

## Aluminum Electrolytic Capacitors

### Power High Ripple Current Long Life Screw Terminals

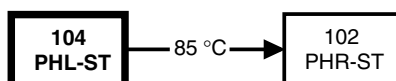


Fig. 1

#### QUICK REFERENCE DATA

| DESCRIPTION                                         | VALUE                   |
|-----------------------------------------------------|-------------------------|
| Nominal case size (Ø D x L in mm)                   | 35 x 60 to 90 x 220     |
| Rated capacitance range (E6 series), C <sub>R</sub> | 150 µF to 33 000 µF     |
| Tolerance on C <sub>R</sub>                         | ± 20 %                  |
| Rated voltage range, U <sub>R</sub>                 | 200 V to 450 V          |
| Category temperature range                          | -40 °C to +105 °C       |
| Endurance test at 105 °C                            | 2000 h                  |
| Useful life at 105 °C                               | 5000 h                  |
| Shelf life at 0 V, 105 °C                           | 1000 h                  |
| Based on sectional specification                    | IEC 60384-4 / EN 130300 |
| Climatic category IEC 60068                         | 40 / 105 / 56           |

#### FEATURES

- Long useful life: 5000 h at +105 °C
- High reliability
- Available in case sizes up to Ø 90 mm x 220 mm
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, cylindrical aluminum case, insulated with a blue sleeve
- Also available in bolt version (104 PHL-STB)
- Pressure relief in the sealing
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

#### APPLICATIONS

- Telecom and industrial, high temperature systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems
- Traction (subway, metro, light rail)

#### MARKING

The capacitors are marked with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (± 20 %)
- Rated voltage (in V)
- Date code (YYMM)
- Name of manufacturer
- Code for factory of origin
- “-” sign to identify the negative terminal, visible from the top and side of the capacitor
- Code number
- Climatic category in accordance with IEC 60068
- “LL” for long life grade

#### SELECTION CHART FOR C<sub>R</sub>, U<sub>R</sub>, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

| C <sub>R</sub><br>(µF) | U <sub>R</sub> (V) |          |          |          |          |
|------------------------|--------------------|----------|----------|----------|----------|
|                        | 200                | 250      | 350      | 400      | 450      |
| 150                    | -                  | -        | -        | -        | 35 x 60  |
| 220                    | -                  | -        | -        | 35 x 60  | 35 x 80  |
| 330                    | -                  | -        | 35 x 60  | 35 x 80  | 35 x 105 |
| 470                    | -                  | -        | 35 x 80  | 35 x 80  | 50 x 80  |
| 680                    | 35 x 60            | 35 x 60  | 35 x 105 | 50 x 80  | 50 x 105 |
|                        | 35 x 60            | 35 x 80  | 50 x 80  | 50 x 105 | 50 x 105 |
| 1000                   | 35 x 80            | 35 x 105 | -        | -        | 65 x 105 |
|                        | 35 x 80            | -        | -        | -        | -        |
| 1500                   | 35 x 80            | 35 x 105 | 50 x 105 | 50 x 105 | 65 x 105 |
|                        | 35 x 105           | 50 x 80  | -        | 65 x 105 | 76 x 105 |
| 2200                   | 35 x 105           | 50 x 80  | 65 x 105 | 65 x 105 | 76 x 105 |
|                        | 50 x 80            | 35 x 105 | -        | 76 x 105 | 76 x 146 |
| 3300                   | 50 x 80            | 50 x 105 | -        | 76 x 105 | 76 x 146 |
|                        | 50 x 105           | 65 x 105 | -        | 76 x 146 | -        |

| <b>SELECTION CHART FOR <math>C_R</math>, <math>U_R</math>, AND RELEVANT NOMINAL CASE SIZES (<math>\varnothing D \times L</math> in mm)</b> |           |          |          |          |          |
|--------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------|----------|----------|----------|
| $C_R$<br>( $\mu F$ )                                                                                                                       | $U_R$ (V) |          |          |          |          |
|                                                                                                                                            | 200       | 250      | 350      | 400      | 450      |
| 4700                                                                                                                                       | 50 x 105  | 65 x 105 | -        | 76 x 146 | 76 x 220 |
|                                                                                                                                            | 65 x 105  | 76 x 105 | 76 x 146 | -        | 90 x 146 |
| 6800                                                                                                                                       | 65 x 105  | 76 x 105 | 76 x 146 | 76 x 220 | 90 x 220 |
|                                                                                                                                            | 76 x 105  | 76 x 146 | -        | 90 x 146 | -        |
| 10 000                                                                                                                                     | 76 x 105  | 76 x 146 | 76 x 220 | 90 x 220 | -        |
|                                                                                                                                            | 76 x 146  | -        | 90 x 146 | -        | -        |
| 15 000                                                                                                                                     | 76 x 146  | 76 x 220 | 90 x 220 | -        | -        |
|                                                                                                                                            | -         | 90 x 146 | -        | -        | -        |
| 22 000                                                                                                                                     | 76 x 220  | 90 x 220 | -        | -        | -        |
|                                                                                                                                            | 90 x 146  | -        | -        | -        | -        |
| 33 000                                                                                                                                     | 90 x 220  | -        | -        | -        | -        |

