

# Automotive Grade EMI Suppression Safety Capacitor, Ceramic Disc, Class X1, 440 V<sub>AC</sub>, Class Y2, 300 V<sub>AC</sub>



## FEATURES

- AEC-Q200 qualified
- Withstands 85 / 85 / 1000 h test
- Can pass 3000 temperature cycles (from -55 °C to +125 °C)
- Complying with IEC 60384-14
- High reliability
- Vertical (inline) kinked or straight leads
- Singlelayer AC disc safety capacitors
- PPAP (AIAG version) is available
- Material categorization:  
for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



## LINKS TO ADDITIONAL RESOURCES



| QUICK REFERENCE DATA       |        |     |                  |                  |
|----------------------------|--------|-----|------------------|------------------|
| DESCRIPTION                | VALUE  |     |                  |                  |
| Ceramic Class              | 1      |     | 2                |                  |
| Ceramic Dielectric         | U2J    | U2J | Y5S, Y5U,<br>Y5V | Y5S, Y5U,<br>Y5V |
| Voltage (V <sub>AC</sub> ) | 300    | 440 | 300              | 440              |
| Min. Capacitance (pF)      | 10     |     | 68               |                  |
| Max. Capacitance (pF)      | 47     |     | 10 000           |                  |
| Mounting                   | Radial |     |                  |                  |

## OPERATING TEMPERATURE RANGE

-55 °C to +125 °C

## TEMPERATURE CHARACTERISTICS

Class 1: U2J

Class 2: Y5S, Y5U, Y5V

## SECTIONAL SPECIFICATIONS

Climatic category (according to EN 60058-1)

Class 1 and class 2: 40 / 125 / 21

## COATING

According to UL 94 V-0

Epoxy resin, isolating, flame retardant

## APPROVALS

IEC 60384-14

UL 60384-14

DIN EN 60384-14

CSA E60384-1:03, CSA E60384-14:09

CQC (IEC 60384-14)

## PACKAGING

Bulk, tape and reel, taped ammpack

## APPLICATIONS

- X1, Y2 according to IEC 60384-14
- Application as Y capacitors for EMI suppression and primary-secondary coupling on battery chargers for PHEV/EV
- Application as filter capacitors on DC/DC converters for PHEV/EV and HEV
- EMI / RFI suppression and filtering

## DESIGN

The capacitor consists of a ceramic disc which is silver plated on both sides. Connection leads are made of tin plated copper-clad steel having a diameter of 0.6 mm.

The capacitors may be supplied with straight or kinked leads having a lead spacing of 5 mm, 7.5 mm, or 10.0 mm. Encapsulation is made of flame retardant epoxy resin in accordance with UL 94 V-0.

## CAPACITANCE RANGE

10 pF to 10 000 pF

## RATED VOLTAGE U<sub>R</sub>

IEC 60384-14.4:

(X1): 440 V<sub>AC</sub>, 50 Hz

(Y2): 300 V<sub>AC</sub>, 50 Hz

1000 V<sub>DC</sub>

## TEST VOLTAGE

Component test (100 %):

2600 V<sub>AC</sub>, 50 Hz, 2 s

Random sampling test (destructive test):

2600 V<sub>AC</sub>, 50 Hz, 60 s

Voltage proof of coating (destructive test):

2600 V<sub>AC</sub>, 50 Hz, 60 s

## INSULATION RESISTANCE

≥ 10 000 MΩ

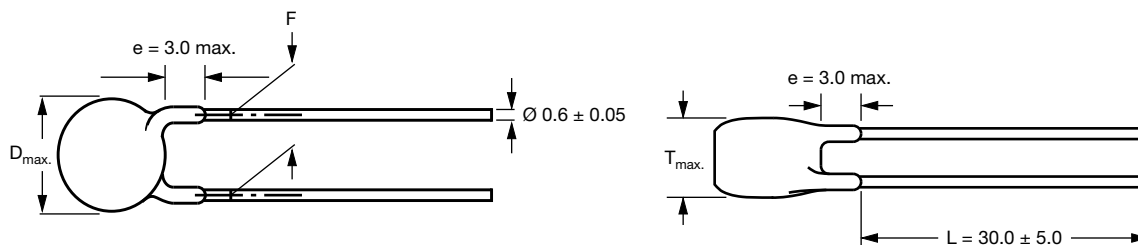
## CAPACITANCE TOLERANCE

± 20 % (code M); ± 10 % (code K)

## DISSIPATION FACTOR

Class 1: max. 0.3 % (1 MHz)

Class 2: max. 2.5 % (1 kHz)

