

## Interference Suppression Film Capacitor - Class X1 Radial MKP 480 V<sub>AC</sub> - 3-Phase Across the Line



### FEATURES

- AEC-Q200 qualified (rev. D, 85 °C maximum application temperature) for pitch 10 mm, 15 mm, and 22.5 mm
- Internal series construction
- Stable capacitance in severe ambient conditions 85 °C, 85 % RH, 400 V<sub>AC</sub>, 500 h for C > 100 nF
- THB: 40 °C / 90 % RH for 1000 h at rated voltage in compliance with AEC-Q200
- Complying with IEC 60384-14: AMD1 Grade IA
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

AUTOMOTIVE  
GRADE  
Available

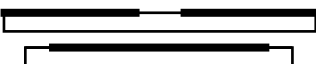


**RoHS**  
COMPLIANT  
**HALOGEN**  
**FREE**  
**GREEN**  
(5-2008)

### APPLICATIONS

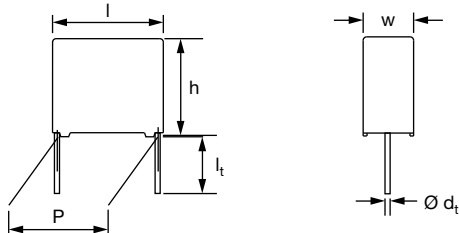
- 3-phase and continuous across the line X1 applications
- Standard and continuous in series with the mains operation

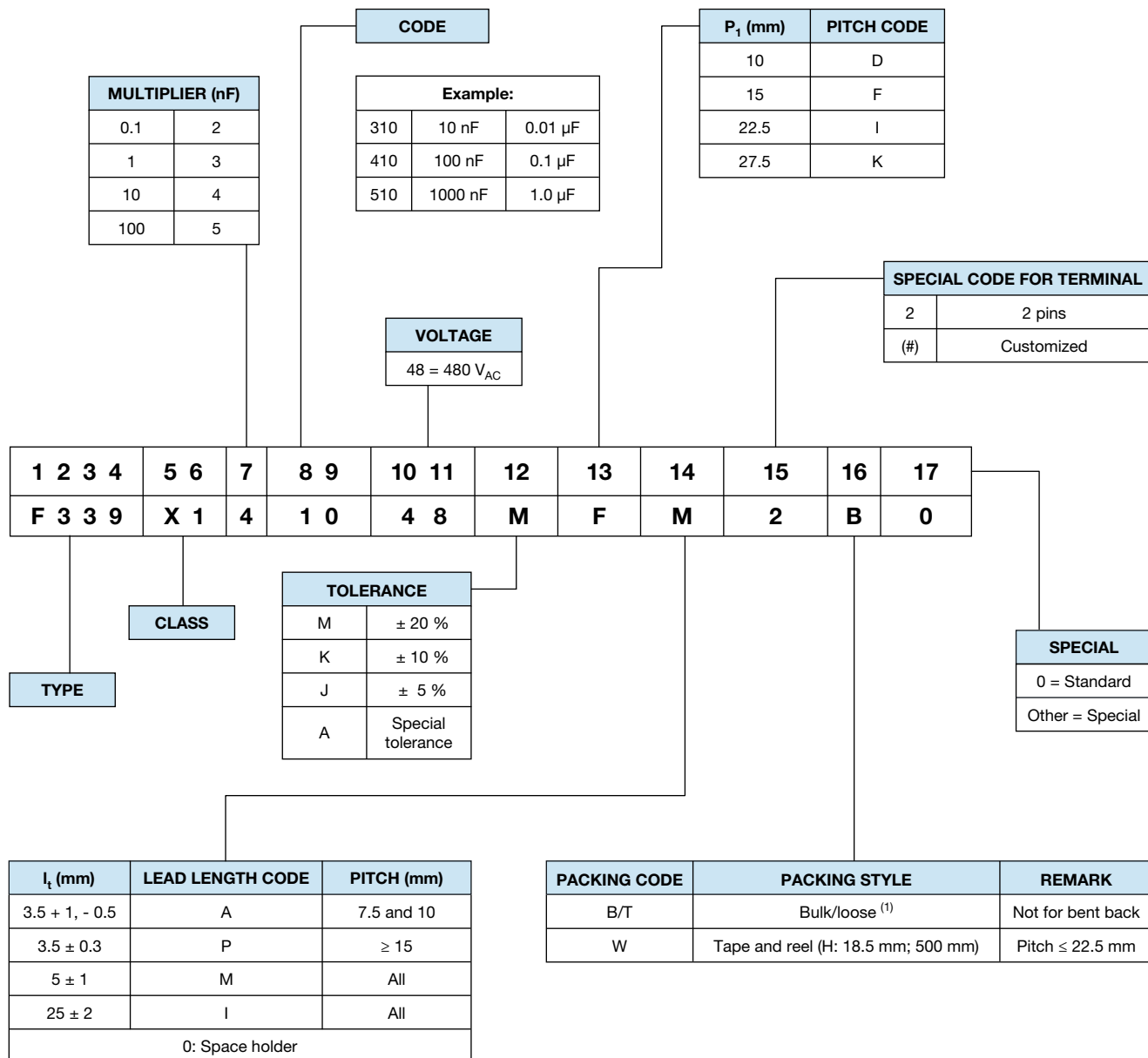
See also application note: [www.vishay.com/doc?28153](http://www.vishay.com/doc?28153)

| QUICK REFERENCE DATA                            |                                                                                                                                                                                                                          |
|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Capacitance range (E12 series)                  | 0.001 µF to 1.0 µF (preferred values according to E6)                                                                                                                                                                    |
| Capacitance tolerance                           | ± 20 %; ± 10 %; (± 5 % on request)                                                                                                                                                                                       |
| Climatic testing class according to IEC 60068-1 | 55 / 110 / 56 / C for product volumes ≤ 1750 mm <sup>3</sup><br>55 / 110 / 56 / B for product volumes > 1750 mm <sup>3</sup>                                                                                             |
| Rated AC voltage                                | 480 V <sub>AC</sub> ; 50 Hz to 60 Hz                                                                                                                                                                                     |
| Permissible DC voltage                          | 1000 V <sub>DC</sub> at 85 °C<br>800 V <sub>DC</sub> at 110 °C                                                                                                                                                           |
| Maximum application temperature                 | 110 °C                                                                                                                                                                                                                   |
| Reference standards                             | IEC 60384-14 ed-4 (2013) and EN 60384-14<br>IEC 60065 requires pass. flamm. class B for volumes > 1750 mm <sup>3</sup> ,<br>class C for volume < 1750 mm <sup>3</sup><br>CSA-E384-14; UL60384-14<br>CQC GB/T6346.14-2015 |
| Dielectric                                      | Polypropylene film                                                                                                                                                                                                       |
| Electrodes                                      | Metallized                                                                                                                                                                                                               |
| Construction                                    | Series construction<br>                                                                                                               |
| Encapsulation                                   | Plastic case, epoxy resin sealed, flame retardant<br>UL-class 94 V-0                                                                                                                                                     |
| Leads                                           | Tinned wire                                                                                                                                                                                                              |
| Marking                                         | C-value; tolerance; rated voltage; sub-class; manufacturer's type;<br>code for dielectric material; manufacturer location, year and week;<br>manufacturer's logo or name; safety approvals                               |

#### Note

- For more detailed data and test requirements, contact [rfi@vishay.com](mailto:rfi@vishay.com)

| DIMENSIONS in millimeters                                                            |
|--------------------------------------------------------------------------------------|
|  |

**COMPOSITION OF CATALOG NUMBER**

**Notes**

- For detailed tape specifications refer to packaging information [www.vishay.com/doc?28139](http://www.vishay.com/doc?28139)
- <sup>(1)</sup> Packaging will be bulk for all capacitors with pitch  $\leq 15$  mm and such with long leads ( $> 5$  mm). Capacitors with short leads up to 5 mm and pitch  $> 15$  mm will be in tray and asking code will be "T"



