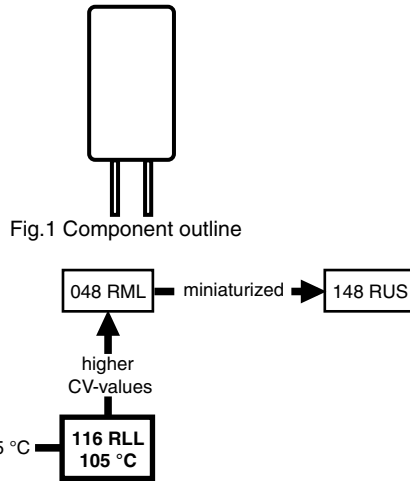


## Aluminum Capacitors Radial Long Life



### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Long useful life: 2000 h at 105 °C, high reliability
- Lead (Pb)-free versions are RoHS compliant


**RoHS  
COMPLIANT**

### APPLICATIONS

- Automotive, telecommunication, industrial and EDP
- Stand-by applications in audio and video equipment
- Coupling, decoupling, timing; smoothing, filtering and buffering in dc-to-dc converters
- Portable and mobile equipment (small size, low mass)

### MARKING

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

- Rated capacitance (in  $\mu\text{F}$ )
- 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
- Minus-sign on top to identify the negative terminal
- Series number (116)

| QUICK REFERENCE DATA                            |                           |
|---|---------------------------|
| DESCRIPTION                                     | VALUE                     |
| Nominal Case sizes ( $\varnothing$ D x L in mm) | 5 x 11 and 8.2 x 11       |
| Rated capacitance range, $C_R$                  | 0.47 to 470 $\mu\text{F}$ |
| Tolerance on $C_R$                              | $\pm 20\%$                |
| Rated voltage range, $U_R$                      | 6.3 to 100 V              |
| Category temperature range                      | - 55 to + 105 °C          |
| Endurance test at 105 °C                        | 1500 hours                |
| Endurance test at 85 °C                         | 5000 hours                |
| Useful life at 105 °C                           | 2000 hours                |
| Useful life at 40 °C, $1.3 \times I_R$ applied  | 200 000 hours             |
| Shelf life at 0 V, 105 °C                       | 1500 hours                |
| Based on sectional specification                | IEC 60384-4/EN130300      |
| Climatic category IEC 60068                     | 55/105/56                 |

| SELECTION CHART FOR $C_R$ , $U_R$ AND RELEVANT NOMINAL CASE SIZES ( $\varnothing$ D x L in mm) |           |          |          |          |          |          |          |          |          |
|--|-----------|----------|----------|----------|----------|----------|----------|----------|----------|
| $C_R$<br>( $\mu\text{F}$ )   | $U_R$ (V) |          |          |          |          |          |          |          |          |
|  | 6.3       | 10       | 16       | 25       | 35       | 40       | 50       | 63       | 100      |
| 0.47   | -         | -        | -        | -        | -        | -        | 5 x 11   | -        | -        |
| 1.0  | -         | -        | -        | -        | -        | -        | 5 x 11   | -        | -        |
| 1.5  | -         | -        | -        | -        | -        | -        | 5 x 11   | -        | -        |
| 2.2  | -         | -        | -        | -        | -        | -        | 5 x 11   | -        | -        |
| 3.3  | -         | -        | -        | -        | -        | -        | 5 x 11   | -        | -        |
| 4.7  | -         | -        | -        | -        | -        | -        | 5 x 11   | -        | 8.2 x 11 |
| 6.8  | -         | -        | -        | -        | -        | -        | 5 x 11   | -        | -        |
| 10   | -         | -        | -        | -        | -        | -        | 5 x 11   | 8.2 x 11 | 8.2 x 11 |
| 15   | -         | -        | -        | -        | -        | -        | 8.2 x 11 | -        | -        |
| 22   | -         | -        | -        | -        | -        | -        | 5 x 11   | -        | -        |
| 33   | -         | -        | -        | -        | -        | -        | 5 x 11   | 8.2 x 11 | -        |
| 47   | -         | -        | -        | 5 x 11   | -        | -        | 8.2 x 11 | -        | -        |
| 68   | -         | -        | 5 x 11   | -        | -        | -        | 8.2 x 11 | -        | -        |
| 100  | -         | 5 x 11   | -        | -        | 8.2 x 11 | 8.2 x 11 | -        | -        | -        |
| 150  | 5 x 11    | -        | -        | 8.2 x 11 | -        | -        | -        | -        | -        |
| 220  | -         | -        | 8.2 x 11 | -        | -        | -        | -        | -        | -        |
| 330  | -         | 8.2 x 11 | -        | -        | -        | -        | -        | -        | -        |
| 470  | 8.2 x 11  | -        | -        | -        | -        | -        | -        | -        | -        |

