

## Aluminum Capacitors

### Axial High Temperature, High Ripple Current

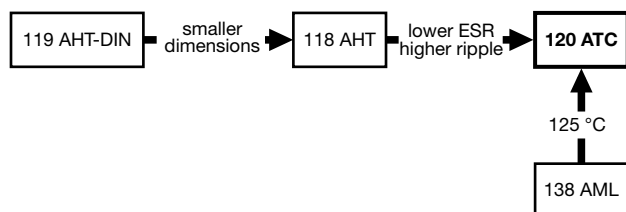


Fig. 1

| QUICK REFERENCE DATA                               |                          |
|----------------------------------------------------|--------------------------|
| DESCRIPTION                                        | VALUE                    |
| Nominal case sizes (Ø D x L in mm)                 | 10 x 30 to 21 x 38       |
| Rated capacitance range, C <sub>R</sub>            | 47 µF to 6800 µF         |
| Tolerance on C <sub>R</sub>                        | ± 20 %                   |
| Rated voltage range, U <sub>R</sub>                | 16 V to 100 V            |
| Category temperature range                         | - 40 °C to + 125 °C      |
| Endurance test at 150 °C                           | 1000 h                   |
| Endurance test at 125 °C                           | 4000 h                   |
| Useful life at 125 °C                              | 8000 h                   |
| Useful life at 85 °C, 1.4 x I <sub>R</sub> applied | 40 000 h                 |
| Shelf life at 0 V, 125 °C                          | 1000 h<br>(100 V: 500 h) |
| Shelf life at 0 V, 150 °C                          | ≤ 63 V: 500 h            |
| Based on sectional specification                   | IEC 60384-4/EN 130300    |
| Climatic category IEC 60068                        | 40/125/56                |

#### FEATURES

- Extra long useful life: Up to 8000 h at 125 °C
- Extended temperature range: Usable up to 150 °C
- Lowest ESR levels providing very high ripple current capability
- Miniaturized, high CV-product per unit volume
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Taped versions up to case Ø 15 mm x 30 mm available for automatic insertion
- Lead diameter Ø d = 1.0 mm, available on request
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

#### APPLICATIONS

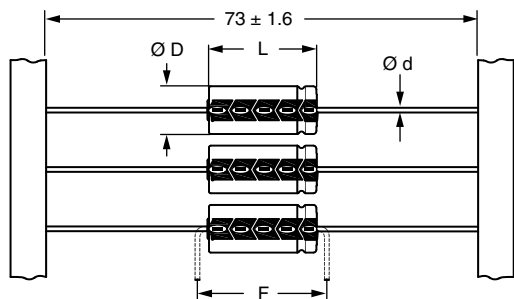
- Automotive, industrial and telecommunication
- Smoothing, filtering, buffering
- Low mounting height applications, vibration and shock resistant
- SMPS and standard power supplies

#### MARKING

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

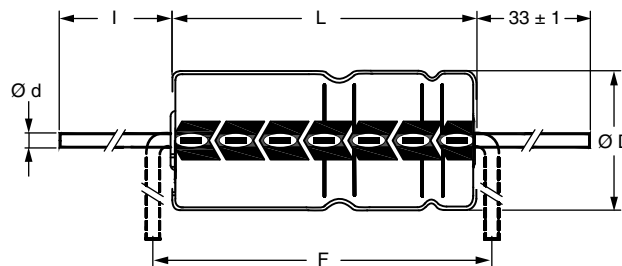
- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Upper category temperature (125 °C)
- Date code in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (120)

