

# Non-solid Al-electrolytic capacitors Radial Low Leakage Current

RLC 013

### FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Low leakage current, low energy consumption.

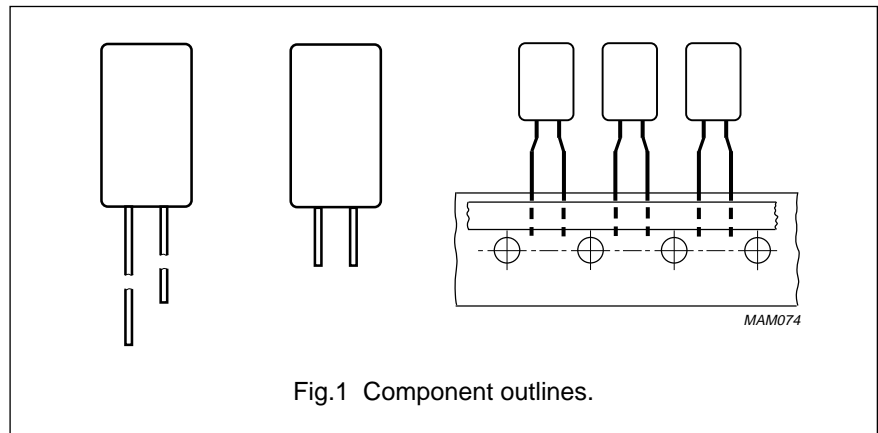
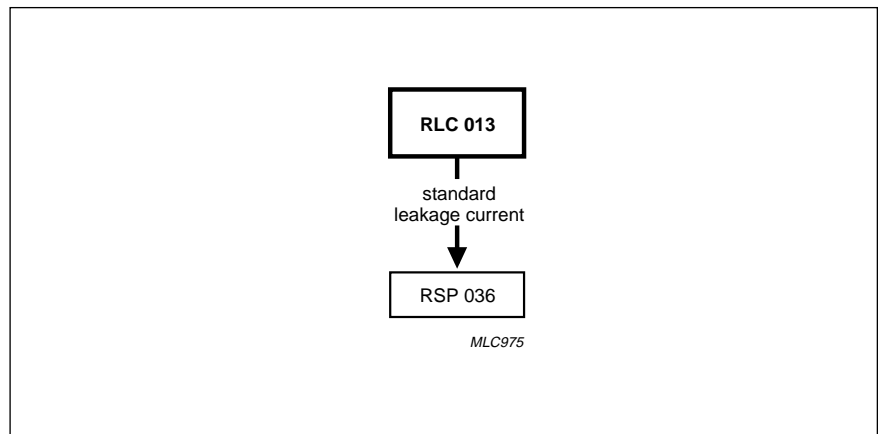


Fig.1 Component outlines.

### APPLICATIONS

- Telecommunication, automotive, audio-video, EDP and industrial
- Coupling, decoupling, buffering, timing, energy storage
- Portable and mobile equipment
- Low surface demand on printed-circuit board.



### QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ( $\varnothing D_{nom} \times L_{nom}$ in mm)	5 × 11 and 8.2 × 11
Rated capacitance range, $C_R$	0.47 to 470 $\mu F$
Tolerance on $C_R$	$\pm 20\%$ ; $\pm 10\%$ available on request
Rated voltage range, $U_R$	6.3 to 50 V
Category temperature range	-40 to +85 °C
Leakage current after 2 minutes: $U_R = 6.3$ to 25 V $U_R = 35$ and 50 V	$0.002C_R \times U_R$ or 0.7 $\mu A$ (whichever is greater) $0.002C_R \times U_R + 1 \mu A$
Endurance test at 85 °C	2000 hours
Useful life at 105 °C	750 hours
Useful life at 85 °C	3000 hours
Useful life at 40 °C, $1.4 \times I_R$ applied	80000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300, LL grade
Climatic category IEC 68 (DIN 40040)	40/085/56 (GPF)
Approvals	LNZ 44-04

# Non-solid Al-electrolytic capacitors

## Radial Low Leakage Current

RLC 013

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

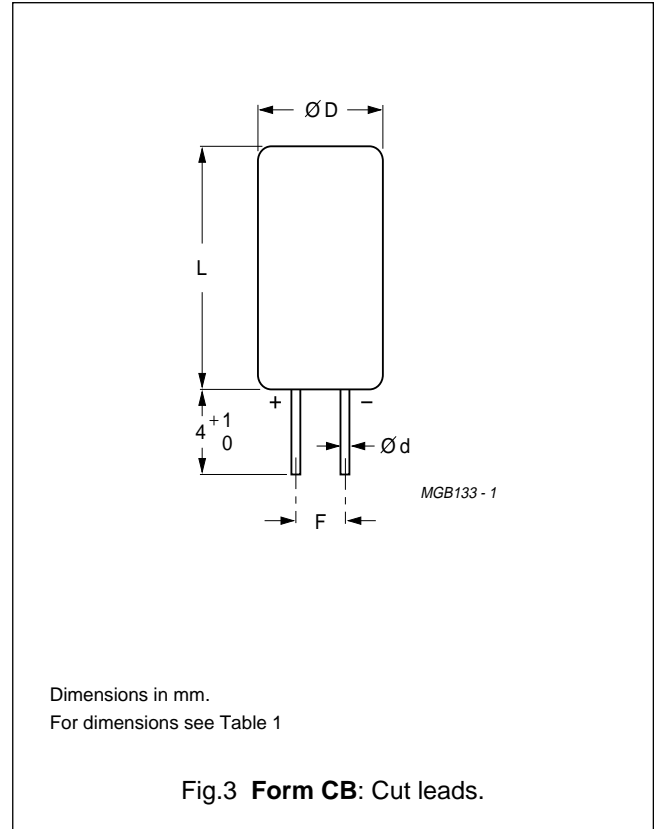
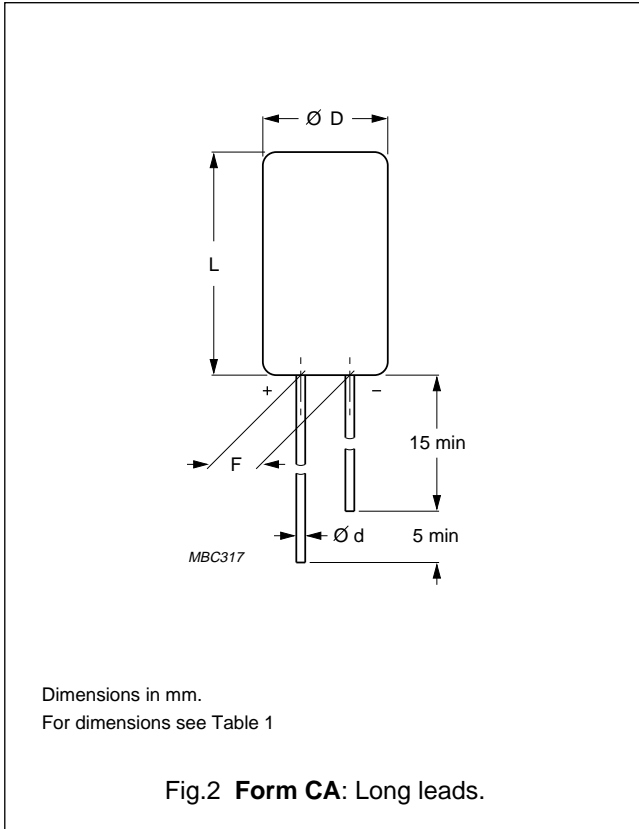
Preferred types in **bold**.

