

# Surface Mount Ceramic <u>Capacitor Prod</u>ucts





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## How to Order

### **Part Number Explanation**



#### Commercial Surface Mount Chips EXAMPLE: 08055A101JAT2A



\* B, C & D tolerance for  $\leq 10 \text{ pF}$  values.

Standard Tape and Reel material (Paper/Embossed) depends upon chip size and thickness. See individual part tables for tape material type for each capacitance value.

NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers. For Tin/Lead Terminations, please refer to LD Series

## High Voltage MLC Chips EXAMPLE: 1808AA271KA11A



NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers. For Tin/Lead Terminations, please refer to LD Series

#### Not RoHS Compliant



For RoHS compliant products, please select correct termination style.



## How to Order



## **Part Number Explanation**



## **General Specifications**



RoHS



COG (NP0) is the most popular formulation of the "temperature-compensating," EIA Class I ceramic materials. Modern C0G (NP0) formulations contain neodymium, samarium and other rare earth oxides.

COG (NP0) ceramics offer one of the most stable capacitor dielectrics available. Capacitance change with temperature is 0 ±30ppm/°C which is less than ±0.3% C from -55°C to +125°C. Capacitance drift or hysteresis for C0G (NP0) ceramics is negligible at less than ±0.05% versus up to ±2% for films. Typical capacitance change with life is less than ±0.1% for COG (NP0), one-fifth that shown by most other dielectrics. COG (NP0) formulations show no aging characteristics.

### PART NUMBER (see page 4 for complete part number explanation)



NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers. Contact factory for non-specified capacitance values.













Insulation Resistance vs Temperature



Variation of Impedance with Ceramic Formulation Impedance vs. Frequency 1000 pF - COG (NP0) vs X7R









	ter/Test	NP0 Specification Limits	Measuring (	
	perature Range	-55°C to +125°C	Temperature C	
•	itance Q	Within specified tolerance <30 pF: Q≥ 400+20 x Cap Value ≥30 pF: Q≥ 1000	Freq.: 1.0 MHz ± 10% for cap ≤ 1000 pF 1.0 kHz ± 10% for cap > 1000 pF Voltage: 1.0Vrms ± .2V	
Insulation	Resistance	100,000MΩ or 1000MΩ - μF, whichever is less	Charge device with rated voltage for 60 ± 5 sec @ room temp/humidity	
Dielectric	: Strength	No breakdown or visual defects	Charge device with 250% of rated voltage for 1- seconds, w/charge and discharge current limite to 50 mA (max) Note: Charge device with 150% of rated voltage for 500V devices.	
	Appearance	No defects		
Resistance to	Capacitance Variation	$\pm 5\%$ or $\pm .5$ pF, whichever is greater	Deflectio Test Time: 3	
Flexure	Q	Meets Initial Values (As Above)	V	
Stresses	Insulation Resistance	≥ Initial Value x 0.3	90 mm	
Solder	rability	≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic sol ± 0.5 se	
	Appearance	No defects, <25% leaching of either end terminal		
	Capacitance Variation	$\leq$ ±2.5% or ±.25 pF, whichever is greater	Dip device in eutectic	solder at 260°C for
Resistance to	Q	Meets Initial Values (As Above)	60sec- onds. Store at	t room temperature
Solder Heat	Insulation Resistance	Meets Initial Values (As Above)	<ul> <li>for 24 ± 2hours before measuring elect</li> <li>properties.</li> </ul>	
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
	Capacitance Variation	$\leq$ ±2.5% or ±.25 pF, whichever is greater	Step 2: Room Temp	≤ 3 minutes
Thermal Shock	Q	Meets Initial Values (As Above)	Step 3: +125°C ± 2°	30 ± 3 minutes
incinia chock	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles 24 hours at roor	
	Appearance	No visual defects		
	Capacitance Variation	$\leq$ ±3.0% or ± .3 pF, whichever is greater	Charge device with twic	
Load Life	Q (C=Nominal Cap)	≥ 30 pF: Q≥ 350 ≥10 pF, <30 pF: Q≥ 275 +5C/2 <10 pF: Q≥ 200 +10C	chamber set at 125°C ± 2°C for 1000 hours (+48, -0). Remove from test chamber and stabilize at	
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	room temperatu before me	re for 24 hours
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects	Store in a test chamber set at 85°C ± 2°C/ 859	
	Capacitance Variation	$\leq$ ±5.0% or ± .5 pF, whichever is greater		
Load Humidity	Q	≥ 30 pF:       Q≥ 350         ≥10 pF, <30 pF:	5% relative humidi (+48, -0) with rated	l voltage applied.
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from chamber and stabilize at room temperature for 24 ± 2 hours before measuring.	
	Dielectric Strength	Meets Initial Values (As Above)		





## **Capacitance Range**

### **PREFERRED SIZES ARE SHADED**

SIZE		0101*	02	01		0402				0603						0805						1206	6		
Solderin	g	Reflow Only	Reflow	v Only	Ref	flow/W	ave		Re	eflow/W	ave				Ref	low/Wav	e				R	eflow/W	/ave		
Packagin	•	All Paper	All P	-		All Pape				All Pape						/Emboss						per/Emb			
(L) Length	mm (in.)	0.40 ± 0.02 (0.016 ± 0.0008)	0.60 ±			00 ± 0. 40 ± 0.				.60 ± 0. 063 ± 0.						01 ± 0.20 79 ± 0.00						3.20 ± 0. .126 ± 0.			
W) Width	mm	0.20 ± 0.02	0.30 ±	± 0.09	0.	50 ± 0.	10		0	.81 ± 0.	15				1.2	25 ± 0.20						1.60 ± 0.	.20		
	(in.) mm	(0.008 ± 0.0008) 0.10 ± 0.04	0.15			20 ± 0. 25 ± 0.				032 ± 0.						49 ± 0.00 50 ± 0.25						.063 ± 0.			
(t) Terminal	(in.)	(0.004 ± 0.0016)	(0.006 ±	0.002)	(0.0	10 ± 0.	006)		(0.0	014 ± 0.	006)			1	(0.02	20 ± 0.01	0)				(0	.020 ± 0	.010)		
Сар	WVDC 0.5	16	25 A	50 A	16 C	25 C	50 C	16 G	25 G	50 G	100 G	200	16 J	25 J	50 J	100 J	200 J	250	16 J	25 J	50 J	100 J	200 J	250	500 J
(pF)	1.0 1.2	B	A A	A	C C	C C	C C	G G	G G	G G	G G		J J	J	J J	J J	J J		J J	J J	J	J J	J		J
	1.5	В	A	A	с	С	С	G	G	G	G		J	J	J	J	J		J	J	J	J	J		J
	1.8 2.2	B	A A	A	C C	C C	C C	G	G G	G	G		J	J	J	J	J		J	J	J	J	J		J J
	2.7 3.3	B	A	A	C C	C C	C C	G G	G G	G G	G G		J J	J	J	J	J		J J	J	J	J J	J		J
	3.9	В	A	A	С	С	С	G	G	G	G		J	J	J	J	J		J	J	J	J	J		J
	4.7 5.6	B	A A	A	C C	C C	C C	G G	G G	G G	G		J	J	J	J	J		J	J	J	J	J		J
	6.8 8.2	B	A	A	C C	C C	С	G G	G G	G G	G		J J	J	J	J	J J		J	J	J	J	J		J
	10	В	A A	A	С	С	C C	G	G	G	G G	G	J	J	J	J	J	N	J J	J	J	J	J	J	J J
	12 15	B	A A	A	C C	C C	C C	G G	G G	G G	G G	G G	J	J	J	J	J J	N N	J	J	J	J	J	J J	J J
	18 22	B	A	A	С	C C	С	G	GG	G	G	G	J	J	J	J	J J	N	J	J	J	J	J	J	J
	27	В	А	A	C C	С	C C	G	G	G	G G	G G	J	J	J	J	J	N N	J J	J	J	J	J	J	J
	33 39	B	A A	A	C C	C C	C C	G G	G G	G G	G G	G G	J	J	J	J	J J	N N	J	J	J	J	J	J	J J
	47 56	B	A	A	C C	C C	C C	G G	G G	G G	G G	G G	J	J	J	J J	J J	N N	J J	J	J	J	J J	J	J J
	68	В	A	A	С	С	С	G	G	G	G	G	J	J	J	J	J	N	J	J	J	J	J		J
	82 100	B	A A	A	C C	C C	С С	G G	G G	G G	G	G G	J	J	J	J	J	N N	J	J	J	J	J		J
	120				C C	C C	C C	G	G	G	G	G	J	J	J	J	J	N	J	J	J	J	J		J
	150 180				С	С	С	G	G	G G	G G	G G	J	J	J	J	J	N N	J	J	J	J	J		J
	220 270				C C	C C	C C	G G	G G	G	G	G	J	J	J	J	J	N N	J	J	J	J	J		M M
	330 390				C C	C C	C C	G G	G G	G G	G G		J	J	J J	J J	J J	N	J J	J	J	J J	J J		M M
	470				С	С	С	G	G	G	G		J	J	J	J	J		J	J	J	J	J		м
	560 680				C C	C C	C C	G G	G G	G G	G		J	J	J	J	J		J	J	J	J	J		M P
	820 1000				C C	C C	C C	G G	G G	G G	G G		J	J	J	J	J J		J J	J	J	J J	M Q		
	1200				U	U		G	G	G	9		J	J	J	J	J		J	J	J	J	Q		
	1500 1800							G G	G G	G G			J J	J	J	J N			J	J	J M	M	Q Q		
	2200 2700							G G	G G	G G			N N	N N	N N	N N			J J	J	M M	P P	Q Q		
	3300							G	G	G			Р	N	N	N			J	J	М	Р	Q		
	3900 4700							G G	G G	G			P P	P P	P P	N N			J	J	M	P P			
	5600 6800												P P	P P	P P				J M	J	M M	P P			
	8200				$\leq$		N						Р	Р	Р				м	м	м	Р			
Cap (µF)	0.010 0.012	~	2	<			7<	Т					P P	P P	P P				Р	Р	Р	Р			
	0.015												P P	P P	P P						<u> </u>				
	0.022												P	P	P										
	0.027			t	1			_												-					
	0.039 0.047																								
	0.068															İ		İ							
	0.082 0.1																								
WVDC		16	25	50	16	25	50	16	25	50	100	200	16	25	50	100	200	250	16	25	50	100	200	250	500
SIZE		0101*	02	01		0402				0603						0805						1206			
Letter	4	ВС		E	G		J		К		М	1	N	I	P	Q		х		Y		z	]		
Max. 0. Thickness (0.0	33 013) (	0.22 0.56	.) (0.0	71	0.90		0.94 (0.037)		1.02		1.27 ).050)	1 (0.0	40 15 5)		52 060)	1.7		2.29 (0.090)		2.54 ).100)		.79 110)			
(0.0	-/ (			·	(2.000		(		(			(0.0	)			OSSEI		(			(3.	,			
										-															





## **Capacitance Range**

### **PREFERRED SIZES ARE SHADED**

SIZ	E			1210					1812				1825			2220			2225	
Solder	ring			Reflow Onl	/				Reflow Only	,			Reflow Only	,		Reflow Only	y	R	eflow Only	,
Packa	ging			per/Embos					All Embosse				All Embosse			All Embosse			l Embosse	
(L) Length	mm (in.)			3.20 ± 0.20 0.126 ± 0.00					4.50 ± 0.30 0.177 ± 0.01				4.50 ± 0.30			5.70 ± 0.40			5.72 ± 0.25 225 ± 0.01	
W) Width	mm			2.50 ± 0.20	)				3.20 ± 0.20				6.40 ± 0.40			5.00 ± 0.40	)	6	.35 ± 0.25	
	(in.) mm			0.098 ± 0.00					0.126 ± 0.00 0.61 ± 0.36				0.252 ± 0.01 0.61 ± 0.36			0.197 ± 0.01 0.64 ± 0.39			250 ± 0.01	
(t) Terminal	(in.)		(0	0.020 ± 0.01	0)			(0	0.024 ± 0.01	4)		(0	0.024 ± 0.01	4)	(0	0.025 ± 0.01	5)	(0.	025 ± 0.01	5)
Сар	WVDC 0.5	25	50	100	200	500	25	50	100	200	500	50	100	200	50	100	200	50	100	200
(pF)	1.0 1.2 1.5																			
	1.8 2.2 2.7																		<u> </u>	
	3.3 3.9															~				) <u></u> ††
	4.7 5.6 6.8																	t		-
	8.2 10 12					J														
	15 18 22					J J J														
	27 33					J														
	39 47 56					J J														
	68 82 100					J J														
	120 150 180					J J														
	220 270					J J														
	330 390 470					J M M														
	560 680 820	L J J	L L L	J J J	J K K	M P P														
	1000 1200 1500	J P P	J P P	P P P	P P P	P P P	K K K	K K K	N N N	N N N	M M M	M M M	M M M	M M M				M M M	M M M	P P P
	1800 2200 2700	P P P	P P P	P P P	P P P	P N	к к к	к к к	N N N	N N P	M P Q	M X X	M X X	M M M				M M M	M M M	P P P
	3300 3900 4700	P P P	P P P	P P P	P		K K K	K K K	N N N	P P P	Q Q Y	X X X	X X X	X X X	X	x	X X X	M M M	M M	P P P
	5600 6800 8200	P P P	P P P	P			K K K	к к	P Q	P Q	Y	X X X	X X X	X X X X	X X X	x x	X X X	M M	M M M	P P P
Cap (pF)	0.010 0.012	N N	P N N				к к	M M M	Q Q Q	Q Q		X X	X X	X X	X X	X X X	X X	M M M	M M M	P P
	0.015 0.018 0.022						P P P	P P P	Q Q Q	<u> </u>		X X X	X X X	X X X	X X X	X X X	x x	M M M	M M Y	Y Y Y
	0.027 0.033 0.039						Q Q X	Q Q X	X X X			X X X	X X	Y	X X Y	X X		P X X	Y Y Y	Y Y Y
	0.047 0.068 0.082						X Z Z	X Z Z	X Y Y			x			Y Z Z			X X X	Z Z Z	
	0.1 WVDC	25	50	100	200	500	Z 25	Z 50	Z 100	200	500	50	100	200	Z 50	100	200	Z 50	Z 100	200
	SIZE			1210					1812				1825			2220			2225	
Letter	A	В		С	E	G		J	К	М		N	Ρ	Q		х	Y	Z		
Max. Thickness	0.33 (0.013)	0.22		0.56 0.022)	0.71 (0.028)	0.90		0.94 0.037)	1.02 (0.040)	1.22		1.40 0.055)	1.52 (0.060)	1.7 (0.07		2.29 0.090)	2.54 (0.100)	2.7		
			`	PAP					. ,		`			OSSED			. ,	`	-	



## U Dielectric RF/Microwave C0G (NP0) Capacitors (RoHS)



Ultra Low ESR, "U" Series, COG (NP0) Chip Capacitors

### **GENERAL INFORMATION**

"U" Series capacitors are COG (NP0) chip capacitors specially designed for "Ultra" low ESR for applications in the communications market. Max ESR and effective capacitance are met on each value producing lot to lot uniformity. Sizes available are EIA chip sizes 0402, 0603, 0805, and 1210.

### **DIMENSIONS: INCHES (MILLIMETERS)**







inches (mm)

Size	Α	В	C	D	E
0402	0.039±0.004 (1.00±0.1)	0.020±0.004 (0.50±0.1)	0.022 (0.55mm) max	N/A	N/A
0603	0.060±0.010 (1.52±0.25)	0.030±0.010 (0.76±0.25)	0.036 (0.91mm) max	0.010±0.005 (0.25±0.13)	0.030 (0.76) min
0805	0.079±0.008 (2.01±0.2)	0.049±0.008 (1.25±0.2)	0.040±0.005 (1.02±0.127)	0.020±0.010 (0.51±0.255)	0.020 (0.51) min
1210	0.126±0.008 (3.2±0.2)	0.098±0.008 (2.49±0.2)	0.050±0.005 (1.27±0.127)	0.025±0.015 (0.635±0.381)	0.040 (1.02) min

### **HOW TO ORDER**



NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers.

## **ELECTRICAL CHARACTERISTICS**

#### **Capacitance Values and Tolerances:**

 Size 0402
 - 0.2 pF to 30 pF @ 1 MHz

 Size 0603
 - 1.0 pF to 100 pF @ 1 MHz

 Size 0805
 - 1.6 pF to 160 pF @ 1 MHz

 Size 1210
 - 2.4 pF to 1000 pF @ 1 MHz

#### Temperature Coefficient of Capacitance (TC):

0±30 ppm/°C (-55° to +125°C)

#### Insulation Resistance (IR):

 $10^{12}\,\Omega$  min. @ 25°C and rated WVDC  $10^{11}\,\Omega$  min. @ 125°C and rated WVDC

#### Working Voltage (WVDC):

 Size
 Working Voltage

 0402
 100, 50, 25 WVDC

 0603
 200, 100, 50 WVDC

1210 - 200, 100 WVDC

0805 - 200, 100 WVDC

"R" significant figures.

#### Dielectric Working Voltage (DWV):

250% of rated WVDC

#### Equivalent Series Resistance Typical (ESR):

- 0402 See Performance Curve, page 13
- 0603 See Performance Curve, page 13
- 0805 See Performance Curve, page 13
- 1210 See Performance Curve, page 13

#### Marking:

Laser marking EIA J marking standard (except 0603) (capacitance code and tolerance upon request).

#### Military Specifications

Meets or exceeds the requirements of MIL-C-55681



## U Dielectric RF/Microwave COG (NP0) Capacitors (RoHS)

A KYOCERA GROUP COMPANY

Ultra Low ESR, "U" Series, COG (NP0) Chip Capacitors

### **CAPACITANCE RANGE**



RoHS COMPLIANT	

	Available		Si	ze			Available		Si	ze			Available		Siz	ze	
Cap (pF)	Tolerance	0402	0603	0805	1210	Cap (pF)	Tolerance	0402	0603	0805	1210	Cap (pF)	Tolerance	0402	0603	0805	1210
1.0	B,C,D	100V	200V	200V	200V	7.5	B,C,J,K,M	100V	200V	200V	200V	100	F,G,J,K,M	N/A	100V	200V	200V
1.1						8.2	l l					110			50V		
1.2						9.1	B,C,J,K,M	↓				120			50V	+	
1.3						10	F,G,J,K,M	100V				130			N/A	200V	
1.4						11	1	50V				140				100V	
1.5						12						150				+	
1.6						13						160				100V	
1.7						15			+			180				N/A	
1.8						18			200V			200					
1.9						20			100V			220					
2.0						22						270					
2.1						24						300					
2.2						27		*				330					
2.4						30		50V				360					
2.7						33		N/A				390					•
3.0						36						430					200V
3.3						39						470					100V
3.6						43						510					
3.9						47						560					
4.3						51						620					
4.7						56						680					
5.1						68						750					
5.6	+					75						820					
6.2	B,C,D					82						910	*				
6.8	B,C,J,K,M	•	*	•	*	91	*	+	•	*	*	1000	F,G,J,K,M	•	*	•	•

## **ULTRA LOW ESR, "U" SERIES**







#### TYPICAL ESR vs. FREQUENCY 0603 "U" SERIES



#### TYPICAL ESR vs. FREQUENCY 1210 "U" SERIES



ESR Measured on the Boonton 34A



## U Dielectric RF/Microwave C0G (NP0) Capacitors









120216

## U Dielectric RF/Microwave COG (NP0) Capacitors (Sn/Pb)



**Not RoHS Compliant** 

## Ultra Low ESR, "U" Series, COG (NP0) Chip Capacitors

### **GENERAL INFORMATION**

"U" Series capacitors are COG (NP0) chip capacitors specially designed for "Ultra" low ESR for applications in the communications market. Max ESR and effective capacitance are met on each value producing lot to lot uniformity. Sizes available are EIA chip sizes 0402, 0603, 0805, and 1210.

## **DIMENSIONS: INCHES (MILLIMETERS)**



### HOW TO ORDER



ELECTRICAL CHARACTERISTICS

#### **Capacitance Values and Tolerances:**

Size 0402 - 0.2 pF to 22 pF @ 1 MHz Size 0603 - 1.0 pF to 100 pF @ 1 MHz Size 0805 - 1.6 pF to 160 pF @ 1 MHz Size 1210 - 2.4 pF to 1000 pF @ 1 MHz

#### **Temperature Coefficient of Capacitance (TC):**

0±30 ppm/°C (-55° to +125°C)

#### Insulation Resistance (IR):

 $10^{12}\,\Omega$  min. @ 25°C and rated WVDC  $10^{11}\,\Omega$  min. @ 125°C and rated WVDC

#### Working Voltage (WVDC):

Size Working Voltage 0402 - 50, 25 WVDC 0603 - 200, 100, 50 WVDC

0805 - 200, 100 WVDC 1210 - 200, 100 WVDC



The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.

**Military Specifications** 

**Dielectric Working Voltage (DWV):** 

0402 - See Performance Curve, page 16

0603 - See Performance Curve, page 16 0805 - See Performance Curve, page 16

1210 - See Performance Curve, page 16

Equivalent Series Resistance Typical (ESR):

Laser marking EIA J marking standard (except 0603)

(capacitance code and tolerance upon request).

Meets or exceeds the requirements of MIL-C-55681

250% of rated WVDC

Marking:



## U Dielectric RF/Microwave COG (NP0) Capacitors (Sn/Pb)

Ultra Low ESR, "U" Series, COG (NP0) Chip Capacitors

### **CAPACITANCE RANGE**

	Available		Si	ze			Available		Si	ze			Available		Si	ze			Available		Si	ze	
Cap (pF)	Tolerance	LD02	LD03	LD05	LD10	Cap (pF)	Tolerance	LD02	LD03	LD05	LD10	Cap (pF)	Tolerance	LD02	LD03	LD05	LD10	Cap (pF)	Tolerance	LD02	LD03	LD05	LD10
0.2	B,C	50V	N/A	N/A	N/A	1.0	B,C,D	50V	200V	200V	200V	7.5	B,C,J,K,M	50V	200V	200V	200V	100	F,G,J,K,M	N/A	100V	200V	200
0.3						1.1						8.2	L L					110			50V		
0.4	+					1.2						9.1	B,C,J,K,M					120			50V	+	
0.5	B,C					1.3						10	F,G,J,K,M					130			N/A	200V	
0.6	B,C,D					1.4						11						140				100V	
0.7						1.5						12						150				+	
0.8 0.9	B,C,D					1.6 1.7						13 15						160 180				100V	
0.9	B,C,D	*	*	*	•	1.7						18			200V			200				N/A	
						1.9						20			100V			220					
						2.0						22						270					
						2.1						24						300					
						2.2						27						330					
						2.4						30		50V				360					
						2.7 3.0						33 36						390 430					200
						3.0						30						430					100
- 1 N						3.6						43						510					
2mg						3.9						47						560					
RoH	TO					4.3						51						620					
KOL	15					4.7						56						680					
COMPLI	ANT					5.1						68						750					
						5.6	*					75						820					
						6.2	B,C,D	1			$ \downarrow $	82 91						910					
						6.8	B,C,J,K,M	v			▼	91	I	1 '	1 1		•	1000	F,G,J,K,M	I .	I .		1 1

### **ULTRA LOW ESR, "U" SERIES**







#### TYPICAL ESR vs. FREQUENCY 0603 "U" SERIES



#### TYPICAL ESR vs. FREQUENCY 1210 "U" SERIES



ESR Measured on the Boonton 34A





## U Dielectric RF/Microwave Automotive COG (NP0) Capacitors (RoHS) AEC Q200 Qualified Ultra Low ESR, "U" Series, COG (NP0) Chip Capacitors



### **GENERAL INFORMATION**

Automotive "U" Series capacitors are COG (NP0) chip capacitors specially designed for "Ultra" low ESR for applications in the automotive market. Max ESR and effective capacitance are met on each value producing lot to lot uniformity. Sizes available are EIA chip sizes 0402 and 0603.

### **DIMENSIONS: INCHES (MILLIMETERS)**





Size	Α	В	С	D	E
0402	1.00±0.1 (0.039±0.004)	0.50±0.1 (0.020±0.004)	0.60 max (0.024)	N/A	N/A
0603	1.52±0.25 (0.060±0.010)	0.76±0.25 (0.030±0.010)	0.91 max (0.036)	0.25±0.13 (0.010±0.005)	0.76 min (0.030)



### **ELECTRICAL CHARACTERISTICS**

#### **Capacitance Values and Tolerances:**

Size 0402 - 0.2 pF to 22 pF @ 1 MHz Size 0603 - 1.0 pF to 100 pF @ 1 MHz

#### **Temperature Coefficient of Capacitance (TC):**

0±30 ppm/°C (-55° to +125°C)

#### Insulation Resistance (IR):

 $10^{12}\,\Omega$  min. @ 25°C and rated WVDC  $10^{11}\,\Omega$  min. @ 125°C and rated WVDC

#### Working Voltage (WVDC):

 Size
 Working Voltage

 0402
 50, 25 WVDC

 0603
 200, 100, 50 WVDC

#### Dielectric Working Voltage (DWV):

#### 250% of rated WVDC

**Equivalent Series Resistance Typical (ESR):** 

0402 - See Performance Curve

0603 - See Performance Curve

#### **Automotive Specifications**

Meets or exceeds the requirements of AEC Q200





## AEC Q200 Qualified, Ultra Low ESR, "U" Series, C0G (NP0) Chip Capacitors

### **CAPACITANCE RANGE**



		S	ze
Cap (pF)	Available Tolerance	0402	0603
1.0	B,C,D	100V	200V
1.1			
1.2			
1.3			
1.4			
1.5			
1.6			
1.7			
1.8			
1.9			
2.0			
2.1			
2.2			
2.4			
2.7			
3.0			
3.3			
3.6			
3.9			
4.3			
4.7			
5.1			
5.6	V		
6.2	B,C,D		
6.8	B,C,J,K,M	♥	♥

	Available Tolerance	Si	ze		Available	Si	ze
)		0402	0603	Cap (pF)	Tolerance	0402	0603
	B,C,D	100V	200V	7.5	B,C,J,K,M	100V	200V
				8.2	*		
				9.1	B,C,J,K,M		
				10	F,G,J,K,M		
				11			
				12			
				13			
				15			V
				18			200V
				20			100V
				22			
				24			
				27		♥	
				30		50V	
				33		N/A	
				36			
				39			
				43			
				47			
				51			
				56			
				68			
	*			75			
	B,C,D			82			
	B,C,J,K,M	♥	♥	91	V	\ ▼	¥

	Available	S	ize
Cap (pF)	Tolerance	0402	0603
100	F,G,J,K,M	N/A	100V
110			50V
120			50V
130			N/A
140			
150			
160			
180			
200			
220			
270			
300			
330			
360			
390			
430			
470			
510			
560			
620			
680			
750			
820			
910	▼		
1000	F,G,J,K,M	♥	♥

## **ULTRA LOW ESR, "U" SERIES**



(



**TYPICAL ESR vs. FREQUENCY** 0603 "U" SERIES



TYPICAL SERIES RESONANT FREQUENCY **"U" SERIES CHIP** 





## U Dielectric Designer Kits

**Communication Kits "U" Series** 



## **"U" SERIES KITS**

	0402											
	Kit 5000 UZ											
Cap. Value pF	Tolerance	Cap. Value pF	Tolerance									
0.5		4.7										
1.0		5.6	B (±0.1pF)									
1.5		6.8	D (±0.1p1)									
1.8	D (10 1=F)	8.2										
2.2	B (±0.1pF)	10.0										
2.4		12.0	(±5%)									
3.0		15.0	(±3%)									
3.6												

\*\*\*25 each of 15 values

#### 0603

	Kit 4000 UZ											
Cap. Value pF	Tolerance	Cap. Value pF	Tolerance									
1.0		6.8										
1.2		7.5	B (±0.1pF)									
1.5		8.2										
1.8		10.0										
2.0		12.0										
2.4	D (10 1- F)	15.0										
2.7	B (±0.1pF)	18.0										
3.0		22.0	J (±5%)									
3.3		27.0										
3.9		33.0										
4.7		39.0										
5.6	h = f 0 4 + = h = =	47.0										

\*\*\*25 each of 24 values

#### 0805

	Kit 30	00 UZ	
Cap. Value pF	Tolerance	Cap. Value pF	Tolerance
1.0		15.0	
1.5		18.0	
2.2		22.0	
2.4		24.0	
2.7		27.0	
3.0		33.0	
3.3	B (±0.1pF)	36.0	
3.9	B (±0.1pF)	39.0	J (±5%)
4.7		47.0	
5.6		56.0	
7.5		68.0	
8.2		82.0	
9.1		100.0	
10.0	J (±5%)	130.0	
12.0	5 (25%)	160.0	

\*\*\*25 each of 30 values

#### 1210

	Kit 35	00 UZ	
Cap. Value pF	Tolerance	Cap. Value pF	Tolerance
2.2		36.0	
2.7		39.0	
4.7		47.0	
5.1	B (±0.1pF)	51.0	
6.8		56.0	
8.2		68.0	
9.1		82.0	
10.0		100.0	J (±5%)
13.0		120.0	
15.0		130.0	
18.0	1 (+ 5%)	240.0	
20.0	J (±5%)	300.0	
24.0		390.0	
27.0		470.0	
30.0		680.0	

\*\*\*25 each of 30 values



## X8R/X8L Dielectric

## **General Specifications**





AVX has developed a range of multilayer ceramic capacitors designed for use in applications up to 150°C. These capacitors are manufactured with an X8R and an X8L dielectric material. X8R material has capacitance variation of  $\pm$  15% between -55°C and +150°C. The X8L material has capacitance variation of  $\pm$ 15% between -55°C to 125°C to 125°C to 125°C and +15/40% from +125°C to +150°C.

The need for X8R and X8L performance has been driven by customer requirements for parts that operate at elevated temperatures. They provide a highly reliable capacitor with low loss and stable capacitance over temperature.



They are ideal for automotive under the hood sensors, and various industrial applications. Typical industrial application would be drilling monitoring system. They can also be used as bulk capacitors for high temperature camera modules. Both X8R and X8L dielectric capacitors are automotive AEC-Q200 qualified. Optional termination systems, tin,

FLEXITERM<sup>®</sup> and conductive epoxy for hybrid applications are available. Providing this series with our FLEXITERM<sup>®</sup> termination system provides further advantage to customers by way of enhanced resistance to both, temperature cycling and mechanical damage.

0805	5	Α	104	K	4	Т	2	Α
<b>Size</b> 0402 0603 0805 1206	Voltage 10V = Z 16V = Y 25V = 3 50V = 5 100V = 1	<b>Dielectric</b> X8R = F X8L = L	Capacitance Code (in pF) 2 Sig. Digits + Number of Zeros e.g. 10 F = 106	<b>Capacitance</b> <b>Tolerance</b> J = ±5% K = ±10% M = ±20%	Failure Rate 4=Automotive A = Not Applicable	<b>Terminations</b> T = Plated Ni and Sn Z = FLEXITERM <sup>®**</sup>	<b>Packaging</b> 2 = 7" Reel 4 = 13" Reel	<b>Special Code</b> A = Std. Product

NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers.

Size         0603         0805           Soldering         Reflow/Wave         Reflow/Wave         Reflow/Wave           WVDC         25V         50V         25V         50V           271         Cap         270         G         G         300           331         (pF)         330         G         G         J         J           471         470         G         G         J         J           102         1000         G         G         J         J           152         1500         G         G         J         J           222         2200         G         G         J         J           332         3300         G         G         J         J           472         4700         G         G         J         J           103         Cap         0.01         G         G         J         J           133         0.022         G         G         J         J           223         0.022         G         G         J         J           333         0.033         G         G         J         J <th></th> <th></th> <th>271 331 471 681 102 152 152 272 332 392 472 562 682 822 562 682 822 103 123 153 153 153 153 153 333 333 333</th> <th>Size Soldering WVD Cap 27 (pF) 33 47 68 100 150 180 220 270 330 220 270 330 470 560 680 0.02 0.01 0.01 0.02 0.02 0.03 0.03</th> <th>C         25V           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           3         G           2         G           2         G           2         G</th> <th>0603 Flow/Wi 50V G G G G G G G G G G G G G</th> <th>ave 100V G G G G G G G G G G G G G G G G G G</th> <th>Ref 25V J J J J J J J J J J J J J J J J J J J</th> <th>0805 Tow/Wi 50V 1 1 1 1 1 1 1 1 1 1 1 1 1</th> <th>100V J J J J J J J J J J J J J</th> <th></th> <th>Reflow 25V J J J J J J J J J J J J J J J J J J J</th> <th>206 v/Wave 50V 50V 50V 50V 50V 50V 50V 50V</th> <th>- - - - - - - - - - - - - - - - - - -</th> <th></th> <th>1210 flow/W 50V</th> <th>ave 100V 100V 100V 100V 1000 1000 1000 100</th>			271 331 471 681 102 152 152 272 332 392 472 562 682 822 562 682 822 103 123 153 153 153 153 153 333 333 333	Size Soldering WVD Cap 27 (pF) 33 47 68 100 150 180 220 270 330 220 270 330 470 560 680 0.02 0.01 0.01 0.02 0.02 0.03 0.03	C         25V           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           3         G           2         G           2         G           2         G	0603 Flow/Wi 50V G G G G G G G G G G G G G	ave 100V G G G G G G G G G G G G G G G G G G	Ref 25V J J J J J J J J J J J J J J J J J J J	0805 Tow/Wi 50V 1 1 1 1 1 1 1 1 1 1 1 1 1	100V J J J J J J J J J J J J J		Reflow 25V J J J J J J J J J J J J J J J J J J J	206 v/Wave 50V 50V 50V 50V 50V 50V 50V 50V	- - - - - - - - - - - - - - - - - - -		1210 flow/W 50V	ave 100V 100V 100V 100V 1000 1000 1000 100	
WVDC         25V         50V         25V         50V           271         Cap         270         G         G	25V J J J J J J J J J M M M M	50V J J J J J J J J J J J J J J M M M	271 331 471 681 102 152 152 272 332 392 472 562 682 822 562 682 822 103 123 153 153 153 153 153 333 333 333	wVD           Cap         27           (pF)         33           68         100           150         180           2200         270           3300         3900           470         6880           000         6800           6820         Cap         0.01           0.01         0.01         0.01           0.02         0.02         0.02	C         25V           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           3         G           2         G           2         G           2         G	50V G G G G G G G G G G G G G G G G G G G	100V G G G G G G G G G G G G G G G G G G	25V J J J J J J J J J J J J J	50V J J J J J J J J J J J J J	100V J J J J J J J J J J J J J		25V J J J J J J J J J J J J J J J J J J J	50V J J J J J J J J J J J J J J J J J J J	100V J J J J J J J J J J J J J				
WVDC         25V         50V         25V         50V           271         Cap         270         G         G	25V J J J J J J J J J M M M M	50V J J J J J J J J J J J J J J M M M	331           471           681           102           152           182           2222           332           332           332           332           332           332           332           332           332           332           153           183           223           273           333           333	Cap         27           (pF)         33           47           68           100           150           220           270           330           270           330           330           390           470           560           680           820           Cap           0.01           0.01           0.01           0.02           0.02	0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           5         G           8         G           2         G           7         G	G G G G G G G G G G G G G G G G G G G	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6											
331         (pF)         330         G         G         J         J           471         470         G         G         J         J           681         680         G         G         J         J           102         1000         G         G         J         J           152         1500         G         G         J         J           222         2200         G         G         J         J           332         3300         G         G         J         J           472         4700         G         G         J         J           103         Cap         0.01         G         G         J         J           133         0.022         G         G         J         J         J           233         0.023         G         G         J         J           473         0.047         G         G         J         J           683         0.068         M         N         N           224         0.22         N         M         N           334         0.33         M         M </td <td>J J J J J J J J J M M M M M</td> <td>J J J J J J J J J M M M</td> <td>331           471           681           102           152           182           2222           332           332           332           332           332           332           332           332           332           332           153           183           223           273           333           333</td> <td>(pF) 33 47 68 100 150 220 270 330 390 470 560 680 680 680 680 620 0.01 0.01 0.01 0.02 0.02 0.02</td> <td>0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           5         G           8         G           2         G           7         G</td> <td>G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G</td> <td>G G G G G G G G G G G G G G G G G G G</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J</td> <td></td> <td></td> <td></td>	J J J J J J J J J M M M M M	J J J J J J J J J M M M	331           471           681           102           152           182           2222           332           332           332           332           332           332           332           332           332           332           153           183           223           273           333           333	(pF) 33 47 68 100 150 220 270 330 390 470 560 680 680 680 680 620 0.01 0.01 0.01 0.02 0.02 0.02	0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           5         G           8         G           2         G           7         G	G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G           G	G G G G G G G G G G G G G G G G G G G							J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J				
471         470         G         G         J         J           681         680         G         G         J         J           102         1000         G         G         J         J           152         1500         G         G         J         J           222         2200         G         G         J         J           332         3300         G         G         J         J           472         4700         G         G         J         J           682         6800         G         G         J         J           133         (µF)         0.01         G         G         J         J           223         0.022         G         G         J         J         J           473         0.047         G         G         J         J           683         0.068         N         N         N           124         0.22         N          334         0.33           474         0.47               155         1.5	J J J J J J J J J M M M M M	J J J J J J J J J M M M	471           681           102           152           152           182           2222           332           392           472           562           682           103           153           183           223           273           333           333	47 68 100 220 270 330 390 470 560 680 680 680 680 0.02 (μF) 0.01 0.01 0.02 0.02	0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           5         G           8         G           2         G           7         G	G G G G G G G G G G G G G G G G G G G	G G G G G G G G G G G G G G G G G G G							J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J				
681         680         G         G         J         J           102         1000         G         G         J         J           152         1500         G         G         J         J           222         2200         G         G         J         J           332         3300         G         G         J         J           472         4700         G         G         J         J           682         6800         G         G         J         J           103         Cap         0.01         G         G         J         J           233         0.022         G         G         J         J           333         0.033         G         G         J         J           683         0.068         G         N         N      104         0.15         N         N         N           154         0.15         N         N         N           224         0.22         N          334         0.33           225         1.5          1055<1.5	J J J J J J J J J M M M M M	J J J J J J J J J M M M	681           102           152           182           222           232           392           472           562           682           103           153           183           223           273           333           333	68 100 150 220 270 330 330 390 470 560 680 680 680 680 (μF) 0.01 0.01 0.01 0.02 0.02	0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           5         G           8         G           2         G           7         G	G G G G G G G G G G G G G G G G G G G	G G G G G G G G G G G G G G G G G G G							J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J				
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	J J J J J J J J J M M M M M	J J J J J J J J J M M M	102           152           182           222           272           332           392           472           562           682           822           103           153           183           223           273           3333           393	100 150 220 270 3300 470 560 680 820 Cap 0.0 (μF) 0.01 0.01 0.02 0.02	0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           5         G           8         G           2         G           7         G	G G G G G G G G G G G G G G G G G G G	G G G G G G G G G G G G G G							J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J				
152         1500         G         G         J         J           222         2200         G         G         J         J           332         3300         G         G         J         J           472         4700         G         G         J         J           682         6800         G         G         J         J           103         Cap         0.01         G         G         J         J           133         (µF)         0.015         G         G         J         J           223         0.022         G         G         J         J           333         0.033         G         G         J         J           683         0.068         G         N         N           154         0.15         N         N         N           124         0.22         N         N         N           334         0.33         -         -         -           105         1         -         -         -           105         1.5         -         -         -           105         1.	J J J J J J J J J M M M M M	J J J J J J J J J M M M	152           182           222           332           392           472           562           682           8223           153           183           223           333           333           393	150 180 220 330 390 470 560 680 680 680 680 680 0.02 0.01 0.01 0.01 0.02 0.02 0.02	0 G 0 G 0 G 0 G 0 G 0 G 0 G 0 G	G G G G G G G G G G G G G G G G G G G	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0							J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J				
222         2200         G         G         G         J         J           332         3300         G         G         G         J         J           472         4700         G         G         G         J         J           682         6800         G         G         G         J         J           103         Cap         0.01         G         G         J         J           153         (µF)         0.015         G         G         J         J           223         0.022         G         G         J         J           333         0.033         G         G         J         J           683         0.068         G         N         N         N           104         0.15         N         N         N         N           224         0.22         N         N         N         N           334         0.33         -         -         -         -           105         1          -         -         -           155         1.5          -         -         -	J J J J J J J J M M M M M	J J J J J J J J M M M M	182           222           272           332           392           472           562           682           822           103           123           153           183           273           333           393	180           220           270           330           390           470           560           680           820           Cap 0.0           (µF) 0.01           0.01           0.02           0.02	0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           5         G           2         G           5         G           2         G           7         G	G G G G G G G G G G G G G G G G G G G	G G G G G G G G G G G G G G G G G G G					J J J J J J J J J J J J J J J J		J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J				
332         3300         G         G         J         J           472         4700         G         G         J         J           682         6800         G         G         J         J           103         Cap         0.01         G         G         J         J           153         (μF)         0.015         G         G         J         J           223         0.022         G         G         J         J           333         0.033         G         G         J         J           473         0.047         G         G         J         J           683         0.068         G         N         N         N           154         0.15         N         N         N           224         0.22         N         N         N           224         0.22         N         N         N           2334         0.33         -         -         -           155         1.5         -         -         -           225         2.2         -         -         -      WVDC	J J J J J J M M M M M	J J J J J J J J M M M M	222 272 332 392 472 562 682 822 103 123 153 183 223 273 333 393	220 270 330 470 560 680 820 Cap 0.0 (µF) 0.01 0.01 0.01 0.02 0.02	0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           0         G           1         G           2         G           5         G           8         G           12         G           12         G           13         G           14         G           15         G           16         G           17         G	G G G G G G G G G G G G G G G G G	G G G G G G G G G G G G G G G G G G G						J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J					
472     4700     G     G     J     J       682     6800     G     G     J     J       103     Cap     0.01     G     G     J     J       153     (µF)     0.015     G     G     J     J       223     0.022     G     G     J     J       333     0.033     G     G     J     J       473     0.047     G     G     J     J       683     0.068     G     N     N       154     0.15     N     N     N       224     0.22     N      N       334     0.33     -     -     -       334     0.33     -     -     -       684     0.68     -     -     -       105     1     -     -     -       105     1.5     -     -     -       105     1.5     -     -     -       125     2.2     -     -     -       155     1.5     -     -     -       155     2.2     50V     25V     50V    Size     0603     0805 <td cols<="" td=""><td>J J J J J J J M M M M M</td><td>J J J J J J M M M</td><td>272 332 392 472 562 682 822 103 123 123 123 183 183 223 273 333 393</td><td>270 330 390 470 680 820 Cap 0.0 (µF) 0.01 0.01 0.01 0.02 0.02</td><td>0 G 0 G 0 G 0 G 0 G 0 G 0 G 1 G 2 G 5 G 8 G 2 G 7 G</td><td>G G G G G G G G G G G G G G</td><td>G G G G G G G G</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td>	<td>J J J J J J J M M M M M</td> <td>J J J J J J M M M</td> <td>272 332 392 472 562 682 822 103 123 123 123 183 183 223 273 333 393</td> <td>270 330 390 470 680 820 Cap 0.0 (µF) 0.01 0.01 0.01 0.02 0.02</td> <td>0 G 0 G 0 G 0 G 0 G 0 G 0 G 1 G 2 G 5 G 8 G 2 G 7 G</td> <td>G G G G G G G G G G G G G G</td> <td>G G G G G G G G</td> <td></td>	J J J J J J J M M M M M	J J J J J J M M M	272 332 392 472 562 682 822 103 123 123 123 183 183 223 273 333 393	270 330 390 470 680 820 Cap 0.0 (µF) 0.01 0.01 0.01 0.02 0.02	0 G 0 G 0 G 0 G 0 G 0 G 0 G 1 G 2 G 5 G 8 G 2 G 7 G	G G G G G G G G G G G G G G	G G G G G G G G										
682         6800         G         G         J         J           103         Cap         0.01         G         G         J         J           153         (μF)         0.015         G         G         J         J           223         0.022         G         G         J         J           333         0.033         G         G         J         J           473         0.047         G         G         J         J           683         0.068         G         N         N         N           104         0.1         N         N         N         N           224         0.22         N         N         N           334         0.33         -         -         -           474         0.47         -         -         -           684         0.68         -         -         -           105         1         -         -         -           225         2.2         -         -         -           WVDC         25V         50V         25V         50V              Size         0603	U U U U U U U U U U U U U U U U U U U	J J J J J J M M M	392 472 562 682 103 123 153 183 223 273 333 393	390 470 560 680 Cap 0.0 (μF) 0.01 0.01 0.02 0.02	0 G 0 G 0 G 0 G 1 G 2 G 5 G 8 G 2 G 7 G	6 6 6 6 6 6 6 6 6 6 6 6 6 6	6 6 6 6 6						J           J           J           J           J           J           J           J           J           J           J           J           J           J					
103         Cap         0.011         G         G         J         J           153         (µF)         0.015         G         G         J         J           223         0.022         G         G         J         J           333         0.033         G         G         J         J           473         0.047         G         G         J         J           683         0.068         G         N         N         N           104         0.1         N         N         N           224         0.22         N          334         0.33           474         0.47                474         0.47                 155         1.5                  225         .2                  Size         0603         0805         1206               155	U U U U U U U U U U U U U U U U U U U	J J J M M M M	472 562 682 103 123 153 183 223 273 333 393	470 560 820 Cap 0.0 (μF) 0.01 0.01 0.02 0.02	0 G 0 G 0 G 1 G 2 G 5 G 8 G 2 G 7 G	G G G G G G G G G G G	G G G					リ リ リ リ	J           J           J           J           J           J           J           J	J J J J				
153         (μF)         0.015         G         G         J         J           223         0.022         G         G         J         J           333         0.033         G         G         J         J           473         0.047         G         G         J         J           683         0.068         G         N         N         N           104         0.1         N         N         N           224         0.22         N         N         N           224         0.22         N         N         1           334         0.33         -         -         684         0.68           105         1         -         -         684         0.68         -           105         1.5         -         -         -         603         0805           225         2.2         -         -         -         50V         50V         50V           Size         0603         0805         1206           Size         0603         0805         1206            All Paper         Pap	J J M M M M M M	J J M M M M	562 682 103 123 153 183 223 273 333 393	560 680 820 Cap 0.0 (μF) 0.01 0.01 0.01 0.02 0.02	0 G 0 G 1 G 2 G 5 G 8 G 2 G 7 G	G G G G G G G G	G G G	- フ - フ - フ - フ	し し し し し し し	し し し し し		J J J J	J J J J	J J J J				
333         0.033         G         G         J         J           473         0.047         G         G         J         J           683         0.068         G         N         N         N           104         0.1         N         N         N           154         0.15         N         N         N           224         0.22         N         -         -           334         0.33         -         -         -           474         0.47         -         -         -           684         0.68         -         -         -           155         1.5         -         -         -           225         2.2         -         -         -           WVDC         25V         50V         25V         50V           Size         0603         0805         1206           Soldering         Reflow/Wave         Reflow/Wave         Reflow/Paper/Embosed           Paper/Embosed         All Paper         Paper/Embosed         Paper/Embosed	J J M M M M M M	J J M M M M	682 822 103 123 153 183 223 273 333 393	680 820 Cap 0.0 (μF) 0.01 0.01 0.01 0.02 0.02	0 G 0 G 1 G 2 G 5 G 8 G 2 G 7 G	G G G G G G G	G G	し し し し し	L L L	」 」 」 」		J J J J	J J J	J J J				
473         0.047         G         G         J         J           683         0.068         G         N         N         N           104         0.1         N         N         N           154         0.15         N         N         N           224         0.22         N         1         2           334         0.33         -         -         -           684         0.68         -         -         -           105         1         -         -         -           155         1.5         -         -         -           225         2.2         -         -         -           WVDC         25V         50V         25V         50V           Size         0603         0805         1206           Soldering         Reflow/Wave         Reflow/Wave         Reflow/Paper/Embosed           Paper/Embosed         All Paper         Paper/Embosed         Paper/Embosed	J M M M M M	J M M M M	822 103 123 153 183 223 273 333 393	820           Cap         0.0           (μF)         0.01           0.01         0.01           0.01         0.01           0.02         0.02	0 G 1 G 2 G 5 G 8 G 2 G 2 G 7 G	G G G G G	G	J J J	J J	J J J		J J J	J J J	J				
683         0.068         G         N         N           104         0.1         N         N         N           154         0.15         N         N         N           224         0.22         N          334         33           474         0.47         684           684             105         1              684               684	M M M M M M	M M M M	103 123 153 183 223 273 333 393	Cap         0.0           (μF)         0.01           0.01         0.01           0.01         0.01           0.02         0.02	1 G 2 G 5 G 8 G 2 G 7 G	G G G G		J	J J J	J		J	J	J				
104         0.1         N         N           154         0.15         N         N         N           224         0.22         N         N         N           334         0.33         N         N         N           334         0.33         N         N         N           474         0.47         N         N         N           684         0.68         N         N         N           105         1         N         N         N           225         2.2         N         N         N           WVDC         25V         50V         25V         50V           Size         0603         0805         1206           Soldering         Reflow/Wave         Reflow/Wave         Reflow/Wave           Packaging         All Paper         Paper/Embossed         Paper/Embossed	M M M M	M M M	123 153 183 223 273 333 393	(μF) 0.01 0.01 0.02 0.02 0.02	2 G 5 G 8 G 2 G 7 G	G G G G	6	J J	J J	J J		J	J					
154         0.15         N         N           224         0.22         N         N           334         0.33         -         -           474         0.47         -         -           684         0.68         -         -           105         1         -         -           225         2.2         -         -           WVDC         25V         50V         25V         50V           Size         0603         0805         1206           Soldering         Reflow/Wave         Reflow/Wave         Reflow/Paper/Embosed           Paper/Embosed         040:015         2:01+0:20         3:20:40	M M M	M M	153 183 223 273 333 393	0.01 0.01 0.02 0.02	5 G 8 G 2 G 7 G	G G G		J	J	J							1	
224         0.22         N           334         0.33             474         0.47             684         0.68             105         1             225         2.2             WVDC         25V         50V         25V         50V           Size         0603         0805         1206           Soldering         Reflow/Wave         Reflow/Wave         Reflow/Wave           Paper/Embosed         All Paper         Paper/Embosed         Paper/Emb	M M	М	183 223 273 333 393	0.01 0.02 0.02	8 G 2 G 7 G	G G		-					J	J			──	
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155         1.5            225         2.2            WVDC         25V         50V         25V           SIZE         0603         0805         1206           Size         0603         0805         1206           Soldering         Reflow/Wave         Reflow/Wave         Reflow/Wave         Reflow/Wave           Packaging         All Paper         Paper/Embossed         Paper/Embossed         Paper/Embossed				0.03	9 G	G		J	J	N		J	J	J				
225         2.2         V         50V         25V         50V           SIZE         0603         0805         1206         50V         50V         25V         50V         20V         20V <td></td> <td></td> <td>473</td> <td>0.04</td> <td></td> <td>G</td> <td></td> <td>J</td> <td>J</td> <td>N</td> <td></td> <td>J</td> <td>J</td> <td>J</td> <td></td> <td></td> <td></td>			473	0.04		G		J	J	N		J	J	J				
SIZE         0603         0805           Size         0603         0805         1206           Soldering         Reflow/Wave         Reflow/Wave         Reflow/Wave           Packaging         All Paper         Paper/Embossed         Paper/Embossed			563	0.05		G		J	J	N		J	J	J				
Size         0603         0805         1206           Soldering         Reflow/Wave         Reflow/Wave         Reflow/Wave           Packaging         All Paper         Paper/Embossed         Paper/Embossed           mm         1.60±0.15         2.01±0.20         3.20±0	25V	50V	683	0.06		G		J	J	N		J	J	J			L	
Soldering         Reflow/Wave         Reflow/Wave         Reflow/Wave           Packaging         All Paper         Paper//Embossed         Paper/Embo           160+015         201+020         320+0	1206	<b>i</b>	823	0.08		G		J	J	N		J	J	J			<u> </u>	
Soldering         Reflow/Wave         Reflow/Wave         Reflow/Wave           Packaging         All Paper         Paper//Embossed         Paper/Embo           Image: Description of the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second s	12	10	104 124	0.		G		J	J	N		J	J	M			──	
Packaging All Paper Paper//Embossed Paper/Emb			124	0.1				J	N		J	J	J	Q			<u> </u>	
mm 160+015 201+020 320+0			184	0.1				N	N		J	J	J	Q				
			224	0.2				N	N		J	J	J	Q				
(I) ength			274	0.2				N			J	M	M	1 Q		1		
(III) $(0.063 \pm 0.006)$ $(0.079 \pm 0.008)$ $(0.126 \pm 0.008)$	, ,		334	0.3				N			J	M	M	Q				
(W) Width mm 0.81 ± 0.15 1.25 ± 0.20 1.60 ± 0.			394	0.3	19			N			М	M	P	Q				
(in) $(0.032 \pm 0.006)$ $(0.049 \pm 0.008)$ $(0.063 \pm 0.008)$			474	0.4				N			M	M	P	Q				
(t) Terminal mm $0.35 \pm 0.15$ $0.50 \pm 0.25$ $0.50 \pm 0.$			684	0.6				N			M	M	P	Q			$\vdash$	
(i) $(0.014 \pm 0.006)$ $(0.020 \pm 0.010)$ $(0.020 \pm 0.010)$	.010) (0.020±	0.010)	824	0.8	_			N			M	M	P	Q			<u> </u>	
			105 155	1.	1			N			M	M	P	Q			──	
			225	2.							M	M				Z	Z	
			475	Z.							IVI	IVI			+	Z		
			106		+										Z		<u> </u>	
				WVD	C 25V	50V	100V	25V	50V	100V	16V	25V	50V	100V	10V	50V	100V	
				SIZE		0603			0805				206			1210		
		_						1					1					
Letter A C E	G ,	J	к	М	Ν	Р		Q	Х	Y		Z		= AÉC	C-Q200 alified			
Max. 0.33 0.56 0.71	0.9 0.	94	1.02	1.27	1.4	1.52	1	.78	2.29	2.5	54	2.79	1	Que	anneu			
			(-0.04)		(-0.055)	(-0.06			(-0.09)	(-0.1		(-0.11)	1					
		,	( 0.04)	(0.00)	(0.000)		/ ( '		(0.03)	(0.	1	(0.11)	1					
PAPER	0.033) [ (=0.0					EME	BOSSE	U										



## X8R/X8L Dielectric

## **General Specifications**



- All market sectors with a 150°C requirement
- Automotive on engine applications
- Oil exploration applications
- · Hybrid automotive applications
  - Battery control
  - Inverter / converter circuits
  - Motor control applications
  - Water pump
- Hybrid commercial applications
- Emergency circuits
- Sensors
- Temperature regulation



## ADVANTAGES OF X8R AND X8L MLC CAPACITORS

- Both ranges are qualified to the highest automotive AEC-Q200 standards
- Excellent reliability compared to other capacitor technologies
- RoHS compliant
- Low ESR / ESL compared to other technologies
- Tin solder finish
- FLEXITERM® available
- Epoxy termination for hybrid available
- 100V range available

## **ENGINEERING TOOLS FOR HIGH VOLTAGE MLC CAPACITORS**

- Samples
- Technical Articles
- Application Engineering
- Application Support

#### X8R/X8L Dielectric





## X8R/X8L Dielectric



## **Specifications and Test Methods**

Parame	ter/Test	X8R/X8L Specification Limits	Measuring	Conditions
Operating Tem		-55°C to +150°C	Temperature C	ycle Chamber
Сарас	itance	Within specified tolerance	Freq.: 1.0 k	(Hz ± 10%
Dissipati	on Factor	$\leq$ 2.5% for $\geq$ 50V DC rating $\leq$ 3.5% for 25V DC and 16V DC rating	Voltage: 1.0	
Insulation	Resistance	100,000MΩ or 1000MΩ - μF, whichever is less	Charge device with rated @ room terr	voltage for 120 ± 5 secs pp/humidity
Dielectric	Strength	No breakdown or visual defects	Charge device with 250 1-5 seconds, w/charge limited to 50 Note: Charge device wit for 500V	and discharge current ) mA (max) h 150% of rated voltage
	Appearance	No defects	Deflectio	
Resistance to Flexure	Capacitance Variation	≤ ±12%	Test Time: 3	30 seconds 7 1mm/sec
Stresses	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3	90	mm
Solder	ability	≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic so ± 0.5 se	
	Appearance	No defects, <25% leaching of either end terminal		
	Capacitance Variation	≤ ±7.5%	Dip device in eutectio	c solder at 260°C for
Resistance to Solder Heat	Dissipation Factor	Meets Initial Values (As Above)		room temperature for
	Insulation Resistance	Meets Initial Values (As Above)	properties.	J
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
	Capacitance Variation	≤ ±7.5%	Step 2: Room Temp	≤ 3 minutes
Thermal Shock	Dissipation Factor	Meets Initial Values (As Above)	Step 3: +125°C ± 2°	30 ± 3 minutes
	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles 24 ± 2 hours at ro	
	Appearance	No visual defects	-	
	Capacitance Variation	≤ ±12.5%	Charge device with 1.5 test chamber set	
Load Life	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	for 1000 hou	
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from test chamb temperature for 24 ± 2 h	
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects		
	Capacitance Variation	≤ ±12.5%	Store in a test chamber s 5% relative humidi	
Load	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	(+48, -0) with rate	
Humidity	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from chamber temperature and humidit	y for 24 ± 2 hours before
	Dielectric Strength	Meets Initial Values (As Above)	measu	ıring



## X7R Dielectric General Specifications





X7R formulations are called "temperature stable" ceramics and fall into EIA Class II materials. X7R is the most popular of these intermediate dielectric constant materials. Its temperature variation of capacitance is within  $\pm 15\%$  from -55°C to +125°C. This capacitance change is non-linear.

