Automotive Grade AC Line Rated Ceramic Disc Capacitors Class X1, 760 V_{AC}, Class Y1, 500 V_{AC}

FEATURES

- AEC-Q200 qualified
- Withstands 85 / 85 / 1000 h test
- Can pass 1000 temperature cycles (from -55 °C to +125 °C)
- Complying with IEC 60384-14 4th edition
- High reliability
- Singlelayer AC disc safety capacitors
- PPAP (AIAG version) is available
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

Pb-free

e3

RoHS COMPLIANT

HALOGEN FREE

GREEN (5-2008)

QUICK REFERENCE DATA		
DESCRIPTION	VALUE	
Ceramic Class	2	
Ceramic Dielectric	Y5U	
Voltage (V_{AC})	500	760
Min. Capacitance (pF)	470	
Max. Capacitance (pF)	4700	
Mounting	Radial	

OPERATING TEMPERATURE RANGE

-55 °C to +125 °C

TEMPERATURE CHARACTERISTICS

Class 2: Y5U

SECTIONAL SPECIFICATIONS

Climatic category (according to EN 60058-1)
Class 2: 40 / 125 / 21

COATING

According to UL 94 V-0
Epoxy resin, isolating, flame retardant

APPROVALS

IEC 60384-14.4
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 ammopack

APPLICATIONS

- X1, Y1 according to IEC 60384-14.4
- Application as Y capacitors for AC line filter and primary-secondary coupling on battery chargers for PHEV/EV
- Application as filter capacitors on DC/DC converters for PHEV/EV and HEV

DESIGN

The capacitor consists of a ceramic disc which is copper plated on both sides. Connection leads are made of tin plated copper-clad steel having a diameter of 0.6 mm or 0.8 mm.
The capacitors may be supplied with straight leads having a lead spacing of 10.0 mm and 12.5 mm. Encapsulation is made of flame retardant epoxy resin in accordance with UL 94 V-0.

CAPACITANCE RANGE

470 pF to 4700 pF

RATED VOLTAGE U_R

IEC 60384-14.4:
(X1): 760 V_{AC}, 50 Hz
(Y1): 500 V_{AC}, 50 Hz
1500 V_{DC}

TEST VOLTAGE

Component test (100 %):
4000 V_{AC}, 50 Hz, 2 s
Random sampling test (destructive test):
4000 V_{AC}, 50 Hz, 60 s
Voltage proof of coating (destructive test):
4000 V_{AC}, 50 Hz, 60 s

INSULATION RESISTANCE

≥ 10 000 MΩ

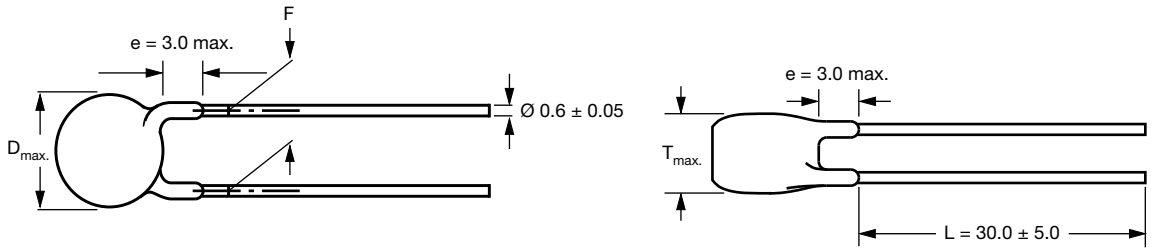
CAPACITANCE TOLERANCE

± 20 % (code M)

DISSIPATION FACTOR

Class 2: max. 2.5 % (1 kHz)

