AUTOMOTIVE

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COMPLIANT



# Aluminum Electrolytic Capacitors Axial High Temperature, High Ripple Current

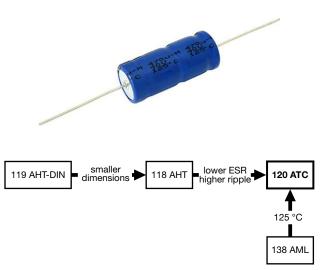


Fig. 1

| 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
- Low ESR levels provide 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
- AEC-Q200 qualified
- Material categorization: for definitions of compliance please see <a href="https://www.vishay.com/doc?99912"><u>www.vishay.com/doc?99912</u></a>

### **APPLICATIONS**

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

#### **MARKING**

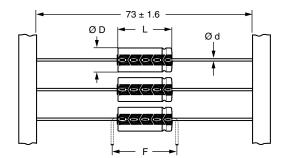
The capacitors are marked (where possible) with the following information:

- 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      | 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> | U <sub>R</sub> (V)   |           |           |           |           |  |  |  |  |  |
| (μ <b>F</b> )  | 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  | -         | -         | -         | -         |  |  |  |  |  |

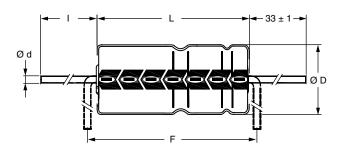


### **DIMENSIONS** in millimeters **AND AVAILABLE FORMS**



Form BR: Taped on reel Case  $\emptyset$  D x L = 6.5 mm x 18 mm to 15 mm x 30 mm

Fig. 2 - Form BR



Form AA: Axial in box Case Ø D x L = 10 mm x 30 mm to 21 mm x 38 mm

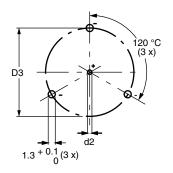
Fig. 3 - Form AA

### Table 1

| AXIAL; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES |                    |        |                     |                    |                   |             |                      |            |
|--|--------------------|--------|---------------------|--------------------|-------------------|-------------|----------------------|------------|
| NOMINAL CASE SIZE  |                    | AXIAL: | FORM AA AN          | ID BR              |                   | MACC        | PACKAGING QUANTITIES |            |
| Ø D x L<br>(mm)  | Ø d <sup>(1)</sup> | ı      | Ø D <sub>max.</sub> | L <sub>max</sub> . | F <sub>min.</sub> | MASS<br>(g) | FORM<br>AA           | FORM<br>BR |
| 10 x 30  | 0.8                | 55 ± 1 | 10.5                | 30.5               | 35                | ≈ 4.8       | 340                  | 500        |
| 12.5 x 30  | 0.8                | 55 ± 1 | 13.0                | 30.5               | 35                | ≈ 7.4       | 260                  | 400        |
| 15 x 30  | 0.8                | 55 ± 1 | 15.5                | 30.5               | 35                | ≈ 11.7      | 200                  | 250        |
| 18 x 30  | 0.8                | 55 ± 1 | 18.5                | 30.5               | 35                | ≈ 12.9      | 120                  | -          |
| 18 x 38  | 0.8                | 34 ± 1 | 18.5                | 39.5               | 44                | ≈ 19.0      | 125                  | -          |
| 21 x 38  | 0.8                | 34 ± 1 | 21.5                | 39.5               | 44                | ≈ 24.0      | 100                  | -          |

### Notes

- For detailed tape dimensions, please see www.vishay.com/doc?28361
- $^{(1)}$  Lead diameter Ø d = 1.0 mm, available on request



Mounting holes

Case Ø D x L = 15 mm x 30 mm to 21 mm x 38 mm Especially for applications with severe shocks and vibrations