| SELECTION CHART FOR C <sub>R</sub> , U <sub>R</sub> , AND RELEVANT NOMINAL CASE SIZE (Ø D x L in mm) |                    |           |           |           |           |
|------------------------------------------------------------------------------------------------------|--------------------|-----------|-----------|-----------|-----------|
| C <sub>R</sub><br>(µF)                                                                               | U <sub>R</sub> (V) |           |           |           |           |
|                                                                                                      | 16                 | 25        | 40        | 63        | 100       |
| 47                                                                                                   | -                  | -         | -         | -         | 10 x 30   |
| 68                                                                                                   | -                  | -         | -         | -         | 12.5 x 30 |
| 100                                                                                                  | -                  | -         | -         | 10 x 30   | 12.5 x 30 |
| 150                                                                                                  | -                  | -         | -         | 12.5 x 30 | 15 x 30   |
| 220                                                                                                  | -                  | -         | 10 x 30   | 12.5 x 30 | 18 x 30   |
| 330                                                                                                  | -                  | -         | 12.5 x 30 | 15 x 30   | 18 x 38   |
| 470                                                                                                  | -                  | 10 x 30   | 12.5 x 30 | 18 x 30   | 21 x 38   |
| 680                                                                                                  | 10 x 30            | 12.5 x 30 | 15 x 30   | 18 x 38   | -         |
| 1000                                                                                                 | 12.5 x 30          | 12.5 x 30 | 18 x 30   | 21 x 38   | -         |
| 1500                                                                                                 | 12.5 x 30          | 15 x 30   | 18 x 38   | -         | -         |
| 2200                                                                                                 | 15 x 30            | 18 x 30   | 21 x 38   | -         | -         |
| 3300                                                                                                 | 18 x 30            | 18 x 38   | -         | -         | -         |
| 4700                                                                                                 | 18 x 38            | 21 x 38   | -         | -         | -         |
| 6800                                                                                                 | 21 x 38            | -         | -         | -         | -         |

**DIMENSIONS in millimeters AND AVAILABLE FORMS**


**Form BR:** Taped on reel  
Case  $\varnothing D \times L = 6.5 \text{ mm} \times 18 \text{ mm}$  to  $15 \text{ mm} \times 30 \text{ mm}$

Fig. 2 - **Form BR**



**Form AA:** Axial in box  
Case  $\varnothing D \times L = 10 \text{ mm} \times 30 \text{ mm}$  to  $21 \text{ mm} \times 38 \text{ mm}$

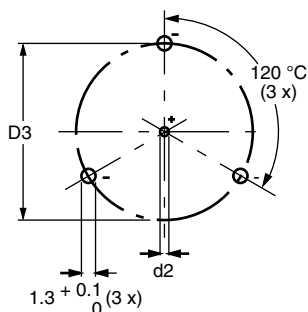
Fig. 3 - **Form AA**

Table 1

| <b>AXIAL; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES</b> |                       |            |                               |                   |                   |                |                      |         |
|-------------------------------------------------------------------------|-----------------------|------------|-------------------------------|-------------------|-------------------|----------------|----------------------|---------|
| NOMINAL CASE SIZE<br>$\varnothing D \times L$<br>(mm)                   | AXIAL: FORM AA AND BR |            |                               |                   |                   | MASS<br>(g)    | PACKAGING QUANTITIES |         |
|                                                                         | $\varnothing d$ (1)   | L          | $\varnothing D_{\text{max.}}$ | $L_{\text{max.}}$ | $F_{\text{min.}}$ |                | FORM AA              | FORM BR |
| 10 x 30                                                                 | 0.8                   | $55 \pm 1$ | 10.5                          | 30.5              | 35                | $\approx 4.8$  | 340                  | 500     |
| 12.5 x 30                                                               | 0.8                   | $55 \pm 1$ | 13.0                          | 30.5              | 35                | $\approx 7.4$  | 260                  | 400     |
| 15 x 30                                                                 | 0.8                   | $55 \pm 1$ | 15.5                          | 30.5              | 35                | $\approx 11.7$ | 200                  | 250     |
| 18 x 30                                                                 | 0.8                   | $55 \pm 1$ | 18.5                          | 30.5              | 35                | $\approx 12.9$ | 120                  | -       |
| 18 x 38                                                                 | 0.8                   | $34 \pm 1$ | 18.5                          | 39.5              | 44                | $\approx 19.0$ | 125                  | -       |
| 21 x 38                                                                 | 0.8                   | $34 \pm 1$ | 21.5                          | 39.5              | 44                | $\approx 24.0$ | 100                  | -       |

**Notes**

- (1) Lead diameter  $\varnothing d = 1.0 \text{ mm}$ , available on request.  
• For detailed tape dimensions, please see [www.vishay.com/doc?28361](http://www.vishay.com/doc?28361).