$C_R$ ( $\mu F$ )	$U_R$ (V)					
	6.3	10	16	25	35	50
0.47	–	–	–	–	–	5 × 11
1.0	–	–	–	5 × 11	–	<b>5 × 11</b>
2.2	–	–	–	5 × 11	–	<b>5 × 11</b>
3.3	–	–	–	5 × 11	–	5 × 11
4.7	–	–	–	<b>5 × 11</b>	–	<b>5 × 11</b>
10	–	–	–	5 × 11	–	<b>5 × 11</b>
22	–	–	–	<b>5 × 11</b>	–	5 × 11
33	–	–	5 × 11	–	5 × 11	8.2 × 11
47	–	5 × 11	5 × 11	8.2 × 11	–	8.2 × 11
68	–	5 × 11	–	–	–	8.2 × 11
100	–	5 × 11	<b>8.2 × 11</b>	–	8.2 × 11	–
220	–	<b>8.2 × 11</b>	–	–	–	–
330	8.2 × 11	–	–	–	–	–
470	8.2 × 11	–	–	–	–	–

Non-solid Al-electrolytic capacitors  
Radial Low Leakage Current

RLC 013

MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



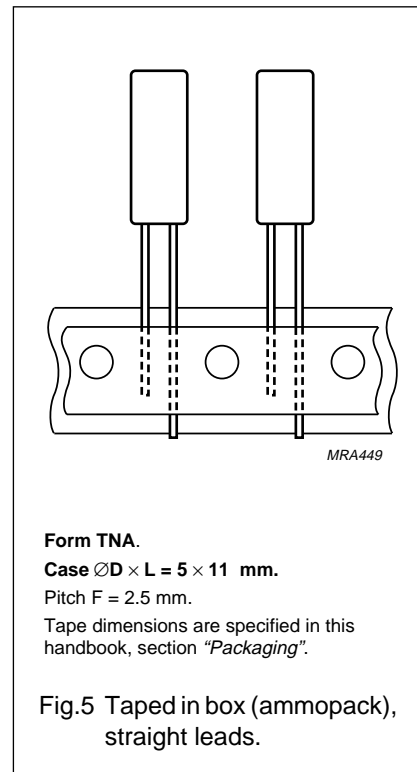
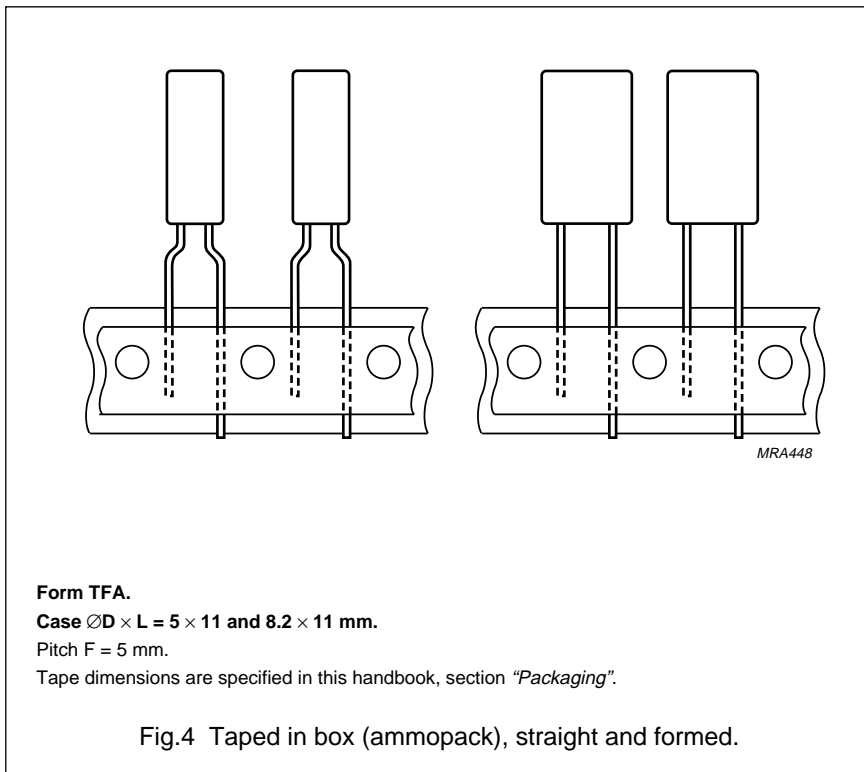
**Table 1** Physical dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD <sub>max</sub> (mm)	L <sub>max</sub> (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES	
							FORM CA, CB	FORM TFA, TNA
5 × 11	11	0.5	5.5	12	2.5 ±0.5	≈0.4	1000	2000
8.2 × 11	13	0.6	8.7	12	5.0 ±0.5	≈1.1	1000	1000

Non-solid Al-electrolytic capacitors  
Radial Low Leakage Current

RLC 013

Taped products



MARKING

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

- Rated capacitance (in  $\mu F$ )
- Tolerance on rated capacitance, code letter in accordance with "IEC 62"
- Rated voltage (in V)
- Group number (013)
- Name of manufacturer (PH)
- Date code in accordance with "IEC 62"
- Code indicating factory of origin
- Minus-sign on top to identify the negative terminal.

# Non-solid Al-electrolytic capacitors

## Radial Low Leakage Current

RLC 013

**ELECTRICAL DATA**

Unless otherwise specified, all electrical values in Tables 2 and 4 apply at  $T_{amb} = 20\text{ °C}$ ,  $P = 86$  to  $106\text{ kPa}$ ,  $RH = 45$  to  $75\%$ .

