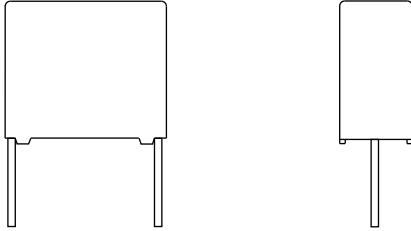




# Interference Suppression Film Capacitors - Class X2 Radial MKP 300 V<sub>AC</sub> - Standard Across The Line X2



### FEATURES

- Compliant with IEC 60381-14: AMD1 THB grade IA
- 7 A max. I<sub>RMS</sub> at 10 µF
- Self-healing properties
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



RoHS COMPLIANT

### APPLICATIONS

For across the line X2 applications.

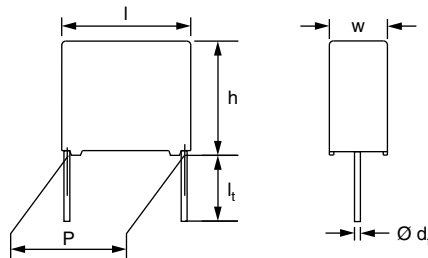
Please see section application notes in this specification and especially [www.vishay.com/doc?28153](http://www.vishay.com/doc?28153).

| QUICK REFERENCE DATA                            |  |
|---|--|
| Capacitance range (E12 series)                  | 0.01 µF to 10 µF<br>(preferred values according to E6)   |
| Capacitance tolerance                           | ± 20 %, ± 10 %   |
| Rated AC voltage                                | 300 V <sub>AC</sub> ; 50 Hz to 60 Hz   |
| Permissible DC voltage                          | 800 V <sub>DC</sub> at 85 °C<br>630 V <sub>DC</sub> at 110 °C  |
| Climatic testing class according to IEC 60068-1 | 55/105/56/C for product volumes ≤ 1750 mm <sup>3</sup><br>55/105/56/B for product volumes > 1750 mm <sup>3</sup>   |
| Rated temperature                               | 105 °C   |
| Maximum application temperature                 | 105 °C   |
| Reference standards                             | IEC 60384-14:2013<br>IEC 60384-14:2013 / AMD1:2016<br>EN 60384-14:2013 + AMD1:2016<br>IEC 60065 pass. flamm. class B for volumes > 1750 mm <sup>3</sup><br>ENEC; UL 60384-14                     |
| Dielectric                                      | Polypropylene film   |
| Electrodes                                      | Metallized film  |
| Construction                                    | Mono construction<br>  |
| Encapsulation                                   | Plastic case, epoxy resin sealed, flame retardant UL-class 94 V-0  |
| Leads   | Tinned wire  |
| Marking   | C-value; tolerance; rated voltage; sub-class; manufacturer's type designation; code for dielectric material; manufacturer location, year and week; manufacturer's logo or name; safety approvals |

### Note

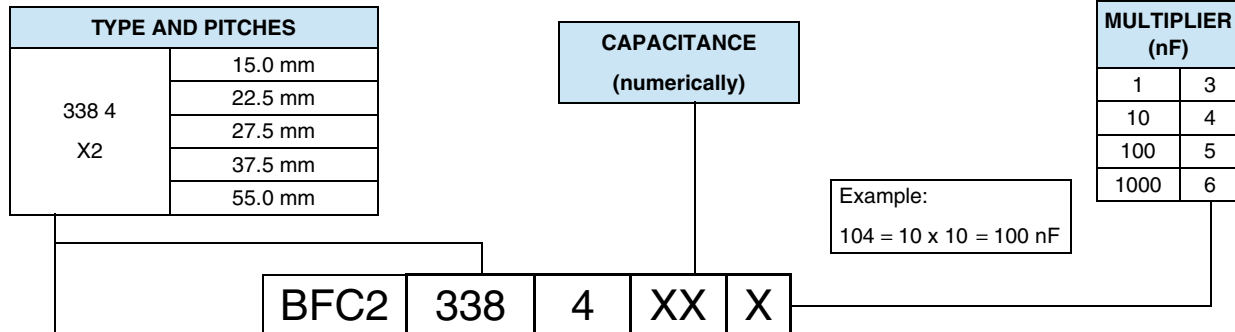
- For more detailed data and test requirements, contact [rfi@vishay.com](mailto:rfi@vishay.com)