**DIMENSIONS** in millimeters


Capacitors with 5.0 mm, 7.5 mm, or 10.0 mm lead spacing

**TECHNICAL DATA**

| CAPACITANCE<br>C (pF) | CAPACITANCE<br>TOLERANCE<br>(%) | BODY<br>DIAMETER<br>D <sub>max.</sub> (mm) | BODY<br>THICKNESS<br>T <sub>max.</sub> (mm) | LEAD SPACING<br>F (mm) ± 1 mm | PART NUMBER                               |
|-----------------------|---------------------------------|--------------------------------------------|---------------------------------------------|-------------------------------|-------------------------------------------|
|                       |                                 |                                            |                                             |                               | MISSING DIGITS SEE<br>ORDERING CODE BELOW |
| U2J                   |                                 |                                            |                                             |                               |                                           |
| 10                    | ± 10                            | 7.5                                        | 5.0                                         | 5.0, 7.5, or 10.0             | AY2100K29U2JS6###                         |
| 15                    |                                 |                                            |                                             |                               | AY2150K29U2JS6###                         |
| 22                    |                                 |                                            |                                             |                               | AY2220K29U2JS6###                         |
| 33                    |                                 |                                            |                                             |                               | AY2330K29U2JS6###                         |
| 47                    |                                 |                                            |                                             |                               | AY2470K29U2JS6###                         |
| Y5S                   |                                 |                                            |                                             |                               |                                           |
| 68                    | ± 10                            | 7.5                                        | 5.0                                         | 5.0, 7.5, or 10.0             | AY2680K29Y5SS6###                         |
| 100                   |                                 |                                            |                                             |                               | AY2101K29Y5SS6###                         |
| 150                   |                                 |                                            |                                             |                               | AY2151K29Y5SS6###                         |
| 220                   |                                 |                                            |                                             |                               | AY2221K29Y5SS6###                         |
| 330                   |                                 |                                            |                                             |                               | AY2331K29Y5SS6###                         |
| 470                   |                                 |                                            |                                             |                               | AY2471K29Y5SS6###                         |
| Y5U                   |                                 |                                            |                                             |                               |                                           |
| 680                   | ± 20                            | 7.5                                        | 5.0                                         | 5.0, 7.5, or 10.0             | AY2681#29Y5US6###                         |
| 1000                  |                                 |                                            |                                             |                               | AY2102#29Y5US6###                         |
| 1500                  |                                 | 8.5                                        |                                             |                               | AY2152#31Y5US6###                         |
| 2200                  |                                 | 9.5                                        |                                             |                               | AY2222#35Y5US6###                         |
| 3300                  |                                 | 11.0                                       |                                             |                               | AY2332#41Y5US6###                         |
| 3900                  |                                 | 11.5                                       |                                             |                               | AY2392#43Y5US6###                         |
| 4700                  |                                 | 13.0                                       |                                             |                               | AY2472#49Y5US6###                         |
| Y5V                   |                                 |                                            |                                             |                               |                                           |
| 6800                  | ± 20                            | 13.0                                       | 6.0                                         | 7.5 or 10.0                   | AY2682M51Y5VS6#L#                         |
| 10 000                |                                 | 15.5                                       |                                             |                               | AY2103M61Y5VS6#L#                         |

**Note**
<sup>(1)</sup> ± 10 % available on request

**ORDERING CODE**

| #              | 7 <sup>th</sup> digit                      | Capacitance tolerance | ± 10 % = K, ± 20 % = M             |           |                         |               |                    |                                              |                                      |                                |
|----------------|--------------------------------------------|-----------------------|------------------------------------|-----------|-------------------------|---------------|--------------------|----------------------------------------------|--------------------------------------|--------------------------------|
| ###            | 15 <sup>th</sup> to 17 <sup>th</sup> digit | Lead configuration    | Available configurations see below |           |                         |               |                    |                                              |                                      |                                |
| <b>Example</b> | <b>AY2</b>                                 | <b>221</b>            | <b>K</b>                           | <b>29</b> | <b>Y5S</b>              | <b>S</b>      | <b>6</b>           | <b>U</b>                                     | <b>V</b>                             | <b>7</b>                       |
|                | Series                                     | Capacitance value     | Tolerance code                     | Size code | Temperature coefficient | Rated voltage | Lead wire diameter | Packaging / lead length                      | Lead style                           | Lead spacing                   |
|                |                                            |                       |                                    |           |                         |               |                    | 3 = bulk<br>T = tape and reel<br>U = ammpack | L = straight<br>V = inline<br>kinked | 5 = 5.0<br>7 = 7.5<br>0 = 10.0 |

| PACKAGING           |                      |                                     |                      |      |      |                |
|---------------------|----------------------|-------------------------------------|----------------------|------|------|----------------|
| LEADSPACING<br>(mm) | CAPACITANCE VALUE    | BODY DIAMETER<br>$D_{max.}$<br>(mm) | PACKAGING QUANTITIES |      |      | TAPING<br>FIG. |
|                     |                      |                                     | BULK                 | REEL | AMMO |                |
| 5.0                 | 10 pF to 3900 pF     | 11.0                                | 1000                 | 1000 | 1000 | Fig. 1         |
| 7.5                 | 10 pF to 4700 pF     | 13.0                                | 1000                 | 1000 | 1000 | Fig. 1         |
|                     | 6800 pF to 10 000 pF | 15.5                                | 500                  | 500  | 500  | Fig. 2         |
| 10.0                | 10 pF to 4700 pF     | 15.5                                | 1000                 | 500  | 750  | Fig. 2         |
|                     | 6800 pF to 10 000 pF | 15.5                                | 500                  | 500  | 500  | Fig. 2         |

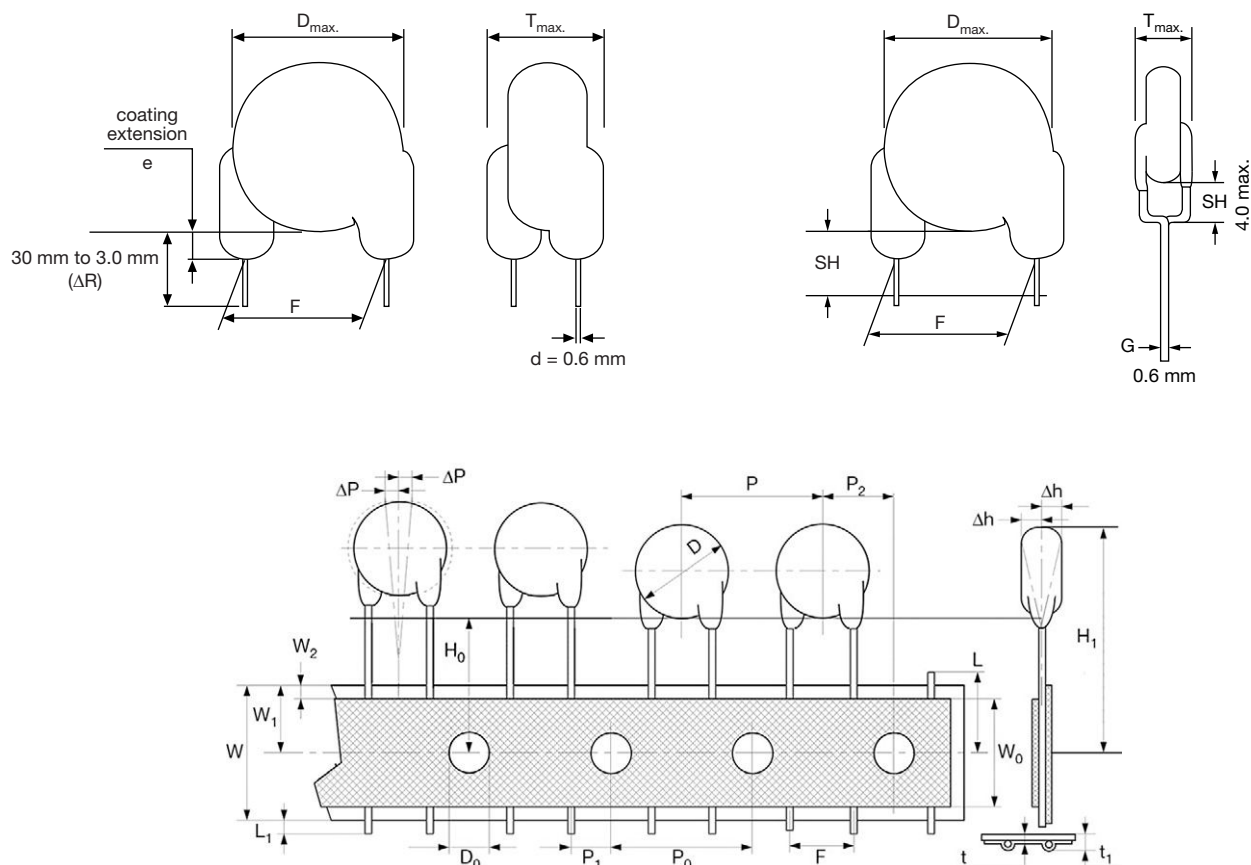
**STRAIGHT LEADS**
**INLINE KINKED LEADS**