DIMENSIONS in millimeters



Capacitors with 10.0 mm or 12.5 mm lead spacing

TECHNICAL DATA

CAPACITANCE C (pF)	CAPACITANCE TOLERANCE (%)	BODY DIAMETER $D_{max.}$ (mm)	BODY THICKNESS $T_{max.}$ (mm)	LEAD SPACING F (mm) ± 1 mm	PART NUMBER MISSING DIGITS SEE ORDERING CODE BELOW
Y5U (2E3)					
470	± 20	8.0	7.0	10 or 12.5	AY1471M31Y5UC6#L#
680		9.0		10 or 12.5	AY1681M35Y5UC6#L#
1000		9.5		10 or 12.5	AY1102M37Y5UC6#L#
1500		10.5		10 or 12.5	AY1152M41Y5UC6#L#
2200		12.0		10 or 12.5	AY1222M47Y5UC6#L#
2700		13.5		10 or 12.5	AY1272M53Y5UC6#L#
3300		14.5		10 or 12.5	AY1332M57Y5UC6#L#
3900		15.5		10 or 12.5	AY1392M61Y5UC6#L#
4700		16.5		10 or 12.5	AY1472M65Y5UC6#L#

ORDERING CODE

###	15th to 17th digit		Lead configuration			Available configurations see below				
Example	**AY1**	**222**	**M**	**47**	**Y5U**	**C**	**6**	**U**	**L**	**0**
	Series	Capacitance value	Tolerance code	Size code	Temperature coefficient	Compact design	Lead wire diameter	Packaging / lead length	Lead style	Lead spacing
							6 = 0.6 8 = 0.8	3 = bulk T = tape and reel U = ammopack	L = straight	0 = 10.0 X = 12.5

LEADSPACING 10.0 mm AND 12.5 mm

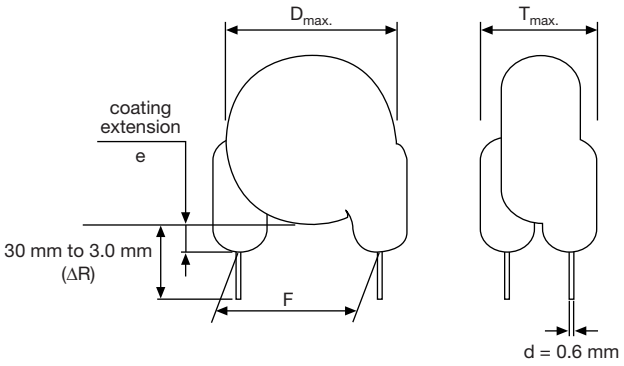
PACKAGING

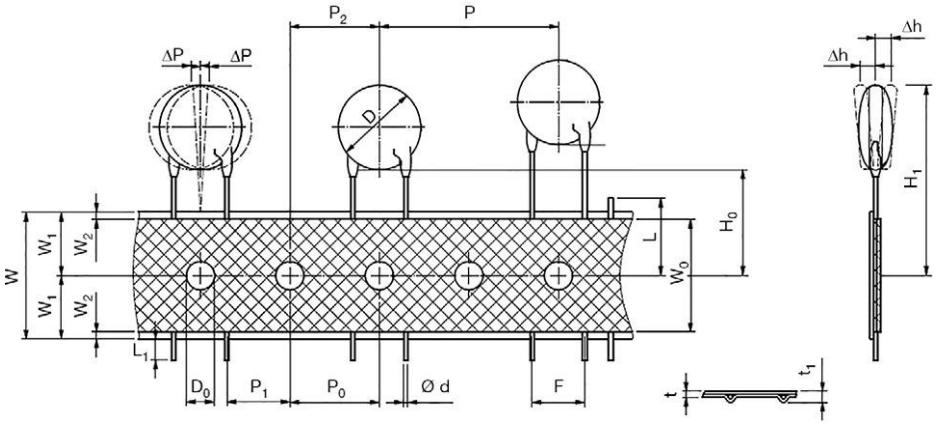
CAPACITANCE VALUE	SIZE CODE	BODY DIAMETER $D_{max.}$ (mm)	PACKAGING QUANTITIES		
			BULK	REEL	AMMO
470 pF to 2200 pF	31 to 47	12.0	1000	500	750
2700 pF to 4700 pF	53 to 65	16.5	500	500	750