### DIMENSIONS





**COMPOSITION OF CATALOG NUMBER**



| TYPE                         | PACKAGING                             | STANDARD DIMENSIONS                       | C-TOL.        | PREFERRED TYPES        |
|------------------------------|---------------------------------------|---|---------------|------------------------|
| 338 4<br>X2                  | Loose in box                          | Lead length 3.5 mm ± 0.3 mm               | ± 20 %        | BFC2 338 44 ...        |
|                              |                                       | Lead length 5.0 mm ± 1.0 mm               |               | BFC2 338 40 ...        |
|                              |                                       | Lead length 25.0 mm ± 2.0 mm              |               | BFC2 338 41 ...        |
|                              | Taped <sup>(1)(2)</sup>               | 15.0 mm                                   |               | BFC2 338 4. ...        |
|                              | <b>PACKAGING</b>                      | <b>ALTERNATIVE PITCH SIZES</b>            | <b>C-TOL.</b> | <b>ON REQUEST</b>      |
|                              | Loose in box                          | Lead length 3.5 mm ± 0.3 mm               | ± 20 %        | See tables for details |
|                              |                                       | Lead length 5.0 mm ± 1.0 mm               |               |                        |
|                              |                                       | Lead length 25.0 mm ± 2.0 mm              |               |                        |
|                              | <b>PACKAGING</b>                      | <b>ALTERNATIVE TAPED VERSION</b>          | <b>C-TOL.</b> | <b>ON REQUEST</b>      |
|                              | Taped <sup>(1)(2)</sup>               | H = 18.5 mm; for P <sub>0</sub> = 12.7 mm | ± 20 %        | See tables for details |
|                              | <b>PACKAGING</b>                      | <b>ALTERNATIVE C-TOL.</b>                 | <b>C-TOL.</b> | <b>ON REQUEST</b>      |
|                              | Loose in box                          | Lead length 3.5 mm ± 0.3 mm               | ± 10 %        | See tables for details |
| Lead length 5.0 mm ± 1.0 mm  |                                       |   |               |                        |
| Lead length 25.0 mm ± 2.0 mm |                                       |   |               |                        |
| Taped <sup>(1)(2)</sup>      | 15.0 mm                               |   |               |                        |
|                              | H = 18.5 mm; P <sub>0</sub> = 12.7 mm |   |               |                        |

**Notes**

- (1) For detailed tape specification refer to packaging information: [www.vishay.com/doc?28139](http://www.vishay.com/doc?28139)
- (2) Tape on reel pitch = 27.5 mm is not available

| SPECIFIC REFERENCE DATA  |                          |                         |                          |
|--|--------------------------|-------------------------|--------------------------|
| DESCRIPTION  | VALUE                    |                         |                          |
|  | at 1 kHz                 | at 10 kHz               | at 100 kHz               |
| Tangent of loss angle:   |                          |                         |                          |
| Pitch = 15 mm; 22.5 mm and 27.5 mm for C ≤ 470 nF  | ≤ 10 x 10 <sup>-4</sup>  | ≤ 20 x 10 <sup>-4</sup> | ≤ 100 x 10 <sup>-4</sup> |
| Pitch = 15 mm; 22.5 mm and 27.5 mm for 470 nF < C ≤ 1 μF                                 | ≤ 20 x 10 <sup>-4</sup>  | ≤ 70 x 10 <sup>-4</sup> | -                        |
| Pitch = 15 mm; 22.5 mm and 27.5 mm for 1 μF < C ≤ 3.3 μF                                 | ≤ 30 x 10 <sup>-4</sup>  | -                       | -                        |
| Pitch = 37.5 mm and 55 mm for 2.2 μF < C ≤ 4.7 μF  | ≤ 50 x 10 <sup>-4</sup>  | -                       | -                        |
| Pitch = 37.5 mm and 55 mm for 4.7 μF < C ≤ 10 μF   | ≤ 100 x 10 <sup>-4</sup> | -                       | -                        |
| Rated voltage pulse slope (dU/dt) <sub>R</sub> at 420 V <sub>DC</sub>                    | 100 V/μs                 |                         |                          |
| R between leads, for C ≤ 0.33 μF at 100 V; 1 min   | > 15 000 MΩ              |                         |                          |
| RC between leads, for C > 0.33 μF at 100 V; 1 min  | > 5000 s                 |                         |                          |
| R between leads and case; 100 V; 1 min   | > 30 000 MΩ              |                         |                          |
| Withstanding (DC) voltage (cut off current 10 mA) <sup>(1)</sup> ; rise time ≤ 1000 V/s: |                          |                         |                          |
| C ≤ 1 μF   | 2200 V; 1 min            |                         |                          |
| 1 μF < C ≤ 3.3 μF (not pitch = 37.5 mm)  | 1850 V; 1 min            |                         |                          |
| Pitch = 37.5 mm and 55 mm  | 1400 V; 1 min            |                         |                          |
| Withstanding (AC) voltage between leads and case   | 2200 V; 1 min            |                         |                          |

