



**THE DATASHEET OF**  
**F17725102000**



## Interference Suppression Film Capacitor - Class X2 Radial MKT 310 V<sub>AC</sub> - High Stability Grade

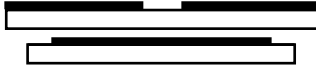

**FEATURES**

- AEC-Q200 qualified (rev. D) up to 110 °C for  $\leq 470$  nF
- Compliant with IEC 60381-14: AMD1 grade IB - THB: 85 °C / 85 % RH, 168 h at U<sub>RAC</sub>
- THB: 40 °C / 90 % RH for 1000 h at rated voltage, in compliance with AEC-Q200
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**APPLICATIONS**

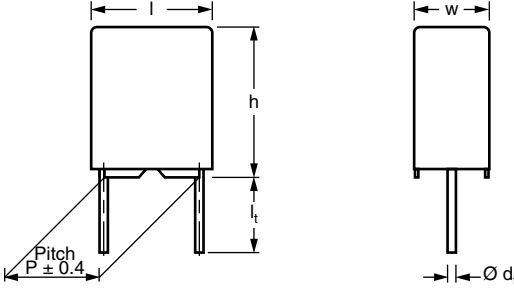
High stability grade for continuous across the line X2 applications.

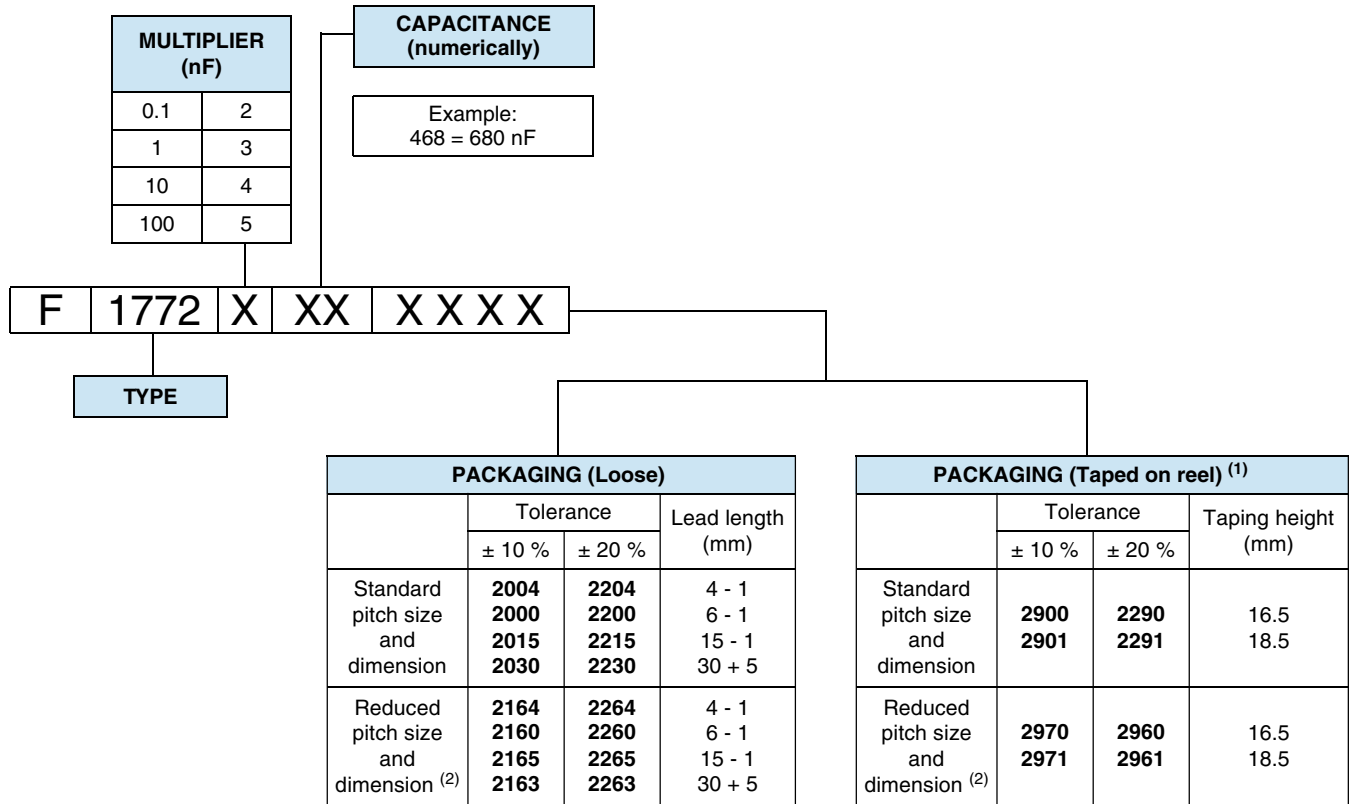
See also application note: [www.vishay.com/doc?28153](http://www.vishay.com/doc?28153)

