

Aluminum Capacitors Radial Miniature Long Life

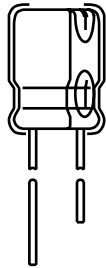
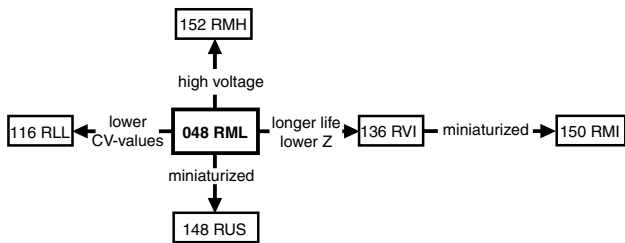


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum 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
- Lead (Pb)-free versions are RoHS compliant



RoHS
COMPLIANT

APPLICATIONS

- EDP, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass)

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 $\pm 20\%$)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (048)

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes ($\varnothing D \times L$ in mm)	10 x 12 to 18 x 35
Rated capacitance range, C_R	100 to 10 000 μF
Tolerance on C_R	$\pm 20\%$
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	200 000 hours
case $\varnothing D = 16$ and 18 mm	260 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/105/56

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	35	40	50	63
100	-	-	-	-	-	-	-	10 x 12
220	-	-	-	-	10 x 12	-	10 x 16	10 x 20
330	-	-	-	-	-	-	-	12.5 x 20
470	-	-	10 x 12	10 x 16	10 x 20	-	12.5 x 20	12.5 x 25
1000	-	10 x 16	10 x 20	12.5 x 20	12.5 x 25	-	16 x 25	16 x 31
2200	-	12.5 x 20	12.5 x 25	16 x 25	16 x 31	16 x 35	18 x 35	18 x 35
3300	-	12.5 x 25	16 x 25	16 x 31	18 x 35	18 x 35	18 x 35	-
4700	-	16 x 25	16 x 31	18 x 35	18 x 35	-	-	-
6800	16 x 25	16 x 31	16 x 35	-	-	-	-	-
10 000	16 x 35	18 x 35	18 x 35	-	-	-	-	-

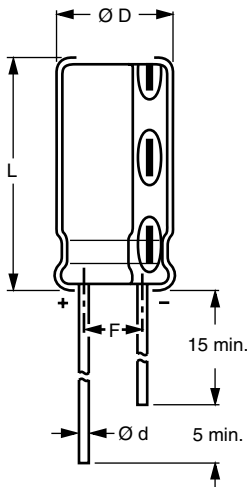
DIMENSIONS in millimeters, **AND AVAILABLE FORMS**


Fig.2 Form CA: Long leads

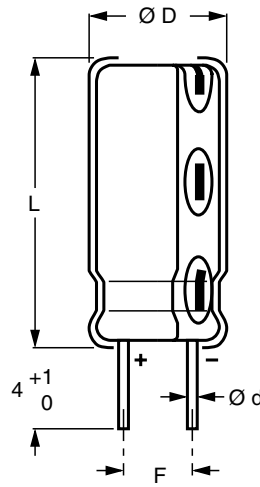


Fig.3 Form CB: Cut leads

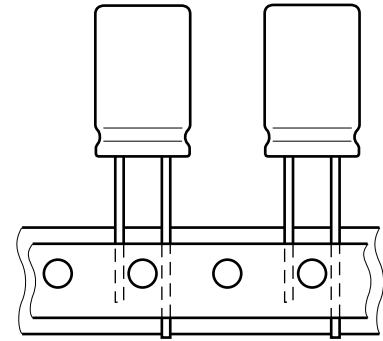

 Fig.4 Form TFA: Taped in box
 (ammopack)

Table 1

DIMENSIONS IN MILLIMETERS, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE Ø D x L	CASE CODE	Ø d	Ø D _{max.}	L _{max.}	F	MASS (g)	PACKAGING QUANTITIES		
							Form CA	Form CB	Form TFA
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.5	100	100	-
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	-

Note

Detailed tape dimensions see section 'PACKAGING'.