## SPECIFIC REFERENCE DATA

| DESCRIPTION                                                                                            | VALUE                       |                          |
|--------------------------------------------------------------------------------------------------------|-----------------------------|--------------------------|
| Rated AC voltage ( $U_{RAC}$ )                                                                         | 480 V                       |                          |
| Permissible DC voltage ( $U_{RDC}$ )                                                                   | 1000 V                      |                          |
| Tangent of loss angle                                                                                  | At 1 kHz                    | At 10 kHz                |
| $C < 470 \text{ nF}$                                                                                   | $\leq 10 \times 10^{-4}$    | $\leq 20 \times 10^{-4}$ |
| $470 \text{ nF} \leq C \leq 1 \text{ }\mu\text{F}$                                                     | $\leq 20 \times 10^{-4}$    | $\leq 70 \times 10^{-4}$ |
| Rated voltage pulse slope (dU/dt) <sub>R</sub> at 670 V <sub>DC</sub>                                  |                             |                          |
| Pitch = 10 mm                                                                                          | 800 V/ $\mu$ s              |                          |
| Pitch = 15 mm                                                                                          | 600 V/ $\mu$ s              |                          |
| Pitch = 22.5 mm                                                                                        | 400 V/ $\mu$ s              |                          |
| Pitch = 27.5 mm                                                                                        | 250 V/ $\mu$ s              |                          |
| R between leads, for $C \leq 0.33 \text{ }\mu\text{F}$ at 100 V; 1 min                                 | $> 15\,000 \text{ M}\Omega$ |                          |
| RC between leads, for $C > 0.33 \text{ }\mu\text{F}$ at 100 V; 1 min                                   | $> 5000 \text{ s}$          |                          |
| R between leads and case; 100 V; 1 min                                                                 | $> 30\,000 \text{ M}\Omega$ |                          |
| Withstanding (DC) voltage (cut off current 10 mA) <sup>(1)</sup> ; rise time $\leq 1000 \text{ V/s}$ : | 3400 V; 1 min               |                          |
| Withstanding (AC) voltage between leads and case                                                       | 2460 V; 1 min               |                          |
| Maximum application temperature                                                                        | 110 °C                      |                          |

## Note

<sup>(1)</sup> See "Voltage Proof Test for Metalized Film Capacitors": [www.vishay.com/doc?28169](http://www.vishay.com/doc?28169)

## ELECTRICAL DATA AND ORDERING INFORMATION

| U <sub>RAC</sub><br>(V) | CAP.<br>(μF)                                                                  | DIMENSIONS <sup>(4)</sup><br>w x h x l<br>(mm) | MASS<br>(g) <sup>(3)</sup> | CATALOG NUMBER F339X1... AND PACKAGING                                                             |                                   |      |                                    |      |                                                                          |            |  |
|-------------------------|-------------------------------------------------------------------------------|------------------------------------------------|----------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------|------|------------------------------------|------|--------------------------------------------------------------------------|------------|--|
|                         |                                                                               |                                                |                            | LOOSE IN BOX                                                                                       |                                   |      |                                    |      |                                                                          | TAPED REEL |  |
|                         |                                                                               |                                                |                            | SHORT LEADS                                                                                        |                                   |      | LONG LEADS                         |      |                                                                          |            |  |
|                         |                                                                               |                                                |                            | $l_t = 3.5\text{ mm}$<br>+1 mm/-0.5 mm<br>(PITCH ≤ 10 mm)<br>or 3.5 mm ± 0.3 mm<br>(PITCH ≥ 15 mm) | $l_t = 5.0\text{ mm}$<br>± 1.0 mm | SPQ  | $l_t = 25.0\text{ mm}$<br>± 2.0 mm | SPQ  | Ø = 500 mm <sup>(1)(2)</sup><br>H = 18.5 mm;<br>P <sub>0</sub> = 12.7 mm | SPQ        |  |
| 480                     | PITCH = 10 mm ± 0.4 mm; d <sub>t</sub> = 0.60 mm ± 0.06 mm; C-TOL. = ± 20 %   |                                                |                            |                                                                                                    |                                   |      |                                    |      |                                                                          |            |  |
|                         | 0.0010                                                                        | 4.0 x 10.0 x 12.5                              | 0.6                        | 21048MDA2B0                                                                                        | 21048MDM2B0                       | 1000 | 21048MDI2B0                        | 1250 | 21048MD02W0                                                              | 1400       |  |
|                         | 0.0015                                                                        |                                                |                            | 21548MDA2B0                                                                                        | 21548MDM2B0                       |      | 21548MDI2B0                        |      | 21548MD02W0                                                              |            |  |
|                         | 0.0022                                                                        |                                                |                            | 22248MDA2B0                                                                                        | 22248MDM2B0                       |      | 22248MDI2B0                        |      | 22248MD02W0                                                              |            |  |
|                         | 0.0033                                                                        |                                                |                            | 23348MDA2B0                                                                                        | 23348MDM2B0                       |      | 23348MDI2B0                        |      | 23348MD02W0                                                              |            |  |
|                         | 0.0047                                                                        | 5.0 x 11.0 x 12.5                              | 0.82                       | 24748MDA2B0                                                                                        | 24748MDM2B0                       | 1000 | 24748MDI2B0                        | 1000 | 24748MD02W0                                                              | 1100       |  |
|                         | 0.0068                                                                        | 6.0 x 12.0 x 12.5                              | 1.1                        | 26848MDA2B0                                                                                        | 26848MDM2B0                       | 750  | 26848MDI2B0                        | 750  | 26848MD02W0                                                              | 900        |  |
|                         | 0.010                                                                         |                                                |                            | 31048MDA2B0                                                                                        | 31048MDM2B0                       |      | 31048MDI2B0                        |      | 31048MD02W0                                                              |            |  |
|                         | PITCH = 15 mm ± 0.4 mm; d <sub>t</sub> = 0.60 mm ± 0.06 mm; C-TOL. = ± 20 %   |                                                |                            |                                                                                                    |                                   |      |                                    |      |                                                                          |            |  |
|                         | 0.010                                                                         | 5.0 x 11.0 x 17.5                              | 1.0                        | 31048MFP2B0                                                                                        | 31048MFM2B0                       | 1250 | 31048MFI2B0                        | 1000 | 31048MF02W0                                                              | 1100       |  |
|                         | 0.015                                                                         |                                                |                            | 31548MFP2B0                                                                                        | 31548MFM2B0                       |      | 31548MFI2B0                        |      | 31548MF02W0                                                              |            |  |
|                         | 0.022                                                                         |                                                |                            | 32248MFP2B0                                                                                        | 32248MFM2B0                       |      | 32248MFI2B0                        |      | 32248MF02W0                                                              |            |  |
|                         | 0.033                                                                         |                                                |                            | 33348MFP2B0                                                                                        | 33348MFM2B0                       |      | 33348MFI2B0                        |      | 33348MF02W0                                                              |            |  |
|                         | 0.047                                                                         | 6.0 x 12.0 x 17.5                              | 1.4                        | 34748MFP2B0                                                                                        | 34748MFM2B0                       | 1000 | 34748MFI2B0                        | 1000 | 34748MF02W0                                                              | 900        |  |
|                         | PITCH = 15 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 %   |                                                |                            |                                                                                                    |                                   |      |                                    |      |                                                                          |            |  |
|                         | 0.068                                                                         | 8.5 x 15.0 x 17.5                              | 2.4                        | 36848MFP2B0                                                                                        | 36848MFM2B0                       | 750  | 36848MFI2B0                        | 500  | 36848MF02W0                                                              | 650        |  |
|                         | 0.100                                                                         | 10 x 16.5 x 17.5                               | 3.0                        | 41048MFP2B0                                                                                        | 41048MFM2B0                       | 500  | 41048MFI2B0                        | 450  | 41048MF02W0                                                              | 600        |  |
|                         | PITCH = 22.5 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 % |                                                |                            |                                                                                                    |                                   |      |                                    |      |                                                                          |            |  |
|                         | 0.047                                                                         | 6.0 x 15.5 x 26.0                              | 2.4                        | 34748MIP2T0                                                                                        | 34748MIM2T0                       | 300  | 34748MII2B0                        | 250  | 34748MI02W0                                                              | 600        |  |
|                         | 0.068                                                                         |                                                |                            | 36848MIP2T0                                                                                        | 36848MIM2T0                       |      | 36848MII2B0                        |      | 36848MI02W0                                                              |            |  |
|                         | 0.10                                                                          |                                                |                            | 41048MIP2T0                                                                                        | 41048MIM2T0                       |      | 41048MII2B0                        |      | 41048MI02W0                                                              |            |  |
|                         | 0.15                                                                          | 7.0 x 16.5 x 26.0                              | 2.9                        | 41548MIP2T0                                                                                        | 41548MIM2T0                       | 200  | 41548MII2B0                        | 250  | 41548MI02W0                                                              | 500        |  |
|                         | 0.22                                                                          | 8.5 x 18.0 x 26.0                              | 3.8                        | 42248MIP2T0                                                                                        | 42248MIM2T0                       | 200  | 42248MII2B0                        | 250  | 42248MI02W0                                                              | 450        |  |
|                         | 0.33                                                                          | 12 x 22.0 x 26.0                               | 7.8                        | 43348MIP2T0                                                                                        | 43348MIM2T0                       | 150  | 43348MII2B0                        | 200  | 43348MI02W0                                                              | 300        |  |