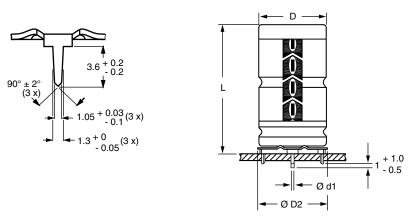


Fig. 4 - Mounting hole diagram and outline; form MR: With mounting ring and pins

### Table 2

| MOUNTING RING; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES |      |      |           |                     |                      |            |                   |        |            |
|--|------|------|-----------|---------------------|----------------------|------------|-------------------|--------|------------|
| NOMINAL CASE SIZE  | CASE |      | N         | MASS                | PACKAGING            |            |                   |        |            |
| ØDxL   | CODE | Ø d1 | Ø d2      | Ø D <sub>max.</sub> | Ø D2 <sub>max.</sub> | D3         | L <sub>max.</sub> | (g)    | QUANTITIES |
| 15 x 30  | 02   | 0.8  | 1.0 + 0.4 | 15.5                | 17.5                 | 16.5 ± 0.2 | 33                | ≈ 8.6  | 200        |
| 18 x 30  | 03   | 0.8  | 1.0 + 0.4 | 18.5                | 19.5                 | 18.5 ± 0.2 | 33                | ≈ 11.5 | 240        |
| 18 x 38  | 04   | 0.8  | 1.0 + 0.4 | 18.5                | 19.5                 | 18.5 ± 0.2 | 42                | ≈ 14.0 | 100        |
| 21 x 38  | 05   | 0.8  | 1.0 + 0.4 | 21.5                | 22.5                 | 21.5 ± 0.2 | 42                | ≈ 19.2 | 100        |



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

### **ORDERING EXAMPLE**

Electrolytic capacitor 120 series  $1000 \mu F / 16 V; \pm 20 \%$ 

Nominal case size: Ø 12.5 mm x 30 mm; form BR

Ordering code: MAL212025102E3 Former 12NC: 2222 120 25102

### Note

 Unless otherwise specified, all electrical values in Table 3 apply at T<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