Note

- The capacitors are supplied in bulk packaging (cardboard boxes), in tape on reel in ammopack

STRAIGHT LEADS





The hole pitch 12.7 mm for lead spacing 10.0 mm (0.4") or 12.5 mm (0.49")

DIMENSION OF TAPE		
SYMBOL	PARAMETER	DIMENSIONS (mm)
		10 mm OR 12 mm
D (1)	Body diameter	16.0 max.
d	Lead diameter	0.6 ± 0.05
P	Pitch of component	25.4 ± 1
P_0 (2)	Pitch of sprocket hole	12.7 ± 0.3
P_1 (3)	Distance, hole center to lead	7.7 or 6.5 ± 1.0
P_2 (3)	Distance, hole to center of component	12.7 ± 1.5
F	Lead spacing	10.0 or 12.5 (+ 0.6/- 0.4)
Δh	Average deviation across tape	± 1.0 max.
ΔP	Average deviation in direction of reeling	± 1.0 max.
W	Carrier tape width	18.0 + 1/- 0.5
W_0	Hold-down tape width	5.0 min.
W_1	Position of sprocket hole	9.0 + 0.75/- 0.5
W_2	Distance of hold-down tape	3.0 max.
H_1	Maximum component height	40
H_0	Height to seating plane	20.0 ± 0.5
L	Length of cut leads	11.0 max.
L_1	Length of lead protrusion	1.0 max.
D_0	Diameter of sprocket hole	4.0 ± 0.2
t	Total tape thickness	0.9 max.
t_1	Maximum thickness of tape and wires	1.5 max.

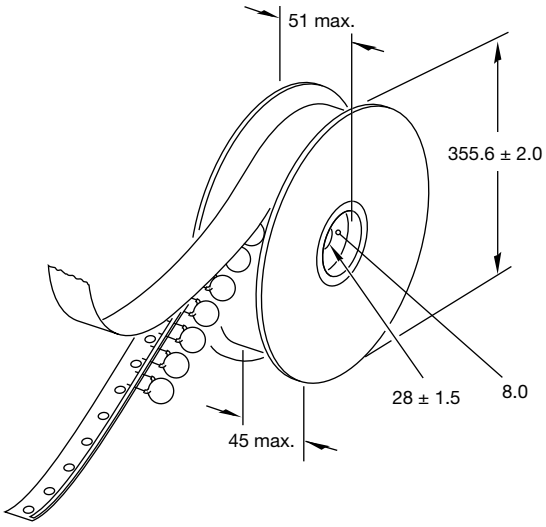
Notes

(1) See “Technical Data” table

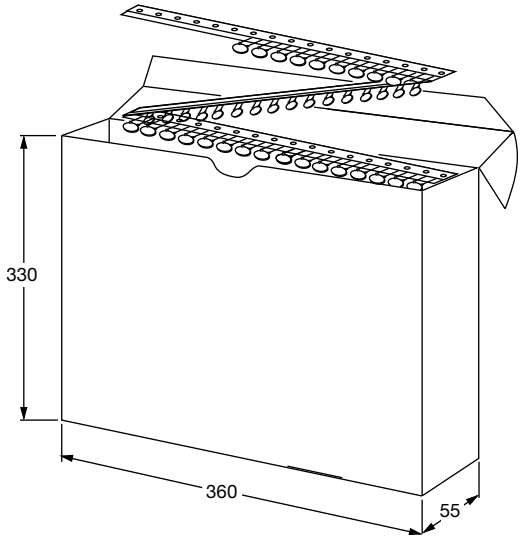
(2) Cumulative pitch error: ± 1 mm/20 pitches

(3) Obliquity maximum 3°

REEL AND TAPE DATA in millimeters



Reel with capacitors on tape



Ammopack with capacitors on tape

APPROVALS

IEC 60384-14.4 - Safety tests
This approval together with CB test certificate substitutes all national approvals.