**Note**

- (1) 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<br>w x h x l<br>(mm) | MASS <sup>(3)</sup><br>(g) | CATALOG NUMBER BFC2 338 ..... AND PACKAGING |                                     |       |                                      |      |  |      |
|   |   |                                 |                            | LOOSE IN BOX                                |                                     |       |                                      |      | REEL <sup>(1)(2)</sup>                                 |      |
|   |   |                                 |                            | SHORT LEADS                                 |                                     |       | LONG LEADS                           |      | Ø = 500 mm<br>H = 18.5 mm;<br>P <sub>0</sub> = 12.7 mm |      |
|   |   |                                 |                            | l <sub>t</sub> = 3.5 mm ±<br>0.3 mm         | l <sub>t</sub> = 5.0 mm ±<br>1.0 mm | SPQ   | l <sub>t</sub> = 25.0 mm ±<br>2.0 mm | SPQ  |  | SPQ  |
| 300   | PITCH = 15.0 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                        | 44103                                       | 40103                               | 1000  | 41103                                | 1000 | 48127  | 1000 |
|   | 0.015   |                                 |                            | 44153                                       | 40153                               |       | 41153                                |      | 48128  |      |
|   | 0.022   |                                 |                            | 44223                                       | 40223                               |       | 41223                                |      | 48129  |      |
|   | 0.033   |                                 |                            | 44333                                       | 40333                               |       | 41333                                |      | 48131  |      |
|   | 0.047   |                                 |                            | 44473                                       | 40473                               |       | 41473                                |      | 48132  |      |
|   | 0.068   |                                 |                            | 44683                                       | 40683                               |       | 41683                                |      | 48133  |      |
|   | 0.10  | 6.0 x 12.0 x 17.5               | 1.4                        | 44104                                       | 40104                               | 1000  | 41104                                | 1000 | 48134  | 1000 |
|   | PITCH = 15.0 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 % |                                 |                            |   |                                     |       |                                      |      |  |      |
|   | 0.15  | 7.0 x 13.5 x 17.5               | 1.8                        | 44154                                       | 40154                               | 750   | 41154                                | 500  | 48135  | 500  |
|   | 0.22  | 8.5 x 15.0 x 17.5               | 2.4                        | 44224                                       | 40224                               | 750   | 41224                                | 500  | 48136  | 500  |
|   | 0.33  | 10.0 x 16.5 x 17.5              | 3.0                        | 44334                                       | 40334                               | 500   | 41334                                | 450  | 48137  | 600  |
|   | PITCH = 22.5 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 % |                                 |                            |   |                                     |       |                                      |      |  |      |
|   | 0.22  | 7.0 x 16.5 x 26.0               | 2.9                        | 48101                                       | 48109                               | 200   | 48118                                | 250  | -  | -    |
|   | 0.33  |                                 |                            | 48103                                       | 48112                               |       | 48121                                |      |  |      |
|   | 0.47  | 8.5 x 18.0 x 26.0               | 3.8                        | 44474                                       | 40474                               | 200   | 41474                                | 250  |  |      |
|   | 0.68  | 10.0 x 19.5 x 26.0              | 6.8                        | 44684                                       | 40684                               | 200   | 41684                                | 200  |  |      |
|   | 1.0   | 12.0 x 22.0 x 26.0              | 7.8                        | 44105                                       | 40105                               | 150   | 41105                                | 200  |  |      |
|   | PITCH = 27.5 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 % |                                 |                            |   |                                     |       |                                      |      |  |      |
|   | 0.47  | 9.0 x 19.0 x 31.0               | 5.5                        | 48104                                       | 48113                               | 100   | 48122                                | 150  | -  | -    |
|   | 0.68  | 11.0 x 21.0 x 31.0              | 7.4                        | 48106                                       | 48115                               | 100   | 48124                                | 150  |  |      |
|   | 1.0   |                                 |                            | 48108                                       | 48117                               |       | 48126                                |      |  |      |
|   | 1.5   | 15.0 x 25.0 x 31.0              | 12.3                       | 44155                                       | 40155                               | 100   | 41155                                | 125  |  |      |
|   | 2.2   | 18.0 x 28.0 x 31.0              | 16.1                       | 44225                                       | 40225                               | 100   | 41225                                | 100  |  |      |
| 3.3   | 21.0 x 31.0 x 31.0  | 20.3                            | 44335                      | 40335                                       | 50                                  | 41335 | 75                                   |      |  |      |
| PITCH = 37.5 mm ± 0.7 mm; d <sub>t</sub> = 1.0 mm ± 0.1 mm; C-TOL. = ± 20 % |   |                                 |                            |   |                                     |       |                                      |      |  |      |
| 4.7   | 18.5 x 35.5 x 43.0  | 29.0                            | -                          | 40475                                       | 105                                 | 41475 | 105                                  | -    | -  |      |
| 6.8   | 21.5 x 38.5 x 42.0  | 35.0                            |                            | 40685                                       | 91                                  | 41685 | 91                                   |      |  |      |
| 10  | 30.0 x 46.0 x 44.0  | 55.0                            |                            | 48159                                       | 63                                  | 48161 | 63                                   |      |  |      |
| PITCH = 55.0 mm ± 1.0 mm; d <sub>t</sub> = 1.0 mm ± 0.1 mm; C-TOL. = ± 20 % |   |                                 |                            |   |                                     |       |                                      |      |  |      |
| 10  | 21.5 x 38.5 x 61.0  | 50.0                            | -                          | 40106                                       | 65                                  | 41106 | 65                                   | -    | -  |      |
| 300   | 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                        | 45103                                       | 42103                               | 1000  | 43103                                | 1000 | 48138  | 1000 |
|   | 0.015   |                                 |                            | 45153                                       | 42153                               |       | 43153                                |      | 48141  |      |
|   | 0.022   |                                 |                            | 45223                                       | 42223                               |       | 43223                                |      | 48143  |      |
|   | 0.033   |                                 |                            | 45333                                       | 42333                               |       | 43333                                |      | 48145  |      |
|   | 0.047   |                                 |                            | 45473                                       | 42473                               |       | 43473                                |      | 48147  |      |
|   | 0.068   |                                 |                            | 45683                                       | 42683                               |       | 43683                                |      | 48149  |      |
|   | 0.10  | 6.0 x 12.0 x 17.5               | 1.4                        | 45104                                       | 42104                               | 1000  | 43104                                | 1000 | 48153  | 1000 |



