

► **Specifications / Spezifikationen**

| Items                                    | Characteristics  |
|--|--|
| Temperature range                        | -40°C ~ + 105°C  |
| Capacitance tolerance                    | +/- 20%  |
| Surge voltage                            | Repetitive max. 30 sec per 6 Minutes                           |
| Leakage current max. $I_L$ (20°C, 5 min) | $0.02 \cdot C \cdot V_r$ [ $\mu$ A] or 3 mA, which is smaller. |
| Useful life                              | 12000h at 105°C  |
| Field failure rate                       | 0.5 FIT = $0.5 \cdot 10^{-9}$ Failures/hour                    |
| RoHS conform                             | Directive 2002/95/ECff Annex                                   |
| Specification / Vibration                | JIS C 5101-4 / 0.75mm, 10...55Hz, 10g, 3x2h                    |



► **Outline Drawings / Bauformen**

Refer to page 6 for available terminal shapes and dimensions. / Auf Seite 6 finden Sie die verfügbaren Bauformen und Maße.

► **Ripple Current Multiplier / Wechselstrommultiplikator**

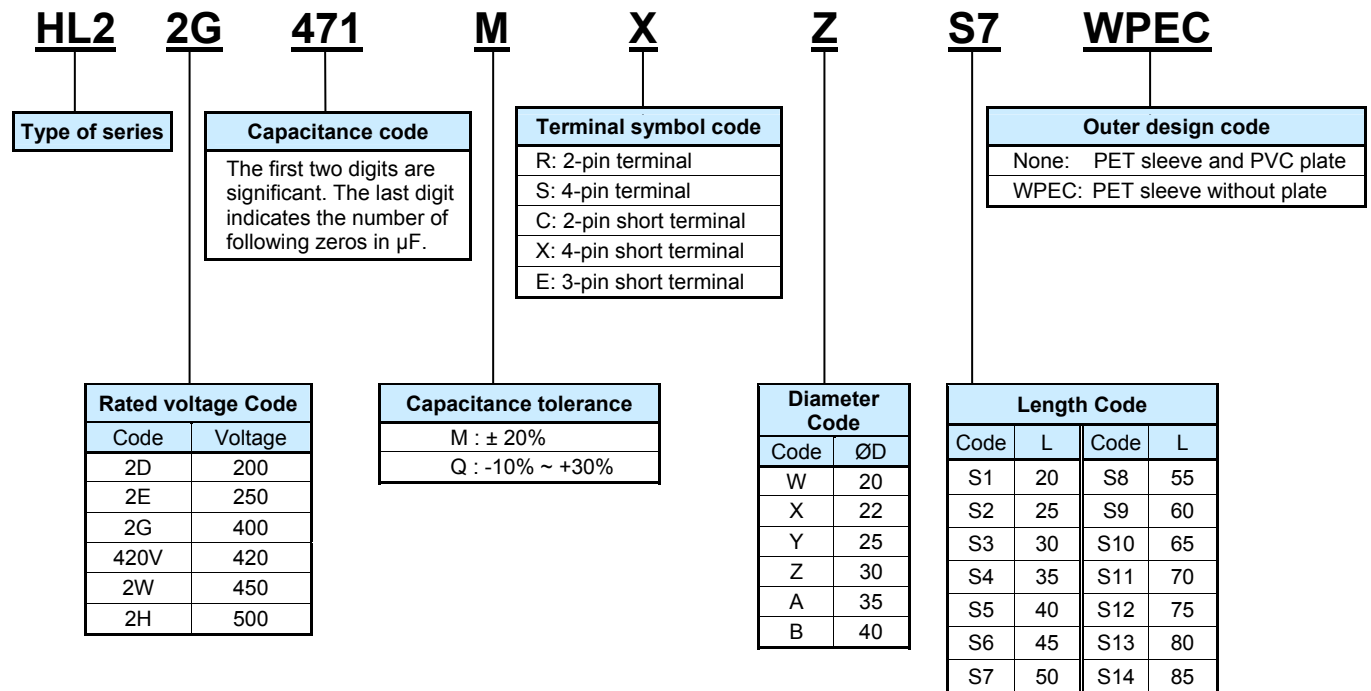
| Frequency [Hz] | 50/60 | 120  | 300  | 1k   | ≥ 10k |
|----------------|-------|------|------|------|-------|
| multiplier     | 0.70  | 1.00 | 1.18 | 1.34 | 1.45  |

