Surface Mount Multilayer Ceramic Chip Capacitor to Prohibit Arc-Over in High-Voltage Applications



HVArc Guard Capacitor with no Surface Arc-over



Standard Capacitor with Surface Arc-over

FEATURES

For this Worldwide Patented Technology

- Specialty: high-voltage applications
- MLCC that protects against surface arc-over
- Excellent high-voltage performance
- Higher capacitances and smaller case sizes that save board space, as compared to standard high-voltage MLCCs
- Voltage breakdowns as much as twice that of competitors' products
- X7R dielectric available with polymer termination for increase resistance to board flex cracking
- Wet build process
- Reliable Noble Metal Electrode (NME) system
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT
HALOGEN FREE
GREEN (5-2008) Available

LINKS TO ADDITIONAL RESOURCES

Packages | Technical Notes | Related Documents

APPLICATIONS

- Power supplies
- DC/DC converters (buck and boost)
- Voltage multipliers for flyback converters
- For lighting and other AC applications please contact: mlcc@vishay.com

ELECTRICAL SPECIFICATIONS

C0G (NP0)

GENERAL SPECIFICATION

Note
Electrical characteristics at +25 °C unless otherwise specified

Operating Temperature: -55 °C to +125 °C

Capacitance Range: 10 pF to 8.2 nF

Voltage Range: 1000 V_{DC} to 2500 V_{DC}

Temperature Coefficient of Capacitance (TCC):
0 ppm/°C ± 30 ppm/°C from -55 °C to +125 °C

Dissipation Factor (DF):
0.1 % maximum at 1.0 V_{RMS} and
1 MHz for values ≤ 1000 pF
0.1 % maximum at 1.0 V_{RMS} and
1 kHz for values > 1000 pF

Insulating Resistance:
at +25 °C 100 000 MΩ min. or 1000 ΩF whichever is less
at +125 °C 10 000 MΩ min. or 100 ΩF whichever is less

Aging Rate: 0 % maximum per decade

Dielectric Strength Test:
performed per method 103 of EIA 198-2-E.
Applied test voltages

1000 V_{DC}-rated:	150 % of rated voltage
1500 V_{DC}, 2500 V_{DC}-rated:	120 % of rated voltage

X7R

GENERAL SPECIFICATION

Note
Electrical characteristics at +25 °C unless otherwise specified

Operating Temperature: -55 °C to +125 °C

Capacitance Range: 220 pF to 270 nF

Voltage Range: 250 V_{DC} to 1000 V_{DC}

Temperature Coefficient of Capacitance (TCC):
± 15 % from -55 °C to +125 °C, with 0 V_{DC} applied

Dissipation Factor (DF):
2.5 % maximum at 1.0 V_{RMS} and 1 kHz

Insulating Resistance:
at +25 °C 100 000 MΩ min. or 1000 ΩF whichever is less
at +125 °C 10 000 MΩ min. or 100 ΩF whichever is less

Aging Rate: 1 % maximum per decade

Dielectric Strength Test:
performed per method 103 of EIA 198-2-E.
Applied test voltages

≤ 250 V_{DC}-rated:	200 % of rated voltage
500 V_{DC}-rated:	min. 150 % of rated voltage
630 V_{DC}, 1000 V_{DC}-rated:	min. 120 % of rated voltage

For technical questions, contact: mlcc@vishay.com
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

QUICK REFERENCE DATA

DIELECTRIC	CASE	MAXIMUM VOLTAGE (V)	CAPACITANCE	
			MINIMUM	MAXIMUM
C0G (NP0)	0805	1500	10 pF	390 pF
	1206	1500	10 pF	1.5 nF
	1210	1500	10 pF	2.7 nF
	2220	1500	470 pF	5.6 nF
	2225	2500	470 pF	8.2 nF
X7R	0805	1000	470 pF	3.3 nF
	1206	1000	220 pF	47 nF
	1210	1000	220 pF	82 nF
	1808	1000	220 pF	100 nF
	1812	1000	220 pF	270 nF

Note

- Detail ratings see “Selection Chart”

ORDERING INFORMATION (4)