SYMBOL	DESCRIPTION
$C_R$	rated capacitance at 100 Hz, tolerance $\pm 20\%$
$I_R$	rated RMS ripple current at 100 Hz, $85\text{ °C}$
$I_{L2}$	max. leakage current after 2 minutes at $U_R$
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and $C_R$ )
Z	max. impedance at 10 kHz and $+20$ , $-25$ or $-40\text{ °C}$

**Table 2** Electrical data; preferred types in **bold**

$U_R$ (V)	$C_R$ 100 Hz ( $\mu\text{F}$ )	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$I_R$ 100 Hz $85\text{ °C}$ (mA)	$I_{L2}$ 2 min ( $\mu\text{A}$ )	$\tan \delta$ 100 Hz	ESR 100 Hz ( $\Omega$ )	Z 10 kHz $+20\text{ °C}$ ( $\Omega$ )	Z 10 kHz $-25\text{ °C}$ ( $\Omega$ )	Z 10 kHz $-40\text{ °C}$ ( $\Omega$ )
6.3	330	$8.2 \times 11$	13	210	4.2	0.2	1.0	0.9	5.2	15
	470	$8.2 \times 11$	13	250	5.9	0.2	0.7	0.64	3.5	10
10	47	$5 \times 11$	11	75	1.0	0.16	5.4	2.8	15	53
	68	$5 \times 11$	11	90	1.4	0.16	3.7	2.5	13	47
	100	$5 \times 11$	11	110	2.0	0.16	2.5	1.7	9.0	25
	<b>220</b>	<b><math>8.2 \times 11</math></b>	<b>13</b>	190	4.4	0.16	1.2	0.9	5.2	15
16	33	$5 \times 11$	11	70	1.1	0.13	6.3	2.8	14	52
	47	$5 \times 11$	11	85	1.5	0.13	4.4	2.1	9.5	36
	<b>100</b>	<b><math>8.2 \times 11</math></b>	<b>13</b>	150	3.2	0.13	2.1	1.0	5.5	17
25	1.0	$5 \times 11$	11	5	0.7	0.06	95	40	130	400
	2.2	$5 \times 11$	11	10	0.7	0.06	43	18	59	180
	3.3	$5 \times 11$	11	18	0.7	0.06	29	12	39	120
	<b>4.7</b>	<b><math>5 \times 11</math></b>	<b>11</b>	25	0.7	0.06	20	8.5	27	85
	10	$5 \times 11$	11	50	0.7	0.06	9.5	4.0	17	65
	<b>22</b>	<b><math>5 \times 11</math></b>	<b>11</b>	75	1.1	0.08	5.8	2.7	15	56
	47	$8.2 \times 11$	13	130	2.4	0.08	2.7	1.3	6.5	17
35	33	$5 \times 11$	11	70	3.3	0.13	6.3	2.8	14	52
	100	$8.2 \times 11$	13	150	8.0	0.13	2.1	1.0	5.5	17

# Non-solid Al-electrolytic capacitors

## Radial Low Leakage Current

RLC 013

**ORDERING INFORMATION****Ordering example**

Electrolytic capacitor RLC 013

100  $\mu$ F/16 V;  $\pm$ 20%Nominal case size:  $\varnothing$ 8.2  $\times$  11 mm; Form TFA

Catalogue number: 2222 013 35101.

**Table 3** Ordering information; preferred types in **bold**

U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz ( $\mu$ F)	CASE CODE	CATALOGUE NUMBER 2222 . . . . .							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS		FORM TFA		FORM TNA	
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	330	13	013 53331	5.0	013 63331	5.0	013 33331	5.0	–	–
	470	13	013 53471	5.0	013 63471	5.0	013 33471	5.0	–	–
10	47	11	013 54479	2.5	–	–	013 34479	5.0	013 74479	2.5
	68	11	013 54689	2.5	–	–	013 34689	5.0	013 74689	2.5
	100	11	013 54101	2.5	–	–	013 34101	5.0	013 74101	2.5
	<b>220</b>	<b>13</b>	<b>013 54221</b>	5.0	013 64221	5.0	<b>013 34221</b>	5.0	–	–
16	33	11	013 55339	2.5	–	–	013 35339	5.0	013 75339	2.5
	47	11	013 55479	2.5	–	–	013 35479	5.0	013 75479	2.5
	<b>100</b>	<b>13</b>	<b>013 55101</b>	5.0	013 65101	5.0	<b>013 35101</b>	5.0	–	–
25	1.0	11	013 56108	2.5	–	–	013 36108	5.0	013 76108	2.5
	2.2	11	013 56228	2.5	–	–	013 36228	5.0	013 76228	2.5
	3.3	11	013 56338	2.5	–	–	013 36338	5.0	013 76338	2.5
	<b>4.7</b>	<b>11</b>	<b>013 56478</b>	2.5	–	–	<b>013 36478</b>	5.0	013 76478	2.5
	10	11	013 56109	2.5	–	–	013 36109	5.0	013 76109	2.5
	<b>22</b>	<b>11</b>	<b>013 56229</b>	2.5	–	–	<b>013 36229</b>	5.0	013 76229	2.5
35	47	13	013 56479	5.0	013 66479	5.0	013 36479	5.0	–	–
	33	11	013 50339	5.0	–	–	013 30339	5.0	013 70339	2.5
	100	13	013 50101	5.0	013 60101	5.0	013 30101	5.0	–	–

# Non-solid Al-electrolytic capacitors

## Radial Low Leakage Current

RLC 013

**ELECTRICAL DATA (continued)****Table 4** Electrical data continued; preferred types in **bold**

$U_R$ (V)	$C_R$ 100 Hz ( $\mu$ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	$I_R$ 100 Hz 85°C (mA)	$I_{L2}$ 2 min ( $\mu$ A)	Tan $\delta$ 100 Hz	ESR 100 Hz ( $\Omega$ )	Z 10 kHz +20 °C ( $\Omega$ )	Z 10 kHz -25 °C ( $\Omega$ )	Z 10 kHz -40 °C ( $\Omega$ )
50	0.47	5 × 11	11	5	1.1	0.06	200	85	230	850
	<b>1.0</b>	<b>5 × 11</b>	<b>11</b>	10	1.1	0.06	95	40	130	400
	<b>2.2</b>	<b>5 × 11</b>	<b>11</b>	20	1.2	0.06	43	18	59	180
	3.3	5 × 11	11	32	1.3	0.06	29	12	39	120
	<b>4.7</b>	<b>5 × 11</b>	<b>11</b>	38	1.5	0.06	20	8.5	27	85
	<b>10</b>	<b>5 × 11</b>	<b>11</b>	55	2.0	0.06	9.5	4.0	17	65
	22	5 × 11	11	75	3.2	0.08	5.8	2.7	15	56
	33	8.2 × 11	13	110	4.3	0.06	2.9	1.4	7.0	18
	47	8.2 × 11	13	130	5.7	0.08	2.7	1.3	6.5	17
	68	8.2 × 11	13	150	7.8	0.08	1.9	1.2	6.0	17

