High Voltage Ceramic Capacitors Radial-Leaded Singlelayer Disc

FEATURES

- Ceramic singlelayer DC disc / AC disc capacitor
- High reliability
- High capacitance values up to 2 nF
- Small sizes
- Low losses
- Radial leads
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT

APPLICATIONS

- High voltage power supplies for x-ray sources and pulsed lasers
- Baggage scanner
- Medical x-ray
- Industrial laser
- Airpurifier / ionizer

LINKS TO ADDITIONAL RESOURCES

3D Models | Related Documents | Why It Matters | Capabilities and Custom Options | Did You Know? | Infographics

QUICK REFERENCE DATA			
DESCRIPTION	**VALUE**		
Ceramic class	2		
Ceramic dielectric	Y6P		
Temperature coefficient of capacitance	± 10 % within -30 °C to +105 °C		
Voltage ($U_{rated, DC}$)	10 000	15 000	20 000
Min. capacitance (pF)	100	100	100
Max. capacitance (pF)	2000	2000	1000
Capacitance tolerance	± 20 %, ± 10 %		
Max. dissipation factor (%)	1.5		
Min. insulation resistance (GΩ)	200		
Operating temperature (°C)	-30 to +105		
Mounting	Radial		

RATED VOLTAGE

$U_{rated, AC} = U_{rated, DC}/2.8$ at 50 Hz / 60 Hz
$U_{rated, DC}$: 10 000 V → $U_{rated, AC}$: 3500 V
$U_{rated, DC}$: 15 000 V → $U_{rated, AC}$: 5300 V
$U_{rated, DC}$: 20 000 V → $U_{rated, AC}$: 7000 V

INSULATION RESISTANCE

Min. 200 000 MΩ at 500 V_{DC} / 60 s max.

TOLERANCE ON CAPACITANCE

± 20 %, ± 10 %

DISSIPATION FACTOR

Max. 1.5 % at 1 kHz

OPERATING TEMPERATURE RANGE

-30 °C to +105 °C

DESIGN

The capacitors consist of a ceramic disc of which both sides are silver-plated. Connection leads are made of tinned copper clad steel wire having diameters of 0.026" (0.65 mm) and 0.032" (0.80 mm).

The capacitors may be supplied with straight leads having lead spacing of 0.37" (9.5 mm) and 0.49" (12.5 mm).

Coating is made of flame retardant epoxy resin in accordance with “UL 94 V-0”.

CAPACITANCE RANGE

100 pF to 2000 pF

DIELECTRIC STRENGTH BETWEEN LEADS

1.5 x $U_{rated, DC}$ for maximum 60 s

Test voltage: customer re-test 1.35 x $U_{rated, DC}$ for maximum 60 s

Notes

- Considered as destructive test in insulation liquid
- Avoid flashover between wires and currents higher than 50 mA

CERAMIC DIELECTRIC

Y6P (± 10 % within -30 °C to +105 °C)

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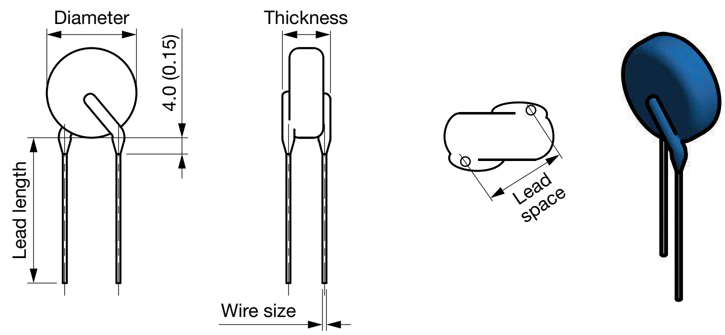
DIMENSIONS in millimeters (inches)