## DIMENSIONS in millimeters AND AVAILABLE FORMS

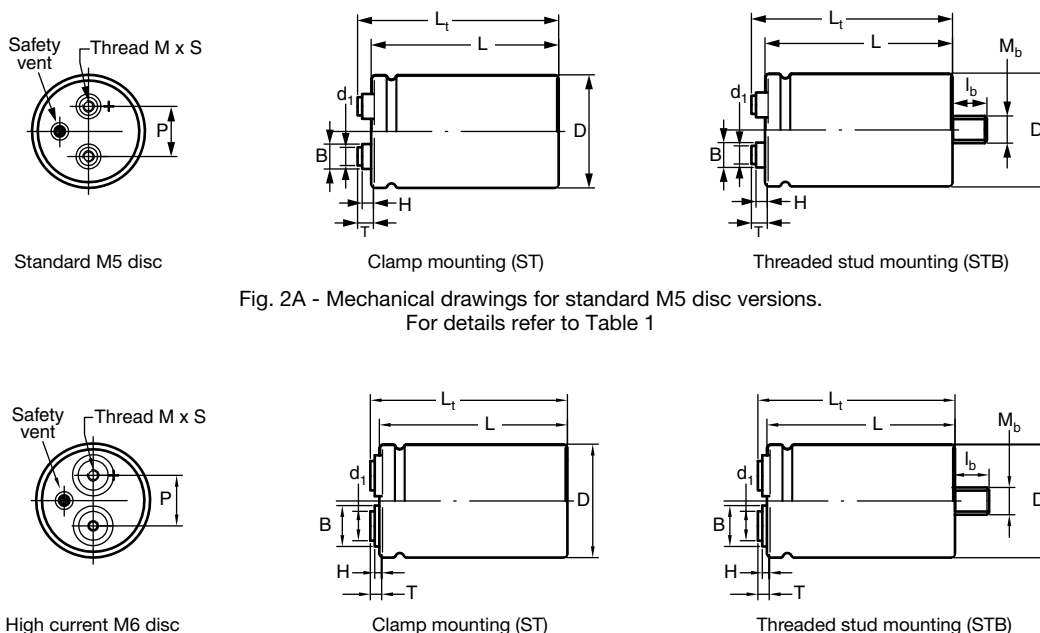


Fig. 2A - Mechanical drawings for standard M5 disc versions.  
For details refer to Table 1

Fig. 2B - Mechanical drawings for high current M6 disc versions.  
For details refer to Table 1

### Notes

- Maximum permissible torque which may be applied to the termination screws: 2 Nm for M5; 2.5 Nm for M6  
For accessories refer to document "Mounting Accessories", see [www.vishay.com/doc?28348](http://www.vishay.com/doc?28348)  
The capacitors are delivered with screws and washers
- High current disc with 1/4 28 UNF (US) thread is available on request