Fig. 1 - The hole pitch 12.7 mm for lead spacing 5.0 mm (0.2"), and hole pitch 15.0 mm for lead spacing 7.5 mm (0.3")

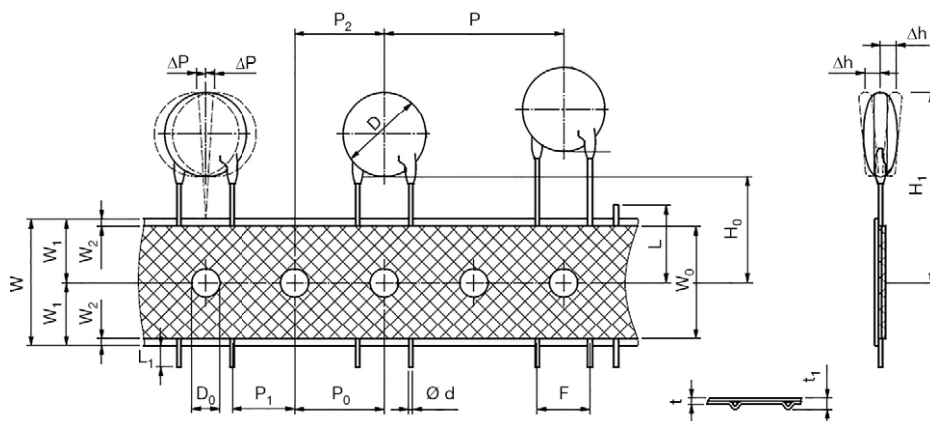
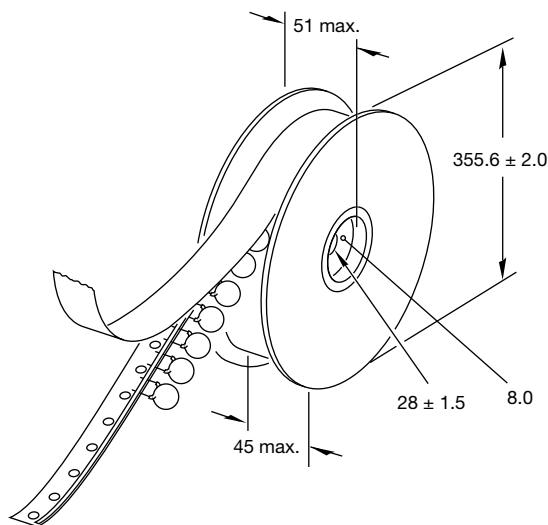


Fig. 2 - The hole pitch 12.7 mm for lead spacing 10.0 mm (0.4")