## DIMENSIONS in millimeters AND AVAILABLE FORMS

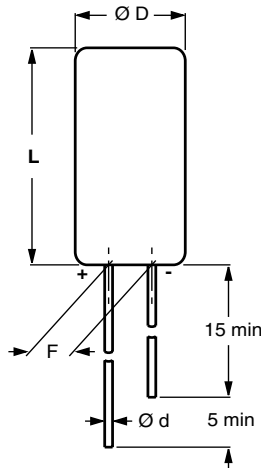
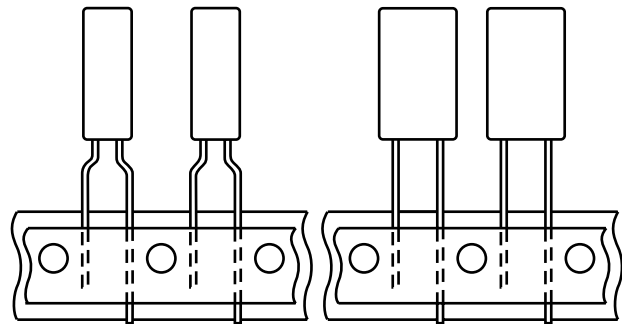
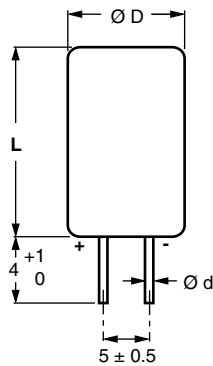


Fig.2 **Form CA:** Long leads



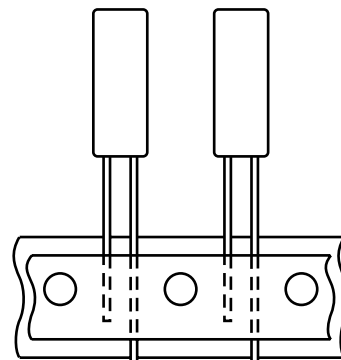
Case  $\text{Ø D} \times L = 5 \times 11$  and  $8.2 \times 11$  mm  
Pitch  $F = 5$  mm

Fig.3 **Form TFA:** Taped in box (ammopack)



Case  $\text{Ø D} \times L = 8.2 \times 11$  mm only

Fig.4 **Form CB:** Cut leads



Case  $\text{Ø D} \times L = 5 \times 11$  mm only  
Pitch  $F = 2.5$  mm

Fig.5 **Form TNA:** Taped in box (ammopack)