| ELECTRICAL DATA AND ORDERING INFORMATION |   |                                 |                            |   |                                     |     |                                      |     |  |     |
|--|---|---------------------------------|----------------------------|---|-------------------------------------|-----|--------------------------------------|-----|--|-----|
| U <sub>RAC</sub><br>(V)                  | CAP.<br>(μF)  | DIMENSIONS<br>w x h x l<br>(mm) | MASS <sup>(3)</sup><br>(g) | CATALOG NUMBER BFC2 338 ..... AND PACKAGING |                                     |     |                                      |     |  |     |
|  |   |                                 |                            | LOOSE IN BOX                                |                                     |     |                                      |     | REEL <sup>(1)(2)</sup>                                 |     |
|  |   |                                 |                            | SHORT LEADS                                 |                                     |     | LONG LEADS                           |     | Ø = 500 mm<br>H = 18.5 mm;<br>P <sub>0</sub> = 12.7 mm |     |
|  |   |                                 |                            | l <sub>t</sub> = 3.5 mm ±<br>0.3 mm         | l <sub>t</sub> = 5.0 mm ±<br>1.0 mm | SPQ | l <sub>t</sub> = 25.0 mm ±<br>2.0 mm | SPQ |  | SPQ |
| 300                                      | PITCH = 15.0 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 % |                                 |                            |   |                                     |     |                                      |     |  |     |
|  | 0.12  | 7.0 x 13.5 x 17.5               | 1.8                        | 45124                                       | 42124                               | 750 | 43124                                | 500 | 48154  | 500 |
|  | 0.15  |                                 |                            | 45154                                       | 42154                               |     | 43154                                |     | 48155  |     |
|  | 0.18  | 8.5 x 15.0 x 17.5               | 2.4                        | 45184                                       | 42184                               | 750 | 43184                                | 500 | 48156  | 500 |
|  | 0.22  |                                 |                            | 45224                                       | 42224                               |     | 43224                                |     | 48157  |     |
|  | 0.27  | 10.0 x 16.5 x 17.5              | 3.0                        | 45274                                       | 42274                               | 500 | 43274                                | 450 | 48158  | 600 |
|  | PITCH = 22.5 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 % |                                 |                            |   |                                     |     |                                      |     |  |     |
|  | 0.33  | 8.5 x 18.0 x 26.0               | 3.8                        | 45334                                       | 42334                               | 200 | 43334                                | 250 | -  | -   |
|  | 0.47  | 10.0 x 19.5 x 26.0              | 6.8                        | 45474                                       | 42474                               | 200 | 43474                                | 200 |  |     |
|  | 0.68  | 12.0 x 22.0 x 26.0              | 7.8                        | 45684                                       | 42684                               | 150 | 43684                                | 200 |  |     |
|  | PITCH = 27.5 mm ± 0.4 mm; d <sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 % |                                 |                            |   |                                     |     |                                      |     |  |     |
|  | 1.0   | 13.0 x 23.0 x 31.0              | 9.2                        | 45105                                       | 42105                               | 100 | 43105                                | 125 | -  | -   |
|  | 1.5   | 15.0 x 25.0 x 31.0              | 12.3                       | 45155                                       | 42155                               | 100 | 43155                                | 125 |  |     |
|  | 2.2   | 21.0 x 31.0 x 31.0              | 20.3                       | 45225                                       | 42225                               | 50  | 43225                                | 75  |  |     |
|  | PITCH = 37.5 mm ± 0.7 mm; d <sub>t</sub> = 1.0 mm ± 0.1 mm; C-TOL. = ± 10 %   |                                 |                            |   |                                     |     |                                      |     |  |     |
|  | 3.3   | 18.5 x 35.5 x 43.0              | 32.0                       |   | 42335                               | 105 | 43335                                | 105 |  |     |
|  | 3.9   |                                 |                            |   | 42395                               |     | 43395                                |     |  |     |
|  | 4.7   | 21.5 x 38.5 x 42.0              | 39.0                       | -   | 42475                               | 91  | 43475                                | 91  |  |     |
|  | 5.6   |                                 |                            |   | 42565                               |     | 43565                                |     |  |     |
|  | 6.8   | 30.0 x 46.0 x 44.0              | 55.0                       |   | 48162                               | 63  | 48165                                | 63  |  |     |
|  | 8.2   |                                 |                            |   | 48163                               |     | 48166                                |     |  |     |
|  | 10  | 30.0 x 46.0 x 44.0              | 65.0                       |   | 48164                               |     | 48167                                |     |  |     |
|  | PITCH = 55.0 mm ± 1.0 mm; d <sub>t</sub> = 1.0 mm ± 0.1 mm; C-TOL. = ± 10 %   |                                 |                            |   |                                     |     |                                      |     |  |     |
|  | 6.8   | 21.5 x 38.5 x 61.0              | 50.0                       | -   | 42685                               | 65  | 43685                                | 65  | -  | -   |
| 8.2                                      | 42825   |                                 |                            |   | 43825                               |     |                                      |     |  |     |
| 10                                       | 42106   |                                 |                            |   | 43106                               |     |                                      |     |  |     |