| ELECTRICAL DATA AND ORDERING INFORMATION |                                                                               |                                                |                            |                                                                                                    |                                   |      |                                    |      |                                                                          |      |
|------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------|----------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------|------|------------------------------------|------|--------------------------------------------------------------------------|------|
| U <sub>RAC</sub><br>(V)                  | CAP.<br>(μF)                                                                  | DIMENSIONS <sup>(4)</sup><br>w x h x l<br>(mm) | MASS<br>(g) <sup>(3)</sup> | CATALOG NUMBER F339X1... AND PACKAGING                                                             |                                   |      |                                    |      |                                                                          |      |
|                                          |                                                                               |                                                |                            | LOOSE IN BOX                                                                                       |                                   |      |                                    |      | TAPED REEL                                                               |      |
|                                          |                                                                               |                                                |                            | SHORT LEADS                                                                                        |                                   |      | LONG LEADS                         |      |                                                                          |      |
|                                          |                                                                               |                                                |                            | $l_t = 3.5\text{ mm}$<br>+1 mm/-0.5 mm<br>(PITCH ≤ 10 mm)<br>or 3.5 mm ± 0.3 mm<br>(PITCH ≥ 15 mm) | $l_t = 5.0\text{ mm}$<br>± 1.0 mm | SPQ  | $l_t = 25.0\text{ mm}$<br>± 2.0 mm | SPQ  | Ø = 500 mm <sup>(1)(2)</sup><br>H = 18.5 mm;<br>P <sub>0</sub> = 12.7 mm | SPQ  |
| 480                                      | PITCH = 27.5 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 % |                                                |                            |                                                                                                    |                                   |      |                                    |      |                                                                          |      |
|                                          | 0.15                                                                          | 9.0 x 19.0 x 31.5                              | 5.5                        | 41548MKP2T0                                                                                        | 41548MKM2T0                       | 100  | 41548MKI2B0                        | 150  |                                                                          |      |
|                                          | 0.22                                                                          |                                                |                            | 42248MKP2T0                                                                                        | 42248MKM2T0                       |      | 42248MKI2B0                        |      |                                                                          |      |
|                                          | 0.33                                                                          | 11.0 x 21.0 x 31.0                             | 7.4                        | 43348MKP2T0                                                                                        | 43348MKM2T0                       | 100  | 43348MKI2B0                        | 125  |                                                                          |      |
|                                          | 0.47                                                                          | 13.0 x 23.0 x 31.0                             | 9.2                        | 44748MKP2T0                                                                                        | 44748MKM2T0                       | 100  | 44748MKI2B0                        | 125  |                                                                          |      |
|                                          | 0.68                                                                          | 15.0 x 25.0 x 31.5                             | 12.3                       | 46848MKP2T0                                                                                        | 46848MKM2T0                       | 100  | 46848MKI2B0                        | 125  |                                                                          |      |
|                                          | 1.0                                                                           | 18.0 x 28.0 x 31.5                             | 16.1                       | 51048MKP2T0                                                                                        | 51048MKM2T0                       | 100  | 51048MKI2B0                        | 100  |                                                                          |      |
|                                          | PITCH = 10.0 mm ± 0.4 mm; d <sub>t</sub> = 0.60 mm ± 0.06 mm; C-TOL. = ± 10 % |                                                |                            |                                                                                                    |                                   |      |                                    |      |                                                                          |      |
|                                          | 0.0010                                                                        | 4.0 x 10.0 x 12.5                              | 0.6                        | 21048KDA2B0                                                                                        | 21048KDM2B0                       | 1000 | 21048KDI2B0                        | 1250 | 21048KD02W0                                                              | 1400 |
|                                          | 0.0012                                                                        |                                                |                            | 21248KDA2B0                                                                                        | 21248KDM2B0                       |      | 21248KDI2B0                        |      | 21248KD02W0                                                              |      |
|                                          | 0.0015                                                                        |                                                |                            | 21548KDA2B0                                                                                        | 21548KDM2B0                       |      | 21548KDI2B0                        |      | 21548KD02W0                                                              |      |
|                                          | 0.0018                                                                        |                                                |                            | 21848KDA2B0                                                                                        | 21848KDM2B0                       |      | 21848KDI2B0                        |      | 21848KD02W0                                                              |      |
|                                          | 0.0022                                                                        |                                                |                            | 22248KDA2B0                                                                                        | 22248KDM2B0                       |      | 22248KDI2B0                        |      | 22248KD02W0                                                              |      |
|                                          | 0.0027                                                                        |                                                |                            | 22748KDA2B0                                                                                        | 22748KDM2B0                       |      | 22748KDI2B0                        |      | 22748KD02W0                                                              |      |
|                                          | 0.0033                                                                        |                                                |                            | 23348KDA2B0                                                                                        | 23348KDM2B0                       |      | 23348KDI2B0                        |      | 23348KD02W0                                                              |      |
|                                          | 0.0039                                                                        |                                                |                            | 23948KDA2B0                                                                                        | 23948KDM2B0                       |      | 23948KDI2B0                        |      | 23948KD02W0                                                              |      |
|                                          | 0.0047                                                                        | 5.0 x 11.0 x 12.5                              | 0.82                       | 24748KDA2B0                                                                                        | 24748KDM2B0                       | 1000 | 24748KDI2B0                        | 1000 | 24748KD02W0                                                              | 1100 |
|                                          | 0.0056                                                                        |                                                |                            | 25648KDA2B0                                                                                        | 25648KDM2B0                       |      | 25648KDI2B0                        |      | 25648KD02W0                                                              |      |
|                                          | 0.0068                                                                        | 6.0 x 12.0 x 12.5                              | 1.1                        | 26848KDA2B0                                                                                        | 26848KDM2B0                       | 750  | 26848KDI2B0                        | 750  | 26848KD02W0                                                              | 900  |
|                                          | 0.0082                                                                        |                                                |                            | 28248KDA2B0                                                                                        | 28248KDM2B0                       |      | 28248KDI2B0                        |      | 28248KD02W0                                                              |      |
|                                          | PITCH = 15.0 mm ± 0.4 mm; d <sub>t</sub> = 0.60 mm ± 0.06 mm; C-TOL. = ± 10 % |                                                |                            |                                                                                                    |                                   |      |                                    |      |                                                                          |      |
|                                          | 0.010                                                                         | 5.0 x 11.0 x 17.5                              | 1.0                        | 31048KFP2B0                                                                                        | 31048KFM2B0                       | 1250 | 31048KFI2B0                        | 1000 | 31048KF02W0                                                              | 1100 |
|                                          | 0.012                                                                         |                                                |                            | 31248KFP2B0                                                                                        | 31248KFM2B0                       |      | 31248KFI2B0                        |      | 31248KF02W0                                                              |      |
|                                          | 0.015                                                                         |                                                |                            | 31548KFP2B0                                                                                        | 31548KFM2B0                       |      | 31548KFI2B0                        |      | 31548KF02W0                                                              |      |
|                                          | 0.018                                                                         |                                                |                            | 31848KFP2B0                                                                                        | 31848KFM2B0                       |      | 31848KFI2B0                        |      | 31848KF02W0                                                              |      |
|                                          | 0.022                                                                         |                                                |                            | 32248KFP2B0                                                                                        | 32248KFM2B0                       |      | 32248KFI2B0                        |      | 32248KF02W0                                                              |      |
|                                          | 0.027                                                                         |                                                |                            | 32748KFP2B0                                                                                        | 32748KFM2B0                       |      | 32748KFI2B0                        |      | 32748KF02W0                                                              |      |
|                                          | 0.033                                                                         | 6.0 x 12.0 x 17.5                              | 1.4                        | 33348KFP2B0                                                                                        | 33348KFM2B0                       | 1000 | 33348KFI2B0                        | 1000 | 33348KF02W0                                                              | 900  |
|                                          | 0.039                                                                         |                                                |                            | 33948KFP2B0                                                                                        | 33948KFM2B0                       |      | 33948KFI2B0                        |      | 33948KF02W0                                                              |      |
|                                          | PITCH = 15.0 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 % |                                                |                            |                                                                                                    |                                   |      |                                    |      |                                                                          |      |
|                                          | 0.047                                                                         | 7.0 x 13.5 x 17.5                              | 1.8                        | 34748KFP2B0                                                                                        | 34748KFM2B0                       | 750  | 34748KFI2B0                        | 500  | 34748KF02W0                                                              | 800  |
|                                          | 0.056                                                                         |                                                |                            | 35648KFP2B0                                                                                        | 35648KFM2B0                       |      | 35648KFI2B0                        |      | 35648KF02W0                                                              |      |
|                                          | 0.068                                                                         | 8.5 x 15.0 x 17.5                              | 2.4                        | 36848KFP2B0                                                                                        | 36848KFM2B0                       | 750  | 36848KFI2B0                        | 500  | 36848KF02W0                                                              | 650  |
|                                          | 0.082                                                                         |                                                |                            | 38248KFP2B0                                                                                        | 38248KFM2B0                       |      | 38248KFI2B0                        |      | 38248KF02W0                                                              |      |
|                                          | 0.100                                                                         | 10.0 x 16.5 x 17.5                             | 3.0                        | 41048KFP2B0                                                                                        | 41048KFM2B0                       | 500  | 41048KFI2B0                        | 450  | 41048KF02W0                                                              | 600  |