### Table 3

| E                     | ELECTRICAL DATA AND ORDERING INFORMATION |                              |                          |                                  |                                  |                       |                       |                       |                       |                        |                   |                   |                             |                             |
|-----------------------|--|------------------------------|--------------------------|----------------------------------|----------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|-------------------|-------------------|-----------------------------|-----------------------------|
|                       |  | NOMINAL                      | I <sub>R</sub>           | ١.                               |                                  | TYP.                  | MAX.                  | TYP.                  | MAX.                  | z                      |                   | ORDERIN           | ORDERING CODE MAL2120       |                             |
| U <sub>R</sub><br>(V) | C <sub>R</sub><br>100 Hz<br>(µF)         | CASE SIZE<br>Ø D x L<br>(mm) | 10 kHz<br>125 °C<br>(mA) | I <sub>L1</sub><br>1 min<br>(μΑ) | Ι <sub>L5</sub><br>5 min<br>(μΑ) | ESR<br>100 Hz<br>(mΩ) | ESR<br>100 Hz<br>(mΩ) | ESR<br>10 kHz<br>(mΩ) | ESR<br>10 kHz<br>(mΩ) | MAX.<br>10 kHz<br>(mΩ) | FREQ.<br>CODE (1) | IN BOX<br>FORM AA | TAPED<br>ON REEL<br>FORM BR | MOUNTING<br>RING<br>FORM MR |
|                       | 680                                      | 10 x 30                      | 2100                     | 171                              | 84                               | 106                   | 177                   | 44                    | 74                    | 78                     | MF1               | 15681E3           | 25681E3                     | -                           |
|                       | 1000                                     | 12.5 x 30                    | 2550                     | 232                              | 104                              | 77                    | 128                   | 35                    | 58                    | 61                     | MF1               | 15102E3           | 25102E3                     | -                           |
|                       | 1500                                     | 12.5 x 30                    | 2650                     | 328                              | 136                              | 60                    | 100                   | 32                    | 53                    | 53                     | MF1               | 15152E3           | 25152E3                     | -                           |
| 16                    | 2200                                     | 15 x 30                      | 2940                     | 462                              | 181                              | 48                    | 79                    | 28                    | 46                    | 46                     | MF1               | 15222E3           | 25222E3                     | 45222E3                     |
|                       | 3300                                     | 18 x 30                      | 3430                     | 674                              | 251                              | 41                    | 68                    | 26                    | 43                    | 43                     | MF2               | 15332E3           | -                           | 45332E3                     |
|                       | 4700                                     | 18 x 38                      | 4350                     | 942                              | 341                              | 27                    | 45                    | 18                    | 29                    | 29                     | MF2               | 15472E3           | -                           | 45472E3                     |
|                       | 6800                                     | 21 x 38                      | 4590                     | 1346                             | 475                              | 26                    | 43                    | 18                    | 29                    | 29                     | MF2               | 15682E3           | -                           | 45682E3                     |
|                       | 470                                      | 10 x 30                      | 2100                     | 181                              | 87                               | 112                   | 187                   | 45                    | 74                    | 84                     | MF1               | 16471E3           | 26471E3                     | -                           |
|                       | 680                                      | 12.5 x 30                    | 2550                     | 244                              | 108                              | 81                    | 136                   | 35                    | 59                    | 64                     | MF1               | 16681E3           | 26681E3                     | -                           |
|                       | 1000                                     | 12.5 x 30                    | 2600                     | 340                              | 140                              | 64                    | 107                   | 32                    | 53                    | 55                     | MF1               | 16102E3           | 26102E3                     | -                           |
| 25                    | 1500                                     | 15 x 30                      | 2890                     | 490                              | 190                              | 49                    | 82                    | 28                    | 46                    | 46                     | MF1               | 16152E3           | 26152E3                     | 46152E3                     |
|                       | 2200                                     | 18 x 30                      | 3310                     | 700                              | 260                              | 43                    | 71                    | 27                    | 44                    | 44                     | MF2               | 16222E3           | -                           | 46222E3                     |
|                       | 3300                                     | 18 x 38                      | 4350                     | 1030                             | 370                              | 28                    | 47                    | 18                    | 29                    | 29                     | MF2               | 16332E3           | -                           | 46332E3                     |
|                       | 4700                                     | 21 x 38                      | 4470                     | 1450                             | 510                              | 27                    | 44                    | 18                    | 29                    | 29                     | MF2               | 16472E3           | -                           | 46472E3                     |
|                       | 220                                      | 10 x 30                      | 1990                     | 146                              | 75                               | 192                   | 320                   | 52                    | 87                    | 124                    | MF1               | 17221E3           | 27221E3                     | -                           |
|                       | 330                                      | 12.5 x 30                    | 2430                     | 198                              | 93                               | 130                   | 216                   | 37                    | 62                    | 83                     | MF1               | 17331E3           | 27331E3                     | -                           |
|                       | 470                                      | 12.5 x 30                    | 2550                     | 266                              | 115                              | 101                   | 169                   | 35                    | 58                    | 70                     | MF1               | 17471E3           | 27471E3                     | -                           |
| 40                    | 680                                      | 15 x 30                      | 2840                     | 366                              | 149                              | 75                    | 125                   | 30                    | 50                    | 55                     | MF1               | 17681E3           | 27681E3                     | 47681E3                     |
|                       | 1000                                     | 18 x 30                      | 3150                     | 520                              | 200                              | 59                    | 99                    | 28                    | 47                    | 49                     | MF2               | 17102E3           | -                           | 47102E3                     |
|                       | 1500                                     | 18 x 38                      | 4130                     | 760                              | 280                              | 39                    | 65                    | 19                    | 31                    | 32                     | MF2               | 17152E3           | -                           | 47152E3                     |
|                       | 2200                                     | 21 x 38                      | 4170                     | 1096                             | 392                              | 34                    | 56                    | 19                    | 31                    | 31                     | MF2               | 17222E3           | -                           | 47222E3                     |
|                       | 100                                      | 10 x 30                      | 1560                     | 116                              | 65                               | 297                   | 495                   | 92                    | 154                   | 249                    | MF3               | 18101E3           | 28101E3                     | -                           |
|                       | 150                                      | 12.5 x 30                    | 2050                     | 153                              | 78                               | 195                   | 325                   | 61                    | 102                   | 162                    | MF3               | 18151E3           | 28151E3                     | -                           |
|                       | 220                                      | 12.5 x 30                    | 2150                     | 206                              | 95                               | 149                   | 249                   | 55                    | 92                    | 126                    | MF3               | 18221E3           | 28221E3                     | -                           |
| 63                    | 330                                      | 15 x 30                      | 2510                     | 289                              | 123                              | 105                   | 175                   | 44                    | 73                    | 91                     | MF3               | 18331E3           | 28331E3                     | 48331E3                     |
|                       | 470                                      | 18 x 30                      | 2860                     | 395                              | 158                              | 81                    | 135                   | 38                    | 64                    | 74                     | MF4               | 18471E3           | -                           | 48471E3                     |
|                       | 680                                      | 18 x 38                      | 3720                     | 554                              | 211                              | 55                    | 92                    | 26                    | 43                    | 49                     | MF4               | 18681E3           | -                           | 48681E3                     |
|                       | 1000                                     | 21 x 38                      | 3780                     | 796                              | 292                              | 44                    | 74                    | 25                    | 41                    | 43                     | MF4               | 18102E3           | -                           | 48102E3                     |
|                       | 47                                       | 10 x 30                      | 760                      | 96                               | 59                               | 760                   | 1269                  | 349                   | 581                   | 720                    | MF3               | 19479E3           | 29479E3                     | -                           |
|                       | 68                                       | 12.5 x 30                    | 1030                     | 122                              | 67                               | 531                   | 885                   | 246                   | 410                   | 503                    | MF3               | 19689E3           | 29689E3                     | -                           |
|                       | 100                                      | 12.5 x 30                    | 1140                     | 160                              | 80                               | 389                   | 648                   | 196                   | 327                   | 381                    | MF3               | 19101E3           | 29101E3                     | -                           |
| 100                   | 150                                      | 15 x 30                      | 1480                     | 220                              | 100                              | 266                   | 443                   | 137                   | 229                   | 262                    | MF3               | 19151E3           | 29151E3                     | 49151E3                     |
|                       | 220                                      | 18 x 30                      | 1960                     | 304                              | 128                              | 181                   | 302                   | 95                    | 158                   | 179                    | MF4               | 19221E3           | -                           | 49221E3                     |
|                       | 330                                      | 18 x 38                      | 2550                     | 436                              | 172                              | 120                   | 200                   | 62                    | 104                   | 117                    | MF4               | 19331E3           | -                           | 49331E3                     |
|                       | 470                                      | 21 x 38                      | 2800                     | 604                              | 228                              | 92                    | 154                   | 52                    | 86                    | 94                     | MF4               | 19471E3           | -                           | 49471E3                     |