ORDERING INFORMATION, 10 kV_{DC}

C (pF)	TOL. (%)	MAXIMUM DIAMETER		MAXIMUM THICKNESS		LEAD SPACE ± 1 mm (± 0.04")		WIRE SIZE ± 0.05 mm (± 0.002")		LEAD LENGTH ± 5 mm (± 0.2")		ORDERING CODE
		mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	
100	± 20	8.0	0.31	9.0	0.35	12.5 and 9.5	0.49 and 0.37	0.80 and 0.65	0.032 and 0.026	30	1.18	HVCC103Y6P101M###
100	± 10	8.0	0.31	9.0	0.35							HVCC103Y6P101K###
150	± 20	8.0	0.31	8.0	0.31							HVCC103Y6P151M###
150	± 10	8.0	0.31	8.0	0.31							HVCC103Y6P151K###
220	± 20	9.0	0.35	8.0	0.31							HVCC103Y6P221M###
220	± 10	9.0	0.35	8.0	0.31							HVCC103Y6P221K###
330	± 20	10.0	0.39	8.0	0.31							HVCC103Y6P331M###
330	± 10	10.0	0.39	8.0	0.31							HVCC103Y6P331K###
470	± 20	12.0	0.47	8.0	0.31							HVCC103Y6P471M###
470	± 10	12.0	0.47	8.0	0.31							HVCC103Y6P471K###
680	± 20	13.0	0.51	7.5	0.30							HVCC103Y6P681M###
680	± 10	13.0	0.51	7.5	0.30							HVCC103Y6P681K###
1000	± 20	15.0	0.59	7.5	0.30							HVCC103Y6P102M###
1000	± 10	15.0	0.59	7.5	0.30							HVCC103Y6P102K###
1500	± 20	17.0	0.67	7.5	0.30							HVCC103Y6P152M###
1500	± 10	17.0	0.67	7.5	0.30							HVCC103Y6P152K###
2000	± 20	19.0	0.75	8.0	0.31							HVCC103Y6P202M###

ORDERING INFORMATION, 15 kV_{DC}

C (pF)	TOL. (%)	MAXIMUM DIAMETER		MAXIMUM THICKNESS		LEAD SPACE ± 1 mm (± 0.04")		WIRE SIZE ± 0.05 mm (± 0.002")		LEAD LENGTH ± 5 mm (± 0.2")		ORDERING CODE
		mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	
100	± 20	8.0	0.31	9.0	0.35	12.5 and 9.5	0.49 and 0.37	0.80 and 0.65	0.032 and 0.026	30	1.18	HVCC153Y6P101M###
100	± 10	8.0	0.31	9.0	0.35							HVCC153Y6P101K###
150	± 20	8.0	0.31	8.0	0.31							HVCC153Y6P151M###
150	± 10	8.0	0.31	8.0	0.31							HVCC153Y6P151K###
220	± 20	9.0	0.35	8.0	0.31							HVCC153Y6P221M###
220	± 10	9.0	0.35	8.0	0.31							HVCC153Y6P221K###
330	± 20	10.0	0.39	8.0	0.31							HVCC153Y6P331M###
330	± 10	10.0	0.39	8.0	0.31							HVCC153Y6P331K###
470	± 20	12.0	0.47	8.0	0.31							HVCC153Y6P471M###
470	± 10	12.0	0.47	8.0	0.31							HVCC153Y6P471K###
680	± 20	13.0	0.51	8.0	0.31							HVCC153Y6P681M###
680	± 10	13.0	0.51	9.5	0.37							HVCC153Y6P681K###
1000	± 20	15.0	0.59	8.0	0.31							HVCC153Y6P102M###
1000	± 10	15.0	0.59	9.5	0.37							HVCC153Y6P102K###
1500	± 20	19.0	0.75	8.0	0.31							HVCC153Y6P152M###
1500	± 10	19.0	0.75	8.0	0.31							HVCC153Y6P152K###
2000	± 20	19.0	0.75	8.0	0.31							HVCC153Y6P202M###

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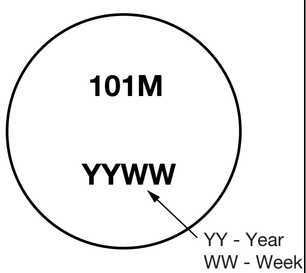
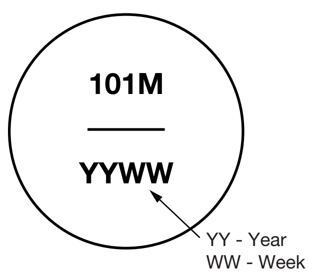
ORDERING INFORMATION, 20 kV_{DC}