CB Certificate

Y1-capacitor: CB test certificate:	US-26163-UL	470 pF to 4.7 nF	500 V_{AC}
X1-capacitor: CB test certificate:	US-26163-UL	470 pF to 4.7 nF	760 V_{AC}

VDE

Y1-capacitor: VDE marks approval:	40009669	470 pF to 4.7 nF	500 V_{AC}
X1-capacitor: VDE marks approval:	40009669	470 pF to 4.7 nF	760 V_{AC}

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

Underwriters Laboratories Inc./Canadian Standards Association

Y1-capacitor: UL-test certificate:	E183844	470 pF to 4.7 nF	500 V_{AC}
X1-capacitor: UL-test certificate:	E183844	470 pF to 4.7 nF	760 V_{AC}

UL 60384-14, CSA E60384-1:03 2nd edition, CSA E60384-14:09 2nd edition

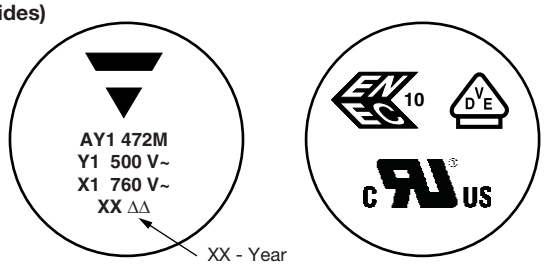
Across-the-line, antenna-coupling and line-by-pass component

CQC

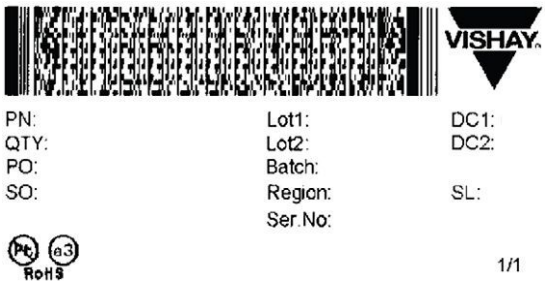
Y1-capacitor: CQC test certificate:	CQC05001012316	470 pF to 4.7 nF	500 V_{AC}
X1-capacitor: CQC test certificate:	CQC05001012316	470 pF to 4.7 nF	760 V_{AC}

MARKING

Sample
(2 sides)



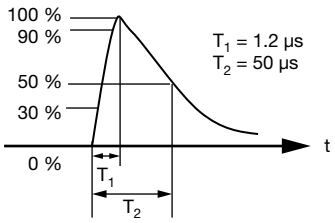
Front Back

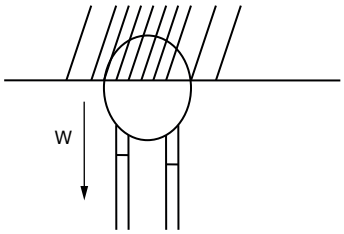
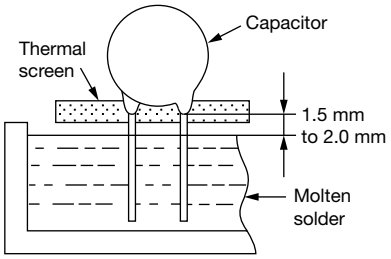


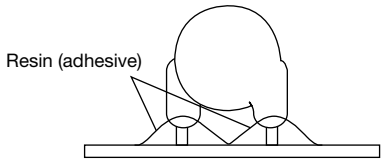
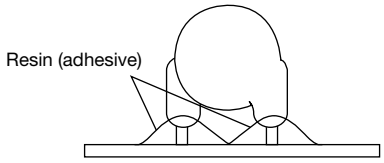
PERFORMANCE