Capacitance for X7R varies under the influence of electrical operating con-ditions such as voltage and frequency. X7R dielectric chip usage covers the broad spectrum of industrial applications where known changes in capacitance due to applied voltages are acceptable.



## PART NUMBER (SEE PAGE 4 FOR COMPLETE PART NUMBER EXPLANATION)



NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers. Contact factory for non-specified capacitance values.











Insulation Resistance vs Temperature 10,000 1,000 0 20 40 60 80 100 120 Temperature C





The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.

Frequency, MHz

## X7R Dielectric



## **Specifications and Test Methods**

Paramet		X7R Specification Limits		Conditions
Operating Tem Capac		-55°C to +125°C Within specified tolerance	Temperature	Cycle Chamber
Dissipatio		≤ 10% for ≥ 50V DC rating≤ 12.5% for 25V DC rating ≤ 12.5% for 25V and 16V DC rating ≤ 12.5% for ≤ 10V DC rating Contact Factory for DF by PN	Voltage: 1.	kHz ± 10% 0Vrms ± .2V 0.5Vrm @ 120Hz
Insulation I	Resistance	100,000MΩ or 1000MΩ - μF, whichever is less		h rated voltage for om temp/humidity
Dielectric	Strength	No breakdown or visual defects	seconds, w/charge and to 50 m Note: Charge device wi	% of rated voltage for 1-5 discharge current limited nA (max) th 150% of rated voltage / devices.
	Appearance	No defects		
Resistance to	Capacitance Variation	≤ ±12%		on: 2mm
Flexure Stresses	Dissipation Factor	Meets Initial Values (As Above)	Test Time:	30 seconds
	Insulation Resistance	≥ Initial Value x 0.3		
Solder	ability	$\ge$ 95% of each terminal should be covered with fresh solder		c solder at 230 ± 5°C .5 seconds
	Appearance	No defects, <25% leaching of either end terminal	-	
	Capacitance Variation	≤ ±7.5%	-	
Resistance to Solder Heat	Dissipation Factor	Meets Initial Values (As Above)	seconds. Store at room	solder at 260°C for 60 m temperature for 24 ±
Soluel Heat	Insulation Resistance	Meets Initial Values (As Above)	2hours before measuri	ng electrical properties.
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
	Capacitance Variation	≤ ±7.5%	Step 2: Room Temp	≤ 3 minutes
Thermal Shock	Dissipation Factor	Meets Initial Values (As Above)	Step 3: +125°C ± 2°	30 ± 3 minutes
	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)		nd measure after 24 ± 2 n temperature
	Appearance	No visual defects		
	Capacitance Variation	≤ ±12.5%	test chamber set at 125	rated voltage ( $\leq 10V$ ) in 5°C ± 2°C for 1000 hours
	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	Ì	8, -0) est voltage will be 2xRV
Load Life	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	but there are exceptions	on exceptions)
	Dielectric Strength	Meets Initial Values (As Above)	Remove from test cham	ber and stabilize at room hours before measuring.
	Appearance	No visual defects		
	Capacitance Variation	≤ ±12.5%		set at 85°C ± 2°C/ 85% ± 1000 hours (+48, -0) with
Load Humidity	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	rated volta	ige applied.
Humulty	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	temperature and humidi	er and stabilize at room ty for 24 ± 2 hours before
	Dielectric Strength	Meets Initial Values (As Above)	meas	suring.





## Capacitance Range

### **PREFERRED SIZES ARE SHADED**

	SIZE		0101*			020	1				040	2		Τ			(	060	3						0	805				1				120	06			
S	olderin	g	Reflow Only		Re	flow (	Only			Re	flow/V	Vave					Ref	low/V	Vave						Reflo	w/Wa	ve						R	eflow,	/Wave	9		
Pa	ackagin	q	Paper/Embossed		A	II Pap	ber			ļ	All Pap	er					A	II Pap	oer					Р	aper/	Embo	ssed					-	Pap	oer/En	nboss	ed	-	
		mm	0.40 ± 0.02		0.	60 ± 0	0.09			1.	00 ± 0	.10					1.0	50 ± 0	.15						2.01	1 ± 0.2	0						;	3.20 ±	0.20			
(L) Ler	ngth	(in.)	(0.016 ± 0.0008)		(0.0	24 ± 0	0.004)			(0.0	40 ± 0	.004)	1				(0.0	53 ± 0	0.006)						(0.079	9±0.0	08)			1			(0.	.126 ±	0.008	B)		
W) Wid	-141-	mm	0.20 ± 0.02	1	0.	30 ± 0	0.09			0.	50 ± 0	.10					0.8	31 ± 0	).15						1.25	5±0.2	0			1				1.60 ±	0.20			
vv) vvic	um	(in.)	(0.008 ± 0.0008)		(0.0	11 ± 0	0.004)				20 ± 0								0.006)							9±0.0								.063 ±				
(t) Terr	minal	mm	0.10± 0.04		0.	15±0	0.05			0.	25 ± 0	.15					0.3	35 ± 0	).15							) ± 0.2								0.50 ±	0.25			
(1) Terr		(in.)	(0.004 ± 0.0016)		<u>`</u>	06 ± 0					10 ± 0								0.006)							) ± 0.0								.020 ±			_	
	WVDC		16	63	10	16	25	50	63	10		25	50	6	3 10	16	25			200	250	63	10	16	25	50	100	200	250	63	10	16	25	50	100	200	250	500
Сар	100	101	В	Α	Α	Α	Α	Α			С	С	С					G		G																		
(pF)	150	151	В	Α	Α	Α	Α	Α			С	С	С					G	_	G																		
	220	221	В	Α	Α	Α	Α	Α			С	С	С					G	_	G		E	E	E	E	E	E	E										
	330	331	В	Α	Α	Α	Α	Α			С	С	С					G		G			J	J	J	J	J	J										K
	470	471	В	Α	Α	Α	Α	Α			С	С	С					G	_	G			J	J	J	J	J	J				$\vdash$		$\vdash$		$\vdash$	<u> </u>	K
	680	681	В	Α	Α	Α	Α				С	С	_					G	_	G			J	J	J	J	J	J				$\vdash$		$\downarrow$		<u> </u>		K
	1000	102	В	A	Α	Α	Α			С	С	С	С					G		G	G		J	J	J	J	J	J	J								J	К
	1500	152	В	A	Α	Α	A			С	С	С	С			_	_	G	G	J	G		J	J	J	J	J	J	J		J	L	J	J	J	J	J	М
	2200	222	В	Α	Α	Α	A			С	С	С	С				_	G		J	G		J	J	J	J	J	J	J		J	J	J	J	J	J	J	М
	3300	332		A	Α	Α	Α			С	С	С	С				_	G	_	J	G		J	J	J	J	J	J	J		J	J	J	J	J	J	J	М
	4700	472		A	A	A	A			С	С	С	С			_	_	G		J	G		J	J	J	J	J	J	J		J	J	J	J	J	J	J	М
-	6800	682		A	A	A	A			C	C	C	C			_		G		J	G		J	J	J	J	J	J	J		J	J	J	J	J	J	J	Р
Cap	0.01	103 153		A	Α	Α	Α			C	C	C	C			_	G	_	_	J	G		J	J	J	J	J	J	J	<u> </u>	J	J	J	J	J	J	J	P
(µF)	0.015	223								C C	C C	C C	C C			_	G		G	J			J	J	J	J	J	J	N	<u> </u>	J	J	J		J	M	J	Q Q
	0.022	333			-	-	-			C					-	-	G	_	 		-		J	J	J	<u> </u>	J	N	N	<u> </u>	J	J	J			M	J	0
	0.033	473			-					C					-	G	-	_	J	-			J	J	J	J	N	N	N		J	J	J	 	J	M	M	ų
	0.047	683				-	-			C	C	C C	C C		+	G		_			-		J	1	J		N	N	IN	-	J	1		H-	J	P	M	
	0.008	104			-					C	C		_		G			_					J		J	J	N	N			J	1	J		P	P	P	
	0.15	154			-									6	_		_	_			+		J	<u> </u>	J	N	N			-	J	1	J		Q	Q	Q	
	0.13	224			1	1	1		-	С	С	С		6	_	_	_	_		+	+		J	1	N	N	N	-	+	-	J	1	J	Ť	Q	Q	Q	
	0.33	334			1	1	1									_	_		-	1	+		N	N	N	N	N	-	1		J	Ĵ	M	P	Q			$\vdash$
	0.47	474					1	1	С	С	-		+		J	_	- J				1		N	N	N	N	N	-			M	м	м	_	0		+	$\vdash$
	0.68	684										1	1			-				1	1		N	N	N						M	M		<u> </u>		1	+	
	1.0	105			1	1	1		С		1	1	+			_	J	J	-	+	+		N	N	N	N					M	M	м	Q	Q	<u> </u>	+	
	2.2	225			1	1	1				1	1	1		_	_				1	1		P	P	P	P**			1		Q	Q	Q	_			+	
	4.7	475			1					1	1	1			-				1	1	1		Р	P	P			1	1		Q	Q	Q			1	+	
	10	106			1	1	1	1	1	1	1	1	1				1		1	1	1	Р	P	P				1	1		Q	Q	X			1	+	
	22	226					1							+												1				Х	Q	Q		1		$\mathbf{t}$	1	
	47	476			1	1	1	1		1	1	1	1	+		+			1	1						1								$\square$		1	1	
	100	107			1	1	1	1	1	1	1	1							1	1			1			1	1	İ	1		1			1				
	WVDC		16	63	10	16	25	50	6.3	10	16	25	50	6	3 10	) 16	25	50	100	200	250	63	10	16	25	50	100	200	250	6.3	10	16	25	50	100	200	250	500
	SIZE		0101*			020	1				040	2					. (	060	3						0	805								120	06			
							-			-		_				_			-											L								

Letter	A	В	С	E	G	J	К	М	N	Р	Q	Х	Y	Z
Max. Thickness	0.33 (0.013)	0.22 (0.009)	0.56 (0.022)	0.71 (0.028)	0.90 (0.035)	0.94 (0.037)	1.02 (0.040)	1.27 (0.050)	1.40 (0.055)	1.52 (0.060)	1.78 (0.070)	2.29 (0.090)	2.54 (0.100)	2.79 (0.110)
			PA	PER						EMBO	SSED			

NOTE: Contact factory for non-specified capacitance values

\*EIA 01005

\*\*Contact Factory for Specifications



## **X7R Dielectric**



## **Capacitance Range**

## **PREFERRED SIZES ARE SHADED**

Packaging         Paper/Embossed         All Embossed         All Embossed </th <th>ng         Paper/Embosed         All Embosed         Close 1000         Cl</th> <th>:</th> <th>SIZE</th> <th></th> <th></th> <th></th> <th></th> <th>1210</th> <th>)</th> <th></th> <th></th> <th></th> <th></th> <th>18</th> <th>812</th> <th></th> <th></th> <th></th> <th>1825</th> <th></th> <th></th> <th></th> <th>2220</th> <th></th> <th></th> <th></th> <th>2225</th> <th></th>	ng         Paper/Embosed         All Embosed         Close 1000         Cl	:	SIZE					1210	)					18	812				1825				2220				2225	
(L) Length         mm         3 30 ± 0.4         4 50 ± 0.30         5 70 ± 0.30         5 70 ± 0.50         (0.77 ± 0.12)         (0.177 ± 0.012)         (0.177 ± 0.012)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.03)         (0.225 ± 0.016)         (0.025 ± 0.016)         (0.225 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016)         (0.025 ± 0.016) <th< th=""><th>mm         3.30 ± 0.4         4.50 ± 0.30         4.50 ± 0.30         4.50 ± 0.30         5.70 ± 0.50         5.72 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.16         (b) 225 ± 0.15         (b) 24 ± 0.030         (a) 224 ± 0.014         (a) 224 ± 0.014         (b) 225 ± 0.015         (b) 24 ± 0.014         (a) 224 ± 0.014         (a) 224 ± 0.014         (b) 225 ± 0.015         (b) 24 ± 0.014         (a) 224 ± 0.014         (b) 225 ± 0.015         (b) 24 ± 0.014         (a) 224 ± 0.015         (a) 226 ± 0.015         (a) 226 ± 0.015         (a) 22</th><th>So</th><th>Idering</th><th></th><th></th><th></th><th>Re</th><th>flow (</th><th>Only</th><th></th><th></th><th></th><th></th><th>Reflo</th><th>w Only</th><th>,</th><th></th><th>Re</th><th>flow O</th><th>nly</th><th></th><th>Re</th><th>flow C</th><th>Dnly</th><th></th><th>Re</th><th>flow O</th><th>nly</th></th<>	mm         3.30 ± 0.4         4.50 ± 0.30         4.50 ± 0.30         4.50 ± 0.30         5.70 ± 0.50         5.72 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.25         (a) 225 ± 0.16         (b) 225 ± 0.15         (b) 24 ± 0.030         (a) 224 ± 0.014         (a) 224 ± 0.014         (b) 225 ± 0.015         (b) 24 ± 0.014         (a) 224 ± 0.014         (a) 224 ± 0.014         (b) 225 ± 0.015         (b) 24 ± 0.014         (a) 224 ± 0.014         (b) 225 ± 0.015         (b) 24 ± 0.014         (a) 224 ± 0.015         (a) 226 ± 0.015         (a) 226 ± 0.015         (a) 22	So	Idering				Re	flow (	Only					Reflo	w Only	,		Re	flow O	nly		Re	flow C	Dnly		Re	flow O	nly
(c), Length         (n)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1)         (1) <th< td=""><td>(n)         (1)30+016)         (0)177+012)         (0)177+012)         (0)274+0.020         (0)222+0.010         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)</td><td>Pac</td><td>kaging</td><td></td><td></td><td></td><td>Pape</td><td>r/Emb</td><td>ossec</td><td>ł</td><td></td><td></td><td>4</td><td>All Em</td><td>bosse</td><td>d</td><td></td><td>Alle</td><td>Embos</td><td>sed</td><td></td><td>Alle</td><td>Embos</td><td>ssed</td><td></td><td>All I</td><td>Embos</td><td>sed</td></th<>	(n)         (1)30+016)         (0)177+012)         (0)177+012)         (0)274+0.020         (0)222+0.010         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)         (0)251+0.010)	Pac	kaging				Pape	r/Emb	ossec	ł			4	All Em	bosse	d		Alle	Embos	sed		Alle	Embos	ssed		All I	Embos	sed
Image: constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the constraint of the	mm         2 20 ± 0 30         3 20 ± 0 20         6 40 ± 0 40         5 00 ± 0 40         6 53 ± 0.25         (0.25 ± 0.016)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0.25 ± 0.015)         (0	// · · · · ·		mm			. 3	.30 ± 0	.4					4.50	± 0.30			4.	50 ± 0.	30		5.	70 ± 0.	.50		5.	72 ± 0.3	25
Width         (m)         (m) </td <td>(n)         (0.099 ± 0.012)         (0.126 ± 0.03)         (0.25 ± 0.016)         (0.177 ± 0.016)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)<!--</td--><td>(L) Length</td><td></td><td>(in.)</td><td></td><td></td><td>(0.1</td><td>30± 0.</td><td>016)</td><td></td><td></td><td></td><td></td><td>(0.177</td><td>± 0.012</td><td>2)</td><td></td><td>(0.1</td><td>77 ± 0.</td><td>012)</td><td></td><td>(0.2</td><td>24 ± 0.</td><td>.020)</td><td></td><td>(0.2</td><td>.25 ± 0.0</td><td>010)</td></td>	(n)         (0.099 ± 0.012)         (0.126 ± 0.03)         (0.25 ± 0.016)         (0.177 ± 0.016)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017)         (0.25 ± 0.017) </td <td>(L) Length</td> <td></td> <td>(in.)</td> <td></td> <td></td> <td>(0.1</td> <td>30± 0.</td> <td>016)</td> <td></td> <td></td> <td></td> <td></td> <td>(0.177</td> <td>± 0.012</td> <td>2)</td> <td></td> <td>(0.1</td> <td>77 ± 0.</td> <td>012)</td> <td></td> <td>(0.2</td> <td>24 ± 0.</td> <td>.020)</td> <td></td> <td>(0.2</td> <td>.25 ± 0.0</td> <td>010)</td>	(L) Length		(in.)			(0.1	30± 0.	016)					(0.177	± 0.012	2)		(0.1	77 ± 0.	012)		(0.2	24 ± 0.	.020)		(0.2	.25 ± 0.0	010)
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	mm         0.50 ± 0.25         0.61 ± 0.36         0.61 ± 0.34         0.64 ± 0.39         0.64 ± 0.39         0.64 ± 0.35           WVC0         10         16         25         50         100         200         500         50         10         200         500         50         100         200         500         50         100         200         500         50         100         200         500         50         100         200         500         50         100         200         500         50         100         200         500         50         100         200         50         50         100         200         500         50         100         200         500         50         100         200         500         50         100         200         500         50         100         200         500         50         100         200         500         50         100         200         50         50         100         200         50         50         100         200         50         50         100         200         500         50         100         200         50         100         200         50         100	W) Width		mm			2	.50 ± 0	.30					3.20	± 0.20							5.	00 ± 0.	.40				
(h) Terminal       (h)	(h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h)         (h) <td>w) width</td> <td></td> <td>. ,</td> <td></td> <td>3)</td> <td></td> <td><u> </u></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>,</td>	w) width		. ,												3)		<u> </u>										,
WDD         10         16         25         50         100         200         50         100         200         50         100         200         25         50         100         200         50         100         200         50         100         200         50         100         200         25         50         100         200         50         100         200         25         50         100         200         50         100         200         50         100         200         25         50         100         200         50         100         200         50         100         200         25         50         100         200         50         100         200         50         100         200         25         50         100         200         50         100         200         25         50         100         200         50         100         200         25         100         200         25         100         200         25         100         200         25         25         100         200         25         25         100         200         25         25         20         20         25	WVOC       10       16       25       50       100       200       500       50       100       200       25       50       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       500       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       200       100       100       100       100 <td>(t) Termina</td> <td>al</td> <td></td>	(t) Termina	al																									
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680       662       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J <td>6662       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J</td> <td></td> <td>3300</td> <td>332</td> <td>J</td> <td>J</td> <td>J</td> <td>J</td> <td>J</td> <td>J</td> <td>М</td> <td></td>	6662       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J		3300	332	J	J	J	J	J	J	М																	
Cap       0.01       103       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J<	103       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J <thj< th=""> <thj< th=""> <thj< th=""></thj<></thj<></thj<>				J	J			J																			
upp       0.015       153       J       J       J       J       J       J       J       J       J       J       Q       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K	5         1         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J         J <th< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>-</td><td>-</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></th<>								-	-																		
0.022         223         J         J         J         J         J         J         J         Q         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K </td <td>2         3         J         J         J         J         Q         K         K         K         K         N         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         Q         M         Q         M         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         <th< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>_</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td><u> </u></td><td></td><td></td><td></td><td></td><td></td><td>_</td><td></td><td></td><td></td><td></td></th<></td>	2         3         J         J         J         J         Q         K         K         K         K         N         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         Q         M         Q         M         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         K         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M         M <th< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>_</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td><u> </u></td><td></td><td></td><td></td><td></td><td></td><td>_</td><td></td><td></td><td></td><td></td></th<>									_								<u> </u>						_				
0.033       333       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J </td <td>3       3       J       J       J       J       J       J       Q       K       K       K       K       K       M       M       M       M       X       X       X       X       X       M       P       P         473       J       J       J       J       J       J       J       Q       K       K       K       K       M       M       M       M       X       X       X       X       X       X       X       X       X       X       M       P       P         668       J       J       J       J       J       Q       K       K       K       K       X       M       M       M       X       X       X       X       X       X       M       P       P         104       J       J       J       M       M       Z       X       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       &lt;</td> <td>. ,</td> <td></td> <td>_</td> <td></td> <td></td> <td></td> <td></td>	3       3       J       J       J       J       J       J       Q       K       K       K       K       K       M       M       M       M       X       X       X       X       X       M       P       P         473       J       J       J       J       J       J       J       Q       K       K       K       K       M       M       M       M       X       X       X       X       X       X       X       X       X       X       M       P       P         668       J       J       J       J       J       Q       K       K       K       K       X       M       M       M       X       X       X       X       X       X       M       P       P         104       J       J       J       M       M       Z       X       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       <	. ,																						_				
0.047       473       J       J       J       J       J       J       J       J       J       J       J       J       J       M       Q       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K       K </td <td>473       J       J       J       J       J       J       J       Q       K       K       K       K       M       M       M       M       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td> <td>_</td> <td></td> <td></td> <td></td> <td></td> <td></td>	473       J       J       J       J       J       J       J       Q       K       K       K       K       M       M       M       M       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X								-														_					
0.058       683       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J </td <td>3       3       J       J       J       J       M       Q       K       K       K       K       M       M       M       X       X       X       X       X       X       X       X       M       P       P         104       J       J       J       J       J       J       M       X       K       K       K       K       K       M       M       M       M       X       X       X       X       X       X       X       M       P       P         5       154       J       J       J       J       P       Z       C       K       K       K       P       Z       M       M       M       X       X       X       X       M       P       X         334       J       J       J       Q       C       C       K       K       M       P       X       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       &lt;</td> <td></td> <td>_</td> <td></td> <td></td> <td></td>	3       3       J       J       J       J       M       Q       K       K       K       K       M       M       M       X       X       X       X       X       X       X       X       M       P       P         104       J       J       J       J       J       J       M       X       K       K       K       K       K       M       M       M       M       X       X       X       X       X       X       X       M       P       P         5       154       J       J       J       J       P       Z       C       K       K       K       P       Z       M       M       M       X       X       X       X       M       P       X         334       J       J       J       Q       C       C       K       K       M       P       X       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       <																								_			
0.1       104       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J <td>104       J       J       J       J       J       J       J       M       X       K       K       K       K       K       M       M       M       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td>-</td> <td>-</td> <td></td> <td>_</td> <td></td>	104       J       J       J       J       J       J       J       M       X       K       K       K       K       K       M       M       M       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X						-	-	-																		_	
0.15       154       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J       J <td>5       15       J       J       J       M       Z       I       K       K       K       P       Z       M       M       M       X       X       X       X       X       M       P       X         2       224       J       J       J       J       P       Z       I       K       K       K       P       Z       M       M       M       M       X       X       X       X       M       P       X         3       334       J       J       J       Q       I       K       K       M       X       Z       M       M       M       M       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       X       M       P       X       X       M       P       X       X       X       X       X       M       P       X       X       X       X       X</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td> <td>_</td> <td></td> <td></td> <td></td> <td></td>	5       15       J       J       J       M       Z       I       K       K       K       P       Z       M       M       M       X       X       X       X       X       M       P       X         2       224       J       J       J       J       P       Z       I       K       K       K       P       Z       M       M       M       M       X       X       X       X       M       P       X         3       334       J       J       J       Q       I       K       K       M       X       Z       M       M       M       M       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       X       M       P       X       X       M       P       X       X       X       X       X       M       P       X       X       X       X       X								-															_				
0.22       12       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1 <td>2       2       3       3       3       3       3       3       4       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1</td> <td></td> <td></td> <td>-</td> <td></td> <td>-</td> <td></td> <td>-</td> <td>-</td> <td></td> <td>^</td> <td></td> <td>_</td> <td>_</td>	2       2       3       3       3       3       3       3       4       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1			-		-		-	-		^																_	_
0.33       334       J       J       J       Q       Q       R       K       K       K       K       Z       M       M       Z       X       X       X       X       X       X       M       M       M       M       M       Q       C       C       K       K       K       K       P       X       Z       M       M       Z       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X </td <td>3       34       J       J       J       Q       Q       C       K       K       M       X       Z       M       M       C       X       X       X       X       M       P       X         4474       M       M       M       Q       C       C       K       K       P       X       Z       M       M       X       X       X       X       M       P       X         3       684       M       M       P       X       X       C       M       M       M       P       X       X       M       P       X         0       105       N       N       P       X       Z       C       M       M       M       Z       M       P       X       X       X       X       M       P       X       X       M       P       X       X       X       M       P       X       X       X       X       X       X       M       P       X       X       X       X       X       M       P       X       X       X       X       X       X       X       X       X       X</td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td>	3       34       J       J       J       Q       Q       C       K       K       M       X       Z       M       M       C       X       X       X       X       M       P       X         4474       M       M       M       Q       C       C       K       K       P       X       Z       M       M       X       X       X       X       M       P       X         3       684       M       M       P       X       X       C       M       M       M       P       X       X       M       P       X         0       105       N       N       P       X       Z       C       M       M       M       Z       M       P       X       X       X       X       M       P       X       X       M       P       X       X       X       M       P       X       X       X       X       X       X       M       P       X       X       X       X       X       M       P       X       X       X       X       X       X       X       X       X       X					-																						
0.47 $474$ $M$ $M$ $M$ $M$ $M$ $Q$ $Q$ $K$ $K$ $P$ $X$ $Z$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $M$ $P$ $0.68$ $684$ $M$ $M$ $P$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$	474       M       M       M       M       Q       C       C       K       K       P       X       Z       M       M       M       X       X       X       X       M       P       X         8       684       M       M       P       X       X       C       M       M       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       X       M       P       X       X       X       M       P       X       X       X       X       X       X       M       P       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td> <td>_</td> <td></td> <td></td> <td></td> <td></td>									-														_				
0.68 $684$ $M$ $M$ $P$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ $X$ <	3       684       M       M       P       X       X       I       I       M       M       Q       I       M       P       X       X       M       P       X         0       105       N       N       P       X       Z       I       M       M       M       X       Z       M       P       X       X       X       M       P       X       X       M       P       X       X       M       P       X       X       M       P       X       X       X       M       P       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X       X </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>_</td> <td></td>																										_	
1.5       155       N       N       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z <thz< th=""> <thz< th=""> <thz< th=""> <thz< th=""></thz<></thz<></thz<></thz<>	5       N       N       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z <thz< th=""> <thz< th=""> <thz< th=""></thz<></thz<></thz<>						_		_						Q													_
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	2       25       X       X       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z <thz< th=""> <thz< th=""> <thz< th=""></thz<></thz<></thz<>		1.0	105	N	N	Р	Х	Z				М	м	X	Z		М	Р			Х	Х			М	Р	Х
3.3       335       X       X       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z <thz< th=""> <thz< th=""> <thz< th=""> <thz< th=""></thz<></thz<></thz<></thz<>	3 335       X       X       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z <thz< th=""> <thz< th=""> <thz< th=""> <thz< th=""></thz<></thz<></thz<></thz<>		1.5	155	Ν	N	Z	Z	Z				Z	Z	Z			Q				Х	Х			М	Х	Z
4.7       475       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z <thz< th=""> <thz< th=""> <thz< th=""> <thz< th=""></thz<></thz<></thz<></thz<>	475       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z <thz< th=""> <thz< th=""> <thz< th=""></thz<></thz<></thz<>		2.2	225	Х	Х	Z	Z	Z				Z	Z	Z							Х	Х			М	Х	Z
10       10       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z <thz< th=""> <thz< th=""> <thz< th=""></thz<></thz<></thz<>	0       106       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z       Z <thz< th=""> <thz< th=""> <thz< th=""></thz<></thz<></thz<>														Z													
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WVDC         10         16         25         50         100         200         50         16         25         50         100         200         50         100         200         25         50         100         200         50         100	10       16       25       50       100       200       50       100       200       500       100       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       500       100       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200       200 </td <td></td> <td></td> <td></td> <td>Ζ</td> <td></td> <td></td> <td></td> <td> </td> <td></td> <td> </td> <td></td> <td> </td> <td><u> </u></td> <td></td> <td></td> <td><u> </u></td> <td><u> </u></td>				Ζ																			<u> </u>			<u> </u>	<u> </u>
	1210 1812 1825 2220 2225			107	4.5		6-		4.55	0.55			a=		4.65	0.000			4.65	0.55	0-		4.55	0.55			4.55	0.55
SIZE 1210 1812 1825 2220 2225					10	16	25	L		200	500	16	25		· · · · ·	200	500	50	L	200	25	50		-	500	50		200
			SIZE					1210						18	812				1825				2220				2225	

Letter	A	В	С	E	G	J	К	М	N	Р	Q	X	Y	Z
Max. Thickness	0.33 (0.013)	0.22 (0.009)	0.56 (0.022)	0.71 (0.028)	0.90 (0.035)	0.94 (0.037)	1.02 (0.040)	1.27 (0.050)	1.40 (0.055)	1.52 (0.060)	1.78 (0.070)	2.29 (0.090)	2.54 (0.100)	2.79 (0.110)
			PAI	PER						EMBO	SSED			

NOTE: Contact factory for non-specified capacitance values



011320





### **GENERAL DESCRIPTION**

X7S formulations are called "temperature stable" ceramics and fall into EIA Class II materials. Its temperature variation of capacitance s within  $\pm 22\%$  from  $-55^{\circ}$ C to  $\pm 125^{\circ}$ C. This capacitance change is non-linear.

Capacitance for X7S varies under the influence of electrical operating conditions such as voltage and frequency.

X7S dielectric chip usage covers the broad spectrum of industrial applications where known changes in capacitance due to applied voltages are acceptable.

### PART NUMBER (SEE PAGE 4 FOR COMPLETE PART NUMBER EXPLANATION)



NOTE: Contact factory for availability of Tolerance Options for Specific Part Numbers.

## **TYPICAL ELECTRICAL CHARACTERISTICS**



## **X7S Dielectric** Specifications and Test Methods



Parame	ter/Test	X7S Specification Limits	Measuring	Conditions
Operating Tem	perature Range	-55°C to +125°C	Temperature C	ycle Chamber
Сарас	itance	Within specified tolerance		
Dissipati	on Factor	≤ 5.0% for ≥ 100V DC rating ≤ 5.0% for ≥ 25V DC rating ≤ 10.0% for ≥ 10V DC rating ≤ 10.0% for ≤ 10V DC rating	Freq.: 1.0 k Voltage: 1.0 For Cap > 10 μF, 0	Vrms ± .2V .5Vrms @ 120Hz
Insulation	Resistance	100,000MΩ or 1000MΩ - μF, whichever is less	Charge device with 120 ± 5 secs @ roc	
Dielectric	Strength	No breakdown or visual defects	Charge device with 250 1-5 seconds, w/charge limited to 50	and discharge current
	Appearance	No defects	Deflectio	n: 2mm
Resistance to	Capacitance Variation	≤ ±12%	Test Time: 3	8 <b>0 seconds</b> 7 1mm/sec
Flexure Stresses	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3	90 r	mm
Solder	rability	≥ 95% of each terminal should be covered with fresh solder	Dip device in eutection for $5.0 \pm 0.3$	
	Appearance	No defects, <25% leaching of either end terminal		
	Capacitance Variation	≤ ±7.5%		
Resistance to Solder Heat	Dissipation Factor	Meets Initial Values (As Above)	Dip device in eutectic s seconds. Store at room	temperature for 24 ± 2
	Insulation Resistance	Meets Initial Values (As Above)	hours before measuring	g electrical properties.
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
	Capacitance Variation	≤ ±7.5%	Step 2: Room Temp	≤ 3 minutes
Thermal Shock	Dissipation Factor	Meets Initial Values (As Above)	Step 3: +125°C ± 2°	30 ± 3 minutes
	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles 24 ± 2 hours at ro	and measure after om temperature
	Appearance	No visual defects	-	
	Capacitance Variation	≤ ±12.5%	Charge device with 1.5 r test chamber set	
Load Life	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	for 1000 hou	
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from test chamb temperature for 24 ± 2 h	
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects		
	Capacitance Variation	≤ ±12.5%	Store in a test chamber s 5% relative humidi	
Load	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	(+48, -0) with rated	
Humidity	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from chamber temperature an	d humidity for
	Dielectric Strength	Meets Initial Values (As Above)	24 ± 2 hours bef	ore measuring.



101316

## X7S Dielectric



Υ

2.54

(0.100)

Ζ

2.79 (0.110)

## **Capacitance Range**

### **PREFERRED SIZES ARE SHADED**

		•									0	
SIZE		0402		0603		0805		1206		121	0	
Solderi	ing	Reflow/Wa	ave	Reflow/Wav	e	Reflow/Wave	Re	eflow/W	ave	Reflow	Only	
Packag		All Pape	r	All Paper		Paper/Embossed	Pap	er/Embo	ossed	Paper/Em		
	mm		± 0.10	1.60 ± 0.15		2.01 ± 0.20		.20 ± 0.		3.20 ±		
(L) Length	(in.)	(0.040 ±		$(0.063 \pm 0.00)$		(0.079 ± 0.008)	(0.	126 ± 0.	008)	(0.126 ±	0.008)	
W) Width	mm	0.50	± 0.10	0.81 ± 0.15		1.25 ± 0.20	1	.60 ± 0.	20	2.50 ±		
w) width	(in.)	(0.020 ±		(0.032 ± 0.00		(0.049 ± 0.008)		063 ± 0.		(0.098 ±		
(t)	mm		± 0.15	0.35 ± 0.15		0.50 ± 0.25		0.50 ± 0.		0.50 ±		
Terminal	(in.)	(0.010 ±	0.006) (	(0.014 ± 0.00	6)	(0.020 ± 0.010)	<u> </u>	020 ± 0.	<u> </u>	(0.020 ±		
_	WVDC	6.3		6.3		4	10	50	100	6.3	;	
Сар	100											
(pF)	150								7	W		
	220								-		~_	
	330							$\sim$		. )	) 1 <sub>T</sub>	
	470										<u> </u>	
	680								$\smile$			
	1000								-	-		
	1500								۲t	1		
	2200 3300						_		-			
	4700											
Сар	6800 0.010						_					
(μF)	0.010											
(µr)	0.013											
	0.022	С					-					
	0.047	c										
	0.047	c										
	0.000	C										
	0.15	C										
	0.22											
	0.33			G								
	0.47			G								
	0.68			G								
	1.0			G					1			
	1.5					Ν						
	2.2					Ν						
	3.3					N						
	4.7					N	Q		Q*			
	10											
	22				Γ					Z		
	47											
	100											
	WVDC	6.3		6.3		4	10	50	100	6.3		
	SIZE	0402		0603		0805		1206		121	0	
Letter	А	С	E	G	J	К	М		N	Р	Q	
Max.	0.33	0.56	0.71	0.90	0.9		1.27	1	.40	1.52	1.90	2.
	(0.013)	(0.022)	(0.028)	(0.035)	(0.03		(0.050		.055)	(0.060)	(0.075)	(0.0
Thickness												

\*Contact Factory for Specifications



## **X5R Dielectric**

## **General Specifications**





### **GENERAL DESCRIPTION**

- · General Purpose Dielectric for Ceramic Capacitors
- EIA Class II Dielectric

•

- Temperature variation of capacitance is within ±15% from -55°C to +85°C
- Well suited for decoupling and filtering applications
- Available in High Capacitance values (up to 100µF)

### PART NUMBER (SEE PAGE 4 FOR COMPLETE PART NUMBER EXPLANATION)



NOTE: Contact factory for availability of Tolerance Options for Specific Part Numbers. Contact factory for non-specified capacitance values.

### **TYPICAL ELECTRICAL CHARACTERISTICS**







121818

## **X5R Dielectric**



## **Specifications and Test Methods**

Parame	ter/Test	X5R Specification Limits	Measuring C	onditions
	•	-55°C to +85°C	Temperature Cy	cle Chamber
	exure resses       Dissipation Factor         resses       Insulation Resistance         Solderability       Appearance         Capacitance Variation       Dissipation Factor         Insulation Resistance       Dissipation Factor         Insulation Resistance       Dissipation Factor         Insulation Resistance       Dissipation Factor         Insulation Resistance       Dielectric Strength         Appearance       Capacitance Variation         Dissipation Factor       Dissipation Factor         Insulation Resistance       Dissipation Factor         Dissipation Factor       Dissipation Factor         Dissipation Resistance       Dissipation Factor         Insulation Resistance       Dielectric Strength         Appearance       Capacitance Variation         Dislectric Strength       Appearance         Disloperance       Capacitance Variation         Disloperance       Dissipation Factor         Dissipation Resistance       Dissipation Factor	Within specified tolerance ≤ 2.5% for ≥ 50V DC rating ≤ 12.5% for 25V, 35V DC rating ≤ 12.5% Max. for 16V DC rating and lower Contact Factory for DF by PN	- Freq.: 1.0 kł Voltage: 1.0V For Cap > 10 μF, 0.3	′rms ± .2V
Insulation		10,000MΩ or 500MΩ - μF, whichever is less	Charge device with rate secs @ room te	
Dielectric	Strength	No breakdown or visual defects	Charge device with 2509 1-5 seconds, w/charge a limited to 50	ind discharge current
	Appearance	No defects	- Deflectior	: 2mm
Resistance to	Variation	≤ ±12%	Test Time: 30	
Flexure Stresses		Meets Initial Values (As Above)		
		≥ Initial Value x 0.3	90 m	m
Solder	ability	≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic solo ± 0.5 sec	
	Appearance	No defects, <25% leaching of either end terminal		
		≤ ±7.5%		
Resistance to		Meets Initial Values (As Above)	Dip device in eutectic 60seconds. Store at roon	n temperature for 24 ±
Soluer Heat		Meets Initial Values (As Above)	2hours before measuring	gelectrical properties.
		Meets Initial Values (As Above)		
	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
		≤ ±7.5%	Step 2: Room Temp	≤ 3 minutes
Thermal Shock		Meets Initial Values (As Above)	Step 3: +85°C ± 2°	30 ± 3 minutes
		Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
		Meets Initial Values (As Above)	Repeat for 5 cycles and hours at room	
	Appearance	No visual defects	Charge device with 1.5X	rated voltage in test
		≤ ±12.5%	chamber set at 85°C ± (+48,-	2°C for 1000 hours
Load Life		≤ Initial Value x 2.0 (See Above)	Note: Contact factory for	
		≥ Initial Value x 0.3 (See Above)	part numbers that are to voltage	
		Meets Initial Values (As Above)	Remove from test chan room temperature	
	Appearance	No visual defects		
	Capacitance Variation	≤ ±12.5%	Store in a test chamber s ± 5% relative humidity fo	
Load	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	with rated volta	
Humidity	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from chamber and temperature and	l humidity for
	Dielectric Strength	Meets Initial Values (As Above)	- 24 ± 2 hours befo	ore measuring.





## **Capacitance Range**

### **PREFERRED SIZES ARE SHADED**

Case Size		010	01*	1		0201			1		04	02						0603							0805			
Soldering		Reflow	-		Re	flow 0				-		/Wav	p				Ref	ow/W	feve					Ref	low/W	feve		
Packaging		Paper/Er				II Pap					All F							II Pap								ossed		
(L) Length	mm (in.)	0.40 ± (0.016 ±	± 0.02		0.0	50 ± 0. 24 ± 0.	.09			(0	1.00 :	± 0.15 ± 0.00					1.0	50 ± 0 53 ± 0	.15					2.0	01 ± 0 79 ± 0	.20		
W) Width	mm (in.)	0.20 ±				30 ± 0. 11 ± 0.				(0		± 0.15 ± 0.00						81 ± 0 32 ± 0							25 ± 0 49 ± 0			
(t) Terminal	mm (in.)	0.10 ± (0.004 ±				15 ± 0. 06 ± 0.				(0		± 0.15 ± 0.00						35 ± 0 14 ± 0							50 ± 0 20 ± 0			
Voltage:		63	10	4	63	10	16	25	4	63	10	16	25	50	4	63	10	16	25	35	50	4	63	10	16	25	35	50
Cap (pF) 100	101		В					Α																				
150	151		В					Α																				
220	221		В					Α						С														
330	331		В					Α						С														
470	471		В					Α						С														
680	681		В					Α						С														
1000	102		В				Α	Α						С														
1500	152	В	В				Α	Α						С														
2200	222	В	В			Α	Α	Α						С														
3300	332	В	В			Α	Α	Α						С														
4700	472	В	В			Α	Α	Α					С								G							
6800	682	В	В			Α	Α	Α					С								G							
Cap (µF) 0.01	103	В	В			Α	Α	Α					С						G	G	G							
0.015	150	В											С						G	G	G							
0.022	223	В			Α	Α	Α	Α				С	С			1			G	G	G				1			N
0.033	333	В										С							G	G	G				1			Ν
0.047	473	В			Α	Α	Α	Α				С	С						G	G	G				1			Ν
0.068	689	В										С							G		G				ĺ			N
0.1	104	В			Α	Α	Α	Α			С	С	С	С					G	G	G				ĺ	Ν	N	N
0.15	154																		G							N	N	
0.22	224	В		Α	Α	Α		1		С	С	С	С	С				G	G		ĺ				ĺ	Ν	N	Ν
0.33	334							1										G	G		ĺ				ĺ	Ν		
0.47	474	В		Α	Α			1	С	С	С	С	С	Е				G	J		ĺ				ĺ	Ν	Р	Р
0.68	684																	G								N		
1.0	105			Α	Α	С	С		С	С	С	С	С	Е	G	G	G	G	J	G	G				N	N	Р	Р
1.5	155																											
2.2	225			С	С	С			С	С	С	С	С		G	G	J	J	J	K	K			N	Ν	Р	Р	Р
3.3	335														J	J	J						Ν	N				
4.7	475								Е	Е	Е	Е			J	J	J	G	G			Ν	Р	J	N	N	Р	Р
10	106				1				Е	E	Е				K	J	J	J				Р	Р	Р	Р	Р		
22	226				1				Е	E					K	K	K				1	Р	Р	Р	Р	Р		
47	476				1										K	K					1	Р	Р	Р				
100	107				1				1	ĺ		İ									1							
Voltage:		63	10	4	63	10	16	25	4	63	10	16	25	50	4	63	10	16	25	35	50	4	63	10	16	25	35	50
Case Size		010	D1*			0201					04	02						0603							0805			

Letter	А	В	С	E	G		К	М	N	Р	Q	Х	Y	Z
Max.	0.33	0.22	0.56	0.71	0.90	0.94	1.02	1.27	1.40	1.52	1.78	2.29	2.54	2.79
Thickness	(0.013)	(0.009)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.050)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)
			PAR	PER						EMBO	SSED			

PAPER and EMBOSSED available for 01005

NOTE: Contact factory for non-specified capacitance values \*EIA 01005



042020

## **Capacitance Range**



### **PREFERRED SIZES ARE SHADED**

Case	Size					1206							1210				1			1812			
Solde					Ref	low/W	/ave					Re	flow O	nly					Re	flow C	nly		
Packa	nging				Paper	/Emb	ossec	1					/Emb		I					Embos			
(L) Lengt	h	mm				20 ± 0							20 ± 0.						4.	50 ± 0	.30		
(L) Lengt	.11	(in.)				26 ± 0							26 ± 0.							77 ± 0.			
W) Width	h	mm				50 ± 0							50 ± 0.							20 ± 0			
		(in.)				53 ± 0							98 ± 0.							26 ± 0.			
(t) Termin	al	mm (in.)				$50 \pm 0$							$50 \pm 0.$							61 ± 0.			
Volta		(in.)	4	6.3	10	20 ± 0 16	25	35	50	4	6.3	10.0.	20 ± 0. 16	25	35	50	4	6.3	10.0.	24 ± 0 16	25	35	50
Cap (pF)	100	101	4	0.5	10	10	25	30	50	4	0.5	10	10	23	30	50	4	0.3	10	10	25	30	50
	150	151																					
	220	221																					
	330	331																					
	470																						
		471																					
	680	681																					
	1000	102			<u> </u>																		
	1500	152																					
	2200	222																					<u> </u>
	3300	332																					<u> </u>
	4700	472																					<b> </b>
	6800	682																					<u> </u>
	0.01	103							ļ														<u> </u>
	0.015	150																		ļ			<u> </u>
	0.022	223																					ļ
	0.033	333																					
	0.047	473																					
(	0.068	689																					
	0.1	104																					
	0.15	154																					
	0.22	224																					
	0.33	334																					
	0.47	474					Q	Q							X	Х							
	0.68	684																					
	1.0	105					Q	Q	Q					Х	X	Х							
	1.5	155																					
	2.2	225			Q	Q	Q	Q	Q					Х	Z	Z							
	3.3	335		Q	Q																		
	4.7	475	Х	Х	X	Х	X	Х	Х			Ζ	Ζ	Ζ	Z	Z							
	10	106	Х	Х	X	Х	Х	Х	Х		Х	Х	Ζ	Ζ	Z	Z					Z		
	22	226	Х	Х	X	Х	Х			Z	Z	Z	Ζ	Ζ			Z	Z	Z	Z			
	47	476	Х	Х	X	Х				Z	Z	Z	Ζ	Ζ									
	100	107	Х	Х				İ		Ζ	Z					l	İ		İ			ĺ	
Volta	age:		4	6.3	10	16	25	35	50	4	6.3	10	16	25	35	50	4	6.3	10	16	25	35	50
Case						1206							1210							1812			
Lattar		٨		D	C		F					/	Ν.4		N			0		v	V		7

Letter	Α	В	С	E	G	J	K	М	N	Р	Q	Х	Y	Z
Max.	0.33	0.22	0.56	0.71	0.90	0.94	1.02	1.27	1.40	1.52	1.78	2.29	2.54	2.79
Thickness	(0.013)	(0.009)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.050)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)
			PA	PER						EMBO	SSED			

PAPER and EMBOSSED available for 01005

NOTE: Contact factory for non-specified capacitance values \*EIA 01005



## **Y5V Dielectric General Specifications**





### **GENERAL DESCRIPTION**

Y5V formulations are for general-purpose use in a limited temperature range. They have a wide temperature characteristic of +22% -82% capacitance change over the operating temperature range of -30°C to +85°C.

These characteristics make Y5V ideal for decoupling applications within limited temperature range.



## PART NUMBER (SEE PAGE 4 FOR COMPLETE PART NUMBER EXPLANATION)





G

	104
;	Capacitance Code (In pF) 2 Sig. Digits + Number of Zeros

Capacitance Tolerance Z = +80 -20%

Ζ

Failure Rate A = Not Applicable

Α



т



**Temperature Coefficient** +20 +10 0 % Δ Capacitance -10 -20 -30 -40 -50 -60 -70 -80 -35 -15 +5 +25 +45 +65 +85 +105 +125 -55 Temperature °C



Insulation Resistance (Ohm-Farads) 10,000 1,00 100 0

+50

Temperature °C

+60 +70 +80 +90

+20 +30 +40

Insulation Resistance vs. Temperature







## Y5V Dielectric



## **Specifications and Test Methods**

Parame	Capacitance         Dissipation Factor         sulation Resistance         Dielectric Strength         Appearance         Capacitance         Variation         Jre         Ses         Appearance         Capacitance         Variation         Factor         Insulation         Resistance         Solderability         Appearance         Capacitance         Variation         Resistance         Solderability         Appearance         Capacitance         Variation         Resistance         Dissipation         Factor         Insulation         Resistance         Dielectric         Strength         Appearance         Capacitance         Variation         Resistance         Dissipation         Factor         Insulation         Resistance         Dielectric         Strength         Appearance         Capacitance         Variation         Resistance	Y5V Specification Limits	Measuring	Conditions
• •		-30°C to +85°C	Temperature C	Cycle Chamber
Сарас	ating Temperature Range Capacitance Dissipation Factor nsulation Resistance Dielectric Strength Appearance Capacitance Variation Factor Insulation Resistance Solderability Appearance Capacitance Variation Resistance Dissipation Factor Insulation Resistance Dissipation Factor Insulation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Dissipation Factor Insulation Resistance Dielectric Strength Appearance Capacitance Variation Dissipation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dissipation Factor Insulation Resistance Dissipation Factor Dissipation Factor Insulation Resistance Dissipation Dissipation Factor Dissipation Resistance Dissipation Dissipation Resistance Dielectric Strength Appearance Capacitance Variation Dissipation Resistance Dislectric Strength Appearance	Within specified tolerance ≤ 5.0% for $≥ 50V$ DC rating ≤ 7.0% for 25V DC rating	Freq.: 1.0   Voltage: 1.0	kHz ± 10%
Dissipation	on Factor	$\leq$ 9.0% for 16V DC rating $\leq$ 12.5% for $\leq$ 10V DC rating	For Cap > 10 μF, 0	).5Vrms @ 120Hz
Insulation	rating Temperature Range Capacitance Dissipation Factor Insulation Resistance Dielectric Strength Appearance Capacitance Variation Factor Insulation Resistance Solderability ≥ 95% Solderability ≥ 95% Appearance No det Capacitance Variation Resistance Dissipation Factor Insulation Resistance Dissipation Factor Dissipation Factor Insulation Resistance Dielectric Strength Appearance Dielectric Strength Appearance Dielectric Strength Appearance Dissipation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dissipation Factor Insulation Resistance Dissipation Factor Insulation Resistance Dissipation Factor Dissipation Factor Dissipation Factor Dissipation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dissipation Factor Insulation Resistance Dielectric Strength Appearance Capacitance Variation Resistance	10,000MΩ or 500MΩ - μF, whichever is less	Charge device with rated @ room tem	voltage for 120 ± 5 secs pp/humidity
Dielectric		No breakdown or visual defects	Charge device with 250 1-5 seconds, w/charge limited to 50	and discharge current
	Appearance	No defects	Deflectio	
Resistance to		≤ ±30%	Test Time: :	30 seconds 7 1mm/sec
Stresses	Factor	Meets Initial Values (As Above)		
		≥ Initial Value x 0.1	90	mm — 🕨
Solder	rability	≥ 95% of each terminal should be covered with fresh solder	Dip device in eutection for 5.0 ± 0.	
	Appearance	No defects, <25% leaching of either end terminal		
	Variation	≤ ±20%		
Resistance to Solder Heat	Factor	Meets Initial Values (As Above)	Dip device in eutectic seconds. Store at room hours before measurin	temperature for $24 \pm 2$
	Resistance	Meets Initial Values (As Above)		g electrical properties.
		Meets Initial Values (As Above)		
	1	No visual defects	Step 1: -30°C ± 2°	30 ± 3 minutes
	Variation	≤ ±20%	Step 2: Room Temp	≤ 3 minutes
Thermal Shock		Meets Initial Values (As Above)	Step 3: +85°C ± 2°	30 ± 3 minutes
	Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
		Meets Initial Values (As Above)	Repeat for 5 cycles 24 ±2 hours at ro	
	••	No visual defects	-	
	Variation	≤ ±30%	Charge device with twi chamber set a	
Load Life	Factor	≤ Initial Value x 1.5 (See Above)	for 1000 ho	
	Resistance	≥ Initial Value x 0.1 (See Above)	Remove from test chamb temperature for 24 ± 2 h	
	Strength	Meets Initial Values (As Above)		
		No visual defects	4	
	Variation	≤ ±30%	Store in a test chamber s 5% relative humid	
Load Humidity	Factor	≤ Initial Value x 1.5 (See above)	(+48, -0) with rate	
	Resistance	≥ Initial Value x 0.1 (See Above)	Remove from chamber temperature ar	nd humidity for
	Dielectric Strength	Meets Initial Values (As Above)	24 ± 2 hours bet	iore measuring.