**Table 1**

| DIMENSIONS in millimeters AND MASS |         |       |                    |       |         |         |         |         |          |    |       |                |                      |          |
|------------------------------------|---------|-------|--------------------|-------|---------|---------|---------|---------|----------|----|-------|----------------|----------------------|----------|
| DESIGN                             | DRAWING | L ± 1 | L <sub>t</sub> ± 1 | D ± 1 | P ± 0.3 | T ± 0.2 | H ± 0.3 | B ± 0.3 | D1 ± 0.1 | M  | S - 0 | M <sub>b</sub> | I <sub>b</sub> ± 0.1 | MASS (g) |
| 35 x 60                            | 2A      | 63.3  | 68.7               | 35.3  | 12.8    | 7.0     | 4.6     | 11.0    | 7.9      | M5 | 9.5   | M8             | 12.0                 | 75       |
| 35 x 80                            | 2A      | 81.3  | 86.7               | 35.3  | 12.8    | 7.0     | 4.6     | 11.0    | 7.9      | M5 | 9.5   | M8             | 12.0                 | 95       |
| 35 x 105                           | 2A      | 103.3 | 108.7              | 35.3  | 12.8    | 7.0     | 4.6     | 11.0    | 7.9      | M5 | 9.5   | M8             | 12.0                 | 130      |
| 50 x 80                            | 2A      | 82.8  | 88.8               | 51.0  | 22.2    | 7.1     | 4.8     | 11.0    | 7.9      | M5 | 9.5   | M12            | 16.0                 | 200      |
| 50 x 105                           | 2A      | 104.8 | 110.8              | 51.0  | 22.2    | 7.1     | 4.8     | 11.0    | 7.9      | M5 | 9.5   | M12            | 16.0                 | 300      |
| 65 x 105                           | 2A      | 104.8 | 110.7              | 65.0  | 28.5    | 7.0     | 4.6     | 11.9    | 7.9      | M5 | 9.5   | M12            | 16.0                 | 480      |
| 65 x 105 HC                        | 2B      | 104.8 | 109.2              | 65.0  | 28.5    | 5.5     | 3.5     | 18.0    | 13.0     | M6 | 8.5   | M12            | 16.0                 | 480      |
| 76 x 105                           | 2A      | 105.8 | 111.7              | 76.4  | 31.8    | 7.0     | 4.6     | 11.7    | 7.9      | M5 | 9.5   | M12            | 16.0                 | 700      |
| 76 x 105 HC                        | 2B      | 105.8 | 110.2              | 76.4  | 31.8    | 5.5     | 3.5     | 18.3    | 13.0     | M6 | 8.5   | M12            | 16.0                 | 700      |
| 76 x 146                           | 2A      | 145.8 | 151.7              | 76.4  | 31.8    | 7.0     | 4.6     | 11.7    | 7.9      | M5 | 9.5   | M12            | 16.0                 | 1000     |
| 76 x 146 HC                        | 2B      | 145.8 | 150.2              | 76.4  | 31.8    | 5.5     | 3.5     | 18.3    | 13.0     | M6 | 8.5   | M12            | 16.0                 | 1000     |
| 76 x 220                           | 2A      | 219.8 | 225.7              | 76.4  | 31.8    | 7.0     | 4.6     | 11.7    | 7.9      | M5 | 9.5   | M12            | 16.0                 | 1500     |
| 76 x 220 HC                        | 2B      | 219.8 | 224.2              | 76.4  | 31.8    | 5.5     | 3.5     | 18.3    | 13.0     | M6 | 8.5   | M12            | 16.0                 | 1500     |
| 90 x 146 HC                        | 2B      | 150.1 | 155.4              | 89.4  | 31.8    | 7.9     | 0.0     | 13.0    | 13.0     | M6 | 10.0  | M12            | 16.0                 | 1300     |
| 90 x 220 HC                        | 2B      | 218.1 | 223.4              | 89.4  | 31.8    | 7.9     | 0.0     | 13.0    | 13.0     | M6 | 10.0  | M12            | 16.0                 | 2000     |

| <b>PACKAGING QUANTITIES AND DIMENSIONS in millimeters</b> |                                         |                                       |
|-----------------------------------------------------------|-----------------------------------------|---------------------------------------|
| DESIGN                                                    | PACKAGING QUANTITIES<br>(units per box) | CARDBOARD BOX DIMENSIONS<br>L x W x H |
| 35 x 60                                                   | 50                                      | 377 x 375 x 88                        |
| 35 x 80                                                   | 50                                      | 377 x 375 x 123                       |
| 35 x 105                                                  | 50                                      | 377 x 375 x 129                       |
| 50 x 80                                                   | 25                                      | 377 x 375 x 123                       |
| 50 x 105                                                  | 25                                      | 377 x 375 x 129                       |
| 65 x 105                                                  | 16                                      | 377 x 375 x 129                       |
| 65 x 105 HC                                               | 16                                      | 377 x 375 x 129                       |
| 76 x 105                                                  | 12                                      | 377 x 375 x 129                       |
| 76 x 105 HC                                               | 12                                      | 377 x 375 x 129                       |
| 76 x 146                                                  | 12                                      | 377 x 375 x 168                       |
| 76 x 146 HC                                               | 12                                      | 377 x 375 x 168                       |
| 76 x 220                                                  | 12                                      | 377 x 375 x 242                       |
| 76 x 220 HC                                               | 12                                      | 377 x 375 x 242                       |
| 90 x 146 HC                                               | 8                                       | 377 x 375 x 168                       |
| 90 x 220 HC                                               | 8                                       | 377 x 375 x 242                       |

**Note**

- For STB version holds:  
H of cardbox box: + 10 mm

| <b>ELECTRICAL DATA</b> |                                                    |
|------------------------|----------------------------------------------------|
| SYMBOL                 | DESCRIPTION                                        |
| C <sub>R</sub>         | Rated capacitance at 100 Hz, tolerance ± 20 %      |
| I <sub>R</sub>         | Rated RMS ripple current at 100 Hz, 105 °C         |
| I <sub>L5</sub>        | Max. leakage current after 5 min at U <sub>R</sub> |
| ESR                    | Max. equivalent series resistance at 100 Hz        |
| Z                      | Impedance at 20 kHz                                |

**Note**

- Unless otherwise specified, all electrical values in Table 2 apply at T<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