| ELECTRICAL DATA AND ORDERING INFORMATION |                                                                               |                                                |                            |                                                                                                    |                                   |             |                                    |     |                                                                          |     |  |
|------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------|----------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------|-------------|------------------------------------|-----|--------------------------------------------------------------------------|-----|--|
| U <sub>RAC</sub><br>(V)                  | CAP.<br>(μF)                                                                  | DIMENSIONS <sup>(4)</sup><br>w x h x l<br>(mm) | MASS<br>(g) <sup>(3)</sup> | CATALOG NUMBER F339X1... AND PACKAGING                                                             |                                   |             |                                    |     |                                                                          |     |  |
|                                          |                                                                               |                                                |                            | LOOSE IN BOX                                                                                       |                                   |             |                                    |     | TAPED REEL                                                               |     |  |
|                                          |                                                                               |                                                |                            | SHORT LEADS                                                                                        |                                   |             | LONG LEADS                         |     |                                                                          |     |  |
|                                          |                                                                               |                                                |                            | $l_t = 3.5\text{ mm}$<br>+1 mm/-0.5 mm<br>(PITCH ≤ 10 mm)<br>or 3.5 mm ± 0.3 mm<br>(PITCH ≥ 15 mm) | $l_t = 5.0\text{ mm}$<br>± 1.0 mm | SPQ         | $l_t = 25.0\text{ mm}$<br>± 2.0 mm | SPQ | Ø = 500 mm <sup>(1)(2)</sup><br>H = 18.5 mm;<br>P <sub>0</sub> = 12.7 mm | SPQ |  |
| 480                                      | PITCH = 22.5 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 % |                                                |                            |                                                                                                    |                                   |             |                                    |     |                                                                          |     |  |
|                                          | 0.047                                                                         | 6.0 x 15.5 x 26.0                              | 2.4                        | 34748KIP2T0                                                                                        | 34748KIM2T0                       | 300         | 34748KII2B0                        | 250 | 34748KI02W0                                                              | 600 |  |
|                                          | 0.056                                                                         |                                                |                            | 35648KIP2T0                                                                                        | 35648KIM2T0                       |             | 35648KII2B0                        |     | 35648KI02W0                                                              |     |  |
|                                          | 0.068                                                                         |                                                |                            | 36848KIP2T0                                                                                        | 36848KIM2T0                       |             | 36848KII2B0                        |     | 36848KI02W0                                                              |     |  |
|                                          | 0.082                                                                         |                                                |                            | 38248KIP2T0                                                                                        | 38248KIM2T0                       |             | 38248KII2B0                        |     | 38248KI02W0                                                              |     |  |
|                                          | 0.10                                                                          |                                                |                            | 41048KIP2T0                                                                                        | 41048KIM2T0                       |             | 41048KII2B0                        |     | 41048KI02W0                                                              |     |  |
|                                          | 0.12                                                                          | 7.0 x 16.5 x 26.0                              | 2.9                        | 41248KIP2T0                                                                                        | 41248KIM2T0                       | 200         | 41248KII2B0                        | 250 | 41248KI02W0                                                              | 500 |  |
|                                          | 0.15                                                                          | 8.5 x 18.0 x 26.0                              | 3.8                        | 41548KIP2T0                                                                                        | 41548KIM2T0                       | 200         | 41548KII2B0                        | 250 | 41548KI02W0                                                              | 450 |  |
|                                          | 0.18                                                                          |                                                |                            | 41848KIP2T0                                                                                        | 41848KIM2T0                       |             | 41848KII2B0                        |     | 41848KI02W0                                                              |     |  |
|                                          | 0.22                                                                          | 10.0 x 19.5 x 26.0                             | 6.8                        | 42248KIP2T0                                                                                        | 42248KIM2T0                       | 200         | 42248KII2B0                        | 200 | 42248KI02W0                                                              | 350 |  |
|                                          | 0.27                                                                          | 12.0 x 22.0 x 26.0                             | 7.8                        | 42748KIP2T0                                                                                        | 42748KIM2T0                       | 150         | 42748KII2B0                        | 200 | 42748KI02W0                                                              | 300 |  |
|                                          | 0.33                                                                          |                                                |                            | 43348KIP2T0                                                                                        | 43348KIM2T0                       |             | 43348KII2B0                        |     | 43348KI02W0                                                              |     |  |
|                                          | PITCH = 27.5 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 % |                                                |                            |                                                                                                    |                                   |             |                                    |     |                                                                          |     |  |
|                                          | 0.15                                                                          | 9.0 x 19.0 x 31.5                              | 5.5                        | 41548KKP2T0                                                                                        | 41548KKM2T0                       | 100         | 41548KKI2B0                        | 150 | -                                                                        |     |  |
|                                          | 0.18                                                                          |                                                |                            | 41848KKP2T0                                                                                        | 41848KKM2T0                       |             | 41848KKI2B0                        |     |                                                                          |     |  |
|                                          | 0.22                                                                          |                                                |                            | 42248KKP2T0                                                                                        | 42248KKM2T0                       |             | 42248KKI2B0                        |     |                                                                          |     |  |
|                                          | 0.27                                                                          | 11.0 x 21.0 x 31.0                             | 7.4                        | 42748KKP2T0                                                                                        | 42748KKM2T0                       | 100         | 42748KKI2B0                        | 125 |                                                                          |     |  |
|                                          | 0.33                                                                          |                                                |                            | 43348KKP2T0                                                                                        | 43348KKM2T0                       |             | 43348KKI2B0                        |     |                                                                          |     |  |
|                                          | 0.39                                                                          | 13.0 x 23.0 x 31.0                             | 9.2                        | 43948KKP2T0                                                                                        | 43948KKM2T0                       | 100         | 43948KKI2B0                        | 125 |                                                                          |     |  |
|                                          | 0.47                                                                          |                                                |                            | 44748KKP2T0                                                                                        | 44748KKM2T0                       |             | 44748KKI2B0                        |     |                                                                          |     |  |
|                                          | 0.56                                                                          | 15.0 x 25.0 x 31.5                             | 12.3                       | 45648KKP2T0                                                                                        | 45648KKM2T0                       | 100         | 45648KKI2B0                        | 125 |                                                                          |     |  |
|                                          | 0.68                                                                          | 18.0 x 28.0 x 31.5                             | 16.1                       | 46848KKP2T0                                                                                        | 46848KKM2T0                       | 100         | 46848KKI2B0                        | 100 |                                                                          |     |  |
|                                          | 0.82                                                                          |                                                |                            | 48248KKP2T0                                                                                        | 48248KKM2T0                       |             | 48248KKI2B0                        |     |                                                                          |     |  |
| 1.0                                      | 21.0 x 31.0 x 31.0                                                            | 20.3                                           | 51048KKP2T0                | 51048KKM2T0                                                                                        | 50                                | 51048KKI2B0 | 75                                 |     |                                                                          |     |  |