Mounting holes

Case  $\varnothing D \times L = 15 \text{ mm} \times 30 \text{ mm}$  to  $21 \text{ mm} \times 38 \text{ mm}$   
Especially for applications with severe shocks and vibrations

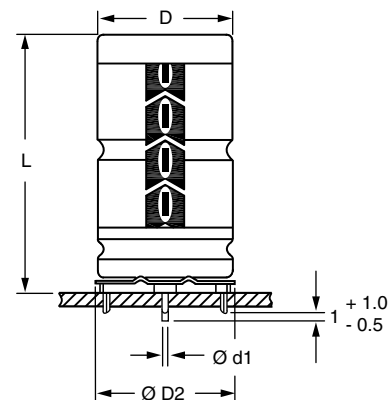
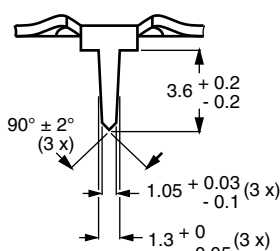


Fig. 4 - Mounting hole diagram and outline; **form MR:** With mounting ring and pins

Table 2

| <b>MOUNTING RING; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES</b> |           |                        |                  |                               |                                |                |                   |                |                      |
|---------------------------------------------------------------------------------|-----------|------------------------|------------------|-------------------------------|--------------------------------|----------------|-------------------|----------------|----------------------|
| NOMINAL CASE SIZE<br>$\varnothing D \times L$                                   | CASE CODE | MOUNTING RING: FORM MR |                  |                               |                                |                |                   | MASS<br>(g)    | PACKAGING QUANTITIES |
|                                                                                 |           | $\varnothing d1$       | $\varnothing d2$ | $\varnothing D_{\text{max.}}$ | $\varnothing D2_{\text{max.}}$ | D3             | $L_{\text{max.}}$ |                |                      |
| 15 x 30                                                                         | 02        | 0.8                    | $1.0 \pm 0.4$    | 15.5                          | 17.5                           | $16.5 \pm 0.2$ | 33                | $\approx 8.6$  | 200                  |
| 18 x 30                                                                         | 03        | 0.8                    | $1.0 \pm 0.4$    | 18.5                          | 19.5                           | $18.5 \pm 0.2$ | 33                | $\approx 11.5$ | 240                  |
| 18 x 38                                                                         | 04        | 0.8                    | $1.0 \pm 0.4$    | 18.5                          | 19.5                           | $18.5 \pm 0.2$ | 42                | $\approx 14.0$ | 100                  |
| 21 x 38                                                                         | 05        | 0.8                    | $1.0 \pm 0.4$    | 21.5                          | 22.5                           | $21.5 \pm 0.2$ | 42                | $\approx 19.2$ | 100                  |



| ELECTRICAL DATA |                                                                                         |
|-----------------|-----------------------------------------------------------------------------------------|
| SYMBOL          | DESCRIPTION                                                                             |
| $C_R$           | Rated capacitance at 100 Hz, tolerance $\pm 20\%$                                       |
| $I_R$           | Rated RMS ripple current at 10 kHz, 125 °C                                              |
| $I_{L1}$        | Max. leakage current after 1 min at $U_R$                                               |
| $I_{L5}$        | Max. leakage current after 5 min at $U_R$                                               |
| ESR             | Equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and $C_R$ ) |
| Z               | Max. impedance at 10 kHz                                                                |

**Note**

- Unless otherwise specified, all electrical values in Table 3 apply at  $T_{amb} = 20\text{ °C}$ ,  $P = 86\text{ kPa}$  to  $106\text{ kPa}$ ,  $RH = 45\%$  to  $75\%$ .