VJ0805	A	101	J	X	G	A	T	5Z (2)
CASE CODE	DIELECTRIC	CAPACITANCE NOMINAL CODE	CAPACITANCE TOLERANCE	TERMINATION (5)	DC VOLTAGE RATING (1)	MARKING	PACKAGING	PROCESS CODE
0805 1206 1210 1808 1812 2220 2225	A = C0G (NP0) Y = X7R	Expressed in picofarads (pF). The first two digits are significant, the third is a multiplier. **Examples** 102 = 1000 pF 223 = 22 000 pF	J = ± 5 % K = ± 10 % M = ± 20 %	X = Ni barrier 100 % matte tin plate finish F, E = AgPd (3) B = polymer 100 % matte tin plate finish (4)	P = 250 V E = 500 V L = 630 V G = 1000 V R = 1500 V O = 2500 V	A = unmarked	T = 7" reel / plastic tape R = 11 1/4" / 13" reel / plastic tape	5Z = HVArc Guard®

Notes

(1) DC voltage rating should not be exceeded in application. Other application factors may affect the MLCC performance. Consult for questions: mlcc@vishay.com

(2) Process code has to be added

(3) Termination code “E” is for conductive epoxy assembly, contact mlcc@vishay.com for availability

(4) Polymer termination is available for X7R dielectric only

(5) Other termination options contact mlcc@vishay.com for availability

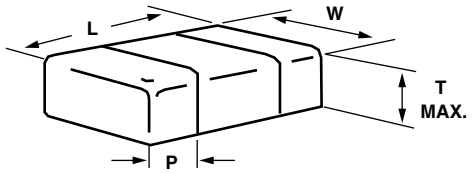
ENVIRONMENTAL STATUS

TERMINATION CODE	TERMINATION DESCRIPTION	RoHS COMPLIANT	VISHAY GREEN
X	Ni barrier 100 % tin plated matte finish	Yes	Yes
E	AgPd	Yes	Yes
B	Polymer layer, 100 % tin plated matte finish	Yes	No
F	AgPd	Yes	No

For technical questions, contact: mlcc@vishay.com

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

DIMENSIONS in inches (millimeters)



CASE CODE	STYLE	LENGTH (L)	WIDTH (W)	MAXIMUM THICKNESS (T)	TERMINATION PAD (P)	
					MINIMUM	MAXIMUM
0805	VJ0805	0.079 ± 0.008 (2.00 ± 0.20)	0.049 ± 0.008 (1.25 ± 0.20)	0.057 (1.45)	0.010 (0.25)	0.030 (0.76)
1206	VJ1206	0.126 ± 0.008 (3.20 ± 0.20)	0.063 ± 0.008 (1.60 ± 0.20)	0.067 (1.70)	0.010 (0.25)	0.030 (0.76)
1210	VJ1210	0.126 ± 0.008 (3.20 ± 0.20)	0.098 ± 0.008 (2.50 ± 0.20)	0.067 (1.70)	0.010 (0.25)	0.030 (0.76)
1808	VJ1808	0.180 ± 0.012 (4.57 ± 0.30)	0.080 ± 0.010 (2.03 ± 0.25)	0.086 (2.18)	0.010 (0.25)	0.035 (0.90)
1812	VJ1812	0.177 ± 0.012 (4.50 ± 0.30)	0.126 ± 0.008 (3.20 ± 0.20)	0.086 (2.18)	0.010 (0.25)	0.035 (0.90)
2220	VJ2220	0.220 ± 0.010 (5.59 ± 0.25)	0.200 ± 0.010 (5.08 ± 0.25)	0.086 (2.18)	0.010 (0.25)	0.037 (0.95)
2225	VJ2225	0.220 ± 0.010 (5.59 ± 0.25)	0.250 ± 0.010 (6.35 ± 0.25)	0.090 (2.30)	0.010 (0.25)	0.037 (0.95)

Note

- Polymer (B-termination) have increased dimensions: part length increased by 0.006" (0.15 mm)

For technical questions, contact: mlcc@vishay.com

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

SELECTION CHART C0G (NP0)