NO.	ITEMS		SPECIFICATION	TEST METHOD
1	Visual and mechanical examination		No visible damage. The marking shall be legible. Dimensions are within specification.	Capacitors shall be visually inspected for visible evidence of defect. 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_{RMS} ± 0.2 V_{RMS}, 1 kHz.
3	Dissipation factor (D.F.)		2.5 % max.	The dissipation factor shall be measured at 25 °C ± 3 °C, 75 % RH maximum with 1.0 V_{RMS} ± 0.2 V_{RMS}, 1 kHz.
4	Insulation resistance (I.R.)		10 GΩ min.	Insulation resistance shall be measured within 60 s ± 5 s of charging at 500 V_{DC}.
5	Dielectric strength (between lead wires)		No damage.	4000 V_{AC} are applied for 60 s. 50 mA max. (destructive test)
6	Temperature characteristic			The capacitance shall be measured at each step specified in table below. The capacitance change from the value of step 3 shall not exceed the limit specified.
7	High temperature operation life	External appearance	No visible damage. The marking shall be legible.	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 760 V_{AC}. Pre-treatment: capacitor shall be backed at 125 °C ± 3 °C for 1 h before initial measurements. Post-treatment: capacitors shall be placed at room condition for 24 h ± 2 h before measurements.
		Capacitance change	± 15 % max.	
		Dissipation factor	5 % max. at 1 V, 1 kHz	
		Insulation resistance	3 GΩ min. at 500 V_{DC}, 60 s	
		Dielectric strength (between lead wires)	No failure at 4000 V_{AC}, 60 s	

Step	Temperature
1	25 °C ± 3 °C
2	-40 °C ± 3 °C
3	25 °C ± 3 °C
4	125 °C ± 3 °C
5	25 °C ± 3 °C