Table 1

| DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES |           |              |                            |                   |               |               |                      |               |
|--|-----------|--------------|----------------------------|-------------------|---------------|---------------|----------------------|---------------|
| NOMINAL CASE SIZE<br>$\text{Ø D} \times L$               | CASE CODE | $\text{Ø D}$ | $\text{Ø D}_{\text{max.}}$ | $L_{\text{max.}}$ | F             | MASS (g)      | PACKAGING QUANTITIES |               |
|  |           |              |                            |                   |               |               | FORM CA, CB          | FORM TFA, TNA |
| 5 x 11   | 11        | 0.5          | 5.5                        | 12                | $2.5 \pm 0.5$ | $\approx 0.4$ | 1000                 | 2000          |
| 8.2 x 11   | 13        | 0.6          | 8.7                        | 12                | $5.0 \pm 0.5$ | $\approx 1.1$ | 1000                 | 1000          |

**Note**

Tape dimension 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 kHz, 105 °C       |
| $I_{L1}$        | max. leakage current after 1 minutes at $U_R$     |
| $\tan \delta$   | max. dissipation factor at 100 Hz                 |
| $Z$             | max. impedance at 100 kHz and 20 °C               |

**ORDERING EXAMPLE**

Electrolytic capacitor 116 series

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

Nominal case size:  $\varnothing 8.2 \times 11\text{ mm}$ ; Form TFA

Ordering code: MAL211635221E3

Former 12NC: 2222 116 35221

**Note**

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

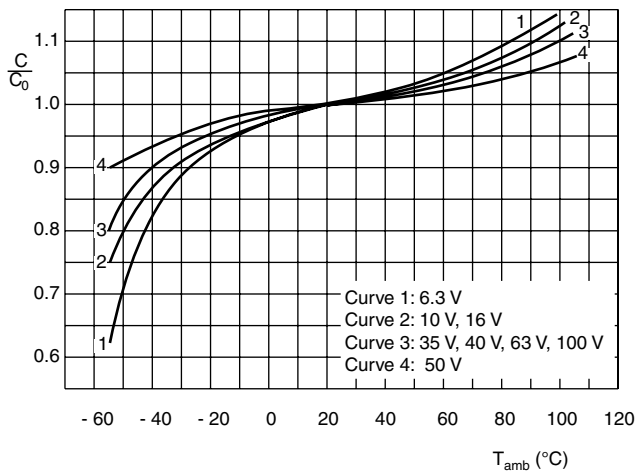
Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION |                                      |   |                                    |  |                         |                                |                             |           |            |           |                |           |             |           |
|--|--------------------------------------|---|------------------------------------|--|-------------------------|--------------------------------|-----------------------------|-----------|------------|-----------|----------------|-----------|-------------|-----------|
| $U_R$<br>(V)                             | $C_R$<br>100 Hz<br>( $\mu\text{F}$ ) | NOMINAL<br>CASE<br>SIZE<br>$\varnothing D \times L$<br>(mm) | $I_R$<br>100 kHz<br>105 °C<br>(mA) | $I_{L1}$<br>1 min<br>( $\mu\text{A}$ ) | $\tan \delta$<br>100 Hz | $Z$<br>100 kHz<br>( $\Omega$ ) | ORDERING CODE MAL2116 ..... |           |            |           |                |           |             |           |
|  |                                      |   |                                    |  |                         |                                | BULK PACKAGING              |           |            |           | TAPED AMMOPACK |           |             |           |
|  |                                      |   |                                    |  |                         |                                | LONG LEADS                  |           | CUT LEADS  |           | FORM TFA       |           | FORM TNA    |           |
|  |                                      |   |                                    |  |                         |                                | FORM<br>CA                  | F<br>(mm) | FORM<br>CB | F<br>(mm) | FORM<br>TFA    | F<br>(mm) | FORM<br>TNA | F<br>(mm) |
| 6.3                                      | 150                                  | 5 x 11  | 130                                | 8.7                                    | 0.25                    | 1.3                            | 53151E3                     | 2.5       | -          | -         | 33151E3        | 5.0       | 73151E3     | 2.5       |
|  | 470                                  | 8.2 x 11  | 300                                | 21                                     | 0.25                    | 0.45                           | 53471E3                     | 5.0       | 63471E3    | 5.0       | 33471E3        | 5.0       | -           | -         |
| 10                                       | 100                                  | 5 x 11  | 130                                | 9                                      | 0.2                     | 1.4                            | 54101E3                     | 2.5       | -          | -         | 34101E3        | 5.0       | 74101E3     | 2.5       |
|  | 330                                  | 8.2 x 11  | 280                                | 23                                     | 0.2                     | 0.45                           | 54331E3                     | 5.0       | 64331E3    | 5.0       | 34331E3        | 5.0       | -           | -         |
| 16                                       | 68                                   | 5 x 11  | 130                                | 9.5                                    | 0.16                    | 1.5                            | 55689E3                     | 2.5       | -          | -         | 35689E3        | 5.0       | 75689E3     | 2.5       |
|  | 220                                  | 8.2 x 11  | 280                                | 24                                     | 0.16                    | 0.5                            | 55221E3                     | 5.0       | 65221E3    | 5.0       | 35221E3        | 5.0       | -           | -         |
| 25                                       | 47                                   | 5 x 11  | 120                                | 10                                     | 0.14                    | 1.6                            | 56479E3                     | 2.5       | -          | -         | 36479E3        | 5.0       | 76479E3     | 2.5       |
|  | 150                                  | 8.2 x 11  | 260                                | 26                                     | 0.14                    | 0.5                            | 56151E3                     | 5.0       | 66151E3    | 5.0       | 36151E3        | 5.0       | -           | -         |
| 35                                       | 33                                   | 5 x 11  | 110                                | 9.9                                    | 0.12                    | 1.7                            | 50339E3                     | 2.5       | -          | -         | 30339E3        | 5.0       | 70339E3     | 2.5       |
|  | 100                                  | 8.2 x 11  | 240                                | 24                                     | 0.12                    | 0.55                           | 50101E3                     | 5.0       | 60101E3    | 5.0       | 30101E3        | 5.0       | -           | -         |