**Additional electrical data**

PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage for short periods		$U_s \leq 1.3 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
<b>Current</b>		
Leakage current	after 2 minutes at $U_R$ : $U_R = 6.3 \text{ to } 25 \text{ V}$ $U_R = 35 \text{ and } 50 \text{ V}$	$I_{L2} \leq 0.002C_R \times U_R$ or $0.7 \mu\text{A}$ (whichever is greater) $I_{L2} \leq 0.002C_R \times U_R + 1 \mu\text{A}$
<b>Inductance</b>		
Equivalent series inductance (ESL)	case $\varnothing D \times L = 5 \times 11 \text{ mm}$	typ. 13 nH
	case $\varnothing D \times L = 8.2 \times 11 \text{ mm}$	typ. 16 nH

# Non-solid Al-electrolytic capacitors

## Radial Low Leakage Current

RLC 013

**ORDERING INFORMATION (continued)****Table 5** Ordering information continued; preferred types in **bold**

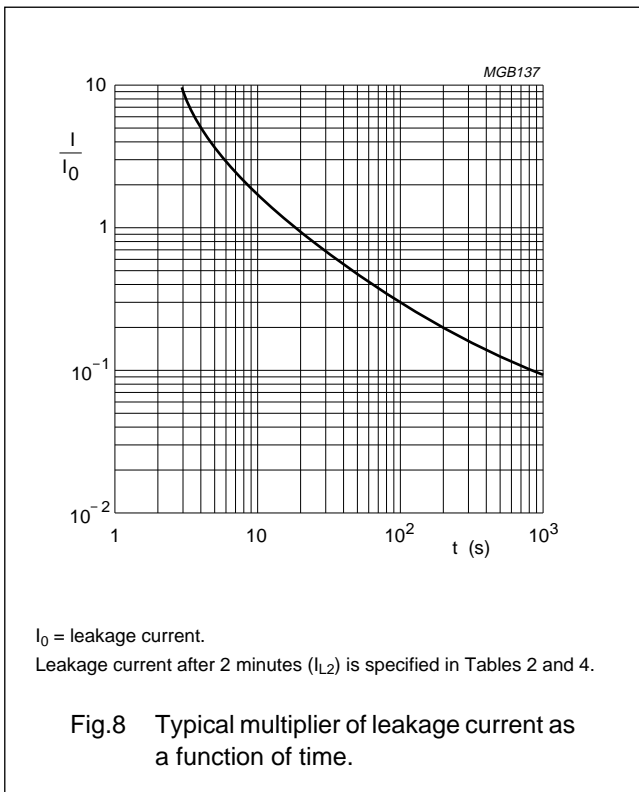
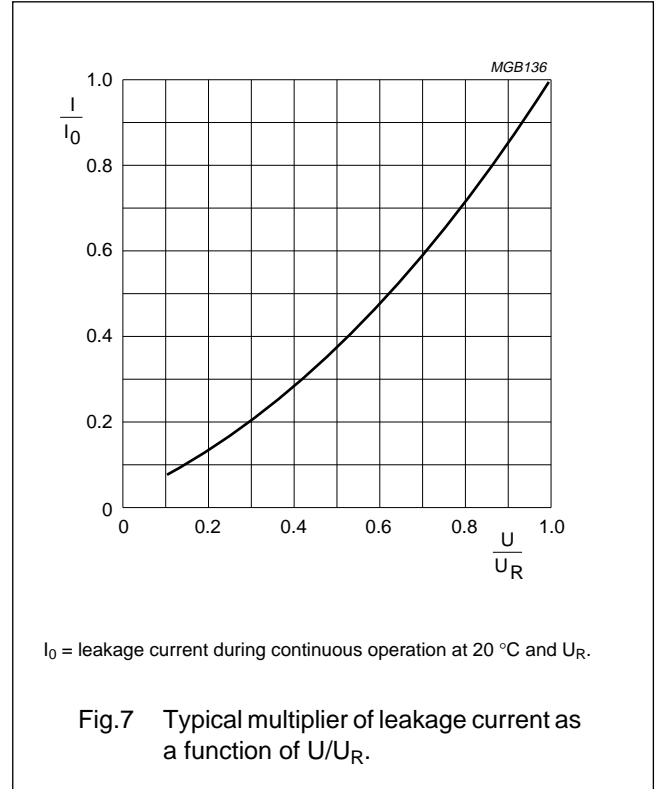
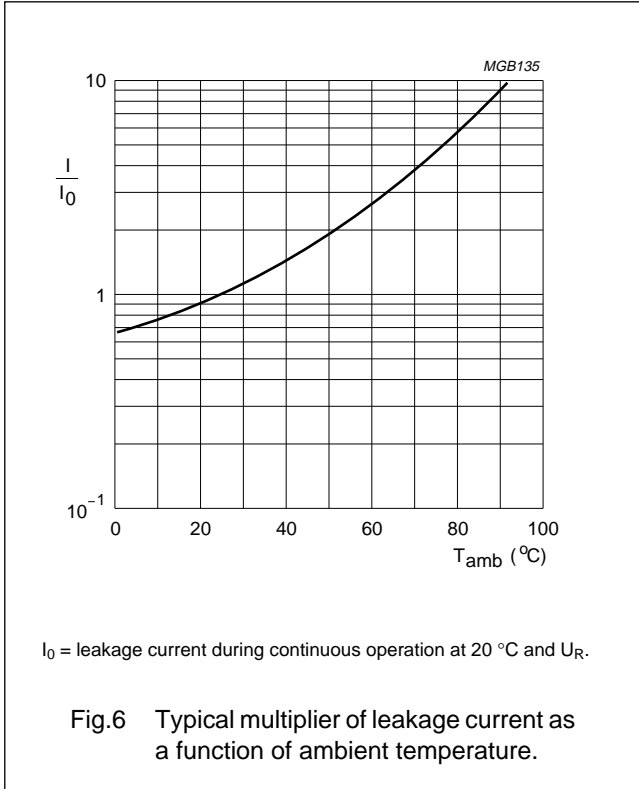
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222 . . . . .							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
50	0.47	11	013 51477	2.5	–	–	013 31477	5.0	013 71477	2.5
	<b>1.0</b>	<b>11</b>	<b>013 51108</b>	2.5	–	–	<b>013 31108</b>	5.0	013 71108	2.5
	<b>2.2</b>	<b>11</b>	<b>013 51228</b>	2.5	–	–	<b>013 31228</b>	5.0	013 71228	2.5
	3.3	11	013 51338	2.5	–	–	013 31338	5.0	013 71338	2.5
	<b>4.7</b>	<b>11</b>	<b>013 51478</b>	2.5	–	–	<b>013 31478</b>	5.0	013 71478	2.5
	<b>10</b>	<b>11</b>	<b>013 51109</b>	2.5	–	–	<b>013 31109</b>	5.0	013 71109	2.5
	22	11	013 51229	2.5	–	–	013 31229	5.0	013 71229	2.5
	33	13	013 51339	5.0	013 61339	5.0	013 31339	5.0	–	–
	47	13	013 51479	5.0	013 61479	5.0	013 31479	5.0	–	–
	68	13	013 51689	5.0	013 61689	5.0	013 31689	5.0	–	–



