

# Aluminum Capacitors

## SMD (Chip), High Temperature, Low Impedance

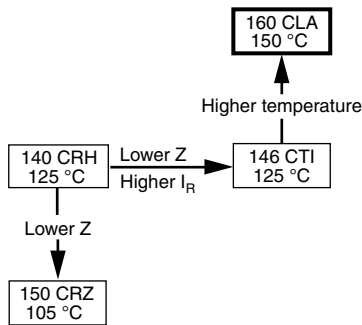


Fig. 1

| QUICK REFERENCE DATA                        |                                  |
|---|----------------------------------|
| DESCRIPTION                                 | VALUE                            |
| Nominal case sizes (L x W x H in mm)        | 12.5 x 12.5 x 13 to 18 x 18 x 21 |
| Rated capacitance range, $C_R$              | 100 $\mu$ F to 3300 $\mu$ F      |
| Tolerance on $C_R$                          | $\pm 20$ %                       |
| Rated voltage range, $U_R$                  | 16 V to 50 V                     |
| Category temperature range                  | - 55 °C to + 150 °C              |
| Endurance test at 150 °C                    | 1000 h to 1500 h                 |
| Useful life at 150 °C                       | 1250 h to 2000 h                 |
| Useful life at 40 °C<br>1.8 x $I_R$ applied | 300 000 h to 400 000 h           |
| Shelf life at 0 V, 150 °C                   | 1000 h                           |
| Based on sectional specification            | IEC 60384-18/CECC 32300          |
| Climatic category IEC 60068                 | 55/150/56                        |

### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte, self healing
- SMD-version with base plate, lead (Pb)-free reflow solderable
- Charge and discharge proof, no peak current limitation
- High temperature reflow soldering according to JEDEC J-STD-020
- High temperature proof
- Vibration proof, 4-pin version and 6-pin version
- AEC-Q200 qualified
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

AUTOMOTIVE GRADE



RoHS COMPLIANT

### APPLICATIONS

- SMD technology, for high temperature reflow soldering
- High temperature environment, high peak load
- Automotive, industrial
- Smoothing, filtering, buffering

### MARKING

- Rated capacitance (in  $\mu$ F)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Black mark or “-” sign indicating the cathode (the anode is identified by bevelled edges)
- Code indicating group number (A)

### PACKAGING

Supplied in blister tape on reel

| <b>SELECTION CHART FOR <math>C_R</math>, <math>U_R</math>, AND RELEVANT NOMINAL CASE SIZES (L x W x H in mm)</b> |                  |                  |                  |                  |
|--|------------------|------------------|------------------|------------------|
| $C_R$<br>( $\mu\text{F}$ )   | $U_R$ (V)        |                  |                  |                  |
|  | 16               | 25               | 35               | 50               |
| 100  | →                | →                | →                | 12.5 x 12.5 x 13 |
| 150  | →                | →                | →                | 12.5 x 12.5 x 13 |
| 220  | →                | →                | 12.5 x 12.5 x 13 | 12.5 x 12.5 x 16 |
| 330  | →                | 12.5 x 12.5 x 13 | 12.5 x 12.5 x 13 | 16 x 16 x 16     |
| 470  | 12.5 x 12.5 x 13 | 12.5 x 12.5 x 13 | 16 x 16 x 16     | 18 x 18 x 16     |
| 680  | 12.5 x 12.5 x 13 | 16 x 16 x 16     | 18 x 18 x 16     | 16 x 16 x 21     |
| 1000   | 16 x 16 x 16     | 18 x 18 x 16     | 16 x 16 x 21     | 18 x 18 x 21     |
| 1500   | 18 x 18 x 16     | 16 x 16 x 21     | 18 x 18 x 21     | -                |
| 2200   | 16 x 16 x 21     | 18 x 18 x 21     | -                | -                |
| 2700   | 18 x 18 x 21     | -                | -                | -                |
| 3300   | 18 x 18 x 21     | -                | -                | -                |