**Table 3**

| ELECTRICAL DATA AND ORDERING INFORMATION |                                      |                                                          |                                   |                                        |                                        |                                        |                                        |                                        |                                        |                                      |                            |                             |                             |
|------------------------------------------|--------------------------------------|----------------------------------------------------------|-----------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|--------------------------------------|----------------------------|-----------------------------|-----------------------------|
| $U_R$<br>(V)                             | $C_R$<br>100 Hz<br>( $\mu\text{F}$ ) | NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$<br>(mm) | $I_R$<br>10 kHz<br>125 °C<br>(mA) | $I_{L1}$<br>1 min<br>( $\mu\text{A}$ ) | $I_{L5}$<br>5 min<br>( $\mu\text{A}$ ) | TYP.<br>ESR<br>100 Hz<br>(m $\Omega$ ) | MAX.<br>ESR<br>100 Hz<br>(m $\Omega$ ) | TYP.<br>ESR<br>10 kHz<br>(m $\Omega$ ) | MAX.<br>ESR<br>10 kHz<br>(m $\Omega$ ) | Z<br>MAX.<br>10 kHz<br>(m $\Omega$ ) | ORDERING CODE MAL2120..... |                             |                             |
|                                          |                                      |                                                          |                                   |                                        |                                        |                                        |                                        |                                        |                                        |                                      | IN BOX<br>FORM AA          | TAPED<br>ON REEL<br>FORM BR | MOUNTING<br>RING<br>FORM MR |
| 16                                       | 680                                  | 10 x 30                                                  | 2100                              | 171                                    | 84                                     | 106                                    | 177                                    | 44                                     | 74                                     | 78                                   | 15681E3                    | 25681E3                     | -                           |
|                                          | 1000                                 | 12.5 x 30                                                | 2550                              | 232                                    | 104                                    | 77                                     | 128                                    | 35                                     | 58                                     | 61                                   | 15102E3                    | 25102E3                     | -                           |
|                                          | 1500                                 | 12.5 x 30                                                | 2650                              | 328                                    | 136                                    | 60                                     | 100                                    | 32                                     | 53                                     | 53                                   | 15152E3                    | 25152E3                     | -                           |
|                                          | 2200                                 | 15 x 30                                                  | 2940                              | 462                                    | 181                                    | 48                                     | 79                                     | 28                                     | 46                                     | 46                                   | 15222E3                    | 25222E3                     | 45222E3                     |
|                                          | 3300                                 | 18 x 30                                                  | 3430                              | 674                                    | 251                                    | 41                                     | 68                                     | 26                                     | 43                                     | 43                                   | 15332E3                    | -                           | 45332E3                     |
|                                          | 4700                                 | 18 x 38                                                  | 4350                              | 942                                    | 341                                    | 27                                     | 45                                     | 18                                     | 29                                     | 29                                   | 15472E3                    | -                           | 45472E3                     |
|                                          | 6800                                 | 21 x 38                                                  | 4590                              | 1346                                   | 475                                    | 26                                     | 43                                     | 18                                     | 29                                     | 29                                   | 15682E3                    | -                           | 45682E3                     |
| 25                                       | 470                                  | 10 x 30                                                  | 2100                              | 181                                    | 87                                     | 112                                    | 187                                    | 45                                     | 74                                     | 84                                   | 16471E3                    | 26471E3                     | -                           |
|                                          | 680                                  | 12.5 x 30                                                | 2550                              | 244                                    | 108                                    | 81                                     | 136                                    | 35                                     | 59                                     | 64                                   | 16681E3                    | 26681E3                     | -                           |
|                                          | 1000                                 | 12.5 x 30                                                | 2600                              | 340                                    | 140                                    | 64                                     | 107                                    | 32                                     | 53                                     | 55                                   | 16102E3                    | 26102E3                     | -                           |
|                                          | 1500                                 | 15 x 30                                                  | 2890                              | 490                                    | 190                                    | 49                                     | 82                                     | 28                                     | 46                                     | 46                                   | 16152E3                    | 26152E3                     | 46152E3                     |
|                                          | 2200                                 | 18 x 30                                                  | 3310                              | 700                                    | 260                                    | 43                                     | 71                                     | 27                                     | 44                                     | 44                                   | 16222E3                    | -                           | 46222E3                     |
|                                          | 3300                                 | 18 x 38                                                  | 4350                              | 1030                                   | 370                                    | 28                                     | 47                                     | 18                                     | 29                                     | 29                                   | 16332E3                    | -                           | 46332E3                     |
|                                          | 4700                                 | 21 x 38                                                  | 4470                              | 1450                                   | 510                                    | 27                                     | 44                                     | 18                                     | 29                                     | 29                                   | 16472E3                    | -                           | 46472E3                     |
| 40                                       | 220                                  | 10 x 30                                                  | 1990                              | 146                                    | 75                                     | 192                                    | 320                                    | 52                                     | 87                                     | 124                                  | 17221E3                    | 27221E3                     | -                           |
|                                          | 330                                  | 12.5 x 30                                                | 2430                              | 198                                    | 93                                     | 130                                    | 216                                    | 37                                     | 62                                     | 83                                   | 17331E3                    | 27331E3                     | -                           |