Non-solid Al-electrolytic capacitors  
Radial Low Leakage Current

RLC 013

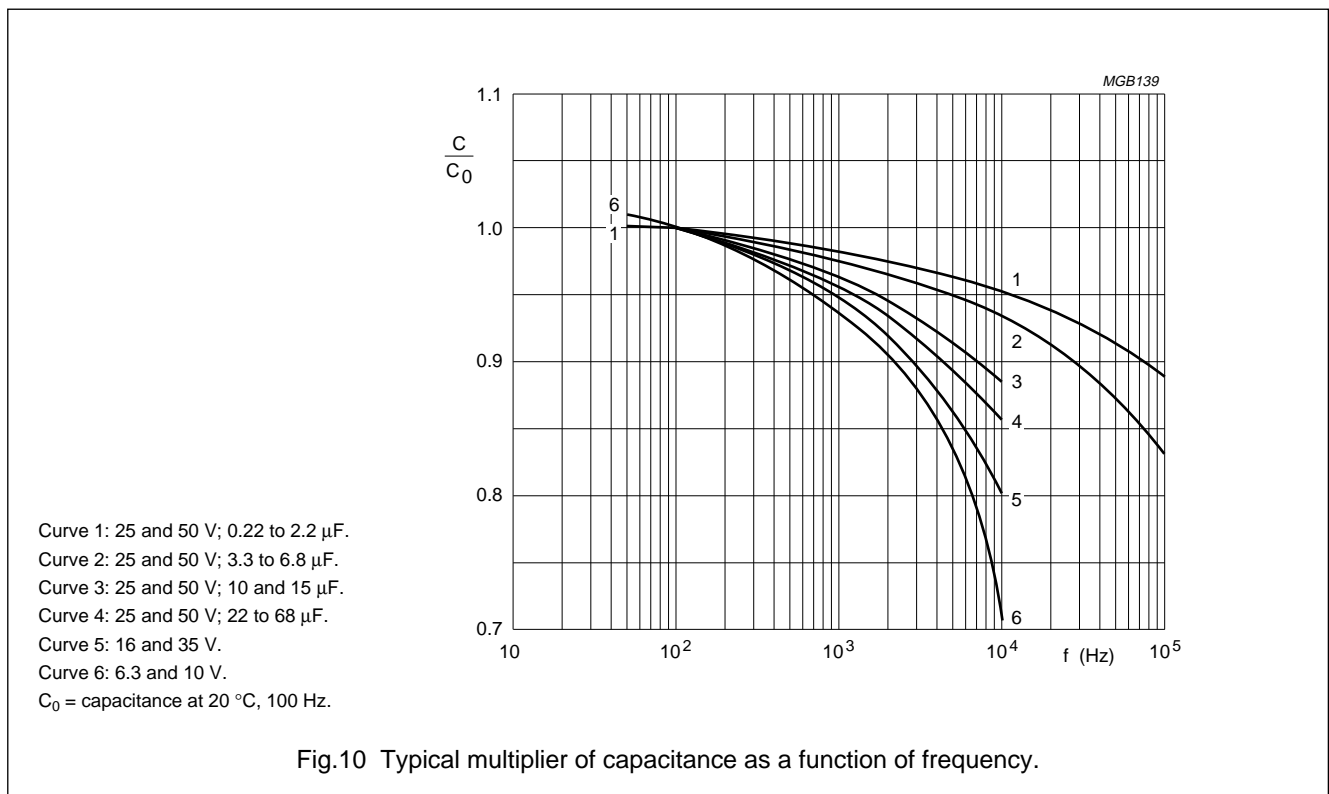
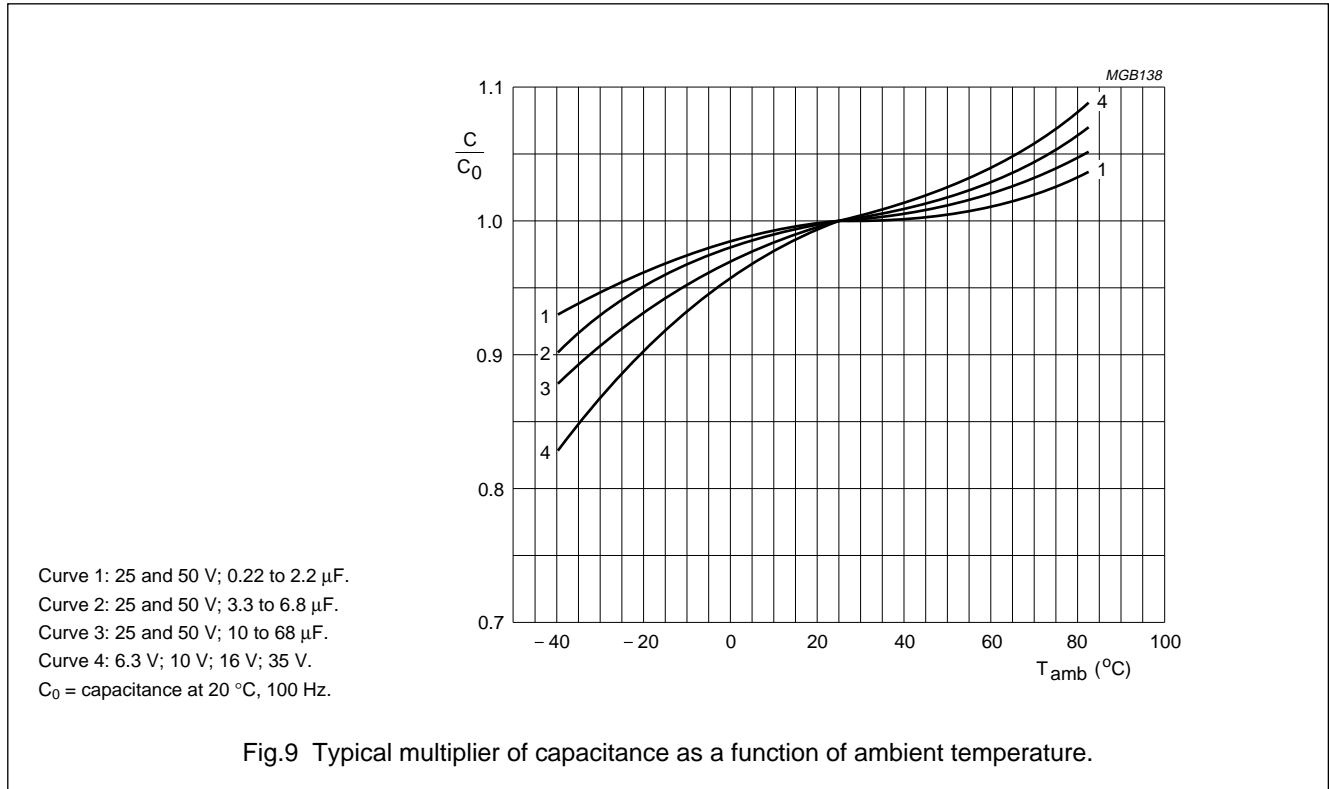
ELECTRICAL DATA (continued)