## Capacitance Range

### **PREFERRED SIZES ARE SHADED**

SIZE		02	01			0402				06	03			08	05			12	06			12	10	
Solderir	ng	Reflov	v Only		Ref	low/W	ave		F	Reflow	/Wave	9	F	Reflow	/Wave	9	F	Reflow	Mfeve	è	F	Reflow	/Wav	е
Packagi	ng	All P	aper		A	II Pape	er			All P	aper		Pa	per/Ei	mboss	sed	Pa	per/Er	nboss	ed	Pa	per/Er	nboss	sed
(L) Length	mm	0.60 ±	0.09		1.0	)0 ± 0.	10			1.60 :	± 0.15			2.01 :	± 0.20			3.20 ±	£ 0.20			3.20 :	± 0.20	
(L) Length	(in.)	(0.024 ±				40 ± 0.			(0		± 0.00	6)	· · · ·	-	± 0.00	8)		.126 ±		B)			£ 0.00	
W) Width	mm	0.30 ±				50 ± 0.					0.15				± 0.20			1.60 ±					£ 0.20	
m) maan	(in.)	(0.011 ±			<u> </u>	20 ± 0.	/		(0		± 0.00	6)	· · ·	-	± 0.00	8)	<u> </u>	.063 ±		B)	(0		± 0.00	8)
(t) Terminal	mm	0.15 ±				25 ± 0.					± 0.15	- 1			± 0.25			0.50 ±		- 1			0.25	
(4) - 51111-21	(in.)	(0.006 ±	,		· · ·	10 ± 0.	,		( ) ( )		± 0.00	- /	· · ·		± 0.01	.,	· · ·	.020 ±		- /	· ·		£ 0.01	/
Can	WVDC 820	63	10	6	10	16	25	50	10	16	25	50	10	16	25	50	10	16	25	50	10	16	25	50
Сар																				1	$\mathbf{x}$		× w/	·
(pF)	1000 2200		A																	<u>_</u>	1	$\sim$		<
	4700		A																_	ſ	-		D	JT .
Сар	0.010	А	A																					
(μF)	0.010	A	A																		4			
(µr)	0.022	<u>A</u>				С													_					. 1
	0.10	~			С	c					G	G				к								
	0.22				U	U				G	0	0				ĸ								
	0.33									G														$\vdash$
	0.47					С				G	G													
	1.0			С	С				G	G	J			N	N	Ν		М	М	м				Ν
	2.2				С				J					N	N				К	Q				
	4.7												Ν	Ν	Ν			Р	Q			Ν	Ν	
	10.0												Ν	Р			Q	Q	Х		Х	Q	Q	Z
	22.0																Q				Х	Z		1 7
	47.0																							$\square$
	WVDC	63	10	6	10	16	25	50	10	16	25	50	10	16	25	50	10	16	25	50	10	16	25	50
SIZE		02	01			0402				06	03			08	05			12	06			12	10	

0.00 0.00 0.7	0.70	0.74	1.02	1.27	1.40	1.02	1.70	2.25	2.04	2.75
Letter         A         C         E           Max.         0.33         0.56         0.7	G	J	K	M	N	P	Q	X	Y	Z
	0.90	0.94	1.02	1 27	1.40	1.52	1.78	2.29	2.54	2.79



060120

## **MLCC Gold Termination – AU Series**

## **General Specifications**





AVX Corporation will support those customers for commercial and military Multilayer Ceramic Capacitors with a termination consisting of Gold. This termination is indicated by the use of a "7" or "G" in the 12th position of the AVX Catalog Part Number. This fulfills AVX's commitment to providing a full range of products to our customers. Please contact the factory if you require additional information on our MLCC Gold Termination.

### PART NUMBER



\* Contact factory for availability.



## **MLCC Gold Termination – AU Series**



## Capacitance Range (NP0 Dielectric)

### **PREFERRED SIZES ARE SHADED**

SIZE Soldering			AU02 flow/Epc Vire Bond			AU Reflow/ Wire B	Epoxy/				AU05 eflow/Epo Wire Bond					Reflow	<b>IO6</b> /Epoxy/ Bond*		
Packaging			All Pape			All P					per/Embo					Paper/Ei		d	
	mm		.00 ± 0.1			1.60 ±	·				2.01 ± 0.2						± 0.20	u	
L) Length	(in.)		.00 ± 0.1 040 ± 0.0			(0.063 ±					.079 ± 0.2					(0.126 :			
	mm		0.50 ± 0.1			0.81 ±					1.25 ± 0.2						± 0.20		
/) Width	(in.)	(0.0	020 ± 0.0	04)		(0.032 ±	£ 0.006)			(0	.049 ± 0.0	08)				(0.063 :	± 0.008)		
	mm		.25 ± 0.1	· ·		0.35 ±	,				0.50 ± 0.2				-		± 0.25		
) Terminal	(in.)		010 ± 0.0			(0.014 ±					.020 ± 0.0					(0.020 :			
	WVDC	16	25	50	16	25	50	100	16	25	50	100	200	16	25	50	100	200	500
Сар	0.5	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
(pF)	1.0	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	1.2	С	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	1.5 1.8	C C	C C	C C	G G	G G	G	G	J J	J	J	J J	J J	J	J	J J	J	JJ	J J
	2.2	c	c	C C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	2.7	c	c	c	G	G	G	G	J	J	J	J	J	Ĵ	J	J	J	J	J
	3.3	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	3.9	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	4.7	<u>C</u>	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	
	5.6 6.8	C C	C C	C C	G G	G G	G G	GG	J J	J	J	J J	J J	J	J	J J	J	JJ	J J
	8.2	č	c	c	G	G	G	G	J	J	J	J	J	Ĵ	J	J	J	J	J
	10	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	12	С	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	15	<u>C</u>	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	
	18 22	C C	C C	C C	G G	G G	G G	GG	J J	J	J	J J	J J	J	J	J	J	JJ	J J
	27	c	c	c	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	33	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	39	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	47	<u>C</u>	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	
	56 68	C C	C C	C C	G G	G G	G G	GG	J J	J	J	J	J J	J	J	J J	J	JJ	J J
	82	c	c	c	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	100	С	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	120	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	150	<u>С</u> С	C C	C	G G	G	G	GG	J	J	J	J	J	J	J	J	J	J	J
	180 220	C	C	C C	G	G G	G G	G	J J	J	J	J	J J	J	J	J J	J	JJ	J M
	270	č	c	c	G	G	G	G	J	Ĵ	J	J	M	J	J	J	J	J	M
	330	С	С	С	G	G	G	G	J	J	J	J	М	J	J	J	J	J	М
	390	С	C	C	G	G	G		J	J	J	J	М	J	J	J	J	J	М
	470 560	С	С	С	G G	G G	G		J J	J	J	J J	M	J	J	J J	J	JJ	M
	680				G	G	G		J	J	J	J	M	J	J	J	J	J	P
	820				G	G	G		J	Ĵ	J	J	M	J	J	J	J	M	•
	1000		1		G	G	G		J	J	J	J	М	J	J	J	J	Q	
	1200								J	J	J			J	J	J	J	Q	
	1500 1800								J J	J	J			J	J	J M	M	Q	
	2200								J	J	N			J	J	M	P		
	2700								J	J	N			J	Ĵ	M	P.		
	3300								J	J				J	J	М	Р		
	3900								J	J				J	J	M	P		
	4700 5600								J	J				J	J J	M M	Р		
	6800													M	M	IVI			
	8200													М	М				
	0.010					~	-W							М	М				
	0.012			L	$\sim$		~~>												
	0.013		~	$\sim$				1											
	0.022		(				$\mathcal{V}_{-}$	<b>↓</b> I											
	0.027		C																
	0.033																		
	0.039 0.047																		
	0.047				1.0						+								
	0.082																		
	0.1																		
	WVDC	16	25	50	16	25	50	100	16	25	50	100	200	16	25	50	100	200	500
	SIZE		AU02			AU	03				AU05					AU	106		
Contact Factor	ry																		
Le	etter			Α	C		E	G			K	М		N	Р		Q	Х	
M	ax.			0.33	0.56	0	.71	0.90	0.	94	1.02	1.27	1	1.40	1.52		78	2.29	2
Max. Thickness				0.013)	(0.022		028)	(0.035)	(0.0		(0.040)	(0.050		.055)	(0.060		070)	(0.090)	(0.



The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.avx.com/disclaimer/ by reference and should be reviewed in full before placing any order. Z 2.79 (0.110)
**Capacitance Range (NP0 Dielectric)** 



### **PREFERRED SIZES ARE SHADED**

SIZE				AU10				-	AU12				AU13			AU14	
Solderi	ng			eflow/Epo					low/Epc				Reflow/Epox			Reflow/Epoxy	/
Packagi	-			Wire Bond per/Embos					lire Bond Emboss				Wire Bond <sup>3</sup> All Embosse			Wire Bond* All Embossed	
(L) Length	mm			3.20 ± 0.2					.50 ± 0.3				4.50 ± 0.30			5.72 ± 0.25	
(L) Length	(in.) mm			0.126 ± 0.0 2.50 ± 0.2					77 ± 0.0				$\frac{(0.177 \pm 0.01)}{6.40 \pm 0.40}$			(0.225 ± 0.010 6.35 ± 0.25	)
W) Width	(in.)			2.30 ± 0.2					26 ± 0.2				(0.252 ± 0.01			(0.250 ± 0.25	)
	mm			0.50 ± 0.2	· ·				.61 ± 0.3				0.61 ± 0.36			0.64 ± 0.39	/
(t) Terminal	(in.)		(0	0.020 ± 0.0	10)			(0.0	24 ± 0.0	)14)			(0.024 ± 0.01	4)		(0.025 ± 0.015	)
	WVDC	25	50	100	200	500	25	50	100	200	500	50	100	200	50	100	200
Cap (pF)	0.5 1.0																
())	1.2																
	1.5 1.8			-													
	2.2														J-1-		W~
	2.7 3.3																) ) <u>(</u> -
	3.9														$\subseteq$		
	4.7 5.6			-												-	-
	6.8															[[t]	
	8.2 10					J											
	12					J											
	15 18					J J											
	22					J											
	27 33					J J											
	39					J											
	47 56					J J											
	68					J											
	82 100					J								-		-	
	120					J											
	150 180			-		J J											
	220					J											
	270 330			-		J J					+						
	390					М											
	470 560	J	J	J	J	M M											
	680	J	J	J	J	М											
	820 1000	J J	J	J	J J	M M	к	K	К	К	М	М	М	M	М	М	Р
	1200	J	J	J	м	М	К	К	K	К	M	М	M	M	M	M	Р
	1500 1800	J J	J	J	M	М	K K	K K	K K	K K	M	M	M M	M	M	M	P P
	2200 2700	J	J	J	Q		K	K	K	K	P	M	M	M	M	M	P
	3300	J J	J	J	Q		K K	K K	K K	P	Q	M	M M	M	M	M	P P
	3900 4700	J	J	M			K K	K K	K K	P P	Q	M	M M	M	M	M	P P
	5600	J	J				K	K	M	P	X	M	M	М	M	M	Р
	6800 8200	J J	J				K K	K M	M M	X		M	M M	М	M	M	P P
	0.010	J	J				К	М	M			М	M		М	М	P
	0.012 0.015	J	J				K M	M M				M M	M M		M M	M M	P Y
	0.018			1			М	М				Р	M		М	М	Y
	0.022 0.027						M M	M M				P P			M	Y Y	Y Y
	0.033						М	М				Р		1	Р		
	0.039 0.047						M M	M M				P P			P P		
	0.068						М	М						1	Р		
	0.082 0.1						M	M							Q Q		
	WVDC	25	50	100	200	500	25	50	100	200	500	50	100	200	50	100	200
	SIZE			AU10					AU12				AU13			AU14	
* Contact Fact				٨	-			0	1		Ľ		N	D	0	V V	7
	Letter Max.			A 0.33	C 0.56		E .71	G 0.90		J 94	K 1.02	M 1.27	N 1.40	P 1.52		X Y .29 2.54	Z 2.79
т	hickness			(0.013)	(0.022		028)	(0.035)	(0.0		(0.040)	(0.050)	(0.055)	(0.060) (0	.070) (0.	090) (0.100)	
						P	APER							EMBOSS	D		



Capacitance Range (X7R Dielectric)



### **PREFERRED SIZES ARE SHADED**

SIZE			AL	J02					AU03	3						AU0	5			AU06							
Solderin	g	R		/Epoxy Bond*	/				ow/Ej ire Bo		'					ow/E ire Bo	poxy ond*	/					eflow Wire	Bond	*		
Packagin	ng			Paper				A	All Pap	ber				F	Pape	r/Em	boss	ed				Pa	per/E	mbos	sed		
(L) Length	mm			± 0.10	- •				60 ± 0							01 ±							3.20				
(-)g	(in.) mm	(0		± 0.004 ± 0.10	4)			<u>`</u>	63 ± 0 81 ± 0		)				<u>`</u>	79 ± 25 ±	800.0	3)				<u> </u>	.126				
W) Width	(in.)			± 0.10 ± 0.004	1)				32 ± 0		<b>`</b>						0.20 0.008	3)					.063				
	mm			± 0.00- ± 0.15	<u>, , , , , , , , , , , , , , , , , , , </u>			· ·	$\frac{32 \pm 0}{35 \pm 0}$		/				<u>`</u>	50 ±		)					0.50				
(t) Terminal	(in.)	(0	0.010	± 0.006	5)			(0.0	14 ± 0	.006	)				(0.0	20 ±	0.010	))				(0	.020	± 0.01	10)		
WVDC		10	16	25	50	63	10	16	25	50	100	200	63	10	16	25	50	100	200	63	10	16	25	50	100	200	500
Сар	100																										
(pF)	150				_				-																		
	220 330				C				G	0		0															14
	330 470				C					G	G	G G		J	J	J	J	J	J								K
	680				C C					G G	G G	G		J J	J	J	J	J	J								K K
	1000				C					G	G	G		J	J	J	J	J	J								K
	1500				c					G	G	Ū		J	J	J	J	J	J		J	J	J	J	J	J	M
	2200				С					G	G			J	J	J	J	J	J		J	J	J	J	J	J	М
	3300			С	С					G	G			J	J	J	J	J	J		J	J	J	J	J	J	М
	4700			С	С					G	G			J	J	J	J	J	J		J	J	J	J	J	J	М
	6800		С	С						G	G			J	J	J	J	J	J		J	J	J	J	J	J	Р
Сар	0.010		С					G		G	G			J	J	J	J	J	J		J	J	J	J	J	J	Р
(µF)	0.015 0.022	С	C						G	G				J	J	J	J	J	J		J	J	J	J	J	M	
	0.022	C	С						G G	G G				J J	J	J	J	J	N		J J	J J	J	J	J	M	
	0.033	U						G	G	G				J	J	J	J	N			J	J	J	J	J	M	
	0.068							G	G	G				J	J	J	J	N			J	J	J	J	J	P	
	0.10						G	G	G	G				J	J	J	J				J	J	J	J	M	P	
	0.15					G	G							J	J	J	N	Ν			J	J	J	J	Q		
	0.22					G	G							J	J	Ν	Ν	Ν			J	J	J	J	Q		
	0.33													Ν	Ν	N	N	N			J	J	М	Р	Q		
	0.47													N	N	N	N	N			M	M	M	P	Q		
	0.68													N	N	N	-				M	M	Q	Q	Q		
	1.0 1.5													N	Ν	N					M P	M Q	Q	Q	Q		
	2.2															P*					Q	Q	Q				
	3.3																				~	4	4				
	4.7													P*							Q	Q	1				
	10																				Q*						
	22																			Q*							
	47																										
	100	10	16	25	50	62	10	16	25	FO	100	200	60	10	16	25	FO	100	~	62	10	16	25	FO	100	200	F00
	WVDC SIZE	10	16	25 AU02	50	63	10	16	25 AU03	50	100	200	63	10	16	25 AU0		100	200	63	10	16	25 <b>AI</b>	50 <b>J06</b>	100	200	500
* Contact Facto	-			A002					A003	,						AUU	5						AL				

\* Contact Factory

Letter	Α	C	E	G	J	K	М	N	Р	Q	X	Y	Z
Max. Thickness	0.33 (0.013)	0.56 (0.022)	0.71 (0.028)	0.90 (0.035)	0.94 (0.037)	1.02 (0.040)	1.27 (0.050)	1.40 (0.055)	1.52 (0.060)	1.78 (0.070)	2.29 (0.090)	2.54 (0.100)	2.79 (0.110)
PAPER									EMBO	DSSED			



# **MLCC Gold Termination – AU Series**

## Capacitance Range (X7R Dielectric)

## **PREFERRED SIZES ARE SHADED**

SIZE					AU10					AU	12		4	U13		AU14
Soldering	I				eflow/Ep Wire Boi						/Epoxy/ Bond*			w/Epoxy/ e Bond*		ow/Epoxy/ ire Bond*
Packagin	a			Par	per/Emb	osseU				All Em	oossed		All Er	nbossed	All E	Embossed
	mm				3.20 ± 0	.20	-			4.50	± 0.30		4.50	) ± 0.30	5.7	72 ± 0.25
L) Length	(in.)			(0	.126 ± 0	.008)				(0.177 :	± 0.012)		(0.177	7 ± 0.012)	(0.22	25 ± 0.010)
A/) \A/;d+b	mm				2.50 ± 0	.20				3.20 :	± 0.20		6.40	) ± 0.40	6.3	35 ± 0.25
N) Width	(in.)				.098 ± 0					<u>`</u>	± 0.008)		· ·	2 ± 0.016)		50 ± 0.010)
t) Terminal	mm (in)				0.50 ± 0	.25				0.61 :	± 0.36		0.61	1 ± 0.36	0.6	54 ± 0.39
	(in.)			(0	.020 ± 0	.010)				(0.024 :	± 0.014)		(0.024	4 ± 0.014)	(0.02	25 ± 0.015)
WVDC		10	16	25	50	100	200	500	50	100	200	500	50	100	50	100
	100												· _		-	1
Cap	150												-1-			
(pF)	220												~	$\leq$		$\sum$
	330												( -			) [T -
	470															-
	680											L				_
	1000													1		_
	1500	J	J	J	J	J	J	М						Tt I		
	2200	J	J	J	J	J	J	М								
	3300	J	J	J	J	J	J	М								
	4700	J	J	J	J	J	J	М								
	6800	J	J	J	J	J	J	М								
Сар	0.010	J	J	J	J	J	J	М	K	К	K	K	М	М	М	P
(μF)	0.015	J	J	J	J	J	J	Р	К	К	K	Р	M	M	M	P
	0.022	J	J	J	J	J	J	Q	K	K	K	Р	M	M	M	P
	0.033	J	J	J	J	J	J	Q	K	K	K	X	M	М	M	P
	0.047	J	J	J	J	J	J		K	K	K	Z	M	M	M	P
	0.068	J	J	J	J	J	M		K	K	K	Z	M	M	M	P
	0.10	J	J	J	J	J	M		K	K	K	Z	M	M	M	P
	0.15	J	J	J	J	M	Z		K	K	P		M	M	M	P
	0.22	J	J	J	J	P	Z		K	K M	P X		M	M	M	P P
	0.33 0.47	J M	J M	J M	J	Q Q			K K	P	~		M	M	M	P P
	0.47	M	M	P	X	X			M	Q			M	P	M	P P
	1.0	N	N	F	X	Z		1	M	X			M	P P	M	P P
	1.5	N	N	Z	Z	Z			Z	Z			M		M	X
	2.2	X	X	Z	z	z			Z	z					M	
	3.3	X	X	Z	Z	-		L	Z	-						
	4.7	X	X	Z	Z				Z							
	10	Z	Z	Z					_							
	22															
	47															
	100															
	WVDC	10	16	25	50	100	200	500	50	100	200	500	50	100	50	100
	SIZE									AU	10			U13		AU14

A KYOCERA GROUP CO

\* Contact Factory

Letter	А	С	E	G	J	K	М	N	Р	Q	Х	Y	Z
Max.	0.33	0.56	0.71	0.90	0.94	1.02	1.27	1.40	1.52	1.78	2.29	2.54	2.79
Thickness	(0.013)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.050)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)
			PAPER						EMBC	DSSED			



# **MLCC Gold Termination – AU Series**



## **Capacitance Range (X5R Dielectric)**

### **PREFERRED SIZES ARE SHADED**

Cap       100	) )	ed	d			W	flow Vire	Bor	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	)	)	d		/	All	Em		
Length       (in)       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U       U	)	·						DOS	ssec
Langent       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1 <th1< th="">       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1<!--</td--><td>)</td><td>·</td><td></td><td></td><td></td><td>4</td><td>4.50</td><td>± 0.</td><td>30</td></th1<>	)	·				4	4.50	± 0.	30
Width       (in)		)			1	(0.1	.177	± 0.	012)
Width       (i)       d=""><td></td><td>)</td><td></td><td></td><td></td><td>3</td><td>3.20</td><td>± 0.</td><td>20</td></th<>		)				3	3.20	± 0.	20
Image: conditione of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the low of the					1	(0.1	.126	± 0.	008)
(i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (i)       (	)				+		0.61	+ 0	36
WVDC       4       63       10       16       25       30       4       63       10       16       25       35       50       63       10       16       25       35       50       4       63       10       16       25       35       50       63       10       16       25       35       50       4       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       63       10       16       25       35       50       6									
Cap       100       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A <td></td> <td></td> <td></td> <td></td> <td></td> <td>L.</td> <td>.024</td> <td></td> <td>´</td>						L.	.024		´
(pF)     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150     150 </td <td>35 50</td> <td>35 5</td> <td>5 50</td> <td>50</td> <td>i0 (</td> <td>6.3</td> <td>10</td> <td>) 25</td> <td>5 50</td>	35 50	35 5	5 50	50	i0 (	6.3	10	) 25	5 50
220       20       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C									
330       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C       C									
470     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C<					$\downarrow$	⊢	$\vdash$	$\perp$	+
680     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C<									
1000     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C									
1500     C       2200     C       3300     C       4700     C					+	<u> </u>	┢	+	_
2200     C     G     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C     C									
3300 C G G G									
4700 C G G					+	<u> </u>		+	+
6800 C C C C C C C C C C C C C C C C C C									
Cap 0.010 C G G G G G G G G G G G G G G G G G G					+		1	+	-
(µF) 0.015 C G G G G									
0.022 C C G G G N N									
0.047 C C G G G N									
0.068 C G G N N					+	⊢	$\vdash$	╇	$\perp$
0.10 C C C G G N N									
0.15 G G N N N 0.22 C* G G G N N N									
0.22         C*         G         G         N         N         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q         Q <td>-+</td> <td>_</td> <td>-</td> <td></td> <td>+</td> <td><u> </u></td> <td>+</td> <td>+</td> <td>+</td>	-+	_	-		+	<u> </u>	+	+	+
0.33 0.47 C*									
	x		x	X	X				
			_	X		<u> </u>	+	+	+
1.5 N					1				
2.2 C* G* G* J* J* N N N N Q Q Q	х	X	×			1			
3.3 J* J* J* J* N N Q Q O					T		Τ	Τ	
4.7 J* J* J* N N N* N* Q Q Q Q Q Z									
10 K* K* P* P* P* Q Q Q Q* X Z Z	$\square$				$\perp$	<u> </u>	$\perp$	Z	
22 P* Q* Q* Q* Z Z Z Z									
47 Q* Z*									
100 V V V V V V V V V V V V V V V V V V		35 5	5 50	50		62	10	1 2	5 5
SIZE AU02 AU03 AU05 AU06 AU10	25 150			100	4	0.5		14	ມ່າງ
* Contact Factory	35   50	00 10	0 100			1	ΔI	U12	

Letter	A	С	E	G	J	K	М	N	Р	Q	Х	Y	Z
Max.	0.33	0.56	0.71	0.90	0.94	1.02	1.27	1.40	1.52	1.78	2.29	2.54	2.79
Thickness	(0.013)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.050)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)
PAPER									EMBC	SSED			

= \*Optional Specifications – Contact Factory

NOTE: Contact factory for non-specified capacitance values



# MLCC Gold Termination – AU Series AU16/AU17/AU18



	ZE		(	AU1 030	6)			(0	U17 508	3)			(	AU1 061:	2)	
Pack	aging			nbos					boss					nboss		
Length	mm (in.)			31 ± 0 32 ± 0		、 、			7 ± 0. 0 ± 0.					50 ± 0 53 ± 0		
	(iii.) mm			$52 \pm 0$ $50 \pm 0$		)			$0 \pm 0.00 \pm 0.000$					$3 \pm 0$ 20 ± 0		)
Width	(in.)			53 ± 0		)	(		0 ± 0.					26 ± 0		
Cap Code	WVDC	4	6.3	10	16	25	6.3	10	16	25	50	6.3	10	16	25	50
102	Cap 0.001		Α	А	Α	А	S	S	S	S	۷	S	S	S	S	V
222	(µF) .0022		Α	Α	Α	Α	S	S	S	S	V	S	S	S	S	V
332	0.0033		А	А	Α	Α	S	S	S	S	V	S	S	S	S	V
472	0.0047		Α	Α	Α	А	S	S	S	S	V	S	S	S	S	V
682	0.0068		Α	Α	Α	Α	S	S	S	S	V	S	S	S	S	V
103	0.01		Α	Α	Α	Α	S	S	S	S	V	S	S	S	S	V
153	0.015		Α	Α	Α	Α	S	S	S	S	V	S	S	S	S	W
223	0.022		Α	Α	A	Α	S	S	S	S	V	S	S	S	S	w
333	0.033		Α	Α	Α		S	S	S	۷	V	S	S	S	S	W
473	0.047		Α	Α	A		S	S	S	V	А	S	S	S	S	W
683	0.068		Α	Α	A		S	S	S	А	Α	S	S	S	V	W
104	0.1		Α	Α	VK/		S	S	V	А	А	S	S	S	V	W
154	0.15		Α	Α			S	S	V			S	S	S	W	W
224	0.22		Α	Α			S	S	А			S	S	۷	W	
334	0.33						V	۷	А			S	S	۷		
474	0.47						۷	۷	K)			S	S	۷		
684	0.68						А	Α				۷	۷	W		
105	1	A					А	Α				V	V	А		
155	1.5						K					W	W			
225	2.2											А	А			
335	3.3											K/				
475	4.7															
685	6.8															
106	10															

#### Solid = X7R

= X5R



	mm (in.)
	AU16
	(0508)
Code	Thickness
S	0.56 (0.022)
V	0.76 (0.030)
А	1.02 (0.040)

	1	
	mm (in.)	
	AU16	
	(0612)	
Code	Thickness	
S	0.56 (0.022)	
V	0.76 (0.030)	
W	1.02 (0.040)	
А	1.27 (0.050)	

### PHYSICAL DIMENSIONS AND PAD LAYOUT



### PHYSICAL DIMENSIONS MM (IN.)

	L	W	t
AU16	0.81 ± 0.15	1.60 ± 0.15	0.13 min.
(0306)	(0.032 ± 0.006)	(0.063 ± 0.006)	(0.005 min.)
AU17	1.27 ± 0.25	2.00 ± 0.25	0.13 min.
(0508)	(0.050 ± 0.010)	(0.080 ± 0.010)	(0.005 min.)
AU18	1.60 ± 0.25	3.20 ± 0.25	0.13 min.
(0612)	(0.063 ± 0.010)	(0.126 ± 0.010)	(0.005 min.)

T - See Range Chart for Thickness and Codes

### PAD LAYOUT DIMENSIONS MM (IN.)

	Α	В	С
AU16 (0306)	0.31 (0.012)	1.52 (0.060)	0.51 (0.020)
AU17 (0508)	0.51 (0.020)	2.03 (0.080)	0.51 (0.020)
AU18 (0612)	0.76 (0.030)	3.05 (0.120)	0.635 (0.025)



# MLCC Tin/Lead Termination "B" (LD Series)

## COG (NP0) - General Specifications





AVX Corporation will support those customers for commercial and military Multilayer Ceramic Capacitors with a termination consisting of 5% minimum lead. This termination is indicated by the use of a "B" in the 12th position of the AVX Catalog Part Number. This fulfills AVX's commitment to providing a full range of products to our customers. AVX has provided in the following pages a full range of values that we are currently offering in this special "B" termination. Please contact the factory if you require additional information on our MLCC Tin/Lead Termination "B" products.

**Not RoHS Compliant** 

See FLEXITERM® section for CV options

## PART NUMBER (SEE PAGE 4 FOR COMPLETE PART NUMBER EXPLANATION)



\*LD04 has the same CV ranges as LD03.

NOTE: Contact factory for availability of Tolerance Options for Specific Part Numbers. Contact factory for non-specified capacitance values.



available online at www.avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.



## COG (NP0) - Specifications and Test Methods

Paramet	er/Test	NP0 Specification Limits	Measuring	Conditions
Operating Temp	-	-55°C to +125°C	Temperature C	Cycle Chamber
Capac C		Within specified tolerance <30 pF: Q≥ 400+20 x Cap Value ≥30 pF: Q≥ 1000	Freq.: 1.0 MHz ± 10 1.0 kHz ± 10% fc Voltage: 1.0	or cap > 1000 pF
Insulation F	Resistance	100,000MΩ or 1000MΩ - μF, whichever is less	Charge device with 60 ± 5 secs @ roo	h rated voltage for om temp/humidity
Dielectric	Strength	No breakdown or visual defects	Charge device with 250 1-5 seconds, w/charge limited to 50 Note: Charge device wit for 500V	0% of rated voltage for and discharge current 0 mA (max) h 150% of rated voltage
	Appearance	No defects	Deflectio	on: 2mm
Resistance to Flexure	Capacitance Variation	$\pm 5\%$ or $\pm .5$ pF, whichever is greater	Test Time: :	30 seconds 7 1mm/sec
Stresses	Q	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3	90	mm
Solder	ability	≥ 95% of each terminal should be covered with fresh solder	Dip device in eutection for 5.0 ± 0.	
	Appearance	No defects, <25% leaching of either end terminal		
	Capacitance Variation	$\leq$ ±2.5% or ±.25 pF, whichever is greater	Dip device in eutectic	addar at 26000 for 60
Resistance to Solder Heat	Q	Meets Initial Values (As Above)	seconds. Store at room	temperature for 24 ± 2
Solder Heat	Insulation Resistance	Meets Initial Values (As Above)	hours before measurin	g electrical properties.
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
·	Capacitance Variation	$\leq$ ±2.5% or ±.25 pF, whichever is greater	Step 2: Room Temp	≤ 3 minutes
Thermal Shock	Q	Meets Initial Values (As Above)	Step 3: +125°C ± 2°	30 ± 3 minutes
	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles 24 hours at roo	and measure after m temperature
	Appearance	No visual defects		
	Capacitance Variation	$\leq$ ±3.0% or ± .3 pF, whichever is greater	Charge device with twi	
Load Life	Q	≥ 30 pF: Q≥ 350 ≥10 pF, <30 pF: Q≥ 275 +5C/2 <10 pF: Q≥ 200 +10C	chamber set a for 1000 hou Remove from test chaml	urs (+48, -0).
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	temperature before m	for 24 hours
	Dielectric Strength	Meets Initial Values (As Above)		
· · · · · · · · ·	Appearance	No visual defects	-	
·	Capacitance Variation	$\leq$ ±5.0% or ± .5 pF, whichever is greater	Store in a test chamber s	
Load Humidity	Q	≥ 30 pF: Q≥ 350 ≥10 pF, <30 pF: Q≥ 275 +5C/2 <10 pF: Q≥ 200 +10C	(+48, -0) with rate	0 11
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from chamber temperature for 24 ± 2 h	r and stabilize at room nours before measuring
	Dielectric Strength	Meets Initial Values (As Above)		





## COG (NPO) – Capacitance Range

### **PREFERRED SIZES ARE SHADED**

							<b>d</b> 20										I		
SIZE			LD02			LD	03				LD05					LDO	6		
Solder	ing	Re	eflow/Wa	ave		Reflow	v/Wave			Re	eflow/Wa	ve				Reflow/\	Nave		
Packag	<b>jing</b> mm		All Pape .00 ± 0.1				Paper ± 0.15				er/Embos .01 ± 0.2				Pa	aper/Eml 3.20 ± (			
(L) Length	(in.)	(0.0	040 ± 0.0	004)		(0.063	± 0.006)			(0.0	079 ± 0.0	08)			(	0.126 ± (	0.008)		
W) Width	mm (in.)		.50 ± 0.1 020 ± 0.0				± 0.15 ± 0.006)				.25 ± 0.2 )49 ± 0.0				(	1.60 ± ( 0.063 ± (			
(t) Terminal	mm (in.)	0	.25 ± 0.1 010 ± 0.0	15		0.35	± 0.15 ± 0.006)			0	.50 ± 0.2 020 ± 0.0	5				0.50 ± 0 0.020 ± 0	).25		
	WVDC	16	25	50	16	25	50	100	16	25	50	100	200	16	25	50	100	200	500
Cap (pF)	0.5 1.0	C C	C C	C C	G G	G G	G G	G G	J	J J	J	J	J J	J	J	J	J	J	J J
	1.2 1.5	C C	C C	C C	G G	G G	G G	G G	J	J J	J	J J	J J	J	J	J	J J	J J	J J
	1.8	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	2.2 2.7	C C	C C	C C	G G	G G	G	G	J	J J	J	J	J J	J	J	J J	J J	J	J J
	3.3	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	3.9 4.7	C C	C C	C C	G G	G G	G G	G G	J	J J	J	J	J J	J	J	J	J	J	J J
	5.6 6.8	C C	C C	C C	G G	G G	G G	G G	J	J	J	J J	J J	J	J	J	J	J	J J
	8.2	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	10 12	C C	C C	C C	G G	G G	G	G	J	J J	J	J	J J	J	J	J J	J J	J	J J
	15	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	18 22	C C	C C	C C	G G	G G	G	G	J	J J	J	J	J J	J	J	J J	J	J	J J
	27 33	C C	C C	C C	G G	G G	G G	G G	J	J J	J	J	J J	J	J	J J	J J	J J	J J
	39	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	47 56	C C	C C	C C	G G	G G	G G	GG	J	J J	J	J	J J	J	J	J	J J	J J	J J
	68	С	С	С	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	82 100	C C	C C	C C	G G	G G	G G	GG	J	J J	J	J	J J	J	J	J J	J J	J	J J
	120 150	C C	C C	C C	G G	G G	G	G G	J	J	J	J	J	J	J	J	J J	J	J
	180	С	C	C	G	G	G	G	J J	J	J	J	J J	J	J	J J	J	J	J J
	220 270	C C	C C	C C	G G	G G	G	G	J J	J J	J	J	J M	J	J	J J	J J	J	M M
	330	С	С	С	G	G	G	G	J	J	J	J	М	J	J	J	J	J	М
	390 470	C C	C C	C C	G G	G G	G	G	J	J J	J	J	M M	J	J	J J	J	J	M M
	560 680				G G	G G	G G		J	J J	J	J	М	J	J	J	J J	J J	M P
	820				G	G	G		J	J	J	J		J	J	J	J	M	F
	1000 1200				G	G G	G		J J	J J	J	J		J	J	J J	J	Q Q	
	1500								J	J	J			J	J	J	М	Q	
	1800 2200								J	J J	J			J	J	M M	M P		1
	2700 3300								J J	J J	N			J	J	M M	P P		
	3900								J	J				J	J	М	Р		
	4700 5600								J	J				J	J	M M	Р		
	6800 8200													M M	M M				
Cap	0.010													M	M				
(pF)	0.012 0.015																		1
	0.018		ſ		$\sim$	<-₩-	*												
	0.022 0.027			$\leq$		ر ل	ÎT -												
	0.033 0.039						¥.												
	0.047		Ļ						l										
	0.068 0.082			1	111		I												
	0.1	16	25	FO	16	0E	50	100	16	<b>2</b> E	50	100	m	10	~	50	100	200	FTC
	WVDC SIZE	16	25 LD02	50	16	25 LD	50 50	100	16	25	50 LD05	100	200	16	25	50 LDO	100 <b>6</b>	200	500
Letter	A		-	E	G		J	K	M		N	P		2	X		-	Z	1
Max.	0.33	0.5	56	0.71	0.90	_	.94	1.02	1.27		1.40	1.52	1.7	78	2.29	2.54		2.79	1
Thickness	(0.013)	(0.0		(0.028)	(0.035	i) (0.	.037)	(0.040)	(0.050	0) (0	.055)	(0.060)	(0.0		(0.090)	(0.10	D) ((	0.110)	4
I				PAPER								EM	BOSSED						4





## COG (NP0) - Capacitance Range

#### **PREFERRED SIZES ARE SHADED**





### X8R – General Specifications





AVX Corporation will support those customers for commercial and military Multilayer Ceramic Capacitors with a termination consisting of 5% minimum lead. This termination is indicated by the use of a "B" in the 12th position of the AVX Catalog Part Number. This fulfills AVX's commitment to providing a full range of products to our customers. AVX has provided in the following pages a full range of values that we are currently offering in this special "B" termination. Please contact the factory if you require additional information on our MLCC Tin/Lead Termination "B" products.

**Not RoHS Compliant** 

### PART NUMBER (SEE PAGE 4 FOR COMPLETE PART NUMBER EXPLANATION)



LD04 has the same CV ranges as LD03.

NOTE: Contact factory for availability of Tolerance Options for Specific Part Numbers. Contact factory for non-specified capacitance values.





X8R – Specifications and Test Methods

Parame	ter/Test	X8R Specification Limits	Measuring	Conditions
Operating Tem		-55°C to +150°C	Temperature C	cycle Chamber
Сарас	itance	Within specified tolerance	Freg.: 1.0	∠U-7 + 10%
Dissipatio	on Factor	$\leq$ 2.5% for ≥ 50V DC rating $\leq$ 3.5% for 25V DC and 16V DC rating	Voltage: 1.0	
Insulation	Resistance	100,000MΩ or 1000MΩ - μF, whichever is less	Charge device with 120 ± 5 secs @ roo	
Dielectric	Strength	No breakdown or visual defects	Charge device with 250 1-5 seconds, w/charge limited to 50 Note: Charge device wit for 500V	and discharge current 0 mA (max) h 150% of rated voltage
	Appearance	No defects	Deflectio	
Resistance to	Capacitance Variation	≤ ±12%	Test Time: 3	30 seconds 7 1mm/sec
Flexure Stresses	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3	90	
Solder	ability	≥ 95% of each terminal should be covered with fresh solder	Dip device in eutection for 5.0 ± 0.	
	Appearance	No defects, <25% leaching of either end terminal		
	Capacitance Variation	≤ ±7.5%		
Resistance to Solder Heat	Dissipation Factor	Meets Initial Values (As Above)	Dip device in eutectic seconds. Store at room hours before measurin	temperature for 24 ± 2
	Insulation Resistance	Meets Initial Values (As Above)	nours before measurin	g electrical properties.
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
	Capacitance Variation	≤ ±7.5%	Step 2: Room Temp	≤ 3 minutes
Thermal Shock	Dissipation Factor	Meets Initial Values (As Above)	Step 3: +125°C ± 2°	30 ± 3 minutes
	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles 24 ± 2 hours at ro	
	Appearance	No visual defects		
	Capacitance Variation	≤ ±12.5%	Charge device with 1.5 test chamber se	
Load Life	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	for 1000 ho	
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from test chamb temperature for 24 ± 2 h	
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects	4	
	Capacitance Variation	≤ ±12.5%	Store in a test chamber s 5% relative humid	
Load Humidity	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	(+48, -0) with rate	d voltage applied.
numuity	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from chamber temperature ar	nd humidity for
	Dielectric Strength	Meets Initial Values (As Above)	24 ± 2 hours be	rore measuring.





## X8R – Capacitance Range

	SI	ZE			LD0	3			L	D05			LD06	
		WVD	С	2	5V	50V			25V	5	0V	25V		50V
271	Cap	270		(	3	G	ĺ							
331	(pF)				3	G			J		J			
471		470		(	G	G			J		J			
681		680		(	3	G	Î		J		J			
102		1000		(	3	G			J		J	J		J
152		1500		(	3	G			J		J	J	1	J
182		1800		(	G	G			J		J	J		J
222		2200		(	3	G	ĺ		J		J	J		J
272		2700		(	G	G			J		J	J		J
332		3300			G	G			J		J	J	1	J
392		3900			3	G			J		J	J		J
472		4700		(	3	G			J		J	J		J
562		5600		(	3	G			J		J	J		J
682		6800			3	G			J		J	J		 J
822	Сар				G	G			J		J	J		 J
103	(µF)				3	G			J		J	J		J
123		0.012			3	G			J		J	J		J
153		0.015			3	G			J		J	J		J
183		0.018			3	G			J		J	J		J
223		0.022			G	G			J		J	J		J
273		0.027			3	G			J		J	J		J
333		0.033			3	G			J		J	J		J
393		0.039			G	G			 J		J	J		 J
473		0.047			3	G			J		J	J		J
563		0.056			G	-			N		N	M		M
683		0.068			G				N		N	M		M
823		0.082							N		N	M		M
104		0.1							N		N	M		M
124		0.12							N		N	М		М
154		0.15		1					N		N	M		M
184		0.18							N			M		M
224		0.22							N			M		M
274		0.27		1								M		M
334		0.33		1				-		1		M		M
394		0.39		1						1		M		
474		0.47		1								M		
684		0.68		1										
824		0.82		1										
105		1		1										
		WVD	С	2	5V	50V			25V	5	0V	25V		50V
	SI		-		LDO					D05		207	LD06	
Letter	A	C	E	G	J	K	N	M	N	P	Q	X	Y	Z
	0.33	0.56	0.71	0.90	0.94	1.02		27	1.40	1.52	1.78	2.29	2.54	2.79
Max.														
Thickness	(0.013)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.0	)50)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)
			PAPER						I	EMB	OSSED			



### X7R – General Specifications





AVX Corporation will support those customers for commercial and military Multilayer Ceramic Capacitors with a termination consisting of 5% minimum lead. This termination is indicated by the use of a "B" in the 12th position of the AVX Catalog Part Number. This fulfills AVX's commitment to providing a full range of products to our customers. AVX has provided in the following pages a full range of values that we are currently offering in this special "B" termination. Please contact the factory if you require additional information on our MLCC Tin/Lead Termination "B" products.

## **Not RoHS Compliant**

#### PART NUMBER (SEE PAGE 4 FOR COMPLETE PART NUMBER EXPLANATION)



See FLEXITERM® section for CV options

Contact factory for availability of Tolerance Options for Specific Part Numbers. NOTE: Contact factory for non-specified capacitance values.















Variation of Impedance with Chip Size Impedance vs. Frequency 100,000 pF - X7R







## **X7R – Specifications and Test Methods**

Parame	ter/Test	X7R Specification Limits	Measuring	Conditions
Operating Tem	perature Range	-55°C to +125°C	Temperature C	ycle Chamber
Сарас	itance	Within specified tolerance		
Dissipati	on Factor	≤ 10% for ≥ 50V DC rating ≤ 12.5% for 25V DC rating ≤ 12.5% for 25V and 16V DC rating ≤ 12.5% for ≤ 10V DC rating	Freq.: 1.0 k Voltage: 1.0	
Insulation	Resistance	100,000MΩ or 1000MΩ - μF, whichever is less	Charge device with 120 ± 5 secs @ roc	
Dielectric	Strength	No breakdown or visual defects	Charge device with 250 1-5 seconds, w/charge limited to 50 Note: Charge device with for 500V	and discharge current mA (max) 150% of rated voltage
	Appearance	No defects	Deflectio	n: 2mm
Resistance to	Capacitance Variation	≤ ±12%	Test Time: 3	3 <b>0 seconds</b> 7 1mm/sec
Flexure Stresses	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3	90 r	mm
Solder	ability	≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic for 5.0 ± 0.9	
	Capacitance         Variation         Dissipation         Factor         Insulation         Resistance         Olderability         Appearance         Capacitance         Variation         Resistance         Dissipation         Factor         Insulation         Resistance         Dissipation         Factor         Insulation         Resistance         Dielectric         Strength         Appearance         Capacitance         Dielectric         Strength         Appearance         Capacitance         Variation         Dissipation	No defects, <25% leaching of either end terminal		
		≤ ±7.5%		
Resistance to Solder Heat		Meets Initial Values (As Above)	Dip device in eutectic s seconds. Store at room	temperature for 24 ± 2
		Meets Initial Values (As Above)	hours before measuring	g electrical properties.
		Meets Initial Values (As Above)		
		No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
		≤ ±7.5%	Step 2: Room Temp	≤ 3 minutes
Thermal Shock		Meets Initial Values (As Above)	Step 3: +125°C ± 2°	30 ± 3 minutes
		Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
		Meets Initial Values (As Above)	Repeat for 5 cycles 24 ± 2 hours at ro	
	Appearance	No visual defects		
		≤ ±12.5%	Charge device with 1.5 r test chamber set	rated voltage (≤ 10V) in
Load Life	•	≤ Initial Value x 2.0 (See Above)	for 1000 hou	
		≥ Initial Value x 0.3 (See Above)	Remove from test chamb temperature for 24 ± 2 h	
		Meets Initial Values (As Above)		
		No visual defects		
		≤ ±12.5%	Store in a test chamber s 5% relative humidi	
Load Humidity	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	(+48, -0) with rated	d voltage applied.
numany	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from chamber temperature an	d humidity for
	Dielectric Strength	Meets Initial Values (As Above)	24 ± 2 hours bef	ore measuring.





### X7R – Capacitance Range

### **PREFERRED SIZES ARE SHADED**

			•					8														Ē	1			
SIZE			LD02	2				LD03	3						LD05	;						LD	06			
Solder	ing	Ret	flow/W	/ave			Ref	low/W	/ave					Ref	low/W	/ave						Reflow	/Wave			
Packad	ina	A	ll Pap	er			A	II Pap	er					Paper	/Emb	osse	d				Pa	per/En	nbos	sed		
(L) Length	mm (in.)	1.	00 ± 0 40 ± 0	.10			1.6	60 ± 0 63 ± 0	.15					2.0	01 ± 0. 79 ± 0.	.20	-					3.20 ± 0.126 ±	0.20			
	(in.) mm		$\frac{40 \pm 0}{50 \pm 0}$					<u>53 ± 0</u> B1 ± 0							$79 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.25 \pm 0.$						(	<u>0.120 ±</u> 1.60 ±		5)		
W) Width	(in.)		20 ± 0					32 ± 0							49 ± 0.						(	0.063 ±		3)		
(t) Terminal	mm (in.)		25 ± 0 10 ± 0					35 ± 0 14 ± 0					-		50 ± 0. 20 ± 0.						(	0.50 ± 0.020 ±		))		
WVD		16		50	6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200	6.3	10	16	25	50		200	500
Сар	100																									
(pF)	150																									
	220			С																						
	330			С					G	G	G		J	J	J	J	J	J								K
	470			C					G	G	G		J	J	J	J	J	J								K
	680			C					G	G	G		J	J	J	J	J	J								K
	1000 1500			C C					G G	G G	G		J	J	J	J	J	J								K
	2200			C					G	G			J	J	J	J	J	J		J	J	J	J J	J	J J	M M
	3300		С	C					G	G			J	J	J	J	J	J		J	J	J			J	M
	4700		c	c					G	G			J	J	J	J	J	J		J	J	J	J	3	J	M
	6800	С	c						G	G			J	J	Ĵ	Ĵ	Ĵ	Ĵ		J	Ĵ	J	J	J	J	P
Сар	0.010	C	C						G	G			J	J	J	J	J	J		J	J	J	J	J	J	P
(µF)	0.015	С						G	G				J	J	J	J	J	J		J	J	J	J	J	М	
. ,	0.022	С						G	G				J	J	J	J	J	N		J	J	J	J	J	М	
	0.033	С						G	G				J	J	J	J	N			J	J	J	J	J	М	
	0.047						G	G	G				J	J	J	J	N			J	J	J	J	J	М	
	0.068					_	G	G	G				J	J	J	J	N			J	J	J	J	J	P	
	0.10		C*		0	G	G	G	G				J	J	J	J	N			J	J	J	J	P	Р	
	0.15 0.22				G	G G							J	J	J	N	N			J	J	J	J J	Q		
	0.22				G	G							N	J	N	N	N N			J	J	M	 P	Q		
	0.33							J*					N	N	N	N	N			M	M	M	P	Q		
	0.47							J					N	N	N	IN	IN			M	M	Q	Q	Q		
	1.0					J*	J*						N	N	N*					M	M	Q	<del>0</del>	Q		
	1.5					-	-													P	Q	Q				
	2.2				J*										P*					Q	Q	Q				
	3.3																									
	4.7												P*	P*						Q*	Q*	Q*				
L	10											P*	Р							Q*	Q*	Q				
	22																		Q*							
	47 100																									
	WVDC	16	25	50	6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200	500
	SIZE	10	LD02		0.3	10		LD03		100	200	0.0	10		LD05		100	1200	0.0	10	10	LD		100	200	000
<b>1</b> - 44 - 1	•	_	0	_	-		0	-	_							-			_	V		V		7	-	
Letter	A	-	<u>C</u>		E	-	G	+	J		K		M 07	N		P		Q		<u>X</u>		Y	-	Z	_	
Max.	0.33		0.56		0.71		).90		).94		02		27	1.4	-	1.5		1.78		2.29		2.54		2.79		
Thickness	(0.013)	((	(0.022) (0.028) (0.035) (0.037) PAPER							(0.0	040)	0.0	) (050	(0.0	55)	(0.06		(0.07	U)   (U	(0.090	)   (נ	0.100)	(0	).110)	_	
l				P	APER											E	MBOS	SED								

= Under Development





### X7R – Capacitance Range

#### **PREFERRED SIZES ARE SHADED**

SIZE	Ξ				LD10					LD	12		LD	13		LD	20		LD	14
Solder	ing			F	eflow Only	,				Reflow	v Only		Reflov	/ Only		Reflow	w Only		Reflow	v Only
Packad	ling			Pap	er/Embos	sed				All Emb	oossed		All Emb	ossed		All Em	bossed		All Emi	oossed
(L) Length	mm			3	.20 + 0.20					4.50 ±	£ 0.30		4.50 ±	0.30		5.70 :	± 0.50		5.72 ±	£ 0.25
	(in.)				126 ± 0.00					(0.177 ±		)	(0.177 ±				± 0.020)			± 0.010)
W) Width	mm (in.)				2.50 ± 0.20 098 ± 0.00					3.20 ±		)	6.40 ± (0.252 ±				± 0.40 ± 0.016)		6.35 ± (0.250 ±	£ 0.25 £ 0.010)
(t) Terminal	mm (in.)				0.50 ± 0.25 020 ± 0.01					0.61 ±		<u> </u>	0.61 ±			0.64 :	± 0.39 ± 0.015)		0.64	
WVD		10	16	25	50 <u>50</u>	100	200	500	50	100	200	500	50	100	25	50	<u>= 0.015)</u> 100	200	50	100
Сар	100																1			
(pF)	150																~		<u></u>	>
	220											_				+ <	$\leq$	_	7)-	Îτ I
	330 470																	ר ר		*'
	680																	<u> </u>		
	1000															Т		<b>t</b>		1
	1500	J	J	J	J	J	J	M										1		
	2200 3300	 	J	J	J	 	J	M				-								
	4700	J	J	J	J	J	J	M												
	6800	J	J	J	J	J	J	М												
Сар	0.010	J	J	J	J	J	J	М	К	К	K	К	М	М		Х	X	Х	М	Р
(µF)	0.015	J	J	J	J	J	J	P	K	K	K	P	M	M		X	X	X	M	P P
	0.022	 	J	J	J	 	J	Q Q	K K	K K	K K	<u>Р</u> Х	M	M		X	X X	X X	M M	<u>Р</u> Р
	0.033	J	J	J	J	J	J	¥	ĸ	ĸ	ĸ	Z	M	M		x	x	x	M	P
	0.068	J	J	J	J	J	М		К	К	К	Z	М	М		Х	Х	Х	М	Р
	0.10	J	J	J	J	J	M		К	K	K	Z	М	М		Х	X	X	М	Р
	0.15 0.22	J J	J	J	J	M P	Z Z		K K	K K	P P		M M	M M		X X	X X	X X	M M	P P
	0.22	J	J	J	J	Q	2		K	M	X		M	M		X	x	x	M	P
	0.47	М	М	М	М	Q			к	Р			м	М		х	X	х	М	Р
	0.68	М	М	P	X	X			М	Q			М	P		Х	X		M	P
	1.0 1.5	N N	N N	P Z	X Z	Z Z			M Z	X Z			M M	Р		X X	X X		M M	P X
	2.2	X	X	Z	Z	Z			z	Z			IVI			x	x		M	^
	3.3	Х	X	Z	Z			1	Z							Х	Z			
	4.7	Х	Х	Z	Z				Z							X	Z			
	10 22	Z Z	Z	Z	Z			+							Z	Z	Z			
	22 47	2	2												2					
	100																			
	WVDC	10	16	25	50	100	200	500	50	100	200	500	50	100	25	50	100	200	50	100
SIZE					LD10					LD	12		LD	13		LD	20		LD	14
Letter	Α	(		E	G		J	K	M		N	Р	Q		X	Y	Z			
Max.	0.33	0.		0.71	0.90	0.		1.02	1.27		40	1.52	1.78		29	2.54	2.79			
Thickness	(0.013)	(0.0	22)	(0.028)	(0.035)	(0.0	)37)	(0.040)	(0.050	) (0.0	)55)	(0.060)		)   (0.0	090)	(0.100)	(0.110	D)		
l				PAPER					_			EMB	DSSED							



### X5R – General Specifications





AVX Corporation will support those customers for commercial and military Multilayer Ceramic Capacitors with a termination consisting of 5% minimum lead. This termination is indicated by the use of a "B" in the 12th position of the AVX Catalog Part Number. This fulfills AVX's commitment to providing a full range of products to our customers. AVX has provided in the following pages a full range of values that we are currently offering in this special "B" termination. Please contact the factory if you require additional information on our MLCC Tin/Lead Termination "B" products.