|                                          | 470                                  | 12.5 x 30                                                | 2550                              | 266                                    | 115                                    | 101                                    | 169                                    | 35                                     | 58                                     | 70                                   | 17471E3                    | 27471E3                     | -                           |
|                                          | 680                                  | 15 x 30                                                  | 2840                              | 366                                    | 149                                    | 75                                     | 125                                    | 30                                     | 50                                     | 55                                   | 17681E3                    | 27681E3                     | 47681E3                     |
|                                          | 1000                                 | 18 x 30                                                  | 3150                              | 520                                    | 200                                    | 59                                     | 99                                     | 28                                     | 47                                     | 49                                   | 17102E3                    | -                           | 47102E3                     |
|                                          | 1500                                 | 18 x 38                                                  | 4130                              | 760                                    | 280                                    | 39                                     | 65                                     | 19                                     | 31                                     | 32                                   | 17152E3                    | -                           | 47152E3                     |
|                                          | 2200                                 | 21 x 38                                                  | 4170                              | 1096                                   | 392                                    | 34                                     | 56                                     | 19                                     | 31                                     | 31                                   | 17222E3                    | -                           | 47222E3                     |
| 63                                       | 100                                  | 10 x 30                                                  | 1560                              | 116                                    | 65                                     | 297                                    | 495                                    | 92                                     | 154                                    | 249                                  | 18101E3                    | 28101E3                     | -                           |
|                                          | 150                                  | 12.5 x 30                                                | 2050                              | 153                                    | 78                                     | 195                                    | 325                                    | 61                                     | 102                                    | 162                                  | 18151E3                    | 28151E3                     | -                           |
|                                          | 220                                  | 12.5 x 30                                                | 2150                              | 206                                    | 95                                     | 149                                    | 249                                    | 55                                     | 92                                     | 126                                  | 18221E3                    | 28221E3                     | -                           |
|                                          | 330                                  | 15 x 30                                                  | 2510                              | 289                                    | 123                                    | 105                                    | 175                                    | 44                                     | 73                                     | 91                                   | 18331E3                    | 28331E3                     | 48331E3                     |
|                                          | 470                                  | 18 x 30                                                  | 2860                              | 395                                    | 158                                    | 81                                     | 135                                    | 38                                     | 64                                     | 74                                   | 18471E3                    | -                           | 48471E3                     |
|                                          | 680                                  | 18 x 38                                                  | 3720                              | 554                                    | 211                                    | 55                                     | 92                                     | 26                                     | 43                                     | 49                                   | 18681E3                    | -                           | 48681E3                     |
|                                          | 1000                                 | 21 x 38                                                  | 3780                              | 796                                    | 292                                    | 44                                     | 74                                     | 25                                     | 41                                     | 43                                   | 18102E3                    | -                           | 48102E3                     |
| 100                                      | 47                                   | 10 x 30                                                  | 760                               | 96                                     | 59                                     | 760                                    | 1269                                   | 349                                    | 581                                    | 720                                  | 19479E3                    | 29479E3                     | -                           |
|                                          | 68                                   | 12.5 x 30                                                | 1030                              | 122                                    | 67                                     | 531                                    | 885                                    | 246                                    | 410                                    | 503                                  | 19689E3                    | 29689E3                     | -                           |
|                                          | 100                                  | 12.5 x 30                                                | 1140                              | 160                                    | 80                                     | 389                                    | 648                                    | 196                                    | 327                                    | 381                                  | 19101E3                    | 29101E3                     | -                           |
|                                          | 150                                  | 15 x 30                                                  | 1480                              | 220                                    | 100                                    | 266                                    | 443                                    | 137                                    | 229                                    | 262                                  | 19151E3                    | 29151E3                     | 49151E3                     |
|                                          | 220                                  | 18 x 30                                                  | 1960                              | 304                                    | 128                                    | 181                                    | 302                                    | 95                                     | 158                                    | 179                                  | 19221E3                    | -                           | 49221E3                     |
|                                          | 330                                  | 18 x 38                                                  | 2550                              | 436                                    | 172                                    | 120                                    | 200                                    | 62                                     | 104                                    | 117                                  | 19331E3                    | -                           | 49331E3                     |
|                                          | 470                                  | 21 x 38                                                  | 2800                              | 604                                    | 228                                    | 92                                     | 154                                    | 52                                     | 86                                     | 94                                   | 19471E3                    | -                           | 49471E3                     |