Non-solid Al-electrolytic capacitors  
Radial Low Leakage Current

RLC 013

Capacitance (C)



Non-solid Al-electrolytic capacitors  
Radial Low Leakage Current

RLC 013

Equivalent series resistance (ESR)

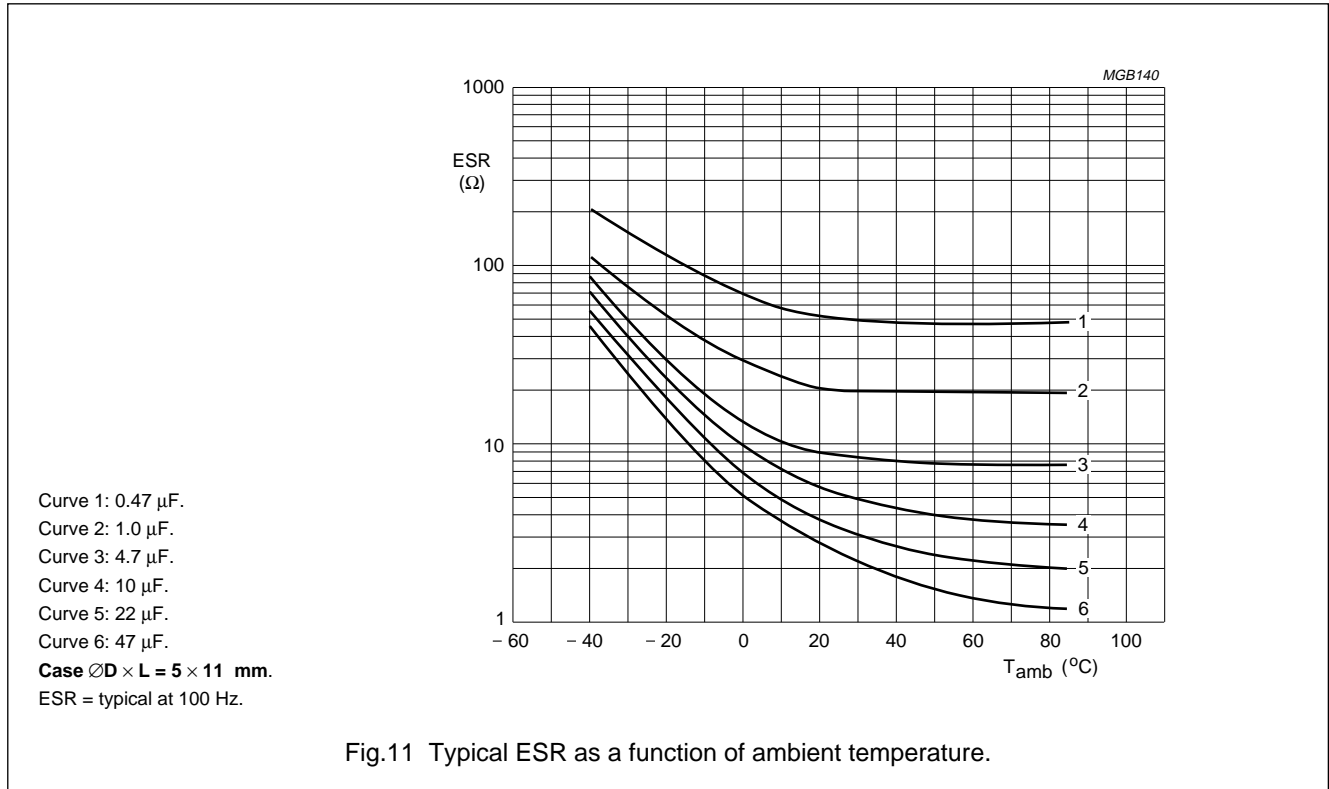


Fig.11 Typical ESR as a function of ambient temperature.