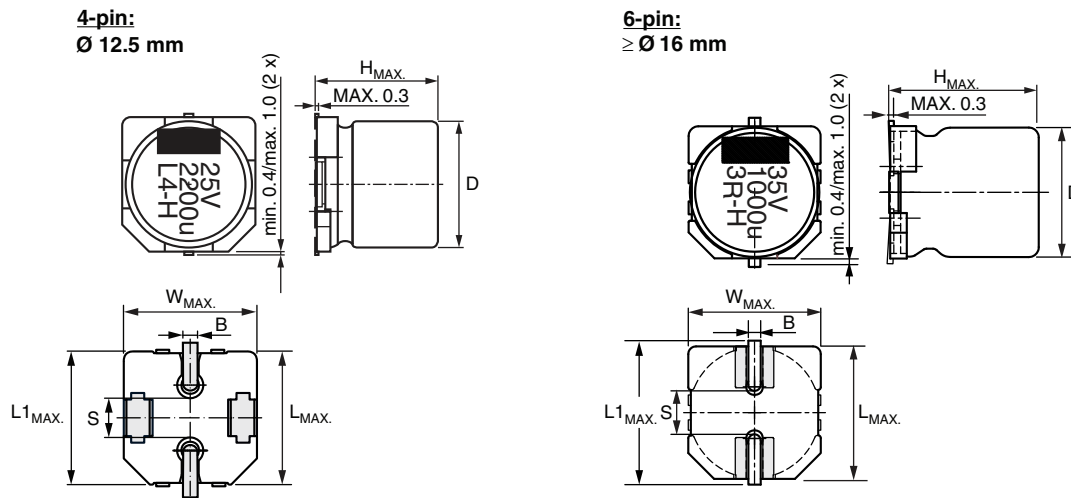


Fig. 2 - Dimensional outline

Table 1

| <b>DIMENSIONS in millimeters AND MASS</b> |           |                   |                   |                   |      |                   |     |                    |          |
|---|-----------|-------------------|-------------------|-------------------|------|-------------------|-----|--------------------|----------|
| NOMINAL CASE SIZE<br>L x W x H            | CASE CODE | L <sub>MAX.</sub> | W <sub>MAX.</sub> | H <sub>MAX.</sub> | Ø D  | B <sub>MAX.</sub> | S   | L1 <sub>MAX.</sub> | MASS (g) |
| 12.5 x 12.5 x 13                          | 1213      | 12.9              | 12.9              | 14.0              | 12.5 | 1.3               | 3.6 | 14.9               | ≈ 2.9    |
| 12.5 x 12.5 x 16                          | 1216      | 12.9              | 12.9              | 16.5              | 12.5 | 1.3               | 3.6 | 14.9               | ≈ 3.2    |
| 16 x 16 x 16                              | 1616      | 16.6              | 16.6              | 17.5              | 16.0 | 1.3               | 6.5 | 18.6               | ≈ 5.8    |
| 16 x 16 x 21                              | 1621      | 16.6              | 16.6              | 22.0              | 16.0 | 1.3               | 6.5 | 18.6               | ≈ 7.1    |
| 18 x 18 x 16                              | 1816      | 19.0              | 19.0              | 17.5              | 18.0 | 1.3               | 6.5 | 21.0               | ≈ 8.0    |
| 18 x 18 x 21                              | 1821      | 19.0              | 19.0              | 22.0              | 18.0 | 1.3               | 6.5 | 21.0               | ≈ 9.3    |

**Table 2**

| <b>TAPE AND REEL DIMENSIONS</b> in millimeters, <b>PACKAGING QUANTITIES</b> |                  |                                |                        |   |                      |                                    |
|---|------------------|--------------------------------|------------------------|---|----------------------|------------------------------------|
| <b>NOMINAL CASE SIZE</b><br>L x W x H                                       | <b>CASE CODE</b> | <b>PITCH</b><br>P <sub>1</sub> | <b>TAPE WIDTH</b><br>W | <b>TAPE THICKNESS</b><br>T <sub>2</sub> | <b>REEL DIAMETER</b> | <b>PACKAGING QUANTITY PER REEL</b> |
| 12.5 x 12.5 x 13  | 1213             | 20                             | 24                     | 16.2                                    | 380                  | 250                                |
| 12.5 x 12.5 x 16  | 1216             | 24                             | 32                     | 18.5                                    | 380                  | 200                                |
| 16 x 16 x 16  | 1616             | 28                             | 44                     | 18.9                                    | 380                  | 150                                |
| 16 x 16 x 21  | 1621             | 28                             | 44                     | 23.4                                    | 380                  | 100                                |
| 18 x 18 x 16  | 1816             | 32                             | 44                     | 18.9                                    | 380                  | 125                                |
| 18 x 18 x 21  | 1821             | 32                             | 44                     | 23.4                                    | 380                  | 100                                |

**Note**

- Detailed tape dimensions see section "PACKAGING"

**MOUNTING**

The capacitors are designed for automatic placement on to printed-circuit boards.

Optimum dimensions of soldering pads depend amongst others on soldering method, mounting accuracy, print layout and/or adjacent components.

For recommended soldering pad dimensions, refer to Fig. 3 and Table 3.