DIELECTRIC		C0G (NP0)										
STYLE		VJ0805		VJ1206 (1)		VJ1210 (1)		VJ2220 (1)		VJ2225 (1)		
CASE CODE		0805		1206		1210		2220		2225		
VOLTAGE (V_{DC})		1000	1500	1000	1500	1000	1500	1000	1500	1000	1500	2500
VOLTAGE CODE		G	R	G	R	G	R	G	R	G	R	O
CAP. CODE	CAP.											
100	10 pF	•	•	•	•	•	•					
120	12 pF	•	•	•	•	•	•					
150	15 pF	•	•	•	•	•	•					
180	18 pF	•	•	•	•	•	•					
220	22 pF	•	•	•	•	•	•					
270	27 pF	•	•	•	•	•	•					
330	33 pF	•	•	•	•	•	•					
390	39 pF	•	•	•	•	•	•					
470	47 pF	•	•	•	•	•	•					
560	56 pF	•	•	•	•	•	•					
680	68 pF	•	•	•	•	•	•					
820	82 pF	•	•	•	•	•	•					
101	100 pF	•	•	•	•	•	•					
121	120 pF	•	•	•	•	•	•					
151	150 pF	•	•	•	•	•	•					
181	180 pF	•	•	•	•	•	•					
221	220 pF	•	•	•	•	•	•					
271	270 pF	•	•	•	•	•	•					
331	330 pF	•	•	•	•	•	•					
391	390 pF	•	•	•	•	•	•					
471	470 pF			•	•	•	•	•	•	•	•	•
561	560 pF			•	•	•	•	•	•	•	•	•
681	680 pF			•	•	•	•	•	•	•	•	•
821	820 pF			•	•	•	•	•	•	•	•	•
102	1.0 nF			•	•	•	•	•	•	•	•	•
122	1.2 nF			•	•	•	•	•	•	•	•	•
152	1.5 nF			•	•	•	•	•	•	•	•	•
182	1.8 nF					•	•	•	•	•	•	•
222	2.2 nF					•	•	•	•	•	•	•
272	2.7 nF					•	•	•	•	•	•	•
332	3.3 nF							•	•	•	•	•
392	3.9 nF							•	•	•	•	•
472	4.7 nF							•	•	•	•	•
562	5.6 nF							•	•	•	•	•
682	6.8 nF									•	•	•
822	8.2 nF									•	•	•

Notes

(1) See soldering recommendations within this data book, or visit www.vishay.com/doc?45034

• Available in plastic carrier tape only

RoHS-compliant

For technical questions, contact: mlcc@vishay.com

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

SELECTION CHART X7R

DIELECTRIC		X7R																	
STYLE		VJ0805		VJ1206 (1)				VJ1210 (1)				VJ1808 (1)				VJ1812 (1)			
CASE CODE		0805		1206				1210				1808				1812			
VOLTAGE (V_{DC})		630	1000	250	500	630	1000	250	500	630	1000	250	500	630	1000	250	500	630	1000
VOLTAGE CODE		L	G	P	E	L	G	P	E	L	G	P	E	L	G	P	E	L	G
CAP. CODE	CAP.																		
101	100 pF																		
121	120 pF																		
151	150 pF																		
181	180 pF																		
221	220 pF			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
271	270 pF			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
331	330 pF			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
391	390 pF			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
471	470 pF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
561	560 pF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
681	680 pF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
821	820 pF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
102	1.0 nF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
122	1.2 nF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
152	1.5 nF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
182	1.8 nF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
222	2.2 nF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
272	2.7 nF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
332	3.3 nF	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
392	3.9 nF			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
472	4.7 nF			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
562	5.6 nF			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
682	6.8 nF			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
822	8.2 nF			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
103	10 nF			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
123	12 nF			•	•	•		•	•	•	•	•	•	•	•	•	•	•	•
153	15 nF			•	•	•		•	•	•	•	•	•	•	•	•	•	•	•
183	18 nF			•	•	•		•	•	•	•	•	•	•	•	•	•	•	•
223	22 nF			•	•	•		•	•	•	•	•	•	•	•	•	•	•	•
273	27 nF			•	•			•	•	•	•	•	•	•	•	•	•	•	•
333	33 nF			•	•			•	•	•	•	•	•	•	•	•	•	•	•
393	39 nF			•	•			•	•	•	•	•	•	•	•	•	•	•	•
473	47 nF			•	•			•	•	•	•	•	•	•	•	•	•	•	•
563	56 nF							•	•			•	•			•	•	•	•
683	68 nF							•				•				•	•	•	•
823	82 nF							•				•				•	•	•	•
104	100 nF											•				•	•	•	
124	120 nF															•			
154	150 nF															•			
184	180 nF															•			
224	220 nF															•			
274	270 nF															•			
334	330 nF																		