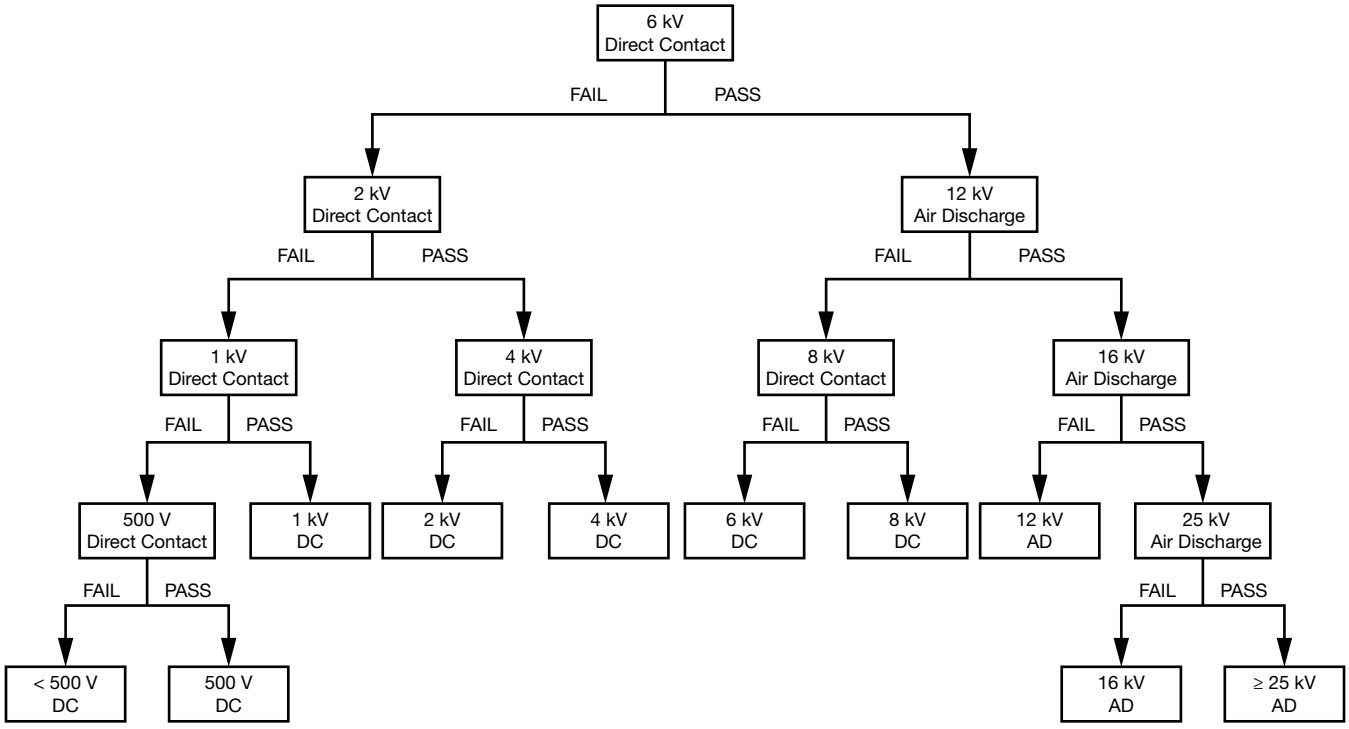
PERFORMANCE				
NO.	**ITEMS**		**SPECIFICATION**	**TEST METHOD**
8	Life test	External appearance	No visible damage. The marking shall be legible.	Test voltage: 4000 V_{AC}, 60 s Impulse voltage: each individual capacitor shall be subjected to a 10 kV impulse for ten times each polarity. Before the capacitors are applied to life test.  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 1500 V_{AC}. Pre-treatment: capacitor shall be backed at 125 °C ± 3 °C for 1 h before initial measurements. Post-treatment: capacitors shall be placed at room condition for 24 h ± 2 h before measurements.
		Capacitance change	± 15 % max.	
		Dissipation factor	5 % max. at 1 V, 1 kHz	
		Insulation resistance	3 GΩ min. at 500 V_{DC}, 60 s	
		Dielectric strength (between lead wires)	No failure at 4000 V_{AC}, 60 s	
9	Humidity test (under steady state)	External appearance	No visible damage.	Ambient temperature: 40 °C ± 2 °C Relative humidity: 90 % to 95 % RH Duration: 500 h + 48 h / - 0 h Without loading Pre-treatment: capacitor shall be stored at 40 °C ± 2 °C for 24 h ± 5 h before initial measurements. Post-treatment: capacitor shall be stored for 2 h at room conditions before final measurements.
		Capacitance change	± 20 %	
		Dissipation factor	5 % max. at 1 V, 1 kHz	
		Insulation resistance	3 GΩ min. at 500 V_{DC}, 60 s	
		Dielectric strength (between lead wires)	No failure at 4000 V_{AC}, 60 s	
10	Humidity test (under load state)	External appearance	No visible damage. The marking shall be legible.	Ambient temperature: 40 °C ± 2 °C Relative humidity: 90 % to 95 % RH Duration: 500 h + 48 h / - 0 h Loading voltage: 760 V_{AC} Pre-treatment: capacitor shall be stored at 40 °C ± 5 °C for 24 h ± 2 h before initial measurements. Post-treatment: capacitor shall be stored for 2 h at room conditions before final measurements.
		Capacitance change	± 15 %	
		Dissipation factor	5 % max. at 1 V, 1 kHz	
		Insulation resistance	3 GΩ min. at 500 V_{DC}, 60 s	
		Dielectric strength (between lead wires)	No failure at 4000 V_{AC}, 60 s	