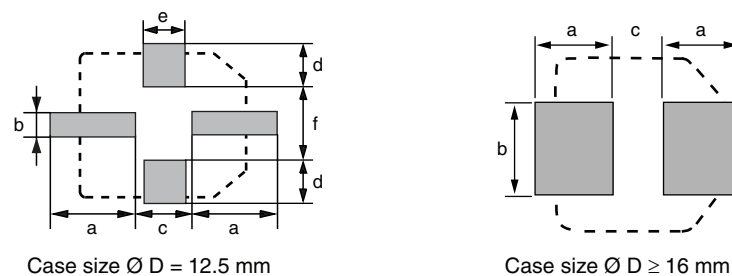
**SOLDERING**

Soldering conditions are defined by the curve, temperature versus time, where the temperature is that measured on the component during processing.

For maximum conditions refer to Fig. 4.

Any temperature versus time curve which does not exceed the specified maximum curves may be applied.

As a general principle, temperature and duration shall be the **minimum** necessary required to ensure good soldering connections. However, the specified maximum curves should never be exceeded.


**Fig. 3 - Recommended soldering pad dimensions**
**Table 3**

| <b>RECOMMENDED SOLDERING PAD DIMENSIONS</b> in millimeters |          |          |          |          |          |          |
|--|----------|----------|----------|----------|----------|----------|
| <b>CASE CODE</b>   | <b>a</b> | <b>b</b> | <b>c</b> | <b>d</b> | <b>e</b> | <b>f</b> |
| 1213   | 6.3      | 2.5      | 4.0      | 4.2      | 5.0      | 5.6      |
| 1216   | 6.3      | 2.5      | 4.0      | 4.2      | 5.0      | 5.6      |
| 1616   | 7.8      | 9.6      | 4.7      | -        | -        | -        |
| 1621   | 7.8      | 9.6      | 4.7      | -        | -        | -        |
| 1816   | 8.8      | 9.6      | 4.7      | -        | -        | -        |
| 1821   | 8.8      | 9.6      | 4.7      | -        | -        | -        |

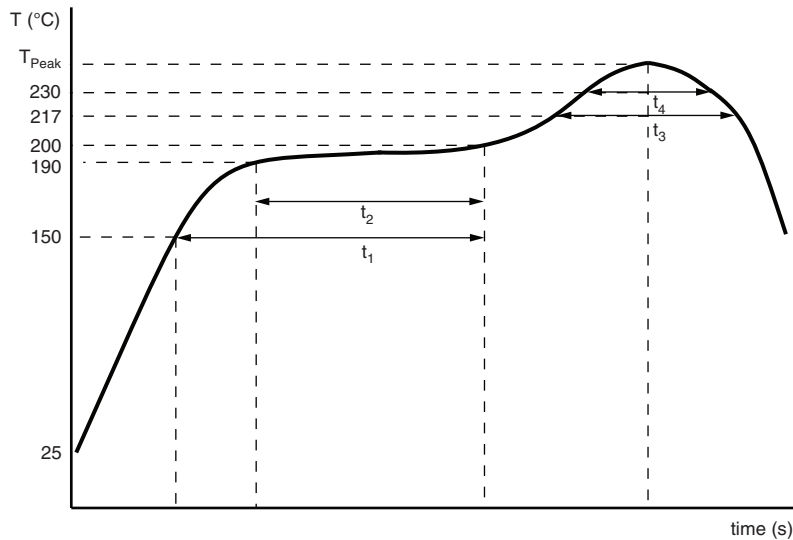
**ADVANCED SOLDERING PROFILE FOR LEAD (Pb)-FREE REFLOW PROCESS  
ACCORDING TO JEDEC J-STD-020**


Fig. 4 - Maximum temperature load during reflow soldering

**Table 4**

| REFLOW SOLDERING CONDITIONS for MAL216099xxxE3    |                           |                           |
|---|---------------------------|---------------------------|
| PROFILE FEATURES                                  | CASE CODE<br>1213 TO 1216 | CASE CODE<br>1616 TO 1821 |
| Max. time from 25 °C to $T_{Peak}$                | 300 s                     | 300 s                     |
| Min. ramp-up rate to 150 °C                       | 3 K/s                     | 3 K/s                     |
| Max. time from 150 °C to 200 °C ( $t_1$ )         | 150 s                     | 150 s                     |
| Max. time from 190 °C to 200 °C ( $t_2$ )         | 110 s                     | 110 s                     |
| Ramp up rate from 200 °C to $T_{Peak}$            | 0.5 K/s to 3 K/s          | 0.5 K/s to 3 K/s          |
| Max. time above $T_{Liquidus}$ (217 °C) ( $t_3$ ) | 90 s                      | 90 s                      |
| Max. time above 230 °C ( $t_4$ )                  | 65 s                      | 60 s                      |
| Peak temperature $T_{Peak}$                       | 250 °C                    | 245 °C                    |
| Max. time above $T_{Peak}$ minus 5 °C             | 30 s                      | 30 s                      |
| Ramp-down rate from $T_{Liquidus}$                | 3 K/s to 6 K/s            | 3 K/s to 6 K/s            |