| QUICK REFERENCE DATA                            |  |
|---|--|
| Capacitance range (E12 series)                  | 0.01 $\mu$ F to 2.2 $\mu$ F<br>(preferred values acc. to E6)   |
| Capacitance tolerance                           | $\pm 10$ %, $\pm 20$ % ( $\pm 5$ % on request)   |
| Rated AC voltage                                | 310 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 | 40/110/56/C for the product volume $\leq 1750$ mm <sup>3</sup><br>40/110/56/B for the product volume $\geq 1750$ mm <sup>3</sup>   |
| Maximum application temperature                 | 110 °C   |
| Reference standards                             | IEC 60384-14 ed-4 and EN 60384-14<br>IEC 60065 pass. flamm. class C<br>CSA-E384-14<br>UL 60384-14  |
| Dielectric                                      | Polyester film   |
| Electrodes                                      | Metallized   |
| Construction                                    | Series 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; 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 in millimeters  |
|--|
|  |

**COMPOSITION OF CATALOG NUMBER**


Example: F17724152215 means 0.15 µF, ± 20 %; standard pitch 22.5 mm; lead length 15 mm - 1 mm;  
 F17724152265 means 0.15 µF, ± 20 %; reduced pitch 15.0 mm; lead length 15 mm - 1 mm

**Notes**

- For detailed tape specifications refer to packaging information [www.vishay.com/doc?28139](http://www.vishay.com/doc?28139)
- <sup>(1)</sup> Taped on reel pitch ≥ 27.5 mm is not available
- <sup>(2)</sup> Same capacitance values ≥ 0.15 µF are available in two different pitch sizes and dimensions

| SPECIFIC REFERENCE DATA   |                                   |
|---|-----------------------------------|
| DESCRIPTION   | VALUE                             |
| Rated AC voltage (U <sub>RAC</sub> )  | 310 V                             |
| Permissible DC voltage (U <sub>RDC</sub> )  | 630 V                             |
| Tangent of loss angle   | ≤ 100 × 10 <sup>-4</sup> at 1 kHz |
| Rated voltage pulse slope at (dU/dt) <sub>R</sub> 435 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, 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 ≤ 0.47 µF   | 2200 V; for 1 min                 |
| C > 0.47 µF   | 2150 V; for 1 min                 |
| Withstanding (AC) voltage between leads and case  | 2120 V; 1 min                     |
| Maximum application temperature   | 110 °C                            |