PERFORMANCE					
NO.	**ITEMS**			**SPECIFICATION**	**TEST METHOD**
11	Biased humidity	External appearance		No visible damage. The marking shall be legible.	Loading voltage: 760 V_{AC} Ambient temperature: 85 °C ± 3 °C Relative humidity: 85 % RH Duration: 1000 h + 48 h / - 0 h Pre-treatment: capacitor shall be stored at 40 °C ± 5 °C for 24 h ± 2 h, then place at room condition for 24 h ± 2 h before initial measurements. Post-treatment: capacitor shall be stored for 24 h at room conditions before final measurements.
		Capacitance change		± 15 %	
		Dissipation factor		5 % max. at 1 V, 1 kHz	
		Insulation resistance		3 GΩ min. at 500 V_{DC}, 60 s	
		Dielectric strength (between lead wires)		No failure at 4000 V_{AC}, 60 s	
12	Termination strength	Pull test	External appearance	Lead wire should not be cut off, capacitor should not be broken.	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 ± 1 s. 
			Capacitance change	Within specification	
			Dissipation factor	Within specification	
			Insulation resistance	Within specification	
		Bending test	External appearance	Lead wire should not be cut off, capacitor should not be broken.	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. Totally 3 bends, 3 s each time. 1 bend: bending to 90° the return to normal position is one bend. Start from 1.6 mm to 3.2 mm from the part body.
13	Resistance to solder heat	Visual		No visible damage. The marking shall be legible.	The lead wire shall be immersed into the melted solder of 260 °C ± 5 °C up to about 1.5 mm to 2 mm from the main body for 10 s ± 2 s. Inspect under 10 x magnification  Pre-treatment: Capacitor shall be stored at 125 °C ± 5 °C for 1 h, then placed at room condition for 24 h ± 2 h before initial measurements. Post-treatment: Capacitor shall be stored for 24 h ± 2 h at room condition.
		Capacitance change		Within ± 10 %	
		Dissipation factor		5 % max. at 1 V, 1 kHz	
		Insulation resistance		1 GΩ min. at 500 V_{DC}, 60 s	
		Dielectric strength (between lead wires)		No failure at 4000 V_{AC}, 60 s	

PERFORMANCE				
NO.	**ITEMS**		**SPECIFICATION**	**TEST METHOD**
14	Solderability	External appearance	95 % of terminations evenly covered with solder under 10 x magnification.	Method A at category 3, steam aging for 8 h ± 15 min. Solder and temperature: a) Lead (Pb)-free solder (Sn-3Ag-0.5Cu) 245 °C ± 5 °C b) H63 eutectic solder 235 °C ± 5 °C dip lead wire into an ethanol solution of 25 % ± 0.5 % rosin and then into molten solder for 5 s + 0 s / - 0.5 s. Depth of immersion within 1.25 mm, immerse and withdraw at 25 mm/s ± 6 mm/s
15	Vibration test	Visual	No visible damage. The marking shall be legible.	 Solder the capacitor and gum up the body to the test jig by resin (adhesive). The capacitor should be firmly soldered to the supporting lead wire. Vibration change from 10 Hz to 2000 Hz, then back to 10 Hz. Total amplitude: 1.5 mm with 5 *g* max., 12 cycles, 20 min for each mutually perpendicular directions, 3 directions.
		Capacitance change	Within ± 10 %	
		Dissipation factor	5 % max. at 1 V, 1 kHz	
		Insulation resistance	10 GΩ min. at 500 V_{DC}, 60 s	
16	Mechanical shock	External appearance	No visible damage. The marking shall be legible.	 Solder the capacitor and gum up the body to the test jig by resin (adhesive). 3 shocks in 2 directions should be applied, totally 3 mutually perpendicular axes, 18 shocks. Shock from: half-sine Duration: 6 ms Acceleration: 100 *g*
		Capacitance change	Within the specified tolerance.	
		Dissipation factor	5 % max. at 1 V, 1 kHz	
		Insulation resistance	10 GΩ min. at 500 V_{DC}, 60 s	
17	Resistance to solvents	External appearance	No visible damage. The marking shall be legible.	Leave parts in solvent for 3 to 8 min at 25 °C ± 5 °C, 1 min air-drying Rub parts against wet bristle 10 times (3 x for marking, 10 x for part damage) Solvent 1: 1 part (by volume) of isopropyl alcohol, 3 parts (by volume) of mineral spirits Solvent 2: Terpene defluxer Solvent 3: 42 parts (by volume) of water, 1 part (by volume) of propylene glycol, 1 part (by volume) of monoethanolomine