**Notes**

- SPQ = Standard Packing Quantity
- (1) Reel diameter = 356 mm is available on request
- (2) H = in-tape height; P<sub>0</sub> = sprocket hole distance; for detailed specifications refer to "Packaging Information"
- (3) Weight for short lead product only
- (4) For tolerances see chapter "Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances"

| APPROVALS                                                                                                                                                                                                                                                                                                                                                           |                     |                |               |                                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------|---------------|------------------------------------------------------------------------|
| SAFETY APPROVALS X1                                                                                                                                                                                                                                                                                                                                                 | VOLTAGE             | VALUE          | FILE NUMBERS  | LINK                                                                   |
| EN 60384-14 (ENEC)<br>(= IEC 60384-14 ed-4 (2013))                                                                                                                                                                                                                                                                                                                  | 480 V <sub>AC</sub> | 1 nF to 1.0 μF | 40033060      | <a href="http://www.vishay.com/doc?28230">www.vishay.com/doc?28230</a> |
| UL 60384-14                                                                                                                                                                                                                                                                                                                                                         | 480 V <sub>AC</sub> | 1 nF to 1.0 μF | E354331A      | <a href="http://www.vishay.com/doc?28209">www.vishay.com/doc?28209</a> |
| CSA-E384-14                                                                                                                                                                                                                                                                                                                                                         | 480 V <sub>AC</sub> | 1 nF to 1.0 μF | E354331A      | <a href="http://www.vishay.com/doc?28209">www.vishay.com/doc?28209</a> |
| CQC                                                                                                                                                                                                                                                                                                                                                                 | 480 V <sub>AC</sub> | 1 nF to 1.0 μF | L-16001150859 | <a href="http://www.vishay.com/doc?28233">www.vishay.com/doc?28233</a> |
|                                                                                                                                                                                                                                                                                                                                                                     |                     |                | F-16001161460 | <a href="http://www.vishay.com/doc?28234">www.vishay.com/doc?28234</a> |
| CB-test certificate                                                                                                                                                                                                                                                                                                                                                 | 480 V <sub>AC</sub> | 1 nF to 1.0 μF | DE1-58018     | <a href="http://www.vishay.com/doc?28219">www.vishay.com/doc?28219</a> |
| The ENEC-approval together with the CB-certificate replace all national marks of the following countries (they have already signed the ENEC-agreement): Austria; Belgium; Czech. Republic; Denmark; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Luxembourg; Netherlands; Norway; Portugal; Slovenian; Spain; Sweden, Switzerland and United Kingdom. |                     |                |               |                                                                        |
|                                                                                                          |                     |                |               |                                                                        |

## MOUNTING

### Normal Use

The capacitors are designed for mounting on printed-circuit boards. The capacitors packed in bandoliers are designed for mounting on printed-circuit boards by means of automatic insertion machines.

For detailed tape specifications refer to packaging information [www.vishay.com/docs?28139](http://www.vishay.com/docs?28139)

### Specific Method of Mounting to Withstand Vibration and Shock

In order to withstand vibration and shock tests, it must be ensured that the stand-off pips are in good contact with the printed-circuit board:

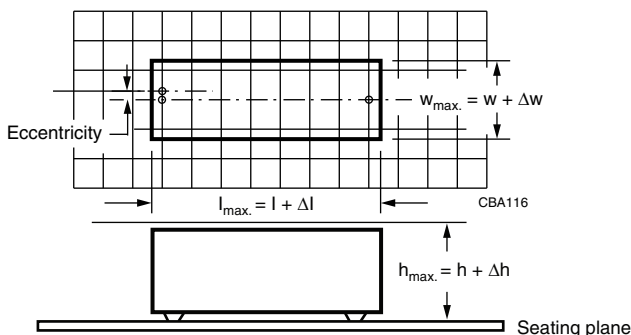
- For original pitch  $\leq 15$  mm the capacitors shall be mechanically fixed by the leads
- For larger pitches the capacitors shall be mounted in the same way and the body clamped

### Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances

For the maximum product dimensions and maximum space requirements for length ( $l_{max.}$ ), width ( $w_{max.}$ ) and height ( $h_{max.}$ ) following tolerances must be taken in account in the envelopment of the components as shown in the drawings below.

- For products with pitch  $\leq 15$  mm,  $\Delta w = \Delta l = 0.3$  mm and  $\Delta h = 0.1$  mm
- For products with  $15 \text{ mm} < \text{pitch} \leq 27.5$  mm,  $\Delta w = \Delta l = 0.5$  mm and  $\Delta h = 0.1$  mm

Eccentricity defined as in drawing. The maximum eccentricity is smaller than or equal to the lead diameter of the product concerned.



For the minimum product dimensions for length ( $l_{min.}$ ), width ( $w_{min.}$ ) and height ( $h_{min.}$ ) following tolerances of the components are valid:

$l_{min.} = l - \Delta l$ ,  $w_{min.} = w - \Delta w$  and  $h_{min.} = h - \Delta h$  following

- For products with pitch  $\leq 10$  mm,  $\Delta l = 0.3$  mm and  $\Delta w = \Delta h = 0.3$  mm
- For products with pitch = 15 mm,  $\Delta l = 0.5$  mm and  $\Delta w = \Delta h = 0.5$  mm
- For products with  $15 \text{ mm} < \text{pitch} \leq 27.5$  mm,  $\Delta l = 1.0$  mm and  $\Delta w = \Delta h = 0.5$  mm

## SOLDERING CONDITIONS

For general soldering conditions and wave soldering profile we refer to the document "Soldering Guidelines for Film Capacitors": [www.vishay.com/doc?28171](http://www.vishay.com/doc?28171)

## STORAGE TEMPERATURE

$T_{stg} = -25$  °C to  $+35$  °C with RH maximum 75 % without condensation

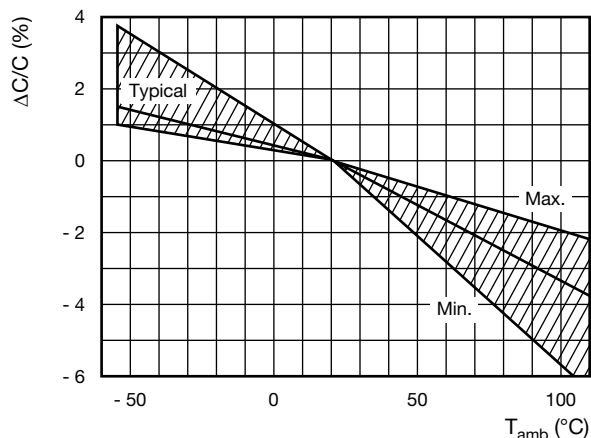
## RATINGS AND CHARACTERISTICS REFERENCE CONDITIONS

Unless otherwise specified, all electrical values apply to an ambient free temperature of  $23$  °C  $\pm 1$  °C, an atmospheric pressure of 86 kPa to 106 kPa and a relative humidity of  $50$  %  $\pm 2$  %.

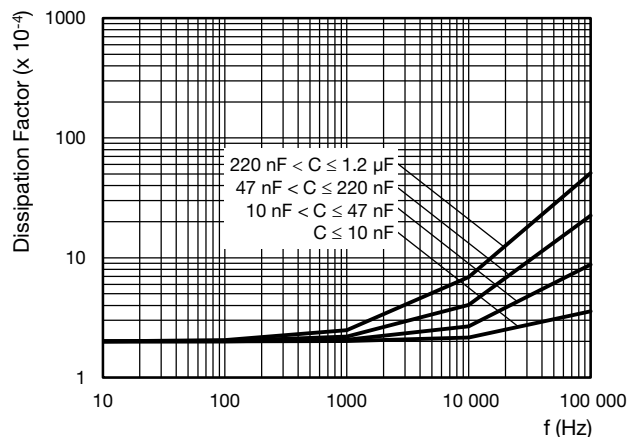
For reference testing, a conditioning period shall be applied over  $96 \text{ h} \pm 4 \text{ h}$  by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20 %.