| 40                                       | 33                                   | 5 x 11  | 110                                | 10.9                                   | 0.12                    | 1.7                            | 57339E3                     | 2.5       | -          | -         | 37339E3        | 5.0       | 77339E3     | 2.5       |
|  | 100                                  | 8.2 x 11  | 240                                | 27                                     | 0.12                    | 0.55                           | 57101E3                     | 5.0       | 67101E3    | 5.0       | 37101E3        | 5.0       | -           | -         |
| 50                                       | 0.47                                 | 5 x 11  | 30                                 | 3.1                                    | 0.09                    | 10                             | 51477E3                     | 2.5       | -          | 5.0       | 31477E3        | 5.0       | 71477E3     | 2.5       |
|  | 1.0                                  | 5 x 11  | 40                                 | 3.3                                    | 0.09                    | 6                              | 51108E3                     | 2.5       | -          | 5.0       | 31108E3        | 5.0       | 71108E3     | 2.5       |
|  | 1.5                                  | 5 x 11  | 50                                 | 3.5                                    | 0.09                    | 4                              | 51158E3                     | 2.5       | -          | 5.0       | 31158E3        | 5.0       | 71158E3     | 2.5       |
|  | 2.2                                  | 5 x 11  | 60                                 | 3.7                                    | 0.09                    | 3.5                            | 51228E3                     | 2.5       | -          | 5.0       | 31228E3        | 5.0       | 71228E3     | 2.5       |
|  | 3.3                                  | 5 x 11  | 65                                 | 4                                      | 0.09                    | 3.1                            | 51338E3                     | 2.5       | -          | 5.0       | 31338E3        | 5.0       | 71338E3     | 2.5       |
|  | 4.7                                  | 5 x 11  | 70                                 | 4.4                                    | 0.09                    | 2.8                            | 51478E3                     | 2.5       | -          | 5.0       | 31478E3        | 5.0       | 71478E3     | 2.5       |
|  | 6.8                                  | 5 x 11  | 75                                 | 5                                      | 0.09                    | 2.5                            | 51688E3                     | 2.5       | -          | 5.0       | 31688E3        | 5.0       | 71688E3     | 2.5       |
|  | 10                                   | 5 x 11  | 80                                 | 6                                      | 0.09                    | 2.2                            | 51109E3                     | 2.5       | -          | 5.0       | 31109E3        | 5.0       | 71109E3     | 2.5       |
|  | 10                                   | 8.2 x 11  | 160                                | 6                                      | 0.05                    | 1.0                            | 90084E3                     | 5.0       | 90085E3    | 5.0       | 90036E3        | 5.0       | -           | -         |
|  | 15                                   | 5 x 11  | 90                                 | 7.5                                    | 0.09                    | 2.0                            | 51159E3                     | 2.5       | -          | 5.0       | 31159E3        | 5.0       | 71159E3     | 2.5       |
|  | 22                                   | 5 x 11  | 110                                | 9.6                                    | 0.09                    | 1.9                            | 51229E3                     | 2.5       | -          | 5.0       | 31229E3        | 5.0       | 71229E3     | 2.5       |
|  | 22                                   | 8.2 x 11  | 190                                | 9.6                                    | 0.06                    | 0.9                            | 90025E3                     | 5.0       | 90086E3    | 5.0       | 90039E3        | 5.0       | -           | -         |
|  | 33                                   | 8.2 x 11  | 190                                | 13                                     | 0.09                    | 0.77                           | 51339E3                     | 5.0       | 61339E3    | 5.0       | 31339E3        | 5.0       | -           | -         |
| 47                                       | 8.2 x 11                             | 210   | 17                                 | 0.09                                   | 0.65                    | 51479E3                        | 5.0                         | 61479E3   | 5.0        | 31479E3   | 5.0            | -         | -           |           |
| 68                                       | 8.2 x 11                             | 240   | 23                                 | 0.09                                   | 0.55                    | 51689E3                        | 5.0                         | 61689E3   | 5.0        | 31689E3   | 5.0            | -         | -           |           |
| 63                                       | 10                                   | 8.2 x 11  | 160                                | 7                                      | 0.06                    | 1.3                            | 58109E3                     | 5.0       | 68109E3    | 5.0       | 38109E3        | 5.0       | -           | -         |
|  | 22                                   | 8.2 x 11  | 190                                | 11                                     | 0.06                    | 0.9                            | 58229E3                     | 5.0       | 68229E3    | 5.0       | 38229E3        | 5.0       | -           | -         |
| 100                                      | 2.2                                  | 8.2 x 11  | 60                                 | 4.3                                    | 0.06                    | 4                              | 59228E3                     | 5.0       | 69228E3    | 5.0       | 39228E3        | 5.0       | -           | -         |
|  | 4.7                                  | 8.2 x 11  | 75                                 | 5.8                                    | 0.07                    | 3.5                            | 59478E3                     | 5.0       | 69478E3    | 5.0       | 39478E3        | 5.0       | -           | -         |
|  | 10                                   | 8.2 x 11  | 100                                | 9                                      | 0.08                    | 3                              | 59109E3                     | 5.0       | 69109E3    | 5.0       | 39109E3        | 5.0       | -           | -         |