| Forced cooling [m/sec] | v < 1.0 | v ≥ 1.0 |
|------------------------|---------|---------|
| multiplier             | 1.0     | 1.1     |

| Temperature [°C] | 40  | 60  | 70  | 85  | 105 |
|------------------|-----|-----|-----|-----|-----|
| multiplier       | 2.8 | 2.4 | 2.1 | 2.0 | 1.0 |

► **Product Code / Bestellbezeichnung**

Example: HL2 400V 470µF ±20% 30x50mm Shape „X“



| Rated Voltage Code<br>(Surge Voltage)<br>$V_r$<br>[V DC] | Capacitance<br>$C_r$<br>[ $\mu$ F] | Dissipation factor<br>$\tan \delta$ | Ripple Current              | Ripple Current                        | ESR (typ)<br>at<br>20°C/100Hz<br>[m $\Omega$ ] | DxL<br>[mm]   | Product Code  |
|--|------------------------------------|-------------------------------------|-----------------------------|---------------------------------------|--|---------------|---------------|
|  |                                    |                                     | at<br>40°C/120Hz<br>[A RMS] | at<br>105°C/120Hz<br>$I_r$<br>[A RMS] |  |               |               |
| 200<br>2D<br>(250)                                       | 220                                | 0.15                                | 2.72                        | 0.97                                  | 456  | 20x25         | HL22D221M□WS2 |
|  | 270                                | 0.15                                | 3.25                        | 1.16                                  | 372  | 20x30         | HL22D271M□WS3 |
|  | 330                                | 0.15                                | 3.50                        | 1.25                                  | 304  | 25x25         | HL22D331M□YS2 |
|  |                                    | 0.15                                | 3.67                        | 1.31                                  | 304  | 22x30         | HL22D331M□XS3 |
|  | 390                                | 0.15                                | 3.78                        | 1.35                                  | 304  | 20x35         | HL22D331M□WS4 |
|  |                                    | 0.15                                | 4.06                        | 1.45                                  | 257  | 25x30         | HL22D391M□YS3 |
|  | 470                                | 0.15                                | 4.37                        | 1.56                                  | 214  | 30x25         | HL22D471M□ZS2 |
|  |                                    | 0.15                                | 4.48                        | 1.60                                  | 214  | 25x30         | HL22D471M□YS3 |
|  |                                    | 0.15                                | 4.87                        | 1.74                                  | 214  | 22x40         | HL22D471M□XS5 |
|  | 560                                | 0.15                                | 5.15                        | 1.84                                  | 179  | 25x35         | HL22D561M□YS4 |
|  |                                    | 0.15                                | 5.57                        | 1.99                                  | 179  | 22x45         | HL22D561M□XS6 |
|  | 680                                | 0.15                                | 5.57                        | 1.99                                  | 148  | 30x30         | HL22D681M□ZS3 |
|  |                                    | 0.15                                | 5.94                        | 2.12                                  | 148  | 25x40         | HL22D681M□YS5 |
|  | 820                                | 0.15                                | 6.47                        | 2.31                                  | 122  | 30x35         | HL22D821M□ZS4 |
|  |                                    | 0.15                                | 6.83                        | 2.44                                  | 122  | 25x45         | HL22D821M□YS6 |
|  | 1 000                              | 0.15                                | 6.33                        | 2.26                                  | 100  | 35x30         | HL22D102M□AS3 |
| 0.15   |                                    | 7.48                                | 2.67                        | 100                                   | 30x40  | HL22D102M□ZS5 |               |
| 1 200  | 0.15                               | 7.28                                | 2.60                        | 84                                    | 35x35  | HL22D122M□AS4 |               |
|  | 0.15                               | 8.57                                | 3.06                        | 84                                    | 30x45  | HL22D122M□ZS6 |               |
| 1 500  | 0.15                               | 8.51                                | 3.04                        | 67                                    | 35x40  | HL22D152M□AS5 |               |
| 250<br>2E<br>(300)                                       | 150                                | 0.15                                | 2.24                        | 0.80                                  | 496  | 20x25         | HL22E151M□WS2 |
|  | 180                                | 0.15                                | 2.52                        | 0.90                                  | 413  | 22x25         | HL22E181M□XS2 |
|  |                                    | 0.15                                | 2.63                        | 0.94                                  | 413  | 20x30         | HL22E181M□WS3 |
|  | 220                                | 0.15                                | 2.88                        | 1.03                                  | 338  | 20x30         | HL22E221M□WS3 |
|  | 270                                | 0.15                                | 3.16                        | 1.13                                  | 275  | 25x25         | HL22E271M□YS2 |
|  |                                    | 0.15                                | 3.42                        | 1.22                                  | 275  | 20x35         | HL22E271M□WS4 |
|  | 330                                | 0.15                                | 3.72                        | 1.33                                  | 225  | 25x30         | HL22E331M□YS3 |
|  |                                    | 0.15                                | 3.89                        | 1.39                                  | 225  | 22x35         | HL22E331M□XS4 |
|  | 390                                | 0.15                                | 4.00                        | 1.43                                  | 191  | 30x25         | HL22E391M□ZS2 |