ELECTRICAL DATA	
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
$\tan \delta$	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

Note

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 %.

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION									
U_R (V)	C_R 100 Hz (μF)	DIMENSIONS $\varnothing D \times L$ (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (μA)	$\tan \delta$ 100 Hz	Z 100 kHz (m Ω)	ORDERING NUMBER MAL2048.....		
							BULK PACKAGING		TAPED
							Form CA	Form CB	Form TFA
6.3	6800	16 x 25	1350	430	0.32	56	53682E3	63682E3	33682E3
	10 000	16 x 35	1700	630	0.40	42	53103E3	63103E3	-
10	1000	10 x 16	470	100	0.19	180	54102E3	64102E3	34102E3
	2200	12.5 x 20	800	220	0.21	90	54222E3	64222E3	34222E3
	3300	12.5 x 25	1000	330	0.23	68	54332E3	64332E3	34332E3
	4700	16 x 25	1270	470	0.25	56	54472E3	64472E3	34472E3
	6800	16 x 31	1550	680	0.29	45	54682E3	64682E3	34682E3
	10 000	18 x 35	1870	1000	0.37	36	54103E3	64103E3	-
16	470	10 x 12	360	78	0.16	250	55471E3	65471E3	35471E3
	1000	10 x 20	600	160	0.16	140	55102E3	65102E3	35102E3
	2200	12.5 x 25	1000	360	0.18	70	55222E3	65222E3	35222E3
	3300	16 x 25	1220	530	0.20	56	55332E3	65332E3	35332E3
	4700	16 x 31	1500	760	0.22	45	55472E3	65472E3	35472E3
	6800	16 x 35	1690	1100	0.26	42	55682E3	65682E3	-
10 000	18 x 35	1980	1600	0.34	34	55103E3	65103E3	-	
25	470	10 x 16	440	120	0.14	180	56471E3	66471E3	36471E3
	1000	12.5 x 20	720	250	0.14	100	56102E3	66102E3	36102E3
	2200	16 x 25	1120	550	0.16	56	56222E3	66222E3	36222E3
	3300	16 x 31	1450	830	0.18	45	56332E3	66332E3	36332E3
4700	18 x 35	1720	1200	0.20	36	56472E3	66472E3	-	
35	220	10 x 12	310	80	0.12	280	50221E3	60221E3	30221E3
	470	10 x 20	500	170	0.12	150	50471E3	60471E3	30471E3
	1000	12.5 x 25	900	350	0.12	75	50102E3	60102E3	30102E3
	2200	16 x 31	1340	770	0.14	45	50222E3	60222E3	30222E3
	3300	18 x 35	1600	1200	0.16	36	50332E3	60332E3	-
	4700	18 x 35	1950	1600	0.18	34	50472E3	60472E3	-
40	2200	16 x 35	1500	880	0.13	45	57222E3	67222E3	-
	3300	18 x 35	1600	1300	0.15	36	57332E3	67332E3	-
50	220	10 x 16	340	110	0.10	250	51221E3	61221E3	31221E3
	470	12.5 x 20	620	240	0.10	110	51471E3	61471E3	31471E3
	1000	16 x 25	1030	500	0.10	60	51102E3	61102E3	31102E3
	2200	18 x 35	1500	1100	0.12	50	51222E3	61222E3	-
3300	18 x 35	1900	1700	0.14	40	51332E3	61332E3	-	
63	100	10 x 12	240	66	0.09	310	58101E3	68101E3	38101E3
	220	10 x 20	400	140	0.09	200	58221E3	68221E3	38221E3
	330	12.5 x 20	550	210	0.09	120	58331E3	68331E3	38331E3
	470	12.5 x 25	700	300	0.09	80	58471E3	68471E3	38471E3
	1000	16 x 31	1150	630	0.09	49	58102E3	68102E3	38102E3
	2200	18 x 35	1600	1400	0.11	45	58222E3	68222E3	-