Notes

- SPQ = Standard Packing Quantity

(1) H = in-tape height; P<sub>0</sub> = sprocket hole distance; for detailed specifications refer to packaging information: [www.vishay.com/doc?28139](http://www.vishay.com/doc?28139)

(2) Reel diameter = 356 mm is available on request

(3) Weight for short lead product only

| APPROVALS  |                     |                |                    |  |
|--|---------------------|----------------|--------------------|--|
| SAFETY APPROVALS X2  | VOLTAGE             | VALUE          | FILE NUMBERS       | LINK   |
| EN 60384-14 (ENEC)<br>(= IEC 60384-14 ed-4 (2013))   | 300 V <sub>AC</sub> | 10 nF to 10 μF | ENEC16/FI/21/01063 | <a href="http://www.vishay.com/doc?28208">www.vishay.com/doc?28208</a> |
| UL 60384-14  | 300 V <sub>AC</sub> | 10 nF to 10 μF | E354331            | <a href="http://www.vishay.com/doc?28187">www.vishay.com/doc?28187</a> |
| CSA-E384-14  | 300 V <sub>AC</sub> | 10 nF to 10 μF | E354331            |  |
| CB-test certificate  | 300 V <sub>AC</sub> | 10 nF to 10 μF | FI-39830/A1        | <a href="http://www.vishay.com/doc?28207">www.vishay.com/doc?28207</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 in printed-circuit boards by means of automatic insertion machines.

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

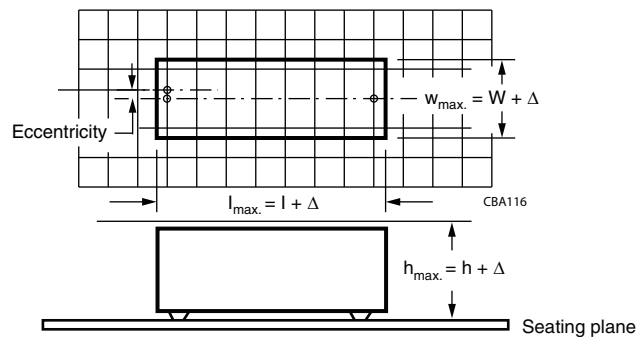
- For pitches  $\leq 15$  mm capacitors shall be mechanically fixed by the leads
- For longer pitches the capacitors shall be mounted in the same way and the body clamped

### Space Requirements on Printed Circuit Board

The maximum space for length ( $l_{max.}$ ), width ( $w_{max.}$ ) and height ( $h_{max.}$ ) of film capacitors to take in account on the printed circuit board is shown in the drawings.

- For products with pitch  $\leq 15$  mm,  $\Delta w = \Delta l = 0.3$  mm;  $\Delta h = 0.1$  mm
- For products with  $15$  mm  $<$  pitch  $\leq 27.5$  mm,  $\Delta w = \Delta l = 0.5$  mm;  $\Delta h = 0.1$  mm
- For products with  $15$  mm  $<$  pitch  $\leq 37.5$  mm,  $\Delta w = \Delta l = 0.7$  mm;  $\Delta h = 0.5$  mm
- For products with  $15$  mm  $<$  pitch  $\leq 52.5$  mm,  $\Delta w = \Delta l = 1.0$  mm;  $\Delta h = 0.5$  mm

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



## SOLDERING CONDITIONS

For general soldering conditions and wave soldering profile, we refer to the application note: "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

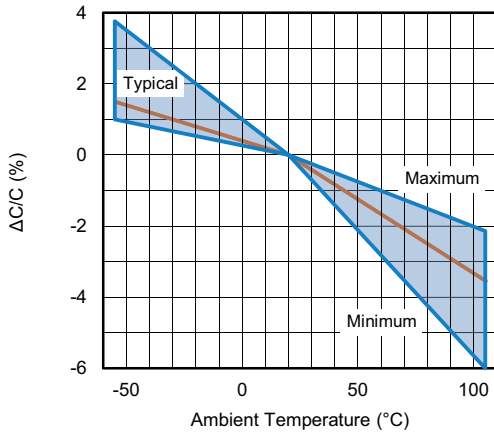
### Ratings and Characteristics Reference Conditions

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

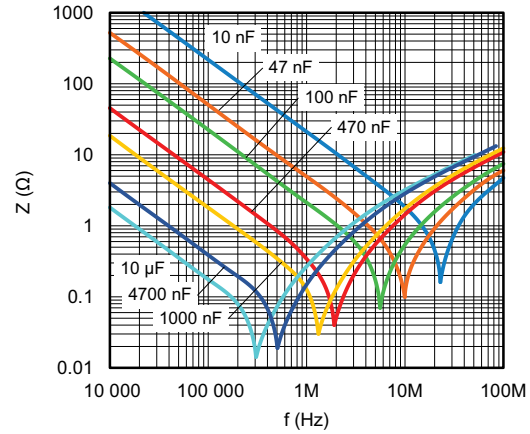
For reference testing, a conditioning period shall be applied over  $96$  h  $\pm 4$  h by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20 %.