Notes

(1) See soldering recommendations within this data book, or visit www.vishay.com/doc?45034

• Available in plastic carrier tape only

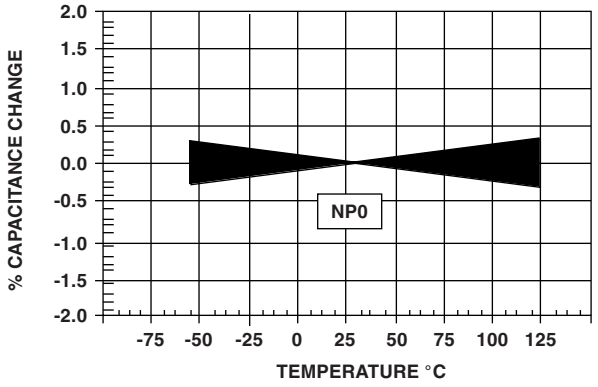
RoHS-compliant

For technical questions, contact: mlcc@vishay.com

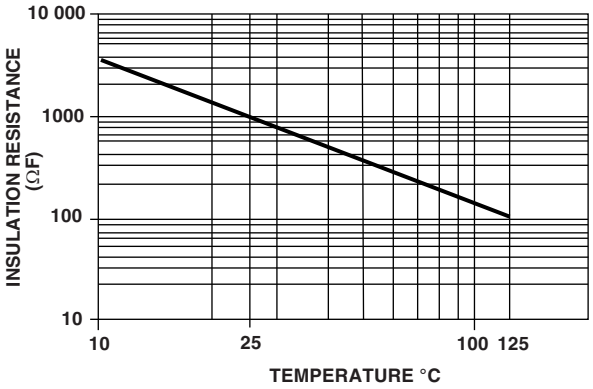
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

HVArc Guard® C0G (NP0) DIELECTRIC - TYPICAL PARAMETERS

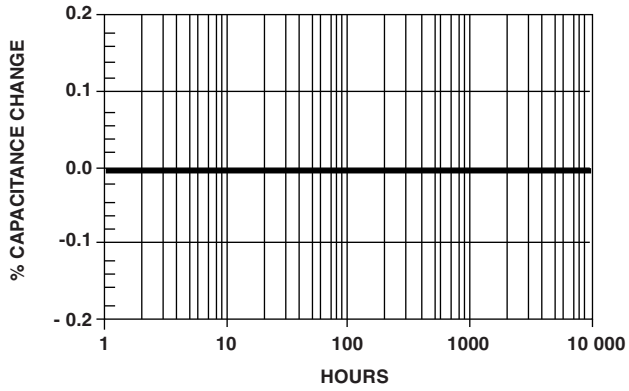
TEMPERATURE COEFFICIENT OF CAPACITANCE



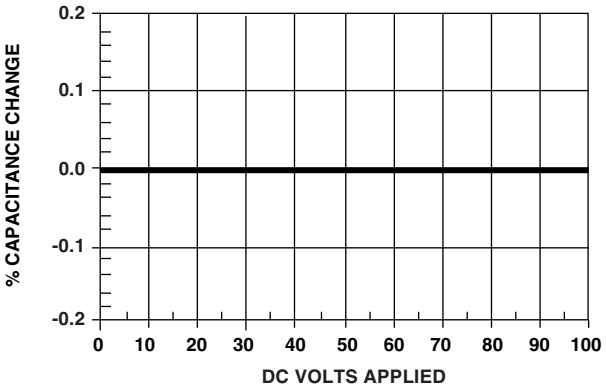
MINIMUM INSULATION RESISTANCE VS. TEMPERATURE