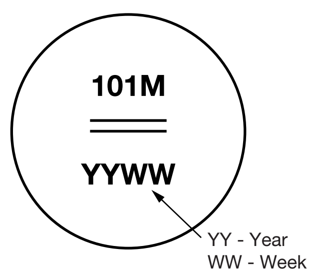
C (pF)	TOL. (%)	MAXIMUM DIAMETER		MAXIMUM THICKNESS		LEAD SPACE ± 1 mm (± 0.04")		WIRE SIZE ± 0.05 mm (± 0.002")		LEAD LENGTH ± 5 mm (± 0.2")		ORDERING CODE
		mm	INCH	mm	INCH	mm	INCH	mm	INCH	mm	INCH	
100	± 20	8.0	0.31	9.0	0.35	12.5 and 9.5	0.49 and 0.37	0.80 and 0.65	0.032 and 0.026	30	1.18	HVCC203Y6P101M###
100	± 10	8.0	0.31	9.0	0.35							HVCC203Y6P101K###
150	± 20	8.0	0.31	9.0	0.35							HVCC203Y6P151M###
150	± 10	8.0	0.31	9.0	0.35							HVCC203Y6P151K###
220	± 20	9.0	0.35	9.0	0.35							HVCC203Y6P221M###
220	± 10	9.0	0.35	9.0	0.35							HVCC203Y6P221K###
330	± 20	12.0	0.47	9.0	0.35							HVCC203Y6P331M###
330	± 10	12.0	0.47	9.0	0.35							HVCC203Y6P331K###
470	± 20	13.0	0.51	9.0	0.35							HVCC203Y6P471M###
470	± 10	13.0	0.51	9.0	0.35							HVCC203Y6P471K###
680	± 20	15.0	0.59	9.0	0.35							HVCC203Y6P681M###
680	± 10	15.0	0.59	9.0	0.35							HVCC203Y6P681K###
1000	± 20	17.0	0.67	9.0	0.35							HVCC203Y6P102M###
1000	± 10	17.0	0.67	9.0	0.35							HVCC203Y6P102K###

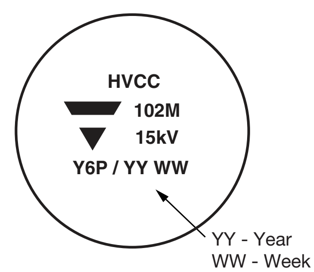
MARKING

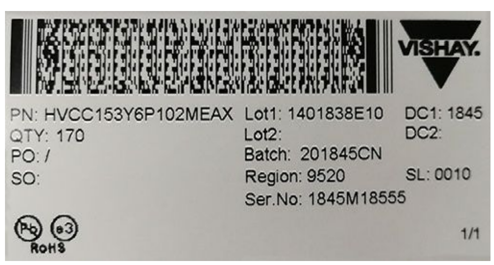
SAMPLE < 470 pF		SAMPLE < 330 pF	SAMPLE ≥ 470 pF	SAMPLE ≥ 330 pF
10 kV	15 kV	20 kV	10 kV / 15 kV	20 kV











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ORDERING CODE

H	V	C	C	1	5	3	Y	6	P	1	0	2	M	E	A	X
1				2			3			4			5	6		7

1	2	3	4	5	6	7
SERIES (**H**IGH **V**OLTAGE **C**ERAMIC **C**APACITOR)	RATED VOLTAGE	TEMPERATURE CHARACTERISTICS	CAPACITANCE VALUE	CAPACITANCE TOLERANCE	1st DIGIT: LEAD TYPE / LEAD SPACING / GAUGE 2nd DIGIT: LEAD LENGTH	PACKAGING

LEAD TYPE (position 6)

STANDARD TYPE

CODE	LEAD TYPE	LEAD SPACING (mm)	LEAD DIAMETER (mm)	# GAUGE	MATERIAL	LEAD LENGTH (mm)
CA	Straight LL	9.5 ± 1.0	0.65	22	TCCSW	30 ± 5
EA	Straight LL	12.5 ± 1.0	0.80	20	TCCSW	30 ± 5

Notes

- 1th digit: lead type / lead spacing / gauge
  2nd digit: A = long leads
- LL = long leads
- TCCSW = **t**inned **c**opper **c**lad **s**teel **w**ire

PACKAGING (position 7)