ORDERING EXAMPLE

Electrolytic capacitor 048 series

2200 $\mu\text{F}/16\text{ V}$; $\pm 20\%$

Nominal case size: $\varnothing 12.5 \times 25\text{ mm}$; Form TFA

Ordering code: MAL204835222E3

Former 12NC: 2222 048 35222



ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 U_R$
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 $\varnothing D = 10 \text{ mm}$	typ. 16 nH
	Case $\varnothing D \geq 12.5 \text{ mm}$	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from $\tan \delta_{max.}$ and C_R (see Table 2)	$ESR = \tan \delta / 2 \pi f C_R$

CAPACITANCE (C)

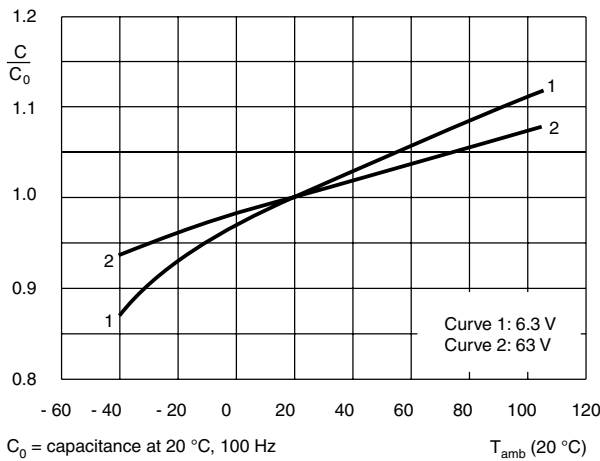


Fig.5 Typical multiplier of capacitance as a function of ambient temperature

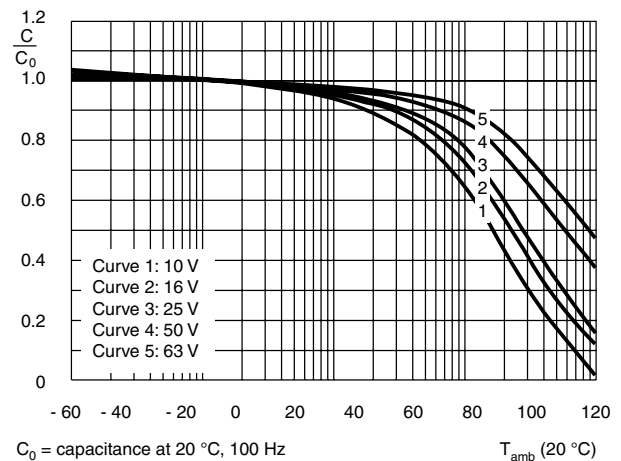


Fig.6 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

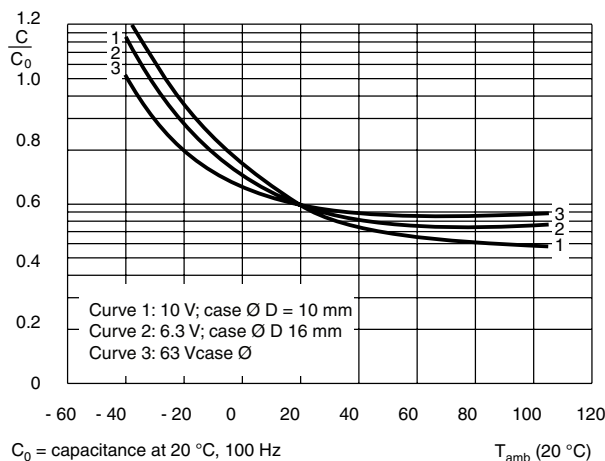


Fig.7 Typical multiplier of ESR as a function of ambient temperature

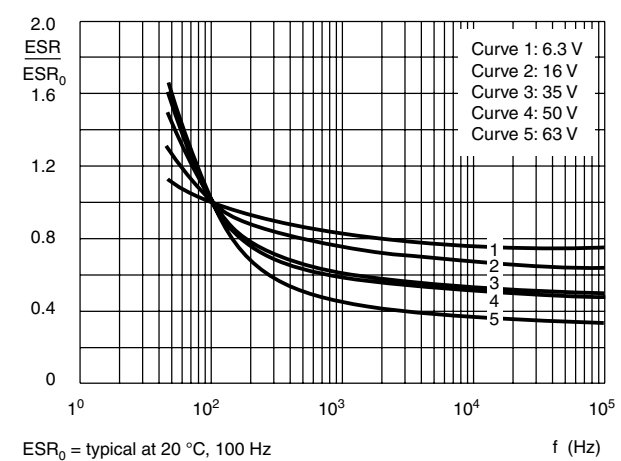


Fig.8 Typical multiplier of ESR as a function of frequency



IMPEDANCE (Z)