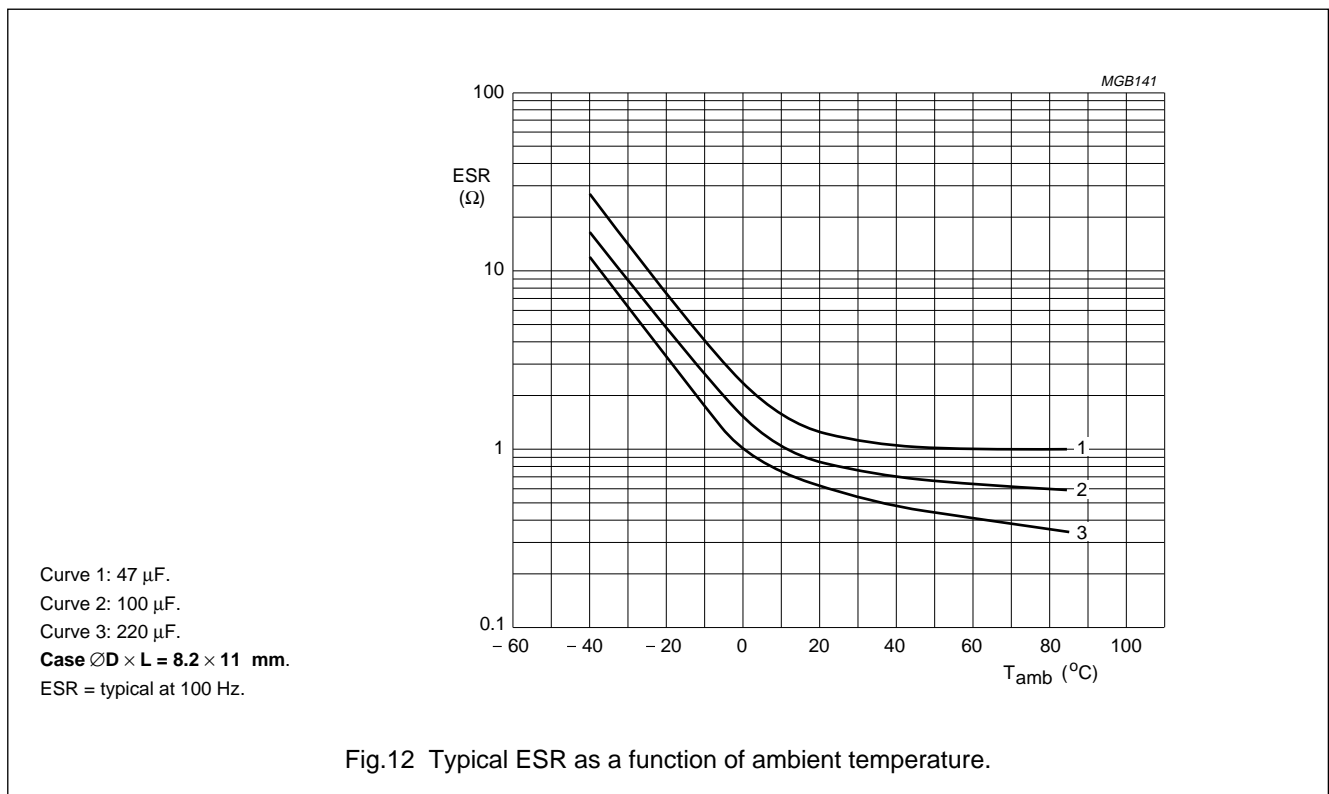
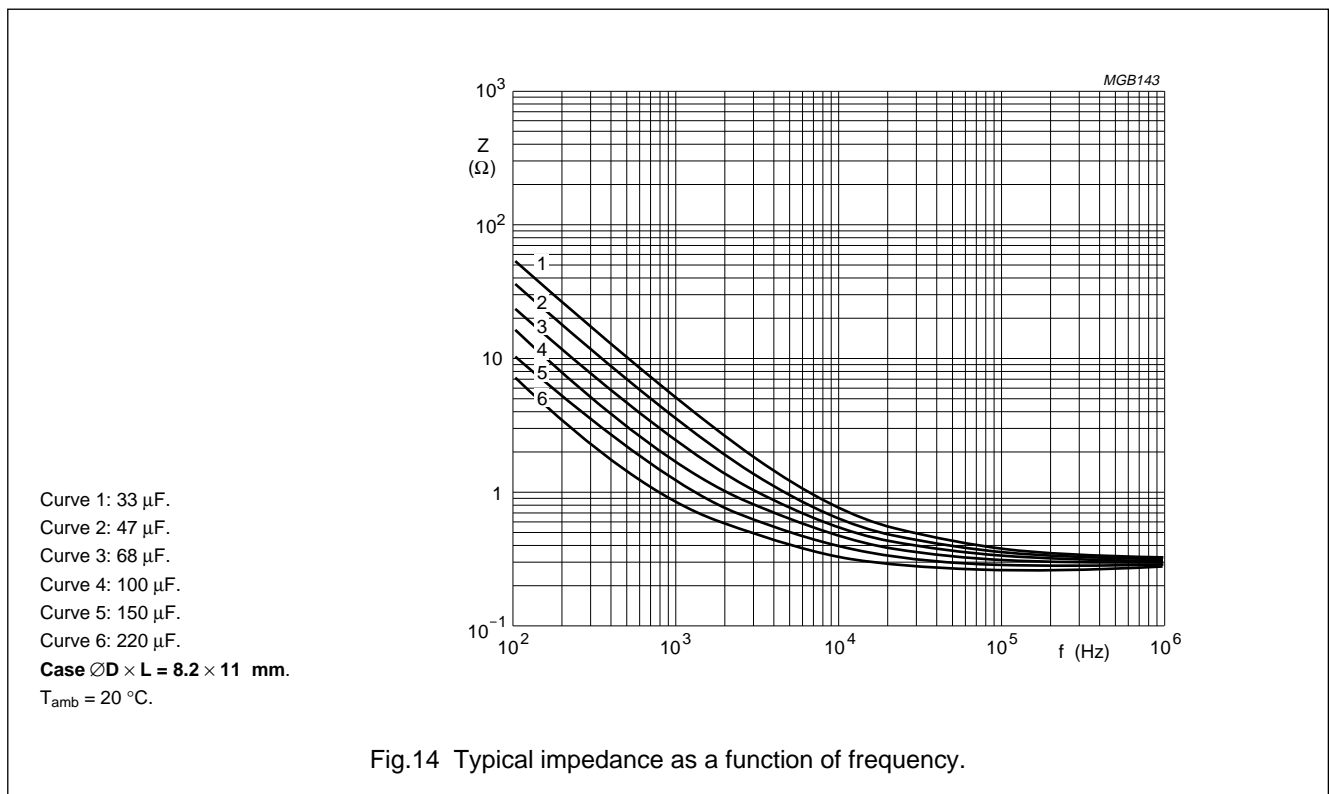
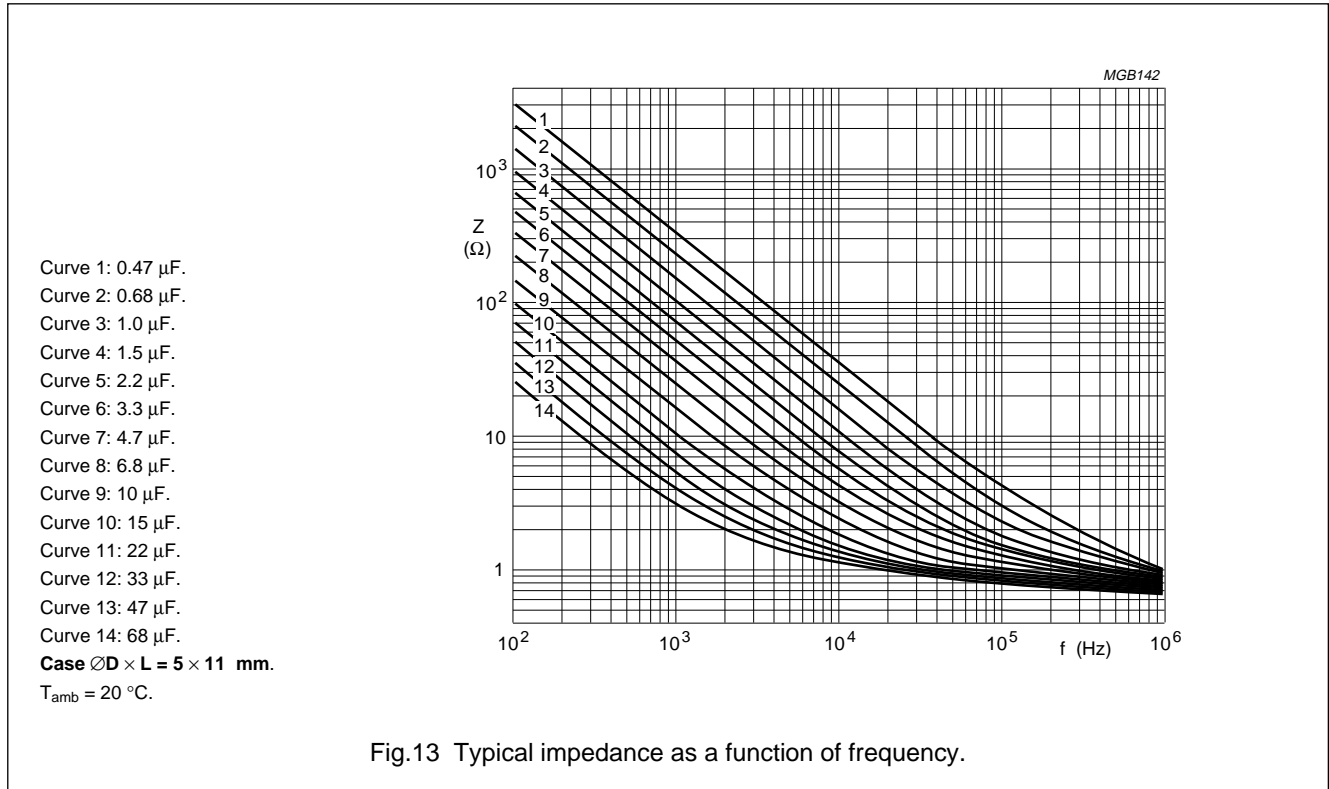