CODE	VERSION
X	Bulk

PERFORMANCE

NO.	PARAMETER	SPECIFICATION	
		TEST CONDITIONS	METHOD AND NOTES
1	Capacitance	Tol. K = ± 10 % at 1000 h Tol. M = ± 20 % at 1000 h	Components are measured with a LCR-meter. Consider aging of ceramic. Given tolerance is valid 1000 h ± 24 h after last heating. Before and after that moment, aging offset has to be considered. (See general information for further instructions)
2	Dissipation factor	DF / tan δ = max. 1.5 %	
3	Insulation resistance	I_R = min. 200 GΩ in 60 s t = 5 s U = 500 V_{DC} ± 10 V_{DC}	NOTE: very high resistances are sensitive to the surrounding area (may lead to unstable measurement values)
4	Dielectric strength (between lead wires)	U1 = +1.35 x U_{RDC}/U_{RAC} max. 60 s U2 = -1.35 x U_{RDC}/U_{RAC} max. 60 s t_{U1} = t_{U2} = 60 s $I_{max.}$ = 50 mA	1. Apply +1.35 x U_{RDC}/U_{RAC} for max. 60 s 2. Unload part ($I_{max.}$ = 50 mA) 3. Apply -1.35 x U_{RDC} for max. 60 s 4. Unload part ($I_{max.}$ = 50 mA) 5. Avoid current spikes higher than 50 mA
5	Appearance and marking	No visible damage. The marking shall be legible	Visual inspection
6	Dimensions	Dimensions are within specification	Measurement by caliper gauge
7.1	Temperature characteristics / **TCC**	EIA code = Y6P $\Delta C/C_0$ = ± 10 % Temp. range = -30 °C to 105 °C	Measurement is done from cooler temperatures to hotter temperatures in reasonable temperature steps. For decreasing temperature run deaging effects must be considered.
7.2	Temperature characteristics / **TCDF**	DF / tan δ = max. 1.5 % Temp. range = -30 °C to 105 °C	

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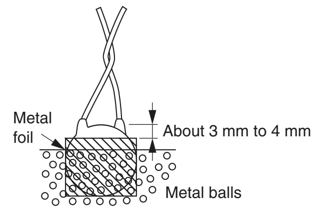
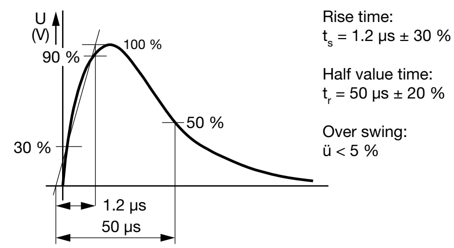
PERFORMANCE			
NO.	**PARAMETER**	**SPECIFICATION**	
		TEST CONDITIONS	**METHOD AND NOTES**
8	Dielectric strength of body insulation	$U = 5000\ V_{DC}$ $t = 60$ s	1. Connect both lead wires together 2. Dip component headfirst into a bath with oil and metal balls (fig.) 3. Apply voltage between lead wires and metal balls 
9	Pulse test	$t_r = 1.2$ μs $t_f = 50$ μs $U = 1.25 \times U_{RDC}$ n = 50 x single polarity	
10	Life test	$U = 1.25 \times U_{RDC}$ t = min. 1000 h T = max. 105 °C $I_{max.} = 50$ mA	1. Initial measurement including no. 1, 2, 3, and 4 2. Condition the components to test temperature 3. Carry out life test / avoid 0 Ω short circuit 4. Final measurement including no. 1, 2, 3, and 4 Result: voltage breakdowns are not accepted
11	Steady state test (without load)	T = 40 °C RH = 93 % t = 240 h / 10 days $U = 1.5 \times U_{RDC}$	1. Initial measurement including no. 1, 2, 3, and 4 2. Carry out steady state test 3. Final measurement including no. 1, 2, 3, and 4 Result: voltage breakdowns are not accepted
12	Temperature cycle	$T_{LOW} = -30$ °C $T_{HIGH} = +105$ °C $t_{DWELL} = 1800$ s t_{CHANGE} = about 300 s n = 50 x	1. Initial measurement including no. 1, 2, 3, and 4 2. Carry out temperature cycle 3. Final measurement including no. 1, 2, 3, and 4 Result: voltage breakdowns and cracks in coating are not accepted
13	Solderability	T_{SOLDER} = max. 250 °C t = max. 3 s dist. solder-epoxy = min. 2 mm	1. Initial measurement incl. no. 1, 2, 3, and 4 2. Carry out test (solder material: no known restrictions) 3. Final measurement incl. 1, 2, 3, and 4 Result: voltage breakdowns are not accepted
14	Strength of lead wire / pulling	F_{PULL} = max. 10 N t_{PULL} = max. 10 s	Fix the body of component, 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
15	Strength of lead wire / bending	F_{BEND} = max. 5 N t_{BEND} = 2 s to 3 s	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