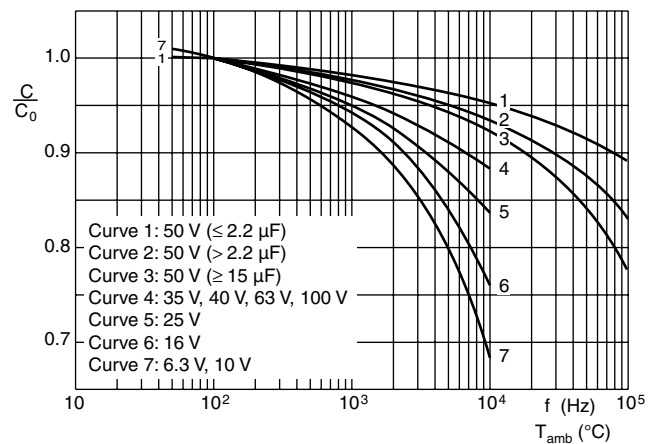
| ADDITIONAL ELECTRICAL DATA         |   |  |
|------------------------------------|---|--|
| PARAMETER                          | CONDITIONS  | VALUE  |
| <b>Voltage</b>                     |   |  |
| Surge voltage                      |   | $U_s \leq 1.3 U_R$                           |
| Reverse voltage                    |   | $U_{rev} \leq 1 V$                           |
| <b>Current</b>                     |   |  |
| Leakage current                    | After 1 minutes at $U_R$                                    | $I_{L1} \leq 0.006 C_R \times U_R + 3 \mu A$ |
|                                    | After 5 minutes at $U_R$                                    | $I_{L5} \leq 0.001 C_R \times U_R + 3 \mu A$ |
| <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                                   |
| <b>Resistance</b>                  |   |  |
| 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)**