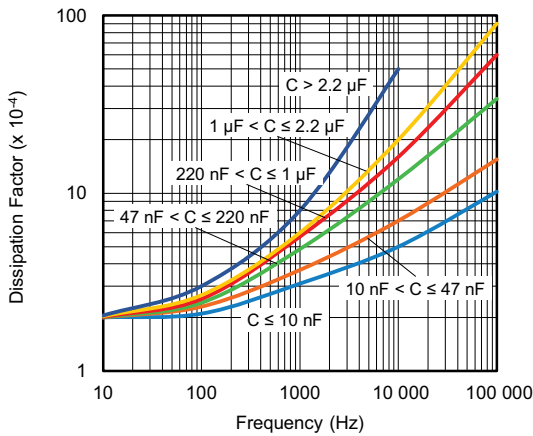
CHARACTERISTICS



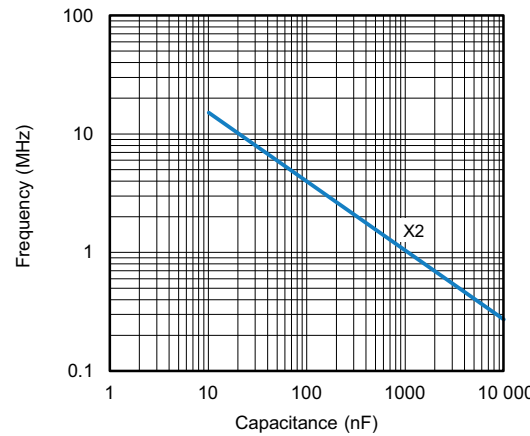
Capacitance as a function of ambient temperature (typical curve)



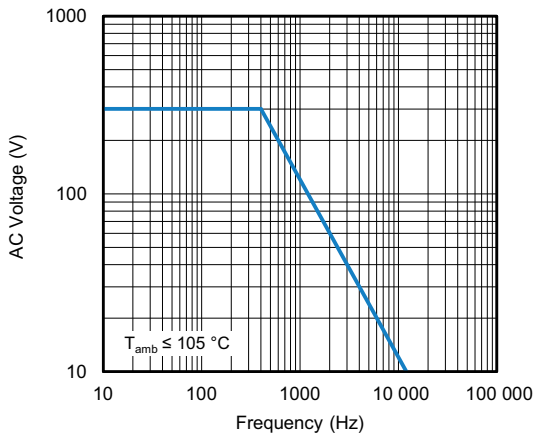
Impedance as a function of frequency (typical curve)



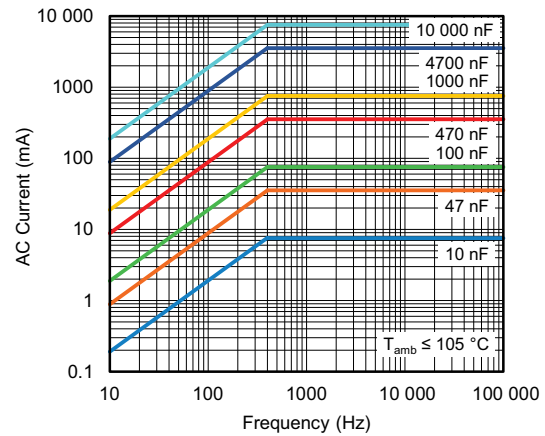
Tangent of loss angle as a function of frequency (typical curve)



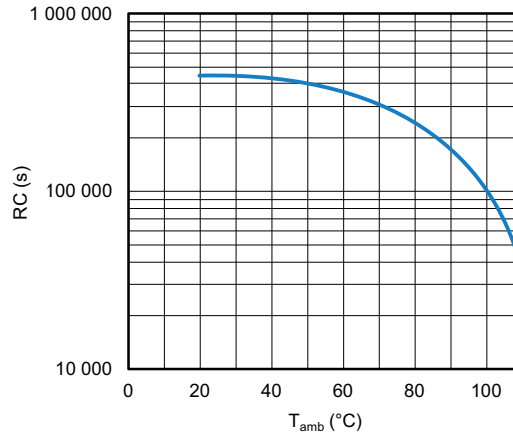
Resonant frequency as a function of capacitance (typical curve)