**ORDERING EXAMPLE**

Electrolytic capacitor 104 PHL-ST series

4700 µF / 250 V; ± 20 %

Nominal case size: Ø 65 mm x 105 mm; ST version

Ordering code: MAL2 104 13472 E3

Former 12NC: 2222 104 13472



Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION |                                  |                                            |                                           |                                  |                               |                             |                                        |                                         |                                     |                                         |
|------------------------------------------|----------------------------------|--------------------------------------------|-------------------------------------------|----------------------------------|-------------------------------|-----------------------------|----------------------------------------|-----------------------------------------|-------------------------------------|-----------------------------------------|
| U <sub>R</sub><br>(V)                    | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE<br>SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 Hz<br>105 °C<br>(A) | I <sub>L5</sub><br>5 MIN<br>(mA) | ESR<br>MAX.<br>100 Hz<br>(mΩ) | Z<br>MAX.<br>20 kHz<br>(mΩ) | STANDARD M5 DISC                       |                                         | HIGH CURRENT M6 DISC                |                                         |
|                                          |                                  |                                            |                                           |                                  |                               |                             | ST<br>ORDERING<br>CODE<br>MAL2104..... | STB<br>ORDERING<br>CODE<br>MAL2104..... | ST ORDERING<br>CODE<br>MAL2104..... | STB<br>ORDERING<br>CODE<br>MAL2104..... |
| 200                                      | 680                              | 35 x 60                                    | 2.9                                       | 0.28                             | 197                           | 117                         | 12681E3                                | 52681E3                                 | -                                   | -                                       |
|                                          | 1000                             | 35 x 60                                    | 3.3                                       | 0.40                             | 148                           | 94                          | 12102E3                                | 52102E3                                 | -                                   | -                                       |
|                                          | 1000                             | 35 x 80                                    | 3.7                                       | 0.40                             | 137                           | 83                          | 22102E3                                | 62102E3                                 | -                                   | -                                       |
|                                          | 1500                             | 35 x 80                                    | 4.1                                       | 0.60                             | 102                           | 66                          | 12152E3                                | 52152E3                                 | -                                   | -                                       |
|                                          | 1500                             | 35 x 105                                   | 4.6                                       | 0.60                             | 95                            | 59                          | 22152E3                                | 62152E3                                 | -                                   | -                                       |
|                                          | 2200                             | 35 x 105                                   | 5.0                                       | 0.88                             | 74                            | 49                          | 12222E3                                | 52222E3                                 | -                                   | -                                       |
|                                          | 2200                             | 50 x 80                                    | 6.7                                       | 0.88                             | 63                            | 39                          | 22222E3                                | 62222E3                                 | -                                   | -                                       |
|                                          | 3300                             | 50 x 80                                    | 8.2                                       | 1.32                             | 42                            | 26                          | 12332E3                                | 52332E3                                 | -                                   | -                                       |
|                                          | 3300                             | 50 x 105                                   | 8.2                                       | 1.32                             | 44                            | 28                          | 22332E3                                | 62332E3                                 | -                                   | -                                       |
|                                          | 4700                             | 50 x 105                                   | 9.9                                       | 1.88                             | 31                            | 19                          | 12472E3                                | 52472E3                                 | -                                   | -                                       |
|                                          | 4700                             | 65 x 105                                   | 11.6                                      | 1.88                             | 31                            | 19                          | 22472E3                                | 62472E3                                 | 42472E3                             | 82472E3                                 |
|                                          | 6800                             | 65 x 105                                   | 13.7                                      | 2.72                             | 22                            | 14                          | 12682E3                                | 52682E3                                 | 32682E3                             | 72682E3                                 |
|                                          | 6800                             | 76 x 105                                   | 15.2                                      | 2.72                             | 22                            | 14                          | 22682E3                                | 62682E3                                 | 42682E3                             | 82682E3                                 |
|                                          | 10 000                           | 76 x 105                                   | 16.4                                      | 4.0                              | 17                            | 12                          | 12103E3                                | 52103E3                                 | 32103E3                             | 72103E3                                 |
|                                          | 10 000                           | 76 x 146                                   | 16.9                                      | 4.0                              | 17                            | 12                          | 22103E3                                | 62103E3                                 | 42103E3                             | 82103E3                                 |
|                                          | 15 000                           | 76 x 146                                   | 19.9                                      | 6.0                              | 12                            | 9                           | 12153E3                                | 52153E3                                 | 32153E3                             | 72153E3                                 |
|                                          | 22 000                           | 76 x 220                                   | 24.6                                      | 8.8                              | 9                             | 7                           | 12223E3                                | 52223E3                                 | 32223E3                             | 72223E3                                 |
|                                          | 22 000                           | 90 x 146                                   | 28.5                                      | 8.8                              | 8                             | 6                           | -                                      | -                                       | 42223E3                             | 82223E3                                 |
|                                          | 33 000                           | 90 x 220                                   | 34.8                                      | 13.2                             | 5                             | 5                           | -                                      | -                                       | 42333E3                             | 82333E3                                 |
| 250                                      | 680                              | 35 x 60                                    | 2.9                                       | 0.34                             | 176                           | 99                          | 13681E3                                | 53681E3                                 | -                                   | -                                       |
|                                          | 1000                             | 35 x 80                                    | 3.7                                       | 0.50                             | 123                           | 70                          | 13102E3                                | 53102E3                                 | -                                   | -                                       |
|                                          | 1000                             | 35 x 105                                   | 4.0                                       | 0.50                             | 116                           | 63                          | 23102E3                                | 63102E3                                 | -                                   | -                                       |
|                                          | 1500                             | 35 x 105                                   | 4.5                                       | 0.75                             | 86                            | 51                          | 13152E3                                | 53152E3                                 | -                                   | -                                       |