Fig.12 Typical ESR as a function of ambient temperature.

Non-solid Al-electrolytic capacitors  
Radial Low Leakage Current

RLC 013

Impedance (Z)



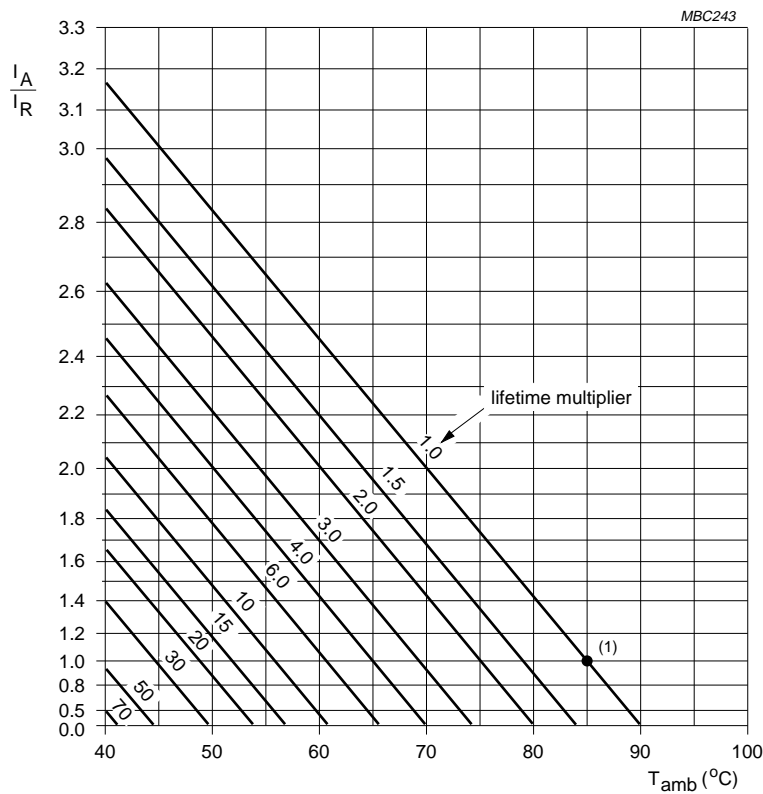
Non-solid Al-electrolytic capacitors  
Radial Low Leakage Current

RLC 013

RIPPLE CURRENT AND USEFUL LIFE

Table 6 Multiplier of ripple current ( $I_R/I_{R0}$ ) as a function of frequency;  $I_{R0}$  = ripple current at 85 °C, 100 Hz

FREQUENCY (Hz)	$I_R$ MULTIPLIER		
	$U_R = 6.3 V$	$U_R = 10, 16 \text{ and } 35 V$	$U_R = 25 \text{ and } 50 V$
50	0.9	0.85	0.8
100	1.0	1.0	1.0
300	1.12	1.2	1.25
1000	1.2	1.3	1.4
3000	1.25	1.35	1.5
$\geq 10000$	1.3	1.4	1.6



$I_A$  = actual ripple current at 100 Hz.  
 $I_R$  = ripple current at 85 °C, 100 Hz.  
 (1) Useful life at 85 °C and  $I_R$  applied: 3000 hours.

Fig.15 Multiplier of useful life as a function of ambient temperature and ripple current load.

# Non-solid Al-electrolytic capacitors

## Radial Low Leakage Current

RLC 013

### SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, section "Tests and Requirements".

**Table 7** Test procedures and requirements

TEST		PROCEDURE	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300, subclause 4.13	$T_{amb} = 85\text{ °C}$ ; $U_R$ applied; 2000 hours	$U_R \leq 6.3\text{ V}$ ; $\Delta C/C: +15/-30\%$ $U_R > 6.3\text{ V}$ ; $\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{amb} = 85\text{ °C}$ ; $U_R$ and $I_R$ applied; 3000 hours	$U_R \leq 6.3\text{ V}$ ; $\Delta C/C: +45/-50\%$ $U_R > 6.3\text{ V}$ ; $\Delta C/C: \pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 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	$\Delta C/C$ , $\tan \delta$ , $Z$ : for requirements see 'Endurance test' above $I_{L2} \leq 2 \times \text{spec. limit}$