$C_0$  = Capacitance at 20 °C, 100 Hz

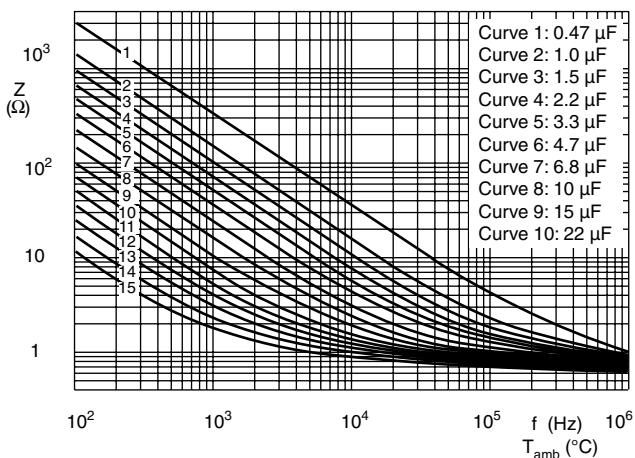
Fig.6 Typical multiplier of capacitance as a function of ambient temperature



$C_0$  = Capacitance at 20 °C, 100 Hz

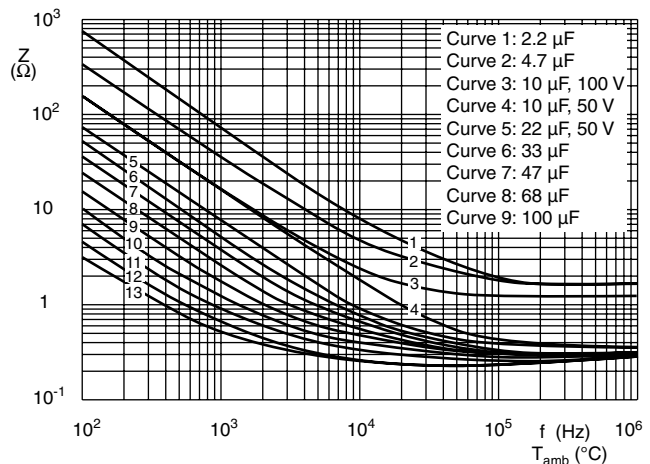
Fig.7 Typical multiplier of capacitance as a function of ambient frequency