**Note**

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





| <b>ELECTRICAL DATA AND ORDERING INFORMATION</b> |   |                             |  |  |  |   |
|---|---|-----------------------------|--|--|--|---|
| <b>U<sub>RAC</sub></b><br><b>(V)</b>            | <b>CAP.</b><br><b>(μF)</b>                                | <b>PITCH</b><br><b>(mm)</b> | <b>DIMENSIONS <sup>(4)</sup></b><br><b>w x h x l</b><br><b>MAX. (mm)</b> | <b>MASS <sup>(3)</sup></b><br><b>(g)</b> | <b>SPQ</b><br><b>(pieces)</b><br><b>SHORT LEAD</b> | <b>ORDERING CODE</b><br><b>BULK</b><br><b>LEAD LENGTH</b><br><b>6 mm - 1 mm <sup>(1)(2)</sup></b> |
| 310   | <b>d<sub>t</sub> = 0.60 mm ± 0.06 mm; C-TOL. = ± 10 %</b> |                             |  |  |  |   |
|   | 0.010   | 15                          | 5.0 x 11.0 x 17.5  | 1.4                                      | 750  | F17723102000  |
|   | 0.012   | 15                          | 5.0 x 11.0 x 17.5  | 1.4                                      | 750  | F17723122000  |
|   | 0.015   | 15                          | 5.0 x 11.0 x 17.5  | 1.4                                      | 750  | F17723152000  |
|   | 0.018   | 15                          | 5.0 x 11.0 x 17.5  | 1.4                                      | 750  | F17723182000  |
|   | 0.022   | 15                          | 5.0 x 11.0 x 17.5  | 1.4                                      | 750  | F17723222000  |
|   | 0.027   | 15                          | 5.0 x 11.0 x 17.5  | 1.4                                      | 750  | F17723272000  |
|   | 0.033   | 15                          | 5.0 x 11.0 x 17.5  | 1.4                                      | 750  | F17723332000  |
|   | 0.039   | 15                          | 6.0 x 12.0 x 17.5  | 2.0                                      | 500  | F17723392000  |
|   | 0.047   | 15                          | 6.0 x 12.0 x 17.5  | 2.0                                      | 500  | F17723472000  |
|   | 0.056   | 15                          | 6.0 x 12.0 x 17.5  | 2.0                                      | 500  | F17723562000  |
|   | <b>d<sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 %</b> |                             |  |  |  |   |
|   | 0.068   | 15                          | 7.0 x 13.5 x 17.5  | 2.4                                      | 450  | F17723682000  |
|   | 0.082   | 15                          | 8.5 x 15.0 x 17.5  | 2.7                                      | 300  | F17723822000  |
|   | 0.10  | 15                          | 8.5 x 15.0 x 17.5  | 2.7                                      | 325  | F17724102000  |
|   | 0.12  | 15                          | 8.5 x 15.0 x 17.5  | 2.7                                      | 300  | F17724122000  |
|   | 0.15  | 15                          | 8.5 x 15.0 x 17.5  | 2.7                                      | 300  | F17724152160  |
|   | 0.15  | 22.5                        | 7.0 x 16.5 x 26.0  | 4.1                                      | 235  | F17724152000  |
|   | 0.18  | 22.5                        | 7.0 x 16.5 x 26.0  | 4.1                                      | 235  | F17724182000  |
|   | 0.22  | 15                          | 10.0 x 16.5 x 17.5   | 3.0                                      | 235  | F17724222160  |
|   | 0.22  | 22.5                        | 8.5 x 16.5 x 26.5  | 4.6                                      | 200  | F17724222000  |
|   | 0.27  | 22.5                        | 10.0 x 19.5 x 26.0   | 6.7                                      | 170  | F17724272000  |
|   | 0.33  | 15                          | 13.5 x 22.5 x 18.0   | 5.5                                      | 185  | F17724332160  |
|   | 0.33  | 22.5                        | 10.0 x 19.5 x 26.0   | 6.7                                      | 170  | F17724332000  |
|   | 0.39  | 27.5                        | 11.0 x 21.0 x 31.0   | 9.1                                      | 125  | F17724392000  |
|   | 0.47  | 22.5                        | 12.0 x 22.0 x 26.0   | 13.0                                     | 110  | F17724472160  |
|   | 0.47  | 27.5                        | 11.0 x 21.0 x 31.0   | 9.1                                      | 125  | F17724472000  |
|   | 0.56  | 27.5                        | 11.0 x 21.0 x 31.0   | 9.1                                      | 125  | F17724562000  |
|   | 0.68  | 22.5                        | 15.5 x 26.5 x 26.5   | 13.5                                     | 110  | F17724682160  |
|   | 0.68  | 27.5                        | 13.0 x 23.0 x 31.0   | 12.9                                     | 110  | F17724682000  |
|   | 0.82  | 27.5                        | 13.0 x 23.0 x 31.0   | 12.9                                     | 110  | F17724822000  |
|   | 1.0   | 22.5                        | 15.5 x 26.5 x 26.5   | 13.5                                     | 110  | F17725102160  |
|   | 1.0   | 27.5                        | 15.0 x 25.0 x 31.5   | 15.0                                     | 100  | F17725102000  |
|   | 1.2   | 37.5                        | 14.5 x 24.5 x 41.5   | 18.9                                     | 80   | F17725122000  |
|   | 1.5   | 27.5                        | 18.0 x 28.0 x 31.0   | 19.0                                     | 85   | F17725152160  |
|   | 1.5   | 37.5                        | 15.5 x 28.5 x 41.5   | 24.0                                     | 70   | F17725152000  |
|   | 1.8   | 37.5                        | 15.5 x 28.5 x 41.5   | 24.0                                     | 70   | F17725182000  |
|   | 2.2   | 27.5                        | 21.0 x 31.0 x 31.0   | 28.0                                     | 70   | F17725222160  |
|   | 2.2   | 37.5                        | 18.0 x 32.5 x 41.5   | 31.6                                     | 60   | F17725222000  |
|   | <b>d<sub>t</sub> = 0.60 mm ± 0.06 mm; C-TOL. = ± 20 %</b> |                             |  |  |  |   |
|   | 0.010   | 15                          | 5.0 x 11.0 x 17.5  | 1.4                                      | 750  | F17723102200  |
|   | 0.015   | 15                          | 5.0 x 11.0 x 17.5  | 1.4                                      | 750  | F17723152200  |
| 0.022   | 15  | 5.0 x 11.0 x 17.5           | 1.4  | 750                                      | F17723222200                                       |   |
| 0.033   | 15  | 5.0 x 11.0 x 17.5           | 1.4  | 750                                      | F17723332200                                       |   |
| 0.047   | 15  | 5.0 x 11.0 x 17.5           | 1.4  | 750                                      | F17723472200                                       |   |
| 0.068   | 15  | 6.0 x 12.0 x 17.5           | 2.0  | 600                                      | F17723682200                                       |   |
| 0.10  | 15  | 6.0 x 12.0 x 17.5           | 2.0  | 600                                      | F17724102200                                       |   |