**Notes**

- Temperature measuring point on top of the case and on terminals.
- Max. 2 runs with pause of min. 30 min in between.



| ELECTRICAL DATA |   |
|-----------------|---|
| SYMBOL          | DESCRIPTION                                       |
| $C_R$           | Rated capacitance at 100 Hz, tolerance $\pm 20\%$ |
| $I_R$           | Rated RMS ripple current at 100 kHz, 150 °C       |
| $I_{L2}$        | Max. leakage current after 2 min at $U_R$         |
| $\tan \delta$   | Max. dissipation factor at 100 Hz                 |
| Z               | Max. impedance at 100 kHz                         |

**ORDERING EXAMPLE**

Electrolytic capacitor 160 CLA series

220  $\mu$ F/50 V;  $\pm 20\%$

Nominal case size: 12.5 mm x 12.5 mm x 16 mm;  
taped on reel

Ordering code: MAL216099103E3

**Note**

- Unless otherwise specified, all electrical values in Table 5 apply at  $T_{amb} = 20\text{ °C}$ ,  $P = 86\text{ kPa}$  to  $106\text{ kPa}$ ,  $RH = 45\%$  to  $75\%$

Table 5

| ELECTRICAL DATA AND ORDERING INFORMATION |                     |  |                                    |                                 |                         |                                       |   |                             |
|--|---------------------|--|------------------------------------|---------------------------------|-------------------------|---------------------------------------|---|-----------------------------|
| $U_R$<br>(V)                             | $C_R$<br>( $\mu$ F) | NOMINAL CASE SIZE<br>L x W x H<br>(mm) | $I_R$<br>150 °C<br>100 kHz<br>(mA) | $I_{L2}$<br>2 min<br>( $\mu$ A) | $\tan \delta$<br>100 Hz | Z<br>100 kHz<br>20 °C<br>( $\Omega$ ) | Z<br>100 kHz<br>- 40 °C<br>( $\Omega$ ) | ORDERING CODE<br>MAL2160... |
| 16                                       | 470                 | 12.5 x 12.5 x 13                       | 750                                | 75                              | 0.16                    | 0.080                                 | 0.70                                    | 99501E3                     |
|  | 680                 | 12.5 x 12.5 x 13                       | 800                                | 109                             | 0.16                    | 0.080                                 | 0.70                                    | 99502E3                     |
|  | 1000                | 16 x 16 x 16                           | 850                                | 160                             | 0.16                    | 0.050                                 | 0.45                                    | 99503E3                     |
|  | 1500                | 18 x 18 x 16                           | 900                                | 240                             | 0.16                    | 0.050                                 | 0.45                                    | 99504E3                     |
|  | 2200                | 16 x 16 x 21                           | 1100                               | 352                             | 0.18                    | 0.035                                 | 0.32                                    | 99505E3                     |
|  | 2700                | 18 x 18 x 21                           | 1350                               | 432                             | 0.18                    | 0.035                                 | 0.32                                    | 99506E3                     |
|  | 3300                | 18 x 18 x 21                           | 1400                               | 528                             | 0.20                    | 0.035                                 | 0.32                                    | 99507E3                     |
| 25                                       | 330                 | 12.5 x 12.5 x 13                       | 650                                | 83                              | 0.14                    | 0.080                                 | 0.70                                    | 99601E3                     |
|  | 470                 | 12.5 x 12.5 x 13                       | 700                                | 118                             | 0.14                    | 0.080                                 | 0.70                                    | 99602E3                     |
|  | 680                 | 16 x 16 x 16                           | 800                                | 170                             | 0.14                    | 0.050                                 | 0.45                                    | 99603E3                     |
|  | 1000                | 18 x 18 x 16                           | 830                                | 250                             | 0.14                    | 0.050                                 | 0.45                                    | 99604E3                     |
|  | 1500                | 16 x 16 x 21                           | 1050                               | 375                             | 0.14                    | 0.035                                 | 0.32                                    | 99605E3                     |
|  | 2200                | 18 x 18 x 21                           | 1350                               | 550                             | 0.16                    | 0.035                                 | 0.32                                    | 99606E3                     |
| 35                                       | 220                 | 12.5 x 12.5 x 13                       | 550                                | 77                              | 0.12                    | 0.080                                 | 0.70                                    | 99001E3                     |
|  | 330                 | 12.5 x 12.5 x 13                       | 650                                | 116                             | 0.12                    | 0.080                                 | 0.70                                    | 99002E3                     |
|  | 470                 | 16 x 16 x 16                           | 800                                | 165                             | 0.12                    | 0.050                                 | 0.45                                    | 99003E3                     |
|  | 680                 | 18 x 18 x 16                           | 830                                | 238                             | 0.12                    | 0.050                                 | 0.45                                    | 99004E3                     |
|  | 1000                | 16 x 16 x 21                           | 1000                               | 350                             | 0.12                    | 0.035                                 | 0.32                                    | 99005E3                     |
|  | 1500                | 18 x 18 x 21                           | 1350                               | 525                             | 0.12                    | 0.035                                 | 0.32                                    | 99006E3                     |
| 50                                       | 100                 | 12.5 x 12.5 x 13                       | 420                                | 50                              | 0.10                    | 0.130                                 | 1.20                                    | 99101E3                     |
|  | 150                 | 12.5 x 12.5 x 13                       | 450                                | 75                              | 0.10                    | 0.120                                 | 1.10                                    | 99102E3                     |
|  | 220                 | 12.5 x 12.5 x 16                       | 550                                | 110                             | 0.10                    | 0.085                                 | 0.76                                    | 99103E3                     |
|  | 330                 | 16 x 16 x 16                           | 700                                | 165                             | 0.10                    | 0.072                                 | 0.65                                    | 99104E3                     |
|  | 470                 | 18 x 18 x 16                           | 720                                | 235                             | 0.10                    | 0.070                                 | 0.63                                    | 99105E3                     |
|  | 680                 | 16 x 16 x 21                           | 800                                | 340                             | 0.10                    | 0.052                                 | 0.47                                    | 99106E3                     |
|  | 1000                | 18 x 18 x 21                           | 1100                               | 500                             | 0.10                    | 0.049                                 | 0.44                                    | 99107E3                     |