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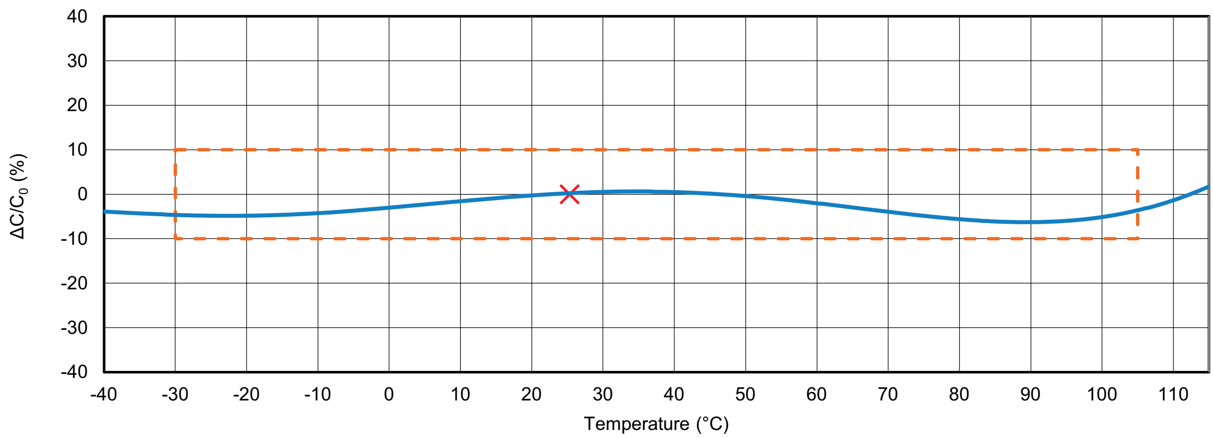
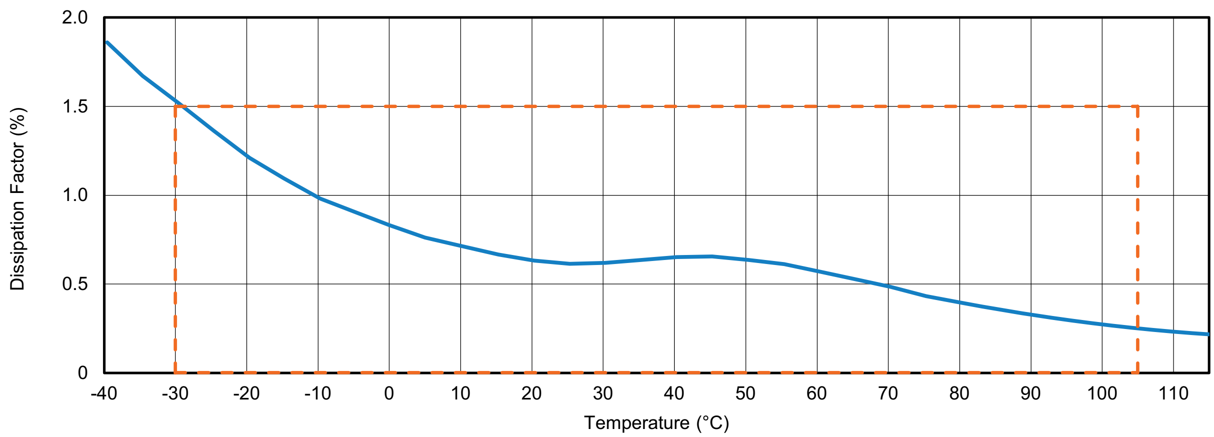
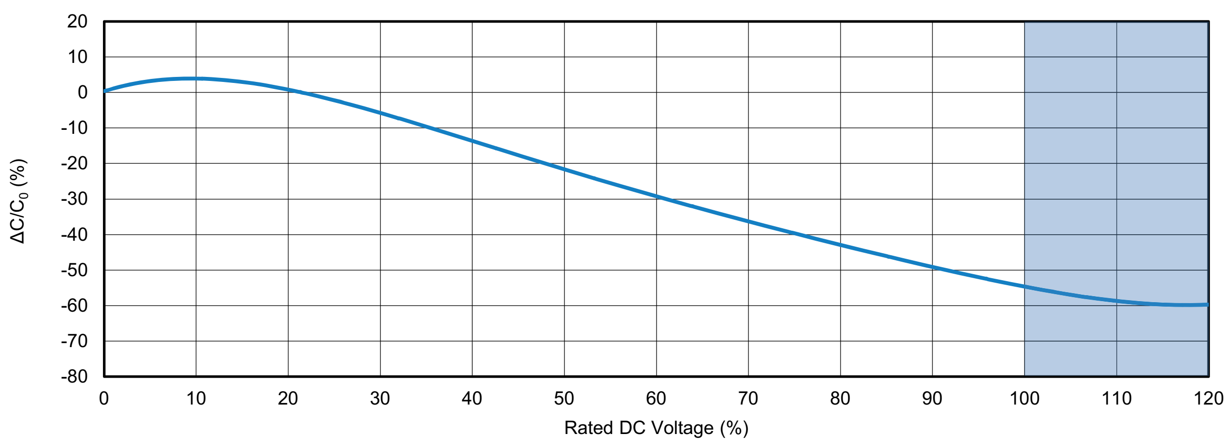
TYPICAL TCC Y6P