| <b>ELECTRICAL DATA AND ORDERING INFORMATION</b>           |                            |                             |  |  |  |   |
|---|----------------------------|-----------------------------|--|--|--|---|
| <b>U<sub>RAC</sub></b><br><b>(V)</b>                      | <b>CAP.</b><br><b>(μF)</b> | <b>PITCH</b><br><b>(mm)</b> | <b>DIMENSIONS</b> <sup>(4)</sup><br><b>w x h x l</b><br><b>MAX. (mm)</b> | <b>MASS</b> <sup>(3)</sup><br><b>(g)</b> | <b>SPQ</b><br><b>(pieces)</b><br><b>SHORT LEAD</b> | <b>ORDERING CODE</b><br><b>BULK</b><br><b>LEAD LENGTH</b><br><b>6 mm - 1 mm</b> <sup>(1)(2)</sup> |
| <b>d<sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 %</b> |                            |                             |  |  |  |   |
| 310   | 0.15                       | 15                          | 8.5 x 15.0 x 17.5  | 2.7                                      | 325  | F17724152260  |
|   | 0.15                       | 22.5                        | 6.0 x 15.5 x 26.0  | 3.3                                      | 260  | F17724152200  |
|   | 0.22                       | 15                          | 10.0 x 16.5 x 17.5   | 4.5                                      | 300  | F17724222260  |
|   | 0.22                       | 22.5                        | 7.0 x 16.5 x 26.0  | 4.1                                      | 235  | F17724222200  |
|   | 0.33                       | 15                          | 13.5 x 22.5 x 18.0   | 5.5                                      | 185  | F17724332260  |
|   | 0.33                       | 22.5                        | 8.5 x 18.0 x 26.0  | 5.3                                      | 190  | F17724332200  |
|   | 0.47                       | 22.5                        | 10.0 x 19.5 x 26.0   | 6.7                                      | 170  | F17724472260  |
|   | 0.47                       | 27.5                        | 9.0 x 19.0 x 31.5  | 6.8                                      | 160  | F17724472200  |
|   | 0.68                       | 22.5                        | 12.0 x 22.0 x 26.0   | 13.4                                     | 110  | F17724682260  |
|   | 0.68                       | 27.5                        | 11.0 x 21.0 x 31.0   | 12.9                                     | 125  | F17724682200  |
|   | 1.0                        | 22.5                        | 15.5 x 26.5 x 26.5   | 13.5                                     | 110  | F17725102260  |
|   | 1.0                        | 27.5                        | 15.0 x 25.0 x 31.5   | 15.0                                     | 100  | F17725102200  |
|   | 1.5                        | 27.5                        | 18.0 x 28.0 x 31.5   | 19.0                                     | 85   | F17725152260  |
|   | 1.5                        | 37.5                        | 14.5 x 24.5 x 41.5   | 18.9                                     | 80   | F17725152200  |
|   | 2.2                        | 27.5                        | 21.0 x 31.0 x 31.0   | 28.0                                     | 70   | F17725222260  |
| 2.2   | 37.5                       | 15.5 x 28.5 x 41.5          | 24.0   | 70                                       | F17725222200                                       |   |

**Notes**

- SPQ = Standard Packing Quantity
- For detailed tape specifications refer to packaging information: [www.vishay.com/doc?28139](http://www.vishay.com/doc?28139)
- (1) For further packaging see table “Composition of Catalog Number”
- (2) Further information about packaging quantities with different lead length and / or taped versions, see document “Packing Quantities” [www.vishay.com/doc?27608](http://www.vishay.com/doc?27608)
- (3) Weight for short lead product only
- (4) For tolerances see chapter “Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances”

| <b>APPROVALS</b>  |                     |  |                     |  |
|---|---------------------|--|---------------------|--|
| <b>SAFETY APPROVALS X2</b>  | <b>VOLTAGE</b>      | <b>VALUE</b>   | <b>FILE NUMBERS</b> | <b>LINK</b>  |
| EN 60384-14 (ENEC)<br>(= IEC 60384-14 ed-4)   | 310 V <sub>AC</sub> | 0.01 μF to 2.2 μF X2   | 40005079            | <a href="http://www.vishay.com/doc?28196">www.vishay.com/doc?28196</a> |
| UL 60384-14   | 310 V <sub>AC</sub> | 0.01 μF to 2.2 μF X2   | E354331             | <a href="http://www.vishay.com/doc?28191">www.vishay.com/doc?28191</a> |
| CSA-E 384-14  | 310 V <sub>AC</sub> | 0.01 μF to 2.2 μF X2   | E354331             |  |
| CB test-certificate   | 310 V <sub>AC</sub> | 0.01 μF to 2.2 μF X2   | DE1-58410           | <a href="http://www.vishay.com/doc?28226">www.vishay.com/doc?28226</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 stand-off pips are in good contact with the printed-circuit board:

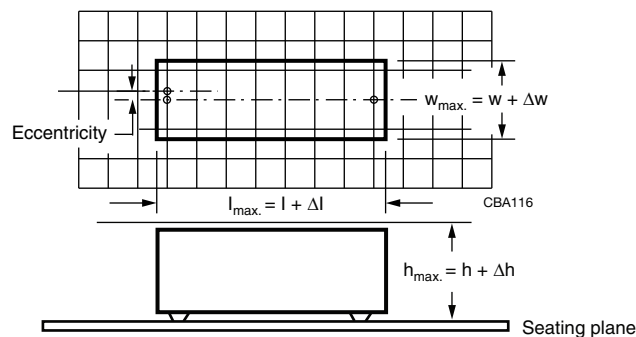
- For pitches  $\leq 15$  mm capacitors shall be mechanically fixed by the leads
- For larger pitches the capacitors shall be mounted in the same way and the body clamped