|                                          | 1500                             | 50 x 80                                    | 5.9                                       | 0.75                             | 76                            | 41                          | 23152E3                                | 63152E3                                 | -                                   | -                                       |
|                                          | 2200                             | 50 x 80                                    | 6.6                                       | 1.10                             | 58                            | 34                          | 13222E3                                | 53222E3                                 | -                                   | -                                       |
|                                          | 2200                             | 50 x 105                                   | 7.3                                       | 1.10                             | 54                            | 30                          | 23222E3                                | 63222E3                                 | -                                   | -                                       |
|                                          | 3300                             | 50 x 105                                   | 8.9                                       | 1.65                             | 36                            | 20                          | 13332E3                                | 53332E3                                 | -                                   | -                                       |
|                                          | 3300                             | 65 x 105                                   | 10.4                                      | 1.65                             | 36                            | 20                          | 23332E3                                | 63332E3                                 | 43332E3                             | 83332E3                                 |
|                                          | 4700                             | 65 x 105                                   | 11.4                                      | 2.35                             | 28                            | 17                          | 13472E3                                | 53472E3                                 | 33472E3                             | 73472E3                                 |
|                                          | 4700                             | 76 x 105                                   | 12.7                                      | 2.35                             | 28                            | 17                          | 23472E3                                | 63472E3                                 | 43472E3                             | 83472E3                                 |
|                                          | 6800                             | 76 x 105                                   | 15.0                                      | 3.40                             | 20                            | 12                          | 13682E3                                | 53682E3                                 | 33682E3                             | 73682E3                                 |
|                                          | 6800                             | 76 x 146                                   | 15.4                                      | 3.40                             | 20                            | 12                          | 23682E3                                | 63682E3                                 | 43682E3                             | 83682E3                                 |
|                                          | 10 000                           | 76 x 146                                   | 18.2                                      | 5.0                              | 14                            | 9                           | 13103E3                                | 53103E3                                 | 33103E3                             | 73103E3                                 |
|                                          | 15 000                           | 76 x 220                                   | 22.7                                      | 7.5                              | 10                            | 7                           | 13153E3                                | 53153E3                                 | 33153E3                             | 73153E3                                 |
|                                          | 15 000                           | 90 x 146                                   | 25.8                                      | 7.5                              | 9                             | 6                           | -                                      | -                                       | 43153E3                             | 83153E3                                 |
|                                          | 22 000                           | 90 x 220                                   | 30.4                                      | 11.0                             | 7                             | 5                           | -                                      | -                                       | 43223E3                             | 83223E3                                 |
| 350                                      | 330                              | 35 x 60                                    | 2.1                                       | 0.26                             | 396                           | 243                         | 15331E3                                | 55331E3                                 | -                                   | -                                       |
|                                          | 470                              | 35 x 80                                    | 2.6                                       | 0.33                             | 280                           | 172                         | 15471E3                                | 55471E3                                 | -                                   | -                                       |
|                                          | 680                              | 35 x 105                                   | 3.2                                       | 0.48                             | 197                           | 122                         | 15681E3                                | 55681E3                                 | -                                   | -                                       |
|                                          | 1000                             | 50 x 80                                    | 4.7                                       | 0.70                             | 132                           | 82                          | 15102E3                                | 55102E3                                 | -                                   | -                                       |
|                                          | 1500                             | 50 x 105                                   | 5.9                                       | 1.05                             | 90                            | 57                          | 15152E3                                | 55152E3                                 | -                                   | -                                       |
|                                          | 2200                             | 65 x 105                                   | 8.4                                       | 1.54                             | 61                            | 38                          | 15222E3                                | 55222E3                                 | 35222E3                             | 75222E3                                 |
|                                          | 3300                             | 65 x 105                                   | 10.1                                      | 2.31                             | 42                            | 26                          | 15332E3                                | 55332E3                                 | 35332E3                             | 75332E3                                 |
|                                          | 3300                             | 76 x 105                                   | 11.2                                      | 2.31                             | 42                            | 26                          | 25332E3                                | 65332E3                                 | 45332E3                             | 85332E3                                 |
|                                          | 4700                             | 76 x 105                                   | 12.6                                      | 3.29                             | 32                            | 21                          | 15472E3                                | 55472E3                                 | 35472E3                             | 75472E3                                 |
|                                          | 4700                             | 76 x 146                                   | 13.7                                      | 3.29                             | 30                            | 19                          | 25472E3                                | 65472E3                                 | 45472E3                             | 85472E3                                 |
|                                          | 6800                             | 76 x 146                                   | 15.4                                      | 4.76                             | 22                            | 15                          | 15682E3                                | 55682E3                                 | 35682E3                             | 75682E3                                 |
|                                          | 10 000                           | 76 x 220                                   | 18.5                                      | 7.0                              | 20                            | 18                          | 15103E3                                | 55103E3                                 | 35103E3                             | 75103E3                                 |
|                                          | 10 000                           | 90 x 146                                   | 20.5                                      | 7.0                              | 19                            | 17                          | -                                      | -                                       | 45103E3                             | 85103E3                                 |
|                                          | 15 000                           | 90 x 220                                   | 25.6                                      | 10.5                             | 13                            | 12                          | -                                      | -                                       | 45153E3                             | 85153E3                                 |