PERFORMANCE				
NO.	**ITEMS**		**SPECIFICATION**	**TEST METHOD**
18	Temperature cycle	Capacitance change	Within ± 20 %	The capacitor should be run 1000 temperature cycles. Step as below: Step 1 -55 °C + 0 °C / - 3 °C, dwell time ≤ 30 min Step 2 Transition time ≤ 1 min Step 3 +125 °C + 3 °C / - 0 °C, dwell time ≤ 30 min Step 4 Transition time ≤ 1 min Pre-treatment: 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. Post-treatment: capacitor shall be stored for 24 h ± 2 h at room condition.
		Dissipation factor	5 % max. at 1 V, 1 kHz	
		Insulation resistance	3 GΩ min at 500 V_{DC}, 60 s	
		Dielectric strength	No failure at 4000 V_{AC}, 60 s	
		External appearance	No visible damage. The marking shall be legible.	
19	High temperature exposure (storage)	External appearance	No visible damage. The marking shall be legible.	Storage capacitor at 125 °C ± 3 °C for 1000 h + 48 h / - 0 h without loading. Pre-treatment: 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. Post-treatment: capacitor shall be stored for 24 h ± 2 h at room condition.
		Capacitance change	Within ± 20 %	
		Dissipation factor	5 % max. at 1 V, 1 kHz	
		Insulation resistance	1 GΩ min. at 500 V_{DC}, 60 s	
20	ESD	External appearance	No visible damage. The marking shall be legible.	See chart “ESD Test Method” below
		Capacitance change	Within ± 10 %	
		Dissipation factor	5 % max. at 1 V, 1 kHz	
		Insulation resistance	1 GΩ min. at 500 V_{DC}, 60 s	

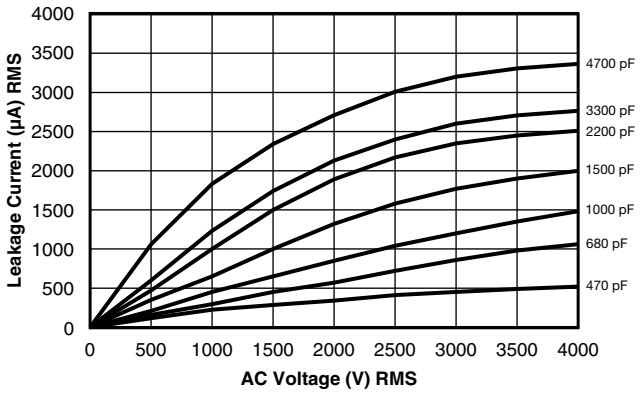
ESD TEST METHOD



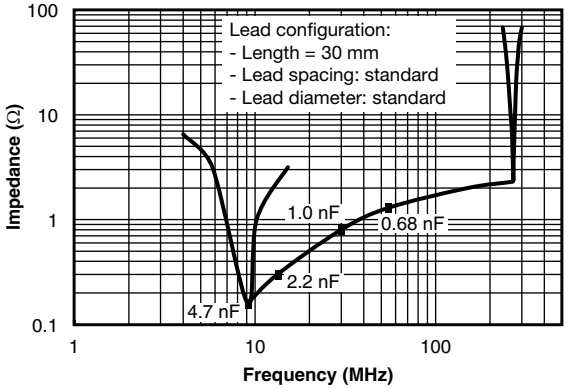
Notes

- 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)



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.

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AY1332M57Y5UC63L0 AY1471M31Y5UC63L0 AY1222M47Y5UC63L0 AY1681M35Y5UC63L0