## 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  $15$  mm  $<$  pitch  $\leq 27.5$  mm,  $\Delta w = \Delta l = 0.5$  mm, and  $\Delta h = 0.1$  mm
- For products with pitch = 37.5 mm,  $\Delta w = \Delta l = 0.7$  mm, and  $\Delta h = 0.5$  mm

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



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  $15$  mm  $<$  pitch  $\leq 27.5$  mm,  $\Delta l = 1.0$  mm and  $\Delta w = \Delta h = 0.5$  mm
- For products with pitch = 37.5 mm,  $\Delta l = 1.0$  mm and  $\Delta w = \Delta h = 1.0$  mm

## 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

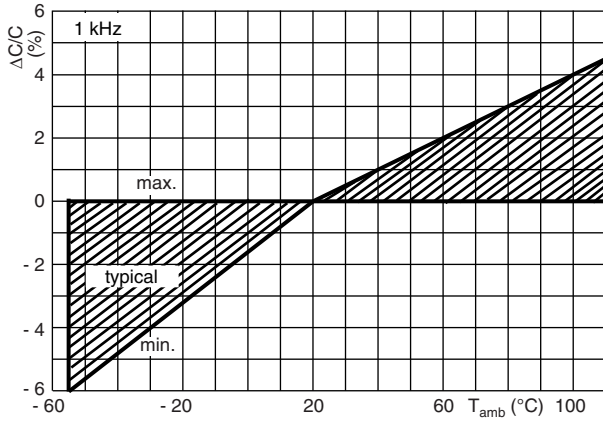
### Ratings and Characteristics Reference Conditions

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 %  $\pm 2$  %.

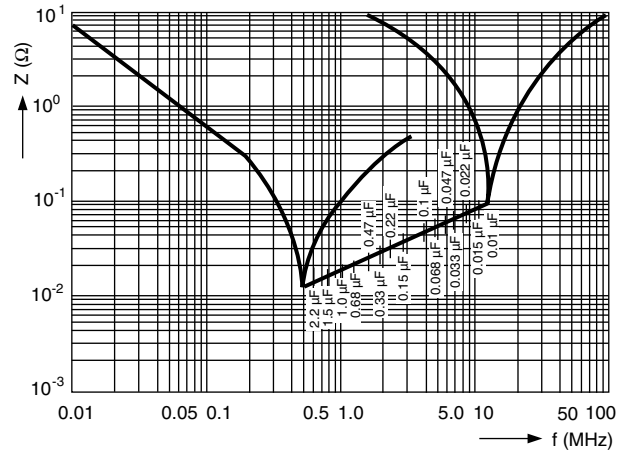
For reference testing, a conditioning period shall be applied over 96 h  $\pm 4$  h by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20 %.



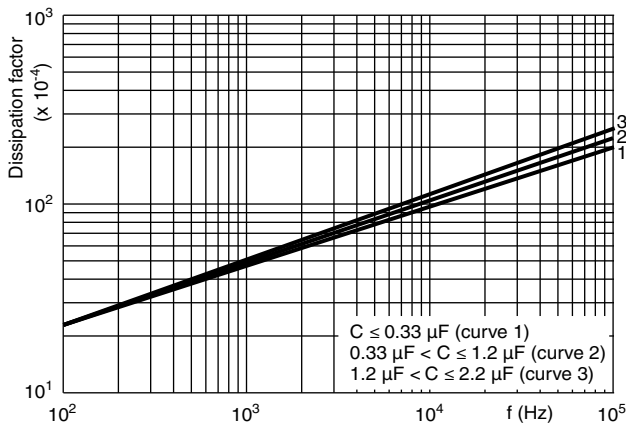
CHARACTERISTICS



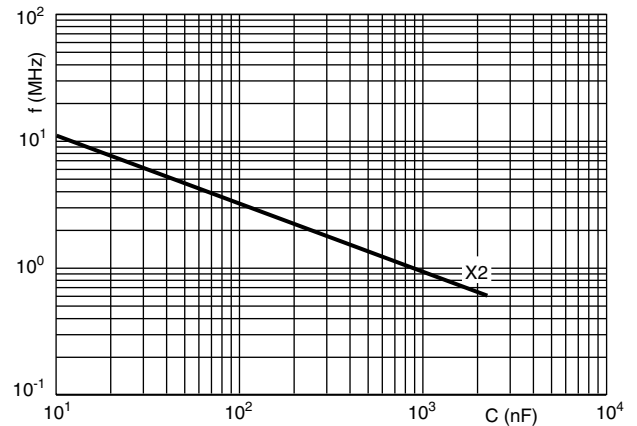
Capacitance as a function of ambient temperature (typical curve)