|  |                                    | 0.15                                | 4.28                        | 1.53                                  | 191  | 25x35         | HL22E391M□YS4 |
|  |                                    | 0.15                                | 4.42                        | 1.58                                  | 191  | 22x40         | HL22E391M□XS5 |
|  | 470                                | 0.15                                | 4.65                        | 1.66                                  | 162  | 30x30         | HL22E471M□ZS3 |
|  |                                    | 0.15                                | 4.96                        | 1.77                                  | 162  | 25x40         | HL22E471M□YS5 |
|  |                                    | 0.15                                | 5.32                        | 1.90                                  | 162  | 22x50         | HL22E471M□XS7 |
|  | 560                                | 0.15                                | 5.66                        | 2.02                                  | 136  | 25x45         | HL22E561M□YS6 |
|  | 680                                | 0.15                                | 5.88                        | 2.10                                  | 112  | 30x35         | HL22E681M□ZS4 |
| 0.15   |                                    | 6.50                                | 2.32                        | 112                                   | 25x50  | HL22E681M□YS7 |               |
| 820  | 0.15                               | 6.78                                | 2.42                        | 93                                    | 30x40  | HL22E821M□ZS5 |               |
| 1 000  | 0.15                               | 8.12                                | 2.90                        | 76                                    | 30x50  | HL22E102M□ZS7 |               |
| 1 200  | 0.15                               | 7.92                                | 2.83                        | 64                                    | 35x45  | HL22E122M□AS6 |               |
| 1 500  | 0.15                               | 9.21                                | 3.29                        | 61                                    | 35x50  | HL22E152M□AS7 |               |
| 400<br>2G<br>(450)                                       | 47                                 | 0.15                                | 1.29                        | 0.46                                  | 1625   | 20x25         | HL22G470M□WS2 |
|  | 68                                 | 0.15                                | 1.57                        | 0.56                                  | 1121   | 20x25         | HL22G680M□WS2 |
|  | 82                                 | 0.15                                | 1.79                        | 0.64                                  | 952  | 22x25         | HL22G820M□XS2 |
|  |                                    | 0.15                                | 1.85                        | 0.66                                  | 952  | 20x30         | HL22G820M□WS3 |
|  | 100                                | 0.15                                | 2.02                        | 0.72                                  | 781  | 25x25         | HL22G101M□YS2 |
|  |                                    | 0.15                                | 2.10                        | 0.75                                  | 781  | 22x30         | HL22G101M□XS3 |
|  |                                    | 0.15                                | 2.16                        | 0.77                                  | 781  | 20x35         | HL22G101M□WS4 |
|  | 120                                | 0.15                                | 2.35                        | 0.84                                  | 651  | 25x30         | HL22G121M□YS3 |
|  |                                    | 0.15                                | 2.38                        | 0.85                                  | 651  | 20x35         | HL22G121M□WS4 |
|  |                                    | 0.15                                | 2.44                        | 0.87                                  | 651  | 22x35         | HL22G121M□XS4 |
|  | 150                                | 0.15                                | 2.46                        | 0.88                                  | 521  | 30x25         | HL22G151M□ZS2 |
|  |                                    | 0.15                                | 2.63                        | 0.94                                  | 521  | 25x30         | HL22G151M□YS3 |
|  |                                    | 0.15                                | 2.86                        | 1.02                                  | 521  | 22x40         | HL22G151M□XS5 |
|  |                                    | 0.15                                | 2.86                        | 1.02                                  | 475  | 30x30         | HL22G181M□ZS3 |
|  | 180                                | 0.15                                | 3.05                        | 1.09                                  | 475  | 25x35         | HL22G181M□YS4 |
|  |                                    | 0.15                                | 3.30                        | 1.18                                  | 475  | 22x45         | HL22G181M□XS6 |
| 0.15   |                                    | 3.16                                | 1.13                        | 389                                   | 30x30  | HL22G221M□ZS3 |               |
| 220  | 0.15                               | 3.53                                | 1.26                        | 389                                   | 25x40  | HL22G221M□YS5 |               |
|  | 0.15                               | 3.78                                | 1.35                        | 389                                   | 22x50  | HL22G221M□XS7 |               |
|  | 0.15                               | 3.72                                | 1.33                        | 317                                   | 30x35  | HL22G271M□ZS4 |               |
| 270  | 0.15                               | 3.72                                | 1.33                        | 317                                   | 35x30  | HL22G271M□AS3 |               |
|  | 0.15                               | 4.09                                | 1.46                        | 317                                   | 25x45  | HL22G271M□YS6 |               |