**ELECTRICAL DATA AND ORDERING INFORMATION**

| U <sub>R</sub><br>(V) | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE<br>SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 Hz<br>105 °C<br>(A) | I <sub>L5</sub><br>5 MIN<br>(mA) | ESR<br>MAX.<br>100 Hz<br>(mΩ) | Z<br>MAX.<br>20 kHz<br>(mΩ) | STANDARD M5 DISC                       |                                         | HIGH CURRENT M6 DISC                |                                         |
|-----------------------|----------------------------------|--------------------------------------------|-------------------------------------------|----------------------------------|-------------------------------|-----------------------------|----------------------------------------|-----------------------------------------|-------------------------------------|-----------------------------------------|
|                       |                                  |                                            |                                           |                                  |                               |                             | ST<br>ORDERING<br>CODE<br>MAL2104..... | STB<br>ORDERING<br>CODE<br>MAL2104..... | ST ORDERING<br>CODE<br>MAL2104..... | STB<br>ORDERING<br>CODE<br>MAL2104..... |
| 400                   | 220                              | 35 x 60                                    | 1.8                                       | 0.18                             | 519                           | 290                         | 16221E3                                | 56221E3                                 | -                                   | -                                       |
|                       | 330                              | 35 x 80                                    | 2.3                                       | 0.27                             | 349                           | 196                         | 16331E3                                | 56331E3                                 | -                                   | -                                       |
|                       | 470                              | 35 x 80                                    | 2.6                                       | 0.38                             | 254                           | 148                         | 16471E3                                | 56471E3                                 | -                                   | -                                       |
|                       | 680                              | 50 x 80                                    | 4.1                                       | 0.55                             | 170                           | 96                          | 26681E3                                | 66681E3                                 | -                                   | -                                       |
|                       | 1000                             | 50 x 105                                   | 5.1                                       | 0.80                             | 117                           | 67                          | 16102E3                                | 56102E3                                 | -                                   | -                                       |
|                       | 1500                             | 50 x 105                                   | 6.0                                       | 1.20                             | 83                            | 49                          | 16152E3                                | 56152E3                                 | -                                   | -                                       |
|                       | 1500                             | 65 x 105                                   | 6.9                                       | 1.20                             | 83                            | 49                          | 26152E3                                | 66152E3                                 | 46152E3                             | 86152E3                                 |
|                       | 2200                             | 65 x 105                                   | 8.4                                       | 1.76                             | 56                            | 33                          | 16222E3                                | 56222E3                                 | 36222E3                             | 76222E3                                 |
|                       | 2200                             | 76 x 105                                   | 9.4                                       | 1.76                             | 56                            | 33                          | 26222E3                                | 66222E3                                 | 46222E3                             | 86222E3                                 |
|                       | 3300                             | 76 x 105                                   | 11.3                                      | 2.64                             | 38                            | 23                          | 16332E3                                | 56332E3                                 | 36332E3                             | 76332E3                                 |
|                       | 3300                             | 76 x 146                                   | 11.6                                      | 2.64                             | 38                            | 23                          | 26332E3                                | 66332E3                                 | 46332E3                             | 86332E3                                 |
|                       | 4700                             | 76 x 146                                   | 13.8                                      | 3.76                             | 27                            | 17                          | 16472E3                                | 56472E3                                 | 36472E3                             | 76472E3                                 |
|                       | 6800                             | 76 x 220                                   | 16.5                                      | 5.4                              | 25                            | 20                          | 16682E3                                | 56682E3                                 | 36682E3                             | 76682E3                                 |
|                       | 6800                             | 90 x 146                                   | 17.7                                      | 5.4                              | 25                            | 20                          | -                                      | -                                       | 46682E3                             | 86682E3                                 |
|                       | 10 000                           | 90 x 220                                   | 22.1                                      | 8.0                              | 17                            | 14                          | -                                      | -                                       | 46103E3                             | 86103E3                                 |
| 450                   | 150                              | 35 x 60                                    | 1.5                                       | 0.14                             | 735                           | 404                         | 17151E3                                | 57151E3                                 | -                                   | -                                       |
|                       | 220                              | 35 x 80                                    | 1.9                                       | 0.20                             | 503                           | 278                         | 17221E3                                | 57221E3                                 | -                                   | -                                       |
|                       | 330                              | 35 x 105                                   | 2.4                                       | 0.30                             | 339                           | 189                         | 17331E3                                | 57331E3                                 | -                                   | -                                       |
|                       | 470                              | 50 x 80                                    | 3.3                                       | 0.43                             | 253                           | 148                         | 17471E3                                | 57471E3                                 | -                                   | -                                       |
|                       | 680                              | 50 x 105                                   | 4.3                                       | 0.62                             | 165                           | 92                          | 17681E3                                | 57681E3                                 | -                                   | -                                       |
|                       | 1000                             | 50 x 105                                   | 5.1                                       | 0.90                             | 117                           | 67                          | 17102E3                                | 57102E3                                 | -                                   | -                                       |
|                       | 1000                             | 65 x 105                                   | 5.9                                       | 0.90                             | 116                           | 66                          | 27102E3                                | 67102E3                                 | 47102E3                             | 87102E3                                 |
|                       | 1500                             | 65 x 105                                   | 7.3                                       | 1.35                             | 77                            | 44                          | 17152E3                                | 57152E3                                 | 37152E3                             | 77152E3                                 |
|                       | 1500                             | 76 x 105                                   | 8.1                                       | 1.35                             | 77                            | 44                          | 27152E3                                | 67152E3                                 | 47152E3                             | 87152E3                                 |
|                       | 2200                             | 76 x 105                                   | 9.7                                       | 1.98                             | 53                            | 31                          | 17222E3                                | 57222E3                                 | 37222E3                             | 77222E3                                 |
|                       | 2200                             | 76 x 146                                   | 10.0                                      | 1.98                             | 53                            | 31                          | 27222E3                                | 67222E3                                 | 47222E3                             | 87222E3                                 |
|                       | 3300                             | 76 x 146                                   | 12.1                                      | 2.97                             | 36                            | 21                          | 17332E3                                | 57332E3                                 | 37332E3                             | 77332E3                                 |
|                       | 4700                             | 76 x 220                                   | 14.1                                      | 4.2                              | 33                            | 25                          | 17472E3                                | 57472E3                                 | 37472E3                             | 77472E3                                 |
|                       | 4700                             | 90 x 146                                   | 15.3                                      | 4.2                              | 31                            | 24                          | -                                      | -                                       | 47472E3                             | 87472E3                                 |
|                       | 6800                             | 90 x 220                                   | 18.9                                      | 6.1                              | 22                            | 17                          | -                                      | -                                       | 47682E3                             | 87682E3                                 |