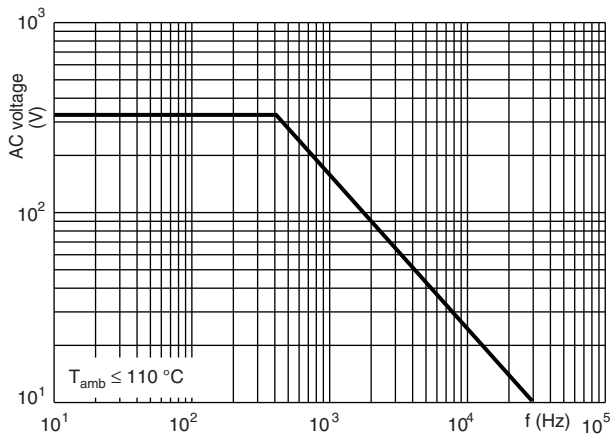
Impedance as a function of frequency (typical curve)



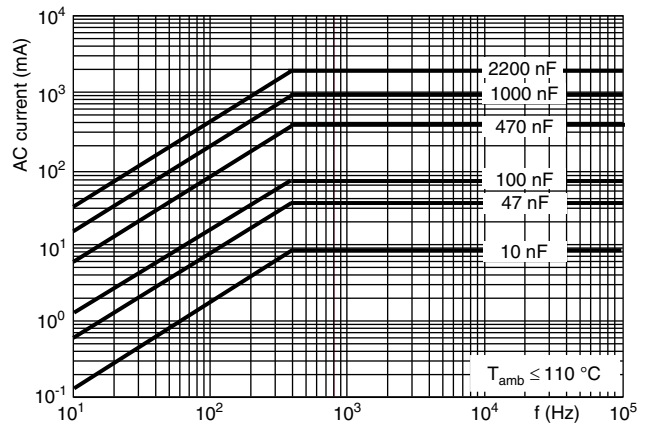
Tangent of loss angle as a function of frequency (typical curve)



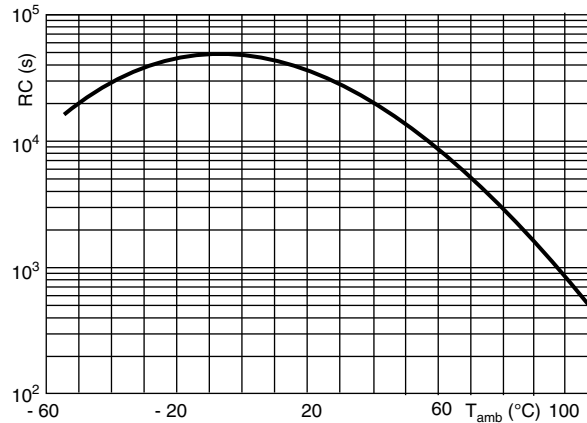
Resonant frequency as a function of capacitance (typical curve)



Max. RMS voltage as a function of frequency



Max. RMS current as a function of frequency



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

**APPLICATION NOTES AND LIMITING CONDITIONS**

- For X2 electromagnetic interference suppression where a higher stability grade is needed for **continuous across the line applications** (50 Hz/60 Hz) with a maximum mains voltage of 310 V<sub>AC</sub>.
- These capacitors are not intended for continuous pulse application. For these situations capacitors of the AC and pulse programs must be used.
- For series impedance applications we refer to application note: [www.vishay.com/doc?28153](http://www.vishay.com/doc?28153)
- 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 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 3 and Specific Reference Data”.

| GROUP C INSPECTION REQUIREMENTS              |  |  |
|--|--|--|
| SUB-CLAUSE NUMBER AND TEST                   | CONDITIONS   | PERFORMANCE REQUIREMENTS                                     |
| SUB-GROUP C1A PART OF SAMPLE OF SUB-GROUP C1 |  |  |
| 4.1 Dimensions (detail)                      |  | As specified in chapter “General Data” of this specification |
| Initial measurements                         | Capacitance<br>Tangent of loss angle:<br>for C ≤ 1 µF at 10 kHz<br>for C > 1 µF at 1 kHz |  |
| 4.3 Robustness of terminations               | Tensile: load 10 N; 10 s<br>Bending: load 5 N; 4 x 90°                                   | No visible damage  |
| 4.4 Resistance to soldering heat             | No pre-drying<br>Method: 1A<br>Solder bath: 280 °C ± 5 °C<br>Duration: 10 s              |  |