**ORDERING EXAMPLE**

Electrolytic capacitor 120 series

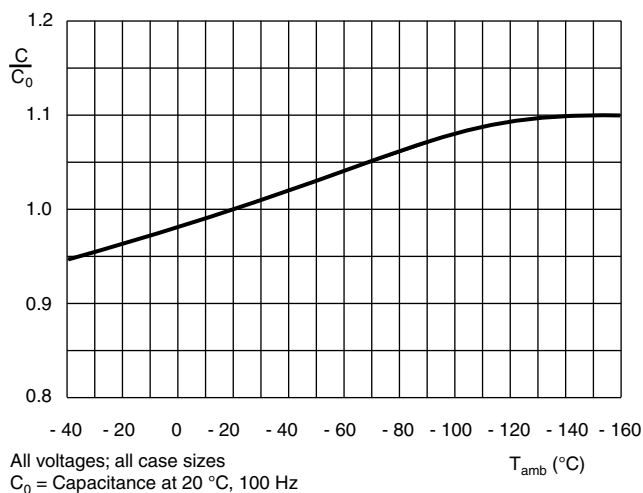
1000  $\mu\text{F}$ /16 V;  $\pm 20\%$ Nominal case size:  $\varnothing 12.5\text{ mm} \times 30\text{ mm}$ ; form BR

Ordering code: MAL212025102E3

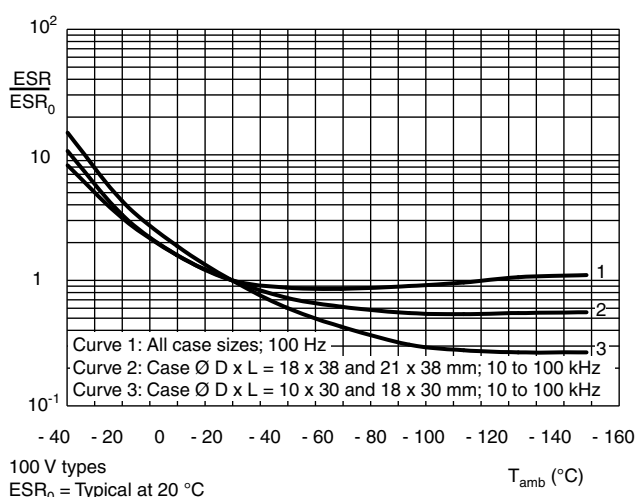
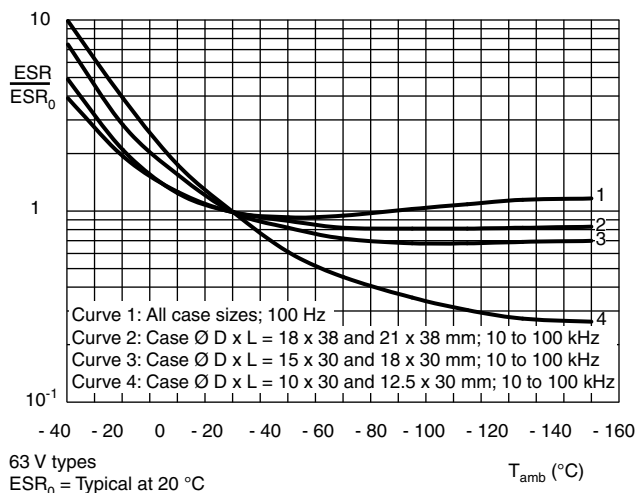
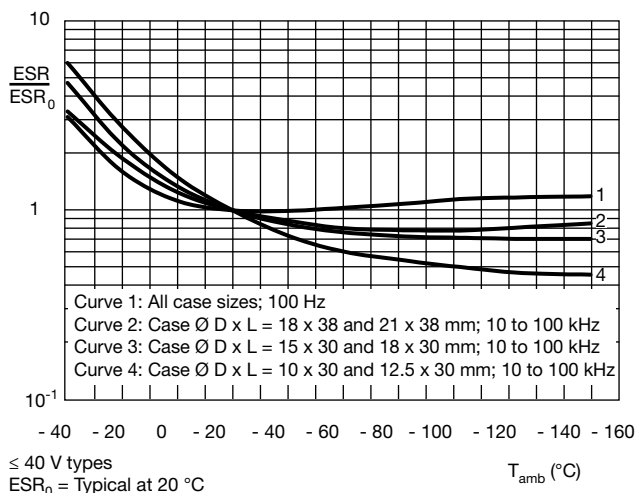
Former 12NC: 2222 120 25102