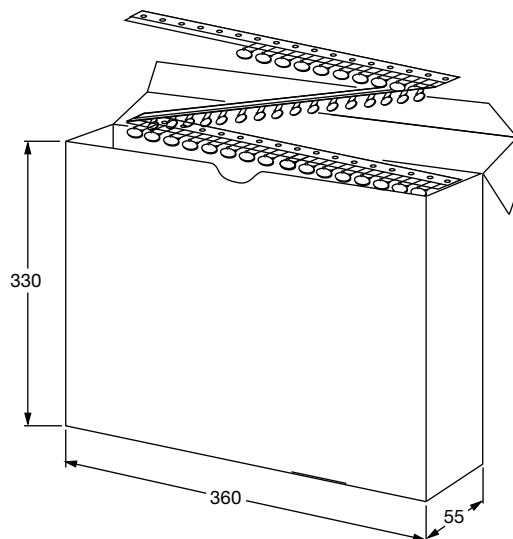
| DIMENSION OF TAPE             |                                              |                   |                   |                    |
|-------------------------------|----------------------------------------------|-------------------|-------------------|--------------------|
| SYMBOL                        | PARAMETER                                    | DIMENSIONS (mm)   |                   |                    |
|                               |                                              | FIG. 1 (5 mm)     | FIG. 1 (7.5 mm)   | FIG. 2 (10 mm)     |
| D <sup>(1)</sup>              | Body diameter                                | 11.0 max.         | 14.0 max.         | 16.0 max.          |
| d                             | Lead diameter                                | 0.6 ± 0.05        | 0.6 ± 0.05        | 0.6 ± 0.05         |
| P                             | Pitch of component                           | 12.7 ± 1          | 15.0 ± 1          | 25.4 ± 1           |
| P <sub>0</sub> <sup>(2)</sup> | Pitch of sprocket hole                       | 12.7 ± 0.3        | 15.0 ± 0.3        | 12.7 ± 0.3         |
| P <sub>1</sub> <sup>(3)</sup> | Distance, hole center to lead                | 3.85 ± 0.7        | 3.75 ± 0.7        | 7.7 ± 1.0          |
| P <sub>2</sub> <sup>(3)</sup> | Distance, hole to center of component        | 6.35 ± 1.3        | 7.5 ± 1.5         | 12.7 ± 1.5         |
| F                             | Lead spacing                                 | 5.0 (+ 0.6/- 0.4) | 7.5 (+ 0.6/- 0.4) | 10.0 (+ 0.6/- 0.4) |
| Δh                            | Average deviation across tape                | ± 1.0 max.        | ± 1.0 max.        | ± 1.0 max.         |
| ΔP                            | Average deviation in direction of reeling    | ± 1.0 max.        | ± 1.0 max.        | ± 1.0 max.         |
| W                             | Carrier tape width                           | 18.0 + 1/- 0.5    | 18.0 + 1/- 0.5    | 18.0 + 1/- 0.5     |
| W <sub>0</sub>                | Hold-down tape width                         | 5.0 min.          | 5.0 min.          | 5.0 min.           |
| W <sub>1</sub>                | Position of sprocket hole                    | 9.0 + 0.75/- 0.5  | 9.0 + 0.75/- 0.5  | 9.0 + 0.75/- 0.5   |
| W <sub>2</sub>                | Distance of hold-down tape                   | 3.0 max.          | 3.0 max.          | 3.0 max.           |
| H <sub>1</sub>                | Maximum component height                     | 32                | 40                | 40                 |
| H <sub>0</sub>                | Height to seating plane (for kinked leads)   | 16.0 ± 0.5        | 16.0 ± 0.5        | 16.0 ± 0.5         |
| H <sub>0</sub>                | Height to seating plane (for straight leads) | 20.0 ± 0.5        | 20.0 ± 0.5        | 20.0 ± 0.5         |
| L                             | Length of cut leads                          | 11.0 max.         | 11.0 max.         | 11.0 max.          |
| L <sub>1</sub>                | Length of lead protrusion                    | 1.0 max.          | 1.0 max.          | 1.0 max.           |
| D <sub>0</sub>                | Diameter of sprocket hole                    | 4.0 ± 0.2         | 4.0 ± 0.2         | 4.0 ± 0.2          |
| t                             | Total tape thickness                         | 0.9 max.          | 0.9 max.          | 0.9 max.           |
| t <sub>1</sub>                | Maximum thickness of tape and wires          | 1.5 max.          | 1.5 max.          | 1.5 max.           |

**Notes**

- (1) See "Technical Data" table  
(2) Cumulative pitch error: ± 1 mm/20 pitches  
(3) Obliquity maximum 3°

**REEL AND TAPE DATA** in millimeters


Reel with capacitors on tape



Ammopack with capacitors on tape

**APPROVALS**

IEC 60384-14 - Safety tests

This approval together with CB test certificate substitutes all national approvals.

**CB Certificate**

Y2-capacitor: CB test certificate:

US-26163-UL

10 pF to 10 nF

300 V<sub>AC</sub>

X1-capacitor: CB test certificate:

US-26163-UL

10 pF to 10 nF

440 V<sub>AC</sub>

**VDE**

Y2-capacitor: VDE marks approval:

40009669

10 pF to 10 nF

300 V<sub>AC</sub>

X1-capacitor: VDE marks approval:

40009669

10 pF to 10 nF

440 V<sub>AC</sub>


DIN EN 60384-14 VDE 0565-1-1:2006-04 - Safety tests

**Underwriters Laboratories Inc./Canadian Standards Association**

Y2-capacitor: UL-test certificate:

E183844

10 pF to 10 nF

300 V<sub>AC</sub>

X1-capacitor: UL-test certificate:

E183844

10 pF to 10 nF

440 V<sub>AC</sub>

UL 60384-14, CSA E60384-1:03 2<sup>nd</sup> edition, CSA E60384-14:09 2<sup>nd</sup> edition

Across-the-line, antenna-coupling and line-by-pass component

**CQC**

Y2-capacitor: CQC test certificate:

CQC05001012316

10 pF to 10 nF

300 V<sub>AC</sub>

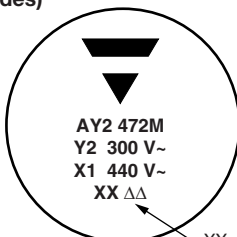
X1-capacitor: CQC test certificate:

CQC05001012316

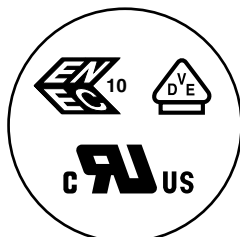
10 pF to 10 nF

440 V<sub>AC</sub>


**MARKING**

Sample  
(2 sides)


Front



Back



PN: AY2472M49Y5US63L0

QTY: 225

PO:

SO:

Lot1: 14Z551S12

Lot2:

Batch: 200601CN

Region: 9520

Ser.No: 0601H69340

DC1: 0601

DC2:

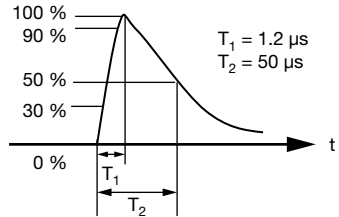
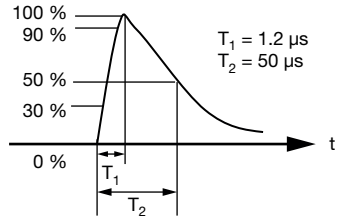
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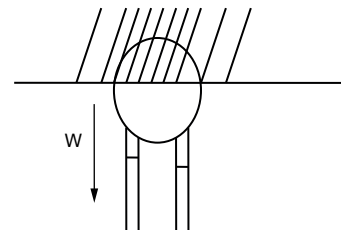
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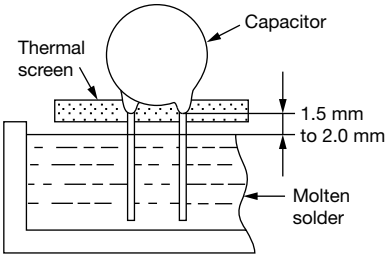
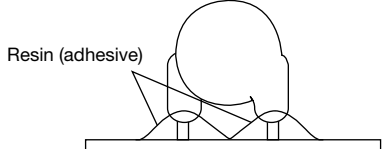
**PERFORMANCE**