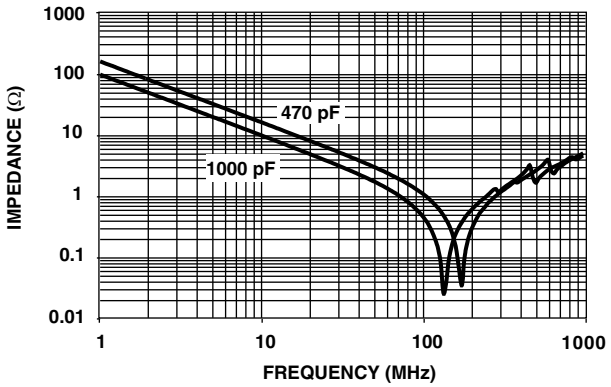
AGING RATE



VOLTAGE COEFFICIENT OF CAPACITANCE



IMPEDANCE VS. FREQUENCY OF 1206 NP0 HVArc Guard®

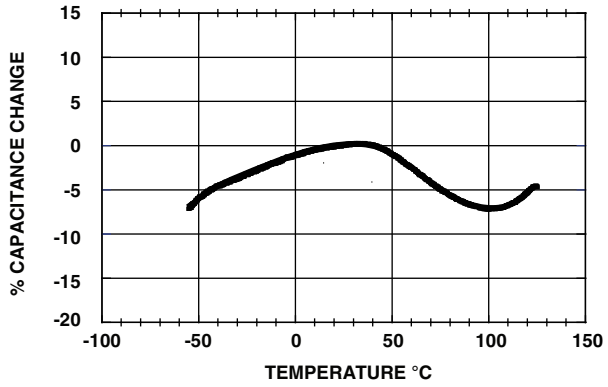


For technical questions, contact: mlcc@vishay.com

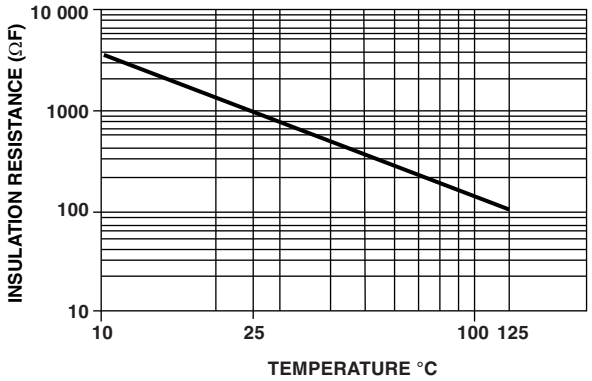
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

HVArc Guard® X7R DIELECTRIC - TYPICAL PARAMETERS

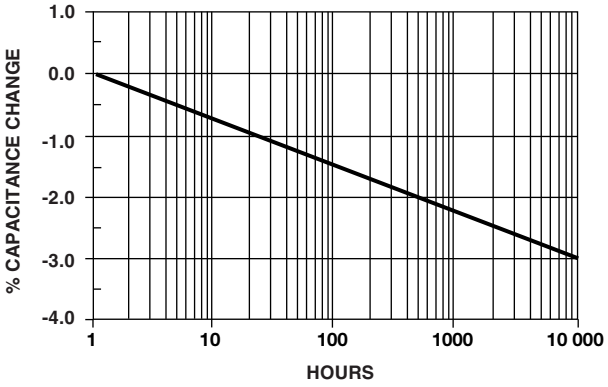
TEMPERATURE COEFFICIENT OF CAPACITANCE



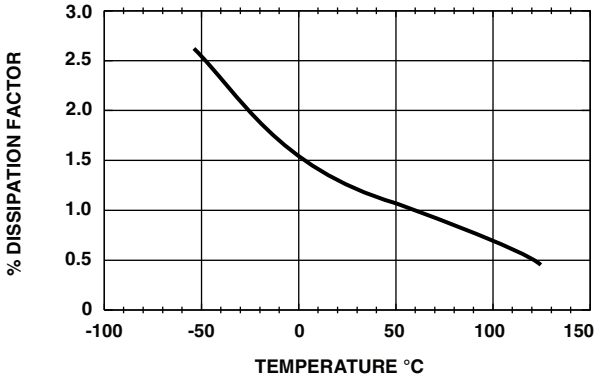
MINIMUM INSULATION RESISTANCE VS. TEMPERATURE