Max. RMS voltage as a function of frequency



Max. RMS current as a function of frequency



Insulation resistance as a function of ambient temperature

### APPLICATION NOTES

- For X2 electromagnetics interference suppression in **standard across the line applications** (50 Hz / 60 Hz) with a maximum mains voltage of 300 V<sub>AC</sub>
- For series impedance applications we refer to application note [www.vishay.com/doc?28153](http://www.vishay.com/doc?28153)
- For capacitors connected in parallel, normally the proof voltage and possibly the rated voltage must be reduced. For information depending of the capacitance value and the number of parallel connections contact: [rfi@vishay.com](mailto:rfi@vishay.com)
- 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 105 °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 435 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.”

| GROUP C INSPECTION REQUIREMENTS                       |  |   |
|---|--|---|
| SUB-CLAUSE NUMBER AND TEST                            | CONDITIONS   | PERFORMANCE REQUIREMENTS                                      |
| <b>SUB-GROUP C-1A PART OF SAMPLE OF SUB-GROUP C-1</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   |   |
| 4.3 Robustness of terminations                        | Tensile:<br>for wire diameter = 0.6 mm and 0.8 mm: load 10 N; 10 s<br>for wire diameter = 1 mm:<br>load 20 N; 10 s<br>Bending:<br>for wire diameter = 0.6 mm and 0.8 mm:<br>load 5 N; 4 x 90°<br>for wire diameter = 1 mm:<br>load 10 N; 4 x 90° | No visible damage   |



| GROUP C INSPECTION REQUIREMENTS                     |  |   |
|---|--|---|
| SUB-CLAUSE NUMBER AND TEST                          | CONDITIONS   | PERFORMANCE REQUIREMENTS  |
| <b>SUB-GROUP C1A PART OF SAMPLE OF SUB-GROUP C1</b> |  |   |
| 4.4 Resistance to soldering heat                    | No pre-drying<br>Method: 1A<br>Solder bath: 280 °C ± 5 °C<br>Duration: 10 s  |   |
| 4.19 Component solvent resistance                   | Isopropylalcohol at room temperature<br>Method: 2<br>Immersion time: 5 min ± 0.5 min<br>Recovery time:<br>min. 1 h, max 2 h  |   |
| 4.4.2 Final measurements                            | Visual examination   | No visible damage<br>Legible marking  |
|   | Capacitance  | $ \Delta C/C  \leq 5\%$ of the value measured initially   |
|   | Tangent of loss angle  | Increase of tan $\delta$ :<br>$\leq 0.008$ for: $C \leq 1 \mu\text{F}$ or<br>$\leq 0.005$ for: $C > 1 \mu\text{F}$<br>Compared to values measured initially |
|   | Insulation resistance  | As specified in chapters "General data" of this specification   |
| <b>SUB-GROUP C1B PART OF SAMPLE OF SUB-GROUP C1</b> |  |   |
| Initial measurements                                | Capacitance<br>Tangent of loss angle:<br>for $C \leq 1 \mu\text{F}$ at 10 kHz<br>for $C > 1 \mu\text{F}$ at 1 kHz  | No visible damage<br>Legible marking  |
| 4.20 Solvent resistance of the marking              | Isopropylalcohol at room temperature<br>Method: 1<br>Rubbing material: cotton wool<br>Immersion time: 5 min. ± 0.5 min   |   |
| 4.6 Rapid change of temperature                     | $\theta A = -55\text{ °C}$<br>$\theta B = +105\text{ °C}$<br>5 cycles<br>Duration $t = 30\text{ min}$  |   |
| 4.6.1 Inspection<br>4.7 Vibration                   | Visual examination<br>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 | No visible damage   |
| 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  |   |

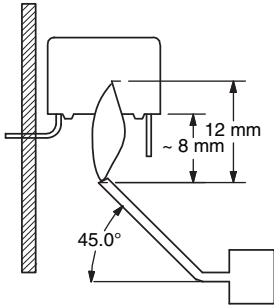




| GROUP C INSPECTION REQUIREMENTS  |  |  |
|--|--|--|
| SUB-CLAUSE NUMBER AND TEST   | CONDITIONS   | PERFORMANCE REQUIREMENTS   |
| <b>SUB-GROUP C1B PART OF SAMPLE OF SUB-GROUP C1</b>                        |  |  |
| 4.9.2 Final measurements   | Visual examination<br><br>Capacitance<br><br><br>Tangent 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 $\tan \delta$ :<br>$\leq 0.008$ for: $C \leq 1 \mu\text{F}$ or<br>$\leq 0.005$ for: $C > 1 \mu\text{F}$<br>Compared to values measured initially<br><br>Increase of $\tan \delta \leq 0.008$<br>Compared to values measured initially<br><br>As specified in chapters "General data" of this specification |
| <b>SUB-GROUP C1 COMBINED SAMPLE OF SPECIMENS 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: 105 °C<br>Duration: 16 h  |  |
| 4.11.3 Damp heat cyclic<br>Test Db<br>First cycle                          |  |  |
| 4.11.4 Cold  | Temperature: -55 °C<br>Duration: 2 h   |  |
| 4.11.5 Damp heat cyclic<br>Test Db<br>Remaining cycles                     |  |  |
| 4.11.6 Final measurements  | Visual examination<br><br>Capacitance<br><br>Tangent of loss angle<br><br>Voltage proof<br>1290 V <sub>DC</sub> ; pitch $\leq 27.5$ mm<br>1320 V <sub>DC</sub> ; pitch $> 27.5$ mm<br>1 min between terminals<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 $\tan \delta$ :<br>$\leq 0.008$ for: $C \leq 1 \mu\text{F}$ or<br>$\leq 0.005$ 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 chapters "General data" of this specification   |