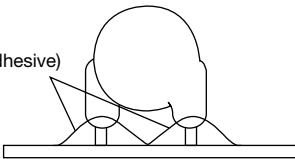
| NO. | ITEMS                                    | SPECIFICATION                                                                                                         | TEST METHOD                                                                                                                                                         |
|-----|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Visual and mechanical examination        | No visible damage.<br>The marking shall be legible.<br>Dimensions are within specification.                           | Capacitors shall be visually inspected for visible evidence of defect.<br>Dimensions shall be measured with calipers or micrometers.                                |
| 2   | Capacitance                              | Within the specified tolerance.                                                                                       | The capacitance shall be measured at 25 °C ± 3 °C, 75 % RH maximum with 1.0 V <sub>RMS</sub> ± 0.2 V <sub>RMS</sub> , 1 kHz for Y5U, Y5S, and 1 MHz for U2J.        |
| 3   | Dissipation factor (D.F.)                | U2J: 0.3 % max.<br>Y5U, Y5S: 2.5 % max.                                                                               | The dissipation factor shall be measured at 25 °C ± 3 °C, 75 % RH maximum with 1.0 V <sub>RMS</sub> ± 0.2 V <sub>RMS</sub> , 1 kHz for Y5U, Y5S, and 1 MHz for U2J. |
| 4   | Insulation resistance (I.R.)             | 10 GΩ min.                                                                                                            | Insulation resistance shall be measured within 60 s ± 5 s of charging at 500 V <sub>DC</sub> .                                                                      |
| 5   | Dielectric strength (between lead wires) | No damage.                                                                                                            | 2600 V <sub>AC</sub> are applied for 60 s.<br>50 mA max. (destructive test)                                                                                         |
| 6   | Temperature characteristic               | External appearance                                                                                                   | The capacitance shall be measured at each step specified in table below.<br>The capacitance change from the value of step 3 shall not exceed the limit specified.   |
|     |                                          | Capacitance change                                                                                                    |                                                                                                                                                                     |
|     |                                          | Dissipation factor                                                                                                    |                                                                                                                                                                     |
|     |                                          | Insulation resistance                                                                                                 | Step                                                                                                                                                                |
|     |                                          | 10 GΩ min. at 500 V <sub>DC</sub><br>60 s at 25 °C and -40 °C<br>500 MΩ min. at 500 V <sub>DC</sub><br>60 s at 125 °C | Temperature                                                                                                                                                         |
|     |                                          |                                                                                                                       | 1                                                                                                                                                                   |
|     |                                          |                                                                                                                       | 2                                                                                                                                                                   |
|     |                                          |                                                                                                                       | 3                                                                                                                                                                   |
|     |                                          |                                                                                                                       | 4                                                                                                                                                                   |
|     |                                          |                                                                                                                       | 5                                                                                                                                                                   |
|     | Dielectric strength (between lead wires) | 5 s 250 % rated voltage                                                                                               | 25 °C ± 3 °C                                                                                                                                                        |