| Rated Voltage Code<br>(Surge Voltage)<br>$V_r$<br>[V DC] | Capacitance<br>$C_r$<br>[ $\mu$ F] | Dissipation factor | Ripple Current<br>at<br>40°C/120Hz | Ripple Current<br>at<br>105°C/120Hz<br>$I_r$ | ESR (typ)<br>at<br>20°C/100Hz | DxL            | Product Code    |
|--|------------------------------------|--------------------|------------------------------------|--|-------------------------------|----------------|-----------------|
|  |                                    | $\tan \delta$      | [A RMS]                            | [A RMS]                                      | [m $\Omega$ ]                 | [mm]           |                 |
| 400<br>2G<br>(450)                                       | 330                                | 0.15               | 4.31                               | 1.54   | 259                           | 30x40          | HL22G331M□ZS5   |
|  |                                    | 0.15               | 4.31                               | 1.54   | 259                           | 35x35          | HL22G331M□AS4   |
|  |                                    | 0.15               | 4.68                               | 1.67   | 259                           | 25x50          | HL22G331M□YS7   |
|  | 390                                | 0.15               | 4.68                               | 1.67   | 219                           | 35x35          | HL22G391M□AS4   |
|  |                                    | 0.15               | 4.90                               | 1.75   | 219                           | 30x45          | HL22G391M□ZS6   |
|  |                                    | 0.15               | 6.04                               | 2.16   | 218                           | 40x31          | HL22G391M□BS3   |
|  | 470                                | 0.15               | 5.38                               | 1.92   | 182                           | 35x40          | HL22G471M□AS5   |
|  |                                    | 0.15               | 5.61                               | 2.00   | 182                           | 30x50          | HL22G471M□ZS7   |
|  | 560                                | 0.15               | 6.13                               | 2.19   | 156                           | 35x45          | HL22G561M□AS6   |
|  | 680                                | 0.15               | 6.84                               | 2.44   | 130                           | 40x40          | HL22G681M□BS5   |
| 0.15   |                                    | 7.02               | 2.51                               | 126  | 35x50                         | HL22G681M□AS7  |                 |
| 820  | 0.15                               | 8.35               | 2.98                               | 105  | 35x70                         | HL22G821M□AS11 |                 |
| 1 000  | 0.15                               | 9.73               | 3.48                               | 86   | 35x80                         | HL22G102M□AS13 |                 |
| 420<br>420V<br>(470)                                     | 150                                | 0.15               | 2.63                               | 0.94   | 570                           | 30x30          | HL2420V151M□ZS3 |
|  | 180                                | 0.15               | 3.02                               | 1.08   | 475                           | 30x35          | HL2420V181M□ZS4 |
|  |                                    | 0.15               | 3.02                               | 1.08   | 475                           | 35x30          | HL2420V181M□AS3 |
|  | 220                                | 0.15               | 3.36                               | 1.20   | 389                           | 30x35          | HL2420V221M□ZS4 |
|  |                                    | 0.15               | 3.36                               | 1.20   | 389                           | 35x30          | HL2420V221M□AS3 |
|  |                                    | 0.15               | 3.82                               | 1.36   | 389                           | 25x50          | HL2420V221M□YS7 |
|  | 330                                | 0.15               | 4.31                               | 1.54   | 259                           | 30x40          | HL2420V331M□ZS5 |
| 450<br>2W<br>(500)                                       | 47                                 | 0.15               | 1.29                               | 0.46   | 1820                          | 20x25          | HL22W470M□WS2   |
|  | 56                                 | 0.15               | 1.48                               | 0.53   | 1527                          | 22x25          | HL22W560M□XS2   |
|  |                                    | 0.15               | 1.54                               | 0.55   | 1527                          | 20x30          | HL22W560M□WS3   |
|  | 68                                 | 0.15               | 1.65                               | 0.59   | 1258                          | 25x25          | HL22W680M□YS2   |
|  |                                    | 0.15               | 1.68                               | 0.60   | 1258                          | 20x30          | HL22W680M□WS3   |
|  |                                    | 0.15               | 1.74                               | 0.62   | 1258                          | 22x30          | HL22W680M□XS3   |
|  | 82                                 | 0.15               | 1.96                               | 0.70   | 1043                          | 20x35          | HL22W820M□WS4   |