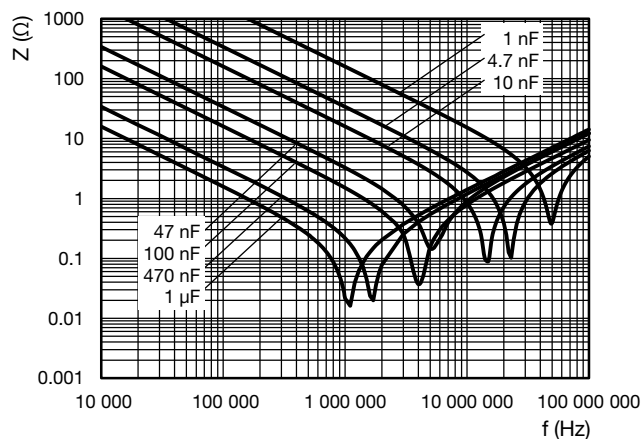
## CHARACTERISTICS



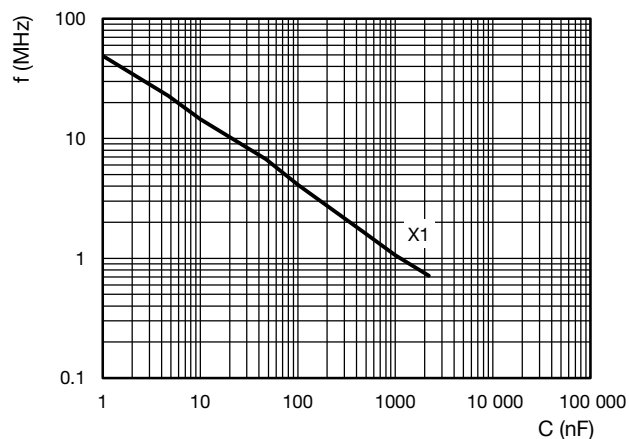
Capacitance as a function of ambient temperature (typical curve)



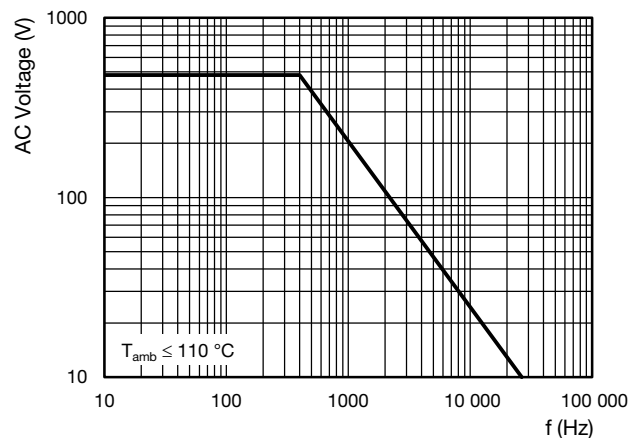
Tangent of loss angle as a function of frequency (typical curve)



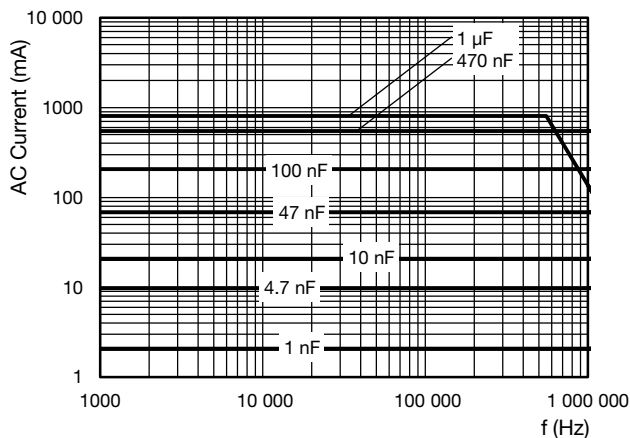
Impedance as a function of frequency (typical curve)



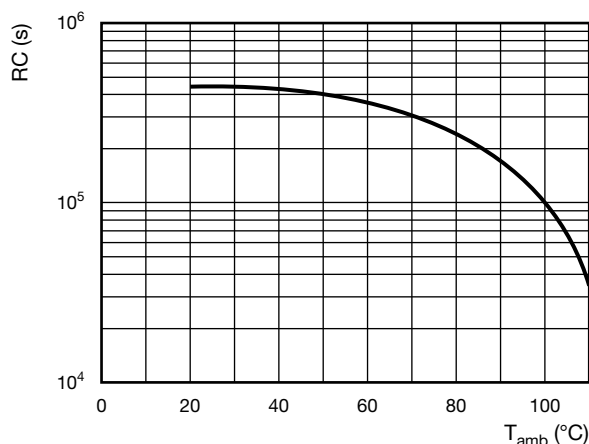
Resonant frequency as a function of capacitance (typical curve)



Max. RMS voltage as a function of frequency



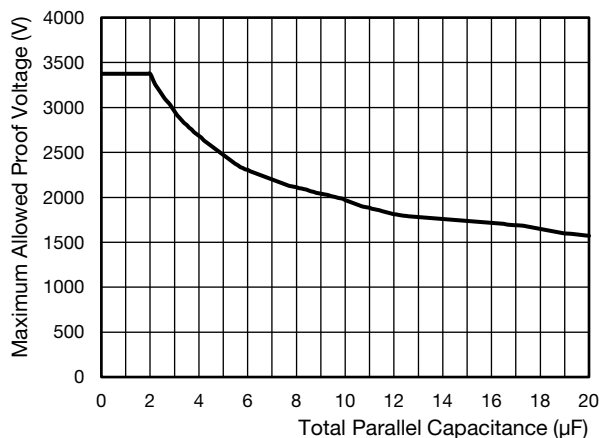
Max. RMS current as a function of frequency



Insulation resistance as a function of ambient temperature  
(typical curve)

### APPLICATION NOTES

- For X1 electromagnetic interference suppression in **standard and 3-phase across the line applications** (50 Hz/60 Hz) with a maximum mains voltage of 480 V<sub>AC</sub>
- For series impedance applications we refer to the application note: [www.vishay.com/doc?28153](http://www.vishay.com/doc?28153)
- To ensure withstanding high humidity requirements in the application it is recommended not to damage the epoxy adhesion at the leads. Therefore the leads may not be damaged or bent before soldering.
- For capacitors connected in parallel, normally the proof voltage must be reduced in function of the total parallel capacitance value.



Proof voltage as function of total parallel capacitance

- These capacitors are not intended for continuous pulse applications. For these situations, capacitors of the AC and pulse programs must be used.
- The maximum ambient temperature must not exceed 110 °C.
- Rated voltage pulse slope:  
if the pulse voltage is lower than the rated voltage, the values of the specific reference data can be multiplied by 670 V<sub>DC</sub> and divided by the applied voltage.

**INSPECTION REQUIREMENTS****General Notes**

Sub-clause numbers of tests and performance requirements refer to the “Sectional Specification, Publication IEC 60384-14 ed-4 (2013) and Specific Reference Data”.

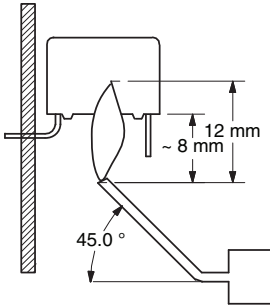
| <b>GROUP C INSPECTION REQUIREMENTS</b>                    |                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SUB-CLAUSE NUMBER AND TEST</b>                         | <b>CONDITIONS</b>                                                                                                                             | <b>PERFORMANCE REQUIREMENTS</b>                                                                                                                                                                                                                                                                                                                                |
| <b>SUB-GROUP C1A PART OF SAMPLE OF SUB-GROUP C1</b>       |                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                |
| 4.1 Dimensions (detail)                                   |                                                                                                                                               | As specified in chapters “General Data” of this specification                                                                                                                                                                                                                                                                                                  |
| Initial measurements                                      | Capacitance<br>Tangent of loss angle at 10 kHz for $C \leq 1 \mu\text{F}$<br>Tangent of loss angle at 1 kHz for $C > 1 \mu\text{F}$           |                                                                                                                                                                                                                                                                                                                                                                |
| 4.3 Robustness of terminations                            | Tensile: load 10 N; 10 s<br>Bending: load 5 N; $4 \times 90^\circ$                                                                            | No visible damage                                                                                                                                                                                                                                                                                                                                              |
| 4.4 Resistance to soldering heat                          | No pre-drying<br>Method: 1A<br>Solder bath: $280^\circ\text{C} \pm 5^\circ\text{C}$<br>Duration: 10 s                                         |                                                                                                                                                                                                                                                                                                                                                                |
| <b>SUB-GROUP C1A PART OF SAMPLE OF SUB-GROUP C1</b>       |                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                |
| 4.19 Component solvent resistance                         | Isopropylalcohol at room temperature<br>Method: 2<br>Immersion time: $5 \text{ min} \pm 0.5 \text{ min}$<br>Recovery time: min. 1 h, max. 2 h |                                                                                                                                                                                                                                                                                                                                                                |
| 4.4.2 Final measurements                                  | Visual examination<br><br>Capacitance<br><br>Tangent of loss angle<br><br>Insulation resistance                                               | No visible damage<br>Legible marking<br><br>$ \Delta C/C  \leq 5\%$ of the value measured initially<br><br>Increase of $\tan \delta \leq 0.008$ for $\leq 1 \mu\text{F}$<br>Increase of $\tan \delta \leq 0.005$ for $C > 1 \mu\text{F}$<br>Compared to values measured initially<br><br>As specified in section “Insulation Resistance” of this specification |
| <b>SUB-GROUP C1B OTHER PART OF SAMPLE OF SUB-GROUP C1</b> |                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                |
| Initial measurements                                      | Capacitance<br>Tangent of loss angle at 10 kHz for $C \leq 1 \mu\text{F}$<br>Tangent of loss angle at 1 kHz for $C > 1 \mu\text{F}$           |                                                                                                                                                                                                                                                                                                                                                                |
| 4.20 Solvent resistance of the marking                    | Isopropyl alcohol at room temperature<br>Method: 1<br>Rubbing material: cotton wool<br>Immersion time: $5 \text{ min} \pm 0.5 \text{ min}$    | No visible damage<br>Legible marking                                                                                                                                                                                                                                                                                                                           |
| 4.6 Rapid change of temperature                           | $\theta A = -55^\circ\text{C}$<br>$\theta B = +110^\circ\text{C}$<br>5 cycles<br>Duration $t = 30 \text{ min}$                                |                                                                                                                                                                                                                                                                                                                                                                |