**Not RoHS Compliant** 

### PART NUMBER (SEE PAGE 4 FOR COMPLETE PART NUMBER EXPLANATION)



\*LD04 has the same CV ranges as LD03.

NOTE: Contact factory for availability of Tolerance Options for Specific Part Numbers. Contact factory for non-specified capacitance values.

## **TYPICAL ELECTRICAL CHARACTERISTICS**









## X5R – Specifications and Test Methods

Parame	ter/Test	X5R Specification Limits	Measuring	Conditions
		-55°C to +85°C	Temperature C	ycle Chamber
Capac	itance	Within specified tolerance		
Dissipatio	on Factor	$\leq$ 2.5% for $\geq$ 50V DC rating $\leq$ 3.0% for 25V, 35V DC rating $\leq$ 12.5% Max. for 16V DC rating and lower Contact Factory for DF by PN	Freq.: 1.0 k Voltage: 1.0 For Cap > 10 μF, 0	Vrms ± .2V
Insulation	Resistance	10,000MΩ or 500MΩ - μF, whichever is less	Charge device with 120 ± 5 secs @ roc	
Dielectric	Strength	No breakdown or visual defects	Charge device with 250 1-5 seconds, w/charge limited to 50	and discharge current
	Appearance	No defects	Deflectio	
Resistance to	Capacitance Variation	≤ ±12%	Test Time: 3	8 <b>0 seconds</b> 7 1mm/sec
Flexure Stresses	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3	90 r	
Solder	ability	≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic for 5.0 ± 0.	
	Appearance	No defects, <25% leaching of either end terminal		
	Capacitance Variation	≤ ±7.5%		
Resistance to Solder Heat	Dissipation Factor	Meets Initial Values (As Above)	Dip device in eutectic s seconds. Store at room	temperature for 24 ± 2
	Insulation Resistance	Meets Initial Values (As Above)	hours before measuring	g electrical properties.
	ation Resistance ectric Strength  to Capacitance Variation Dissipation Factor Insulation Resistance  colderability  to to to to to to to to to to to to to	Meets Initial Values (As Above)		
	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
		≤ ±7.5%	Step 2: Room Temp	≤ 3 minutes
Thermal Shock		Meets Initial Values (As Above)	Step 3: +85°C ± 2°	30 ± 3 minutes
		Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Strength	Meets Initial Values (As Above)	Repeat for 5 cycles 24 ± 2 hours at ro	
		No visual defects		· · · · · · ·
		≤ ±12.5%	Charge device with 1.5 chamber set at 85°C : (+48, -0). Note: Contac	± 2°C for 1000 hours
Load Life		≤ Initial Value x 2.0 (See Above)	specification part num < 1.5X rate	bers that are tested at
		≥ Initial Value x 0.3 (See Above)	Remove from test chamb	Ū
		Meets Initial Values (As Above)	temperature for $24 \pm 2 h$	ours before measuring.
		No visual defects		
	te to e Solderability Appearance Capacitance Variation Factor Insulation Resistance Capacitance Variation Eactor Dissipation Factor Insulation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dielectric Strength Appearance Capacitance Variation Resistance Dissipation Factor Dissipation Factor Dissipation Resistance Dielectric Strength Appearance Capacitance Variation Resistance	≤ ±12.5%	Store in a test chamber s 5% relative humidi	
Load Humidity		≤ Initial Value x 2.0 (See Above)	(+48, -0) with rated	
Fulliuity		≥ Initial Value x 0.3 (See Above)	Remove from chamber temperature an	d humidity for
		Meets Initial Values (As Above)	24 ± 2 hours bef	ore measuring.





### X5R – Capacitance Range

### **PREFERRED SIZES ARE SHADED**

																	α	П																			
SIZ	E			LI	D02					L	D03	3					LD	05					LD	06					l	.D10	)				LD1	12	
Solder	ring		F	leflo	w/W	ave				Reflo	w/V	Vave				R	eflow	/Wav	/e			Re	eflow	/Wa	ve				Refle	ow/V	Vave						
Packa	ging			All I							Pap				P		er/Er			d	P		r/Er			d		Pa		'Emb		ed					
(L) Length	mm (in.)			1.00		10 004)				1.60 0.063			- )				01 ± 079 ±						.20 ± 126 ±							0 ± 0							
W) Width	(in.) mm			0.50				1		0.81			5)				.25 ±						.60 ±							6 ± 0 0 ± 0		)					-
vv) vvidtri	(in.)			.020 0.25		004)		-	(0	0.3			5)				049 ±						063 ±					(		8 ± 0 0 ± 0		)					
(t) Terminal	mm (in.)					006)			(0	0.3: 0.014			5)				020 ±						.50 ± )20 ±					(		0 ± 0 0 ± 0		)					
WVD		4	6.3	10	16	25	50	4	6.3	10	16	25	35	50	6.3	10	16	25	35	50	6.3	10	16	25	35	50	4	6.3	10	16	25	35	50	6.3	10	25	50
Cap	100																																				
(pF)	150 220						С																														
	330						C																				_'				>		_	-v	V	_	
	470						C																					-	<		<	$\sim$	_	5	jج	Ē	
	680						С																						(		5	7		L	ノ	Г	
	1000						С																			ΙT	-			<u> </u>	l	$\downarrow$	/				]
	1500						C																								-	T					
	2200 3300						C C	-									-										<u> </u>	-									
	4700					С	U							G																							
	6800					С								G																							
Сар	0.010					С								G																							
(µF)	0.015					С						G	G	G																							
	0.022				C	С						G	G	G						N													_		$\square$		
	0.033 0.047				C C	С						G G	G G	G G						N N																	
	0.047				c							G	0	G						N																	
	0.10			С	C	С						G		G				Ν		N								_									
	0.15											G			1			Ν	Ν																		
	0.22		C*								G	G						Ν	Ν							Q									$\square$		_
	0.33	Orth	0.1								G	G						N						0	•								×				
	0.47 0.68	C*	C*								G G							N N						Q	Q								X				
	1.0	C*	C*	C*					G	G	G	J*					N	N		P*				Q	Q			_			Х	X	X				_
	1.5																							4	4												
	2.2	C*						G*	G*	J*	J*					Ν	Ν	Ν					Q	Q							Ζ	X					
	3.3							J*	J*	J*	J*				N	N					Х	Х								-	_						
	4.7							J* K*	J*	J*					N P	N P	N*	N*			X	X	X	X					V	Q	Z					7	
	10 22	-	-	-	-	-		K^	-		-	-	-		Р Р*	P				-	X X	X X	X X	X X	-			Z	X Z	Z Z	Z Z	-	-	-	┝╌┡	Ζ	$\neg$
	47																				x	A	A	A				Z*	2	-	2						
	100																										Z*	Z									
	WVDC	4	6.3	·		25	50	4	6.3				35	50	6.3	10	16		35	50	6.3	10		25	35	50	4	6.3	10	16	25	35	50	6.3	· · ·	_	50
	SIZE			LI	D02					L	D03	3					LD	05					LD	06					l	.D10	)				LD1	12	
Letter	А			2		E			G			J			Κ		Ν			Ν			Ρ			Q			Х		Y		Γ	Z			
Max.	0.33			56		0.71 0.90 (0.028) (0.035)			).94			.02	. [	1.			1.4			1.52			1.78			.29		2.5			2.7						
Thickness	(0.013)		(0.(	)22)				((	1.03	5)	(0	.03	/)	(0.	.040	<u>)</u>	(0.0	50)	(	0.0	55)	(	0.06 FN	0) //ВС	1.	.070	J)	(0.	090		(0.1	00)	(	0.11	0)		
l			PAPER											_			_			_		nDC	000	LD							_						

#### \*Optional Specifications – Contact factory

NOTE: Contact factory for non-specified capacitance values



# **Automotive MLCC**

## **General Specifications**





#### **GENERAL DESCRIPTION**

AVX Corporation has supported the Automotive Industry requirements for Multilayer Ceramic Capacitors consistently for more than 25 years. Products have been developed and tested specifically for automotive applications and all manufacturing facilities are QS9000 and VDA 6.4 approved.

AVX is using AECQ200 as the qualification vehicle for this transition. A detailed qualification package is available on request and contains results on a range of part numbers.

#### **HOW TO ORDER**



### **COMMERCIAL VS AUTOMOTIVE MLCC PROCESS COMPARISON**

	Commercial	Automotive
Administrative	Standard Part Numbers. No restriction on who purchases these parts.	Specific Automotive Part Number. sed to control supply of product to Automotive customers.
Design	Minimum ceramic thickness of 0.020"	Minimum Ceramic thickness of 0.029" (0.74mm) on all X7R product.
Dicing	Side & End Margins = 0.003" min	Side & End Margins = 0.004" min Cover Layers = 0.003" min
Lot Qualification (Destructive Physical Analysis - DPA)	As per EIA RS469	Increased sample plan stricter criteria.
Visual/Cosmetic Quality	Standard process and inspection	100% inspection
Application Robustness	Standard sampling for accelerated wave solder on X7R dielectrics	Increased sampling for accelerated wave solder on X7R and NP0 followed by lot by lot reliability testing.

All Tests have Accept/Reject Criteria 0/1



## **Automotive MLCC**

## NP0/X7R Dielectric



#### **FLEXITERM FEATURES**

#### a) Bend Test

The capacitor is soldered to the PC Board as shown:



Typical bend test results are shown below:

Style	Conventional	Soft Term
0603	>2mm	>5
0805	>2mm	>5
1206	>2mm	>5

a) Temperature Cycle testing

FLEXITERM<sup>®</sup> has the ability to withstand at least 1000 cycles between -55°C and +125°C



# **Automotive MLCC-NP0**



### **Capacitance Range**

SI⊿	ZE	04	02		06	03				0805					12	206		
Solde	ering	Reflow	/Wave		Reflow	/Wave			Re	eflow/Wa	ive				Reflov	v/Wave		
WV		25V	50V	25V	50V	100V	200V	25V	50V	100V	200V	250V	25V	50V	100V	200V	250V	500V
0R5	0.5	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
1R0	1.0	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
1R2	1.2	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
1R5	1.5	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
1R8	1.8	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
2R2	2.2	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
2R7	2.7	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
3R3	3.3	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
3R9	3.9	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
4R7	4.7	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
5R6	5.6	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
6R8	6.8	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
8R2	8.2	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
100	10.0	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
120	12	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
150	15	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
180	18	С	С	G	G	G	G	J	J	J	N	N						
220	22	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J J		
270	27	С	С	G	G	G	G	J	J	J	N	N						
330	33	С	С	G	G	G	G	J	J	J	N	N	J	J	J J	J	J	J
390	39	С	С	G	G	G	G	J	J	J	N	N	J	J	J	J	J	
470	47			G	G	G	G	J	J	J	N	N	J	J	J	J	J	J
510	51			G	G	G	G	J	J	J	N	N	J	J	J	J		
560	56			G	G	G	G	J	J	J	N	N	J	J	J	J		
680	68			G	G	G	G	J	J	J	N	N	J	J	J	J		
820	82			G	G	G	G	J	J	J	N	N	J	J	J	J		
101	100			G	G	G	G	J	J	J	N	N	J	J	J	J		
121	120			G	G	G		J	J	J	N	N	J	J	J	J		
151	150			G	G	G		J	J	J	N	N	J	J	J	J		
181	180			G	G	G		J	J	J	N	N	J	J	J	J		
221	220			G	G	G		J	J	J	N	N	J	J	J	J		
271	270			G	G	G		J	J	J	N	N	J	J	J	J		
331	330			G	G	G		J	J	J	N	N	J	J	J	J		
391	390			G	G			J	J	J			J	J	J	J		
471 561	470			G G	G			J	J	J			J	J	J	J		
	560			G	G			J J	J J	J J			J J	J J	J J	J J		
681 821	680 820			6	G					J								
102	1000							J J	J J	J			J J	J J	J	J J		
102	1200		1			1		J	J	J			J	J	J	J		
152	1200																	
152	1800																	
222	2200																	
272	2700							ļ										
332	3300																	
332	3900																	
472	4700																	
103	4/00 10nF																	
WV		25V 50V 25V 50V 100V 200						25V	50V	100V	200V	250V	25V	50V	100V	200V	250V	500V
				230			2000	230	300		2000	2300	230	300			2300	3000
Siz	ze	04	02		06	03				0805					12	206		

Letter	А	С	E	G	J	K	М	N	Р	Q	Х	Y	Z
Max.	0.33	0.56	0.71	0.90	0.94	1.02	1.27	1.40	1.52	1.78	2.29	2.54	2.79
Thickness	(0.013)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.050)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)
			PAPER						EMBC	SSED			



# Automotive MLCC - X7R



## **Capacitance Range**

	SIZE		0402	2				060	3					0	805						120	6				12	210		1	812		2220	
So	Idering	Ref	low/W	lave			Re	flow/V	Nave					Reflo	w/Wa	ve				Re	eflow/	Wave				Reflo	w Only	v	Reflo	w Only	Ref	low C	nly
	WVDC	16V	25V	50V	10V	16V	25V	50V	100V	200V	250V	16V	25V	50V	100V	200V	250V	16V	25V	50V	100V	200V	250V	500V	16V	25V	50V		50V	100V	25V	50V	100V
221	Cap 220	С	С	С											С				1														
271	(pF) 270	С	С	С																													
331	330	С	С	С																													
391	390	С	С	С																													
471	470	С	С	С																													
561	560	С	С	С																													
681	680	С	С	С																													
821	820	С	С	С																													
102	1000	С	С	С	G	G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	К	к	к	К	К	К			
182	1800	С	С	С	G	G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	К	к	к	К	К	К			
222	2200	С	С	С	G	G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	к	к	К	К	К	к			
332	3300	С	С	С	G	G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	К	к	К	К	к	к			
472	4700	С	С	С	G	G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	К	К	К	K	К	К			
103	Cap 0.01	С			G	G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	К	K	К	K	К	К			
123	(F) 0.012	С			G	G	G	G	G			J	J	J	N	N	N	J	J	J	J	J	J		К	К	К	K	К	К			
153	0.015	С			G	G	G	G	G			J	J	J	N	N	N	J	J	J	J	J	J		К	К	К	K	К	К			
183	0.018	С			G	G	G	G	G			J	J	J	N	N	N	J	J	J	J	J	J		К	К	К	K	К	К			
223	0.022	С			G	G	G	G	G			J	J	J	N	N	N	J	J	J	J	J	J		К	К	К	K	К	К			
273	0.027	С			G	G	G	G	J			J	J	J	N	N	N	J	J	J	J	J	J		К	К	К	К	К	К			
333	0.033	С			G	G	G	G	J			J	J	J	Ν	N	N	J	J	J	J	J	J		К	K	К	K	K	К			
473	0.047				G	G	G	G	J			J	J	J	Ν	N	N	J	J	J	М	М	M		К	K	К	K	K	К			
563	0.056				G	G	G	G	J			J	J	J	Ν			J	J	J	М	М	M		К	K	К	М	K	К			
683	0.068				G	G	G	G	J			J	J	J	Ν			J	J	J	М	М	М		К	К	K	М	К	К			
823	0.082				G	G	G	G	J			J	J	J	Ν			J	J	J	М	М	М		K	K	K	М	K	K			
104	0.1				G	G	G	G	J			J	J	J	Ν			J	J	J	М	Р	Р		K	K	K	М	K	K			
124	0.12				G							J	J	Ν	Ν			J	J	М	М	Q	Q		К	K	K	Р	K	K			
154	0.15				G							М	Ν	Ν	Ν			J	J	М	М	Q	Q		К	K	K	Р	K	K			
224	0.22				G							М	Ν	Ν	Ν			J	М	М	Q	Q	Q		М	М	М	Р	М	М			
334	0.33											Ν	Ν	Ν	Ν			J	М	Р	Q				Р	Р	Р	Q	Х	Х			
474	0.47											Ν	Ν	Ν	Ν			М	М	Р	Q				Р	Р	Р	Q	Х	Х			
684	0.68											Ν	Ν	Ν	Ν			М	Q	Q	Q				Р	Р	Q	Х	Х	Х			
105	1											Ν	Ν	Ν	Ν			М	Q	Q	Q				Р	Q	Q	Z	Х	Х		Ζ	Ζ
155	1.5											Ν	Ν					Q	Q	Q	Q				Р	Q	Z	Z	Х	Х		Ζ	Ζ
225	2.2											Ν	Ν					Q	Q	Q	Q				Х	Z	Z	Z	Z	Z		Ζ	Ζ
335	3.3																	Q	Q	Q					Х	Z	Z	Z	Z			Ζ	Ζ
475	4.7																	Q	Q	Q					Х	Z	Z	Z	Z			Ζ	Ζ
106	10																								Z	Z	Z		Z		Z	Ζ	Ζ
226	22																														Z		
1	WVDC	16V	25V	50V	10V	16V	25V			200V	250V	16V	25V	·		200V	250V	16V	25V	50V			250V	500V	16V			100V		100V		50V	100V
	Size		0402					0603	5					0	805						120	C				12	210		1	812		2220	

Letter	А	С	E	G	J	К	М	Ν	Р	Q	Х	Y	Z
Max.	0.33	0.56	0.71	0.90	0.94	1.02	1.27	1.40	1.52	1.78	2.29	2.54	2.79
Thickness	(0.013)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.050)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)
-			PAPER						EMB	OSSED			



# Automotive MLCC - X8R



## **Capacitance Range**

S	IZE	06	03	30	805	12	06
Solo	dering	Reflow	/Wave	Reflow	v/Wave	Reflow	/Wave
WVDC	WVDC	25V	50V	25V	50V	25V	50V
271	Cap 270	G	G				
331	(pF) 330	G	G	J	J		
471	470	G	G	J	J		
681	680	G	G	J	J		
102	1000	G	G	J	J	J	J
152	1500	G	G	J	J	J	J
182	1800	G	G	J	J	J	J
222	2200	G	G	J	J	J	J
272	2700	G	G	J	J	J	J
332	3300	G	G	J	J	J	J
392	3900	G	G	J	J	J	J
472	4700	G	G	J	J	J	J
562	5600	G	G	J	J	J	J
682	6800	G	G	J	J	J	J
822	8200	G	G	J	J	J	J
103	Cap 0.01	G	G	J	J	J	J
123	(F) 0.012	G	G	J	J	J	J
153	0.015	G	G	J	J	J	J
183	0.018	G	G	J	J	J	J
223	0.022	G	G	J	J	J	J
273	0.027	G	G	J	J	J	J
333	0.033	G	G	J	J	J	J
393	0.039	G	G	J	J	J	J
473	0.047	G	G	J	J	J	J
563	0.056	G		N	N	M	М
683	0.068	G		N	N	M	М
823	0.082			N	N	M	М
104	0.1			N	N	M	М
124	0.12			N	N	M	М
154	0.15			N	N	M	М
184	0.18			N		М	М
224	0.22			N		М	М
274	0.27					М	М
334	0.33					М	М
394	0.39					М	
474	0.47					М	
684	0.68						
824	0.82						
105	1						
WVDC	WVDC	25V	50V	25V	50V	25V	50V
S	IZE	06	03	08	805	12	06

Letter	A	C	E	G	J	K	М	N	Р	Q	X	Y	Z
Max.	0.33	0.56	0.71	0.90	0.94	1.02	1.27	1.40	1.52	1.78	2.29	2.54	2.79
Thicknes	s (0.013)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.050)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)
			PAPER						EMBO	DSSED			



# APS for COTS+ High Reliability Applications



## General Specifications Surface Mount NP0, X7R and X8R/L MLCCs



AVX's APS COTS+ series of multilayer ceramic capacitors offers the customer a high reliability solution with an ultralow failure rate, <1ppb, in a variety of case sizes and voltages. The APS range encompasses a wide range of dielectric types to meet the customer's requirements from low temperature/voltage capacitance change dielectric, NP0, to high preforming capacitance voltage X7R to high temperature reliability dielectrics, X8R/L.

APS capacitors have a wider capacitance range than MIL spec parts that satisfies the need for higher CV demands and board space saving requirements. Each production lot is extensively tested and removes the requirement for customer specific drawings. The testing regime uses many of the MIL-STD test methods as per MIL-PRF-55681 and has a field failure rate of less than 1 ppb. The APS testing series uses AVX's unique in-house maverick testing detection system that eliminates infant mortality failures.

Applications suitable for APS include Industrial, Telecommunications, Aviation, and Military. The APS is available with a range of different termination finishes, Flexiterm®, Nickel / Tin and Tin with Pb1. Flexiterm® technology delivers improved thermo-mechanical stress resistance.

#### AVX'S APS RELIABILITY TEST SUMMARY

- 100% Visual Inspection
- DPA

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- IR, DF, Cap, DWV
- Maverick Lot Review
- Thermal Shocl
- 85/85 Testing
- Additional Life Testing
- C of C with every Order
- Quarterly Data Package

### **HOW TO ORDER**

### FEATURES

- The APS range has been extensively reliability tested as standard resulting in an ultralow failure rate, ≤1ppb
- The APS range is available with Flexiterm<sup>®</sup> that deliver's high thermo-mechanical stress resistance.
- High CV range enabling board space saving requirements.

Dielectric	Temperature/Percentage Cap Change
NP0	-30ppm +30ppm from -55°C + 125°C
X7R	-15% +15% from -55°C to + 125°C
X8R	-15% +15% from -55°C to + 150°C
X8L	-15% +40% from -55°C to + 150°C



NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Number.



# **APS COTS+ NP0 Series**



Rohs

### **Capacitance Range**

AP	03 = 060	)3	A	P05 = 08	05		A	P06 = 12	206			AP1	0 = 1210		
25V	50V	100V	25V	50V	100V	25V	50V	100V	200V	500V	25\	/ 50V	100V	200V	
G	G	G	J	J	J	J	J	J	J	J					
G	G	G	J	J	J	J	J	J	J	J					
G	G	G	J	J	J	J	J	J	J	J					
G	G	G	J	J	J	J	J	J	J						
G	G	G	J	J	J	J	J	J	J						
G	G	G	J	J	J	J	J	J	J						
G	G	G	J	J	J	J	J	J	J						
G	G	G	J	J	J	J	J	J	J						
G	G	G	J	J	J	J	J	J	J						
G	G	G	J	J	J	J	J	J	J						
G	G	G	J	J	J	J	J	J	J						
G	G	G	J	J	J	J	J	J	J				_		
G	G	G	J	J	J	J	J	J	J			_	_	<u> </u>	
G	G	G	J	J	J	J	J	J	J				_	<u> </u>	
G	G	G	J	J	J	J	J	J	J						
G G	G G	G G	J	J	J	 	J		J				-		
G	G	G	J J	J	J J		J	 	J				_		
G	G	G	J	J	J		J	 	J				_	<u>├</u>	
G	G	G	J	J	J		J	J	J						
G	G	0	J	J	J	J	J	J	J						
G	G		J	J	J		J	 	J						
	0		J	J	J		J	J	J					11	
			J	J	J	J	J	J	J						
			J	J	J	J	J	J	J						
			J	J	J	J	J	J	J		J	J	J	J	
											J	J	M	M	
Ì								1			J	J	M	M	
							1		1		J	J	M	M	
											J	J	M	М	
25V	50V	100V	25V	50V	100V	25V	50V	100V	200V	500V	25\	· · · · · · · · · · · · · · · · · · ·	100V	200V	
AP	03 = 060	)3	A	P05 = 08	05		A	P06 = 12	206			AP1	0 = 1210		•
Δ	0		F	G		k		м	N	P		0	X	Y	Z
	-										2				2.79
												-			(0.110)
(0.013)	(0.02			(0.035)	(0.037	, (0.0	40)	(0.050)	(0.055)				(0.090)	(0.100)	(0.110)
AP( 0.33 (0.013)		C 0.56	C 0.56 (0.022) (0	C E 0.56 0.71	C         E         G           0.56         0.71         0.90           (0.022)         (0.028)         (0.035)	C         E         G         J           0.56         0.71         0.90         0.94           (0.022)         (0.028)         (0.035)         (0.037)	C         E         G         J         k           0.56         0.71         0.90         0.94         1.0           (0.022)         (0.028)         (0.035)         (0.037)         (0.0	C         E         G         J         K           0.56         0.71         0.90         0.94         1.02           (0.022)         (0.028)         (0.035)         (0.037)         (0.040)	C         E         G         J         K         M           0.56         0.71         0.90         0.94         1.02         1.27           (0.022)         (0.028)         (0.035)         (0.037)         (0.040)         (0.050)	C         E         G         J         K         M         N           0.56         0.71         0.90         0.94         1.02         1.27         1.40           (0.022)         (0.028)         (0.035)         (0.037)         (0.040)         (0.050)         (0.055)	C         E         G         J         K         M         N         P           0.56         0.71         0.90         0.94         1.02         1.27         1.40         1.55           (0.022)         (0.028)         (0.035)         (0.037)         (0.040)         (0.050)         (0.055)         (0.060)	C         E         G         J         K         M         N         P           0.56         0.71         0.90         0.94         1.02         1.27         1.40         1.52           (0.022)         (0.028)         (0.035)         (0.037)         (0.040)         (0.050)         (0.055)         (0.060)	C         E         G         J         K         M         N         P         Q           0.56         0.71         0.90         0.94         1.02         1.27         1.40         1.52         1.78           (0.022)         (0.028)         (0.035)         (0.037)         (0.040)         (0.050)         (0.055)         (0.060)         (0.070)	C         E         G         J         K         M         N         P         Q         X           0.56         0.71         0.90         0.94         1.02         1.27         1.40         1.52         1.78         2.29           (0.022)         (0.028)         (0.035)         (0.037)         (0.040)         (0.050)         (0.055)         (0.060)         (0.070)         (0.090)	C         E         G         J         K         M         N         P         Q         X         Y           0.56         0.71         0.90         0.94         1.02         1.27         1.40         1.52         1.78         2.29         2.54           (0.022)         (0.028)         (0.035)         (0.037)         (0.040)         (0.050)         (0.055)         (0.060)         (0.070)         (0.090)         (0.100)

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# **APS COTS+ X7R Series**



## **Capacitance Range**

	Size		AP	903 = 06	503			AP	05 = 0	805				AP06 =	= 1206				AP10	= 1210	)	AP12:	= 1812	AP2	20 = 22	220
\	VVDC	16V	25V	50V	100V	200V	16V	25V	50V	100V	200V	16V	25V	50V	100V	200V	500V	16V	25V	50V	100V	50V	100V	25V	50V	100V
102	Cap 1000	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	К	K	K	K	К	к			
182	(pF) 1800	G	G	G	G		J	J	J	J	J	J	J	J	J	J	J	К	K	K	K	ĸ	К			
222	2200	G	G	G	G		J	J	J	J	J	J	J	J	J	J	J	К	К	K	K	K	K			
332	3300	G	G	G	G		J	J	J	J	J	J	J	J	J	J	J	К	К	K	K	K	K			
472	4700	G	G	G	G		J	J	J	J	J	J	J	J	J	J	J	К	К	K	K	K	K			
103	0.01	G	G	G	G		J	J	J	J	J	J	J	J	J	J	J	К	К	K	K	K	K			
123	0.012	G	G	G			J	J	J	М		J	J	J	J	J		К	К	К	K	К	К			
153	0.015	G	G	G			J	J	J	М		J	J	J	J	J		К	К	К	K	К	К			
183	0.018	G	G	G			J	J	J	М		J	J	J	J	J		К	К	K	К	К	К			
223	0.022	G	G	G			J	J	J	М		J	J	J	J	J		К	K	K	К	К	К			
273	0.027	G	G	G			J	J	J	М		J	J	J	J	J		К	К	К	К	К	К			
333	0.033	G	G	G			J	J	J	М		J	J	J	J	J		К	K	K	К	К	К			
473	0.047	G	G	G			J	J	J	М		J	J	J	М	J		К	К	K	K	K	К			
563	0.056	G	G	G			J	J	J	M		J	J	J	М	J		К	К	K	М	K	К			
683	0.068	G	G	G			J	J	J	М		J	J	J	М	J		К	K	K	М	K	К			
823	0.082	G	G	G			J	J	J	М		J	J	J	М	J		К	K	K	М	К	К			
104	0.1	G	G	G			J	J	М	М		J	J	J	М	J		K	K	K	М	K	К			
124	0.12						J	J	М	N		J	J	м	М			К	К	K	Р	К	К			
154	0.15						М	N	М	N		J	J	м	М			К	К	K	Р	К	К			
224	0.22						М	N	М	N		J	М	м	Q			М	М	М	Р	м	м			
334	0.33						N	N	М	N		J	М	Р	Q			Р	Р	Р	Q	X	Х			
474	0.47						N	N	М	N		М	М	Р	Q			Р	Р	P	Q	X	X			
684	0.68						N	N	N			М	Q	Q	Q			Р	Р	Q	X	X	X			
105	Cap 1.0						N	N	N*			М	Q	Q	Q*			Р	Q	Q	Z*	X	X			
155	(µF) 1.5											Q	Q	Q				P	Q	Z	Z	X	X			
225	2.2											Q	Q	Q				Х	Z	Z	Z*	Z	Z			
335	3.3											Q						Х	Z	Z	Z	Z				
475	4.7											Q						X	Z	Z		Z*				
106	10																	Z	Z*						Z	Z*
226	22		051/	501/	1001/	00014		0514	501/	1001/	0001/	4.614	051/	501/	1001/	0001/	5001/	4.614	051/	501/	1001/	501/	1001/	Z	501/	1001/
	VVDC	16V	25V	50V	100V	200V	16V	25V	50V		200V	16V	25V	50V	100V	200V	12000	16V	25V	50V	100V		100V	25V	50V	100V
	Size		AP	203 = 06	503			AP	05 = 0	805				AP06 =	= 1206				AP10	= 1210	)	AP12:	= 1812	AP2	20 = 22	220

\*Not currently available with lead plating finish, contact plant for further information.

Letter	A	С	E	G	J	K	М	N	Р	Q	Х	Y	Z
Max.	0.33	0.56	0.71	0.90	0.94	1.02	1.27	1.40	1.52	1.78	2.29	2.54	2.79
Thickness	(0.013)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.050)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)
		·	PAPER				·		EMBO	SSED			

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# **APS COTS+ X8R/L Series**



## **Capacitance Range**

#### **X8R**

	SIZE	AP03 =	0603	AP05 :	= 0805	AP06 =	1206
	WVDC	25V	50V	25V	50V	25V	50V
331	Cap 330	G	G	J	J		
471	(pF) 470	G	G	J	J		
681	680	G	G	J	J		
102	1000	G	G	J	J	J	J
152	1500	G	G	J	J	J	J
222	2200	G	G	J	J	J	J
332	3300	G	G	J	J	J	J
472	4700	G	G	J	J	J	J
682	6800	G	G	J	J	J	J
103	Cap 0.01	G	G	J	J	J	J
153	(µF) 0.015	G	G	J	J	J	J
223	0.022	G	G	J	J	J	J
333	0.033	G	G	J	J	J	J
473	0.047	G	G	J	J	J	J
683	0.068	G		N	Ν	М	M
104	0.1			N	Ν	М	M
154	0.15			N	Ν	М	M
224	0.22			N		М	M
334	0.33					М	M
474	0.47					М	
684	0.68						
105	1						
	WVDC	25V	50V	25V	50V	25V	50V
	SIZE	06	03	05	120	)6	

### **X8L**

	SIZE			AF	PO3 = 0603	;		AP05 = (	0805				AP06 =	1206		
	WVDC		25V		50V	100V	25V	50V	1	00V	1	6V	25V	50V	100V	1
331	Сар	330			G	G		J		J						1
471	(pF)	470			G	G		J		J						1
681		680			G	G		J		J						
102		1000			G	G		J		J						1
152		1500			G	G		J		J				J	J	
222		2200			G	G		J		J				J	J	
332		3300			G	G		J		J				J	J	
472		4700			G	G		J		J				J	J	
682		6800			G	G		J		J				J	J	
103	Сар	0.01			G	G		J		J				J	J	
153	(µF)	0.015	G		G		J	J		J				J	J	
223		0.022	G		G		J	J		J				J	J	
333		0.033	G		G		J	J		Ν				J	J	
473		0.047	G		G		J	J		Ν				J	J	
683		0.068	G		G		J	J						J	J	
104		0.1	G		G		J	J						J	М	
154		0.15					J	N				J	J	J	Q	
224		0.22					N	N				J	J	J	Q	
334		0.33					N					J	М	Р	Q	
474		0.47					N					M	М	Р		
684		0.68										M				
105		1										M				
	WVDC		25V		50V	100V	25V	50V	/   10	<b>V0</b>	1	6V	25V	50V	100V	
	SIZE				0603			080	5				120	)6		
Let	ter	A	0		E	G	J	K	М	1	N	Р	Q	X	Y	
Ma	ax.	0.33	3 0.5	6	0.71	0.90	0.94	1.02	1.27	1.	40	1.52	1.78	2.29	2.54	

(0.040)

(0.050)



(0.110)

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Max. Thickness

(0.013)

(0.022)



(0.028)

PAPER

(0.035)

(0.037)

(0.055)

(0.060)

EMBOSSED

(0.070)

(0.090)

(0.100)

## **General Specifications**

### **GENERAL DESCRIPTION**

With increased requirements from the automotive industry for additional component robustness, AVX recognized the need to produce a MLCC with enhanced mechanical strength. It was noted that many components may be subject to severe flexing and vibration when used in various under the hood automotive and other harsh environment applications.

To satisfy the requirement for enhanced mechanical strength, AVX had to find a way of ensuring electrical integrity is maintained whilst external forces are being applied to the component. It was found that the structure of the termination needed to be flexible and after much research and development, AVX launched FLEXITERM<sup>®</sup>. FLEXITERM<sup>®</sup> is designed to enhance the mechanical flexure and temperature cycling performance of a standard ceramic capacitor with an X7R dielectric. The industry standard for flexure is 2mm minimum. Using FLEXITERM<sup>®</sup>, AVX provides up to 5mm of flexure without internal cracks. Beyond 5mm, the capacitor will generally fail "open".

As well as for automotive applications FLEXITERM<sup>®</sup> will provide Design Engineers with a satisfactory solution when designing PCB's which may be subject to high levels of board flexure.

#### **PRODUCT ADVANTAGES**

- High mechanical performance able to withstand, 5mm bend test guaranteed.
- Increased temperature cycling performance, 3000 cycles and beyond.
- Flexible termination system.
- · Reduction in circuit board flex failures.
- · Base metal electrode system.
- · Automotive or commercial grade products available.



#### **APPLICATIONS**

#### **High Flexure Stress Circuit Boards**

• e.g. Depanelization: Components near edges of board.

#### Variable Temperature Applications

- Soft termination offers improved reliability performance in applications where there is temperature variation.
- e.g. All kind of engine sensors: Direct connection to battery rail.

#### **Automotive Applications**

- · Improved reliability.
- Excellent mechanical performance and thermo mechanical performance.

### **HOW TO ORDER**



NOTE: Contact factory for availability of Tolerance Options for Specific Part Numbers.





## **Specifications and Test Methods**



#### **PERFORMANCE TESTING**

#### AEC-Q200 Qualification:

- Created by the Automotive Electronics
   Council
- Specification defining stress test qualification for passive components

#### Testing:

Key tests used to compare soft termination to AEC-Q200 qualification:

- Bend Test
- · Temperature Cycle Test

## **BOARD BEND TEST RESULTS**

AEC-Q200 Vrs AVX FLEXITERM® Bend Test





1210

X7R

X7R soft term



### **TABLE SUMMARY**

Typical bend test results are shown below:

Style	Conventional Termination	FLEXITERM <sup>®</sup>
0603	>2mm	>5mm
0805	>2mm	>5mm
1206	>2mm	>5mm

## **TEMPERATURE CYCLE TEST PROCEDURE**

#### Test Procedure as per AEC-Q200:

The test is conducted to determine the resistance of the component when it is exposed to extremes of alternating high and low temperatures.

Substrate Bend (mm)

12 10

NPO

- Sample lot size quantity 77 pieces
- TC chamber cycle from -55°C to +125°C for 1000 cycles
- Interim electrical measurements at 250, 500, 1000 cycles
- Measure parameter capacitance dissipation factor, insulation resistance



### **BOARD BEND TEST PROCEDURE**

#### According to AEC-Q200

 Test Procedure as per AEC-Q200:

 Sample size:
 20 components

 Span: 90mm
 Minimum deflection spec: 2 mm

- Components soldered onto FR4 PCB (Figure 1)
- Board connected electrically to the test equipment (Figure 2)



Fig 1 - PCB layout with electrical connections



Fig 2 - Board Bend test equipment

### AVX ENHANCED SOFT TERMINATION BEND TEST PROCEDURE

#### Bend Test

The capacitor is soldered to the printed circuit board as shown and is bent up to 10mm at 1mm per second:



- The board is placed on 2 supports 90mm apart (capacitor side down)
- The row of capacitors is aligned with the load stressing knife



- The load is applied and the deflection where the part starts to crack is recorded (Note: Equipment detects the start of the crack using a highly sensitive current detection circuit)
- The maximum deflection capability is 10mm





## **Specifications and Test Methods**

#### **BEYOND 1000 CYCLES: TEMPERATURE CYCLE TEST RESULTS**



## Soft Term - No Defects up to 3000 cycles

#### AEC-Q200 specification states 1000 cycles compared to AVX 3000 temperature cycles.

#### **FLEXITERM® TEST SUMMARY**

- Qualified to AEC-Q200 test/specification with the exception of using AVX 3000 temperature cycles (up to +150°C bend test guaranteed greater than 5mm).
- FLEXITERM® provides improved performance compared to standard termination systems.

WITHOUT SOFT TERMINATION

- Board bend test improvement by a factor of 2 to 4 times.
- Temperature Cycling:
- Temperature Cycling:
- 0% Failure up to 3000 cycles
- No ESR change up to 3000 cycle



Major fear is of latent board flex failures.

#### WITH SOFT TERMINATION









## Capacitance Range X8R Dielectric

Solderi WVDC 271 Cap 331 (pF) 471 681 102 152 182 222 272 332 392 472 562 682 822 103 Cap 123 (µF) 153 273 333 393 473 563 563 683 823 104 124 124 124 124 124 184 224 274 334 394 474 684	E	06	03	08	05	1206				
271         Cap           331         (pF)           471         681           102         152           152         132           272         272           332         392           472         562           6682         822           103         Cap           123         (µF)           153         133           273         333           393         473           563         683           823         104           124         154           154         154           184         224           274         334           394         4774	ring	Reflow	/Wave	Reflow	/Wave	Reflow	/Wave			
331         (pF)           471         681           681         102           152         152           182         222           272         332           392         392           472         562           662         662           822         103           123         (µF)           153         123           273         333           393         473           563         663           6823         104           124         154           184         224           274         334           394         4774	C	25V	50V	25V	50V	25V	50V			
471         681           102         152           182         222           272         332           392         4472           562         682           822         103           153         153           153         223           273         333           393         473           563         683           6823         104           124         154           154         184           224         274           334         394           4774         474	270	70 G	G							
681           102           152           152           222           272           332           392           472           562           682           822           103           123           173           153           183           223           223           233           333           393           473           563           683           823           104           124           154           184           224           274           334           394           474	330	30 G	G	J	J					
102           152           152           222           272           332           392           472           562           682           822           103           223           273           333           393           473           563           683           823           104           124           154           184           224           274           334           394           4774	470	70 G	G	J	J					
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	680		G	J	J					
182           222           272           332           332           332           332           332           332           472           562           682           822           103           123           (μF)           153           183           223           223           233           333           393           473           563           683           823           104           124           154           184           224           274           334           394           474	1000		G	J	J	J	J			
222 272 332 272 332 273 562 682 682 822 103 Cap 123 (µF) 153 183 223 273 333 393 473 563 683 823 104 124 154 154 154 154 154 394 474 474 474 474 474 474 474 4	1500		G	J	J	J	J			
272           332           3392           372           562           682           822           103           Cap           123           183           223           273           333           393           473           563           683           823           104           124           154           184           227           334           394           4774	1800		G	J	J	J	J			
332         392           392         472           562         682           822         103           103         Cap           123         (μF)           153         183           223         273           333         393           473         563           683         823           104         124           154         184           224         274           334         394           394         474	2200		G	J	J	J	J			
392           472           562           682           822           103           23           (µF)           153           223           273           333           393           473           563           683           823           104           124           154           184           224           274           334           394           474	2700		G	J	J	J	J			
472           562           682           822           103           Cap           153           183           223           273           333           393           473           563           683           823           104           124           154           154           274           334           394           474	3300		G	J	J	J	J			
562         682           822         103         Cap           123         (μF)         153           183         223         273         333           2393         473         563         683           683         683         683         124           154         124         154         184           224         274         334         394           394         474         474	3900		G	J	J	J	J			
682         682           822         103         Cap           123         (μF)         153           183         223         273           273         333         393           473         563         683           823         104         124           154         154         154           184         224         274           334         394         474	4700		G	J	J	J	J			
822           103         Cap           123         (μF)           153         223           273         333           393         473           563         683           6823         104           124         154           154         154           184         224           2774         334           394         474	5600		G	J	J	J	J			
103         Cap           123         (μF)           153         1           183         2           273         3           393         3           473         5           563         6           683         6           823         1           104         1           124         1           184         2           2274         3           334         3           394         4           474         4	6800		G	J	J	J	J			
123         (μF)           153         153           183         223           273         333           393         473           563         683           823         104           124         154           184         224           274         334           394         474	8200		G	J	J	J	J			
153           183           223           273           333           393           473           563           683           823           104           124           154           184           224           274           334           394           474	0.01		G	J	J	J	J			
183           223           273           333           393           473           563           683           823           104           124           154           224           274           334           394           474	0.012		G	J	J	J	J			
223         273           333         393           473         563           563         683           823         104           124         154           184         224           274         334           394         474	0.015		G	J	J	J	J			
273           333           393           473           563           683           823           104           124           154           184           224           274           334           394           474	0.018		G	J	J	J	J			
333         393           393         473           563         683           823         104           124         154           184         224           274         334           394         474	0.022		G	J	J	J	J			
393         473           563         683           823         104           124         154           184         224           274         334           394         474	0.027		G	J	J	J	J			
473           563           683           823           104           124           154           184           224           274           334           394           474	0.033		G	J	J	J	J			
563         683           823         104           124         154           184         224           274         334           394         474	0.039		G	J	J	J	J			
683         823           104         124           154         184           224         274           334         394           474         144	0.047	47 G	G	J	J	J	J			
823           104           124           154           224           274           334           394           474	0.056			N	N N	M	M			
104       124       154       224       274       334       394	0.068			N	N N	M	M			
124       154       184       224       274       334       394       474	0.082			N N		M	M			
154       184       224       274       334       394       474	0.1			N N	N	M	M			
184       224       274       334       394       474	0.12			N N	N N	M	M			
224 274 334 394 474	0.15			N	IN IN	M	M			
274 334 394 474	0.18			N		M	M			
334 394 474	0.22			IN		M	M			
394 474	0.27					M	M			
474	0.33					M	IVI			
	0.39					M				
687 1	0.47					IVI				
824	0.82									
105	0.02									
WVDC		25V	50V	25V	50V	25V	50V			
SIZE		06			05	1206				

Letter	А	С	E	G	J	K	М	N	Р	Q	Х	Y	Z		
Max.	0.33	0.56	0.71	0.90	0.94	1.02	1.27	1.40	1.52	1.78	2.29	2.54	2.79		
Thickness	(0.013)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.050)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)		
			PAPER			EMBOSSED									

TS 16949, ISO 9001Certified





## Capacitance Range X7R Dielectric

	Size			040					06	03					0	805						120	6				12	210		-	12		2220	0
	olderi	•		eflov Wav				Re	flow	/Wav	/e			F	Reflo	w/Wa	ave				Ref	low/	Wave	è			Reflo	wOnl	у		low nly	Ref	flow (	Only
	WVD	С	16V	25V	50V	10V	16V	25V	50V	100 V	200V	250V	16V	25V	50V	100 V	200V	250V	16V	25V	50V	100 V	200V	250V	500V	16V	25V	50V	100 V	50V	100 V	25V	50V	100
221	Сар	220		С	С									1																				1
271	(pF)	270	U U	С	С																													
331		330		С	С																													
391		390		С	С																													
471		470	-	С	С																													
561		560	-	С	С																													
681		680	-	С	С											L																	<u> </u>	
821		820	-	С	С																												<u> </u>	
102		1000		С	С		G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	K	K	K	K	N	N		<u> </u>	
182		1800		C	C	<u> </u>	G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	K	K	K	K	N	N			<u> </u>
222		2200		C	C	<u> </u>	G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	K	K	K	K	N	N			-
332		3300 4700		C	C		G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	K	K	K	K	N	N			-
472	0	4700	-	С	С		G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	K	K	K	K	N	N			$\left  \right $
103	Cap	0.01	C C	<u> </u>			G	G	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J	J	J	K	K	K	K	N	N			-
123 153	(µF)	0.012					G	G	G				J	J	J	M	J	J	J	J	J	J	J	J		K	K	K	K	N	N			
183		0.013			-		G G	G G	G				J J	J	J	M	J	J J	J	J J	J J	J	J	J J		K K	K	K	K K	N N	N			-
223		0.018	-				G	G	G				J	J	J	J	J	J	J	J	J	J	J	J		ĸ	ĸ	K	K	N	N			
273		0.022			-		G	G	G				J	J	J	M	J	J	J	J	J	J	J	J		K	ĸ	K	K	N	N			-
333		0.027					G	G	G				J	J	J	M	J	J	J	J	J	J	J	J		K	K	K	K	N	N			
473		0.033					G	G	G				J	J	J	M	J	J	J	J	J	M	J	J		K	K	K	K	N	N			
563		0.047					G	G	G				J	J	J	M	<u> </u>	5	J	J	J	M	J	J		K	K	K	M	N	N			1
683		0.068					G	G	G				J	J	J	M			J	J	J	M	J	J		K	K	K	M	N	N			
823		0.082					G	G	G				J	J	J	M			J	J	J	M	J	J		K	K	K	M	N	N			1
104		0.1	С				G	G	G				J	J	М	м			J	J	J	м	J	J		К	К	К	м	N	N			
124		0.12											J	J	М	N			J	J	М	м				К	К	К	Р	N	N			
154		0.15		1	1			1		İ			М	N	М	N	İ		J	J	М	м		i i		К	К	к	Р	N	N			1
224		0.22		1	1	G		1		1			М	N	М	N			J	М	М	Q				М	М	М	Р	N	N			1
334		0.33		1				1					Ν	N	М	N			J	М	Р	Q				Р	Р	Р	Q	Х	Х			1
474		0.47											Ν	N	М	N			М	М	Р	Q				Р	Р	Р	Q	Х	Х			
684		0.68											Ν	Ν	Ν				М	Q	Q	Q				Р	Ρ	Q	Х	Х	Х			
105		1											Ν	Ν	N				М	Q	Q	Q				Р	Q	Q	Z	Х	Х			
155		1.5																	Q	Q	Q					Р	Q	Z	Z	Х	Х			
225		2.2																	Q	Q	Q					Х	Ζ	Z	Z	Z	Z			
335		3.3			<u> </u>														Q	Q						Х	Ζ	Z	Z	Z			<u> </u>	
475		4.7			<u> </u>														Q	Q						X	Z	Z	Z	Z				Z
106		10			<u> </u>																					Ζ	Z						Z	Z
226	140.05	22		051	501	101	101	051	501	1001	0001	0501	101	051	501	1001	0001	0501	101	051	FOL (	1001		0501	5001	101	051	501	1001	501	1001	Z	5011	100
	WVD		-			100	167	250			200V	250V	167	250		-	2000	250V	167	257	50V			250V	1200V	167			1 1 U U V		100 V	-	50V	
	Size	;		040	2				06	03					0	805						120	6				12	210		18	12		2220	D

Letter	A	С	E	G	J	K	М	Ν	Р	Q	Х	Y	Z		
Max.	0.33	0.56	0.71	0.90	0.94	1.02	1.27	1.40	1.52	1.78	2.29	2.54	2.79		
Thickness	(0.013)	(0.022)	(0.028)	(0.035)	(0.037)	(0.040)	(0.050)	(0.055)	(0.060)	(0.070)	(0.090)	(0.100)	(0.110)		
			PAPER			EMBOSSED									



# **FLEXISAFE MLC Chips**

## General Specifications and Capacitance Range For Ultra Safety Critical Applications





#### **HOW TO ORDER**

AVX have developed a range of components specifically for safety critical applications.

Utilizing the award-winning FLEXITERM<sup>™</sup> layer in conjunction with the cascade design previously used for high voltage MLCCs, a range of ceramic capacitors is now available for customers who require components designed with an industry leading set of safety features.

The FLEXITERM<sup>™</sup> layer protects the component from any damage to the ceramic resulting from mechanical stress during PCB assembly or use with end customers. Board flexure type mechanical damage accounts for the majority of MLCC failures. The addition of the cascade structure protects the component from low insulation resistance failure resulting from other common causes for failure; thermal stress damage, repetitive strike ESD damage and placement damage. With the inclusion of the cascade design structure to complement the FLEXITERM<sup>™</sup> layer, the FLEXISAFE range of capacitors has unbeatable safety features.



### **FLEXISAFE X7R RANGE**

Cap	oacitance Code		FS03	= 0603			FS05 :	= 0805		F	S06 = 120	6	FS10 = 1210				
Sc	oldering		Reflov	v/Wave			Reflow	/Wave		Re	eflow/Wa	/e	R	eflow Onl			
	WVDC		25	50	100	16	25	50	100	16	25	50	16	25	50		
102	μF 0.001																
182	0.0018																
222	0.0022																
332	0.0033																
472	0.0047																
103	0.01																
123	0.012																
153	0.015																
183	0.018																
223	0.022																
273	0.027																
333	0.033																
473	0.047																
563	0.056																
683	0.068																
823	0.082																
104	0.1																
124	0.12																
154	0.15																
224	0.22																
334	0.33																
474	0.47																

Qualified







#### BENEFITS OF USING CAPACITOR ARRAYS

AVX capacitor arrays offer designers the opportunity to lower placement costs, increase assembly line output through lower component count per board and to reduce real estate requirements.

#### **Reduced Costs**

Placement costs are greatly reduced by effectively placing one device instead of four or two. This results in increased throughput and translates into savings on machine time. Inventory levels are lowered and further savings are made on solder materials, etc.

#### **Space Saving**

Space savings can be quite dramatic when compared to the use of discrete chip capacitors. As an example, the 0508 4-element array offers a space reduction of >40% vs. 4 x 0402 discrete capacitors and of >70% vs. 4 x 0603 discrete capacitors. (This calculation is dependent on the spacing of the discrete components.)

#### Increased Throughput

Assuming that there are 220 passive components placed in a mobile phone:

A reduction in the passive count to 200 (by replacing discrete components with arrays) results in an increase in throughput of approximately 9%.

A reduction of 40 placements increases throughput by 18%.

For high volume users of cap arrays using the very latest placement equipment capable of placing 10 components per second, the increase in throughput can be very significant and can have the overall effect of reducing the number of placement machines required to mount components:

If 120 million 2-element arrays or 40 million 4-element arrays were placed in a year, the requirement for placement equipment would be reduced by one machine.

During a 20Hr operational day a machine places 720K components. Over a working year of 167 days the machine can place approximately 120 million. If 2-element arrays are mounted instead of discrete components, then the number of placements is reduced by a factor of two and in the scenario where 120 million 2-element arrays are placed there is a saving of one pick and place machine.

Smaller volume users can also benefit from replacing discrete components with arrays. The total number of placements is reduced thus creating spare capacity on placement machines. This in turn generates the opportunity to increase overall production output without further investment in new equipment.