### Note

<sup>(1)</sup> Determines the applicable row in the table "Multiplier of Ripple Current (I<sub>R</sub>) as a Function of Frequency"

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| ADDITIONAL ELECTRICAL DATA         |                               |   |                          |  |  |  |  |
|------------------------------------|-------------------------------|---|--------------------------|--|--|--|--|
| PARAMETER                          | CONDITIONS                    | VALUE                                     |                          |  |  |  |  |
| PARAMETER                          | CONDITIONS                    | AXIAL                                     | MOUNTING RING            |  |  |  |  |
| Voltage                            |                               |   |                          |  |  |  |  |
| Surge voltage                      |                               | U <sub>s</sub> ≤ 1.15 x U <sub>R</sub>    |                          |  |  |  |  |
| Reverse voltage                    |                               | U <sub>rev</sub> ≤ 1 V                    |                          |  |  |  |  |
| Current                            |                               |   |                          |  |  |  |  |
| Lookaga ayyyant                    | After 1 min at U <sub>R</sub> | After 1 min at $U_R$ $I_{L1} \le 0.012 C$ |                          |  |  |  |  |
| Leakage current                    | After 5 min at U <sub>R</sub> | $I_{L5} \le 0.004 C_F$                    | x U <sub>R</sub> + 40 μA |  |  |  |  |
| Inductance                         |                               | •   |                          |  |  |  |  |
|                                    | Case Ø D x L mm:              |   |                          |  |  |  |  |
|                                    | 10 x 30                       | Typ. 38 nH                                |                          |  |  |  |  |
|                                    | 12.5 x 30                     | Typ. 46 nH                                |                          |  |  |  |  |
| Equivalent series inductance (ESL) | 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)**

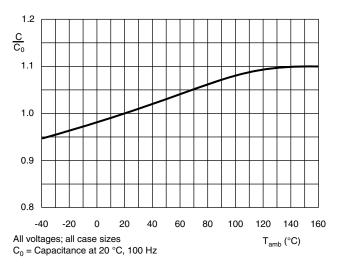


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature

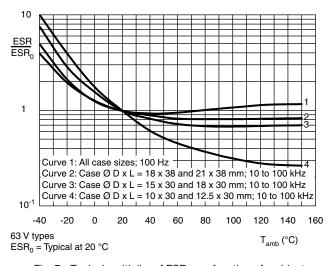


Fig. 7 - Typical multiplier of ESR as a function of ambient temperature at different frequencies