| <b>GROUP C INSPECTION REQUIREMENTS</b>                                             |                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SUB-CLAUSE NUMBER AND TEST</b>                                                  | <b>CONDITIONS</b>                                                                                                                                                                                                           | <b>PERFORMANCE REQUIREMENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>SUB-GROUP C1B OTHER PART OF SAMPLE OF SUB-GROUP C1</b>                          |                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.6.1 Inspection                                                                   | Visual examination                                                                                                                                                                                                          | No visible damage                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 4.7 Vibration                                                                      | Mounting: see section "Mounting" of this specification<br>Procedure B4:<br>frequency range: 10 Hz to 55 Hz<br>Amplitude: 0.75 mm or<br>Acceleration 98 m/s <sup>2</sup><br>(whichever is less severe)<br>Total duration 6 h |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.7.2 Final inspection                                                             | Visual examination                                                                                                                                                                                                          | No visible damage                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 4.9 Shock                                                                          | Mounting: see section "Mounting" for more information<br>Pulse shape: half sine<br>Acceleration: 490 m/s <sup>2</sup><br>Duration of pulse: 11 ms                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.9.2 Final measurements                                                           | Visual examination<br><br>Capacitance<br><br>Tangent of loss angle<br><br>Insulation resistance                                                                                                                             | No visible damage<br><br>$ \Delta C/C  \leq 5\%$ of the value measured initially<br><br>Increase of $\tan \delta \leq 0.008$ for $\leq 1 \mu\text{F}$<br>Increase of $\tan \delta \leq 0.005$ for $C > 1 \mu\text{F}$<br>Compared to values measured initially<br><br>As specified in section "Insulation Resistance" of this specification                                                                                       |
| <b>SUB-GROUP C1<br/>COMBINED SAMPLE OF SPECIMENS<br/>OF SUB-GROUPS C1A AND C1B</b> |                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.11 Climatic sequence                                                             |                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.11.1 Initial measurements                                                        | Capacitance<br>Measured in 4.4.2 and 4.9.2<br>Tangent of loss angle:<br>measured initially in C1A and C1B                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.11.2 Dry heat                                                                    | Temperature: 110 °C                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.11.3 Damp heat cyclic<br>Test Db<br>First cycle                                  | Duration: 16 h                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.11.4 Cold                                                                        | Temperature: -55 °C                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.11.5 Damp heat cyclic<br>Test Db<br>remaining cycles                             | Duration: 2 h                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.11.6 Final measurements                                                          | Visual examination<br><br>Capacitance<br><br>Tangent of loss angle<br><br>Voltage proof<br>1900 V <sub>DC</sub> ; 1 min between terminations<br><br>Insulation resistance                                                   | No visible damage<br>Legible marking<br><br>$ \Delta C/C  \leq 5\%$ of the value measured in 4.11.1.<br><br>Increase of $\tan \delta \leq 0.008$ for $\leq 1 \mu\text{F}$<br>Increase of $\tan \delta \leq 0.005$ for $C > 1 \mu\text{F}$<br>Compared to values measured in 4.11.1<br><br>No permanent breakdown or flash-over<br><br>$\geq 50\%$ of values specified in section<br>"Insulation Resistance" of this specification |



| <b>GROUP C INSPECTION REQUIREMENTS</b> |                                                                                                                                                                             |                                                                                                                                                                         |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SUB-CLAUSE NUMBER AND TEST</b>      | <b>CONDITIONS</b>                                                                                                                                                           | <b>PERFORMANCE REQUIREMENTS</b>                                                                                                                                         |
| <b>SUB-GROUP C2A</b>                   |                                                                                                                                                                             |                                                                                                                                                                         |
| 4.12A Damp heat steady state with load | RH: 85 %, temp: 85 °C, load: 400 V <sub>AC</sub> ,<br>duration: 500 h for C > 100 nF                                                                                        |                                                                                                                                                                         |
| 4.12.1A Initial measurements           | Capacitance<br>Tangent of loss angle at 1 kHz                                                                                                                               |                                                                                                                                                                         |
| 4.12.3A Final measurements             | Visual examination                                                                                                                                                          | No visible damage<br>Legible marking                                                                                                                                    |
|                                        | Capacitance                                                                                                                                                                 | $ \Delta C/C  \leq 10\%$ of the value measured in 4.12.1A.                                                                                                              |
|                                        | Tangent of loss angle                                                                                                                                                       | Increase of $\tan \delta \leq 0.008$<br>Compared to values measured in 4.12.1A.                                                                                         |
|                                        | Voltage proof<br>1900 V <sub>DC</sub> ; 1 min between terminations                                                                                                          | No permanent breakdown or flash-over                                                                                                                                    |
|                                        | Insulation resistance                                                                                                                                                       | $\geq 50\%$ of values specified in section "Insulation Resistance" of this specification                                                                                |
| <b>SUB-GROUP C3</b>                    |                                                                                                                                                                             |                                                                                                                                                                         |
| 4.13.1 Initial measurements            | Capacitance<br>Tangent of loss angle at 10 kHz for C $\leq 1\ \mu\text{F}$<br>Tangent of loss angle at 1 kHz for C > 1 $\mu\text{F}$                                        |                                                                                                                                                                         |
| 4.13 Impulse voltage                   | 3 successive impulses, full wave, peak voltage:<br>X1: 4.0 kV for C $\leq 1\ \mu\text{F}$<br>X1: 4.0 kV/ $\sqrt{C}$ for C > 1 $\mu\text{F}$<br>Max. 24 pulses               | No self healing breakdowns or flash-over                                                                                                                                |
| 4.14 Endurance                         | Duration: 1000 h<br>1.25 x U <sub>RAC</sub> at 110 °C<br>Once in every hour the voltage is increased to 1000 V <sub>RMS</sub> for 0.1 s via resistor of 47 $\Omega \pm 5\%$ |                                                                                                                                                                         |
| 4.14.7 Final measurements              | Visual examination                                                                                                                                                          | No visible damage<br>Legible marking                                                                                                                                    |
|                                        | Capacitance                                                                                                                                                                 | $ \Delta C/C  \leq 10\%$ compared to values measured in 4.13.1.                                                                                                         |
|                                        | Tangent of loss angle                                                                                                                                                       | Increase of $\tan \delta \leq 0.008$ for $\leq 1\ \mu\text{F}$<br>Increase of $\tan \delta \leq 0.005$ for C > 1 $\mu\text{F}$<br>Compared to values measured in 4.13.1 |
|                                        | Voltage proof<br>1900 V <sub>DC</sub> ; 1 min between terminations<br>2460 V <sub>AC</sub> ; 1 min between terminations and case                                            | No permanent breakdown or flash-over                                                                                                                                    |
|                                        | Insulation resistance                                                                                                                                                       | $\geq 50\%$ of values specified in section "Insulation Resistance" of this specification                                                                                |