## 4 pcs 0402 Capacitors = 1 pc 0508 Array 1.4 1.0 (0.055) (0.039) 5.0 (0.197) AREA = 7.0mm<sup>2</sup> (0.276 in<sup>2</sup>) AREA = 3.95mm<sup>2</sup> (0.156 in<sup>2</sup>)

#### W2A (0508) Capacitor Arrays

The 0508 4-element capacitor array gives a PCB space saving of over 40% vs four 0402 discretes and over 70% vs four 0603 discrete capacitors.



#### W3A (0612) Capacitor Arrays

The 0612 4-element capacitor array gives a PCB space saving of over 50% vs four 0603 discretes and over 70% vs four 0805 discrete capacitors.



# **Capacitor Array** Capacitor Array (IPC)





### **GENERAL DESCRIPTION**

AVX is the market leader in the development and manufacture of capacitor arrays. The array family of products also includes the 0612 4-element device as well as 0508 2-element and 4-element series, all of which have received widespread acceptance in the marketplace.

AVX capacitor arrays are available in X5R, X7R and NP0 (C0G) ceramic dielectrics to cover a broad range of capacitance values. Voltage ratings from 6.3 Volts up to 100 Volts are offered. AVX also now offers a range of automotive capacitor arrays qualified to AEC-Q200 (see separate table).

Key markets for capacitor arrays are Mobile and Cordless Phones, Digital Set Top Boxes, Computer Motherboards and Peripherals as well as Automotive applications, RF Modems, Networking Products, etc.



#### **HOW TO ORDER**





NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers.




SIZE	W	2 = 05	08	W3 = 0612			
# Elements		4			4		
Soldering	Re	flow/Wa	ave	Reflow/Wave			
Packaqinq	Pap	er/Embos	ssed	Paper/Embossed			
Length mm		1.30 ± 0.1	5	1.60 ± 0.150			
(in.)		051 ± 0.0			063 ± 0.00		
Width mm		2.10 ± 0.1			.20 ± 0.20		
(IN.)	(0.	083 ± 0.0	06)	(0.1	126 ± 0.00	08)	
Max. mm Thickness (in.)		0.94			1.35		
Thickness (in.) WVDC	16	(0.037) 25	50	16	(0.053) 25	50	
1R0 Cap 1.0		23	- 50	10	23	50	
1R2 (pF) 1.2							
1R5 1.5							
1R8 1.8							
2R2 2.2							
2R7 2.7							
3R3 3.3							
3R9 3.9							
4R7 4.7 5R6 5.6							
5R6 5.6 6R8 6.8							
8R2 8.2							
100 10							
120 12							
150 15	i						
180 18							
220 22							
270 27							
330 33							
390 39							
470 47 560 56	_						
680 68							
820 82							
101 100							
121 120							
151 150							
181 180							
221 220							
271 270							
331 330							
391 390 471 470							
561 560	-						
681 680							
821 820							
102 1000							
122 1200							
152 1500							
182 1800							
222 2200							
272 2700							
332 3300 392 3900							
472 4700							
562 5600							
682 6800							
822 8200							

= Supported Values



# **Capacitor Array** Capacitance Range – X7R



	SIZE			١	N2 =	050	8			V	V2 =	050	8			V	V3 =	061	2	
#	Elemen	ts				2					4	4						4		
	Solderinq				Reflov	v/Wav	′e			F	Reflow	v/Wav	e				Reflow	/Wave	e	
	Packaqinq					Paper				Pa		mboss						mboss		
Lengt	h	mm				± 0.15				10		± 0.15						0.150		
		(in.) mm				± 0.00 ± 0.15				((		± 0.00 ± 0.15				((		± 0.00		
Width		(in.)		(		± 0.10				((		± 0.13				((		± 0.20		
Max.		mm		(		.94	(0)		<u> </u>	(0		94	0)			((		35	5)	
Thickr	ness	(in.)				037)						)37)						)53)		
	WVDC		6	10	16	25	50	100	6	10	16	25	50	100	6	10	16	25	50	100
101	Сар	100					1		1		İ			İ		1		1		
121	(PF)	120																		
151		150																		
181		180																		
221 271		220 270																		
331		330					<u> </u>		<u> </u>											
391		390																		
471		470																		
561		560																		
681		680																		
821		820																		
102		1000																		
122		1200																		
152 182		1500 1800																		
222		2200																		
272		2700																		
332		3300																		
392		3900																		
472		4700																		
562		5600																		
682		6800																		
822		8200																		
103	•	0.010																		
123 153		0.012 0.015																		
183		0.013																		
223		0.022																		
273		0.027																		
333		0.033																		
393		0.039																		
473		0.047																		
563		0.056																		
683 022		0.068																		
823 104		0.082																		
104		0.10																		
154		0.12																		
184		0.18																		
224		0.22																		
274		0.27																		
334		0.33																		
474		0.47																		
564 684		0.56		-					<u> </u>					<u> </u>						
684 824		0.68																		
105		1.0																		
125		1.2				1														
155		1.5																		
185		1.8																		
225		2.2																		
335		3.3																		
						1	1	1	1	1	1	1		1	1			1		
475		4.7										1		1				<u> </u>		
106		10																		



# **Capacitor Array** Automotive Capacitor Array (IPC)





As the market leader in the development and manufacture of capacitor arrays AVX is pleased to offer a range of AEC-Q200 qualified arrays to compliment our product offering to the Automotive industry. Both the AVX 0612 and 0508 4-element capacitor array styles are qualified to the AEC-Q200 automotive specifications.

AEC-Q200 is the Automotive Industry qualification standard and a detailed qualification package is available on request.

All AVX automotive capacitor array production facilities are certified to ISO/TS 16949:2002.

0612 - 4 Element

#### **HOW TO ORDER**



\*Contact factory for availability by part number for K =  $\pm 10\%$  and J =  $\pm 5\%$  tolerance.







For RoHS compliant products,

The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.avy.com/disclaimer/humfure available online at www.avx.com/disclaimer/ by reference and should be reviewed in full before placing any order



millimeters (inches)

#### **PART & PAD LAYOUT DIMENSIONS**



#### **PART DIMENSIONS**

#### 0508 - 2 Element

	L	W	Т	BW	BL	Р	S
	1.30 ± 0.15	2.10 ± 0.15	0.94 MAX	0.43 ± 0.10	0.33 ± 0.08	1.00 REF	0.50 ± 0.10
	(0.051 ± 0.006)	(0.083 ± 0.006)	(0.037 MAX)	(0.017±0.004)	(0.013 ± 0.003)	(0.039 REF)	(0.020 ± 0.004)
(	0508 - 4 E	lement					

L	W	Т	BW	BL	Р	Х	S
1.30 ± 0.15	2.10 ± 0.15	0.94 MAX	0.25 ± 0.06	0.20 ± 0.08	0.50 REF	0.75 ± 0.10	0.25 ± 0.10
(0.051 ± 0.006)	(0.083 ± 0.006)	(0.037 MAX)	(0.010 ± 0.003)	(0.008 ± 0.003)	(0.020 REF)	(0.030 ± 0.004)	(0.010 ± 0.004)

#### 0612 - 4 Element

L	W	Т	BW	BL	Р	X	S
1.60 ± 0.20	3.20 ± 0.20	1.35 MAX	0.41 ± 0.10	0.18 <sup>+0.25</sup>	0.76 REF	1.14±0.10	0.38 ± 0.10
(0.063±0.008)	(0.126 ± 0.008)	(0.053 MAX)	(0.016±0.004)	(0.007+0.010) -0.003	(0.030 REF)	(0.045±0.004)	(0.015±0.004)

#### **PAD LAYOUT DIMENSIONS**

#### 0508 - 2 Element

	Α	В	С	D	E
	0.68	1.32	2.00	0.46	1.00
	(0.027)	(0.052)	(0.079)	(0.018)	(0.039)
1	0508 - 1	Flomont			

USU8 - 4 Element											
Α	В	С	D	E							
0.56	1.32	1.88	0.30	0.50							
(0.022)	(0.052)	(0.074)	(0.012)	(0.020)							

#### 0612 - 4 Element

Α	В	С	D	E		
0.89	1.65	2.54	0.46	0.76		
(0.035)	(0.065)	(0.100)	(0.018)	(0.030)		



# Low Inductance Capacitors

#### Introduction



The signal integrity characteristics of a Power Delivery Network (PDN) are becoming critical aspects of board level and semiconductor package designs due to higher operating frequencies, larger power demands, and the ever shrinking lower and upper voltage limits around low operating voltages. These power system challenges are coming from mainstream designs with operating frequencies of 300MHz or greater, modest ICs with power demand of 15 watts or more, and operating voltages below 3 volts.

The classic PDN topology is comprised of a series of capacitor stages. Figure 1 is an example of this architecture with multiple capacitor stages.

An ideal capacitor can transfer all its stored energy to a load instantly. A real capacitor has parasitics that prevent instantaneous transfer of a capacitor's stored energy. The true nature of a capacitor can be modeled as an RLC equivalent circuit. For most simulation purposes, it is possible to model the characteristics of a real capacitor with one capacitor, one resistor, and one inductor. The RLC values in this model are commonly referred to as equivalent series capacitance (ESC), equivalent series resistance (ESR), and equivalent series inductance (ESL).

The ESL of a capacitor determines the speed of energy transfer to a load. The lower the ESL of a capacitor, the faster that energy can be transferred to a load. Historically, there has been a tradeoff between energy storage (capacitance) and inductance (speed of energy delivery). Low ESL devices typically have low capacitance. Likewise, higher capacitance devices typically have higher ESLs. This tradeoff between ESL (speed of energy delivery) and capacitance (energy storage) drives the PDN design topology that places the fastest low ESL capacitors as close to the load as possible. Low Inductance MLCCs are found on semiconductor packages and on boards as close as possible to the load.



Figure 1 Classic Power Delivery Network (PDN) Architecture

#### LOW INDUCTANCE CHIP CAPACITORS

The key physical characteristic determining equivalent series inductance (ESL) of a capacitor is the size of the current loop it creates. The smaller the current loop, the lower the ESL. A standard surface mount MLCC is rectangular in shape with electrical terminations on its shorter sides. A Low Inductance Chip Capacitor (LICC) sometimes referred to as Reverse Geometry Capacitor (RGC) has its terminations on the longer side of its rectangular shape.

When the distance between terminations is reduced, the size of the current loop is reduced. Since the size of the current loop is the primary driver of inductance, an 0306 with a smaller current loop has significantly lower ESL then an 0603. The reduction in ESL varies by EIA size, however, ESL is typically reduced 60% or more with an LICC versus a standard MLCC.

#### **INTERDIGITATED CAPACITORS**

The size of a current loop has the greatest impact on the ESL characteristics of a surface mount capacitor. There is a secondary method for decreasing the ESL of a capacitor. This secondary method uses adjacent opposing current loops to reduce ESL. The InterDigitated Capacitor (IDC) utilizes both primary and secondary methods of reducing inductance. The IDC architecture shrinks the distance between terminations to minimize the current loop size, then further reduces inductance by creating adjacent opposing current loops.

An IDC is one single capacitor with an internal structure that has been optimized for low ESL. Similar to standard MLCC versus LICCs, the reduction in ESL varies by EIA case size. Typically, for the same EIA size, an IDC delivers an ESL that is at least 80% lower than an MLCC.



# **Low Inductance Capacitors**

#### Introduction



#### LAND GRID ARRAY (LGA) CAPACITORS

Land Grid Array (LGA) capacitors are based on the first Low ESL MLCC technology created to specifically address the design needs of current day Power Delivery Networks (PDNs). This is the 3rd low inductance capacitor technology developed by AVX. LGA technology provides engineers with new options. The LGA internal structure and manufacturing technology eliminates the historic need for a device to be physically small to create small current loops to minimize inductance.

The first family of LGA products are 2 terminal devices. A 2 terminal 0306 LGA delivers ESL performance that is equal to or better than an 0306 8 terminal IDC. The 2 terminal 0805 LGA delivers ESL performance that approaches the 0508 8 terminal IDC. New designs that would have used 8 terminal IDCs are moving to 2 terminal LGAs because the layout is easier for a 2 terminal device and manufacturing yield is better for a 2 terminal LGA versus an 8 terminal IDC.

LGA technology is also used in a 4 terminal family of products that AVX is sampling and will formerly introduce in 2008. Beyond 2008, there are new multi-terminal LGA product families that will provide even more attractive options for PDN designers.

#### LOW INDUCTANCE CHIP ARRAYS (LICA®)

The LICA® product family is the result of a joint development effort between AVX and IBM to develop a high performance MLCC family of decoupling capacitors. LICA was introduced in the 1980s and remains the leading choice of designers in high performance semiconductor packages and high reliability board level decoupling applications.

LICA® products are used in 99.999% uptime semiconductor package applications on both ceramic and organic substrates. The C4 solder ball termination option is the perfect compliment to flip-chip packaging technology. Mainframe class CPUs, ultimate performance multi-chip modules, and communications systems that must have the reliability of 5 9's use LICA®.

LICA<sup>®</sup> products with either Sn/Pb or Pb-free solder balls are used for decoupling in high reliability military and aerospace applications. These LICA<sup>®</sup> devices are used for decoupling of large pin count FPGAs, ASICs, CPUs, and other high power ICs with low operating voltages.

When high reliability decoupling applications require the very lowest ESL capacitors,  $LICA^{\otimes}$  products are the best option.



#### 470 nF 0306 Impedance Comparison

Figure 2 MLCC, LICC, IDC, and LGA technologies deliver different levels of equivalent series inductance (ESL).



# Low Inductance Ceramic Capacitors LICC (Low Inductance Chip Capacitors) 0306/0508/0612 RoHS Compliant

#### **GENERAL DESCRIPTION**

The key physical characteristic determining equivalent series inductance (ESL) of a capacitor is the size of the current loop it creates. The smaller the current loop, the lower the ESL.

A standard surface mount MLCC is rectangular in shape with electrical terminations on its shorter sides. A Low Inductance Chip Capacitor (LICC) sometimes referred to as Reverse Geometry Capacitor (RGC) has its terminations on the longer sides of its rectangular shape. The image on the right shows the termination differences between an MLCC and an LICC.

When the distance between terminations is reduced, the size of the current loop is reduced. Since the size of the current loop is the primary driver of inductance, an 0306 with a smaller current loop has significantly lower ESL then an 0603. The reduction in ESL varies by EIA size, however, ESL is typically reduced 60% or more with an LICC versus a standard MLCC.

AVX LICC products are available with a lead-free finish of plated Nickel/Tin.



#### **PERFORMANCE CHARACTERISTICS**

Capacitance Tolerances	K = ±10%; M = ±20%
Operation Temperature Range	X7R = -55°C to +125°C X5R = -55°C to +85°C X7S = -55°C to +125°C
Temperature Coefficient	X7R, X5R = ±15%; X7S = ±22%
Voltage Ratings	4, 6.3, 10, 16, 25 VDC
Dissipation Factor	4V, 6.3V = 6.5% max; 10V = 5.0% max; 16V = 3.5% max; 25V = 3.0% max
Insulation Resistance (@+25°C, RVDC)	100,000M $\Omega$ min, or 1,000M $\Omega$ per $\mu F$ min.,whichever is less



#### **HOW TO ORDER**



\*See the thickness tables on the next page.

\*\*Select voltages for Automotive version, contact factory

NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers.

#### **TYPICAL IMPEDANCE CHARACTERISTICS**









# **Low Inductance Ceramic Capacitors**



# LICC (Low Inductance Chip Capacitors) 0306/0508/0612 RoHS Compliant

S	IZE			0306	5			(	0508	3			(	0612	2	
Pac	kaging		Er	nboss	ed		Embossed				Embossed					
Length	mm (in.)		(0.03	31 + 0. 32 ± 0.	006)			(0.05	27 + 0. 50 ± 0.	010)		1.60 + 0.25 (0.063 ± 0.010)				
Width	mm (in.)		(0.0	50 + 0. 53 ± 0.					)0 + 0. 30 ± 0.	010)				20 + 0 26 ± 0	.010)	
Cap Code	WVDC	4	6.3	10	16	25	6.3	10	16	25	50	6.3	10	16	25	50
102	Cap 0.001		Α	Α	Α	A	S	S	S	S	V	S	S	S	S	V
222	(μF) .0022		А	А	А	A	S	S	S	S	V	S	S	S	S	V
332	0.0033		Α	А	Α	Α	S	S	S	S	V	S	S	S	S	V
472	0.0047		Α	А	A	A	S	S	S	S	V	S	S	S	S	V
682	0.0068		Α	А	Α	Α	S	S	S	S	V	S	S	S	S	V
103	0.01		Α	Α	A	A	S	S	S	S	V	S	S	S	S	V
153	0.015		Α	Α	Α	Α	S	S	S	S	V	S	S	S	S	W
223	0.022		Α	Α	Α	Α	S	S	S	S	V	S	S	S	S	W
333	0.033		Α	Α	Α		S	S	S	۷	V	S	S	S	S	w
473	0.047		Α	Α	Α		S	S	S	۷	Α	S	S	S	S	W
683	0.068		Α	Α	Α		S	S	S	А	Α	S	S	S	V	w
104	0.1		Α	Α	VK/		S	S	V	А	Α	S	S	S	V	w
154	0.15		Α	Α	<b></b>		S	S	V			S	S	S	W	w
224	0.22		Α	Α			S	S	Α			S	S	V	W	
334	0.33						V	V	Α			S	S	V		
474	0.47						V	V	/K/			S	S	V		
684	0.68						Α	А				V	۷	W		
105	1	A					Α	А				V	۷	А		
155	1.5						/K/					W	W			
225	2.2											Α	А			
335	3.3															
475	4.7															
685	6.8															
106	10															

#### Solid = X7R



= X7S

= X6S





	mm (in.)						
0612							
Code	Thickness						
S	0.56 (0.022)						
V	0.76 (0.030)						
W	1.02 (0.040)						
А	1.27 (0.050)						

#### PHYSICAL DIMENSIONS AND PAD LAYOUT



#### **PHYSICAL DIMENSIONS**

			mm (in.)
Size	L	W	t
0206	0.81 ± 0.15	1.60 ± 0.15	0.13 min.
0306	(0.032 ± 0.006)	(0.063 ± 0.006)	(0.005 min.)
0508	1.27 ± 0.25	2.00 ± 0.25	0.13 min.
0508	(0.050 ± 0.010)	(0.080 ± 0.010)	(0.005 min.)
0612	1.60 ± 0.25	3.20 ± 0.25	0.13 min.
0012	(0.063 ± 0.010)	(0.126 ± 0.010)	(0.005 min.)

T - See Range Chart for Thickness and Codes

#### **PAD LAYOUT DIMENSIONS**

			mm (in.)
Size	Α	В	С
0306	0.31 (0.012)	1.52 (0.060)	0.51 (0.020)
0508	0.51 (0.020)	2.03 (0.080)	0.76 (0.030)
0612	0.76 (0.030)	3.05 (0.120)	0.635 (0.025)





041416

# Low Inductance Capacitors with SnPb Terminations

# LD16/LD17/LD18 Tin-Lead Termination "B"

#### **GENERAL DESCRIPTION**

The key physical characteristic determining equivalent series inductance (ESL) of a capacitor is the size of the current loop it creates. The smaller the current loop, the lower the ESL.

A standard surface mount MLCC is rectangular in shape with electrical terminations on its shorter sides. A Low Inductance Chip Capacitor (LICC) sometimes referred to as Reverse Geometry Capacitor (RGC) has its terminations on the longer sides of its rectangular shape. The image on the right shows the termination differences between an MLCC and an LICC.

When the distance between terminations is reduced, the size of the current loop is reduced. Since the size of the current loop is the primary driver of inductance, an 0306 with a smaller current loop has significantly lower ESL then an 0603. The reduction in ESL varies by EIA size, however, ESL is typically reduced 60% or more with an LICC versus a standard MLCC.

AVX LICC products are available with a lead termination for high reliability military and aerospace applications that must avoid tin whisker reliability issues.





#### **PERFORMANCE CHARACTERISTICS**

Capacitance Tolerances	K = ±10%; M = ±20%
Operation Temperature Range	X7R = -55°C to +125°C X5R = -55°C to +85°C X7S = -55°C to +125°C
Temperature Coefficient	X7R, X5R = ±15%; X7S = ±22%
Voltage Ratings	4, 6.3, 10, 16, 25 VDC
Dissipation Factor	4V, 6.3V = 6.5% max; 10V = 5.0% max; 16V = 3.5% max; 25V = 3.0% max
Insulation Resistance (@+25°C, RVDC)	100,000MΩ min, or 1,000MΩ per $\mu$ F min.,whichever is less

\*Not RoHS Compliant

#### **HOW TO ORDER**



#### \*See the thickness tables on the next page.

NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers.

#### **TYPICAL IMPEDANCE CHARACTERISTICS**







# A KYOCERA GROUP COMPANY The ava



# **Low Inductance Capacitors** with SnPb Terminations

# LD16/LD17/LD18 Tin-Lead Termination "B"

S		LD (03					LD17 0508					LD18 0612			
Pac		Embo	ossed			En	nboss	ed			En	nboss	ed		
Length	mm (in.)	(	0.81 ± 0.15 (0.032 ± 0.006) 1.60 ± 0.15			$\begin{array}{r} 1.27 \pm 0.25 \\ (0.050 \pm 0.010) \\ 2.00 \pm 0.25 \end{array}$					$\begin{array}{r} 1.60 \pm 0.25 \\ (0.063 \pm 0.010) \\ 3.20 \pm 0.25 \end{array}$				
Width	mm (in.)	$(0.063 \pm 0.006)$			5)			$30 \pm 0.30 \pm 0.300 \pm 0.300 \pm 0.3000 \pm 0.30000000000$				20 ± 0. 26 ± 0.			
Cap Code	WVDC	6.3	10	16	25	6.3	10	16	25	50	6.3	10	16	25	50
102	Cap 0.001	А	А	A	А	S	S	S	S	V	S	S	S	S	V
222	(µF) .0022	А	А	Α	А	S	S	S	S	۷	S	S	S	S	V
332	0.0033	А	А	A	Α	S	S	S	S	۷	S	S	S	S	V
472	0.0047	А	Α	A	Α	S	S	S	S	V	S	S	S	S	V
682	0.0068	А	Α	A	А	S	S	S	S	V	S	S	S	S	V
103	0.01	А	Α	A	Α	S	S	S	S	V	S	S	S	S	V
153	0.015	Α	Α	A	Α	S	S	S	S	V	S	S	S	S	W
223	0.022	А	Α	A	Α	S	S	S	S	V	S	S	S	S	W
333	0.033	Α	Α	A		S	S	S	V	V	S	S	S	S	W
473	0.047	Α	Α	A		S	S	S	V	А	S	S	S	S	W
683	0.068	А	Α	A		S	S	S	Α	Α	S	S	S	V	W
104	0.1	Α	Α	VK/		S	S	V	Α	Α	S	S	S	V	W
154	0.15	Α	Α			S	S	V			S	S	S	W	W
224	0.22	Α	Α			S	S	Α			S	S	V	W	
334	0.33					V	V	Α			S	S	V		
474	0.47					V	V	VK/			S	S	V		
684	0.68					Α	Α				V	V	W		
105	1					Α	Α				V	٧	А		
155	1.5					/K/					W	W			İ
225	2.2										Α	Α			
335	3.3													İ	
475	4.7														
685	6.8														
106	10														

#### Solid = X7R

= X5R







	]	
	mm (in.)	
	LD18	
(	(0612)	
bde	Thickness	
S	0.56 (0.022)	
V	0.76 (0.030)	
N	1.02 (0.040)	
4	1.27 (0.050)	

Сс

۷

= X6S

#### PHYSICAL DIMENSIONS AND **PAD LAYOUT**



#### **PHYSICAL DIMENSIONS**

			mm (in.)
Size	L	W	t
LD16	0.81 ± 0.15	1.60 ± 0.15	0.13 min.
(0306)	(0.032 ± 0.006)	(0.063 ± 0.006)	(0.005 min.)
LD17	1.27 ± 0.25	2.00 ± 0.25	0.13 min.
(0508)	(0.050 ± 0.010)	(0.080 ± 0.010)	(0.005 min.)
LD18	1.60 ± 0.25	3.20 ± 0.25	0.13 min.
(0612)	(0.063 ± 0.010)	(0.126 ± 0.010)	(0.005 min.)

T - See Range Chart for Thickness and Codes

#### **PAD LAYOUT DIMENSIONS**

			mm (in.)
Size	Α	В	С
LD16 (0306)	0.31 (0.012)	1.52 (0.060)	0.51 (0.020)
LD17 (0508)	0.51 (0.020)	2.03 (0.080)	0.76 (0.030)
LD18 (0612)	0.76 (0.030)	3.05 (0.120)	0.635 (0.025)





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# **IDC Low Inductance Capacitors (RoHS)** IDC (InterDigitated Capacitors) 0306/0612/0508

#### **GENERAL DESCRIPTION**

Inter-Digitated Capacitors (IDCs) are used for both semiconductor package and board level decoupling. The equivalent series inductance (ESL) of a single capacitor or an array of capacitors in parallel determines the response time of a Power Delivery Network (PDN). The lower the ESL of a PDN, the faster the response time. A designer can use many standard MLCCs in parallel to reduce ESL or a low ESL Inter-Digitated Capacitor (IDC) device. These IDC devices are available in versions with a maximum height of 0.95mm or 0.55mm.

IDCs are typically used on packages of semiconductor products with power levels of 15 watts or greater. Inter-Digitated Capacitors are used on CPU, GPU, ASIC, and ASSP devices produced on 0.13µ, 90nm, 65nm, and 45nm processes. IDC devices are used on both ceramic and organic package substrates. These low ESL surface mount capacitors can be placed on the bottom side or the top side of a package substrate. The low profile 0.55mm maximum height IDCs can easily be used on the bottom side of BGA packages or on the die side of packages under a heat spreader.

IDCs are used for board level decoupling of systems with speeds of 300MHz or greater. Low ESL IDCs free up valuable board space by reducing the number of capacitors required versus standard MLCCs. There are additional benefits to reducing the number of capacitors beyond saving board space including higher reliability from a reduction in the number of components and lower placement costs based on the need for fewer capacitors.

The Inter-Digitated Capacitor (IDC) technology was developed by AVX. This is the second family of Low Inductance MLCC products created by AVX. IDCs are a cost effective alternative to AVX's first generation low ESL family for highreliability applications known as LICA (Low Inductance Chip Array).

AVX IDC products are available with a lead-free finish of plated Nickel/Tin.

Number of

Terminals

1 = 8

Terminals



#### **TYPICAL IMPEDANCE**



NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers.

D

C = X7R

D = X5R

Z = X7S

6

Voltage

4 = 4V

6 = 6.3V

Z = 10V

Y = 16V

3 = 25V

#### PERFORMANCE CHARACTERISTICS

Low

Inductance

**HOW TO ORDER** 

3

IDC Case

Size

2 = 0508

3 = 0612

4 = 0306

w

Style

Capacitance Tolerance	±20% Preferred
Operation Temperature Range	X7R = -55°C to +125°C X5R = -55°C to +85°C X7S = -55°C to +125°C
Temperature Coefficient	±15% (0VDC), ±22% (X7S)
Voltage Ratings	4, 6.3, 10, 16, 25 VDC
Dissipation Factor	≤ 6.3V = 6.5% max; 10V = 5.0% max; ≥ 16V = 3.5% max
Insulation Resistance (@+25°C, RVDC)	100,000MΩ min, or 1,000MΩ per μF min.,whichever is less

Dissipation Factor	No problems observed after 2.5 x RVDC for 5 seconds at 50mA max current
CTE (ppm/C)	12.0
Thermal Conductivity	4-5W/M K
Terminations Available	Plated Nickel and Solder

RoHS COMPLIANT



# **IDC Low Inductance Capacitors (RoHS)**



# IDC (InterDigitated Capacitors) 0306/0612/0508

SIZE	W4 =	0306		W2 =	Thin	050	B		W2	2 = 05	508		W	3= Tł	nin 06	12		W3	3 = 06	512		W3	= TH	ICK 0	612
Max. mm Thickness (in.)	0.				0.55.					0.95					.55				0.95					22	
Thickness (in.) WVDC	(0.0	6.3	4	6.3	(0.022	)	25	4	6.3	(0.037)	)	25	4	6.3	022) 10	16	4	6.3	(0.037 10	) 16	25	4	6.3	48) 10	16
Cap (µF) 0.010	7	0.5		0.0	10	10	23	-	0.0	10	10	23	-	0.0		10	-	0.0	10		23	-	0.0	10	10
0.022																									
0.033																									
0.047																									
0.068																									
0.10																									
0.22																									
0.33																									
0.47															_					_					
0.68																									
1.0																									
1.5																									
2.2																									
3.3																									

#### PHYSICAL DIMENSIONS AND PAD LAYOUT



Consult factory for additional requirements



#### **PHYSICAL CHIP DIMENSIONSMILLIMETERS (INCHES)**

SIZE	w	L	BW	BL	Р
0306	1.60 ± 0.20	0.82 ± 0.10	0.25 ± 0.10	0.20 ± 0.10	0.40 ± 0.05
0300	(0.063 ± 0.008)	(0.032 ± 0.006	(0.010 ± 0.004)	(0.008± 0.004)	(0.015 ± 0.002)
0508	2.03 ± 0.20	1.27 ± 0.20	0.30 ± 0.10	0.25 ± 0.15	0.50 ± 0.05
0508	(0.080 ± 0.008)	(0.050 ± 0.008)	(0.012 ± 0.004)	(0.010± 0.006)	(0.020 ± 0.002)
0612	3.20 ± 0.20	1.60 ± 0.20	0.50 ± 0.10	0.25 ± 0.15	0.80 ± 0.10
0012	(0.126 ± 0.008)	(0.063 ± 0.008)	(0.020 ± 0.004)	(0.010 ± 0.006)	(0.031 ± 0.004)

#### PAD LAYOUT DIMENSIONS

SIZE	Α	В	С	D	Е
0306	0.38	0.89	1.27	0.20	0.40
	(0.015)	(0.035)	(0.050)	(0.008)	(0.015)
0508	0.64	1.27	1.91	0.28	0.50
	(0.025)	(0.050)	(0.075)	(0.011)	(0.020)
0612	0.89	1.65	2.54	0.45	0.80
	(0.035)	(0.065)	(0.010)	(0.018)	(0.031)



# **IDC Low Inductance Capacitors (SnPb)** IDC (InterDigitated Capacitors) 0306/0612/0508

#### GENERAL DESCRIPTION

Inter-Digitated Capacitors (IDCs) are used for both semiconductor package and board level decoupling. The equivalent series inductance (ESL) of a single capacitor or an array of capacitors in parallel determines the response time of a Power Delivery Network (PDN). The lower the ESL of a PDN, the faster the response time. A designer can use many standard MLCCs in parallel to reduce ESL or a low ESL Inter-Digitated Capacitor (IDC) device. These IDC devices are available in versions with a maximum height of 0.95mm or 0.55mm.

IDCs are typically used on packages of semiconductor products with power levels of 15 watts or greater. Inter-Digitated Capacitors are used on CPU, GPU, ASIC, and ASSP devices produced on 0.13µ, 90nm, 65nm, and 45nm processes. IDC devices are used on both ceramic and organic package substrates. These low ESL surface mount capacitors can be placed on the bottom side or the top side of a package substrate. The low profile 0.55mm maximum height IDCs can easily be used on the bottom side of BGA packages or on the die side of packages under a heat spreader.

IDCs are used for board level decoupling of systems with speeds of 300MHz or greater. Low ESL IDCs free up valuable board space by reducing the number of capacitors required versus standard MLCCs. There are additional benefits to reducing the number of capacitors beyond saving board space including higher reliability from a reduction in the number of components and lower placement costs based on the need for fewer capacitors.

The Inter-Digitated Capacitor (IDC) technology was developed by AVX. This is the second family of Low Inductance MLCC products created by AVX. IDCs are a cost effective alternative to AVX's first generation low ESL family for highreliability applications known as LICA (Low Inductance Chip Array).

AVX IDC products are available with a lead termination for high reliability military and aerospace applications that must avoid tin whisker reliability issues.



#### TYPICAL IMPEDANCE



#### **HOW TO ORDER**

L	3	L	1	6	D	225	Μ	Α	В	3	Α
Ţ	Ţ	Ţ	T	T	Ţ	T	Т	T	T	T	T
Style	IDC Case Size 2 = 0508 3 = 0612 4 = 0306	Low Inductance	Number of Terminals 1 = 8 Terminals	Voltage 4 = 4V 6 = 6.3V Z = 10V Y = 16V 3 = 25V	Dielectric C = X7R D = X5R Z = X7S	Capacitance Code (In pF) 2 Sig. Digits + Number of Zeros	Capacitance Tolerance M = ±20%	Failure Rate A = N/A	<b>Termination</b> B =5% min. Lead	Packaging <u>Available</u> 1=7" Reel 3=13" Reel	Thickness Max. Thickness mm (in) A=Standard S=0.55 (0.022)
NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers.											

#### PERFORMANCE CHARACTERISTICS

Capacitance Tolerance	±20% Preferred			
Operation Temperature Range	X7R = -55°C to +125°C X5R = -55°C to +85°C X7S = -55°C to +125°C			
Temperature Coefficient	±15% (0VDC), ±22% (X7S)			
Voltage Ratings	4, 6.3, 10, 16, 25 VDC			
Dissipation Factor	≤ 6.3V = 6.5% max; 10V = 5.0% max; ≥ 16V = 3.5% max			
Insulation Resistance (@+25°C, RVDC)	100,000MΩ min, or 1,000MΩ per μF min.,whichever is less			

Dissipation Factor	No problems observed after 2.5 x RVDC for 5 seconds at 50mA max current
CTE (ppm/C)	12.0
Thermal Conductivity	4-5W/M K
Terminations Available	Plated Nickel and Solder



# **IDC Low Inductance Capacitors (SnPb)**



# IDC (InterDigitated Capacitors) with Sn/Pb Termination 0306/0612/0508

SIZE	W4 =	0306		W2 =	Thin	050	B		W2	2 = 05	508		W	3= Tł	nin O6	12		W3	3 = 00	512		W3	= TH	ICK 0	612
Max. mm	0.5				0.55.					0.95					.55				0.95					22	
Thickness (in.) WVDC	(0.0	(22) 6.3		6.3	(0.022		25	4	6.3	(0.037	<u> </u>	25	4	(0.	022)	16	4	6.3	(0.037	)	25	4	(0.0 6.3	1	16
	4	0.3	4	0.3	10	16	25	4	0.3	10	16	25	4	0.3	10	16	4	0.3	10	16	25	4	0.3	10	16
Cap (μF) 0.010																									
0.022																									
0.033																									
0.047																									
0.068																									
0.10																									
0.22																									
0.33																									
0.47																									
0.68																									
1.0																									
1.5																									
2.2																									
3.3																									

#### PHYSICAL DIMENSIONS AND PAD LAYOUT



Consult factory for additional requirements



#### **PHYSICAL CHIP DIMENSIONSMILLIMETERS (INCHES)**

SIZE	W	L	BW	BL	Р
0306	1.60 ± 0.20	0.82 ± 0.10	0.25 ± 0.10	0.20 ± 0.10	0.40 ± 0.05
0300	(0.063 ± 0.008)	(0.032 ± 0.006	(0.010 ± 0.004)	(0.008± 0.004)	(0.015 ± 0.002)
0500	2.03 ± 0.20	1.27 ± 0.20	0.30 ± 0.10	0.25 ± 0.15	0.50 ± 0.05
0508	(0.080 ± 0.008)	(0.050 ± 0.008)	(0.012 ± 0.004)	(0.010± 0.006)	(0.020 ± 0.002)
0612	3.20 ± 0.20	1.60 ± 0.20	0.50 ± 0.10	0.25 ± 0.15	0.80 ± 0.10
0012	(0.126 ± 0.008)	(0.063 ± 0.008)	(0.020 ± 0.004)	(0.010 ± 0.006)	(0.031 ± 0.004)

#### PAD LAYOUT DIMENSIONS

SIZE	Α	В	С	D	Е
0306	0.38	0.89	1.27	0.20	0.40
	(0.015)	(0.035)	(0.050)	(0.008)	(0.015)
0508	0.64	1.27	1.91	0.28	0.50
	(0.025)	(0.050)	(0.075)	(0.011)	(0.020)
0612	0.89	1.65	2.54	0.45	0.80
	(0.035)	(0.065)	(0.010)	(0.018)	(0.031)



# LGA Low Inductance Capacitors

#### 0204/0306 Land Grid Array





Land Grid Array (LGA) capacitors are the latest family of low inductance MLCCs from AVX. These new LGA products are the third low inductance family developed by AVX. The innovative LGA technology sets a new standard for low inductance MLCC performance.

Our initial 2 terminal versions of LGA technology deliver the performance of an 8 terminal IDC low inductance MLCC with a number of advantages including:

- · Simplified layout of 2 large solder pads compared to 8 small pads for IDCs
- Opportunity to reduce PCB or substrate contribution to system ESL by using multiple parallel vias in solder pads
- Advanced FCT manufacturing process used to create uniformly flat terminations on the capacitor that resist "tombstoning"
- Better solder joint reliability

#### **APPLICATIONS**

#### **Semiconductor Packages**

- Microprocessors/CPUs
- Graphics Processors/GPUs
- Chipsets
- FPGAs
- ASICs

#### **Board Level Device Decoupling**

- · Frequencies of 300 MHz or more
- ICs drawing 15W or more
- Low voltages
- · High speed buses

#### 0306 2 TERMINAL LGA COMPARISON WITH 0306 8 TERMINAL IDC





# LGA Low Inductance Capacitors



## 0204/0306 Land Grid Array



#### PART DIMENSIONS

Series	L	W	Т	BW	BL
LG12 (0204)	0.5 ± 0.05	1.00 ± 0.10	0.50 ± 0.05	0.8 ± 0.10	0.13 ± 0.08
	(0.020±0.002)	(0.039 ± 0.004)	(0.020 ± 0.002)	(0.031 ± 0.004)	(0.005 ± 0.003)
LG22 (0306)	0.76 ± 0.10	1.60 ± 0.10	0.50 ± 0.05	1.50 ±0.10	0.28 ± 0.08
	(0.030 ± 0.004)	(0.063 ± 0.004)	(0.020 ± 0.002)	(0.059 ± 0.004)	(0.011 ± 0.003)



**MM (INCHES)** 

#### **RECOMMENDED SOLDER PAD DIMENSIONS** MM (INCHES)

	Series	PL	PW1	G	
LG12 (0204)		0.50 (0.020)	1.00 (0.039)	0.20 (0.008)	
	LG22 (0306)	0.65 (0.026)	1.50 (0.059)	0.20 (0.008)	



# LGA Low Inductance Capacitors



#### 0204/0306 Land Grid Array - Tin/Lead Termination "B"



#### PART DIMENSIONS

**MM (INCHES)** 

Series	L	W	Т	BW	BL
PG12 (0204)	0.5 ± 0.05	1.00 ± 0.10	0.50 ± 0.05	0.8 ± 0.10	0.13 ± 0.08
	(0.020±0.002)	(0.039 ± 0.004)	(0.020 ± 0.002)	(0.031 ± 0.004)	(0.005 ± 0.003)
PG22 (0306)	0.76 ± 0.10	1.60 ± 0.10	0.50 ± 0.05	1.50 ±0.10	0.28 ± 0.08
	(0.030 ± 0.004)	(0.063 ± 0.004)	(0.020 ± 0.002)	(0.059 ± 0.004)	(0.011 ± 0.003)

#### **RECOMMENDED SOLDER PAD DIMENSIONS** MM (INCHES)

 Series	PL	PW1	G
PG12 (0204)	0.50 (0.020)	1.00 (0.039)	0.20 (0.008)
PG22 (0306)	0.65 (0.026)	1.50 (0.059)	0.20 (0.008)



#### AT Series - 200°C & 250°C Rated





Present military specifications, as well as a majority of commercial applications, require a maximum operating temperature of 125°C. However, the emerging market for high temperature electronics demands capacitors operating reliably at temperatures beyond 125°C. AVX's high temperature chip capacitor product line, has been extended with the BME COG chip. All AT chips have verified capabilities of long term operation up to 250°C for applications in both military and commercial businesses. These capacitors demonstrate high volumetric efficiency, high insulation resistance and low ESR/ESL for the most demanding applications, such as "down-hole" oil exploration and aerospace programs.

#### **HOW TO ORDER**

AT10	3	Ŧ	104	K	A	Ŧ	2	<b>A</b>
AVX Style AT03 = 0603 AT05 = 0805 AT06 = 1206 AT10 = 1210 AT12 = 1812 AT14 = 2225	<b>Voltage</b> <b>Code</b> 16V = Y 25V = 3 50V = 5	Temperature Coefficient PME COG 250°C = A COG 200°C = 2 VHT 250°C = T VHT 200°C = 4 BME COG 250°C = 5 COG 200°C = 3	<b>Capacitance Code</b> (2 significant digits + no. of zeros) 101 = 100pF 102 = 1nF 103 = 10nF 104 = 100nF 105 = 1µF	Capacitance Tolerance J = ±5% K = ±10% M = ±20%	Test Level A = Standard	Termination 1 = Pd/Ag T = 100% Sn Plated (RoHS Compliant) 7 = Ni/Au Plated (For 250°C BME COG Only)	<b>Packaging</b> 2 = 7" Reel 4 = 13" Reel 9 = Bulk	Special Code A = Standard

#### **ELECTRICAL SPECIFICATIONS**

#### **Temperature Coefficient**

PME C0G 0±30ppm/°C, -55C to 250°C BME C0G 0±30ppm/°C, -55C to 200°C

See TCC Plot for +250°C

VHT: T ±15%, -55°C to +150°C See TCC Plot for +250°C

Capacitance Test (MIL-STD-202, Method 305) 25°C, 1.0 ± 0.2 Vrms (open circuit voltage) @ 1kHz

#### **Dissipation factor 25°C**

COG: 0.15% Max at  $1.0 \pm 0.2$  Vrms (open circuit voltage) @ 1kHz VHT: 2.5% Max at  $1.0 \pm 0.2$  Vrms (open circuit voltage) @ 1kHz

Insulation Resistance 25°C (MIL-STD-202, Method 302)  $100G\Omega$  or  $1000M\Omega$ -µF (whichever is less)

Insulation Resistance 125°C (MIL-STD-202, Method 302)  $10G\Omega$  or  $100M\Omega$ - $\mu$ F (whichever is less)

Insulation Resistance 200°C (MIL-STD-202, Method 302) 1G $\Omega$  or 10M $\Omega$ -µF (whichever is less)

Insulation Resistance 250°C (MIL-STD-202, Method 302)  $100M\Omega$  or  $1M\Omega$ -µF (whichever is less)

Direct Withstanding Voltage 25°C (Flash Test)

250% rated voltage for 5 seconds with 50mA max charging current

#### **DIMENSIONS**



Size	AT03 = 0603	AT05= 0805	AT06=1206	AT10=1210	AT12=1812	AT14=2225
(L) Length	1.60 ± 0.15	2.01 ± 0.20	3.20 ± 0.20	3.20 ± 0.20	4.50 ± 0.30	5.72 ± 0.25
	(0.063 ± 0.006)	(0.079 ± 0.008)	(0.126 ± 0.008)	(0.126 ± 0.008)	(0.177 ± 0.012)	(0.225 ± 0.010)
(W) Width	0.81 ± 0.15	$1.25 \pm 0.20$	1.60 ± 0.20	2.50 ± 0.20	3.20 ± 0.20	6.35 ± 0.25
	(0.032 ± 0.006)	(0.049 ± 0.008)	(0.063 ± 0.008)	(0.098 ± 0.008)	(0.126 ± 0.008)	(0.250 ± 0.010)
(T) Thickness Max.	1.02	1.30	1.52	1.70	2.54	2.54
	(0.040)	(0.051)	(0.060)	(0.067)	(0.100)	(0.100)
(t) min.	0.25 (0.010)	0.25 (0.010)	0.25 (0.010)	0.25 (0.010)	0.25 (0.010)	0.25 (0.010)
terminal max.	0.75 (0.030)	0.75 (0.030)	0.75 (0.030)	0.75 (0.030)	1.02 (0.040)	1.02 (0.040)

#### MILLIMETERS (INCHES)





#### \_\_\_\_\_

#### PERFORMANCE CHARACTERISTICS



#### Typical Temperature Coefficient of Capacitance (VHT Dielectric) Typical Temperature Coefficient of Capacitance (COG Dielectric)



#### **Typical Voltage Coefficient of Capacitance (VHT Dielectric)**







Typical Voltage Coefficient of Capacitance (COG Dielectric)



**Typical RC vs Temperature (COG Dielectric)** 





#### AT Series - 200°C & 250°C Rated



#### RELIABILITY



VHT - Failure Rate @ 90% Confidence Level (%/1000 hours)								
Temperature (°C)	Temperature (°C) 50% Rated Voltage 100% Rated Vo							
200	0.002	0.017						
250	0.026	0.210						
*Typical 1210 1812 2225 F	ailure Rate Analysis based	on 250°C testing and						

Impedance Frequency Response (VHT Dielectric)

\*Typical 1210, 1812, 2225 Failure Rate Analysis based on 250°C testing an voltage ratings specified on the following page.



COG - Failure Rate	@ 90% Confidence Lev	/el (%/1000 hours)												
Temperature (°C)	50% Rated Voltage	100% Rated Voltage												
Temperature (°C)         50% Rated Voltage         100% Rated Voltage           200         0.006         0.047														
250	0.074	0.590												

\*Typical 1812 and 2225 Failure Rate Analysis based on 250°C testing and voltage ratings specified on the following page.

#### 1E+05 - AT05YT104 AT123T334 1E+04 AT143T105 1E+03 Impedance (Ω) 1E+02 1E+01 1E+00 1E-01 1E-02 1E+01 1E+02 1E+03 1E+04 1E+05 1E+06 1E+07 1E+08 Frequency (Hz)





# FREQUENCY RESPONSE



#### ESR Frequency Response (COG Dielectric)



The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.

#### 080416

#### 250°C Life Test @ 2x Rated Voltage (C0G Dielectric)

AT Series - 200°C & 250°C Rated

# A KYOCERA GROUP COMPANY

#### CAPACITANCE RANGE PREFERRED SIZES ARE SHADED

V	ΉΤ	Т	emp. Coeffi	cient	: 4	200°C	C Rate	d					VI	HT	Temp	o. Coefficie	nt: T	250	°C Ra	ted				
(	Case Si	ze	AT03 = 0603		05 = 305		06 = 206	AT1	0 = 10	AT12 = 1812	AT14 = 2225			Case	Size	AT03 = 0603	AT(	)5 = 05		06 = 206		10 = 10	AT12 = 1812	AT14 = 2225
	Solderi	na	Reflow/Wave				v/Wave	1		Reflow Only	Reflow Only	1 1		Solde	rina	Reflow/Wave				/Wave		v Only	Reflow Only	Reflow Only
		mm	1.60±0.15		±0.20		±0.20	3.20:		4.50±0.30	5.72±0.25	1	(L) [		mm	1.60±0.15	2.01			±0.20	3.20:		4.50±0.30	5.72±0.25
(-)		(in.)	(0.063±0.006)	(0.079	±0.008)		±0.008)		£0.008)		(0.225±0.010)	1	(-) -		(in.)	(0.063±0.006)	(0.079	<u> </u>		±0.008)		±0.008)		(0.225±0.010)
(W)	Width	mm	0.81 ±0.15		±0.20		±0.20	2.50:		3.20±0.20	6.35±0.25	1	(W)	Width	mm	0.81±0.15	1.25:			±0.20	2.50:		3.20±0.20	6.35±0.25
(71)1	Thickness	(in.)			±0.008) .30					(0.126±0.008)	(0.250±0.010) 2.54		(T) T	hickness	(in.) mm	(0.032±0.006) 1.02	· ·			±0.008)			(0.126±0.008)	(0.250±0.010)
(1)		(in.)	1.02 (0.040)		. <u>50</u> 051)		<u>52</u> 060)	1.1		2.54 (0.100)	(0.100)	łľ	(1)1	I IIUNI IESS	(in.)	(0.040)	1.	51)		52 )60)	·	70 167)	2.54 (0.100)	2.54 (0.100)
(t) 1	Terminal		0.25(0.010)		(0.010)		0.010)	0.25(		0.25(0.010)	0.25(0.010)	1 1	(t) T	erminal		0.25(0.010)		0.010)		0.010)	0.25(		0.25(0.010)	0.25(0.010)
		max	0.75(0.030)	0.75(	(0.030)	0.75(	0.030)	0.75(	0.030)	1.02 (0.040)	1.02 (0.040)				max	0.75(0.030)	0.75(	).030)	0.75(	0.030)	0.75(	0.030)	1.02 (0.040)	1.02 (0.040)
Ra	ted Temp	). (°C)	200	2	00	2	00	20	00	200	200		R	lated Ter	np. (°C)	250	2	50	2	50	2	50	250	250
Ter	np. Coef	ficeint	4		4		4	4	1	4	4		T	emp. Co	efficeint	Т	1	Γ		Т	-	Г	Т	Т
	Voltage		25	25	50	25	50	25	50	50	50			Voltag	e (V)	16	16	25	16	25	16	25	25	25
	1000												Cap	1000	102									
(pF)	1200	122											(pr)	1200	122									
	1500	152											ļ	1500	152									
	1800	182											ļ	1800	182								ļ	
	2200	222											ļ	2200	222									
	2700	272						L					ļ	2700	272								ļ	
	3300	332						L		L			ļ	3300	332									
	3900	392											ļ	3900	392									
	4700	472											ļ	4700	472									
	5600	562											ļ	5600	562									
	6800	682											ļ	6800	682									
	8200	822										╡	_	8200	822									
Cap (IIIF)	0.010	103											Cap (uF)	0.010	103									
(p. )	0.012	123											(µ. )	0.012	123									
	0.015	153											ļ	0.015	153									
	0.018	183											ļ	0.018	183									
	0.022	223											ļ	0.022	223									
	0.027	273											ļ	0.027	273									
	0.033	333											ļ	0.033	333									
	0.039	393											ļ	0.039	393									
	0.047	473											ŀ	0.047	473									
	0.056	563											ł	0.056	563	ļ								
	0.068	683											ŀ	0.068	683									
	0.082	823											ł	0.082	823									
	0.100	104											ŀ	0.100	104									
	0.120	124 154											┟	0.120	124 154									
		154 184			1								ł	0.150	154									
	0.180	184 224											ł	0.180	224	<u> </u>								
	0.220	274											ł	0.220	274									
	0.270	334											ł	0.270	334									
	0.390	394			-								ł	0.390	394		<u> </u>							
	0.390				1								ŀ	0.390	474									
		564											ł	0.470	564									
		684											ł	0.500	684									
		824			1								ł	0.820	824									
	1.000				1								ł	1.000	105									
	Voltage		25	25	50	25	50	25	50	50	50	1		Voltag		16	16	25	16	25	16	25	25	25
	ted Temp	<u> </u>	200		00		00	20		200	200		R	ated Ter		250		50		50		50	250	250
			AT03 =		05 =		06 =	AT		AT12 =	AT14 =	1				AT03 =		)5 =		)6 =	AT		AT12 =	AT14 =
	Case Si	ze	0603		305		206		10	1812	2225	ļ		Case	Size	0603	08			06		10	1812	2225

Voltage rating per table. Capacitance values specified at 25°C, derate capacitance value based on TCC and VCC Plots on page 107. NOTE: Contact factory for non-specified capacitance values.



AT Series - 200°C & 250°C Rated

# A KYOCERA GROUP COMPANY

#### CAPACITANCE RANGE PREFERRED SIZES ARE SHADED

B	ME	CO	G Tem	p. Coefficie	nt: 4 200	0°C Rated			B	ME	E CO	G (Ni/Au)	Temp. Coefficient: 5	250°C Rated
С	ase Si	ze	AT03=	=0603	AT05	=0805	AT06:	=1206		Case	Size	AT03=0603	AT05=0805	AT06 = 1206
S	olderir	ng	Reflow	/Wave	Reflow	/Wave	Reflow	/Wave		Solde	ring	Reflow/Wave	Reflow/Wave	Reflow/Wave
(L) L		mm	1.60±			±0.20	3.20:		(L)	Length		1.60±0.15	2.01 ±0.20	3.20±0.20
		(in.)	(0.063±			±0.008)	(0.126:				(in.)	(0.063±0.006)	(0.079±0.008)	(0.126±0.008)
(W)	Width	mm (in.)	0.81 ±			±0.20	1.60:		(W	) Width	mm (in.)	0.81±0.15	1.25±0.20	1.60±0.20
mπ	nickness	mm	(0.032±			±0.008) 30	(0.063 :		(T)		mm	(0.032±0.006) 1.02	(0.049±0.008) 1.30	(0.063±0.008) 1.52
(1) 11	IIUNI ICSS	(in.)	(0.0			30 )51)	(0.0			ckness	(in.)	(0.040)	(0.051)	(0.060)
(t) Te	erminal	min	0.25(0			0.010)	0.25(		(t)		min	0.25(0.010)	0.25(0.010)	0.25(0.010)
		max	0.25(0			0.030)	0.25(			rminal		0.75(0.030)	0.75(0.030)	0.75(0.030)
Rate	ed Temp		20			00		)0			пр. (°C)	250	250	250
	Temp.	( )								Tem	<u> </u>			
	Coefficei	nt	3	3		3	3	3		Coeffic		5	5	5
V	oltage (		25	50	25	50	25	50	'	Voltag		25	25	25
Cap	39	390							Сар		390			
(p⊦)	47	470							(pF)	47	470			
[	56	560								56	560			
11	68	680								68	680			
		820								82	820			
		101								100	101			
	120	121								120	101			
										<b>—</b>				
	150	151								150	151			
╞		181								180	181			4
		221								220	221			
		271								270	271			
	330	331								330	331			
Ιſ	390	391								390	391			
	470	471								470	471			
	560	561								560	561			
		681								680	681			
		821								820	821			
		102								-				
										1000	102			<u> </u>
╎╎		122								1200	122			
		152								1500	152			
		182								1800	182			
	2200	222								2200	222			
	2700	272								2700	272			
	3300	332								3300	332			
Ιſ	3900	392								3900	392			
	4700	472								4700	472			1
	5600	562								5600	562			
		682								6800	682		1	1
		822								8200	822			+
Cap		103							Can	0.010	103		+	+
(µF)		103							(μF)	0.010	103			
	0.015									0.015				
╎╎	0.018										183			
		223								0.022	223			
ΙL		273								0.027	273			
[	0.033	333								0.033	333			
Ιſ	0.039	393								0.039	393			
ļĪ	0.047	473								0.047	473			
ļľ	0.056	563								0.056	563			1
	0.068									0.068	683			1
		823								0.000	823			+
	0.100										104			+
	oltage (		25	50	25	50	25	50		Voltag		25	25	25
	<u> </u>	<u> </u>									<u>≠(v)</u> 1p. (°C)	250	250	250
	ed Temp		200	200	200	200	200	200			î			
C	ase Si	ze	AT03=	=0603	AT05	=0805	AT06:	=1206		Case	size	AT03=0603	AT05=0805	AT06=1206

Voltage rating per table. Capacitance values specified at 25°C, derate capacitance value based on TCC and VCC Plots on page 107. NOTE: Contact factory for non-specified capacitance values.