### **EQUIVALENT SERIES RESISTANCE (ESR)**

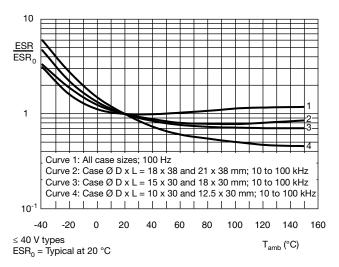


Fig. 6 - Typical multiplier of ESR as a function of ambient temperature at different frequencies

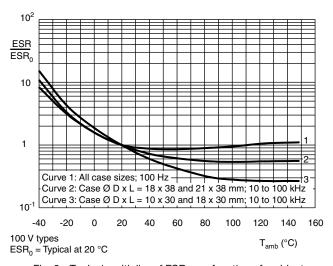


Fig. 8 - Typical multiplier of ESR as a function of ambient temperature at different frequencies



### **RIPPLE CURRENT AND USEFUL LIFE**

### Table 4

| ENDURANCE TEST DURATION AND USEFUL LIFE |                                 |  |  |  |  |
|---|---------------------------------|--|--|--|--|
| ENDURANCE<br>AT 125 °C<br>(h)           | USEFUL LIFE<br>AT 125 °C<br>(h) |  |  |  |  |
| 4000                                    | 8000                            |  |  |  |  |

### Note

• Multiplier of useful life code: JW64

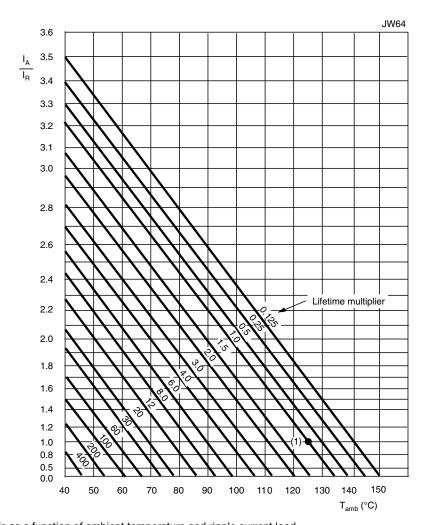


Fig. 9 - Multiplier of useful life as a function of ambient temperature and ripple current load

### Table 5

| MULTIPLIER OF RIPPLE CURRENT (IR) AS A FUNCTION OF FREQUENCY |      |                           |      |      |      |          |  |  |  |
|--|------|---------------------------|------|------|------|----------|--|--|--|
|  |      | FREQUENCY (Hz)            |      |      |      |          |  |  |  |
| FREQ.<br>CODE  | 50   | 100                       | 300  | 1000 | 3000 | ≥ 10 000 |  |  |  |
| 0052   |      | I <sub>R</sub> MULTIPLIER |      |      |      |          |  |  |  |
| MF1  | 0.37 | 0.48                      | 0.69 | 0.86 | 0.96 | 1.00     |  |  |  |
| MF2  | 0.54 | 0.63                      | 0.75 | 0.81 | 0.87 | 1.00     |  |  |  |
| MF3  | 0.23 | 0.32                      | 0.53 | 0.77 | 0.93 | 1.00     |  |  |  |
| MF4  | 0.44 | 0.56                      | 0.76 | 0.88 | 0.94 | 1.00     |  |  |  |

 $I_A$  = Actual ripple current at 10 kHz

 $I_R$  = Rated ripple current at 10 kHz, 125 °C

 $<sup>^{(1)}</sup>$  Useful life at 125  $^{\circ}\text{C}$  and  $\text{I}_{\text{R}}$  applied: 8000 h



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### Table 6

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

Statements about product lifetime are based on calculations and internal testing. They should only be interpreted as estimations. Also due to external factors, the lifetime in the field application may deviate from the calculated lifetime. In general, nothing stated herein shall be construed as a guarantee of durability.



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