|  | 100                                | 0.15               | 2.00                               | 0.72   | 855                           | 25x25          | HL22W101M□YS2   |
|  |                                    | 0.15               | 2.13                               | 0.76   | 855                           | 25x30          | HL22W101M□YS3   |
|  |                                    | 0.15               | 2.21                               | 0.79   | 855                           | 22x35          | HL22W101M□XS4   |
|  | 120                                | 0.15               | 2.21                               | 0.79   | 713                           | 30x25          | HL22W121M□ZS2   |
|  |                                    | 0.15               | 2.46                               | 0.88   | 713                           | 25x35          | HL22W121M□YS4   |
|  |                                    | 0.15               | 2.55                               | 0.91   | 713                           | 22x40          | HL22W121M□XS5   |
|  | 150                                | 0.15               | 2.63                               | 0.94   | 570                           | 30x30          | HL22W151M□ZS3   |
|  |                                    | 0.15               | 2.91                               | 1.04   | 570                           | 25x40          | HL22W151M□YS5   |
|  |                                    | 0.15               | 3.14                               | 1.12   | 570                           | 22x50          | HL22W151M□XS7   |
|  | 180                                | 0.15               | 3.02                               | 1.08   | 475                           | 30x35          | HL22W181M□ZS4   |
|  |                                    | 0.15               | 3.33                               | 1.19   | 475                           | 25x45          | HL22W181M□YS6   |
|  | 220                                | 0.15               | 3.36                               | 1.20   | 389                           | 35x30          | HL22W221M□AS3   |
|  |                                    | 0.15               | 3.50                               | 1.25   | 389                           | 30x40          | HL22W221M□ZS5   |
|  | 270                                | 0.15               | 3.92                               | 1.40   | 317                           | 35x35          | HL22W271M□AS4   |
|  |                                    | 0.15               | 4.06                               | 1.45   | 317                           | 30x45          | HL22W271M□ZS6   |
|  | 330                                | 0.15               | 4.54                               | 1.62   | 259                           | 35x40          | HL22W331M□AS5   |
| 0.15   |                                    | 4.68               | 1.67                               | 259  | 30x50                         | HL22W331M□ZS7  |                 |
| 390  | 0.15                               | 5.12               | 1.83                               | 224  | 35x45                         | HL22W391M□AS6  |                 |
| 470  | 0.15                               | 5.82               | 2.08                               | 190  | 35x50                         | HL22W471M□AS7  |                 |
| 500<br>2H<br>(550)                                       | 100                                | 0.20               | 2.06                               | 0.74   | 960                           | 25x45          | HL22H101M□YS6   |
|  | 120                                | 0.20               | 2.22                               | 0.79   | 800                           | 30x35          | HL22H121M□ZS4   |
|  |                                    | 0.20               | 2.22                               | 0.79   | 800                           | 35x30          | HL22H121M□AS3   |
|  |                                    | 0.20               | 2.37                               | 0.85   | 800                           | 25x50          | HL22H121M□YS7   |
|  | 150                                | 0.20               | 2.62                               | 0.94   | 640                           | 30x40          | HL22H151M□ZS5   |
|  |                                    | 0.20               | 2.62                               | 0.94   | 640                           | 35x35          | HL22H151M□AS4   |
|  | 180                                | 0.20               | 2.99                               | 1.07   | 540                           | 35x40          | HL22H181M□AS5   |
|  |                                    | 0.20               | 3.11                               | 1.11   | 540                           | 30x50          | HL22H181M□ZS7   |
|  | 220                                | 0.20               | 3.45                               | 1.23   | 440                           | 35x45          | HL22H221M□AS6   |
|  | 270                                | 0.20               | 3.97                               | 1.42   | 360                           | 35x50          | HL22H271M□AS7   |
|  | 330                                | 0.20               | 4.37                               | 1.56   | 340                           | 35x60          | HL22H331M□AS9   |
| 390  | 0.20                               | 5.43               | 1.94                               | 250  | 40x61                         | HL22H391M□BS9  |                 |