TYPICAL TCDF Y6P



TYPICAL Y6P - $\Delta C/C_0$ / % VS. $U_{rated, DC}$



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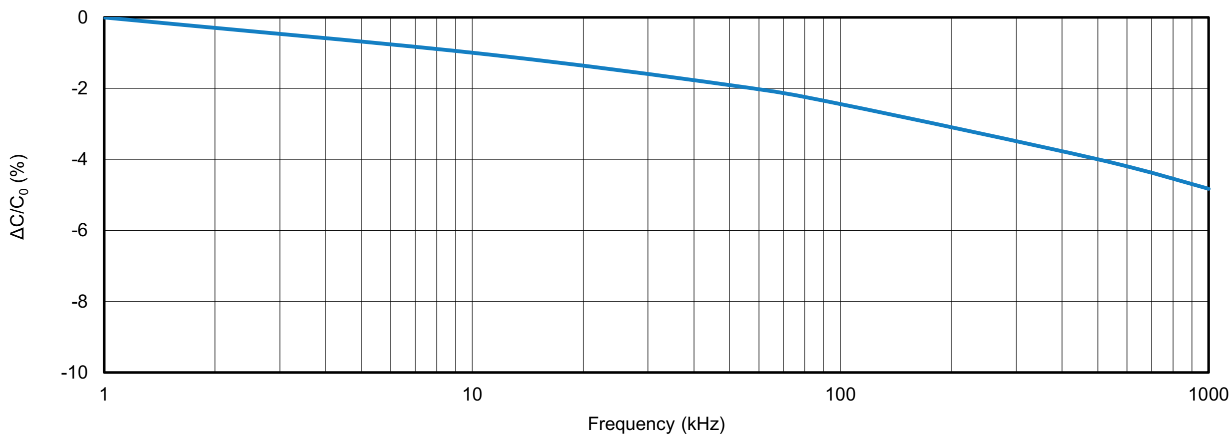
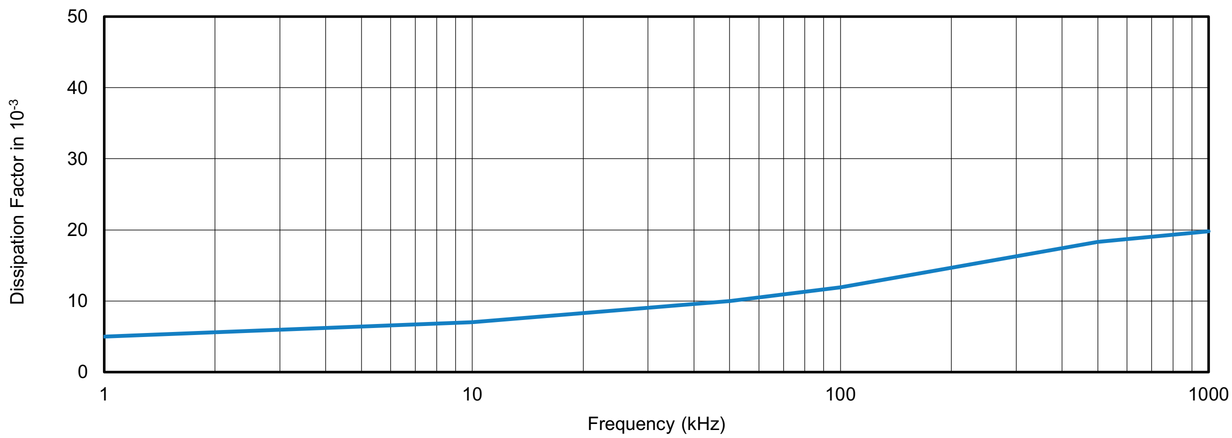
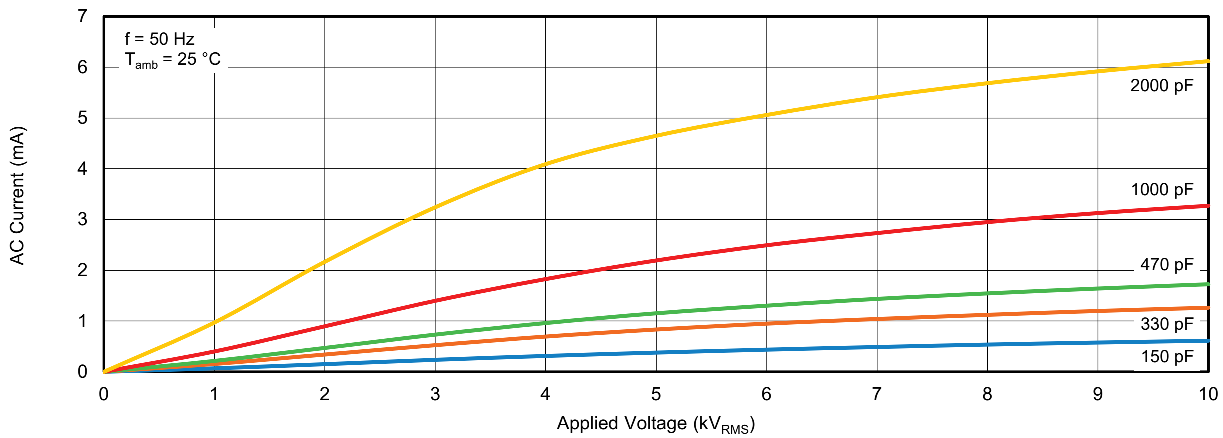
TYPICAL Y6P - $\Delta C/C_0$ / % VS. FREQUENCY