**ADDITIONAL ELECTRICAL DATA**

| PARAMETER                          | CONDITIONS                    | VALUE                                                          |
|------------------------------------|-------------------------------|----------------------------------------------------------------|
| <b>Voltage</b>                     |                               |                                                                |
| Surge voltage                      | ≤ 250 V versions              | U <sub>S</sub> = 1.15 x U <sub>R</sub>                         |
|                                    | ≥ 350 V versions              | U <sub>S</sub> = 1.1 x U <sub>R</sub>                          |
| Reverse voltage                    |                               | U <sub>rev</sub> ≤ 1 V                                         |
| <b>Current</b>                     |                               |                                                                |
| Leakage current                    | After 1 min at U <sub>R</sub> | I <sub>L1</sub> ≤ 0.006 C <sub>R</sub> x U <sub>R</sub> + 4 μA |
|                                    | After 5 min at U <sub>R</sub> | I <sub>L5</sub> ≤ 0.002 C <sub>R</sub> x U <sub>R</sub> + 4 μA |
| <b>Inductance</b>                  |                               |                                                                |
| Equivalent series inductance (ESL) | Case Ø D = 35 mm              | Typ. 13 nH                                                     |
|                                    | Case Ø D = 50 mm              | Typ. 16 nH                                                     |
|                                    | Case Ø D = 65 mm              | Typ. 19 nH <sup>(1)</sup>                                      |
|                                    | Case Ø D = 76 mm              | Typ. 20 nH <sup>(1)</sup>                                      |
|                                    | Case Ø D = 90 mm              | Typ. 21 nH <sup>(1)</sup>                                      |