| PERFORMANCE |                                 |                                          |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------|---------------------------------|------------------------------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NO.         | ITEMS                           |                                          | SPECIFICATION                                                     | TEST METHOD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 7           | High temperature operation life | External appearance                      | No visible damage.<br>The marking shall be legible.               | <p>Test voltage: 1.5 kV<sub>AC</sub>, 60 s<br/>Impulse voltage: each individual capacitor shall be subjected to a 5 kV impulse for three times. Before the capacitors are applied to life test.</p>  <p><math>T_1 = 1.2 \mu s</math><br/><math>T_2 = 50 \mu s</math></p> <p>The specimen capacitors shall be submitted to an endurance test of 1000 h + 48 h / - 0 h in a chamber at 125 °C ± 3 °C with a voltage of 550 V<sub>AC</sub>.</p> <p>Pre-treatment: capacitor shall be backed at 125 °C ± 3 °C for 1 h before initial measurements.</p> <p>Post-treatment: capacitors shall be placed at room condition for 24 h ± 2 h before measurements.</p>                                                                                               |
|             |                                 | Capacitance change                       | ± 15 % max.                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|             |                                 | Dissipation factor                       | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|             |                                 | Insulation resistance                    | 3 GΩ min. at 500 V <sub>DC</sub> , 60 s                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|             |                                 | Dielectric strength (between lead wires) | No failure at 1.5 kV <sub>AC</sub> , 60 s                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 8           | Life Test                       | External appearance                      | No visible damage.<br>The marking shall be legible.               | <p>Test voltage: 1.5 kV<sub>AC</sub>, 60 s<br/>Impulse voltage: each individual capacitor shall be subjected to a 5 kV impulse for three times. Before the capacitors are applied to life test.</p>  <p><math>T_1 = 1.2 \mu s</math><br/><math>T_2 = 50 \mu s</math></p> <p>The specimen capacitors shall be submitted to an endurance test of 1000 h + 48 h / - 0 h in a chamber at 125 °C ± 3 °C with a voltage of 550 V<sub>AC</sub>, except that once every hour the voltage shall be increase to 1000 V<sub>AC</sub> for 0.1 s.</p> <p>Pre-treatment: capacitor shall be backed at 125 °C ± 3 °C for 1 h before initial measurements.</p> <p>Post-treatment: capacitors shall be placed at room condition for 24 h ± 2 h before measurements.</p> |
|             |                                 | Capacitance change                       | ± 15 % max.                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|             |                                 | Dissipation factor                       | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|             |                                 | Insulation resistance                    | 3 GΩ min. at 500 V <sub>DC</sub> , 60 s                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|             |                                 | Dielectric strength (between lead wires) | No failure at 1.5 kV <sub>AC</sub> , 60 s                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| PERFORMANCE |                                       |                                             |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------|---------------------------------------|---------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NO.         | ITEMS                                 |                                             | SPECIFICATION                                                     | TEST METHOD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 9           | Humidity test<br>(under steady state) | External appearance                         | No visible damage.                                                | Ambient temperature: $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$<br>Relative humidity: 90 % to 95 % RH<br>Duration: 500 h + 48 h / - 0 h<br>Without loading<br><br>Pre-treatment: capacitor shall be stored at $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ for 24 h $\pm$ 5 h before initial measurements.<br><br>Post-treatment: capacitor shall be stored for 2 h at room conditions before final measurements.                                                                 |
|             |                                       | Capacitance change                          | U2J: $\pm 10\text{ }%$<br>Y5U, Y5S: $\pm 20\text{ }%$             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       | Dissipation factor                          | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       | Insulation resistance                       | 3 G $\Omega$ min. at 500 V <sub>DC</sub> , 60 s                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       | Dielectric strength<br>(between lead wires) | No failure at 1.5 kV <sub>AC</sub> , 60 s                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 10          | Humidity test<br>(under load state)   | External appearance                         | No visible damage.<br>The marking shall be legible.               | Ambient temperature: $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$<br>Relative humidity: 90 % to 95 % RH<br>Duration: 500 h + 48 h / - 0 h<br>Loading voltage: 440 V <sub>AC</sub><br><br>Pre-treatment: capacitor shall be stored at $40\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ for 24 h $\pm$ 2 h before initial measurements.<br><br>Post-treatment: capacitor shall be stored for 2 h at room conditions before final measurements.                                            |
|             |                                       | Capacitance change                          | U2J: $\pm 10\text{ }%$<br>Y5U, Y5S: $\pm 15\text{ }%$             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       | Dissipation factor                          | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       | Insulation resistance                       | 3 G $\Omega$ min. at 500 V <sub>DC</sub> , 60 s                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       | Dielectric strength<br>(between lead wires) | No failure at 1.5 kV <sub>AC</sub> , 60 s                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 11          | Biased humidity                       | External appearance                         | No visible damage.<br>The marking shall be legible.               | Loading voltage: 440 V <sub>AC</sub><br>Ambient temperature: $85\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$<br>Relative humidity: 85 % RH<br>Duration: 1000 h + 48 h / - 0 h<br><br>Pre-treatment: capacitor shall be stored at $40\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ for 24 h $\pm$ 2 h, then place at room condition for 24 h $\pm$ 2 h before initial measurements.<br><br>Post-treatment: capacitor shall be stored for 24 h at room conditions before final measurements. |
|             |                                       | Capacitance change                          | U2J: $\pm 10\text{ }%$<br>Y5U, Y5S: $\pm 15\text{ }%$             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       | Dissipation factor                          | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       | Insulation resistance                       | 3 G $\Omega$ min. at 500 V <sub>DC</sub> , 60 s                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       | Dielectric strength<br>(between lead wires) | No failure at 1.5 kV <sub>AC</sub> , 60 s                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 12          | Termination strength                  | Pull test                                   | External appearance                                               | As a figure, fix the body of capacitor, apply a tensile weight gradually to each lead wire in the radial direction of capacitor up to 20 N, and keep it for 10 s $\pm$ 1 s.                                                                                                                                                                                                                                                                                                                                     |
|             |                                       |                                             | Capacitance change                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       |                                             | Dissipation factor                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       |                                             | Insulation resistance                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|             |                                       | Bending test                                | External appearance                                               | Bending each lead wire to 90° from the lead egress with 2.5 N force, then back to original position and bent again from the same direction.<br>Totally 3 bends, 3 s each time.<br>1 bend: bending to 90° the return to normal position is one bend.<br>Start from 1.6 mm to 3.2 mm from the part body.                                                                                                                                                                                                          |
|             |                                       |                                             |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |



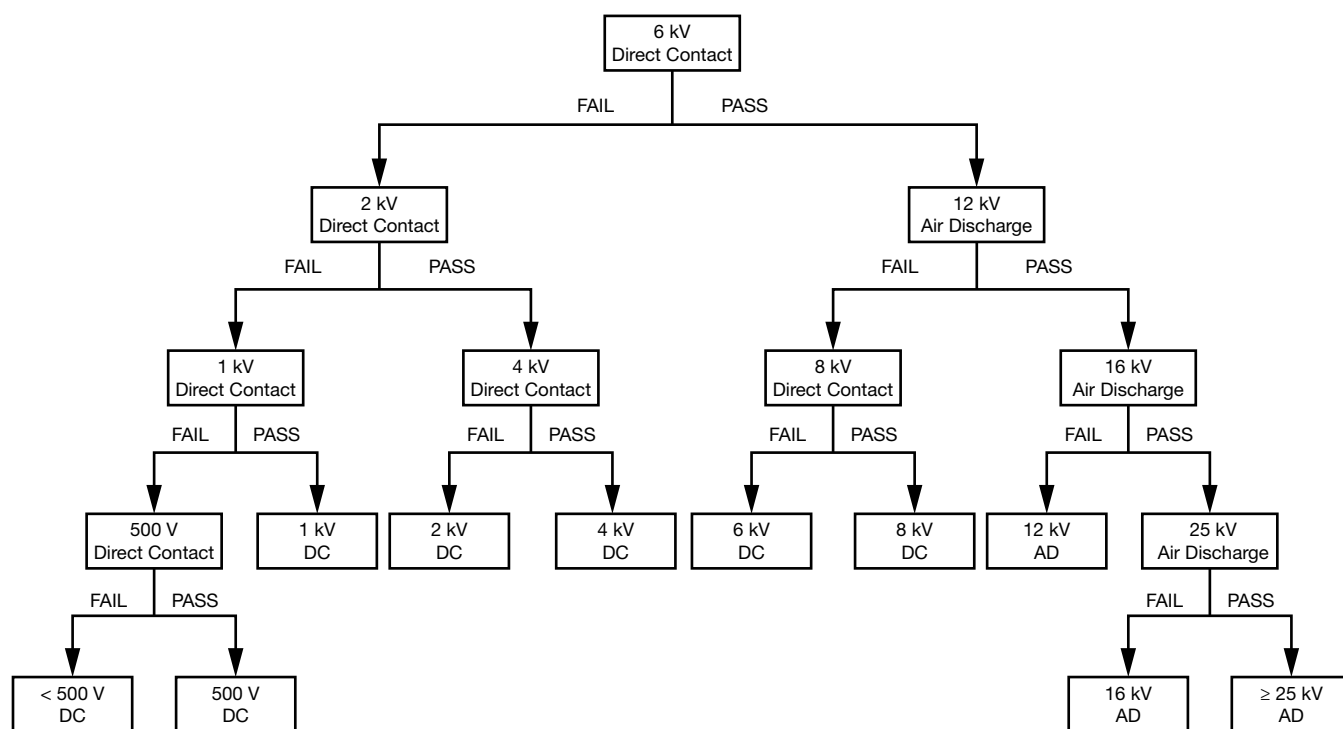
| <b>PERFORMANCE</b> |                           |                                          |                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------|---------------------------|------------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>NO.</b>         | <b>ITEMS</b>              |                                          | <b>SPECIFICATION</b>                                                      | <b>TEST METHOD</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 13                 | Resistance to solder heat | Visual                                   | No visible damage.<br>The marking shall be legible.                       | <p>The lead wire shall be immersed into the melted solder of <math>260^{\circ}\text{C} \pm 5^{\circ}\text{C}</math> up to about 1.5 mm to 2 mm from the main body for <math>10\text{ s} \pm 2\text{ s}</math>.<br/>Inspect under 10 x magnification</p>  <p>Pre-treatment:<br/>Capacitor shall be stored at <math>125^{\circ}\text{C} \pm 5^{\circ}\text{C}</math> for 1 h, then placed at room condition for <math>24\text{ h} \pm 2\text{ h}</math> before initial measurements.</p> <p>Post-treatment:<br/>Capacitor shall be stored for <math>24\text{ h} \pm 2\text{ h}</math> at room condition.</p> |
|                    |                           | Capacitance change                       | Within $\pm 10\%$                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                    |                           | Dissipation factor                       | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                    |                           | Insulation resistance                    | 1 G $\Omega$ min. at 500 V <sub>DC</sub> , 60 s                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                    |                           | Dielectric strength (between lead wires) | No failure at 1.5 kV <sub>AC</sub> , 60 s                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 14                 | Solderability             | External appearance                      | 95 % of terminations evenly covered with solder under 10 x magnification. | <p>Method A at category 3, steam aging for <math>8\text{ h} \pm 15\text{ min}</math>.<br/>Solder and temperature:</p> <p>a) Lead (Pb)-free solder (Sn-3Ag-0.5Cu) <math>245^{\circ}\text{C} \pm 5^{\circ}\text{C}</math></p> <p>b) H63 eutectic solder <math>235^{\circ}\text{C} \pm 5^{\circ}\text{C}</math><br/>dip lead wire into an ethanol solution of <math>25\% \pm 0.5\%</math> rosin and then into molten solder for <math>5\text{ s} + 0\text{ s} / - 0.5\text{ s}</math>.</p> <p>Depth of immersion within 1.25 mm, immerse and withdraw at <math>25\text{ mm/s} \pm 6\text{ mm/s}</math></p>                                                                                       |
| 15                 | Vibration test            | Visual                                   | No visible damage.<br>The marking shall be legible.                       |  <p>Solder the capacitor and gum up the body to the test jig by resin (adhesive).<br/>The capacitor should be firmly soldered to the supporting lead wire.<br/>Vibration change from 10 Hz to 2000 Hz, then back to 10 Hz.<br/>Total amplitude: 1.5 mm with 5 g max., 12 cycles, 20 min for each mutually perpendicular directions, 3 directions.</p>                                                                                                                                                                                                                                                    |
|                    |                           | Capacitance change                       | Within $\pm 10\%$                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                    |                           | Dissipation factor                       | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                    |                           | Insulation resistance                    | 10 G $\Omega$ min. at 500 V <sub>DC</sub> , 60 s                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

| PERFORMANCE |                                     |                       |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------|-------------------------------------|-----------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NO.         | ITEMS                               |                       | SPECIFICATION                                                     | TEST METHOD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 16          | Mechanical shock                    | External appearance   | No visible damage.<br>The marking shall be legible.               |  <p>Resin (adhesive)</p> <p>Solder the capacitor and gum up the body to the test jig by resin (adhesive).<br/>3 shocks in 2 directions should be applied, totally 3 mutually perpendicular axes, 18 shocks.<br/>Shock from: half-sine<br/>Duration: 6 ms<br/>Acceleration: 100 g</p>                                                                                                                                                                                                                           |
|             |                                     | Capacitance change    | Within the specified tolerance.                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|             |                                     | Dissipation factor    | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|             |                                     | Insulation resistance | 10 GΩ min. at 500 V <sub>DC</sub> , 60 s.                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 17          | Resistance to solvents              | External appearance   | No visible damage.<br>The marking shall be legible.               | <p>Leave parts in solvent for 3 to 8 min at 25 °C ± 5 °C, 1 min air-drying<br/>Rub parts against wet bristle 10 times (3 x for marking, 10 x for part damage)</p> <p>Solvent 1:<br/>1 part (by volume) of isopropyl alcohol,<br/>3 parts (by volume) of mineral spirits</p> <p>Solvent 2:<br/>Terpene defluxer</p> <p>Solvent 3:<br/>42 parts (by volume) of water, 1 part (by volume) of propylene glycol, 1 part (by volume) of monoethanolamine</p>                                                                                                                                            |
| 18          | Temperature cycle                   | Capacitance change    | Within ± 10 % for U2J<br>Within ± 20 % for Y5U and Y5S            | <p>The capacitor should be run 3000 temperature cycles. Step as below:</p> <p>Step 1 -55 °C + 0 °C / - 3 °C,<br/>dwell time ≤ 30 min</p> <p>Step 2 Transition time ≤ 1 min</p> <p>Step 3 +125 °C + 3 °C / - 0 °C,<br/>dwell time ≤ 30 min</p> <p>Step 4 Transition time ≤ 1 min</p> <p>Pre-treatment:<br/>capacitor shall be stored at 125 °C ± 3 °C for 1 h, then placed at room condition for 24 h ± 2 h before initial measurement.</p> <p>Post-treatment:<br/>capacitor shall be stored for 24 h ± 2 h at room condition.</p> <p><b>Note</b><br/>• 6800 pF and 10 000 pF only 1000 cycles</p> |
|             |                                     | Dissipation factor    | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|             |                                     | Insulation resistance | 3 GΩ min at 500 V <sub>DC</sub> , 60 s                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|             |                                     | Dielectric strength   | No failure at 1.5 kV <sub>AC</sub> , 60 s                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|             |                                     | External appearance   | No visible damage.<br>The marking shall be legible.               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 19          | High temperature exposure (storage) | External appearance   | No visible damage.<br>The marking shall be legible.               | <p>Storage capacitor at 125 °C ± 3 °C for 1000 h + 48 h / - 0 h without loading.</p> <p>Pre-treatment:<br/>capacitor shall be stored at 125 °C ± 3 °C for 1 h, then placed at room condition for 24 h ± 2 h before initial measurement.</p> <p>Post-treatment:<br/>capacitor shall be stored for 24 h ± 2 h at room condition.</p>                                                                                                                                                                                                                                                                |
|             |                                     | Capacitance change    | Within ± 10 % for U2J<br>Within ± 20 % for Y5U and Y5S            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|             |                                     | Dissipation factor    | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|             |                                     | Insulation resistance | 1 GΩ min. at 500 V <sub>DC</sub> , 60 s                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |