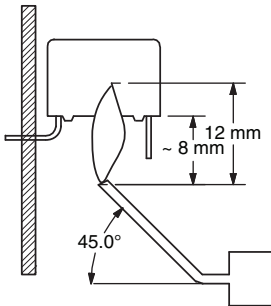
| GROUP C INSPECTION REQUIREMENTS                     |   |  |
|---|---|--|
| SUB-CLAUSE NUMBER AND TEST                          | CONDITIONS  | PERFORMANCE REQUIREMENTS   |
| <b>SUB-GROUP C1A PART OF SAMPLE OF SUB-GROUP C1</b> |   |  |
| 4.19 Component solvent resistance                   | Isopropylalcohol at room temperature<br>Method: 2<br>Immersion time: 5 min ± 0.5 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 $\tan \delta$<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 initially<br><br>As specified in section "Insulation Resistance" 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 $C \leq 1 \mu F$ at 10 kHz<br>for $C > 1 \mu F$ at 1 kHz   |  |
| 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   | No visible damage<br>Legible marking   |
| 4.6 Rapid change of temperature                     | $\theta A = -40\text{ }^\circ C$<br>$\theta B = +110\text{ }^\circ C$<br>5 cycles<br>Duration $t = 30$ min  |  |
| 4.6.1 Inspection                                    | Visual examination  | No visible damage  |
| 4.7 Vibration                                       | Mounting:<br>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:<br>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 $\tan \delta$<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 initially<br><br>As specified in section "Specific Reference" of this specification                       |



| GROUP C INSPECTION REQUIREMENTS  |   |  |
|--|---|--|
| SUB-CLAUSE NUMBER AND TEST   | CONDITIONS  | PERFORMANCE REQUIREMENTS   |
| <b>SUB-GROUP C1 COMBINED SAMPLE OF SPECIMENS OF SUB-GROUPS C1A AND C1B</b> |   |  |
| 4.11 Climatic sequence   | Capacitance   |  |
| 4.11.1 Initial measurements  | 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<br>Duration: 16 h   |  |
| 4.11.3 Damp heat cyclic<br>Test Db, first cycle                            |   |  |
| 4.11.4 Cold  | Temperature: -40 °C<br>Duration: 2 h  |  |
| 4.11.5 Damp heat cyclic<br>Test Db, remaining cycles                       |   |  |
| 4.11.6 Final measurements  | Visual examination  | No visible damage<br>Legible marking   |
|  | Capacitance   | $ \Delta C/C  \leq 5\%$ of the value measured in 4.11.1  |
|  | Tangent of loss angle   | 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 4.11.1 |
|  | Voltage proof<br>1350 V <sub>DC</sub> 1 min between terminations                          | No permanent breakdown or flash-over   |
|  | Insulation resistance   | $\geq 50\%$ of values specified in section<br>"Insulation Resistance" of this specification  |
| <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: 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: $C \leq 1 \mu F$ or<br>$\leq 0.005$ for: $C > 1 \mu F$<br>Compared to values measured in 4.12.1 |
|  | Voltage proof<br>1350 V <sub>DC</sub> ; 1 min between terminations                        | No permanent breakdown or flash-over   |
|  | Insulation resistance   | $\geq 50\%$ of values specified in section<br>"Insulation Resistance" of this specification  |



| GROUP C INSPECTION REQUIREMENTS        |   |  |
|--|---|--|
| SUB-CLAUSE NUMBER AND TEST             | CONDITIONS  | PERFORMANCE REQUIREMENTS   |
| <b>SUB-GROUP C2A</b>                   |   |  |
| 4.12A Damp heat steady state with load | RH: 85 %; temp.: 85 °C, load: 310 V <sub>AC</sub><br>Duration: 168 h  |  |
| 4.12.1A Initial measurements           | Capacitance<br>Tangent of loss angle: 1 kHz   |  |
| 4.12.3A 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 10\%$ of the value measured in 4.12.1<br><br>Increase of $\tan \delta$<br>$\leq 0.024$ for: $C \leq 1 \mu\text{F}$ or<br>$\leq 0.015$ for: $C > 1 \mu\text{F}$<br>Compared to values measured in 4.12.1<br><br>$\geq 50\%$ of values specified in section<br>"Insulation Resistance" of this specification<br>or minimum 200 M $\Omega$ , whichever is higher |
| <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/ $\sqrt{C}$ 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 (RMS) for 0.1 s via resistor of 47 $\Omega \pm 5\%$  |  |
| 4.14.7 Final measurements              | Visual examination<br><br>Capacitance<br><br>Tangent of loss angle<br><br>Voltage proof<br>1350 V <sub>DC</sub> ; 1 min between terminations<br>2120 V <sub>AC</sub> ; 1 min between terminations and case<br><br>Insulation resistance | No visible damage<br>Legible marking<br><br>$ \Delta C/C  \leq 5\%$ compared to values measured in 4.13.1<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 4.13.1<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 C4</b>                    |  |  |
| 4.15 Charge and discharge              | 10 000 cycles<br>Charged to 435 V <sub>DC</sub><br>Discharge resistance:<br>$R = \frac{435 V_{DC}}{1.5 \times C(dU/dt)}$   |  |
| 4.15.1 Initial measurements            | Capacitance<br>Tangent of loss angle:<br>for C ≤ 1 μF at 10 kHz<br>for C > 1 μF at 1 kHz   |  |
| 4.13.3 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 δ<br>≤ 0.008 for: C ≤ 1 μF or<br>≤ 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 C   | Bore of gas jet: Ø 0.5 mm<br>Fuel: butane<br>Test duration for actual volume V in mm <sup>3</sup> :<br>V ≤ 250: 5 s<br>250 < V ≤ 500: 10 s<br>500 < V ≤ 1750: 20 s<br>V > 1750: 30 s<br>One flame application<br> | After removing test flame from capacitor, the capacitor must not continue to burn for more than 30 s. No burning particle must drop from the sample.   |
| <b>SUB-GROUP C7</b>                    |  |  |
| 4.18 Active flammability               | 20 cycles of 2.5 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.  |