**Note**<sup>(1)</sup> Low ESL designs available on request

# RIPPLE CURRENT AND USEFUL LIFE

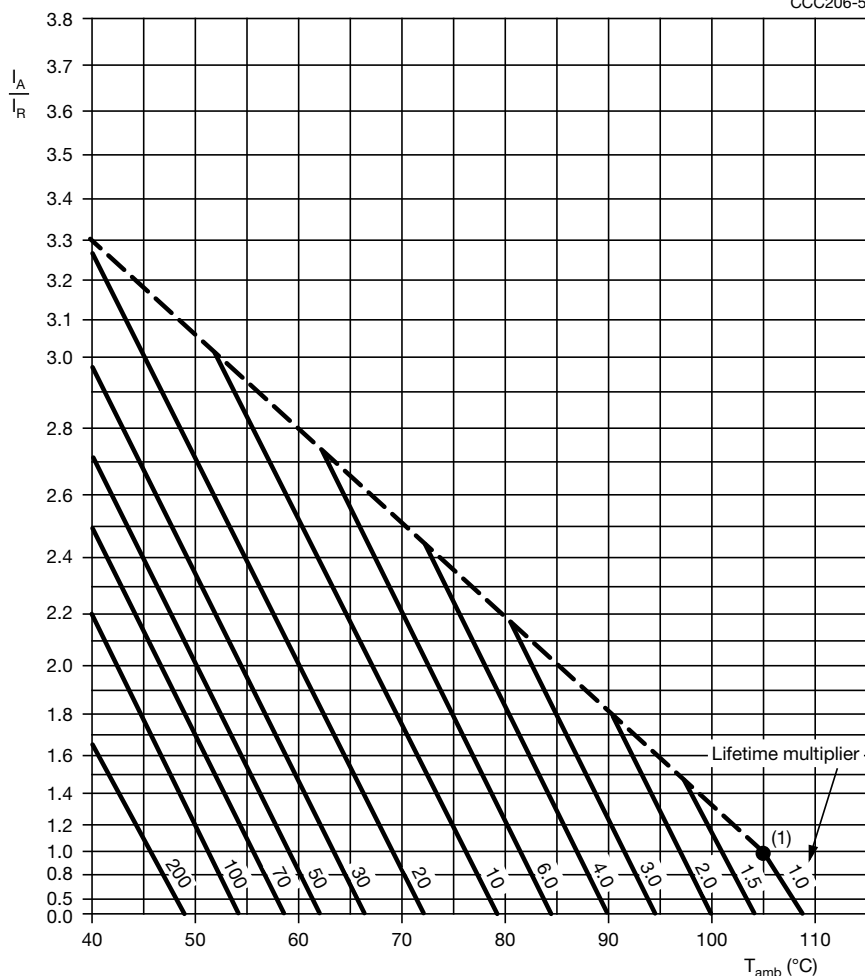
Table 3

| ENDURANCE TEST DURATION AND USEFUL LIFE |                                 |
|-----------------------------------------|---------------------------------|
| ENDURANCE<br>AT 105 °C<br>(h)           | USEFUL LIFE<br>AT 105 °C<br>(h) |
| 2000                                    | 5000                            |

## Note

- Multiplier of useful life code: CCC206-5

CCC206-5



$I_A$  = Actual ripple current at 100 Hz  
 $I_R$  = Actual ripple current at 100 Hz and 105 °C  
 With an absolute maximum of 50 A at 105 °C

<sup>(1)</sup> Useful life at 105 °C and  $I_R$  applied: 5000 h

Fig. 3 - 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 (Hz)                                                    |      |      |      |      |        |
| 50                                                                | 100  | 200  | 400  | 1000 | 10 000 |
| $I_R$ MULTIPLIER                                                  |      |      |      |      |        |
| 0.90                                                              | 1.00 | 1.20 | 1.30 | 1.40 | 1.50   |



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 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ applied;<br>2000 h                                                                                        | $\Delta C/C: \pm 10\%$<br>$ESR \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                                        |
| Useful life                                    | CECC 30301<br>subclause 4.13                 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied;<br>5000 h                                                                              | $\Delta C/C: \pm 30\%$<br>$ESR \leq 3 \times \text{spec. limit}$<br>$Z \leq 3 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$<br>no short or open circuit,<br>no visible damage<br>total failure percentage $\leq 3\%$ |
| Shelf life<br>(storage at<br>high temperature) | IEC 60384-4 /<br>EN 130300<br>subclause 4.17 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; 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 | $\Delta C/C: \pm 10\%$<br>$ESR \leq 1.2 \times \text{spec. limit}$<br>$I_{L5} \leq 2 \times \text{spec. limit}$                                                                                                                       |

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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