TYPICAL Y6P DF VS. FREQUENCY



TYPICAL AC CURRENT VS. APPLIED VOLTAGE



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1. QUALIFICATION

1.1 BASICS

All components are tested according to the related testing plan, which you find in series datasheet. The test procedures are more severe than noted in the datasheet due to aging and storage effects of the components. We do not guarantee if any limit is exceeded. Internal test procedures are more severe than noted in the table “Performance” because of aging and storage effects of the components.

1.2 LIMITS OF APPLICATION

Please take care whilst designing our parts into one of these applications, which require highest reliability and possible errors might harm life, body or property of a third party.

- Transportation (aerospace, aircraft, train, ship, submarine, etc.)
- Medical equipment
- Critical control equipment (power plant, traffic signals, disaster prevention)
- Other application requiring similar reliability characteristics

2. STORAGE

2.1 ORIGINAL PACKAGING

Storing in the sealed original packages is preferred.

2.2 STORING CONDITIONS

Epoxy coating does not protect perfectly from all environmental conditions. Some materials can penetrate the epoxy and harm the performance of the parts. Therefore it is not recommended to use or store the parts in corrosive or humid atmosphere.

Optimal storing conditions should not exceed +10 °C to +35 °C and relative humidity up to 60 %.

3. ASSEMBLY

3.1 WIRE FORMING

If wire forming is needed, excessive mechanical force to the component body must be avoided as it might cause cracks in the ceramic element.

Do not crack coating extension of the epoxy layer, when applying force onto the wire.

3.2 SOLDERING

For best performance it is recommended to dry the components at 125 °C for 2 hours before assembly.

Do not exceed resistance to soldering heat specification of the component. Subjecting this product to excessive heating could melt the internal junction solder and may result in thermal shocks that can crack the ceramic element.

Manual Soldering / Rework

Set the soldering iron (50 W max.) to less than 400 °C and solder the wires within 4 seconds onto the PCB. Exceeding that recommendations might reduce the electrical performance of the component.