► **Life Time Table / Brauchbarkeitsdauer – Tabelle**

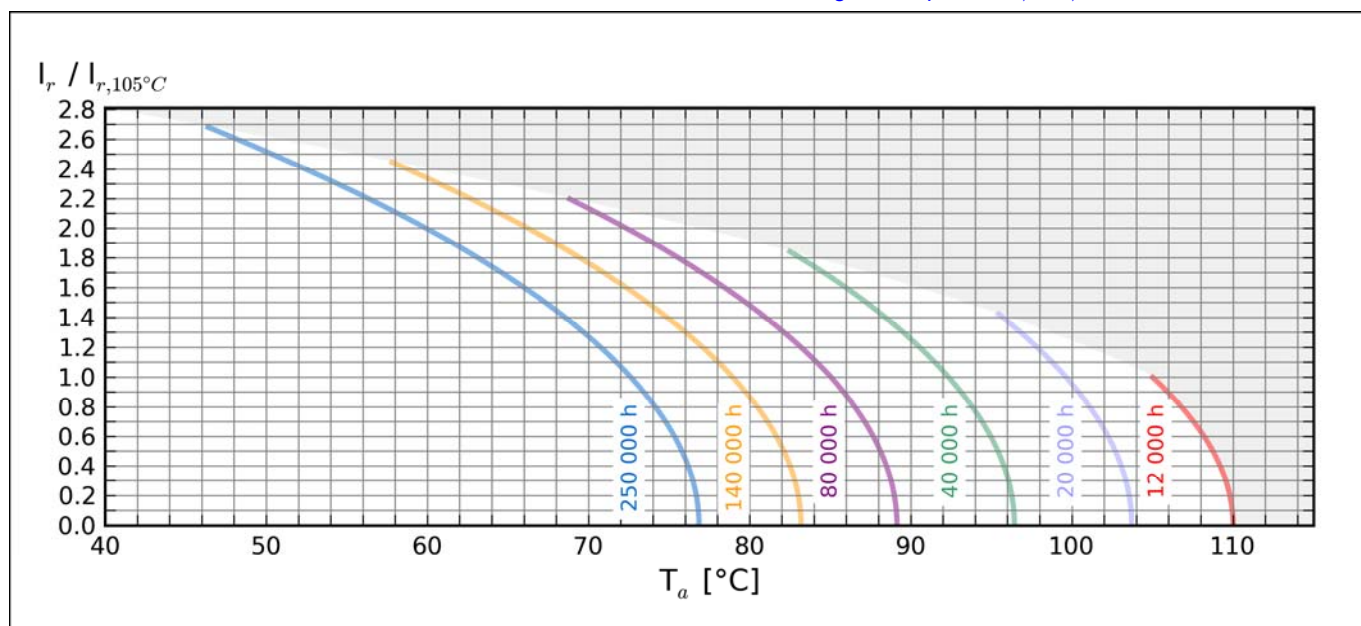
| HL2                    | Useful life as function of ambient temperature and ripple current |       |       |       |       |       |       |       |       |       |       |       |       |       |
|------------------------|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                        | x 1.0   | x 1.2 | x 1.4 | x 1.6 | x 1.8 | x 2.0 | x 2.1 | x 2.2 | x 2.3 | x 2.4 | x 2.5 | x 2.6 | x 2.7 | x 2.8 |
| T <sub>a</sub> = 40°C  | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   |
| T <sub>a</sub> = 45°C  | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   |
| T <sub>a</sub> = 50°C  | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 212   |       |       |
| T <sub>a</sub> = 55°C  | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 250   | 237   | 198   | 163   |       |       |       |
| T <sub>a</sub> = 60°C  | 250   | 250   | 250   | 250   | 250   | 248   | 211   | 179   | 150   | 125   |       |       |       |       |
| T <sub>a</sub> = 65°C  | 250   | 250   | 250   | 250   | 210   | 156   | 133   | 113   | 95    |       |       |       |       |       |
| T <sub>a</sub> = 70°C  | 250   | 250   | 219   | 173   | 133   | 99    | 84    |       |       |       |       |       |       |       |
| T <sub>a</sub> = 75°C  | 201   | 169   | 138   | 109   | 84    | 62    | 53    |       |       |       |       |       |       |       |
| T <sub>a</sub> = 80°C  | 127   | 107   | 87    | 69    | 53    | 39    |       |       |       |       |       |       |       |       |
| T <sub>a</sub> = 85°C  | 80  | 67    | 55    | 43    | 33    | 25    |       |       |       |       |       |       |       |       |
