800	35 x 40	4.59	1.63	0.55	42	31	57682E3
	10 000	35 x 50	5.03	2.40	0.80	41	29	57103E3
	10 000	40 x 40	5.03	2.40	0.80	41	29	47103E3
	15 000	40 x 50	6.09	3.60	1.20	33	24	57153E3
	22 000	40 x 70	8.34	5.28	1.76	23	18	57223E3
33 000	40 x 100	10.97	7.92	2.64	18	15	57333E3	
63	1000	25 x 30	1.55	0.38	0.13	202	155	58102E3
	1500	25 x 40	2.10	0.57	0.19	137	109	58152E3
	2200	30 x 40	2.72	0.83	0.28	100	79	58222E3
	3300	35 x 40	3.44	1.25	0.42	75	61	58332E3
	4700	35 x 50	4.09	1.78	0.60	62	53	58472E3
	4700	40 x 40	4.09	1.78	0.60	62	53	48472E3
	6800	40 x 50	5.10	2.57	0.86	47	40	58682E3
	10 000	40 x 70	6.86	3.78	1.26	34	29	58103E3
15 000	40 x 100	9.31	5.67	1.89	25	21	58153E3	
100	470	25 x 30	1.42	0.28	0.10	240	155	59471E3
	680	25 x 40	1.90	0.41	0.14	167	109	59681E3
	1000	30 x 40	2.48	0.60	0.20	120	79	59102E3
	1500	35 x 40	3.17	0.90	0.30	88	61	59152E3
	2200	35 x 50	3.79	1.32	0.44	72	53	59222E3
	2200	40 x 40	3.79	1.32	0.44	72	53	49222E3
	3300	40 x 50	4.81	1.98	0.66	53	40	59332E3
	4700	40 x 70	6.49	2.82	0.94	38	29	59472E3
6800	40 x 100	8.80	4.08	1.36	28	21	59682E3	