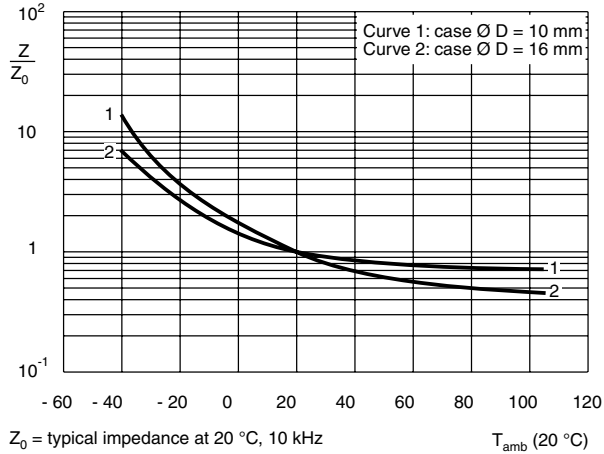


Fig.9 Typical multiplier of impedance as a function of ambient temperature

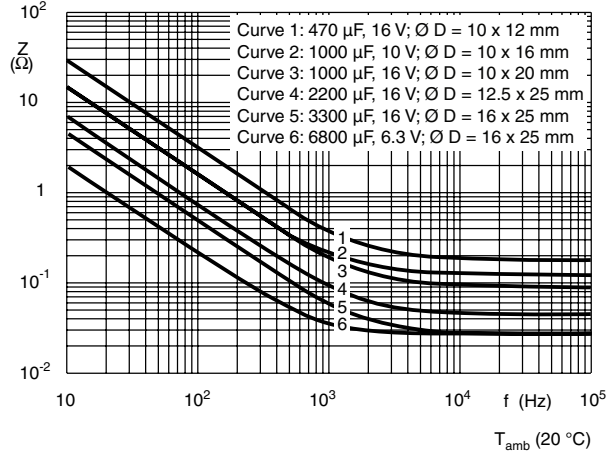


Fig.10 Typical impedance as a function of frequency

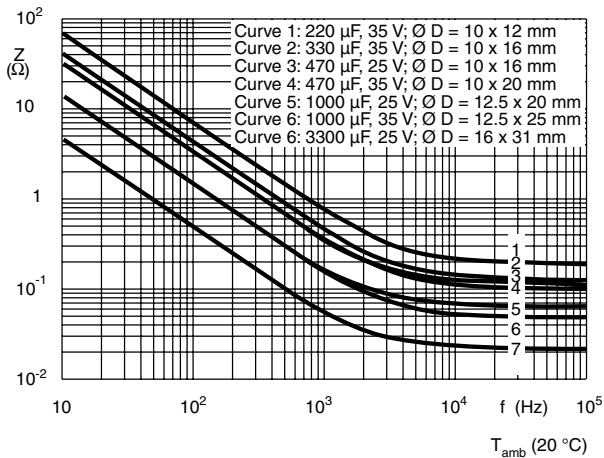


Fig.11 Typical impedance as a function of frequency

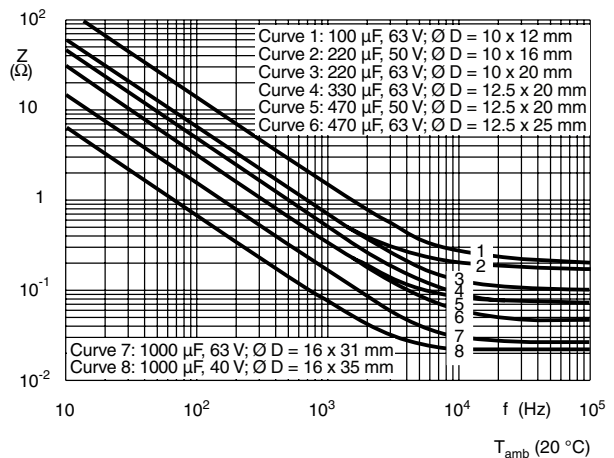
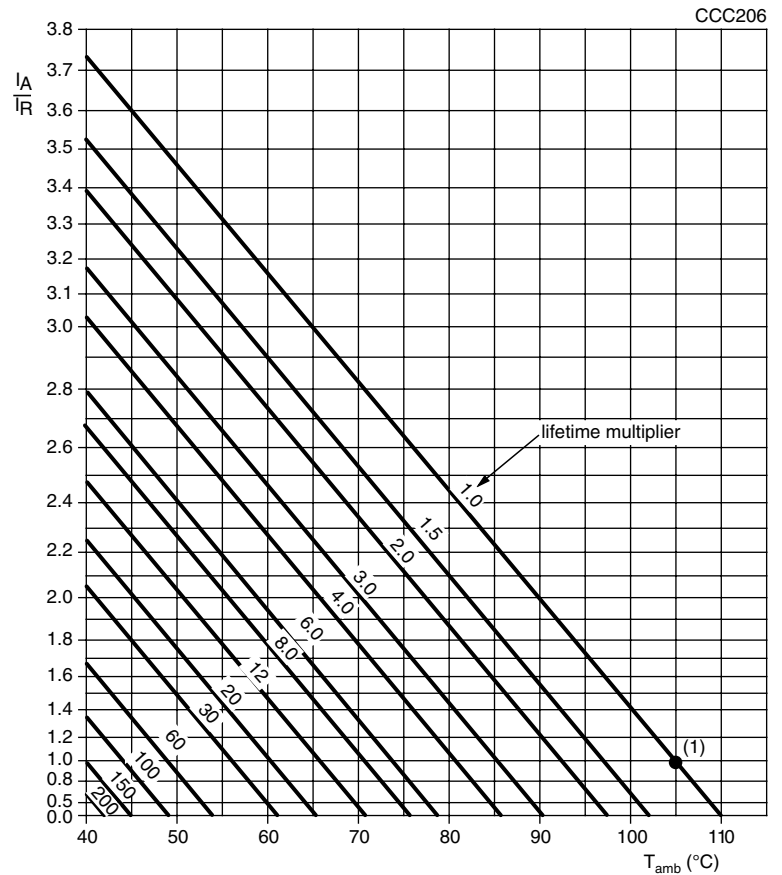


Fig.12 Typical impedance as a function of frequency



RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz
 I_R = rated ripple current at 100 Hz, 105 °C
 (1) Useful life at 105 °C and I_R applied (see table 4)

Fig.13 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
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
$\geq 10\ 000$	1.20	1.40	1.60

**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; 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	$T_{amb} = 105\text{ }^{\circ}\text{C}$; 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	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: + 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 60384-4/ EN130300 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	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: + 15/- 30 % $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$



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Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: ocean@oceanchips.ru

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А