| ADDITIONAL ELECTRICAL DATA         |                      |                                               |               |
|------------------------------------|----------------------|-----------------------------------------------|---------------|
| PARAMETER                          | CONDITIONS           | VALUE                                         |               |
|                                    |                      | AXIAL                                         | MOUNTING RING |
| Voltage                            |                      |                                               |               |
| Surge voltage                      |                      | $U_s \leq 1.15 \times U_R$                    |               |
| Reverse voltage                    |                      | $U_{rev} \leq 1 \text{ V}$                    |               |
| Current                            |                      |                                               |               |
| Leakage current                    | After 1 min at $U_R$ | $I_{L1} \leq 0.012 C_R \times U_R + 40 \mu A$ |               |
|                                    | After 5 min at $U_R$ | $I_{L5} \leq 0.004 C_R \times U_R + 40 \mu A$ |               |
| Inductance                         |                      |                                               |               |
| Equivalent series inductance (ESL) | Case Ø D x L mm:     |                                               |               |
|                                    | 10 x 30              | Typ. 38 nH                                    |               |
|                                    | 12.5 x 30            | Typ. 46 nH                                    |               |
|                                    | 15 x 30              | Typ. 48 nH                                    | Typ. 39 nH    |
|                                    | 18 x 30              | Typ. 50 nH                                    | Typ. 39 nH    |
|                                    | 18 x 38              | Typ. 54 nH                                    | Typ. 39 nH    |
|                                    | 21 x 38              | Typ. 59 nH                                    | Typ. 39 nH    |

### CAPACITANCE (C)



### EQUIVALENT SERIES RESISTANCE (ESR)



**RIPPLE CURRENT AND USEFUL LIFE**

$I_A$  = Actual ripple current at 10 kHz  
 $I_R$  = Rated ripple current at 10 kHz, 125 °C  
<sup>(1)</sup> Useful life at 125 °C and  $I_R$  applied: 8000 h