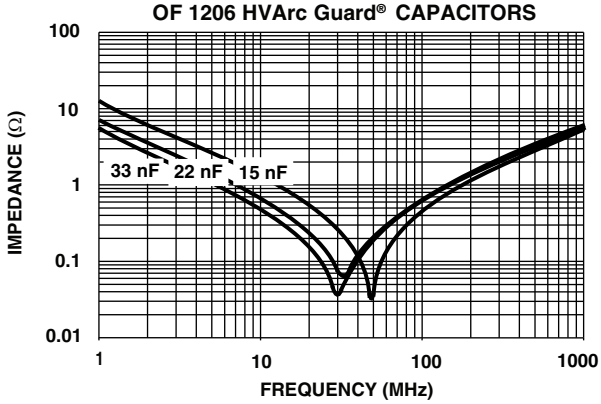
AGING RATE



DISSIPATION FACTOR VS. TEMPERATURE



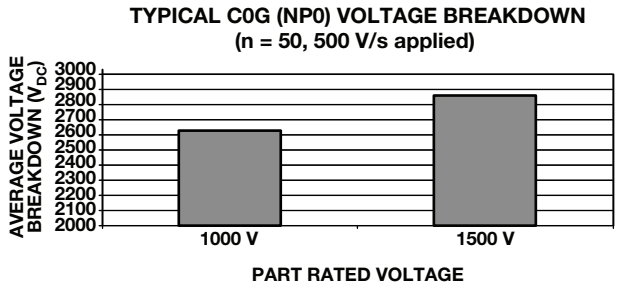
IMPEDANCE VS. FREQUENCY OF 1206 HVArc Guard® CAPACITORS



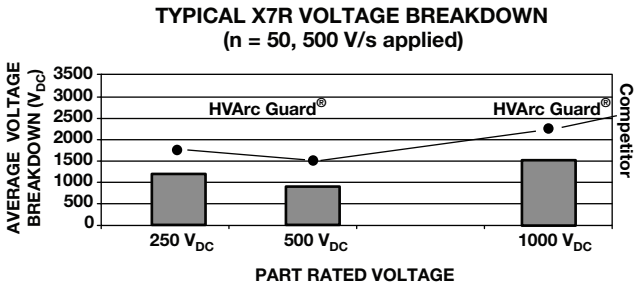
For technical questions, contact: mlcc@vishay.com

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

TYPICAL C0G (NP0) VOLTAGE BREAKDOWN



TYPICAL X7R VOLTAGE BREAKDOWN



TYPICAL

Crack caused by surface arc from end termination to top electrode layer cause component failure



ARCING ON MLCCS (shown in polarized light)

Corona traces due to arc-over become conductive paths leading to component failure



APPLICATION NOTE

- Suitable only for transient voltage and not for periodical pulse(s) chain
- 1000 V rated parts are not suitable for AC / lighting applications above 220 V_{AC}
- 500 V and 630 V are not suitable for AC / lighting applications above 110 V_{AC}
- If further questions, please contact: mlcc@vishay.com

STANDARD PACKAGING QUANTITIES (1)(2)(3)

CASE CODE	TAPE SIZE	7" REEL QUANTITIES	11 1/4" AND 13" REEL QUANTITIES
		PLASTIC TAPE PACKAGING CODE "T"	PLASTIC TAPE PACKAGING CODE "R"
0805	8 mm	3000	10 000
1206 (4)	8 mm	2500 / 3000	10 000
1210 (4)	8 mm	2500 / 3000	10 000
1808	12 mm	2000	10 000
1812	12 mm	1000	4000
2220	12 mm	1000	n/a
2225	12 mm	500	n/a

Notes

(1) Vishay Vitramon uses embossed plastic carrier tape
(2) 11 1/4" reel is standard for large quantities. 13" is maybe used for large "T" dimension parts
(3) Reference: EIA standard RS 481 - "Taping of Surface Mount Components for Automatic Placement"
(4) Packaging quantity can vary with product thickness
Contact mlcc@vishay.com with respect to specific part number requirements

STORAGE AND HANDLING CONDITIONS

(1) Store the components at 5 °C to 40 °C ambient temperature and ≤ 70 % relative humidity conditions.
(2) The product is recommended to be used within a time-frame of 2 years after shipment.
Check solderability in case extended shelf life beyond the expiry date is needed.

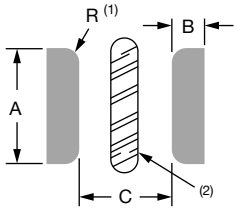
Precautions:

a. Do not store products in an environment containing corrosive elements, especially where chloride gas, sulfide gas, acid, alkali, salt or the like are present. This may cause corrosion or oxidization of the terminations, which can easily lead to poor soldering.
b. Store products on the shelf and avoid exposure to moisture or dust.
c. Do not expose products to excessive shock, vibration, direct sunlight and so on.