**Table 6**

| ADDITIONAL ELECTRICAL DATA                   |  |  |
|--|--|--|
| PARAMETER                                    | CONDITIONS   | VALUE                                    |
| <b>Voltage</b>                               |  |  |
| Surge voltage for short periods              | IEC 60384-18, subclause 4.14                                       | $U_S \leq 1.15 \times U_R$               |
| Reverse voltage for short periods            | IEC 60384-18, subclause 4.16; $T_A \leq 150^\circ\text{C}$         | $U_{\text{rev}} \leq 1\text{ V}$         |
| <b>Current</b>                               |  |  |
| Leakage current                              | After 2 min at $U_R$   | $I_{L2} \leq 0.01 \times C_R \times U_R$ |
| <b>Inductance</b>                            |  |  |
| Equivalent series inductance (ESL)           | $\varnothing D \geq 12.5\text{ mm}$                                | Typ. 11 nH                               |
| <b>Resistance</b>                            |  |  |
| Equivalent series resistance (ESR) at 100 Hz | Calculated from $\tan \delta_{\text{max}}$ and $C_R$ (see Table 5) | $\text{ESR} = \tan \delta / 2\pi f C_R$  |

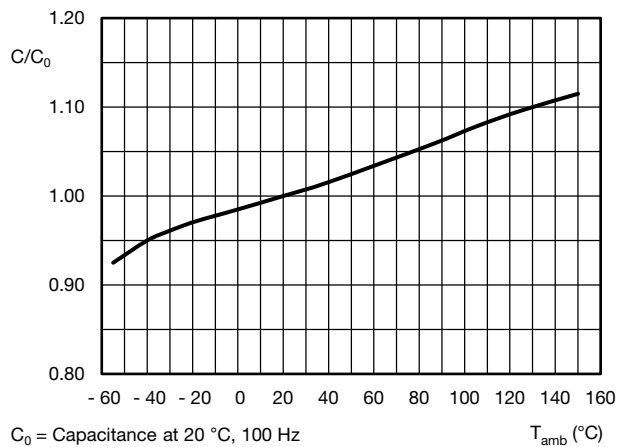
**CAPACITANCE (C)**


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

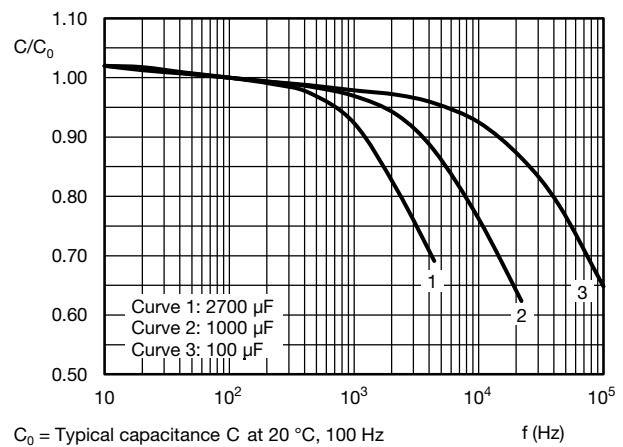
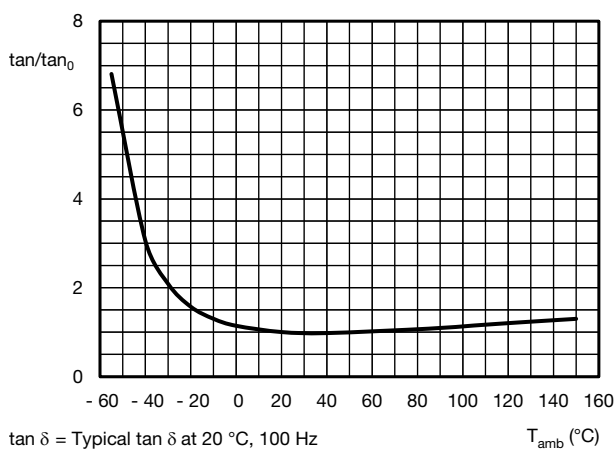
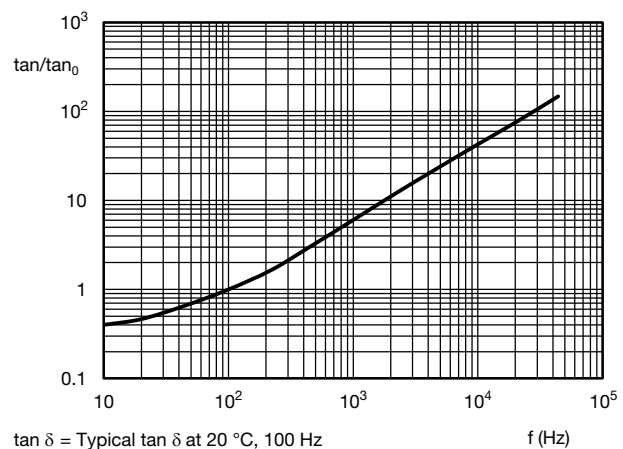


Fig. 6 - Typical multiplier of capacitance as a function of frequency

**DISSIPATION FACTOR ( $\tan \delta$ )**

 Fig. 7 - Typical multiplier of dissipation factor ( $\tan \delta$ ) as a function of ambient temperature

 Fig. 8 - Typical multiplier of dissipation factor ( $\tan \delta$ ) as a function of frequency