#### AT Series - 200°C & 250°C Rated

#### CAPACITANCE RANGE PREFERRED SIZES ARE SHADED

PI	ME	CO	G Temp.	Coefficient: 2	200°C Ra	ted		Ρ	ME	CO	G Temp.	Coefficient: A	250°C Ra	ted	
C	ase Si	ze	AT05 = 0805	AT06 = 1206	AT10 = 1210	AT12 = 1812	AT14 = 2225	(	Case Si	ize	AT05 = 0805	AT06 = 1206	AT10 = 1210	AT12 = 1812	AT14 = 2225
S	olderi	na	Reflow/Wave	Reflow/Wave	Reflow Only	Reflow Only	Reflow Only		Solderi	na	Reflow/Wave	Reflow/Wave	Reflow Only	Reflow Only	Reflow Only
(1) L	ength	mm	2.01 ±0.20	3.20±0.20	3.20±0.20	4.50±0.30	2.75±0.25		ength	mm	2.01 ±0.20	3.20±0.20	3.20±0.20	4.50±0.30	2.75±0.25
(L) L	engui	(in.)	(0.079±0.008)	(0.126±0.008)	(0.126±0.008)	(0.177±0.012)	(0.225±0.010)	(L) L	Lengui	(in.)	(0.079±0.008)	(0.126±0.008)	(0.126±0.008)	(0.177±0.012)	(0.225±0.010)
(W) V	Nidth	mm (in.)	1.25±0.20 (0.049±0.008)	1.60±0.20 (0.063±0.008)	2.50±0.20 (0.098±0.008)	3.20±0.20 (0.126±0.008)	6.35±0.25 (0.250±0.010)	(W)	Width	mm (in.)	1.25±0.20 (0.049±0.008)	1.60±0.20 (0.063±0.008)	2.50±0.20 (0.098±0.008)	3.20±0.20 (0.126±0.008)	6.35±0.25 (0.250±0.010)
		mm	1.30	1.52	1.70	2.54	2.54			mm	1.30	1.52	1.70	2.54	2.54
(T) Th	nickness	(in.)	(0.051)	(0.060)	(0.067)	(0.100)	(0.100)	(Т)Т	hickness	(in.)	(0.051)	(0.060)	(0.067)	(0.100)	(0.100)
(t) Te	erminal	min	0.25 (0.010)	0.25(0.010)	0.25(0.010)	0.25(0.010)	0.25(0.010)	(t) T	erminal	min	0.25(0.010)	0.25(0.010)	0.25(0.010)	0.25(0.010)	0.25(0.010)
		max	0.75(0.030)	0.75(0.030)	0.75(0.030)	1.02 (0.040)	1.02 (0.040)			max	0.75(0.030)	0.75 (0.030)	0.75(0.030)	1.02(0.040)	1.02 (0.040)
	ted Temp		200	200	200	200	200		ated Temp		250	250	250	250	250
	np. Coeff		2 50	2 50	2	2	2		mp. Coeff		A 25	A 25	A	A 25	A 25
	/oltage (		50	50	50	50	50		Voltage (		25	25	25	25	25
	100								100						
	120	121							120	121					
	150 180	151 181							150 180	151 181					
	220								220					ļ	
		221								221					
	270	271 331							270 330	271 331					
	330									331					
	390	391							390	471					
	470 560	471 561							470 560	561					
	680	681							680	681					
0	820							0		821					
Cap (pF)	1000	821 102						Cap (pF)	820 1000	102					
(pr)	1200	102						(pr)	1200						
	1500	152							1500	152					
	1800	182							1800	182					
	2200	222							2200						
	2700	272							2700	272					
	3300	332							3300	332					
	3900	392							3900	392					
	4700	472							4700						
	5600	562							5600						
	6800	682							6800	682					
	8200	822			i				8200	822					
	0.010				İ				0.010		İ				
l I	0.012				Ì				0.012						
1	0.015				Ì				0.015						
1	0.018	183			Ì				0.018						
	0.022	223			1				0.022						
	0.027				1				0.027	273					
Cap	0.033	333			1			Cap	0.033	333					
(µF)	0.039	393						(µF)	0.039						
l I	0.047	473							0.047	473					
	0.056	563						0.056	563						
	0.068	683							0.068	683					
	0.082	823							0.082	823					
	0.100	104							0.100	104					
V	oltage	(V)	50	50	50	50	50		/oltage	(V)	25	25	25	25	25
Rate	ed Temp. (°C)		200	200	200	200	200	Rat	ted Temp	o. (°C)	250	250	250	250	250
	ase Si		AT05 = 0805	AT06 = 1206	AT10 = 1210	AT12 = 1812	AT14 = 2225		Case S		AT05 = 0805	AT06 = 1206	AT10 = 1210	AT12 = 1812	AT14 = 2225

Voltage rating per table. Capacitance values specified at 25°C, derate capacitance value based on TCC and VCC Plots on page 107. NOTE: Contact factory for non-specified capacitance values.



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# High Voltage MLC Chips For 600V to 5000V Applications





#### NEW 630V RANGE

High value, low leakage and small size are difficult parameters to obtain in capacitors for high voltage systems. AVX special high voltage MLC chip capacitors meet these performance characteristics and are designed for applications such as snubbers in high frequency power converters, resonators in SMPS, and high voltage coupling/dc blocking. These high voltage chip designs exhibit low ESRs at high frequencies.

Larger physical sizes than normally encountered chips are used to make high voltage MLC chip products. Special precautions must be taken in applying these chips in surface mount assemblies. The temperature gradient during heating or cooling cycles should not exceed 4°C per second. The preheat temperature must be within 50°C of the peak temperature reached by the ceramic bodies through the soldering process. Chip sizes 1210 and larger should be reflow soldered only. Capacitors may require protective surface coating to prevent external arcing.

For 1825, 2225 and 3640 sizes, AVX offers leaded version in either thru-hole or SMT configurations (for details see section on high voltage leaded MLC chips)

#### **HOW TO ORDER**

1808	Α	Α	271	М	Α	1	2	Α
$\top$	Т	Т	$\top$	Т	Т	Т	Т	T
AVX	Voltage	Temperature	Capacitance Code	Capacitance	Test Level	Termination	* Packaging	Special
Style	600V/630V = C	Coefficient	(2 significant digits	Tolerance	A = Standard	1 = Pd/Ag	1 or 2 = 7" Reel**	Ċode
0805	1000V = A	NPO (COG) = A	+ no. of zeros)	C0G: J = ±5%		T = Plated	3 or 4 = 13" Reel	A = Standard
1206	1500V = S	XŻR = Ć	Examples:	K = ±10%		Ni and Sn		
1210	2000V = G		10 pF = 100	M = ±20%		(RoHS Compli	ant)	
1808	2500V = W		100  pF = 100	X7R: K = ±10%				
1812	3000V = H		1.000  pF = 102	M = ±20%				
1825	4000V = J		22,000  pF = 223	Z = +80%,				
2220	5000V = K		220,000  pF = 224	-20%				
2225			1 µF =105					
3640			·					
***			*Note:	Terminations with	15% minimum lea	d (Pb) is available, se	ee pages 100 and 10	1 for LD style.

Note: Terminations with 5% minimum lead (Pb) is available, see pages 100 and 101 for LD style Leaded terminations are available, see pages 102-106.

> KOHS COMPLIANT

Notes: Capacitors with X7R dielectrics are not intended for applications across AC supply mains or AC line filtering with polarity reversal. Contact plant for recommendations. Contact factory for availability of Termination and Tolerance options for Specific Part Numbers.

\*\*The 3640 Style is not available on 7" Reels.

\*\*\* AVX offers nonstandard chip sizes. Contact factory for details.





#### DIMENSIONS

SIZE	0805	1206	1210*	1808*	1812*	1825*	2220*	2225*	3640*
(L) Length	2.10 ± 0.20	3.30 ± 0.30	3.30 ± 0.40	4.60 ± 0.50	4.60 ± 0.50	4.60 ± 0.50	5.70 ± 0.50	5.72 ± 0.25	9.14 ± 0.25
	(0.083 ± 0.008)	(0.130 ± 0.012)	(0.130 ± 0.016)	(0.181 ± 0.020)	(0.181 ± 0.020)	(0.181 ± 0.020)	(0.224 ± 0.020)	(0.225 ± 0.010)	(0.360 ± 0.010)
(W) Width	1.25 ± 0.20	1.60 ± 0.20	2.50 ± 0.30	2.00 ± 0.20	3.20 ± 0.30	6.30 ± 0.40	5.00 ± 0.40	6.35 ± 0.25	10.2 ± 0.25
	(0.049 ±0.008)	(0.063 ± 0.008)	(0.098 ± 0.012)	(0.079 ± 0.008)	(0.126 ± 0.012)	(0.248 ± 0.016)	(0.197 ± 0.016)	(0.250 ± 0.010)	(0.400 ± 0.010)
(T) Thickness	1.35	1.80	2.80	2.20	2.80	3.40	3.40	2.54	2.54
Max.	(0.053)	(0.071)	(0.110)	(0.087)	(0.110)	(0.134)	(0.134)	(0.100)	(0.100)
(t) terminal min.	0.50 ± 0.20	0.60 ± 0.20	0.75 ± 0.35	0.75 ± 0.35	0.75 ± 0.35	0.75 ± 0.35	0.85 ± 0.35	0.85 ± 0.35	0.76 (0.030)
max.	(0.020 ± 0.008)	(0.024 ± 0.008)	(0.030 ± 0.014)	(0.030 ± 0.014)	(0.030 ± 0.014)	(0.030 ± 0.014)	(0.033 ± 0.014)	(0.033 ± 0.014)	1.52 (0.060)

\*Reflow Soldering Only





#### For 600V to 5000V Applications

#### **NP0 (C0G) DIELECTRIC – PERFORMANCE CHARACTERISTICS**

Capacitance Range	10 pF to 0.100 µF (25°C, 1.0 ±0.2 Vrms at 1kHz, for ≤ 1000 pF use 1 MHz)
Capacitance Tolerances	±5%, ±10%, ±20%
Dissipation Factor	0.1% max. (+25°C, 1.0 ±0.2 Vrms, 1kHz, for ≤ 1000 pF use 1 MHz)
Operating Temperature Range	-55°C to +125°C
Temperature Characteristic	0 ±30 ppm/°C (0 VDC)
Voltage Ratings	600, 630, 1000, 1500, 2000, 2500, 3000, 4000 & 5000 VDC (+125°C)
Insulation Resistance (+25°C, at 500 VDC)	100K MΩ min. or 1000 MΩ - μF min., whichever is less
Insulation Resistance (+125°C, at 500 VDC)	10K MΩ min. or 100 MΩ - μF min., whichever is less
Dielectric Strength	Minimum 120% rated voltage for 5 seconds at 50 mA max. current

#### **NPO (COG) CAPACITANCE RANGE – PREFERRED SIZES ARE SHADED**

Case	Size		0805	5			1206					12	10						18	808							18	12			
Solde	ering		low/V	Vave			ow/W	/ave				Reflo	w Only						Reflo	w Onl							Reflow	v Only			
(L) Length	mm (in.)	2.	10 ± 0 85 ± 0	.20		3.3	30 + 0. 30 + 0.	.30			(	3.30	+ 0.40 + 0.01	6)				(	4.60	+ 0.50	)					(	4.60 +	+ 0.50 + 0.012	2)		
W) Width	mm	1.1	25 ± 0	.20		1.60	+0.30/	/-0.10				2.50	+ 0.30	1					2.00	+ 0.20	)					(		+ 0.30	<u>_)</u>		
	(in.)	(0.0	49 ± 0	.008)	(0	).063 +	0.012	/-0.00	)4)		((	0.098	+ 0.01	2)				((	0.079	+ 0.00	)8)					(0	).126 +	+ 0.008	3)		
(T) Thickness	mm (in.)		1.35 (0.053	3)		(	1.80 0.071	)				2. (0	80 110)						2.	.20 087)							2.3 (0.1	80 00)			
(t) Terminal	mm	0.	50 + C	.20		0.6	50 + 0.	20				0.75	+ 0.35						0.75	+ 0.35	5						0.75 -	+ 0.35			
Valtar	(in.)	(0.0)	$\frac{20+0}{100}$	0.008)	600	(0.0	4 + 0.	008)	10000	600	600		0.014		12000	(00	1 ( 20	11000	(.030	0.014	.)	2000	14000	600	(20)	11000	(.030)	0.014)	0500	2000	4000
Voltag Cap (pF)	.5 OR5	600	03U Δ	1000	000	630	1000	1500	2000	600	030	1000	1500	2000	3000	600	030	1000	1500	2000	2500	3000	4000	600	030	1000	1500	2000	2500	3000	4000
	1.0 1R0		A	Č																											
	1.2 1R2		Α	С																											<u> </u>
	1.5 1R5 1.8 1R8	A	A	C C		X	X		X																						
	2.2 2R2	Ā	Â	C	X	X	X	X	X								С	С		С		С	С								
	2.7 2R7	Α	Α	С	Х	Х	Х	Х	Х								С	C	С	С	С	С	С								
	3.3 3R3	A	A	C	X	X	X	X	X					<u> </u>			C	C	C C	C	C	C	C			<u> </u>					
	3.9 3R9 4.7 4R7	A	A	C C	X	X	X	X	X								C C	C	C	C C		C C	C C								
	5.6 5R6	A	A	Č	X	X	X	X	X								Č	č	Č	Č	Č	Č	Č								i
	6.8 6R8	Α	Α	С	Х	Х	Х	Х	Х								С	С	С	С	С	С	С								
	8.2 8R2	A	A	C	X	X	X	X	X	C	M	M		M	E.	0	C	C	C	C	C	C	C	C	C	6		0	6	0	E
	<u>10 100</u> 12 120	120 A A C X X X X X C M M D M F C C C C C C C C C C C													C	C	C	C	C	C	C	Ē									
	15 150	A	Α	С	X	Х	X	X	Х	С	М	М	D	M	F	С	С	С	С	С	С	С	С	С	С	C	С	С	С	С	E
	18 180	A	A	C	X	X	X	X	X	C	М	M	D	M	F	С	С	C	С	C	C	С	C	C	C	C	C	C	C	С	E
	22 220 27 270	A A	A	C C		X	X	X	X X	C C	M	M	D	M	F	C C	C C	C C	C C	C C	<u>с</u> с	C C	E	C C	C C		<u>с</u> с	C F	C C	C C	E
	33 330	A	A	C	X	X	X	D	M	C	M	M	D	M	F	C		C	C			C	F	C	C	C	C	F	C	C	E
	39 390	Α	Α	С	Х	Х	Х	D	М	С	М	М	D	М	F	C	С	C	C	С	С	С	F	С	С	C	С	F	С	С	E
	47 470	A	A	C	X	X	C	D	M	C	M	M	D	M	F	C	C	C	C	C	C	C	С	C	C	C	C	F	C	C	E
	56 560 68 680	A A	A	C C	X X	X X	C C	C C	C C	C C	M M	M M	C C	C C	F	C C	C C	C C	C C	C C	C C	C C		C C	C C	C C	C C	F	C C	C C	F
	82 820	X	Γ <u>x</u>	X	X	X	C	Č	C	C	M	M	C	č	F	C	č	č	Č	Ċ	Č	Č		C	C	Č	Č	F	č	C	F
	100 101	Х	X	X	Х	Х	С	С	С	С	М	С	С	С	F	С	С	С	С	С	F	F		С	С	С	С	F	С	С	F
	120 121	C C	C C	С С	X	X	C C	E	E	C C	M M	C C	C E	C E	F F	C C	C C	C C	C F	C F		F		C C	C C	C C	C C	F F	C C	C C	G
	<u>150 151</u> 180 181	C			X X	Ι Â	E	E	E	C	M	E	E	E		C	C		F	F	₽	F		C	C			F	F	F	6
	220 221	С	C	С	Х	Х	E	E	Е	С	М	E	E	E	F	C	C	С	F	F	F	F		С	С	C	С	F	F	F	
	270 271	C	C	C	C	М	E	E	E	С	М	E	E	E	G	С	F	C	F	F	F	F		С	С	C	C	F	F	F	<u> </u>
	<u>330 331</u> 390 391	C C	C C	C C	C C	M	E	E	E	C C	M	E	E	E		C C	F	F	F	F	F F	F		C C	C C	C C	F F	F	F	F	
	470 471	C	C		C	M	E	E	E	C	M	E	E	E		C	F	F	F	F	F	F		C	C	F	F	F	F	F	
	560 561	С	C		С	С	E			С	М	E	E	E		С	F	F	F	F		F		С	С	F	F	F	F	F	
	680 681	C C	C C		C E	C F	E			C C	M	E	F G	E		C C	F	F	F F	F				C C	C C	F	F	F F	G G	G	———
	750 751 820 821	C			E	E	E	-		C	M	E	G	E		C			E					C	C				G	G	
	1000 102		Č		Ē	Ē	Ē			Č	C	E	F	F		Č	F	F	Ē	F				Č	Č	F	F	F	G	G	
	1200 122		C		E	E	E			C	C	E		F		C	F	F	E	F				C	C	F	E	E			<u> </u>
	1500 152 1800 182		C C		E	E				C C	C C	F G		G G		E	F	F		F				C C	C C	F	F G	F F			
	2200 222		C		E	E				E	C	G				E	F	F						С	C	E	G	G			
	2700 272				E	E				E	С	G				E	F	F						С	С	E	G	G			
	3300 332 3900 392		<u> </u>		E	E	<u> </u>	-		E	C C	G G		<u> </u>		E	F	F		<u> </u>	<u> </u>		-	C C	C C	F F		G			
	4700 472		1	1	1	E				E	C				1	E	F				1			C	C	G					
	5600 562					Е				Е	Е					E	F							С	С	G					
	6800 682							-			E			<u> </u>		F	F			<u> </u>	<u> </u>			C F	C	<u> </u>		<u> </u>			
Cap (µF)	8200 822 0.010 103		1		-	+					F						F	-			+			E	C C	-					
	0.012 123										G													F	F						
	0.015 153		<u> </u>			<u> </u>						<u> </u>									<u> </u>	<u> </u>		G	G			<u> </u>			
	0.018 183		+			+																		G	G						
	0.022 223																								G						
	0.033 333					I																			G						
	0.047 473		-		-									-	-	L	-	-								-	-	-			)
	0.056 563		-		+	+															-										
	0.100 104																														
Voltag		600			600	630			2000	600	630			2000	3000	600	630	1000			2500	3000	4000	600	630	1000			2500	3000	4000
Case	SIZE		0805	,	1		1206			1	_	12	210				_		18	808							18	12		_	
Letter	A		С		E		F		G		X		7	1	NOT	E: Co	ontad	ct fac	torv	for n	on-sr	becifi	ied ca	apaci	tanc	e val	ues				
Max.	0.813	1.4	448	_	3034	2.2	098		794		940		.30	1					,		-1										
Thickness	(0.032)	(0.0	057)	0.0	071)	(0.0	)87)	(0.1	110)	(0.0	)37)	(0.	130)																		



# **High Voltage MLC Chips**



#### For 600V to 5000V Applications

#### NP0 (C0G) CAPACITANCE RANGE – PREFERRED SIZES ARE SHADED

Case Size					18	25								2220	1								2225	5								3640	)			
Soldering	+			F		w Onl	у							low C						_	_		low (			_			_		Re	flow				
(L) Length					4.60	± 0.50							5.	70 0.5	50							5.7	70 ± 0	.50							9.	14 ± 0	.25			
W) Width	n				6.30	± 0.02 ± 0.40							5.	24 0.0 00 0.4	10							6.	25 ± 0 30 0.4	40							10	60 ± 0	.25			
(T) mr				((		<u>± 0.01</u> 40	6)							97 0.0 3.40									50 ± 0 3.40									00 ± 0 2.54				
Thickness (in.					<u>(0.1</u> 0.75	1 <u>34)</u> ± 0.35								0.134 85 0.3									0.100 35 ± 0									<u>(0.100</u> 76 (0.0				
(i) rerminal ma	ax	(00)	(00	(0	0.030	± 0.01		10000	14000	600	600	1000	(0.03	33 ± 0.	014)	0000	4000	5000	600	(00	1000	(0.03	33 ± 0.	.014)	0000	4000	5000	600	(00)	11000	1.	52 (0.0	)60)	0000	40000	1 5000
Voltage (V) Cap(pF) 1.5 1	1R5	600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000
1.8	1R8																																			
	2R2								<u> </u>																											
	2R7 3R3																																			
	3R9																																			
	4R7 5R6					-			-					<u> </u>																						
6.8 6	5R8																																			
	3R2	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-		1	1	-	_	-	-	1	-									
	100 120	E	E	G G	E	F	E	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F									
15	150	E	Е	G	Е	F	Е	F	F	Е	E	E	E	Е	Е	Е	Е	E	E	E	Е	Е	Е	E	E	F	F									
	180 220	E	E	G G	E	F	E	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F	<u> </u>		-						-
27 2	270	E	E	G	E	F	E	F	F	E	E	E	E	E	E	E	Е	E	E	E	E	E	E	E	E	F	F		L							
	330 390	E	E	G	E	F	E	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F									
	390 470	E	E	G G	E	F	E	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	G									G
56	560	Е	Е	G	Е	F	Е	F	F	Е	Е	E	E	E	Е	Е	Е	E	E	Е	E	E	Е	E	E	F	G									G
	680 820	E	E	G G	E	F	E	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	G G									G G
	101	E	E	G	E	F	E	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G				G	G	G	G	G	G
	121	E	E	G	E	F	E	F	F	E	E	E	E	E	E	E	E	E	E	ш	п	E	E	E	E	G	G				G	G	G	G	G	G
	151 181	E	E	G G	E	F	E	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G G	G G				G G	G G	G G	G G	G G	G G
220 2	221	Е	Е	G	Е	F	Е	F	F	Е	Е	Е	Е	Е	Е	Е	F	F	Е	Е	Е	Е	Е	Е	E	G	G				G	G	G	G	G	G
	271 331	E	E	G G	E	F	E	F	F	E	E	E	E	E	E	E			E	E	E	E	E	E	E	G G	G				G G	G G	G G	G G	G G	G G
	391	E	E	G	E	F	E	F	· ·	E	E	E	E	E	E	E			E	E	E	E	E	E	E	G					G	G	G	G	G	G
	471	E	E	G	E	F	E	F		E	E	E	E	E	E	E			E	E	E	E	E	E	E	G					G	G	G	G	G	G
	561 581	E	E	G G	E	F	E	F		E	E	E	E	E	E	E			E	E	E	E	E	E	E	G					G G	G G	G G	G G	G G	G
750	751	Е	Е	G	Е	F	F	G		Е	Е	Е	E	Е	F	F			E	Е	Е	Е	Е	Е	E						G	G	G	G	G	G
	821 102	E	E	G G	E	F	F	G		E	E	E	E	E	F	F			E	E	E	E	E	F	E			G	G	G	G G	G G	G G	G G	G G	G
1200	122	E	E	G	E	F	G	G		Е	E	E	E	E	G	G			E	E	E	E	E	F	F			G	G	G	G	G	G	G	G	
	152	E	E	G G	F	G	G	G		E	E	E	F	F	G	G G			E	E	E	E	E	F G	F			G	G	G	G G	G G	G G	G G		
	182 222	E	E	G	G	G	G	G		E	E	E	G	G	6	G			E	E	E	E	E	G	6			G G	G	G	G	G	G	G		
	272	E	Е	G	G	G		G		E	E	E	G	G					E	E	E	F	F					G	G	G	G	G	G	G		
	332 392	E	E	G G	G G	G G				E	E	E	G G	G G	-				E	E	E	F G	F G					G G	G G	G G	G G	G G	G G			
4700 4	472	E	Е	G	G	G				Е	E	E	G	G					F	F	F	G	G					G	G	G	G	G				
	562 682	F	F	G G	G	G	-	-		F	F	F	G	G	-				F	F	F	G	G G	<u> </u>				G G	G	G	G G	G G	-			-
	682 822	G	G	G		G				G	G	G							G	G	G	0						G	G	G	G					
	103	F	Е	G						7	7	7							G	G	G							G	G	G	G					
	123		E	G		<u> </u>	<u> </u>	<u> </u>	<u> </u>					<u> </u>					G	G								G	G	G						
	153	_	E			-		-							-				G	G								G	G	G	-					-
	183 223	-	E			-	-		+						-				G G	G G								G G	G G	G G						-
	273		F		-														3																	
	333		F			L	L	L	L										G	G				L				G	G							
	393		G																																	
	473		G																G	G								G	G							
	563	_	G G																G G	G											-		-			
	683 104		G			-	-	-	+						-				6	G					-					-	-		-			-
Voltage (V)		600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000
Case Size	1	- 1				25								2220									2225									3640				
Letter		A	T	(	С		E	T	F			G		Х		7	,	] N	OTE:	Con	tact	fact	ory f	for n	on-si	pecif	fied c	apa	citar	nce	/alue	s				
Max.		0.813	2		148	1	.8034	1	2.20			794		0.940		3.3		1					.,.		-							-				
IVIAA.																0.0																				



120919



# **X7R Dielectric**

#### **Performance Characteristics**

Capacitance Range	10 pF to 0.82 μF (25°C, 1.0 ±0.2 Vrms at 1kHz)
Capacitance Tolerances	±10%; ±20%; +80%, -20%
Dissipation Factor	2.5% max. (+25°C, 1.0 ±0.2 Vrms, 1kHz)
Operating Temperature Range	-55°C to +125°C
Temperature Characteristic	±15% (0 VDC)
Voltage Ratings	600, 630, 1000, 1500, 2000, 2500, 3000, 4000 & 5000 VDC (+125°C)
Insulation Resistance (+25°C, at 500 VDC)	100K MΩ min. or 1000 MΩ - μF min., whichever is less
Insulation Resistance (+125°C, at 500 VDC)	10K MΩ min. or 100 MΩ - μF min., whichever is less
Dielectric Strength	Minimum 120% rated voltage for 5 seconds at 50 mA max. current

#### **X7R CAPACITANCE RANGE – PREFERRED SIZES ARE SHADED**

Case Size	-		0805				1206					1210						18	08							19	12					
Soldering		Ref	low/W			Ref	low/W	lave			Re	flow 0	nlv					Reflo									w Only					
(L) Length	mm	2	2.10 0.2	20		3.	30 ± 0.	30			3	.30 0.4	0					4.60 :	± 0.50							4.60 :	± 0.50					
	(in.) mm		85 ± 0. 25 ± 0.			(0.1	30 ± 0. +0.30/	<u>012)</u>				1 <u>30 0.0</u> .50 0.3					(		<u>± 0.020</u> 0.20	)					(	0.177 :	<u>± 0.012</u> ± 0.30	)				
w) width	(in.)		49 ± 0.		(		+0.012		L)			0.0 890					(	0.079 :	± 0.008	)					(	0.126 :	± 0.008	)				
(T) Thickness	mm (in.)		1.35 (0.053	)			1.80 (0.071)	)				2.80 (0.110)						2. (0.0	20							2.	80 100)					
	mm	0	50 ± 0. 20 ± 0.	20		0.	60 ± 0. 24 ± 0.	20			0	.75 0.3 30 ± 0.	5					0.75	± 0.35 ± 0.014	,						0.75	± 0.35 ± 0.014	,				
Voltage (V	max ')			1000	600		24 ± 0. 1000		2000	600			1500	2000	600	630	1000				3000	4000	600	630	1000				3000	4000		
Cap (pF) 100	101	Х	Х	С	С	С	Е	Е	Е	Е	Е	Е	Е	Е																		
120	121	Х	Х	С	С	С	Е	Е	Е	Е	Е	Е	Е	Е																		
150	151	Х	Х	С	С	С	E	E	E	E	E	E	E	Е																		
180	181 221	X	X	С	С	С	E	E	E	E	E	E	E	E																		
220	221	X X	X X	C C	C C	C C	E	E	E	E	E	E	E	E									F	E	F	Е	E					
330	331	X	X	C	C	C	E	E	E	E	E	E	E	E	F	F	F	F	F	Е	F		E	E	E	E	E					
390	391	X	x	C	c	c	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F		E	E	E	E	E					
470	471	X	X	C	c	c	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F		E	E	E	E	E	E	Е			
560	561	Х	Х	С	С	С	Е	Е	E	E	Е	E	E	Е	E	E	Е	E	E	F	F		Е	Е	Е	Е	E	E	Е			
680	681	Х	X	С	С	С	E	Е	E	E	Е	E	E	Е	E	E	Е	E	E	F	F		Е	Е	E	Е	E	F	F			
750	751	Х	Х	С	С	С	E	Е	Е	Е	Е	Е	Е	Е	Е	E	Е	Е	Е	F	F		Е	Е	E	Е	E	F	F			
820	821	Х	Х	С	С	С	E	Е	E	E	E	E	E	Е	Е	E	E	E	E	F	F		Е	Е	E	Е	E	F	F			
1000	102	X	X	X	С	С	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F		E	E	E	E	E	F	F			
1200	122 152		X	X	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F		E	E	E	E	E	F	F			
1800	152	~	X	X	C	C C	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F		E	E	E	E	E	G	G			
2200	222	X X	X X	X X	C C	C C	E	E	E	E	E	E	E F	E	E	E	E	E F	E F	F	F		E	E	E	E	E	G G	G G			
2700	272	C	C	^	C	C	E	E	E	E	E	E	F	E	E	E	E	F	F	F			E	E	E	E	E	G	G			
3300	332		C		C	C	E	-		E	E	E	F	E	E	E	E	F	F				E	E	E	F	F	G	G			
3900	392	С	С		С	С	E			Е	E	E	F		Е	E	Е	F					Е	E	E	F	F	G	G			
4700	472	С	С		С	С	Е			Е	Е	E	F		Е	E	Е	F					E	Е	Е	F	F	G	G			
5600	562	С	С		С	С	Е			Е	Е	Е	F		Е	E	E	F					Е	Е	Е	G	G	G				
6800	682	С	С		С	С	Е			Е	Е	E			Е	E	Е	F					Е	Е	E	G	G					
8200	822	Ŭ	С		С	С	E			E	E	E			E	E	E						E	E	E	G	G					
Cap (µF) 0.010 0.015	103 153	-	С		C	C	E			E	E	E			E	E	E						E	E	F	G	G					
0.013	183	C C	C C		E	E	E			E	E	E			F	F	F						E	E	F G	G						
0.022	223	c	C		E	E				E	E	F			F	F	F						E	E	G							
0.027	273				E	E				E	E				F	F							E	E	G							
0.033	333				Е	Е				Е	Е				F	F							Е	E	G							
0.039	393									Е	Е				F	F							Е	Е	G							
0.047	473									Е	Е				F	F							Е	E	G							
0.056	563									F	F				F	F							F	F								
0.068	683	<u> </u>	<b> </b>							F	F	L			F	F			<u> </u>				F	F						<u> </u>		
0.082	823					<u> </u>				F	F										<u> </u>		F	F				-				
0.100	104									F	F												F G	F G				-				
0.150	154 224																															
0.220	274																															
0.330	334																															
0.390	394																															
0.470	474																															
0.560	564																															
0.680	684																															
0.820	824		I		L											L								<u> </u>	L			<u> </u>		<u> </u>		
1.000	105		620	1000	600	620	1000	1500	2000	600	600	1000	1500	2000	600	600	1000	1500	2000	2500	2000	4000	600	620	1000	1500	2002	2500	2000	4000		
Voltage (V Case Size		600	630 0805	1000	600	630	1000 1206	1500	2000	600	630	1000 1210	1500	2000	600	630	1000		2000 08	2500	3000	4000	600	630	1000		2000 12	12500	3000	4000		
Udse SIZE	6		0805				1200	_				1210																				
Letter	A	1	C	;	E		F		G	i	Х		7		NC	DTE: (	Conta	ct fac	ctory	for no	on-spe	ecifie	d cap	bacita	ince v	alues	5					
Max.	0.8		1.4		1.80		2.20		2.7		0.9		3.3																			
Thickness	(0.0	32)	(0.0	57)	(0.0	71)	(0.0	87)	(0.1	10)	(0.0	37)	(0.13	30)																		



# **High Voltage MLC Chips**

#### For 600V to 5000V Applications



#### **X7R CAPACITANCE RANGE**

#### **PREFERRED SIZES ARE SHADED**

Case Size	T				18	325								2220	)								2225	5								3640	C			
Soldering	1				Reflo									flow 0									flow (									eflow (				
(L) Length (in.)				(1	4.60 0.181	± 0.50								70 ± 0. 24 ± 0.									70 ± 0 25 ± 0									14 ± 0 60 ± 0				
W) Width mm					6.30	± 0.40		_	-				5.0	)0 ± 0.	.40							6.3	30 ± 0	.40							10	0.2 ± 0	.25			
(T) mm				((	).248 3.	40	0)		_		_	_		97 ± 0. 3.40			_				_		50 ± 0 3.40			_			_			00 ± 0 2.54				
Thickness (in.)					0.75	<u>134)</u> ± 0.35							0.8	0.134 35 ± 0.	.35	_					-	0.1	( <u>0.100</u> 85 ± 0	)) .35						-	0.	<u>(0.100</u> 76 (0.0	<u>))</u> )30)			_
(t) Terminal max Voltage (V)		(00)	(00	((	0.030	± 0.01	4)		14000	600	600	1000	(0.03	33 ± 0.	.014)	10000	4000	5000	600	600	1000	(0.0)	33 ± 0	.014)	0000	4000	5000	(00)	(00	1000	1.	76 (0.0 52 (0.0	060)	0000	4000	5000
Cap (pF) 100 1		600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000
	21																																	++	<u> </u>	
150 1	51						1									1																				
	81																																			
220 2																																				
	71					<u> </u>	-									<u> </u>																				<u> </u>
	31 91						-																													<b> </b>
470 4	_						-	-	-																											
560 5																-																				-
680 6	81																																			
750 7	51																																			
	21																																			
	02	F	F	F	F	F	F	F		F	F	F	F	F	F	G			F	F	F	F	F	F	F			G	G	G	G	G	G	G	G	G
	22 52	F	F	F	F	F	F	F	_	F	F	F	F	F	F	G			F	F	F	F	F	F	F			G	G	G	G	G	G	G	G	G
	32 32	F	F	F	F	F	F	F		F	F	F	F	F	F	G G			F	F	F	F	F	F	F			G G	G G	G G	G G	G G	G G	G G	G G	G G
	22	F	F	F	F	F	F	F	-	F	F	F	F	F	F	G			F	F	F	F	F	F	F			G	G	G	G	G	G	G	G	G
2700 2		F	F	F	F	F	F	F		F	F	F	F	F	F	G			F	F	F	F	F	F	F			G	G	G	G	G	G	G	G	G
3300 3	32	F	F	F	F	F	F	F		F	F	F	F	F	F	G			F	F	F	F	F	F	F			G	G	G	G	G	G	G	G	G
3900 3		F	F	F	F	F	F	F		F	F	F	F	F	F	G			F	F	F	F	F	F	F			G	G	G	G	G	G	G	G	
	72	F	F	F	F	F	F	F		F	F	F	F	F	F	G			F	F	F	F	F	F	F			G	G	G	G	G	G	G	G	
5600 5 6800 6	62	F	F	F	F	F	F	F		F	F	F	F	F	F	G			F	F	F	F	F	F	F			G	G	G	G	G	G	G	G	
8200 8		F	F	F	G	G	G	G		F	F	F	F	F	G	G			F	F	F	F	F	G	G			G	G	G	G	G	G	G	G	<u> </u>
	03	F	F	F	G G	G G	G	G		F	F	F	G G	G G	G G	G G			F	F	F	F	F	G G	G G			G G	G G	G G	G G	G G	G G	G G	<u> </u>	$\vdash$
	53	F	F	F	G	G	G			F	F	F	G	G	G				F	F	F	G	G	G	G			G	G	G	G	G	G	G		
0.018 1	83	F	F	F	G	G				F	F	F	G	G	G				F	F	F	G	G	G				G	G	G	G	G	G	G		
0.022 2	23	F	F	F	G	G				F	F	F	G	G					F	F	F	G	G	G		1		G	G	G	G	G	G			
	73	F	F	F	G					F	F	F	G	G					F	F	F	G	G					G	G	G	G	G				
	33	F	F	F	G					F	F	F	G						F	F	F	G	G					G	G	G	G				╷──┘	
	93	F	F	F	G P			-	-	F	F	F	G						F	F	F	G						G	G	G	G			$\square$		<b> </b>
	73 63	F	F	F	G		-	-	-	F	F	F	G G	_					F	F	F	G G						G G	G G	G G	G G		-			$\vdash$
	33 33	F	F	G	6	-	-		-	F	F	G	6						F	F	F	G						G	G	G	G	-		$\vdash$		
	23	F	F	G			1	1	1	F	F	G							F	F	G							G	G							
0.100 1	04	F	F	G						F	F	G							F	F	G							G	G							
0.150 1	54	F	F							F	F	G							F	F	G							G	G							
	24	F	F							F	F	G							F	F								G	G						╷──┘	
	74	F	F			<u> </u>	<u> </u>		<u> </u>	F	F					<u> </u>			F	F								G	G							<u> </u>
	34	F	F							F	F								F	F								G G	G							
	94 74	4 F F I I I I I I I F F												-	-	-	$\left  - \right $		F	F			-			-		G	G G		$\vdash$		-		$ \rightarrow$	-
	/4 64	G	G		-		-	$\vdash$	-	G	G		-		1		$\vdash$		F	F	-		1			-		G	G	-			$\vdash$	+		
	B4						1		1	G	G								G	G																
0.820 8	24																		G	G																
	05																																			
Voltage (V)	-	600	630	1000			2500	3000	4000	600	630	1000			_	3000	4000	5000	600	630	1000				3000	4000	5000	600	630	1000	1500			3000	4000	5000
Case Size					18	325								2220									2225	)								3640	J			
Letter		Α			С		Е		F			G		Х			7	] N	OTE	: Cor	ntact	fact	tory	for n	on-s	peci	fied c	apa	citar	nce	/alue	es				
Max.		0.81			148		.803		2.20			794		0.940		3.																				
Thickness	(								(0.08	37)	(0.	110)	(	0.037	7)	(0.1	30)																			
																		-																		



101317

# High Voltage MLC Chips Tin/Lead Termination "B" - 600V to 5000V Applications





**NEW 630V RANGE** 

AVX Corporation will support those customers for commercial and military Multilayer Ceramic Capacitors with a termination consisting of 5% minimum lead. This termination is indicated by the use of a "B" in the 12th position of the AVX Catalog Part Number. This fulfills AVX's commitment to providing a full range of products to our customers. AVX has provided in the following pages, a full range of values that we are offering in this "B" termination.

Larger physical sizes than normally encountered chips are used to make high voltage MLC chip product. Special precautions must be taken in applying these chips in surface mount assemblies. The temperature gradient during heating or cooling cycles should not exceed 4°C per second.

The preheat temperature must be within 50°C of the peak temperature reached by the ceramic bodies through the soldering process. Chip sizes 1210 and larger should be reflow soldered only. Capacitors may require protective surface coating to prevent external arcing.

For 1825, 2225 and 3640 sizes, AVX offers leaded version in either thru-hole or SMT configurations (for details see section on high voltage leaded MLC chips).

#### HOW TO ORDER



Notes: Capacitors with X7R dielectrics are not intended for applications across AC supply mains or AC line filtering with polarity reversal. Contact plant for recommendations. Contact factory for availability of Termination and Tolerance options for Specific Part Numbers.

\* FLEXITERM is not available in the LD40 Style

\*\* The LD40 Style is not available on 7" Reels.

\*\*\* AVX offers nonstandard chip sizes. Contact factory for details...

\* Not all values are supported in Automotive grade. Please contact factory for availability.

# wailability.

#### **DIMENSIONS**

#### MILLIMETERS (INCHES)

**NOT RoHS Compliant** 

SIZE		LD05 (0805)	LD06 (1206)	LD10* (1210)	LD08* (1808)	LD12* (1812)	LD13* (1825)	LD20* (2220)	LD14* (2225)	LD40* (3640)
(L) Length		2.10 ± 0.20 (0.083 ± 0.008)	3.30 ± 0.30 (0.130 ± 0.012)	3.30 ± 0.40 (0.130 ± 0.016)	4.60 ± 0.50 (0.181 ± 0.020)	4.60 ± 0.50 (0.181 ± 0.020)	4.60 ± 0.50 (0.181 ± 0.020)	5.70 ± 0.50 (0.224 ± 0.020)	5.70 ± 0.50 (0.224 ± 0.020)	9.14 ± 0.25 (0.360 ± 0.010)
(W) Width		$1.25 \pm 0.20$ (0.049 ± 0.008)	1.60 ± 0.20 (0.063 ± 0.008)	2.50 ± 0.30 ( 0.098 ± 0.012)	2.00 ± 0.20 (0.079 ± 0.008)	3.20 ± 0.30 (0.126 ± 0.012)	6.30 ± 0.40 (0.248 ± 0.016)	5.00 ± 0.40 (0.197 ± 0.016)	6.30 ± 0.40 (0.248 ± 0.016)	10.2 ± 0.25 (0.400 ± 0.010)
(T) Thickness	Max.	1.35 (0.053)	1.80 (0.071)	2.80 (0.110)	2.20 (0.087)	2.80 (0.110)	3.40 (0.134)	3.40 (0.134)	3.40 (0.134)	2.54 (0.100)
(t) terminal min. max.		$0.50 \pm 0.20$ (0.020 $\pm 0.008$ )	$0.60 \pm 0.20$ (0.024 ± 0.008)	0.75 ± 0.35 (0.030 ± 0.014)	0.75 ± 0.35 (0.030 ± 0.014)	0.75 ± 0.35 (0.030 ± 0.014)	0.75 ± 0.35 (0.030 ± 0.014)	0.85 ± 0.35 (0.033 ± 0.014)	0.85 ± 0.35 (0.033 ± 0.014)	0.76 (0.030) 1.52 (0.060)

\*Reflow Soldering Only

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Performance of ceramic capacitors can be simulated by using the online SpiMLCC software program - http://spicat.avx.com/mlcc Custom values, ratings and configurations are also available.



# **High Voltage MLC Chips**

# Tin/Lead Termination "B" - 600V to 5000V Applications



#### NP0 (C0G) Dielectric

Performance Characteristics

Capacitance Range	10 pF to 0.047 μF
Capacitance Range	(25°C, 1.0 ±0.2 Vrms at 1kHz, for ≤ 1000 pF use 1 MHz)
Capacitance Tolerances	±5%, ±10%, ±20%
Dissipation Factor	$0.1\%$ max. (+25°C, 1.0 ±0.2 Vrms, 1kHz, for $\leq$ 1000 pF use 1 MHz)
Operating Temperature Range	-55°C to +125°C
Temperature Characteristic	0 ±30 ppm/°C (0 VDC)
Voltage Ratings	600, 630, 1000, 1500, 2000, 2500, 3000, 4000 & 5000 VDC (+125°C)
Insulation Resistance (+25°C, at 500 VDC)	100K MΩ min. or 1000 MΩ - $\mu$ F min., whichever is less
Insulation Resistance (+125°C, at 500 VDC)	10K M $\Omega$ min. or 100 M $\Omega$ - $\mu$ F min., whichever is less
Dielectric Strength	Minimum 120% rated voltage for 5 seconds at 50 mA max. current

#### **HIGH VOLTAGE COG CAPACITANCE VALUES**

VOLTA	GE	LD05 (0805)	LD06 (1206)	LD10 (1210)	LD08 (1808)	LD12 (1812)	LD13 (1825)	LD20 (2220)	LD14 (2225)	LD40 (3640)
600/630	min.	10 pF	10 pF	100 pF	100 pF	100 pF	1000 pF	1000 pF	1000 pF	1000 pF
-	max.	330 pF	1200 pF	2700 pF	3300 pF	5600 pF	0.012 µF	0.012 pF	0.018 µF	0.047 µF
1000	min.	10 pF	10 pF	10 pF	100 pF	100 pF	100 pF	1000 pF	1000 pF	1000 pF
1000	max.	180 pF	560 pF	1500 pF	2200 pF	3300 pF	8200 pF	0.010 pF	0.010 µF	0.022 µF
1500	min.	_	10 pF	10 pF	10 pF	10 pF	100 pF	100 pF	100 pF	100 pF
1500	max.	-	270 pF	680 pF	820 pF	1800 pF	4700 pF	4700 pF	5600 pF	0.010 µF
2000	min.	-	10 pF	10 pF	10 pF	10 pF	100 pF	100 pF	100 pF	100 pF
2000	max.	-	120 pF	270 pF	330 pF	1000 pF	1800 pF	2200 pF	2700 pF	6800 pF
2500	min.	-	-	-	10 pF	10 pF	10 pF	100 pF	100 pF	100 pF
2300	max.	-	-	-	180 pF	470 pF	1200 pF	1500 pF	1800 pF	3900 pF
3000	min.	-	-	-	10 pF	10 pF	10 pF	10 pF	10 pF	100 pF
3000	max.	-	_	-	120 pF	330 pF	820 pF	1000 pF	1200 pF	2700 pF
4000	min.	_	-	-	10 pF	10 pF	10 pF	10 pF	10 pF	100 pF
4000	max.	_	-	_	47 pF	150 pF	330 pF	470 pF	560 pF	1200 pF
5000	min.	-	-	-	-	-	_	10 pF	10 pF	10 pF
5000	max.	-	-	_	-	-	_	220 pF	270 pF	820 pF

#### **X7R Dielectric**

#### Performance Characteristics

Capacitance Range	10 pF to 0.56 μF (25°C, 1.0 ±0.2 Vrms at 1kHz)
Capacitance Tolerances	±10%; ±20%; +80%, -20%
Dissipation Factor	2.5% max. (+25°C, 1.0 ±0.2 Vrms, 1kHz)
Operating Temperature Range	-55°C to +125°C
Temperature Characteristic	±15% (0 VDC)
Voltage Ratings	600, 630, 1000, 1500, 2000, 2500, 3000, 4000 & 5000 VDC (+125°C)
Insulation Resistance (+25°C, at 500 VDC)	100K MΩ min. or 1000 MΩ - μF min., whichever is less
Insulation Resistance (+125°C, at 500 VDC)	10K M $\Omega$ min. or 100 M $\Omega$ - $\mu$ F min., whichever is less
Dielectric Strength	Minimum 120% rated voltage for 5 seconds at 50 mA max. current

#### **HIGH VOLTAGE X7R MAXIMUM CAPACITANCE VALUES**

VOLTA	GE	0805	1206	1210	1808	1812	1825	2220	2225	3640
600/630	min.	100 pF	1000 pF	1000 pF	1000 pF	1000 pF	0.010 µF	0.010 µF	0.010 µF	0.010 µF
000/030	max.	6800 pF	0.022 µF	0.056 µF	0.068 µF	0.120 µF	0.390 µF	0.270 µF	0.330 µF	0.560 µF
1000	min.	100 pF	100 pF	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF	0.010 µF
1000	max.	1500 pF	6800 pF	0.015 µF	0.018 µF	0.039 µF	0.100 µF	0.120 µF	0.150 µF	0.220 µF
1500	min.	_	100 pF	100 pF	100 pF	100 pF	1000 pF	1000 pF	1000 pF	1000 pF
1500	max.	-	2700 pF	5600 pF	6800 pF	0.015 µF	0.056 µF	0.056 µF	0.068 µF	0.100 µF
2000	min.	-	10 pF	100 pF	100 pF	100 pF	100 pF	1000 pF	1000 pF	1000 pF
2000	max.	_	1500 pF	3300 pF	3300 pF	8200 pF	0.022 µF	0.027 µF	0.033 µF	0.027 µF
2500	min.	_	-	-	10 pF	10 pF	100 pF	100 pF	100 pF	1000 pF
2500	max.	_	-	-	2200 pF	5600 pF	0.015 µF	0.018 µF	0.022 µF	0.022 µF
3000	min.	-	-	-	10 pF	10 pF	100 pF	100 pF	100 pF	1000 pF
3000	max.	_	-	-	1800 pF	3900 pF	0.010 µF	0.012 µF	0.015 µF	0.018 µF
4000	min.	-	-	-	-	-	-	-	-	100 pF
4000	max.	_	_	_	_	-	_	_	—	6800 pF
5000	min.	-	-	-	-	-	-	-	-	100 pF
5000	max.	_	—	_	_	–	-	–	-	3300 pF



# High Voltage MLC Chips FLEXITERM<sup>®</sup> - 600V to 5000V Applications





High value, low leakage and small size are difficult parameters to obtain in capacitors for high voltage systems. AVX special high voltage MLC chips capacitors meet these performance characteristics and are designed for applications such as snubbers in high frequency power converters, resonators in SMPS, and high voltage coupling/DC blocking. These high voltage chip designs exhibit low ESRs at high frequencies.

To make high voltage chips, larger physical sizes than are normally encountered are necessary. These larger sizes require that special precautions be taken in applying these chips in surface mount assemblies. In response to this, and to follow from the success of the FLEXITERM® range of low voltage parts, AVX is delighted to offer a FLEXITERM® high voltage range of capacitors, FLEXITERM<sup>®</sup>.

The FLEXITERM® layer is designed to enhance the mechanical flexure and temperature cycling performance of a standard ceramic capacitor, giving customers a solution where board flexure or temperature cycle damage are concerns.

#### **HOW TO ORDER**

1808	<b>A</b> T	C ⊺	272	<u>к</u>	<b>A</b>	<b>z</b> ∣	<b>1</b> ⊺	<b>A</b>
AVX Style 0805 1206 1210 1808 1812 1825 2220 2225 ***	Voltage 600V/630V = C 1000V = A 1500V = S 2000V = G 2500V = W 3000V = H 4000V = J 5000V = K	Temperature Coefficient COG = A X7R = C	<b>Capacitance Code</b> (2 significant digits + no. of zeros) Examples: 10 pF = 100 100 pF = 101 1,000 pF = 102 22,000 pF = 223 220,000 pF = 224 1 µF =105	Capacitance Tolerance COG: J = ±5% K = ±10% M = ±20% X7R: K = ±10% M = ±20% Z = +80%, -20%	Test Level	<b>Termination*</b> Z=FLEXITERM® 100% Tin (RoHS Compliar	<b>Packaging</b> 2 = 7" Reel 4 = 13" Reel nt)	<b>Special Code</b> A = Standard

Notes: Capacitors with X7R dielectrics are not intended for applications across AC supply mains or AC line filtering with polarity reversal. Contact plant for recommendations. Contact factory for availability of Termination and Tolerance options for Specific Part Numbers.

\*\*\* AVX offers nonstandard chip sizes. Contact factory for details.





#### **MILLIMETERS (INCHES)**

SIZE	0805	1206	1210*	1808*	1812*	1825*	2220*	2225*
(L) Length	2.10 ± 0.20	3.30 ± 0.30	3.30 ± 0.40	4.60 ± 0.50	4.60 ± 0.50	4.60 ± 0.50	5.70 ± 0.50	5.70 ± 0.50
	(0.083 ± 0.008)	(0.130 ± 0.012)	(0.130 ± 0.016)	(0.181 ± 0.020)	(0.181 ± 0.020)	(0.181 ± 0.020)	(0.224 ± 0.020)	(0.224 ± 0.020)
(W) Width	1.25 ± 0.20 (0.049 ±0.008)	$\frac{1.60^{+0.30}_{-0.10}}{\left(0.063^{+0.012}_{-0.004}\right)}$	2.50 ± 0.30 (0.098 ± 0.012)	2.00 ± 0.20 (0.079 ± 0.008)	3.20 ± 0.30 (0.126 ± 0.012)	6.30 ± 0.40 (0.248 ± 0.016)	5.00 ± 0.40 (0.197 ± 0.016)	6.30 ± 0.40 (0.248 ± 0.016)
(T) Thickness	1.35	1.80	2.80	2.20	2.80	3.40	3.40	3.40
Max.	(0.053)	(0.071)	(0.110)	(0.087)	(0.110)	(0.134)	(0.134)	(0.134)
(t) terminal	terminal min. 0.50 ± 0.20		0.75 ± 0.35	0.75 ± 0.35	0.75 ± 0.35	0.75 ± 0.35	0.85 ± 0.35	0.85 ± 0.35
	max. (0.020 ± 0.008)		(0.030 ± 0.014)	(0.030 ± 0.014)	(0.030 ± 0.014)	(0.030 ± 0.014)	(0.033 ± 0.014)	(0.033 ± 0.014)

\*Reflow Soldering Only



100

DIMENSIONS

Performance of SMPS capacitors can be simulated by downloading SpiCalci software program - http://www.avx.com/SpiApps/default.asp#spicalci Custom values, ratings and configurations are also available.