| GROUP C INSPECTION REQUIREMENTS                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                  |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|----------------|---|------|-----------------|---|------|-----------|------|---|------------------------------------------------------------------------------------------------------------------------------------------------------|
| SUB-CLAUSE NUMBER AND TEST                                                                                         | CONDITIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PERFORMANCE REQUIREMENTS                                                                                                                                                                                                                                                                                         |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| <b>SUB-GROUP C4</b>                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                  |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| 4.15 Charge and discharge                                                                                          | 10 000 cycles<br>charged to 670 V <sub>DC</sub><br>Discharge resistance:<br>$R = \frac{670 \text{ V}_{DC}}{1.5 \times C (dU/dt)}$                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                  |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| 4.15.1 Initial measurements                                                                                        | Capacitance<br>Tangent of loss angle at 10 kHz for C ≤ 1 µF<br>Tangent of loss angle at 1 kHz for C > 1 µF                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                  |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| 4.15.3 Final measurements                                                                                          | Capacitance<br><br>Tangent of loss angle<br><br>Insulation resistance                                                                                                                                                                                                                                                                                                                                                                                                          | $ \Delta C/C  \leq 10 \%$ compared to values measured in 4.15.1.<br><br>Increase of $\tan \delta \leq 0.008$ for ≤ 1 µF<br>Increase of $\tan \delta \leq 0.005$ for C > 1 µF<br>Compared to values measured in 4.15.1<br><br>≥ 50 % of values specified in section "Insulation Resistance" of this specification |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| <b>SUB-GROUP C5</b>                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                  |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| 4.16 Radio frequency characteristic                                                                                | Resonance frequency                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ≥ 0.9 times the value as specified in section "Resonant Frequency" of this specification                                                                                                                                                                                                                         |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| <b>SUB-GROUP C6</b>                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                  |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| 4.17 Passive flammability<br>Class B for volume > 1750mm <sup>3</sup><br>Class C for volume ≤ 1750 mm <sup>3</sup> | Bore of gas jet: Ø 0.5 mm<br>Fuel: butane<br>Test duration for actual volume V in mm <sup>3</sup> :<br><table> <tr> <td>Volume</td><td>Class B</td><td>Class C</td></tr> <tr> <td>250 &lt; V ≤ 500:</td><td>-</td><td>10 s</td></tr> <tr> <td>500 &lt; V ≤ 1750:</td><td>-</td><td>20 s</td></tr> <tr> <td>V &gt; 1750:</td><td>60 s</td><td>-</td></tr> </table> One flame application<br> | Volume                                                                                                                                                                                                                                                                                                           | Class B | Class C | 250 < V ≤ 500: | - | 10 s | 500 < V ≤ 1750: | - | 20 s | V > 1750: | 60 s | - | After removing test flame from capacitor, the capacitor must not continue to burn for more than 10 s. No burning particle must drop from the sample. |
| Volume                                                                                                             | Class B                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Class C                                                                                                                                                                                                                                                                                                          |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| 250 < V ≤ 500:                                                                                                     | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 10 s                                                                                                                                                                                                                                                                                                             |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| 500 < V ≤ 1750:                                                                                                    | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 20 s                                                                                                                                                                                                                                                                                                             |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| V > 1750:                                                                                                          | 60 s                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | -                                                                                                                                                                                                                                                                                                                |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| <b>SUB-GROUP C7</b>                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                  |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |
| 4.18 Active flammability                                                                                           | 20 cycles of 4 kV discharges on the test capacitor connected to U <sub>RAC</sub>                                                                                                                                                                                                                                                                                                                                                                                               | The cheese cloth around the capacitors shall not burn with a flame.<br>No electrical measurements are required.                                                                                                                                                                                                  |         |         |                |   |      |                 |   |      |           |      |   |                                                                                                                                                      |

**GROUP C INSPECTION REQUIREMENTS**

| SUB-CLAUSE NUMBER AND TEST              | CONDITIONS                                                                        | PERFORMANCE REQUIREMENTS                                                                   |
|-----------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| <b>SUB-GROUP ADD1</b>                   |                                                                                   |                                                                                            |
| A.1 Damp heat steady state with voltage | RH: 40 %; temperature: 93 °C;<br>Voltage: 480 V <sub>AC</sub> , duration: 21 days |                                                                                            |
| A 1.1 Initial measurements              | Capacitance                                                                       |                                                                                            |
|                                         | Tangent of loss angle: at 10 kHz                                                  |                                                                                            |
| A 1.2 Final measurements                | Visual examination                                                                | No visible damage<br>Legible marking                                                       |
|                                         | Capacitance                                                                       | $ \Delta C/C  \leq 10\%$ of the value with initial measurement A 1.1                       |
|                                         | Tangent of loss angle                                                             | Increase of $\tan \delta$ : $\leq 0.024$ compared to values with initial measurement A 1.1 |
|                                         | Insulation resistance                                                             | $\geq 50\%$ of values specified in section "Insulation Resistance" of this specification   |

**TEST CONDITIONS AND REQUIREMENTS ACCORDING AEC-Q200 REVISION D**

| NO. | TEST NAME                            | REFERENCE              | TEST CONDITION                                                                                                                | PERFORMANCE REQUIREMENTS                                                                                                                                       |
|-----|--------------------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Pre- and post-stress electrical test | User Spec              | -                                                                                                                             | -                                                                                                                                                              |
| 3   | High temperature exposure (storage)  | MIL-STD-202 Method 108 | Temperature: 105 °C;<br>unpowered duration: 1000 h                                                                            | $ \Delta C/C  \leq 10\%$<br>Increase in $\tan \delta = 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz<br>Insulation resistance $\geq 50\%$ of initial requirement |
| 4   | Temperature cycling                  | JESD22 Method JA-104   | Total No. of cycles: 1000 cycles<br>Lower temperature: -40 °C<br>Upper temperature: +85 °C<br>Dwell each 30 min as per Rev. D | $ \Delta C/C  \leq 10\%$<br>Increase in $\tan \delta = 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz<br>Insulation resistance $\geq 50\%$ of initial requirement |
| 6   | Moisture resistance                  | MIL-STD-202 Method 106 | 10 cycles at 24 h/cycle<br>Unpowered                                                                                          | $ \Delta C/C  \leq 10\%$<br>Increase in $\tan \delta = 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz<br>Insulation resistance $\geq 50\%$ of initial requirement |
| 7   | Biased humidity                      | MIL-STD-202 Method 103 | Temperature: 40 °C; RH: 93%;<br>U <sub>RAC</sub> duration: 1000 h                                                             | $ \Delta C/C  \leq 10\%$<br>Increase in $\tan \delta = 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz<br>Insulation resistance $\geq 50\%$ of initial requirement |
| 8   | Operational life                     | MIL-STD-202 Method 108 | Temperature: +85 °C; load = U <sub>RAC</sub> ;<br>duration = 1000 h                                                           | $ \Delta C/C  \leq 10\%$<br>Increase in $\tan \delta = 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz<br>Insulation resistance $\geq 50\%$ of initial requirement |
| 11  | Terminal strength (lead)             | MIL-STD-202 Method 211 | Leaded device lead integrity only                                                                                             | No visual damage                                                                                                                                               |
| 12  | Resistance to solvents               | MIL-STD-202 Method 215 | Also aqueous chemical - OKEM clean or equivalent;<br>do not use banned solvents                                               | No visual damage and legible marking                                                                                                                           |
| 13  | Mechanical shock                     | MIL-STD-202 Method 213 | Figure a of Method 213, Condition C                                                                                           | No visual damage                                                                                                                                               |

**TEST CONDITIONS AND REQUIREMENTS ACCORDING AEC-Q200 REVISION D**

| NO. | TEST NAME                    | REFERENCE              | TEST CONDITION                                  | PERFORMANCE REQUIREMENTS                                                                                                                                                                     |
|-----|------------------------------|------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14  | Vibration                    | MIL-STD-202 Method 204 | 5 g's for 20 min.,<br>12 cycles, 3 orientations | No visual damage                                                                                                                                                                             |
| 15  | Resistance to soldering heat | MIL-STD-202 Method 210 | 260 °C, 10 s                                    | $ \Delta C/C  \leq \pm 5 \%$<br>Increase in $\tan \delta = 0.008$ for<br>$C \leq 1 \mu\text{F}$ at 10 kHz<br>Insulation resistance $\geq 50 \%$<br>of initial requirement                    |
| 18  | Solderability                | J-STD-002              | 235 °C, 5 s                                     | Good tinning as evidence by<br>free flowing of the solder with<br>wetting of terminations $> 95 \%$                                                                                          |
| 19  | Electrical characterization  | User spec              | -                                               |                                                                                                                                                                                              |
| 20  | Flammability                 | UL-94                  | Electrical test not required                    | After removing test flame from<br>capacitor, the capacitor must not<br>continue to burn for more than 10 s<br>for $V > 1750 \text{ mm}^3$ ; no burning<br>particle must drop from the sample |



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