ORDERING EXAMPLE

Electrolytic capacitor 162 series

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

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

Ordering code: MAL216256103E3

Former 12NC: 222216256103



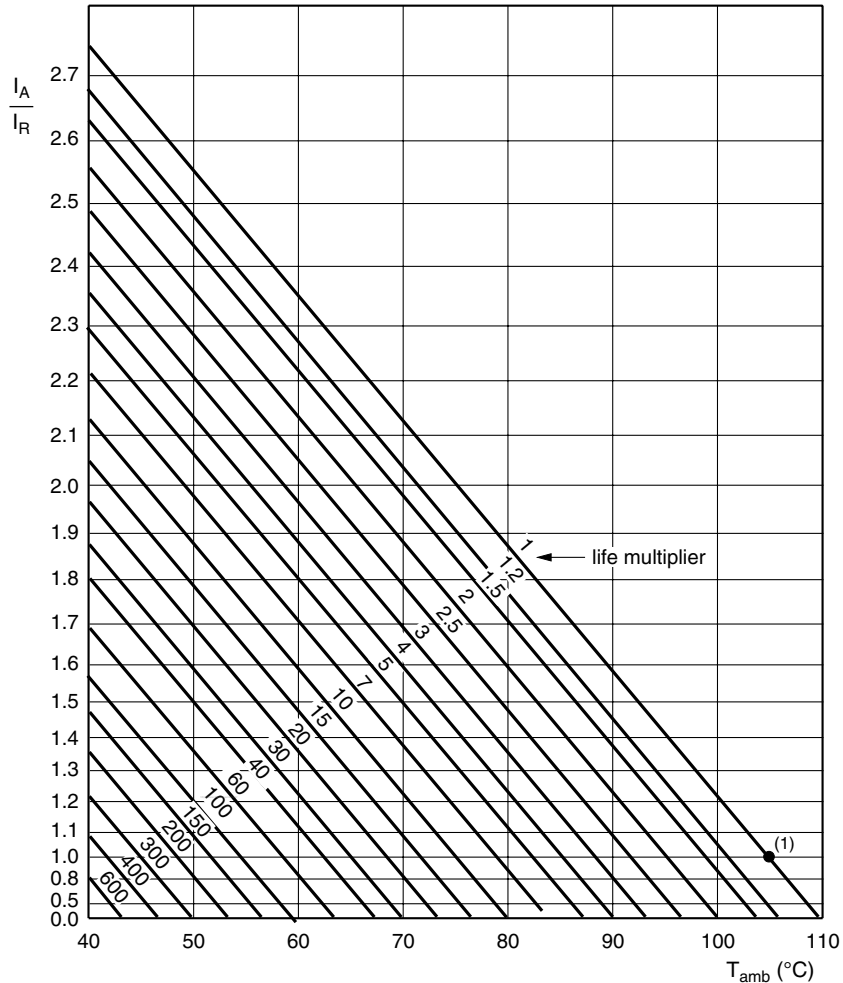
Table 3

ELECTRICAL DATA AND ORDERING INFORMATION FOR 163 SERIES								
U _R (V)	C _R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I _R 100 Hz 105 °C (A)	I _{L1} 1 min (mA)	I _{L5} 5 min (mA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	ORDERING CODE MAL2163.....
200	150	25 x 30	0.72	0.18	0.06	950	710	52151E3
	220	25 x 40	0.96	0.26	0.09	650	485	52221E3
	330	30 x 40	1.29	0.40	0.14	442	330	52331E3
	470	35 x 40	1.66	0.57	0.19	321	240	52471E3
	680	35 x 50	2.09	0.82	0.28	237	185	52681E3
	680	40 x 40	2.09	0.82	0.28	237	185	42681E3
	1000	40 x 50	2.71	1.20	0.40	167	133	52102E3
	1500	40 x 70	3.75	1.80	0.60	114	90	52152E3
2200	40 x 100	5.24	2.64	0.88	79	62	52222E3	
250	100	25 x 30	0.67	0.15	0.05	1060	710	53101E3
	150	25 x 40	0.92	0.22	0.08	710	485	53151E3
	220	30 x 40	1.28	0.33	0.11	492	330	53221E3
	330	35 x 40	1.65	0.49	0.17	325	240	53331E3
	470	35 x 50	2.01	0.70	0.24	256	185	53471E3
	470	40 x 40	2.01	0.70	0.24	256	185	43471E3
	680	40 x 50	2.59	1.02	0.34	182	133	53681E3
	1000	40 x 70	3.58	1.50	0.50	125	90	53102E3
1500	40 x 100	5.05	2.25	0.75	85	62	53152E3	
385	68	25 x 30	0.61	0.16	0.06	1650	1260	58689E3
	100	25 x 40	0.82	0.23	0.08	1120	855	58101E3
	150	30 x 40	1.10	0.35	0.12	755	580	58151E3
	220	35 x 40	1.44	0.51	0.17	525	405	58221E3
	330	35 x 50	1.84	0.77	0.26	360	280	58331E3
	330	40 x 40	1.84	0.77	0.26	360	280	48331E3
	470	40 x 50	2.37	1.09	0.36	260	205	58471E3
	680	40 x 70	3.24	1.58	0.53	180	140	58681E3
1000	40 x 100	4.54	2.31	0.78	125	100	58102E3	
400	68	25 x 30	0.39	0.16	0.06	3200	2660	56689E3
	100	25 x 40	0.53	0.24	0.08	2180	1810	56101E3
	150	30 x 40	0.72	0.36	0.12	1460	1210	56151E3
	220	35 x 40	0.94	0.52	0.17	1010	830	56221E3
	330	35 x 50	1.24	0.79	0.26	680	570	56331E3
	330	40 x 40	1.24	0.79	0.26	680	570	46331E3
	470	40 x 50	1.59	1.12	0.37	485	407	56471E3
	680	40 x 70	2.18	1.63	0.54	336	282	56681E3
1000	40 x 100	3.07	2.40	0.80	230	193	56102E3	

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage	≤ 200 V versions	U _s = 1.15 x U _R
	≥ 385 V versions	U _s = 1.1 x U _R
Reverse voltage		U _{rev} ≤ 1 V
Current		
Leakage current	After 1 minute at U _R	I _{L1} ≤ 0.006 C _R x U _R + 4 µA
	After 5 minutes at U _R	I _{L5} ≤ 0.002 C _R x U _R + 4 µA
Inductance		
Equivalent series inductance (ESL)	Case Ø D = 25 mm	max. 25 nH
	Case Ø D = 30 and 35 mm	max. 30 nH
	Case Ø D = 40 mm	max. 35 nH



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 hours

Fig.10 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		
	$U_R = 10$ 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
≥ 10 000	1.18	1.22	1.40



Table 5

TEST PROCEDURES AND REQUIREMENT			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$U_R \leq 100\text{ V}$; $\Delta C/C: \pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 10\%$ $ESR \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; 5000 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	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 500 hours After test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 10\%$ $ESR \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$



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