#### NP0 (COG) Dielectric Performance Characteristics

Capacitance Range	10 pF to 0.100 μF (+25°C, 1.0 ±0.2 Vrms, 1kHz)
Capacitance Tolerances	±5%, ±10%, ±20%
Dissipation Factor	0.1% max. (+25°C, 1.0 ±0.2 Vrms, 1kHz)
Operating Temperature Range	-55°C to +125°C
Temperature Characteristic	0 ±30 ppm/°C (0 VDC)
Voltage Ratings	600, 630, 1000, 1500, 2000, 2500, 3000, 4000 & 5000 VDC (+125°C)
Insulation Resistance (+25°C, at 500 VDC)	100K MΩ min. or 1000 MΩ - $\mu$ F min., whichever is less
Insulation Resistance (+125°C, at 500 VDC)	10K MΩ min. or 100 MΩ - $\mu$ F min., whichever is less
Dielectric Strength	Minimum 120% rated voltage for 5 seconds at 50 mA max. current

#### NP0 (C0G) CAPACITANCE RANGE

#### **PREFERRED SIZES ARE SHADED**

												40.14																			
Case Size			0805				1206					1210			1808							1812									
Soldering			low/W				low/W					flow O							N Only							Reflo					
	mm (in.)		10 ± 0.: 83 ± 0.				.30 ± 0. 30 ± 0.					30 ± 0.4 30 ± 0.0					(		± 0.50 ± 0.020	)					(	4.60 :	± 0.50 ± 0.020	)			
	mm (m)		25 ± 0.				± 0.30		4)		2.	50 ± 0.3	30						± 0.20							3.20 :					
	(in.) mm	(0.0	49 ± 0. 1.35	008)	<u> </u>		1.80	2/-0.004	4)		(0.0	98 ± 0.0 2.80	J1 <u>Z)</u>				(	2.	<u>± 0.008</u> 20	)					(	<u>0.126 :</u> 2.	<u>± 0.012</u> 80	)			
	(in.)	0	(0.053)	0.0			(0.071)					(0.110)	25		(0.087)								(0.110) 0.75 ± 0.35								
(t) Terminal	mm max	(0.0	50 ± 0. 20 ± 0.	20 008)		(0.0	.60 ± 0. 24 ± 0.	.008)			(0.0	75 ± 0.3 30 ± 0.0	35 014)				(	0.75 0.030	± 0.35 ± 0.014	.)					(	0.75:	± 0.35 ± 0.014	.)			
Voltage (V		600	630	1000	600	630	1000	1500	2000	600	630	1000	1500	2000	600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000	
Cap (pF) 1.5 1.8	1R5 1R8	A	A		X	X		X	X																						
2.2	2R2	A	A		X	X	X	X	X																						
2.7	2R7	A	A		X	X	X	X	X								С	С	С	С	С										
3.3	3R3	Α	Α		Х	Х	Х	Х	Х								С	С	С	С	С										
3.9	3R9 4R7	A	A A		X	X	X	X X									C C	C C	C C	C C	C C										
5.6	5R6	A	A		X	x	Â	X	X								C	C	C	C	C										
6.8	6R8	A	A		X	Х	X	Х	X								C	C	C	C	С										
8.2	8R2	Α	Α		Х	Х	Х	Х	Х			_					С	С	С	С	С										
10	100 120	A	A	A	X	X X	X X	X X	X X	C C	C C	D	D D	D D	C C	C C	C C	C C	C C	C C	C C	C C	C C	C C	C C	C C			C C	E	
12	120	A	A A	A	X X	X	X	X	X	C	C	D D	D	D	C	C			C	C	C	C	C	C	C				C	E	
18	180	A	A	A	X	Х	X	Х	X	C	C	D	D	D	C	C	C	C	C	C	C	С	С	C	C	C	C	C	C	E	
22	220	Α	Α	A	Х	Х	X	Х	X	С	С	D	D	D	С	С	С	С	С	С	С	С	С	С	С	С	С	С	С	E	
27	270 330	A	A A	A A	X	X	X	X D	X D	C C	C C	D D	D D	D D	C C	C C	C C	C C	C C	C C	C C	C C	C C	C C	C C	C C	C C	C C	С С	E	
33	390	Α Δ	A	A	X	X	X	D	D	C	C	D	D	D	C C	C			C C		C	C	C		C	C			C C	E	
47	470	A	A	A	X	X	M	D	D	C	C	D	D	D	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	E	
56	560	Α	Α	Α	Х	Х	М	С	С	С	С	D	С	С	С	С	С	С	С	С	С		С	С	С	С	С	С	С	F	
68	680	A	A X	A X	X	X	M C	C	C C	C C	C C	D	C	C C	C	C C	C	C	C	C	C C		C C	C	C	C C	C C	C	<u>С</u> С	F	
82	820 101	X	X	X	X	X		C C		C	C	D C	C C	C	C C	C		C C		F	F		C		C C	C	C		C	F	
120	121	C	Ċ	Ĉ	X	X	Č	E	Ē	C	C	C	C	C	C	C	c	c	C	F	F		C	c	C	C	č	C	C	G	
150	151	С	С	С	Х	Х	С	E	E	С	С	С	Е	Е	С	С	С	F	F	F	F		С	С	С	С	С	С	С	G	
180	181	C	C	С	X	X	E	E	E	C	C	E	E	E	C	С	C	F	F	F	F		C	C	C	C	C	F	F		
220	221 271	C C	C C		X C	X C	E	E	E	C C	C C	E	E	E	C C	C C	C C	F	F	F	F		C C	C C	C C	C C	C C	F	F		
330	331	c	C		c	C	E	E	E	c	c	E	E	E	c	c	F	F	F	F	F		C	c	C	F	F	F	F		
390	391	С	С		С	С	E	E	E	С	С	Е	Е	Е	С	С	F	F	F	F	F		С	С	С	F	F	F	F		
470	471	С	С		С	С	E	E	E	С	С	E	E	E	С	С	F	F	F	F	F		С	С	F	F	F	F	F		
560	561 681	C C	C C		C C	C C	E			C C	C C	E	E F	E	C C	C C	F	F	F				C C	C C	F	F	F	FG	F G		
750	751	C	C		E	E	E			C	C	E	G	G	c	C	F	F	F				C	C	F	F	F	G	G		
820	821	С	С		Е	Е	E			С	С	Е	G	G	С	С	F	Е	E				С	С	F	F	F	G	G		
1000	102				E	E	E			С	С	E			С	С	F	E	E				С	С	F	F	F	G	G		
1200	122 152				E	E				C C	C C	E G			E	E		E	E				C C	C C	F	E	E				
1800	182				E	E				C	C	G			E	E	F						C	C	F	F	F				
2200	222				Е	E				E	E				Е	E							C	C	E	G	G				
2700	272				E	E				E	E				E	E							C	C	E	G	G				
3300	332 392				E	E				E F	E				E	E	<u> </u>						C C	C C	F					$\left  \right $	
4700	472					1				E	E				E	E							C	C	G						
5600	562									E	E				E	E							С	C							
6800	682														F	F							C	C						$\square$	
8200 Cap (μF) 0.010	822 103									<u> </u>				$\vdash$									E	E						$\left  - \right $	
0.012	103																						F	F							
																							G	G							
0.015	153 183																	-					G	G						$\left  - \right $	
0.018	223																-	-					6	6			-				
0.022	333																-	-									-				
																														$\left  - \right $	
0.047	473				——					——																				$\left  - \right $	
0.056	563																													$\left  \right $	
0.068	683																													$\left  \right $	
0.100 Voltage (V	104	600	620	1000	600	620	1000	1500	2000	600	620	1000	1500	2000	600	620	1000	1500	2000	2500	3000	4000	600	620	1000	1500	2000	2500	3000	4000	
Case Size		000	0805	1000	000	030	1206		12000	000	030	1210	1300	2000	000	030	1000		08	2300	3000	4000	000	030	1000	11500		12300	3000	1-4000	
0436 3126	•		3003				1200					1210				_		10		_	_	_				10					





#### NP0 (C0G) CAPACITANCE RANGE

#### **PREFERRED SIZES ARE SHADED**

	012		_		011																			_				
Case Size			1825					_	2220								2225											
Soldering						ow Onl	,			Reflow Only								Reflow Only										
(L) Length	mm (in)					) ± 0.50								.70 ± 0									72 ± 0					
	(in.)					1 ± 0.02	,							$224 \pm 0$									$25 \pm 0$					
W) Width	mm (in.)					$) \pm 0.40$				5.00 ± 0.40										6.35 ± 0.25								
· · · · · · · · · · · · · · · · · · ·						3 ± 0.01	6)			(0.197 ± 0.016)										(0.250 ± 0.010)								
(T) Thickness	mm (in.)					3.40								3.40					3.40									
	mm					. <u>134)</u> 5 ± 0.35	;						0	<u>(0.134</u> .85 ± 0									(0.134					
(t) Terminal	max					) ± 0.30								.85 ± 0 )33 ± 0								0.	85 ± 0	.35				
Voltage (\		600	630	1000			2500	3000	4000	600	630	1000				3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000	
	, 1.5 1R5																											
	1.8 1R8																											
	2.2 2R2																											
	2.7 2R7																											
	3.3 3R3																											
	3.9 3R9																											
	4.7 4R7 5.6 5R6																											
	6.8 6R8																											
	8.2 8R2																											
	10 100	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	F	F	
	12 120	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F	
	15 150	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F	
	18 180	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F	
	22 220	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	Е	F	F	
	27 270	Е	E	E	E	E	E	Е	E	Е	Е	E	E	E	Е	Е	E	E	Е	Е	E	E	E	Е	E	F	F	
	33 330	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F	
	39 390	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	Е	Е	E	E	E	E	E	E	F	F	
	47 470	E	E	E	E	E	E	E	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	G	
	56 560 68 680	E	E	E	E	E	E	E	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	G	
	68 680 82 820	E	E	E	E	E	E	E	F										G									
	00 101	E	E	E	E	E	E	E	F	E E E E E E E E E E E E E E E E E F E E E E							F G	G G										
	20 121	E	E	E	E	E	E	E	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G	
	50 151	E	E	E	E	E	E	E	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G	
	80 181	E	E	E	E	E	E	E	F	E	E	E	E	E	E	E	F	F	E	E	E	E	E	E	E	G	G	
2	20 221	Е	E	Е	E	E	E	Е	F	Е	E	E	E	Е	E	E	F	F	Е	Е	E	E	E	E	E	G	G	
	270 271	E	E	E	E	E	E	E	F	E	E	E	E	E	E	E			Е	E	E	E	E	E	E	G	G	
	30 331	E	E	E	E	E	E	E	F	E	E	E	E	E	E	E			E	E	E	E	E	E	E	G		
	90 391	E	E	E	E	E	E	E		E	E	E	E	E	E	E			E	E	E	E	E	E	E	G		
	70 471	E	E	E	E	E	E	E		E	E	E	E	E	E	E			E	E	E	E	E	E	E	G		
	60 561	E	E	E	E	E	E	E F		E	E	E	E	E	E	E F			E	E	E	E	E	E	E	G		
	80 681 50 751	E	E	E	E	E	F	F		E	E	E	E	E	F	F			E	E	E	E	E	E	E			
	30 731 320 821	E	E	E	E	E	F	F		E	E	E	E	E	F	F			E	E	E	E	E	F	E			
	00 102	E	E	E	E	E	F	F		E	E	E	E	E	F	F			E	E	E	E	E	E	E			
	200 122	E	E	E	E	E	G	G		E	E	E	E	E	G	G			E	E	E	E	E	F	F			
	00 152	Е	Е	Е	F	F	G	G		Е	Е	E	F	F	G	G			Е	Е	E	E	E	F	F			
	800 182	Е	E	Е	F	F	G	G		Е	Е	E	F	F	G	G			Е	Е	E	E	Е	G	G			
	200 222	E	E	E	G	G				E	E	E	G	G					Е	E	E	E	E					
	00 272	E	E	E	G	G				E	E	E	G	G		L	L		E	E	E	F	F	<u> </u>	L			
	00 332	E	E	E	G	G				E	E	E	G	G					E	E	E	F	F					
	00 392	E	E	E	G	G				E	E	E	G	G					E	E	E	G	G					
	00 472 00 562	E F	E F	E F	G G	G G				F	E F	E F	G	G					F	F	F	G G	G G					
	300 <u>502</u> 300 682	F	F	F	6	6				F	F	F							F	F	F	G	G					
	200 822		G							G	G	G							G	G	G							
	10 103																		G	G	G							
	12 123																		G	G	G							
0.0	15 153																		G	G	G							
0.0	18 183																		G	G	G							
0.0	22 223																		G	G	G							
	33 333																		G	G	G							
	47 473																		G	G	G							
	56 563	I											L				L		G	G	G							
	68 683																		G	G	G						$\mid$	
	00 104	600	620	1000	1500	2000	2500	2000	4000	600	620	1000	1500	2000	2500	2000	4000	5000	<b>G</b>	G 620	1000	1500	2000	2500	2000	4000	5000	
Voltage (\ Case Size		000	030	1000		825	2300	13000	4000	000	030	1000	1300	2000 2220		13000	4000	0000	000	030	1000	1300	2225		1 3000	4000	3000	
0036 312	-		-	-		323					-																	

Letter	A	С	E	F	G	Х
Max.	0.813	1.448	1.803	2.210	2.794	0.940
Thickness	(0.032)	(0.057)	(0.071)	(0.087)	(0.110)	(0.037)

NOTE: Contact factory for non-specified capacitance





# X7R Dielectric

**Performance Characteristics** 

Capacitance Range	10 pF to 0.82 μF (25°C, 1.0 ±0.2 Vrms at 1kHz)
Capacitance Tolerances	±10%; ±20%; +80%, -20%
Dissipation Factor	2.5% max. (+25°C, 1.0 ±0.2 Vrms, 1kHz)
Operating Temperature Range	-55°C to +125°C
Temperature Characteristic	±15% (0 VDC)
Voltage Ratings	600, 630, 1000, 1500, 2000, 2500, 3000, 4000 & 5000 VDC (+125°C)
Insulation Resistance (+25°C, at 500 VDC)	100K MΩ min. or 1000 MΩ - μF min., whichever is less
Insulation Resistance (+125°C, at 500 VDC)	10K MΩ min. or 100 MΩ - $\mu$ F min., whichever is less
Dielectric Strength	Minimum 120% rated voltage for 5 seconds at 50 mA max. current

#### X7R CAPACITANCE RANGE

#### **PREFERRED SIZES ARE SHADED**

Case Size		0805				1206	5				1210	)					18	808							18	12				
Soldering		low/W				low/W					flow 0											Reflow Only								
mm		2.10 0.2				.30 ± 0.					3.30 0.4			Reflow Only 4.60 ± 0.50							4.60 ± 0.50									
(L) Length (in.)	(0.0	83 ± 0.	008)		(0.1	30 ± 0.	.012)			(0.	<u>130 0.0</u>	116)		(0.181 ± 0.020) 2.00 0.20							(0.181 ± 0.020)									
W) Width (in.)		.25 0.2 49 ± 0.				+0.30/	/-0.10	1)		(0.	2.50 0.3 098 0.0	10 112)				(	2.00 : 0.079	± 0.008	3)			3.20 ± 0.30 (0.126 ± 0.012)								
(T) Thickness mm		1.35				1.80		/			2.80						2.	20	/			(0.12010.012) 2.80 (0.110)								
(III.)	0.	(0.053 50 ± 0.	20		0.	(0.071 .60 ± 0.	20			0	<u>(0.110</u> ).75 0.3	5					0.75	087) ± 0.35							0.75	± 0.35				
(t) reminar max	(0.0	<u>20 ± 0.</u>	008)	600	(0.0	24 ± 0.	.008)	0000	600	(0.0	30 ± 0.	014)	10000	600	600		0.030 :	± 0.014		10000	4000	600	1 ( 00		(0.030 :	± 0.014		0000	4000	
Voltage (V) Cap (pF) 100 101	600 X	630 X	C	600 C	630 C	F	1500 F	2000 E	600 E	630 F	1000 F	1500 F	2000 E	600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000	
120 121	X	X	c	c	c	E	E	E	E	E	E	E	E																	
150 151	X	X	c	C	C	E	E	E	E	E	E	E	E																	
180 181	X	X	C	C	C	E	E	E	E	E	E	E	E																	
220 221	х	Х	С	С	С	E	E	E	Е	Е	Е	E	E																	
270 271	Х	Х	С	С	С	E	E	E	E	E	E	E	E									Е	Е	Е	E	Е				
330 331	Х	Х	С	С	С	E	Е	E	Е	Е	Е	E	E	Е	Е	Е	Е	Е	Е	F		Е	Е	E	E	E				
390 391	Х	Х	С	С	С	E	Е	E	Е	Е	Е	E	E	E	Е	E	Е	Е	Е	F		Е	Е	Е	Е	E				
470 471	Х	Х	С	С	С	E	Е	E	Е	Е	E	E	E	Е	Е	E	Е	Е	E	F		E	E	E	E	E	E	Е		
560 561	Х	Х	С	С	С	Е	Е	Е	Е	Е	Е	Е	E	E	Е	Е	Е	Е	F	F		E	Е	Е	Е	Е	Е	E		
680 681	Х	Х	С	С	С	Е	E	Е	Е	Е	Е	E	E	E	Е	Е	Е	E	F	F		E	Е	E	E	E	F	F		
750 751	Х	Х	С	С	С	E	E	E	E	Е	E	E	E	E	E	E	E	E	F	F		E	E	Е	E	E	F	F		
820 821	Х	Х	С	С	С	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F		E	E	E	E	E	F	F		
1000 102	Х	Х	С	С	С	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F		E	E	E	E	E	F	F		
1200 122	Х	Х	С	С	С	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F		E	E	E	E	E	F	F		
1500 152	Х	Х	С	С	С	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F		E	E	E	E	E	G	G		
1800 182 2200 222	X	X		С	С	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F		E	E	E	E	E	G	G		
2700 272	X	X		C	C	E	E	E	E	E	E	F	E	E	E	E	F	F	F			E	E	E	E	E	G	G		
3300 332	X	X		C	C	E	E		E	E	E	F	E	E	E	E		F				E	E	E	E	E	G	G		
3900 392	X X	X X		C C	C C	E			E	E	E	F	E	E	E	E	F	F				E	E	E	F	F	G	G G		
4700 472	X	X		C	C	E			E	E	E	G		E	E	E	F					E	E	E	F	F	G	G		
5600 562	X	X		C	C	E			E	E	E	G		E	E	E	F					E	E	E	G	G	0	6		
6800 682	X	X		C	C	E			F	E	E			E	E	E	F					E	E	E	G	G				
8200 822	X	X		C	C	E			E	E	E			E	E	E						E	E	E	G	G				
Cap(µF) 0.010 103	С	С		С	С	E			Е	Е	E			Е	E	E						Е	E	F	G	G				
0.015 153	С	С		Е	E	E			Е	E	E			F	F	F						Е	E	F	G					
0.018 183	С	С		Е	Е				Е	Е	Е		1	F	F	F						Е	Е	G			1			
0.022 223	С	С		Е	Е				Е	Е	Е			F	F							Е	Е	G						
0.027 273				Е	Е		1		Е	Е			1	F	F			1				E	E	G						
0.033 333				E	Е				Е	Е				F	F							E	Е	G						
0.039 393									Е	Е				F	F							E	Е	G						
0.047 473									Е	E				F	F							E	Е	G						
0.056 563				<b> </b>				L	F	F			<u> </u>	F	F	L					L	F	F				<u> </u>			
0.068 683		<u> </u>			<u> </u>	<u> </u>	<u> </u>		F	F				F	F			<u> </u>	<u> </u>	I	L	F	F				<u> </u>		L	
0.082 823				<u> </u>					F	F												F	F							
0.100 104		<u> </u>			<u> </u>				F	F			<u> </u>						<u> </u>	<u> </u>		F	F		-		<u> </u>			
0.150 154									├													G	G							
0.220 224		-		<u> </u>	-		-											-				G	G							
0.270 274			<u> </u>					-				<u> </u>				-	-						-			<u> </u>				
0.330 334																							-							
0.390 394		-	<u> </u>		-	-		<u> </u>				<u> </u>	-			<u> </u>	<u> </u>						-		-	<u> </u>				
0.560 564			<u> </u>					<u> </u>				<u> </u>	1			<u> </u>							1	+		<u> </u>	1			
0.680 684											1		1		1				1	1	1		1	1			1			
0.820 824		1			1		1				1		1		1			1	1	1	1	1	1	1			1			
1.000 105	1					1					1		1		1				1	1	1		1	1	1		1			
Voltage (V)	600	630	1000	600	630	1000	1500	2000	600	630	1000	1500	2000	600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000	
Case Size		0805				1206	5				1210						18	808							18	12				





#### X7R CAPACITANCE RANGE

#### **PREFERRED SIZES ARE SHADED**

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3.43.43.400 <td< th=""><th></th><th></th><th></th><th></th><th>(</th><th></th><th></th><th>5)</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></td<>					(			5)																													
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0033       33       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F <th></th> <th>_</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>· ·</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>-</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th><u> </u></th> <th></th>		_									· ·														-											<u> </u>	
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0047       473       F       F       F       F       F       F       F       F       F       F       F       G       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0 <th></th> <th></th> <th>_</th> <th></th> <th></th> <th></th> <th><u> </u></th> <th></th> <th></th> <th></th> <th>· ·</th> <th></th> <th></th> <th>_</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th><u> </u></th> <th></th>			_				<u> </u>				· ·			_																						<u> </u>	
0066       56       F       F       G       a       b       F       F       G       a       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b       b <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th><u> </u></th> <th></th> <th></th> <th></th> <th>· ·</th> <th>· ·</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>_</th> <th>_</th> <th></th> <th></th> <th></th> <th><u> </u></th> <th></th>							<u> </u>				· ·	· ·								F											_	_				<u> </u>	
0066       66       F       F       G       A       F       F       G       A       F       F       G       A       A       A       A       A       F       F       G       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A <th></th> <th>_</th> <th>_</th> <th></th> <th></th> <th></th> <th>-</th> <th></th> <th></th> <th></th> <th>-</th> <th></th> <th></th> <th></th> <th>-</th> <th></th> <th></th> <th></th> <th></th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>_</th> <th>_</th> <th>_</th> <th></th> <th></th> <th></th> <th><u> </u></th> <th></th>		_	_				-				-				-					F										_	_	_				<u> </u>	
0022       82       F       F       G       -       F       G       -       F       G       -       F       G       -       F       F       G       -       -       F       F       G       -       -       F       F       G       -       -       F       F       G       -       F       F       G       -       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       G       -       F       F       F       G <th></th> <th></th> <th>- ·</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>· ·</th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>_</th> <th>_</th> <th>_</th> <th></th> <th></th> <th></th> <th><u> </u></th> <th></th>			- ·								· ·	F								F										_	_	_				<u> </u>	
100       16       F       G       2       2       2       2       2       2       2       5       6       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2       2 <th2< th=""> <th2< th=""></th2<></th2<>		_	-								F	F								F		· ·								_						<u> </u>	
1100       154       F       F       G       G       G       G       F       F       G       G       G       F       F       G       G       G       F       F       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G <th></th> <th></th> <th>_</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>· ·</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th><u> </u></th> <th></th>			_									· ·																								<u> </u>	
0220       244       F       F       G       G       F       F       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G       G <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>F</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>F</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>_</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>					-						F									F										_							
0330       334       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F <th></th> <th></th> <th>F</th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>F</th> <th>F</th> <th>G</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>F</th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>G</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>			F	F							F	F	G							F	F								G								
0.300       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F       F <th>0.270 2</th> <th>274</th> <th>F</th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>1</th> <th>F</th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>F</th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>G</th> <th>G</th> <th></th> <th></th> <th></th> <th></th> <th>1</th> <th></th> <th></th>	0.270 2	274	F	F						1	F	F								F	F								G	G					1		
0.400       0.47       F       F       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I       I<	0.330 3	334	F	F							F	F								F	F								G	G							
0.500       564       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6       6 </th <th>0.390 3</th> <th>394</th> <th>F</th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>· ·</th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>F</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	0.390 3	394	F	F							· ·	F								F																	
0.660       660       660       670       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       680       6800       680       680 <t< th=""><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>· ·</th><th>· ·</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>· ·</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></t<>											· ·	· ·								· ·																	
0.820       6.84       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4       8.4 <t< th=""><th></th><th>_</th><th>G</th><th>G</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>_</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>· ·</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>G</th><th>G</th><th></th><th></th><th></th><th></th><th></th><th><u> </u></th><th></th></t<>		_	G	G								_								· ·									G	G						<u> </u>	
1000       1000       1000       1000       1000       2500       3000       4000       660       630       1000       1500       2500       3000       4000       5000       6300       1000       1500       2500       3000       4000       5000       6300       5000       6300       1000       1500       2000       2500       3000       4000       5000       600       630       1000       1500       2000       2500       3000       4000       5000		_																						<u> </u>												⊢	$\square$
Voltage (V) 600 630 1000 1500 2000 2500 3000 4000 600 630 1000 1500 2000 2500 3000 4000 500 630 1000 1500 2000 2500 3000 4000 5000 600 630 1000 1500 2000 2500 3000 4000 5000 600 630 1000 1500 2000 2500 3000 4000 5000		_								<u> </u>		_	<u> </u>									<u> </u>		-					—		<u> </u>	<u> </u>			<u> </u>	⊢	<b> </b>
		_	(00	(00	1000	4501	0000	0505	0000	40.05	_		1000	1500	00000	0500	0000	40.00	5000	_		1000	1500	0000	0505	0000	40.05	5000	600	600	1000	1500	0000	0505	0000	40.00	FOR
Lase Size 1825 2220 2225 3640	/		600	630	1000			2500	3000	4000	600	630	1000				3000	4000	5000	600	630	1000				3000	4000	5000	600	630	1000	1500			3000	4000	5000
	Case Size					18	25								2220	_		_						2225	)								3640				

Letter	Α	С	E	F	G	Р	Х
Max.	0.813	1.448	1.8034	2.2098	2.794	3.048	0.940
Thickness	(0.032)	(0.057)	(0.071)	(0.087)	(0.110)	(0.120)	(0.037)

NOTE: Contact factory for non-specified capacitance values



# High Voltage MLC Chip Capacitors

### For 600V to 3000V Automotive Applications - AEC-Q200







Modern automotive electronics could require components capable to work with high voltage (e.g. xenon lamp circuits or power converters in hybrid cards). AVX offers high voltage ceramic capacitors qualified according to AEC-Q200 standard.

High value, low leakage and small size are diffocult parameters to obtain in cpacitors for high voltage systems. AVX special hgih voltage MLC chip capacitors meet these performance characteristics and are designed for applications such as snubbers in high frequency power converters, resonators in SMPS, and high voltage coupling/dc blocking. These high voltage chip designs exhibit low ESRs at high frequencies.

Due to high voltage nature, larger physical dimensions are necessary. These larger sizes require special precautions to be taken in applying of MLC chips. The temperature gradient during heating or cooling cycles should not exceed 4°C per second. The preheat temperature must be within 50°C of the peak temperature reached by the ceramic bodies through the soldering process. Chip sizes 1210 and larger should be reflow soldered only. Capacitors may require protective surface coating to prevent external arcing.

To improve mechanical and thermal resistance, AVX recommend to use flexible terminations system - FLEXITERM®.



Notes: Capacitors with X7R dielectrics are not indeded for applications across AC supply mains or AC line filtering with polarity reversal. Please contact AVX for recommendations

#### **CHIP DIMENSIONS DESCRIPTION**



L = Length W = Width T = Thickness t = Terminal

#### (See capacitance range chart on page 128)

#### **X7R DIELECTRIC PERFORMANCE CHARACTERISTICS**

Parameter/Test	Specification Limits	Measuring Conditions			
Operating Temperature Range	-55°C to +125°C	Temperature Cycle Chamber			
Capacitance Dissipation Factor Capacitance Tolerance	within specified tolerance 2.5% max. ±5% (J), ±10% (K), ±20% (M)	Freq.: 1kHz ±10% Voltage: 1.0Vrm s ±0.2Vrms T = +25°C, V = 0Vdc			
Temperature Characteristics	X7R = ±15%	Vdc = 0V, T = (-55°C to +125°C)			
Insulation Resistance	100GΩ min. or 1000MΩ • $\mu F$ min. (whichever is less) 10GΩ min. or 100MΩ • $\mu F$ min. (whichever is less)	T = +25°C, V = 500Vdc T = +125°C, V = 500Vdc (t ≥ 120 sec, I ≤ 50mA)			
Dielectric Strength	No breakdown or visual defect	120% of rated voltage t ≤ 5 sec, l ≤ 50mA			




## For 600V to 3000V Automotive Applications - AEC-Q200

### **X7R CAPACITANCE RANGE**

### **PREFERRED SIZES ARE SHADED**

Case Size			1206				12	10				18	08		1812										2220		
Soldering		Refl	ow/W	lave			Reflo	wOnly				Reflo	wOnly					Re	flowO	nly				Re	flowO	nly	
(L) Length mm (in.)			20 ± 0.: 26 ± 0.			(		± 0.20 ± 0.008	3)		(	4.57 : 0.180 :	± 0.25 ± 0.010	)					50 ± 0. 77 ± 0.						70 ± 0. 24 ± 0.		
W) Width mm (in.)			50 ± 0.: 53 ± 0.					± 0.20 ± 0.008	3)		(		± 0.25 ± 0.010	)					20 ± 0. 26 ± 0.						00 ± 0. 97 ± 0.		
(T) Thickness mm (in.)			1.52	)				70 067)				2. (0.0							2.54	)					3.30 (0.130	)	
(t) Terminal mm max			5 (0.0 5 (0.0				0.25 ( 0.75 (					0.25 (	0.040)						5 (0.0 2 (0.0						25 (0.0 02 (0.0		
Voltage (V)	630	1000	1500	2000	2500	630	1000	1500	2000	630	1000	1500	2000	2500	3000	630	1000	1500	2000	2500	3000	4000	630	1000	1500	2000	3000
Cap (pF) 100 101																											
120 121																											
150 151																											,
180 181																											
220 221																											
270 271																											
330 331																											
390 391																											
470 471																											
560 561																											
680 681																											
820 821																											
1000 102																											
1200 122																											
1500 152																											
1800 182																											
2200 222																											
2700 272																											
3300 332																											
3900 392																											
4700 472																											
5600 562																											
6800 682																											
8200 822																											
Cap (µF) 0.01 103																											
0.012 123																											
0.015 153 0.018 183																											
																											<u> </u>
																											<u> </u>
0.027 273																											
0.033 333																											
0.039 393																											
																											1
0.056 563 0.068 683												-															
0.088 683																											
0.082 823																											
0.100 104																											$ \longrightarrow $
0.120 124																											
Voltage (V)	630	1000	1500	2000	2500	630	1000	1500	2000	630	1000	1500	2000	2500	3000	630	1000	1500	2000	2500	3000	4000	630	1000	1500	2000	3000
Case Size	000	1000	1206	2000	2000	030		10	2000	030	1000			2300	3000	000	1000	1000	1812	2300	3000	-+000	030	1000	2220	2000	0000
Case Size		_	1206				12	10	_			18	08	_	_				1812	_					2220	_	

NOTE: Contact factory for non-specified capacitance values



## Part Number Example CDR01 thru CDR06





### **MILITARY DESIGNATION PER MIL-PRF-55681**



NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers.

#### **Termination Finish:**

- M = Palladium silver
- N = Silver-nickel-gold
- S = Solder coated final with a minimum of 4 percent lead
- T = Silver
- U = Base metallization-barrier metal-solder coated
- (tin/lead alloy, with a minimum of 4 percent lead) W = Base metallization-barrier metal-tinned
- (tin or tin/lead alloy) Y = Base metallization-barrier metal-tin (100 percent)
- Z = Base metallization-barrier metal-tinned
  - (tin/lead alloy, with a minimum of 4 percent lead)

\*See MIL-PRF-55681 Specification for more details

Failure Rate Level: M = 1.0%, P = .1%, R = .01%, S = .001%

**Packaging:** Bulk is standard packaging. Tape and reel per RS481 is available upon request.

MIL Style: CDR01, CDR02, CDR03, CDR04, CDR05, CDR06

#### Voltage Temperature Limits:

- BP =  $0 \pm 30 \text{ ppm/°C}$  without voltage;  $0 \pm 30 \text{ ppm/°C}$  with rated voltage from -55°C to +125°C
- BX =  $\pm 15\%$  without voltage;  $\pm 15 25\%$  with rated voltage from  $-55^{\circ}C$  to  $\pm 125^{\circ}C$

**Capacitance:** Two digit figures followed by multiplier (number of zeros to be added) e.g., 101 = 100 pF

Rated Voltage: A = 50V, B = 100V

\*Not RoHS Compliant

Capacitance Tolerance: J  $\pm$  5%, K  $\pm$  10%, M  $\pm$  20%



### CROSS REFERENCE: AVX/MIL-PRF-55681/CDR01 THRU CDR06\*

\*For CDR11, 12, 13, and 14 see AVX Microwave Chip Capacitor Catalog



## **MIL-PRF-55681/Chips** Military Part Number Identification CDR01 thru CDR06



Military Type Designation	Capacitance in pF	Capacitance	Rated temperature and voltage-	WVDC	Military Type Designation/	Capacitance in pF	Capacitance tolerance	Rated temperature and voltage-	WVDC
AVX Style 08			temperature limits		AVX Style 18	· ·		temperature limits	
•	1	1					1		
CDR01BP100B CDR01BP120B CDR01BP150B CDR01BP180B	10 12 15 18	J,K J J,K J	BP BP BP BP	100 100 100 100	CDR03BP331B CDR03BP391B CDR03BP471B CDR03BP561B	330 390 470 560	J,K J J	BP BP BP BP	100 100 100 100
CDR01BP220B	22	J,K	BP	100	CDR03BP681B	680	J,K	BP	100
CDR01BP270B CDR01BP330B CDR01BP390B	27 33 39	J J,K J	BP BP BP	100 100 100	CDR03BP821B CDR03BP102B CDR03BX123B	820 1000 12,000	J J,K K	BP BP BX	100 100 100
CDR01BP470B CDR01BP560B	47 56	J,K J	BP BP	100 100	CDR03BX153B CDR03BX183B	15.000 18.000	K,M K	BX BX	100 100
CDR01BP680B CDR01BP820B CDR01BP101B CDR01B121B	68 82 100 120	J,K J J,K J,K	BP BP BPBX	100 100 100 100	CDR03BX223B CDR03BX273B CDR03BX333B CDR03BX393A	22,000 27.000 33.000 39.000	K,M K K,M K	BX BX BX BX	100 100 100 50
CDR01B151B CDR01B181B CDR01BX221B CDR01BX271B	150 180 220 270	J,K J,K K,M K	BP,BX BP,BX BX BX	100 100 100 100	CDR03BX473A CDR03BX563A CDR03BX683A	47.000 56.000 68.000	К,М К К,М	BX BX BX	50 50 50
CDR01BX331B CDR01BX391B	330	K,M K	BX BX	100 100 100	AVX Style 18	312/CDR04	•	1	T
CDR01BX471B CDR01BX561B CDR01BX681B CDR01BX821B	01BX391B 390 01BX471B 470 01BX561B 560 01BX681B 680		BX BX BX BX	100 100 100 100	CDR04BP122B CDR04BP152B CDR04BP182B CDR04BP222B	1200 1500 1800 2200	J J,K J J,K	BP BP BP BP	100 100 100 100
CDR01BX102B CDR01BX122B CDR01BX152B	1000 1200 1500	К,М К К,М	BX BX BX	100 100 100	CDR04BP272B CDR04BP332B CDR04BX393B CDR04BX473B	2700 3300 39.000 47.000	J J,K K K,M	BP BP BX BX	100 100 100 100
CDR01BX182B CDR01BX222B CDR01BX272B	1800 2200 2700	K K,M K	BX BX BX	100 100 100	CDR04BX473B CDR04BX563B CDR04BX823A CDR04BX104A	56.000 82.000 100,000	K,M K K,M	BX BX BX	100 100 50 50
CDR01BX332B CDR01BX392A CDR01BX472A	3300 3900 4700	К,М К К,М	BX BX BX	100 50 50	CDR04BX104A CDR04BX124A CDR04BX154A CDR04BX184A	120,000 120,000 150.000 180.000	K,M K,M K	BX BX BX BX	50 50 50 50
AVX Style 18	305/CDR02	2	1		AVX Style 18	325/CDR05		1	1
CDR02BP221B CDR02BP271B CDR02BX392B CDR02BX472B CDR02BX562B	220 270 3900 4700 5600	J,K J K K,M K	BP BP BX BX BX	100 100 100 100 100	CDR05BP392B CDR05BP472B CDR05BP562B CDR05BX683B	3900 4700 5600 68,000	J,K J,K J,K K,M	BP BP BP BX	100 100 100 100
CDR02BX682B CDR02BX822B CDR02BX103B	6800 8200 10,000	К,М К К,М	BX BX BX	100 100 100	CDR05BX823B CDR05BX104B CDR05BX124B	82,000 100,000 120,000	K K,M K	BX BX BX	100 100 100
CDR02BX123A CDR02BX153A CDR02BX183A	12,000 15,000 18,000	K K,M K	BX BX BX	50 50 50	CDR05BX154B CDR05BX224A CDR05BX274A CDR05BX334A	150.000 220.000 270,000 330,000	K,M K,M K K,M	BX BX BX BX	100 50 50 50
CDR02BX223A	22,000	K,M	BX	50	AVX Style 22	,		57	00
	— Add appropriat — Add appropriat		nish		CDR06BP682B CDR06BP822B	6800 8200	J,K J,K	BP BP BP	100 100 100
	– Capacitance To	blerance			CDR06BP103B CDR06BX394A CDR06BX474A	10,000 390.000 470.000	J,K K K,M	BP BX BX	100 50 50

Add appropriate failure rate

Add appropriate termination finish

Capacitance Tolerance



## Part Number Example CDR31 thru CDR35





#### MIL Style: CDR31, CDR32, CDR33, CDR34, CDR35

#### Voltage Temperature Limits:

- BP = 0 ± 30 ppm/°C without voltage; 0 ± 30 ppm/°C with rated voltage from -55°C to +125°C
- BX =  $\pm 15\%$  without voltage;  $\pm 15 25\%$  with rated voltage from  $-55^{\circ}$ C to  $\pm 125^{\circ}$ C

**Capacitance:** Two digit figures followed by multiplier (number of zeros to be added) e.g., 101 = 100 pF

#### Rated Voltage: A = 50V, B = 100V

Capacitance Tolerance: B  $\pm$  .10 pF, C  $\pm$  .25 pF, D  $\pm$  .5 pF, F  $\pm$  1%, J  $\pm$  5%, K  $\pm$  10%, M  $\pm$  20%

**MILITARY DESIGNATION PER MIL-PRF-55681** 



NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers.

#### **Termination Finish:**

- M = Palladium silver
- N = Silver-nickel-gold
- S = Solder coated final with a minimum of 4 percent lead
- T = Silver
- U = Base metallization-barrier metal-solder coated (tin/lead alloy, with a minimum of 4 percent lead)
- W = Base metallization-barrier metal-tinned (tin or tin/lead alloy)
- Y = Base metallization-barrier metal-tin (100 percent)
- Z = Base metallization-barrier metal-tinned (tin/lead alloy, with a minimum of 4 percent lead)

\*See MIL-PRF-55681 Specification for more details

Failure Rate Level: M = 1.0%, P = .1%, R = .01%, S = .001%

**Packaging:** Bulk is standard packaging. Tape and reel per RS481 is available upon request.

**\*Not RoHS Compliant** 

Per	AVX Style	Length (L)	Width (W)	Thickness (T)	D	Terminatio	n Band (t)
MIL-PRF-55681	AVA Style	(mm)	(mm)	Max. (mm)	Max. (mm)	Min. (mm)	Max.
CDR31	0805	2.00	1.25	1.3	.50	.70	.30
CDR32	1206	3.20	1.60	1.3	_	.70	.30
CDR33	1210	3.20	2.50	1.5	_	.70	.30
CDR34	1812	4.50	3.20	1.5	_	.70	.30
CDR35	1825	4.50	6.40	1.5	—	.70	.30

### CROSS REFERENCE: AVX/MIL-PRF-55681/CDR31 THRU CDR35



## **Military Part Number Identification CDR32**



Military Type Designation $1/$	Capacitance in pF	Capacitance tolerance	Rated temperature and voltage- temperature limits	WVDC	Military Type Designation <u>1</u> /	Capacitance in pF	Capacitance tolerance	Rated temperature and voltage- temperature limits	WVD
AVX Style 08	05/CDR31	(BP)			AVX Style 08	05/CDR31	(BP) con	ťd	
CDR31BP1R0B	1.0	B,C	BP	100	CDR31BP101B	100	F,J,K	BP	100
CDR31BP1R1B	1.1	B,C	BP	100	CDR31BP111B	110	F,J,K	BP	100
CDR31BP1R2B	1.2	B,C	BP	100	CDR31BP121B	120	F,J,K	BP	100
CDR31BP1R3B	1.3	B.C	BP	100	CDR31BP131B	130	F,J,K	BP	100
CDR31BP1R5B	1.5	B,C	BP	100	CDR31BP151B	150	F,J,K	BP	100
CDR31BP1R6B	1.6	B,C	BP	100	CDR31BP161B	160	F,J,K	BP	100
CDR31BP1R8B	1.8	B,C	BP	100	CDR31BP181B	180	F,J,K	BP	100
CDR31BP2R0B	2.0	B,C B.C	BP	100	CDR31BP201B	200	F,J,K	BP	100
CDR31BP2R0B	2.0	B,C	BP	100	CDR31BP221B	200	F,J,K	BP	100
CDR31BP2R4B	2.2	B,C	BP	100	CDR31BP241B	240		BP	100
							F,J,K		
CDR31BP2R7B	2.7	B,C,D	BP	100	CDR31BP271B	270	F,J,K	BP	100
CDR31BP3R0B	3.0	B,C,D	BP	100	CDR31BP301B	300	F,J,K	BP	100
CDR31BP3R3B	3.3	B,C,D	BP	100	CDR31BP331B	330	F,J,K	BP	100
CDR31BP3R6B	3.6	B,C,D	BP	100	CDR31BP361B	360	F,J,K	BP	100
CDR31BP3R9B	3.9	B,C,D	BP	100	CDR31BP391B	390	F,J,K	BP	100
CDR31BP4R3B	4.3	B,C,D	BP	100	CDR31BP431B	430	F,J,K	BP	100
CDR31BP4R7B	4.7	B,C,D	BP	100	CDR31BP471B	470	F,J,K	BP	100
CDR31BP5R1B	5.1	B,C,D	BP	100	CDR31BP511A	510	F,J,K	BP	50
CDR31BP5R6B	5.6	B,C,D	BP	100	CDR31BP561A	560	F,J,K	BP	50
CDR31BP6R2B	6.2	B,C,D	BP	100	CDR31BP621A	620	F,J,K	BP	50
CDR31BP6R8B	6.8	B,C,D	BP	100	CDR31BP681A	680	F,J,K	BP	50
CDR31BP7R5B	7.5	B,C,D	BP	100			(		
CDR31BP8R2B	8.2	B,C,D	BP	100	AVX Style 08	805/CDR31	(BX)		
CDR31BP9R1B	9.1	B,C,D	BP	100					
CDR31BP100B	10	FJ,K	BP	100	CDR31BX471B	470	K,M	BX	100
CDR31BP110B	11	FJ,K	BP	100	CDR31BX561B	560	K,M	BX	100
CDR31BP120B	12	FJ,K	BP	100	CDR31BX681B	680	K,M	BX	100
CDR31BP130B	13	FJ,K	BP	100	CDR31BX821B	820	K,M	BX	100
CDR31BP150B	15	FJ,K	BP	100	CDR31BX102B	1,000	K,M	BX	100
CDR31BP160B	16	FJ,K	BP	100	CDR31BX122B	1,200	K,M	BX	100
CDR31BP180B	18	FJ,K	BP	100	CDR31BX152B	1,500	K,M	BX	100
CDR31BP200B	20	F,J,K	BP	100	CDR31BX182B	1,800	K,M	BX	100
CDR31BP220B	20	FJ,K	BP	100	CDR31BX222B	2,200	K,M	BX	100
CDR31BP240B	24	F,J,K	BP	100	CDR31BX272B	2,700	K,M	BX	100
CDR31BP270B	27	FJ,K	BP	100	CDR31BX332B	3,300	K,M	BX	100
	30	FJ.K	BP	100	CDR31BX392B	3,900	K,M	BX	100
CDR31BP300B					CDR31BX472B	4,700	K,M	BX	10
CDR31BP330B	33	F,J,K	BP	100	CDR31BX562A	5,600	K,M	BX	50
CDR31BP360B	36	FJ,K	BP	100	CDR31BX682A	6,800	K,M	BX	50
CDR31BP390B	39	F,J,K	BP	100	CDR31BX822A	8,200	K,M	BX	50
CDR31BP430B	43	FJ,K	BP	100	CDR31BX103A	10,000	K,M	BX	50
CDR31BP470B	47	FJ,K	BP	100	CDR31BX103A	12,000	K,M	BX	50
CDR31BP510B	51	F,J,K	BP	100	CDR31BX123A	15.000	K,M	BX	50
CDR31BP560B	56	FJ,K	BP	100	CDR31BX183A	18.000	K.M	BX	50
CDR31BP620B	62	F,J,K	BP	100		10.000	الالبدا		
CDR31BP680B	68	FJ,K	BP	100		- Add appropriate	e failure rate		
CDR31BP750B	75	FJ,K	BP	100					
CDR31BP820B	82	F,J,K	BP	100		- Add appropriate	e termination fi	nish	
CDR31BP910B	91	FJ.K	BP	100				-	

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- Add appropriate failure rate

Add appropriate termination finish

Capacitance Tolerance

1/ The complete part number will include additional symbols to indicate capacitance tolerance, termination and failure rate level.

## Military Part Number Identification CDR32



Military Type Designation $1/$	Capacitance in pF	Capacitance tolerance	Rated temperature and voltage- temperature limits	WVDC	Military Type Designation $1/$	Capacitance in pF	Capacitance tolerance	Rated temperature and voltage- temperature limits	WVD
AVX Style 12	06/CDR32	(BP)			AVX Style 08	05/CDR31	(BP) con	ťd	
CDR32BP1R0B	1.0	B,C	BP	100	CDR32BP101B	100	FJ,K	BP	100
CDR32BP1R1B	1.1	B,C	BP	100	CDR32BP111B	110	FJ,K	BP	100
CDR32BP1R2B	1.2	B,C	BP	100	CDR32BP121B	120	FJ,K	BP	100
CDR32BP1R3B	1.3	B,C	BP	100	CDR32BP131B	130	FJ,K	BP	100
CDR32BP1R5B	1.5	B,C	BP	100	CDR32BP151B	150	FJ,K	BP	100
CDR32BP1R6B	1.6	B,C	BP	100	CDR32BP161B	160	FJ,K	BP	100
CDR32BP1R8B	1.8	B,C	BP	100	CDR32BP181B	180	F,J,K	BP	100
CDR32BP2R0B	2.0	B,C	BP	100	CDR32BP201B	200	FJ,K	BP	100
CDR32BP2R2B	2.2	B,C	BP	100	CDR32BP221B	220	F,J,K	BP	100
CDR32BP2R4B	2.4	B,C	BP	100	CDR32BP241B	240	FJ,K	BP	100
CDR32BP2R7B	2.7	B,C,D	BP	100	CDR32BP271B	270	FJ,K	BP	100
CDR32BP2R7B	3.0	B,C,D B,C,D	BP	100	CDR32BP301B	300	FJ,K F,J,K	BP	100
CDR32BP3R0B CDR32BP3R3B	3.0	B,C,D B,C,D	BP BP	100	CDR32BP301B	300	F,J,K FJ,K	BP	100
CDR32BP3R3B	3.6	B,C,D B,C,D	BP	100	CDR32BP361B	360	FJ,K F,J,K	BP	100
CDR32BP3R0B	3.9	B,C,D B,C,D	BP	100	CDR32BP301B	390	FJ,K	BP	100
CDR32BP4R3B	4.3	B,C,D	BP	100	CDR32BP431B	430	FJ,K	BP	100
CDR32BP4R7B	4.7	B,C,D	BP	100	CDR32BP471B	470	F,J,K	BP	100
CDR32BP5R1B	5.1	B,C,D	BP	100	CDR32BP511B	510	FJ,K	BP	100
CDR32BP5R6B	5.6	B,C,D	BP	100	CDR32BP561B	560	F,J,K	BP	100
CDR32BP6R2B	6.2	B,C,D	BP	100	CDR32BP621B	620	FJ,K	BP	100
CDR32BP6R8B	6.8	B,C,D	BP	100	CDR32BP681B	680	FJ,K	BP	100
CDR32BP7R5B	7.5	B,C,D	BP	100	CDR32BP751B	750	F,J,K	BP	100
CDR32BP8R2B	8.2	B,C,D	BP	100	CDR32BP821B	820	FJ,K	BP	100
CDR32BP9R1B	9.1	B,C,D	BP	100	CDR32BP911B	910	F,J,K	BP	100
CDR32BP100B	10	FJ,K	BP	100	CDR32BP102B	1,000	FJ,K	BP	100
CDR32BP110B	11	F,J,K	BP	100	CDR32BP112A	1,100	FJ,K	BP	50
CDR32BP120B	12	FJ,K	BP	100	CDR32BP122A	1,200	F,J,K	BP	50
CDR32BP130B	13	FJ,K	BP	100	CDR32BP132A	1,300	FJ,K	BP	50
CDR32BP150B	15	FJ,K	BP	100	CDR32BP152A	1,500	F,J,K	BP	50
CDR32BP160B	16	FJ,K	BP	100	CDR32BP162A	1,600	FJ,K	BP	50
CDR32BP180B	18	FJ,K	BP	100	CDR32BP182A	1,800	FJ,K	BP	50
CDR32BP200B	20	F,J,K	BP	100	CDR32BP202A	2,000	F,J,K	BP	50
CDR32BP220B	22	FJ,K	BP	100	CDR32BP222A	2,200	FJ,K	BP	50
CDR32BP240B	24	F,J,K	BP	100				5.	
CDR32BP270B	27	FJ,K	BP	100	AVX Style 12	06/CDR32	(BX)		
CDR32BP300B	30	FJ,K	BP	100				[	1
CDR32BP300B	33	FJ,K F,J,K	BP	100	CDR32BX472B	4,700	K,M	BX	100
CDR32BP350B	36	FJ,K	BP	100	CDR32BX562B	5,600	K,M	BX	100
CDR32BP300B	30		BP	100	CDR32BX682B	6,800	K,M	BX	100
CDR32BP390B CDR32BP430B	43	F,J,K FJ,K	BP BP	100	CDR32BX822B	8,200	K,M	BX	100
		-			CDR32BX103B	10,000	K,M	BX	100
CDR32BP470B	47	FJ,K	BP	100	CDR32BX123B	12,000	K,M	вх	100
CDR32BP510B	51	F,J,K	BP	100	CDR32BX153B	15.000	K,M	BX	100
CDR32BP560B	56	FJ,K	BP	100	CDR32BX183A	18.000	K,M	BX	50
CDR32BP620B	62	F,J,K	BP	100	CDR32BX223A	22,000	K,M	BX	50
CDR32BP680B	68	FJ,K	BP	100	CDR32BX273A	27,000	K,M	BX	50
CDR32BP750B	75	FJ,K	BP	100					
CDR32BP820B	82	F,J,K	BP	100	CDR32BX333A	33.000	K,M	BX BX	50 50
CDR32BP910B	91	FJ,K	BP	100	CDR32BX393A	39.000	K,M	ВХ	1 50

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Add appropriate termination finish

Capacitance Tolerance

1/ The complete part number will include additional symbols to indicate capacitance tolerance, termination and failure rate level.