**EQUIVALENT SERIES RESISTANCE (ESR)**

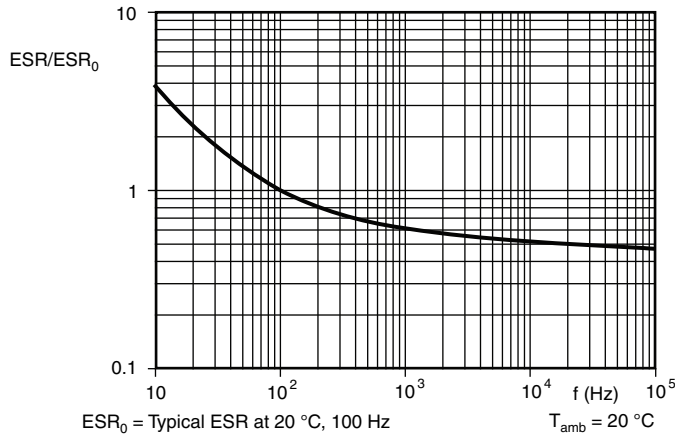


Fig. 9 - Typical multiplier of ESR as a function of frequency

**IMPEDANCE (Z)**

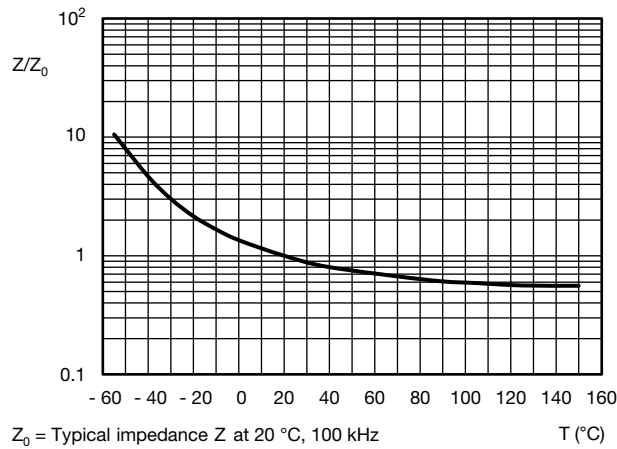


Fig. 10 - Typical multiplier of impedance as a function of temperature

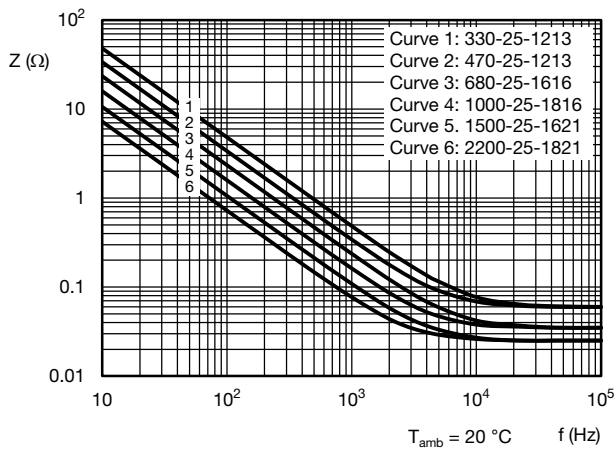


Fig. 11 - Typical impedance as a function of frequency

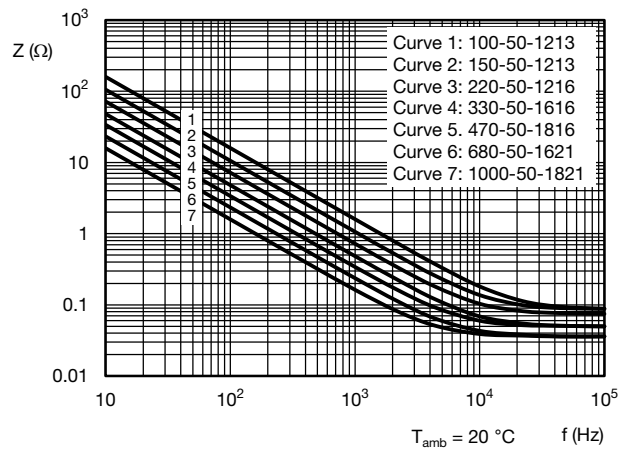


Fig. 12 - Typical impedance as a function of frequency



**RIPPLE CURRENT AND USEFUL LIFE**

Table 7

| ENDURANCE TEST DURATION AND USEFUL LIFE AS A FUNCTION OF CASE SIZE |           |                               |                                 |   |
|--|-----------|-------------------------------|---------------------------------|---|
| NOMINAL CASE SIZE<br>Ø D x L<br>(mm)                               | CASE CODE | ENDURANCE<br>AT 150 °C<br>(h) | USEFUL LIFE<br>AT 150 °C<br>(h) | USEFUL LIFE AT 40 °C<br>1.8 x I <sub>R</sub> APPLIED<br>(h) |
| 12.5 x 12.5 x 13   | 1213      | 1000                          | 1250                            | 300 000   |
| 12.5 x 12.5 x 16   | 1216      | 1000                          | 1250                            | 325 000   |
| 16 x 16 x 16   | 1616      | 1000                          | 1500                            | 350 000   |
| 16 x 16 x 21   | 1621      | 1500                          | 2000                            | 400 000   |
| 18 x 18 x 16   | 1816      | 1000                          | 1500                            | 350 000   |
| 18 x 18 x 21   | 1821      | 1500                          | 2000                            | 400 000   |