**IMPEDANCE (Z)**



Case  $\varnothing D \times L = 5 \times 11 \text{ mm}$

Fig.8 Typical impedance as a function of frequency



Case  $\varnothing D \times L = 8.2 \times 11 \text{ mm}$

Fig.9 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: 2000 h

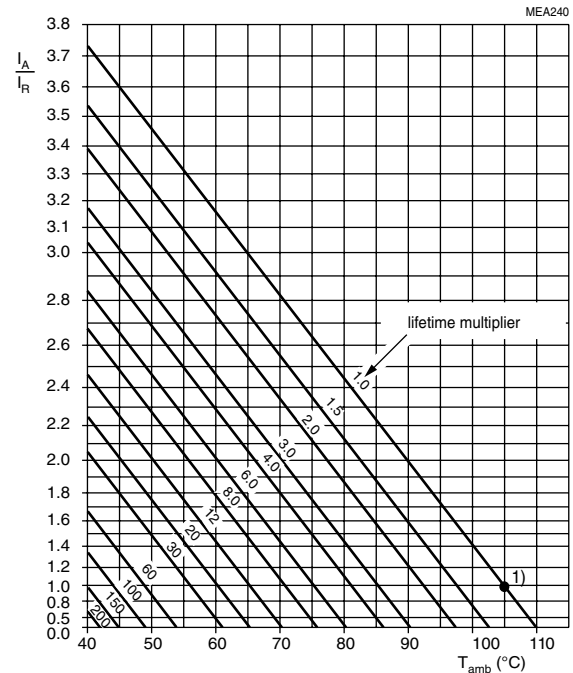


Fig.10 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

| <b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b> |                       |                      |   |
|---|-----------------------|----------------------|---|
| FREQUENCY<br>(Hz)   | $I_R$ MULTIPLIER      |                      |   |
|   | $U_R = 6.3$ to $10$ V | $U_R = 16$ to $35$ V | $U_R = 40$ to $100$ V ( $C_R \geq 10 \mu F$ ) |
| 50  | 0.70                  | 0.60                 | 0.50  |
| 100   | 0.77                  | 0.71                 | 0.63  |
| 300   | 0.86                  | 0.85                 | 0.78  |
| 1000  | 0.92                  | 0.93                 | 0.88  |
| 3000  | 0.96                  | 0.96                 | 0.94  |
| 10 to 100 k   | 1.00                  | 1.00                 | 1.00  |

Table 4

| <b>TEST PROCEDURES AND REQUIREMENTS</b>        |  |   |   |
|--|--|---|---|
| TEST   |  | PROCEDURE<br>(quick reference)  | REQUIREMENTS  |
| NAME OF TEST                                   | REFERENCE                                  |   |   |
| Endurance                                      | IEC 60384-4/<br>EN130300<br>subclause 4.13 | $T_{amb} = 105$ °C; $U_R$ applied;<br>1500 h  | $U_R \leq 6.3$ V; $\Delta C/C$ : + 15/- 30 %<br>$U_R > 6.3$ V; $\Delta C/C$ : $\pm 15$ %<br>$\tan \delta \leq 1.3$ x spec. limit<br>$Z \leq 2$ x spec. limit<br>$I_{L5} \leq$ spec. limit   |
| Useful life                                    | CECC 30301<br>subclause 1.8.1              | $T_{amb} = 105$ °C; $U_R$ and $I_R$ applied;<br>2000 h  | $U_R \leq 6.3$ V; $\Delta C/C$ : + 45/- 50 %<br>$U_R > 6.3$ V; $\Delta C/C$ : $\pm 45$ %<br>$\tan \delta \leq 3$ x spec. limit<br>$Z \leq 3$ x spec. limit<br>$I_{L5} \leq$ spec. limit<br>no short or open circuit<br>total failure percentage: $\leq 1\%$ |
| Shelf life<br>(storage at<br>high temperature) | IEC 60384-4/<br>EN130300<br>subclause 4.17 | $T_{amb} = 105$ °C; no voltage applied;<br>1500 h<br>after test: $U_R$ to be applied for 30 min, 24 to 48 h<br>before measurement | $\Delta C/C$ , $\tan \delta$ , Z:<br>for requirements<br>see 'Endurance test' above<br>$I_{L5} \leq 2$ x spec. limit  |



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- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,  
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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