| T <sub>a</sub> = 90°C  | 50  | 42    | 35    | 27    | 21    |       |       |       |       |       |       |       |       |       |
| T <sub>a</sub> = 95°C  | 32  | 27    | 22    | 17    |       |       |       |       |       |       |       |       |       |       |
| T <sub>a</sub> = 100°C | 20  | 17    |       |       |       |       |       |       |       |       |       |       |       |       |
| T <sub>a</sub> = 105°C | 12  |       |       |       |       |       |       |       |       |       |       |       |       |       |

khrs                      Max. value limited to 250 000 hours.

► **Life Time Graph / Brauchbarkeitsdauer – Diagramm**

Useful life depending on ambient temperature T<sub>a</sub> and ripple current operating conditions I<sub>r</sub> versus rated ripple current at the upper category temperature I<sub>r,105°C,120Hz</sub>

Brauchbarkeitsdauer in Abhängigkeit von Umgebungstemperatur T<sub>a</sub> und Wechselstrombelastung I<sub>r</sub> im Verhältnis zur max. Wechselstrombelastung bei oberer Kategoriertemperatur I<sub>r,105°C,120Hz</sub>



► **Life Time Tests and Requirements / Anforderungen Brauchbarkeitsdauer**

| Life time test | Test procedure   | Life time criteria  |
|----------------|--|---|
| Endurance test | T <sub>a</sub> = 105°C; V <sub>r</sub> , I <sub>r</sub> applied<br>8000 hours  | ΔC/C ≤ 15% (of initial value)<br>Tanδ ≤ 175% (of specified value)<br>I <sub>L</sub> ≤ specified value |
| Useful life    | T <sub>a</sub> = 105°C; V <sub>r</sub> , I <sub>r</sub> applied<br>12000 hours | ΔC/C ≤ 20% (of initial value)<br>Tanδ < 200% (of specified value)<br>I <sub>L</sub> ≤ specified value |

Reference Specification: JIS C 5101-4, JIS C 5102, IEC 60384-4