**RIPPLE CURRENT AND USEFUL LIFE**

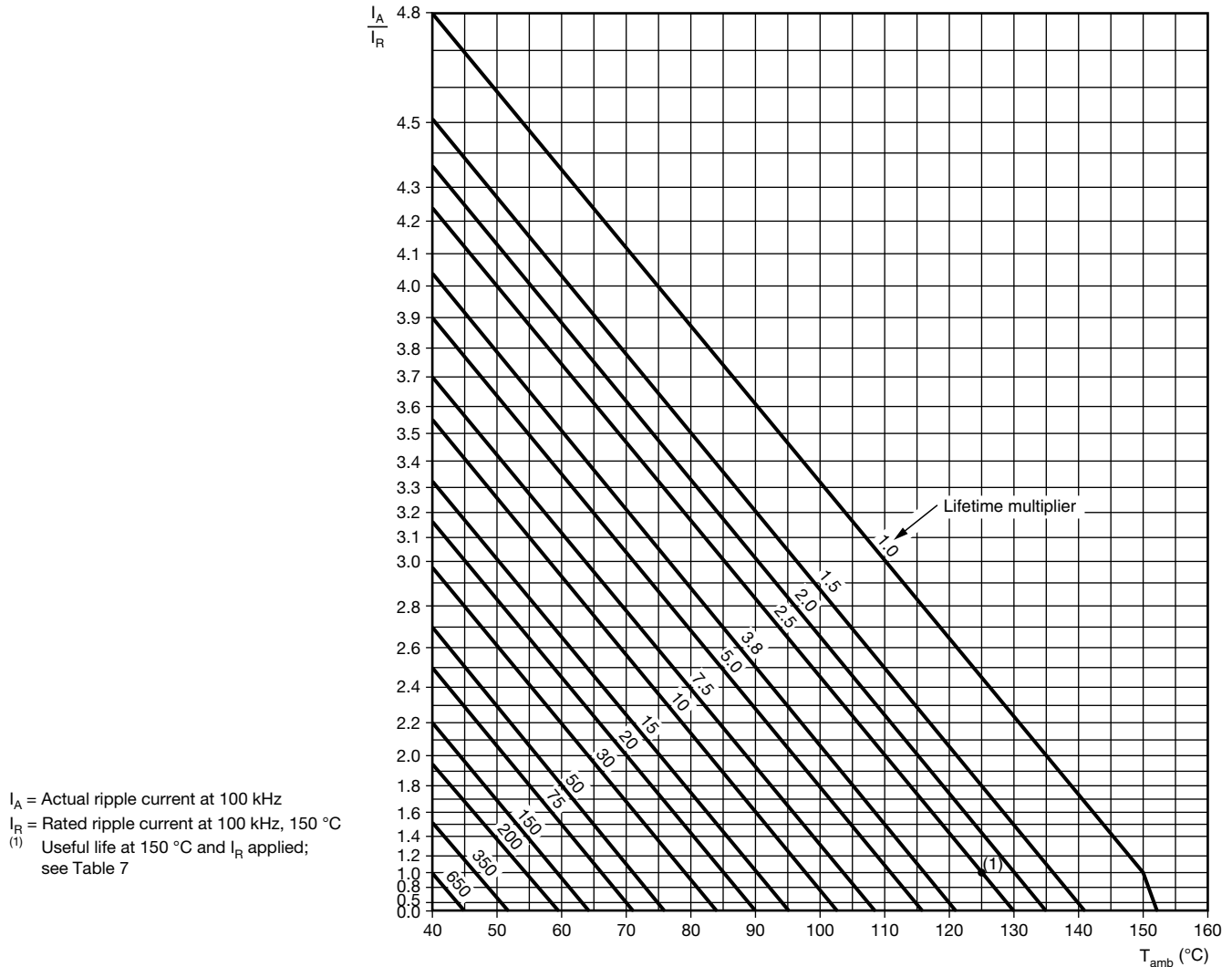


Fig. 13 - Multiplier of useful life as a function of ambient temperature and ripple current load



Table 8

| <b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b> |                                    |
|---|------------------------------------|
| FREQUENCY<br>(Hz)   | $I_R$ MULTIPLIER                   |
|   | $U_R = 16\text{ V TO }50\text{ V}$ |
| 50  | 0.40                               |
| 100   | 0.60                               |
| 300   | 0.75                               |
| 1000  | 0.80                               |
| 3000  | 0.90                               |
| 10 000  | 0.95                               |
| 30 000  | 0.97                               |
| 100 000   | 1.00                               |

Table 9

| <b>TEST PROCEDURES AND REQUIREMENTS</b>        |  |  |  |
|--|--|--|--|
| TEST   |  | PROCEDURE<br>(quick reference)   | REQUIREMENTS   |
| NAME OF TEST                                   | REFERENCE                                      |  |  |
| Mounting                                       | IEC 60384-18,<br>subclause 4.3                 | Shall be performed prior to tests mentioned below;<br>reflow soldering;<br>for maximum temperature load<br>refer to chapter "Mounting"                         | $\Delta C/C: \pm 5\%$<br>$\tan \delta \leq \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$   |