Wave Soldering

Most common way to assemble these kind of components is carried out in 4 steps:

1. Increasing temperature to 120 °C within about 20 s
2. Preheating at 120 °C for about 60 s
3. Soldering at 260 °C in less than 10 s
4. Gradual air cooling in constant air flow

Reflow Soldering

It is not recommended to use reflow soldering with these components.

3.3 MOLDING AND COATING

Molding and / or applying another coating material might harm the performance of the components. Therefore it is recommended to test the electrical characteristics of the molded / coated part in advance.

Typical error is a reduced withstand voltage because of an inadequate solvent in the molding material, which penetrates the epoxy coating (please see recommendations for cleaning and drying in section 4.1 to 4.3). A similar result can be caused by an inadequate coating material, which might pull the original epoxy off the ceramic element.

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4. CLEANING AND DRYING

4.1 CLEANING AGENTS

Cleaning agents might have an influence to the performance of the components after washing and after unsuitable drying. The following agents have been tested and classified:

Recommended

- DI water
- Isopropanol
- Ethanol
- Ehtyl alcohol
- ...

Not Recommended

- Acetone
- ...

4.2 ULTRASONIC

Settings for ultrasonic cleaning

Rinse bath capacity: output of 20 Watts per liter or less

Rinsing time: 5 min max.

Do not vibrate the PCB / PWB directly.

Excessive ultrasonic cleaning may lead to permanent destruction of the component.

4.3 DRYING

In case of cleaning the assembled PCB with cleaning agents a proper drying is recommended. It is recommended to properly insulate the assembled PCB (see section 5.2) after drying.

5. TESTING AND OPERATION

5.1 SHORT CIRCUIT

Avoid repetitive zero-ohm-short circuits because they might harm the components core construction, such as arcs between lead wires because of inadequate insulation material (e.g air).

5.2 INSULATION

During operation, components should be surrounded by adequate insulating material (silicone oil, epoxy or molding material). Voltage breakdowns or leakage current through this material (between lead wires or to ground) is not acceptable. It is recommended to properly clean and dry the assembled PCB (see section 4.1 to 4.3) before enclosing in insulating material.

5.3 APPLIED VOLTAGE

When using DC-rated components in AC applications (also ripple) the peak to peak voltage should not exceed the nominal DC-rating of the component.

6. CAUTION

6.1 OPERATING VOLTAGE AND FREQUENCY CHARACTERISTIC

When sinusoidal or ripple voltage applied to DC ceramic disc capacitors, be sure to maintain the peak-to-peak value or the peak value of the sum of both AC + DC within the rated voltage.

When start or stop applying the voltage, resonance may generate irregular voltage.

When rectangular or pulse wave voltage is applied to DC ceramic disc capacitors, the self-heating generated by the capacitor is higher than the sinusoidal application with the same frequency. The allowable voltage rating for the rectangular or pulse wave corresponds approximately with the allowable voltage of a sinusoidal wave with the double fundamental frequency.

The allowable voltage varies, depending on the voltage and the waveform.

Diagrams of the limiting values are available for each capacitor series on request.

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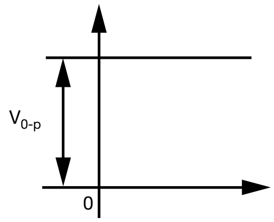
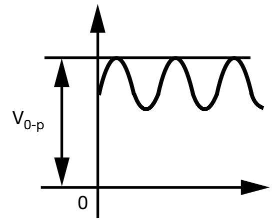
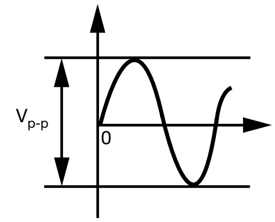
VOLTAGE	DC	DC + AC	AC
Waveform figure			

6.2 OPERATING TEMPERATURE AND SELF-GENERATED HEAT

The surface temperature of the capacitors must not exceed the upper limit of its rated operating temperature.

During operation in a high-frequency circuit or a pulse signal circuit, the capacitor itself generate heat due to dielectric losses.

Applied voltage should be the load such as self-generated heat is within 20 °C on the condition of environmental temperature 25 °C.

Note, that excessive heat may lead to deterioration of the capacitor’s characteristics.

RELATED DOCUMENTS	
General Information	www.vishay.com/doc?22001
Product Sheet	www.vishay.com/doc?48508
Infographic	www.vishay.com/doc?48450

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