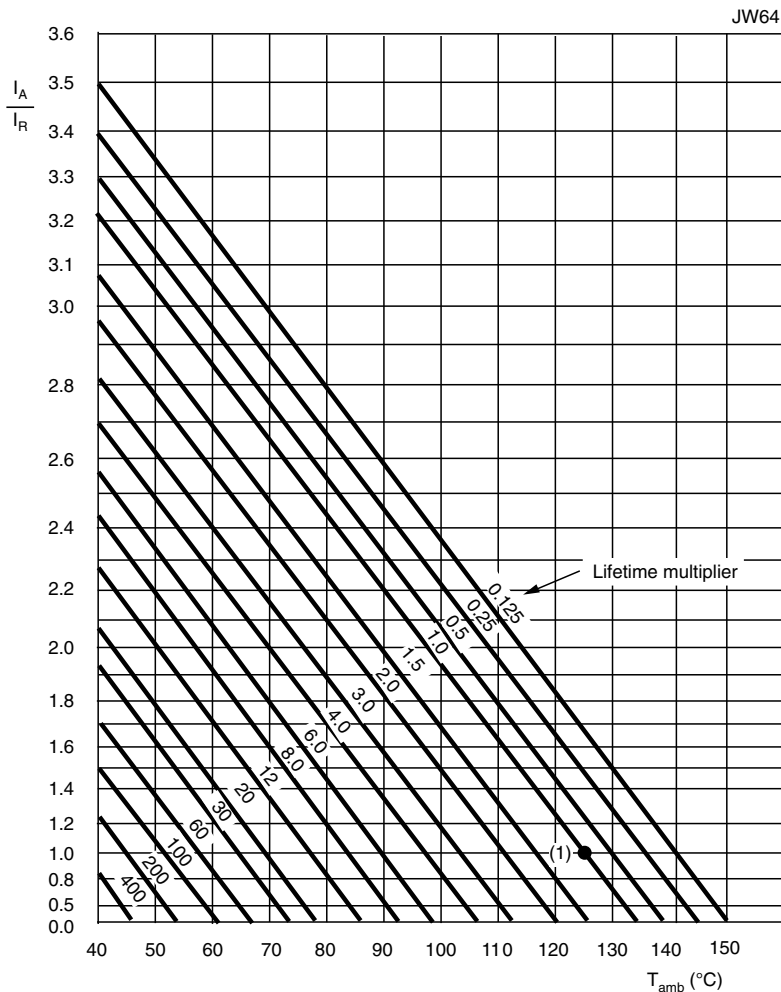


Fig. 9 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                                                                             |                                                                             |                                                                               |                                                                               |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| FREQUENCY<br>(Hz)                                                 | $I_R$ MULTIPLIER                                                            |                                                                             |                                                                               |                                                                               |
|                                                                   | $U_R = 16\text{ V TO }40\text{ V}$<br>CASE SIZES<br>(10 x 30 to 15 x 30) mm | $U_R = 16\text{ V TO }40\text{ V}$<br>CASE SIZES<br>(18 x 30 to 21 x 38) mm | $U_R = 63\text{ V AND }100\text{ V}$<br>CASE SIZES<br>(10 x 30 to 15 x 30) mm | $U_R = 63\text{ V AND }100\text{ V}$<br>CASE SIZES<br>(18 x 30 to 21 x 38) mm |
| 50                                                                | 0.37                                                                        | 0.54                                                                        | 0.23                                                                          | 0.44                                                                          |
| 100                                                               | 0.48                                                                        | 0.63                                                                        | 0.32                                                                          | 0.56                                                                          |
| 300                                                               | 0.69                                                                        | 0.75                                                                        | 0.53                                                                          | 0.76                                                                          |
| 1000                                                              | 0.86                                                                        | 0.81                                                                        | 0.77                                                                          | 0.88                                                                          |
| 3000                                                              | 0.96                                                                        | 0.87                                                                        | 0.93                                                                          | 0.94                                                                          |
| ≥ 10 000                                                          | 1.00                                                                        | 1.00                                                                        | 1.00                                                                          | 1.00                                                                          |

Table 5

| TEST PROCEDURES AND REQUIREMENTS            |                                             |                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                             |
|---------------------------------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST                                        |                                             | PROCEDURE<br>(quick reference)                                                                                                                                                                                                                                                              | REQUIREMENTS                                                                                                                                                                                                                |
| NAME OF TEST                                | REFERENCE                                   |                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                             |
| Endurance                                   | IEC 60384-4/<br>EN 130300<br>subclause 4.13 | $T_{amb} = 125\text{ }^{\circ}\text{C}$ ; $U_R$ applied;<br>4000 h<br><br>$T_{amb} = 150\text{ }^{\circ}\text{C}$ ; $U_R$ applied;<br>1000 h                                                                                                                                                | $\Delta C/C$ : $\pm 15\%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                   |
| Useful life                                 | CECC 30301<br>subclause 1.8.1               | $T_{amb} = 125\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied;<br>8000 h                                                                                                                                                                                                                | $\Delta C/C$ : $\pm 45\%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$Z \leq 3 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1\%$ |
| Shelf life<br>(storage at high temperature) | IEC 60384-4/<br>EN 130300<br>subclause 4.17 | $T_{amb} = 125\text{ }^{\circ}\text{C}$ ; no voltage applied;<br>1000 h (100 V: 500 h)<br><br>$T_{amb} = 150\text{ }^{\circ}\text{C}$ ; no voltage applied;<br>500 h for voltages: $\leq 63\text{ V}$<br><br>After test: $U_R$ to be applied for 30 min,<br>24 h to 48 h before measurement | $\Delta C/C$ , $\tan \delta$ , $Z$ :<br>For requirements<br>see "Endurance test" above<br>$I_{L5} \leq 2 \times \text{spec. limit}$                                                                                         |
| Reverse voltage                             | IEC 60384-4/<br>EN 130300<br>subclause 4.15 | $T_{amb} = 125\text{ }^{\circ}\text{C}$ :<br>125 h at $U = -1\text{ V}$<br>Followed by 125 h at $U_R$                                                                                                                                                                                       | $\Delta C/C$ : $\pm 20\%$<br>$\tan \delta \leq \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                                                                      |



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