| Endurance                                      | IEC 60384-18/<br>CECC 32300,<br>subclause 4.15 | $T_{\text{amb}} = 150\text{ }^\circ\text{C}$ ; $U_R$ applied;<br>for test duration see Table 7   | $\Delta C/C: \pm 20\%$<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$   |
| Useful life                                    | CECC 30301,<br>subclause 1.8.1                 | $T_{\text{amb}} = 150\text{ }^\circ\text{C}$ ; $U_R$ and $I_R$ applied;<br>for test duration see Table 7   | $\Delta C/C: \pm 30\%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1\%$ |
| Shelf life<br>(storage at high<br>temperature) | IEC 60384-18/<br>CECC 32300,<br>subclause 4.17 | $T_{\text{amb}} = 150\text{ }^\circ\text{C}$ ; no voltage applied;<br>1000 h<br>After test: $U_R$ to be applied for 30 min,<br>24 h to 48 h before measurement | For requirements<br>see "Endurance test" above   |
| Reverse voltage                                | IEC 60384-18/<br>CECC 32300,<br>subclause 4.16 | $T_{\text{amb}} = 150\text{ }^\circ\text{C}$ :<br>125 h at $U = -0.5\text{ V}$ ,<br>followed by 125 h at $U_R$   | $\Delta C/C: \pm 15\%$<br>$\tan \delta \leq 1.5 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$   |

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- 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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