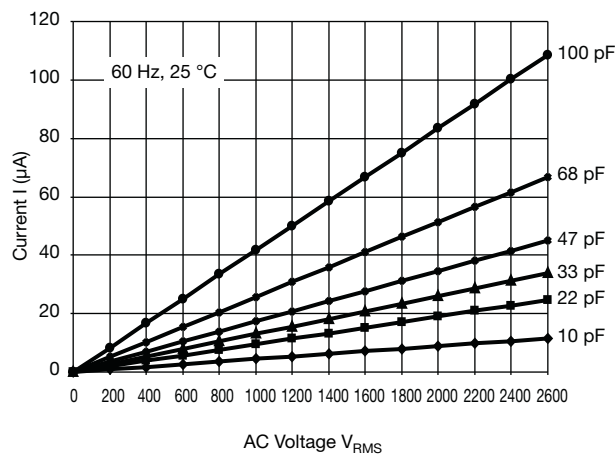
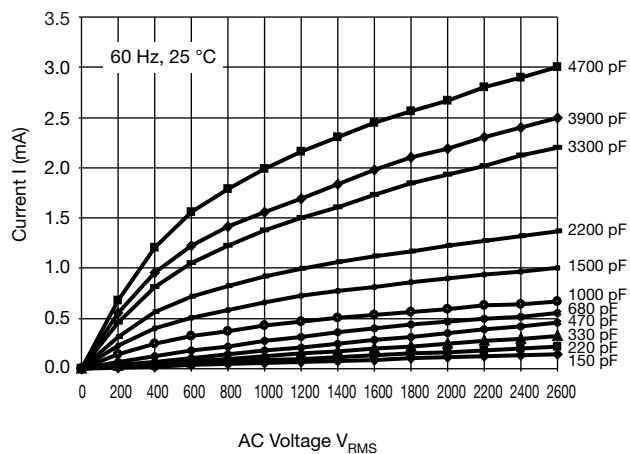
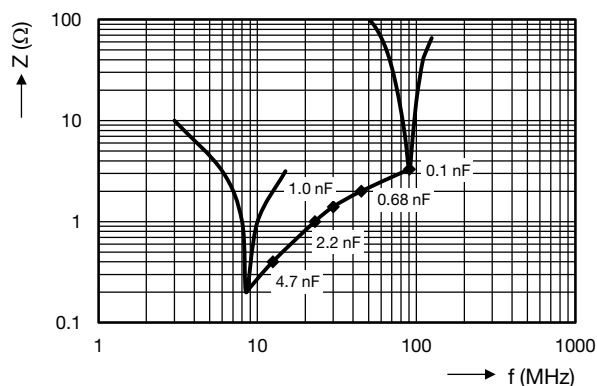
| PERFORMANCE |       |                       |                                                                   |                                   |
|-------------|-------|-----------------------|-------------------------------------------------------------------|-----------------------------------|
| NO.         | ITEMS |                       | SPECIFICATION                                                     | TEST METHOD                       |
| 20          | ESD   | External appearance   | No visible damage.<br>The marking shall be legible.               | See chart “ESD Test Method” below |
|             |       | Capacitance change    | Within $\pm 10\%$                                                 |                                   |
|             |       | Dissipation factor    | U2J: 0.5 % max. at 1 V, 1 MHz<br>Y5U, Y5S: 5 % max. at 1 V, 1 kHz |                                   |
|             |       | Insulation resistance | 1 G $\Omega$ min. at 500 V <sub>DC</sub> , 60 s.                  |                                   |

## ESD TEST METHOD



### Notes

- DC means “direct contact discharge”
- AC means “air discharge”
- Classify the components according to the highest ESD voltage level survived during ESD testing

**LEAKAGE CURRENT VS. VOLTAGE (Typical)**

**IMPEDANCE VS. FREQUENCY (Typical)**


Lead configuration: length = 30 mm, lead spacing: standard, lead diameter: standard, inline crimp

**Note**

- The capacitors meet the essential requirements of "EIA 198". Unless stated otherwise all electrical values apply at an ambient temperature of 25 °C ± 3 °C, at normal atmospheric conditions

**RELATED DOCUMENTS**

|                      |                                                                        |
|----------------------|------------------------------------------------------------------------|
| General Information  | <a href="http://www.vishay.com/doc?28536">www.vishay.com/doc?28536</a> |
| CB Test Certificate  | <a href="http://www.vishay.com/doc?22254">www.vishay.com/doc?22254</a> |
| VDE Marks Approval   | <a href="http://www.vishay.com/doc?22256">www.vishay.com/doc?22256</a> |
| UL Test Certificate  | <a href="http://www.vishay.com/doc?22253">www.vishay.com/doc?22253</a> |
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| LTspice® Models      | <a href="http://www.vishay.com/doc?28568">www.vishay.com/doc?28568</a> |

**SAMPLE KIT**

|             |                                                                        |
|-------------|------------------------------------------------------------------------|
| Part Number | AY21-KIT-HF                                                            |
| Link        | <a href="http://www.vishay.com/doc?28553">www.vishay.com/doc?28553</a> |



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