| GROUP C INSPECTION REQUIREMENTS |  |  |
|---------------------------------|--|--|
| SUB-CLAUSE NUMBER AND TEST      | CONDITIONS   | PERFORMANCE REQUIREMENTS   |
| <b>SUB-GROUP C2</b>             |  |  |
| 4.12 Damp heat steady state     | 56 days, 40 °C, 90 % to 95 % RH<br>No load   |  |
| 4.12.1 Initial measurements     | Capacitance<br>Tangent of loss angle at 1 kHz  |  |
| 4.12.3 Final measurements       | Visual examination   | No visible damage<br>Legible marking   |
|                                 | Capacitance  | $ \Delta C/C  \leq 5\%$ of the value measured in 4.12.1.   |
|                                 | Tangent of loss angle  | Increase of $\tan \delta$ :<br>$\leq 0.008$ for: $C \leq 1 \mu\text{F}$ or<br>$\leq 0.005$ for: $C > 1 \mu\text{F}$<br>Compared to values measured in 4.12.1 |
|                                 | Voltage proof<br>1290 V <sub>DC</sub> ; pitch $\leq 27.5$ mm<br>1320 V <sub>DC</sub> ; pitch $> 27.5$ mm<br>1 min between terminals  | No permanent breakdown or flash-over   |
|                                 | Insulation resistance  | $\geq 50\%$ of values specified in section<br>"Insulation resistance" of this specification  |
| <b>SUB-GROUP C3</b>             |  |  |
| 4.13.1 Initial measurements     | Capacitance<br>Tangent of loss angle:<br>for $C \leq 1 \mu\text{F}$ at 10 kHz<br>for $C > 1 \mu\text{F}$ at 1 kHz  |  |
| 4.13 Impulse voltage            | 3 successive impulses, full wave, peak voltage:<br>X2: 2.5 kV for $C \leq 1 \mu\text{F}$<br>X2: 2.5 kV for $C > 1 \mu\text{F}$<br>Max. 24 pulses   | No self healing breakdowns or flash-over   |
| 4.14 Endurance                  | Duration: 1000 h<br>$1.25 \times U_{RAC}$ at 105 °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 $\tan \delta$ :<br>$\leq 0.008$ for: $C \leq 1 \mu\text{F}$ or<br>$\leq 0.005$ for: $C > 1 \mu\text{F}$<br>Compared to values measured in 4.13.1 |
|                                 | Voltage proof<br>1290 V <sub>DC</sub> ; pitch $\leq 27.5$ mm<br>1320 V <sub>DC</sub> ; pitch $> 27.5$ mm<br>1 min between terminals<br>2200 V <sub>AC</sub> ; 1 min between terminals and case | No permanent breakdown or flash-over   |
|                                 | Insulation resistance  | $\geq 50\%$ of values specified in chapters<br>"General data" 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 C4</b>                    |  |  |
| 4.15 Charge and discharge              | 10 000 cycles<br>Charged to 420 V <sub>DC</sub><br>Discharge resistance:<br>$R = \frac{420 V_{DC}}{1.5 \times C (dU/dt)}$  |  |
| 4.15.1 Initial measurements            | Capacitance<br>Tangent of loss angle at 10 kHz   |  |
| 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 $\delta$ :<br>$\leq 0.008$ for: $C \leq 1 \mu F$ or<br>$\leq 0.005$ for: $C > 1 \mu F$<br>Compared to values measured in 4.15.1<br><br>$\geq 50\%$ of values specified in section "Insulation resistance" of this specification |
| <b>SUB-GROUP C5</b>                    |  |  |
| 4.16 Radio frequency characteristic    | Resonance frequency  | $\geq 0.9$ times value as specified in section "Resonant frequency" of this specification  |
| <b>SUB-GROUP C6</b>                    |  |  |
| 4.17 Passive flammability<br>Class B   | Bore of gas jet: $\varnothing 0.5$ mm<br>Fuel: butane<br>Test duration for actual volume V in mm <sup>3</sup> :<br>V $\leq$ 250: 10 s<br>250 < V $\leq$ 500: 20 s<br>500 < V $\leq$ 1750: 30 s<br>V > 1750: 60 s<br>One flame application<br><br> | 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.   |
| <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 %; temp.: 93 °C, voltage: 300 V <sub>AC</sub><br>Duration: 21 days |   |
| A.1.1 Initial measurements              | Capacitance<br>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 $\tan \delta \leq 0.024$<br>Compared to values with initial measurement A.1.1 |
|   | Insulation resistance   | $\geq 50\%$ of values specified in section "Insulation Resistance" of this specification  |



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