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

Solder Pad Dimensions for Vishay Surface-Mount Multilayer Ceramic Chip Capacitors

DIMENSIONS in millimeters



CASE CODE	A	B	C
0402	0.50	0.50	0.40
0505	1.35	1.00	0.60
0603	0.90	1.00	1.00 (3)
0805	1.30	1.20	1.00
1111	2.90	1.30	1.75
1206	1.80	1.20	2.10
1210	2.80	1.30	1.90
1808	2.40	1.50	3.00
1812	3.60	1.50	3.00
1825	6.50	1.50	3.00
2008	2.70	1.50	4.08
2220	5.50 (4)	1.50	4.20
2225	6.50	1.50	4.20
2525	6.60	1.50	4.50
3040	10.80	2.00	5.50
3640	10.80	2.00	7.00
3838	10.20	2.00	7.50
4044	12.30	2.00	8.00

Notes

(1) For safety capacitors and voltages above 3000 V, corner rounding (R) of 0.5 mm is recommended to suppress arcing

(2) Add a 1 mm slot in PCB between pads to allow cleaning and coating under MLCC

(3) For VJ HiFREQ Series, this dimension is 0.6 mm

(4) For safety capacitors, the A dimension should be 5.80 mm

For technical questions, contact: mlcc@vishay.com

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

PRINTED CIRCUIT BOARD PCB DESIGN CONSIDERATIONS FOR HIGH VOLTAGE SURFACE-MOUNT MLCCS

Special assembly process and design considerations should be employed for today's high voltage rating MLCCs. As case sizes remain the same and voltage ratings increase, MLCC manufacturers must design, evaluate, and qualify their capacitors using methods that reduce the occurrence of corona discharge and arcover events. To meet similar capability in high voltage applications, users should employ similar cautionary design and assembly methods.

MLCC PAD LAYOUT

A capacitor's arcover inception point can degrade due to factors such as the MLCC termination, PCB pad design, PCB cleanliness, solder flux residue, surface contamination / deposits and environmental conditions. PCB pads and their design affect the air gap distance between the opposing polarities of the MLCC termination. For voltage rating greater than 1500 V_{DC} add a corner radius to the inward facing edge of the MLCC pads and as large a gap as possible between the pads. Too small of a pad gap distance will reduce the capacitor's own arcover inception voltage level. Refer to the Figure and Table Figure 1.0, MLCC Pad Layout and Table 1.0, Vishay MLCC Solder Pad Dimensions for the recommended MLCC solder pad dimensions.

SLOT OR TRENCH BETWEEN PADS

PCB assembly can deposit dust, trap solder balls, or flux residue underneath the capacitors. These contaminants will reduce conductive clearances and the arcover inception level. Assembly methods must include a final PCB cleaning process. A slot or trench can be cut into the PCB in between the pads to allow cleaners to penetrate underneath the MLCC. The slot will also allow conformal or epoxy coatings to flow underneath the MLCC and build an insulative barrier between pads. Refer to Figure 1.0 MLCC Pad Layout for slot reference location.

COATING PRINTED CIRCUIT BOARD

Coating a printed circuit board with materials such as acrylic, silicone and urethane resins provide a protective dielectric barrier that is non-conductive and will enhance the resistance to arcing. Various processes exist which include dipping, brushing, and spaying. Optimal performance will come from coating the MLCC on all sides, top and bottom. The PCB slot in between the pads should extend slightly beyond the width of the MLCC. Refer to Figure 1.0 MLCC Pad Layout for slot reference location.

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, “Vishay”), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Hyperlinks included in this datasheet may direct users to third-party websites. These links are provided as a convenience and for informational purposes only. Inclusion of these hyperlinks does not constitute an endorsement or an approval by Vishay of any of the products, services or opinions of the corporation, organization or individual associated with the third-party website. Vishay disclaims any and all liability and bears no responsibility for the accuracy, legality or content of the third-party website or for that of subsequent links.

Vishay products are not designed for use in life-saving or life-sustaining applications or any application in which the failure of the Vishay product could result in personal injury or death unless specifically qualified in writing by Vishay. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.

© 2026 VISHAY INTERTECHNOLOGY, INC. ALL RIGHTS RESERVED

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000