| TEST CONDITIONS AND REQUIREMENTS ACCORDING AEC-Q200 REVISION D |                                      |                         |  |   |
|--|--------------------------------------|-------------------------|--|---|
| NO.  | TEST NAME                            | REFERENCE               | TEST CONDITIONS  | PERFORMANCE REQUIREMENTS  |
| 1  | Pre- and post-stress electrical test | Spec.                   | -  | -   |
| 3  | High temperature exposure (storage)  | MIL-STD 202 method 108  | 110 °C; unpowered<br>250 h / 500 h / 1000 h  | $ \Delta C/C  \leq 5\%$<br>Increase of $\tan \delta$<br>$\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or<br>$\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz<br>$\text{IR} > 50\%$ of initial specified value  |
| 4  | Temperature cycling                  | JESD22 method JA-104    | 1000 cycles: -40 °C / +110 °C<br>30 min. dwell time at each temperature extreme<br>Transition time < 1 min.              | $ \Delta C/C  \leq 5\%$<br>Increase of $\tan \delta$<br>$\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or<br>$\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz<br>$\text{IR} > 50\%$ of initial specified value  |
| 6  | Moisture resistance                  | MIL-STD 202 method 106  | 10 cycles at 24 h/cycle unpowered  | $ \Delta C/C  \leq 5\%$<br>Increase of $\tan \delta$<br>$\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or<br>$\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz<br>$\text{IR} > 50\%$ of initial specified value  |
| 7  | Biased humidity                      | MIL-STD 202 method 103  | 40 °C; 93 % RH; $U_{\text{RAC}}$ (310 $V_{\text{AC}}$ )<br>250 h / 500 h / 1000 h  | $ \Delta C/C  \leq 10\%$<br>Increase of $\tan \delta$<br>$\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or<br>$\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz<br>$\text{IR} > 50\%$ of initial specified value |
| 8  | Operational life                     | MIL-STD 202 method 108  | $T_{\text{amb}} = 110 \text{ °C}$ ; (310 $V_{\text{AC}}$ )<br>250 h / 500 h / 1000 h                                     | $ \Delta C/C  \leq 10\%$<br>Increase of $\tan \delta$<br>$\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or<br>$\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz<br>$\text{IR} > 50\%$ of initial specified value |
| 9  | External visual                      | MIL-STD 883 method 2009 | Device construction, marking, and workmanship  | Device construction and workmanship; legible marking  |
| 10   | Physical dimension                   | JESD22 method JB-100    | Spec.  | Datasheet   |
| 11   | Terminal strength (lead)             | MIL-STD 202 method 211  | Test leaded device lead integrity only.<br>- A (pull-test): 2.27 kg (10 s)<br>- C (wire-lead bend test): 227 g (3 x 3 s) | No visual damage  |
| 12   | Resistance to solvents               | MIL-STD 202 method 215  | - Also aqueous chemical<br>- OKEM clean or equivalent.<br>Do not use banned solvents.                                    | No visual damage<br>Legible marking   |
| 13   | Mechanical shock                     | MIL-STD 202 method 213  | 100 g's; 6 ms<br>half-sine; 3.75 m/s   | No visual damage  |
| 14   | Vibration                            | MIL-STD 202 method 204  | 5 g's for 20 min;<br>12 cycles x 3 directions<br>10 Hz to 2000 Hz  | No visual damage  |
| 15   | Resistance to soldering heat         | MIL-STD 202 method 210  | 280 °C; 10 s<br>solder within 1.5 mm of device body  | $ \Delta C/C  \leq 5\%$<br>Increase of $\tan \delta$<br>$\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or<br>$\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz<br>$\text{IR} > 50\%$ of initial specified value  |
| 17   | ESD                                  | -                       | -  | -   |
| 18   | Solderability                        | J-STD-002               | Leaded: method A,<br>category 3 (245 °C / 3 s)   | Good tinning as evidence by free flowing of the solder with wetting of terminations > 95 %  |
| 19   | Electrical characterization          | -                       | -  | -   |
| 20   | Flammability                         | UL 94 IEC 60384-1       | One flame application<br>Class B   | V-0 or V-1 are acceptable.<br>Class B or C acc. IEC is also acceptable  |



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