Capacitance Tolerance

Add appropriate termination finish



## Military Part Number Identification CDR33/34/35



WVDC

100

100

100

100

100

50

50

50

50

100

100

100

100

100

100

100

100

100

50

50

50

50

50

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50

50

100

100

100

100

100

100

50

50

50

50

50

50

Rated temperature

and voltage-

temperature limits

ВΧ

ΒХ

ΒX

ВΧ

ВΧ

ВΧ

ВΧ

ВΧ

ΒX

BP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ΒP

ВΧ

ΒX

ΒX

ВΧ

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ВΧ

ΒX

ВΧ

ΒX

Military Type Designation $1/$	Capacitance in pF	Capacitance tolerance	Rated temperature and voltage- temperature limits	WVDC	Military Type Designation $1/$	Capacitance in pF	Capacit tolera
AVX Style 12	210/CDR33	(BP)			AVX Style <sup>2</sup>	1812/CDR34	(BX)
CDR33BP102B	1,000	FJ,K	BP	100	CDR34BX273B	- 27.000	K,N
CDR33BP112B	1,100	FJ,K	BP	100	CDR34BX333B	- 33.000	K,N
CDR33BP122B	1,200	FJ,K	BP	100	CDR34BX393B	- 39.000	K,N
CDR33BP132B	1,300	FJ,K	BP	100	CDR34BX473B	- 47.000	K,N
CDR33BP152B	1,500	FJ,K	BP	100	CDR34BX563B	- 56.000	K,N
CDR33BP162B	1,600	FJ,K	BP	100	CDR34BX104A	- 100,000	K,N
CDR33BP182B	1,800	F,J,K	BP	100	CDR34BX124A-		K,N
CDR33BP202B	2,000	FJ,K	BP	100	CDR34BX154A-	- 150.000	K,N
CDR33BP222B	2,200	F,J,K	BP	100	CDR34BX184A-	180.000	K,N
CDR33BP242A	2,400	FJ,K	BP	50			
CDR33BP272A	2,700	FJ,K	BP	50	AVX Style 1	1825/CDR35	(BP)
CDR33BP302A	3,000	F,J,K	BP	50			( )
CDR33BP332A	3,300	FJ,K	BP	50	CDR35BP472B-	- 4,700	FJ,ŀ
	,	,			CDR35BP512B-	- 5,100	F,J,I
VX Style 12	210/CDR33	(BX)			CDR35BP562B-	- 5,600	FJ,ł
•	1				CDR35BP622B-	- 6,200	F,J,ł
CDR33BX153B	15.000	K,M	BX	100	CDR35BP682B-	- 6,800	FJ,ŀ
CDR33BX183B	18.000	K,M	BX	100	CDR35BP752B	- 7,500	FJ,ł
CDR33BX223B	22,000	K,M	BX	100	CDR35BP822B		F,J,I
CDR33BX273B	27.000	K,M	BX	100	CDR35BP912B	- 9,100	FJ,ł
CDR33BX393A	39.000	K,M	BX	50	CDR35BP103B	- 10,000	FJ,⊧
CDR33BX473A	47.000	K,M	BX	50	CDR35BP113A-	- 11,000	F,J,I
CDR33BX563A	56.000	K,M	BX	50	CDR35BP123A-	- 12,000	FJ,ŀ
CDR33BX683A	68.000	K,M	BX	50	CDR35BP133A-		F,J,I
CDR33BX823A	82,000	K,M	BX	50	CDR35BP153A-		FJ,
CDR33BX104A	100,000	K,M	BX	50	CDR35BP163A	- 16.000	F,J,I
VX Style 18	212/0024	(PD)	·		CDR35BP183A-	- 18,000	FJ,
wh style it	DIZ/CDR34				CDR35BP203A-	- 20,000	FJ,H
CDR34BP222B	2,200	FJ,K	BP	100	CDR35BP223A-		F,J,I
CDR34BP242B	2,400	F,J,K	BP	100			
CDR34BP272B	2,700	FJ,K	BP	100	AVX Style <sup>2</sup>	1825/CDR35	(BX)
CDR34BP302B	3,000	F,J,K	BP	100	-		<u>г г</u>
CDR34BP332B	3,300	FJ,K	BP	100	CDR35BX563B		K,N
CDR34BP362B	3,600	FJ,K	BP	100	CDR35BX683B		K,N
CDR34BP392B	3,900	F,J,K	BP	100	CDR35BX823B		K,N
CDR34BP432B	4,300	FJ,K	BP	100	CDR35BX104B		K,N
CDR34BP472B	4,700	F,J,K	BP	100	CDR35BX124B	- 120,000	K,N
CDR34BP512A	5,100	FJ,K	BP	50	CDR35BX154B	- 150.000	K,N
CDR34BP562A	5,600	FJ.K	BP	50	CDR35BX184A	- 180.000	K,N
CDR34BP622A	6,200	F,J,K	BP	50	CDR35BX224A-		K,N
CDR34BP682A	6,800	FJ,K	BP	50	CDR35BX274A-	- 270.000	K,N
CDR34BP752A	7,500	F,J,K	BP	50	CDR35BX334A-	- 330.000	K,N
CDR34BP822A	8,200	FJ,K	BP	50	CDR35BX394A-	- 390.000	K,N
CDR34BP912A	9,100	FJ,K	BP	50	CDR35BX474A-		K,N
CDR34BP103A	10,000	F,J,K	BP	50	L		ı ·

### 681/9/10/11

Capacitance

tolerance

FJ,K

F,J,K

FJ,K

F,J,K

FJ,K

FJ,K

F,J,K

FJ,K

FJ,K

F,J,K

FJ,K

F,J,K

FJ,K

F,J,K

FJ,K

FJ.K

F,J,K

K,M

K,M

Add appropriate failure rate

Add appropriate termination finish

Capacitance Tolerance

1/ The complete part number will include additional symbols to indicate capacitance tolerance, termination and failure rate level.



Add appropriate termination finish

## **MLCC Medical Applications – MM Series**

## **General Specifications**





The AVX MM series is a multi-layer ceramic capacitor designed for use in medical applications other than implantable/life support. These components have the design & change control expected for medical devices and also offer enhanced LAT including reliability testing and 100% inspection.

### **APPLICATIONS**

#### Implantable, Non-Life Supporting Medical Devices

• e.g. implanted temporary cardiac monitor, insulin pumps

#### **External, Life Supporting Medical Devices**

• e.g. heart pump external controller

#### **External Devices**

• e.g. patient monitoring, diagnostic equipment

### **HOW TO ORDER**



### **COMMERCIAL VS MM SERIES PROCESS COMPARISON**

	Commercial	MM Series
Administrative	Standard part numbers; no restriction on who purchases these parts	Specific series part number, used to control supply of product
Design	Minimum ceramic thickness of 0.020" on all X7R product	Minimum ceramic thickness of 0.029" (0.74mm)
Dicing	Side & end margins = 0.003" min	Side & end margins = 0.004" min Cover layers = 0.003" min
Lot Qualification Destructive Physical Analysis (DPA)	As per EIA RS469	Increased sample plan – stricter criteria
Visual/Cosmetic Quality	Standard process and inspection	100% inspection
Application Robustness	Standard sampling for accelerated wave solder on X7R dielectrics	Increased sampling for accelerated wave solder on X7R and NP0 followed by lot by lot reliability testing
Design/Change Control	Required to inform customer of changes in: • form • fit • function	<ul> <li>AVX will qualify and notify customers before making any change to the following materials or processes:</li> <li>Dielectric formulation, type, or supplier</li> <li>Metal formulation, type, or supplier</li> <li>Termination material formulation, type, or supplier</li> <li>Manufacturing equipment type</li> <li>Quality testing regime including sample size and accept/ reject criteria</li> </ul>



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## NP0 (C0G) - Specifications & Test Methods



Parame	ter/Test	NP0 Specification Limits	Measuring	Conditions
Operating Tem		-55°C to +125°C	Temperature C	
Сарас	itance	Within specified tolerance <30 pF: Q≥ 400+20 x Cap Value	Freq.: 1.0 MHz ± 10% 1.0 kHz ± 10% fo	% for cap ≤ 1000 pF
0	2	≥30 pF: Q≥ 1000	Voltage: 1.0	Vrms ± .2V
Insulation I	Resistance	100,000MΩ or 1000MΩ - μF, whichever is less	Charge device with 60 ± 5 secs @ room	
Dielectric	Strength	No breakdown or visual defects	Charge device with 300 1-5 seconds, w/charge limited to 50 Note: Charge device voltage for 50	and discharge curren ) mA (max) with 150% of rated
	Appearance	No defects	Deflectio	n <sup>.</sup> 2mm
Resistance to	Capacitance Variation	±5% or ±.5 pF, whichever is greater	Test Time: 3	
Flexure Stresses	Q	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3	90 r	
Solder		≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic for 5.0 ± 0.5	
	Appearance	No defects, <25% leaching of either end terminal		
	Capacitance Variation	$\leq$ ±2.5% or ±.25 pF, whichever is greater		
Resistance to Solder Heat	Q	Meets Initial Values (As Above)	Dip device in eutectic s seconds. Store at room	temperature for 24 ±
	Insulation Resistance	Meets Initial Values (As Above)	hours before measuring	g electrical properties
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
	Capacitance Variation	$\leq \pm 2.5\%$ or $\pm .25$ pF, whichever is greater	Step 2: Room Temp	≤ 3 minutes
Thermal Shock	Q	Meets Initial Values (As Above)	Step 3: +125°C ± 2°	30 ± 3 minutes
OHOCK	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles 24 hours at room	and measure after m temperature
	Appearance	No visual defects		
	Capacitance Variation	$\leq \pm 3.0\%$ or $\pm .3$ pF, whichever is greater	Charge device with twic chamber set a	ce rated voltage in tes
Load Life	Q	≥ 30 pF: Q≥ 350 ≥10 pF, <30 pF: Q≥ 275 +5C/2 <10 pF: Q≥ 200 +10C	for 1000 hou	ırs (+48, -0).
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from test cha room temperatu before me	re for 24 hours
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects		
	Capacitance Variation	$\leq$ ±5.0% or ± .5 pF, whichever is greater	Store in a test chamber	
Load Humidity	Q	≥ 30 pF: Q≥ 350 ≥10 pF, <30 pF: Q≥ 275 +5C/2 <10 pF: Q≥ 200 +10C	± 5% relative humid (+48, -0) with rated Remove from cham	d voltage applied.
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	room temperature for measu	24 ± 2 hours before
	Dielectric Strength	Meets Initial Values (As Above)		5



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## NP0/C0G Capacitance Range

### **PREFERRED SIZES ARE SHADED**

SIZE			06	03				0805				1206					
	WVDC	16	25	50	100	16	25	50	100	16	25	50	100				
	0R5																
	1R0																
1.2	1R2																
1.5	1R5																
1.8	1R8																
2.2	2R2																
2.7	2R7																
3.3	3R3																
3.9	3R9								-								
4.7	4R7																
5.6	5R6																
6.8	6R8																
8.2	8R2																
10	100																
12 15	120 150																
15	180																
22	220																
22	270																
33	330																
33	390																
47	470																
56	560																
68	680																
82	820																
100	101											<u> </u>					
120	121																
150	151																
180	181																
220	221																
270	271																
330	331										1						
390	391																
470	471																
560	561																
680	681																
820	821																
1000																	
1200																	
1500																	
WVD0		16	25		100	16	25	50	100	16	25	50	100				
SIZE			06	03				0805				1206					







Parame	ter/Test	X7R Specification Limits	Measuring	Conditions
	perature Range	-55°C to +125°C	Temperature C	ycle Chamber
Capac	itance	Within specified tolerance		
C	2	≤ 10% for ≥ 50V DC rating ≤ 12.5% for 25V DC rating ≤ 12.5% for 25V and 16V DC rating ≤ 12.5% for ≤ 10V DC rating	Freq.: 1.0 k Voltage: 1.0	
Insulation	Resistance	100,000MΩ or 1000MΩ - μF, whichever is less	Charge device with rate secs @ room te	ed voltage for 120 ± 5 emp/humidity
Dielectric	: Strength	No breakdown or visual defects	Charge device with 300 1-5 seconds, w/charge limited to 50 Note: Charge device voltage for 50	and discharge current mA (max) with 150% of rated
	Appearance	No defects	Deflectio	n <sup>.</sup> 2mm
Resistance to	Capacitance Variation	≤ ±12%	Test Time: 3	
Flexure Stresses	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3	90 r	nm —
Solder	rability	≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic for 5.0 ± 0.5	
	Appearance	No defects, <25% leaching of either end terminal		
	Capacitance Variation	≤ ±7.5%		
Resistance to Solder Heat	Dissipation Factor	Meets Initial Values (As Above)	Dip device in eutectic s seconds. Store at room	temperature for $24 \pm 2$
oolder medt	Insulation Resistance	Meets Initial Values (As Above)	hours before measuring	g electrical properties.
	Dielectric Strength	Meets Initial Values (As Above)		
	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
	Capacitance Variation	≤ ±7.5%	Step 2: Room Temp	≤ 3 minutes
Thermal Shock	Dissipation Factor	Meets Initial Values (As Above)	Step 3: +125°C ± 2°	30 ± 3 minutes
Unicon	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles 24 ± 2 hours at ro	
	Appearance	No visual defects		
	Capacitance Variation	≤ ±12.5%	Charge device with 1.5 r test chamber set	at 125°C ± 2°C
Load Life	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	for 1000 hou	
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from test cha room temperature for	24 ± 2 hours before
	Dielectric Strength	Meets Initial Values (As Above)	measu	iring.
	Appearance	No visual defects		
	Capacitance Variation	≤ ±12.5%	Store in a test chamber ± 5% relative humid	
Load	Dissipation Factor	≤ Initial Value x 2.0 (See Above)	(+48, -0) with rated	l voltage applied.
Humidity	Insulation Resistance	≥ Initial Value x 0.3 (See Above)	Remove from chamber temperature an	d humidity for
	Dielectric Strength	Meets Initial Values (As Above)	24 ± 2 hours bef	ore measuring.





### **X7R Capacitance Range**

### **PREFERRED SIZES ARE SHADED**

	SIZE			)40	2			(	060	03					(	080	)5						12	06					<b>1210</b>					1	808	;		18	12			222	0		
		WVDC	16	25	50	10	16	5 2	25	50	100	200	10	16	25	50	100	200	250	10	16	25	50	100	200	250	500	10	16	25	50	100	200	250 5	00	50	100	200	50	100	200	250	25	50	100
Cap	220	221		-																																									
(pF)	270	271						+	+								1		1						İ –			1		1															· · · ·
	330	331																								1	1	1	1													1			
	390	391																																											
	470	471																																											
	560	561																								1			1									Î							
	680	681																																											
	820	821																																											
	1000	102																																											
	1200	122																																											1
	1500	152																																											
	1800	182																																											
	2200	222																																				1							
	2700	272																																											
	3300	332																																											
	3900	392																																											
	4700	472																																											I
	5600	562																																											I
	6800	682																																											L
	8200	822																																											-
	0.010	103																																											
	0.012	123					+	_	$\rightarrow$																																				
	0.015	153					+	_	$\rightarrow$																	<u> </u>					<u> </u>				$\rightarrow$								$\vdash$		
	0.018	183					_	_	+						_		_	_			<u> </u>			<u> </u>		<u> </u>			<u> </u>	_	<u> </u>				_							<u> </u>			
	0.022	223					_	_	_						<u> </u>		_	_	<u> </u>		<u> </u>			<u> </u>		<u> </u>			<u> </u>	_	<u> </u>				_							<u> </u>			
	0.027	273					_	_																		<u> </u>			<u> </u>		<u> </u>												$\vdash$		<b> </b>
	0.033	333					_	_	_						<u> </u>		_				<u> </u>								<u> </u>	<u> </u>	<u> </u>							_				_	$\vdash$		
	0.039	393					_	_	_							<u> </u>	-	_			<u> </u>					-			<u> </u>	-												_	$\vdash$		
	0.047	473					_	_	+							<u> </u>	-	-			-				<u> </u>	-			<u> </u>	-					_					<u> </u>		_	$\vdash$		<b></b>
	0.056	563					+	+	+								-		-			<u> </u>		-		-				-	-				_		_					-	$\vdash$		
	0.068	683			-		+-	+	+					<u> </u>	-	<u> </u>	-	-				-	<u> </u>	-		-				-	-	-	_		-								$\vdash$		
$\vdash$	0.082	823 104					-	+	-									-	-		-					-			-					_	-							-	$\vdash$		<u> </u>
$\vdash$	0.10	104			-							-					-		+							-			-						-										
$\vdash$	0.12	124			-			+	+									-	-					-	-										+			-							
$\vdash$	0.15	224					+	+	+									-	+					-	-									_	-										
$\vdash$	0.22	334					+	+	+	_							-	-	+					-	-	-									-										
$\vdash$	0.33	474			-	$\vdash$	+	+	+	_						-	+	-	+					-	-	-	-								-							-			
$\vdash$	0.47	564		-	-	+	+	+	+							$\vdash$	+	+	+						-	+	-							-+	+						-				
$\vdash$	0.56	684		-	-	+	+	+	+			-		-	-	$\vdash$	+	+	+					-	-	+	-							-+	+						-				
$\vdash$	0.82	824			-	+	+	+	+	_				-	-	$\vdash$	+	+	+				-	-	-	+	-							-+	+					-	-				
$\vdash$	1.0	105			-	$\vdash$	+	-	+	_					-	-	+	-	+					-	-	+	-								-					-	-				
$\vdash$	1.0	125			+	+	+	-	-	_					-	-	+	-	1					-	-	+	-								-			-		-	-	+			
$\vdash$	1.2	125		-	-	$\vdash$	+	-	+						$\vdash$	$\vdash$	+	$\vdash$	$\vdash$	-	-	-		-	-	-	-	-	-	$\vdash$	-				-					-		-			
$\vdash$	WVDC			25	50	10	16	5 2	25	50	100	200	10	16	25	50	100	200	250	10	16	25	50	100	200	250	500	10	16	25	50	100	200	250 5	00	50	100	200	50	100	200	250	25	50	100
-	SIZE		1			1.0			 D6(		100	200	1.5	1.0		080		1200	200	1.5	1.0	120	12		1200	1200	000	1.5	1.0	120		10	200	20010			808		00	-	12 12			222	
	SIZE			040	2			Ľ	וסע	03						JQL	13						12	00							12	10					608	•		18	12			222	J





## **Automatic Insertion Packaging**

### **TAPE & REEL QUANTITIES**

All tape and reel specifications are in compliance with RS481.

	4mm	8mm	12mm	
Paper or Embossed Carrier		0612, 0508, 0805, 1206, 1210		
Embossed Only	0101		1808	1812, 1825 2220, 2225
Paper Only		0101, 0201, 0306, 0402, 0603		
Qty. per Reel/7" Reel	4,000	1,000, 2,000, 3,000 or 4,000, 10,000, 15,000, 20,000 Contact factory for exact quantity	3,000	500, 1,000 Contact factory for exact quantity
Qty. per Reel/13" Reel		5,000, 10,000, 50,000 Contact factory for exact quantity	10,000	4,000

### **REEL DIMENSIONS**



Tape Size <sup>(1)</sup>	A Max.	B* Min.	С	D* Min.	N Min.	<b>W</b> <sub>1</sub>	W₂ Max.	W <sub>3</sub>
4mm	1.80 (7.087)	1.5 (0.059)	13.0±0.5 (0.522±0.020)	20.2 (0.795)	60.0 (2.362)	4.35±0.3 (0.171±0.011)	7.95 (0.312)	
8mm	330	1.5	13.0 <sup>+0.50</sup>	20.2	50.0	8.40 <sup>+1.5</sup> (0.331 <sup>+0.059</sup> )	14.4 (0.567)	7.90 Min. (0.311) 10.9 Max. (0.429)
12mm	(12.992)	(0.059)	(0.512+0.020)	(0.795)	(1.969)	12.4 <sup>+2.0</sup> (0.488 <sup>+0.079</sup> )	18.4 (0.724)	11.9 Min. (0.469) 15.4 Max. (0.607)

Metric dimensions will govern.

English measurements rounded and for reference only.

(1) For tape sizes 16mm and 24mm (used with chip size 3640) consult EIA RS-481 latest revision.



## **Embossed Carrier Configuration**



## 4, 8 & 12mm Tape Only





## 4, 8 & 12mm Embossed Tape Metric Dimensions Will Govern

### **CONSTANT DIMENSIONS**

Tape Size	Do	E <sub>1</sub>	Po	P <sub>2</sub>	S₁ Min.	T Max.	T₁ Max.
Amm	0.80±0.04	0.90±0.05	2.0±0.04	1.00±0.02	1.075	0.26	0.06
4mm	(0.031±0.001)	(0.035±0.001)	(0.078±0.001)	(0.039±0.0007)	(0.042)	(0.010)	(0.002)
8mm	1.50 +0.10	1.75 ± 0.10	4.0 ± 0.10	2.0 ± 0.05	0.60	0.60	0.10
& 12mm	$(0.059^{+0.004}_{-0.0})$	(0.069 ± 0.004)	(0.157 ± 0.004)	(0.079 ± 0.002)	(0.024)	(0.024)	(0.004)

### **VARIABLE DIMENSIONS**

Tape Size	B₁ Max.	D₁ Min.	E <sub>2</sub> Min.	F	P <sub>1</sub> See Note 5	R Min. See Note 2	T <sub>2</sub>	W Max.	A <sub>0</sub> B <sub>0</sub> K <sub>0</sub>
8mm	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
12mm	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1
8mm 1/2 Pitch	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	2.00 ± 0.10 (0.079 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
12mm Double Pitch	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	8.00 ± 0.10 (0.315 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1

#### NOTES:

1. The cavity defined by A0, B0, and K0 shall be configured to provide the following: Surround the component with sufficient clearance such that:

b) the component does not protrude beyond the sealing plane of the cover tape.
c) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the cover tape has been removed.
d) rotation of the component is limited to 20° maximum (see Sketches D & E).

Tape with or without components shall pass around radius "R" without damage.
 Bar code labeling (if required) shall be on the side of the reel opposite the round

sprocket holes. Refer to EIA-556.

4.  $B_1$  dimension is a reference dimension for tape feeder clearance only.

5. If  $P_1 = 2.0$ mm, the tape may not properly index in all tape feeders.





## **Paper Carrier Configuration**







## 4, 8 & 12mm Embossed Tape Metric Dimensions Will Govern

### **CONSTANT DIMENSIONS**

Tape Size	Do	E	Po	P <sub>2</sub>	T <sub>1</sub>	G. Min.	R Min.
8mm and 12mm	$\frac{1.50^{+0.10}_{-0.0}}{(0.059^{+0.004}_{-0.0})}$	1.75 ± 0.10 (0.069 ± 0.004)	4.00 ± 0.10 (0.157 ± 0.004)	2.00 ± 0.05 (0.079 ± 0.002)	0.10 (0.004) Max.	0.75 (0.030) Min.	25.0 (0.984) See Note 2 Min.

### **VARIABLE DIMENSIONS**

Tape Size	P <sub>1</sub> See Note 4	E <sub>2</sub> Min.	F	W	A <sub>0</sub> B <sub>0</sub>	т
8mm	4.00 ± 0.10 (0.157 ± 0.004)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	$\frac{8.00^{+0.30}_{-0.10}}{(0.315^{+0.012}_{-0.004})}$	See Note 1	1.10mm (0.043) Max.
12mm	4.00 ± 0.10 (0.157 ± 0.004)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	12.0 ± 0.30 (0.472 ± 0.012)		for Paper Base Tape and
8mm 1/2 Pitch	2.00 ± 0.05 (0.079 ± 0.002)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	$\frac{8.00 \stackrel{+0.30}{_{-0.10}}}{(0.315 \stackrel{+0.012}{_{-0.004}})}$		1.60mm (0.063) Max. for Non-
12mm Double Pitch	8.00 ± 0.10 (0.315 ± 0.004)	10.25 (0.404)	$ \begin{array}{c cccc} 5.50 \pm 0.05 & 12.0 \pm 0.30 \\ (0.217 \pm 0.002) & (0.472 \pm 0.012) \end{array} $	for Non- Paper Base Compositions		

#### NOTES:

- 1. The cavity defined by A0, B0, and T shall be configured to provide sufficient clearance surrounding the component so that:
  - a) the component does not protrude beyond either surface of the carrier tape;
  - b)) the component can be removed from the cavity in a vertical direction without
  - mechanical restriction after the top cover tape has been removed;
  - c) rotation of the component is limited to 20° maximum (see Sketches A & B);
  - d) lateral movement of the component is restricted to 0.5mm maximum (see Sketch C).





### Tape with or without components shall pass around radius "R" without damage. Bar code labeling (if required) shall be on the side of the reel opposite the sprocket holes. Refer to EIA-556.

4. If  $P_1 = 2.0$ mm, the tape may not properly index in all tape feeders.



## **Bar Code Labeling Standard**

AVX bar code labeling is available and follows latest version of EIA-556



## **Basic Capacitor Formulas**



#### I. Capacitance (farads)

English: C =  $\frac{.224 \text{ KA}}{\text{T}_{\text{D}}}$ Metric: C =  $\frac{.0884 \text{ KA}}{\text{T}_{\text{D}}}$ 

II. Energy stored in capacitors (Joules, watt - sec) E =  $\frac{1}{2}\,C\,V^2$ 

III. Linear charge of a capacitor (Amperes)

 $I = C \ \frac{dV}{dt}$ 

IV. Total Impedance of a capacitor (ohms)

 $Z = \sqrt{R_{S}^{2} + (X_{C} - X_{L})^{2}}$ 

V. Capacitive Reactance (ohms)

$$x_{\rm C} = \frac{1}{2 \,\pi \,\rm fC}$$

VI. Inductive Reactance (ohms)  $x_L = 2 \pi fL$ 

VII. Phase Angles:

Ideal Capacitors: Current leads voltage 90° Ideal Inductors: Current lags voltage 90° Ideal Resistors: Current in phase with voltage

#### VIII. Dissipation Factor (%)

D.F.= tan 
$$\delta$$
 (loss angle) =  $\frac{\text{E.S.R.}}{X_{\text{C}}}$  = (2  $\pi$ fC) (E.S.R.)

**IX.** Power Factor (%) P.F. = Sine (loss angle) =  $\cos \varphi$  (phase angle) P.F. = (when less than 10%) = DF

#### X. Quality Factor (dimensionless)

 $Q = Cotan \ \delta \ (loss \ angle) = \frac{1}{D.F.}$ 

#### XI. Equivalent Series Resistance (ohms) E.S.R. = (D.F.) (Xc) = (D.F.) / $(2 \pi fC)$

XII. Power Loss (watts) Power Loss =  $(2 \pi fCV^2)$  (D.F.)

XIII. KVA (Kilowatts) KVA =  $2 \pi fCV^2 \times 10^{-3}$ 

#### XIV. Temperature Characteristic (ppm/°C)

T.C. = 
$$\frac{Ct - C_{25}}{C_{25} (T_{*} - 25)} \times 10^{6}$$

**XV. Cap Drift (%)** C.D. =  $\frac{C_1 - C_2}{C_1} \times 100$ 

XVII. Capacitors in Series (current the same)

Any Number: 
$$\frac{1}{C_{T}} = \frac{1}{C_{1}} + \frac{1}{C_{2}} - \frac{1}{C_{N}}$$
Two:  $C_{T} = \frac{C_{1}C_{2}}{C_{N}}$ 

Two:  $C_T = \overline{C_1 + C_2}$ XVIII. Capacitors in Parallel (voltage the same)

 $C_{T} = C_{1} + C_{2} - + C_{N}$ XIX. Aging Rate

A.R. =  $\Delta$  C/decade of time

XX. Decibels

$$db = 20 \log \frac{V_1}{V_2}$$

METRIC PREFIXES
-----------------

### SYMBOLS

Pico	X 10 <sup>-12</sup>
Nano	X 10 <sup>-9</sup>
Micro	X 10⁻ <sup>6</sup>
Milli	X 10 <sup>-3</sup>
Deci	X 10 <sup>-1</sup>
Deca	X 10 <sup>+1</sup>
Kilo	X 10+3
Mega	X 10 <sup>+6</sup>
Giga	X 10+9
Tera	X 10 <sup>+12</sup>

к	= Dielectric Constant	f	= frequency	L <sub>t</sub>	= Test life
A	= Area	L	= Inductance	V <sub>t</sub>	= Test voltage
T <sub>D</sub>	= Dielectric thickness	δ	= Loss angle	V <sub>o</sub>	= Operating voltage
v	= Voltage	φ	= Phase angle	T <sub>t</sub>	= Test temperature
t	= time	X & Y	= exponent effect of voltage and temp.	$T_{o}$	= Operating temperature
Rs	= Series Resistance	L <sub>o</sub>	= Operating life		





**Basic Construction** – A multilayer ceramic (MLC) capacitor is a monolithic block of ceramic containing two sets of offset, interleaved planar electrodes that extend to two opposite surfaces of the ceramic dielectric. This simple structure requires a considerable amount of sophistication, both in material and manufacture, to produce it in the

quality and quantities needed in today's electronic equipment.



**Formulations** – Multilayer ceramic capacitors are available in both Class 1 and Class 2 formulations. Temperature compensating formulation are Class 1 and temperature stable and general application formulations are classified as Class 2.

**Class 1** – Class 1 capacitors or temperature compensating capacitors are usually made from mixtures of titanates where barium titanate is normally not a major part of the mix. They have predictable temperature coefficients and in general, do not have an aging characteristic. Thus they are the most stable capacitor available. The most popular Class 1 multilayer ceramic capacitors are COG (NPO) temperature compensating capacitors (negative-positive 0 ppm/°C).

**Class 2** – EIA Class 2 capacitors typically are based on the chemistry of barium titanate and provide a wide range of capacitance values and temperature stability. The most commonly used Class 2 dielectrics are X7R and Y5V. The X7R provides intermediate capacitance values which vary only ±15% over the temperature range of -55°C to 125°C. It finds applications where stability over a wide temperature range is required.

The Y5V provides the highest capacitance values and is used in applications where limited temperature changes are expected. The capacitance value for Y5V can vary from 22% to -82% over the -30°C to  $85^{\circ}$ C temperature range.

All Class 2 capacitors vary in capacitance value under the influence of temperature, operating voltage (both AC and DC), and frequency. For additional information on performance changes with operating conditions, consult AVX's software, SpiCap.





## Table 1: EIA and MIL Temperature Stable and General Application Codes

EIA CODE Percent Capacity Change Over Temperature Range					
RS198	Temperature Range				
X7	-55°C to +125°C				
X6	-55°C to +105°C				
X5	-55°C to +85°C				
Y5	-30°C to +85°C				
Z5	+10°C to +85°C				
Code	Percent Capacity Change				
D	±3.3%				
E	±4.7%				
F	±7.5%				
Р	±10%				
P R	±10% ±15%				
R	±15%				
R S	±15% ±22%				

 $\label{eq:example} \begin{array}{l} \mbox{EXAMPLE}-\mbox{A capacitor is desired with the capacitance value at 25°C to} \\ \mbox{increase no more than 7.5% or decrease no more than 7.5% from -30°C} \\ \mbox{to +85°C. EIA Code will be Y5F.} \end{array}$ 

MIL CODE							
Symbol	bol Temperature Range						
A B C	-55°C to +85°C -55°C to +125°C -55°C to +150°C						
Symbol	Cap. Change Zero Volts	Cap. Change Rated Volts					
R	+15%, -15%	+15%, -40%					
S	+22%, -22%	+22%, -56%					
W	+22%, -56%	+22%, -66%					
X	+15%, -15%	+15%, -25%					
Y	+30%, -70%	+30%, -80%					
Z	+20%, -20%	+20%, -30%					
symbols, for exa	Temperature characteristic is specified by combining range and change symbols, for example BR or AW. Specification slash sheets indicate the characteristic applicable to a given style of capacitor.						

In specifying capacitance change with temperature for Class 2 materials, EIA expresses the capacitance change over an operating temperature range by a 3 symbol code. The first symbol represents the cold temperature end of the temperature range, the second represents the upper limit of the operating temperature range and the third symbol represents the capacitance change allowed over the operating temperature range. Table 1 provides a detailed explanation of the EIA system.

**Effects of Voltage** – Variations in voltage have little effect on Class 1 dielectric but does affect the capacitance and dissipation factor of Class 2 dielectrics. The application of DC voltage reduces both the capacitance and dissipation factor while the application of an AC voltage within a reasonable range tends to increase both capacitance and dissipation factor readings. If a high enough AC voltage is applied, eventually it will reduce capacitance just as a DC voltage will. Figure 2 shows the effects of AC voltage.



Figure 2

Capacitor specifications specify the AC voltage at which to measure (normally 0.5 or 1 VAC) and application of the wrong voltage can cause spurious readings. Figure 3 gives the voltage coefficient of dissipation factor for various AC voltages at 1 kilohertz. Applications of different frequencies will affect the percentage changes versus voltages.

D.F. vs. A.C. Measurement Volts



#### Figure 3

Typical effect of the application of DC voltage is shown in Figure 4. The voltage coefficient is more pronounced for higher K dielectrics. These figures are shown for room temperature conditions. The combination characteristic known as voltage temperature limits which shows the effects of rated voltage over the operating temperature range is shown in Figure 5 for the military BX characteristic.











Effects of Time – Class 2 ceramic capacitors change capacitance and dissipation factor with time as well as temperature, voltage and frequency. This change with time is known as aging. Aging is caused by a gradual re-alignment of the crystalline structure of the ceramic and produces an exponential loss in capacitance and decrease in dissipation factor versus time. A typical curve of aging rate for semistable ceramics is shown in Figure 6.

If a Class 2 ceramic capacitor that has been sitting on the shelf for a period of time, is heated above its curie point, (125°C for 4 hours or 150°C for 1/2 hour will suffice) the part will de-age and return to its initial capacitance and dissi-pation factor readings. Because the capacitance changes rapidly, immediately after deaging, the basic capacitance measurements are normally referred to a time period sometime after the de-aging process. Various manufacturers use different time bases but the most popular one is one day or twenty-four hours after "last heat." Change in the aging curve can be caused by the application of voltage and other stresses. The possible changes in capacitance due to de-aging by heating the unit explain why capacitance changes are allowed after test, such as temperature cycling, moisture resistance, etc., in MIL specs. The application of high voltages such as dielectric withstanding voltages also tends to de-age capacitors and is why re-reading of capacitance after 12 or 24 hours is allowed in military specifications after dielectric strength tests have been performed.



**Effects of Frequency** – Frequency affects capacitance and impedance characteristics of capacitors. This effect is much more pronounced in high dielectric constant ceramic formulation than in low K formulations. AVX's SpiCap software generates impedance, ESR, series inductance, series resonant frequency and capacitance all as functions of frequency, temperature and DC bias for standard chip sizes and styles. It is available free from AVX and can be downloaded for free from AVX website: www.avx. com.



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**Effects of Mechanical Stress** – High "K" dielectric ceramic capacitors exhibit some low level piezoelectric reactions under mechanical stress. As a general statement, the piezoelectric output is higher, the higher the dielectric constant of the ceramic. It is desirable to investigate this effect before using high "K" dielectrics as coupling capacitors in extremely low level applications.

**Reliability** – Historically ceramic capacitors have been one of the most reliable types of capacitors in use today. The approximate formula for the reliability of a ceramic capacitor is:

$$\frac{L_{o}}{L_{t}} = \left(\frac{V_{t}}{V_{o}}\right)^{X} \left(\frac{T_{t}}{T_{o}}\right)^{Y}$$

where

 $\begin{array}{l} L_o = \text{operating life} \\ L_t = \text{test life} \\ V_t = \text{test voltage} \\ V_o = \text{operating voltage} \end{array}$ 

T<sub>o</sub> = operating temperature in °C X,Y = see text

T<sub>t</sub> = test temperature and

Historically for ceramic capacitors exponent X has been considered as 3. The exponent Y for temperature effects typically tends to run about 8.

A capacitor is a component which is capable of storing electrical energy. It consists of two conductive plates (electrodes) separated by insulating material which is called the dielectric. A typical formula for determining capacitance is:

$$C = \frac{.224 \text{ KA}}{t}$$

- **C** = capacitance (picofarads)
- K = dielectric constant (Vacuum = 1)
- A = area in square inches
- t = separation between the plates in inches (thickness of dielectric)

.224 = conversion constant (.0884 for metric system in cm)

**Capacitance** – The standard unit of capacitance is the farad. A capacitor has a capacitance of 1 farad when 1 coulomb charges it to 1 volt. One farad is a very large unit and most capacitors have values in the micro  $(10^{-6})$ , nano  $(10^{-9})$  or pico  $(10^{-12})$  farad level.

**Dielectric Constant** – In the formula for capacitance given above the dielectric constant of a vacuum is arbitrarily chosen as the number 1. Dielectric constants of other materials are then compared to the dielectric constant of a vacuum.

**Dielectric Thickness** – Capacitance is indirectly proportional to the separation between electrodes. Lower voltage requirements mean thinner dielectrics and greater capacitance per volume.

**Area** – Capacitance is directly proportional to the area of the electrodes. Since the other variables in the equation are usually set by the performance desired, area is the easiest parameter to modify to obtain a specific capacitance within a material group.



**Energy Stored** – The energy which can be stored in a capacitor is given by the formula:

 $E = \frac{1}{2}CV^{2}$ 

E = energy in joules (watts-sec)V = applied voltageC = capacitance in farads

**Potential Change** – A capacitor is a reactive component which reacts against a change in potential across it. This is shown by the equation for the linear charge of a capacitor:

$$I_{ideal} = C \frac{dV}{dt}$$

where

I = Current

C = Capacitance

dV/dt = Slope of voltage transition across capacitor

Thus an infinite current would be required to instantly change the potential across a capacitor. The amount of current a capacitor can "sink" is determined by the above equation.

**Equivalent Circuit** – A capacitor, as a practical device, exhibits not only capacitance but also resistance and inductance. A simplified schematic for the equivalent circuit is:

<b>C</b> = Capacitance	L = Inductance
<b>R</b> <sub>s</sub> = Series Resistance	$\mathbf{R}_{p}$ = Parallel Resistance



**Reactance** – Since the insulation resistance (Rp) is normally very high, the total impedance of a capacitor is:

$$Z = \sqrt{R_{S}^{2} + (X_{C} - X_{L})^{2}}$$

where

Z = Total Impedance

**R**<sub>s</sub> = Series Resistance **X**<sub>c</sub> = Capacitive Reactance

$$\mathbf{X}_{c}$$
 = Capacitive Reactance =  $\frac{1}{2\pi}$   
 $\mathbf{X}_{i}$  = Inductive Reactance =  $2\pi$ 

The variation of a capacitor's impedance with frequency determines its effectiveness in many applications.

fC

**Phase Angle** – Power Factor and Dissipation Factor are often confused since they are both measures of the loss in a capacitor under AC application and are often almost identical in value. In a "perfect" capacitor the current in the capacitor will lead the voltage by 90°.







In practice the current leads the voltage by some other phase angle due to the series resistance RS. The complement of this angle is called the loss angle and:

> Power Factor (P.F.) = Cos  $\phi$  or Sine  $\delta$ Dissipation Factor (D.F.) = tan  $\delta$

for small values of the tan and sine are essentially equal which has led to the common interchangeability of the two terms in the industry.

**Equivalent Series Resistance** – The term E.S.R. or Equivalent Series Resistance combines all losses both series and parallel in a capacitor at a given frequency so that the equivalent circuit is reduced to a simple R-C series connection.

**Dissipation Factor** – The DF/PF of a capacitor tells what percent of the apparent power input will turn to heat in the capacitor.

Dissipation Factor = 
$$\frac{\text{E.S.R.}}{X_{\text{C}}}$$
 = (2  $\pi$  fC) (E.S.R.)

The watts loss are:

Watts loss =  $(2 \pi fCV^2)$  (D.F.)

Very low values of dissipation factor are expressed as their reciprocal for convenience. These are called the "Q" or Quality factor of capacitors.

**Parasitic Inductance** – The parasitic inductance of capacitors is becoming more and more important in the decoupling of today's high speed digital systems. The relationship between the inductance and the ripple voltage induced on the DC voltage line can be seen from the simple inductance equation:

$$V = L \frac{di}{dt}$$

The  $\frac{di}{dt}$  seen in current microprocessors can be as high as 0.3 A/ ns, and up to 10A/ns. At 0.3 A/ns, 100pH of parasitic inductance can cause a voltage spike of 30mV. While this does not sound very drastic, with the Vcc for microprocessors decreasing at the current rate, this can be a fairly large percentage.

Another important, often overlooked, reason for knowing the parasitic inductance is the calculation of the resonant frequency. This can be important for high frequency, bypass capacitors, as the resonant point will give the most signal attenuation. The resonant frequency is calculated from the simple equation:

$$f_{res} = \frac{1}{2\pi\sqrt{LC}}$$

**Insulation Resistance** – Insulation Resistance is the resistance measured across the terminals of a capacitor and consists principally of the parallel resistance RP shown in the equivalent circuit. As capacitance values and hence the area of dielectric increases, the I.R. decreases and hence the product (C x IR or RC) is often specified in ohm farads or more commonly megohmmicrofarads. Leakage current is determined by dividing the rated voltage by IR (Ohm's Law).

**Dielectric Strength** – Dielectric Strength is an expression of the ability of a material to withstand an electrical stress. Although dielectric strength is ordinarily expressed in volts, it is actually dependent on the thickness of the dielectric and thus is also more generically a function of volts/mil.

**Dielectric Absorption** – A capacitor does not discharge instantaneously upon application of a short circuit, but drains gradually after the capacitance proper has been discharged. It is common practice to measure the dielectric absorption by determining the "reappearing voltage" which appears across a capacitor at some point in time after it has been fully discharged under short circuit conditions.

**Corona** – Corona is the ionization of air or other vapors which causes them to conduct current. It is especially prevalent in high voltage units but can occur with low voltages as well where high voltage gradients occur. The energy discharged degrades the performance of the capacitor and can in time cause catastrophic failures.



## **Surface Mounting Guide**

## **MLC Chip Capacitors**



### **REFLOW SOLDERING**

	Case Size	D1	D2	D3	D4	D5
	0201	0.85 (0.033)	0.30 (0.012)	0.25 (0.010)	0.30 (0.012)	0.35 (0.014)
D2	0402	1.70 (0.067)	0.60 (0.024)	0.50 (0.020)	0.60 (0.024)	0.50 (0.020)
	0603	2.30 (0.091)	0.80 (0.031)	0.70 (0.028)	0.80 (0.031)	0.75 (0.030)
D1 D3	0805	3.00 (0.118)	1.00 (0.039)	1.00 (0.039)	1.00 (0.039)	1.25 (0.049)
	1206	4.00 (0.157)	1.00 (0.039)	2.00 (0.079)	1.00 (0.039)	1.60 (0.063)
	1210	4.00 (0.157)	1.00 (0.039)	2.00 (0.079)	1.00 (0.039)	2.50 (0.098)
D4	1808	5.60 (0.220)	1.00 (0.039)	3.60 (0.142)	1.00 (0.039)	2.00 (0.079)
	1812	5.60 (0.220)	1.00 (0.039)	3.60 (0.142)	1.00 (0.039)	3.00 (0.118)
→ D5 -	1825	5.60 (0.220)	1.00 (0.039)	3.60 (0.142)	1.00 (0.039)	6.35 (0.250)
-	2220	6.60 (0.260)	1.00 (0.039)	4.60 (0.181)	1.00 (0.039)	5.00 (0.197)
Dimensions in millimeters (inches)	2225	6.60 (0.260)	1.00 (0.039)	4.60 (0.181)	1.00 (0.039)	6.35 (0.250)

#### **Component Pad Design**

Component pads should be designed to achieve good solder filets and minimize component movement during reflow soldering. Pad designs are given below for the most common sizes of multilayer ceramic capacitors for both wave and reflow soldering. The basis of these designs is:

· Pad width equal to component width. It is permissible to

decrease this to as low as 85% of component width but it is not advisable to go below this.

- Pad overlap 0.5mm beneath component.
- Pad extension 0.5mm beyond components for reflow and 1.0mm for wave soldering.

## WAVE SOLDERING

	Case Size	D1	D2	D3	D4	D5
D1 D3	0603	3.10 (0.12)	1.20 (0.05)	0.70 (0.03)	1.20 (0.05)	0.75 (0.03)
	0805	4.00 (0.15)	1.50 (0.06)	1.00 (0.04)	1.50 (0.06)	1.25 (0.05)
D4	1206	5.00 (0.19)	1.50 (0.06)	2.00 (0.09)	1.50 (0.06)	1.60 (0.06)
	Dimensions in millimeters (inches)					
→ D5 -						

#### **Component Spacing**

For wave soldering components, must be spaced sufficiently far apart to avoid bridging or shadowing (inability of solder to penetrate properly into small spaces). This is less important for reflow soldering but sufficient space must be allowed to enable rework should it be required.



#### **Preheat & Soldering**

The rate of preheat should not exceed 4°C/second to prevent thermal shock. A better maximum figure is about 2°C/second.

For capacitors size 1206 and below, with a maximum thickness of 1.25mm, it is generally permissible to allow a temperature differential from preheat to soldering of 150°C. In all other cases this differential should not exceed 100°C.

For further specific application or process advice, please consult AVX.

#### Cleaning

Care should be taken to ensure that the capacitors are thoroughly cleaned of flux residues especially the space beneath the capacitor. Such residues may otherwise become conductive and effectively offer a low resistance bypass to the capacitor.

Ultrasonic cleaning is permissible, the recommended conditions being 8 Watts/litre at 20-45 kHz, with a process cycle of 2 minutes vapor rinse, 2 minutes immersion in the ultrasonic solvent bath and finally 2 minutes vapor rinse.



## Surface Mounting Guide Recommended Soldering Profiles



### **REFLOW SOLDER PROFILES**

AVX RoHS compliant products utilize termination finishes (e.g.Sn or SnAg) that are compatible with all Pb-Free soldering systems and are fully reverse compatible with SnPb soldering systems. A recommended SnPb profile is shown for comparison; for Pb-Free soldering, IPC/JEDECJ- STD-020C may be referenced. The upper line in the chart shows the maximum envelope to which products are qualified (typically 3x reflow cycles at 260°C max). The center line gives the recommended profile for optimum wettability and soldering in Pb-Free Systems.

#### Preheat:

The pre-heat stabilizes the part and reduces the temperature differential prior to reflow. The initial ramp to 125°C may be rapid, but from that point (2-3)°C/sec is recommended to allow ceramic parts to heat uniformly and plastic encapsulated parts to stabilize through the glass transition temperature of the body (~ 180°C).

#### Reflow:

In the reflow phase, the maximum recommended time > 230°C is 40secs. Time at peak reflow is 10secs max.; optimum reflow is achieved at 250°C, (see wetting balance chart opposite) but products are qualified to 260°C max. Please reference individual product datasheets for maximum limits

#### **Cool Down:**

Cool down should not be forced and 6°C/sec is recommended. A slow cool down will result in a finer grain structure of the reflow solder in the solder fillet.

### **WAVE SOLDER PROFILES**

For wave solder, there is no change in the recommended wave profile; all standard Pb-Free (SnCu/SnCuAg) systems operate at the same 260°C max recommended for SnPb systems.

#### Preheat:

This is more important for wave solder; a higher temperature preheat will reduce the thermal shock to SMD parts that are immersed (please consult individual product data sheets for SMD parts that are suited to wave solder). SMD parts should ideally be heated from the bottom-Side prior to wave. PTH (Pin through hole) parts on the topside should not be separately heated.

#### Wave:

250°C - 260°C recommended for optimum solderability.

#### **Cool Down:**

As with reflow solder, cool down should not be forced and  $6^{\circ}$ C/sec is recommended. Any air knives at the end of the 2nd wave should be heated.





IMPORTANT NOTE: Typical Pb-Free reflow solders have a more dull and grainy appearance compared to traditional SnPb. Elevating the reflow temperature will not change this, but extending the cool down can help improve the visual appearance of the joint.





## **Surface Mounting Guide**

## **MLC Chip Capacitors**

## **APPLICATION NOTES**

#### Storage

The components should be stored in their "as received packaging" where possible. If the components are removed from their original packaging then they should be stored in an airtight container (e.g. a heat sealed plastic bag) with desiccant (e.g. silica gel). Storage area temperature should be kept between +5 degrees C and +30 degrees C with humidity < 70% RH. Storage atmosphere must be free of gas containing sulfur and chlorine. Avoid exposing the product to saline moisture or to temperature changes that might result in the formation of condensation. To assure good solderability performance we recommend that the product be used within 6 months from our shipping date, but can be used for up to 12 months. Chip capacitors may crack if exposed to hydrogen (H2) gas while sealed or if coated with silicon, which generates hydrogen gas.

#### Solderability

Terminations to be well soldered after immersion in a 60/40 tin/lead solder bath at  $245^{\circ}C$  +/-  $5^{\circ}C$  for 5 +0/-0.5 seconds.

#### Leaching

Terminations will resist leaching for at least the immersion times and conditions shown below.

Termination Type	Solder Tin/ Lead/Silver	Solder Temp °C	Immersion Time Seconds
Nickel Barrier	60/40/0	260 ± 5	30 ± 1

#### Lead-Free Wave Soldering

The recommended peak temperature for lead-free wave soldering is  $250^{\circ}$ C-260°C for 3-5 seconds. The other parameters of the profile remains the same as above.

The following should be noted by customers changing from lead based systems to the new lead free pastes.

- A. The visual standards used for evaluation of solder joints will need to be modified as lead free joints are not as bright as with tin-lead pastes and the fillet may not be as large.
- B. Lead-free solder pastes do not allow the same self alignment as lead containing systems. Standard mounting pads are acceptable, but machine set up may need to be modified.

#### General

Surface mounting chip multilayer ceramic capacitors are designed for soldering to printed circuit boards or other substrates. The construction of the components is such that they will withstand the time/temperature profiles used in both wave and reflow soldering methods.

#### Handling

Chip multilayer ceramic capacitors should be handled with care to avoid damage or contamination from perspiration and skin oils. The use of tweezers or vacuum pick ups is strongly recommended for individual components. Bulk handling should ensure that abrasion and mechanical shock are minimized. Taped and reeled components provides the ideal medium for direct presentation to the placement machine. Any mechanical shock should be minimized during handling chip multilayer ceramic capacitors.

#### Preheat

It is important to avoid the possibility of thermal shock during soldering and carefully controlled preheat is therefore required. The rate of preheat should not exceed 4°C/second and a target figure 2°C/second is recommended. Although an 80°C to 120°C temperature differential is preferred, recent developments allow a temperature differential between the component surface and the soldering temperature of 150°C (Maximum) for capacitors of 1210 size and below with a maximum thickness of 1.25mm. The user is cautioned that the risk of thermal shock increases as chip size or temperature differential increases.

#### Soldering

Mildly activated rosin fluxes are preferred. The minimum amount of solder to give a good joint should be used. Excessive solder can lead to damage from the stresses caused by the difference in coefficients of expansion between solder, chip and substrate. AVX terminations are suitable for all wave and reflow soldering systems. If hand soldering cannot be avoided, the preferred technique is the utilization of hot air soldering tools.

#### Cooling

Natural cooling in air is preferred, as this minimizes stresses within the soldered joint. When forced air cooling is used, cooling rate should not exceed 4°C/second. Quenching is not recommended but if used, maximum temperature differentials should be observed according to the preheat conditions above.

#### Cleaning

Flux residues may be hygroscopic or acidic and must be removed. AVX MLC capacitors are acceptable for use with all of the solvents described in the specifications MIL-STD-202 and EIA-RS-198. Alcohol based solvents are acceptable and properly controlled water cleaning systems are also acceptable. Many other solvents have been proven successful, and most solvents that are acceptable to other components on circuit assemblies are equally acceptable for use with ceramic capacitors.

#### **Prevention of Metallic Migration**

Note that when components with Sn plating on the end terminations are to be used in applications that are likely to experience conditions of high humidity under bias voltage, we strongly recommend that the circuit boards be conformally coated to protect the Sn from moisture that might lead to migration and eventual current leakage.

When using Capacitor Arrays we recommend that there is no differential in applied voltage between adjacent elements.

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## **Surface Mounting Guide**

## **MLC Chip Capacitors**

### **POST SOLDER HANDLING**

Once SMP components are soldered to the board, any bending or flexure of the PCB applies stresses to the soldered joints of the components. For leaded devices, the stresses are absorbed by the compliancy of the metal leads and generally don't result in problems unless the stress is large enough to fracture the soldered connection.

Ceramic capacitors are more susceptible to such stress because they don't have compliant leads and are brittle in nature. The most frequent failure mode is low DC resistance or short circuit. The second failure mode is significant loss of capacitance due to severing of contact between sets of the internal electrodes.

Cracks caused by mechanical flexure are very easily identified and generally take one of the following two general forms:

Mechanical cracks are often hidden underneath the termination and are difficult to see externally. However, if one end termination falls off during the removal process from PCB, this is one indication that the cause of failure was excessive mechanical stress due to board warping.

### COMMON CAUSES OF MECHANICAL CRACKING

The most common source for mechanical stress is board depanelization equipment, such as manual breakapart, v-cutters and shear presses. Improperly aligned or dull cutters may cause torqueing of the PCB resulting in flex stresses being transmitted to components near the board edge. Another common source of flexural stress is contact during parametric testing when test points are probed. If the PCB is allowed to flex during the test cycle, nearby ceramic capacitors may be broken.

A third common source is board to board connections at vertical connectors where cables or other PCBs are connected to the PCB. If the board is not supported during the plug/unplug cycle, it may flex and cause damage to nearby components.

Special care should also be taken when handling large (>6" on a side) PCBs since they more easily flex or warp than smaller boards.



Preferred Method - No Direct Part Contact



Type A: Angled crack between bottom of device to top of solder joint.



Type B: Fracture from top of device to bottom of device.

### **REWORKING OF MLCS**

Thermal shock is common in MLCs that are manually attached or reworked with a soldering iron. AVX strongly recommends that any reworking of MLCs be done with hot air reflow rather than soldering irons. It is practically impossible to cause any thermal shock in ceramic capacitors when using hot air reflow.

However direct contact by the soldering iron tip often causes thermal cracks that may fail at a later date. If rework by soldering iron is absolutely necessary, it is recommended that the wattage of the iron be less than 30 watts and the tip temperature be <300°C. *Rework should be performed by applying the solder iron tip to the pad and not directly contacting any part of the ceramic capacitor.* 



Poor Method - Direct Contact with Part

### **PCB BOARD DESIGN**

To avoid many of the handling problems, AVX recommends that MLCs be located at least .2" away from nearest edge of board. However when this is not possible, AVX recommends that the panel be routed along the cut line, adjacent to where the MLC is located.



No Stress Relief for MLCs



Routed Cut Line Relieves Stress on MLC



The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.





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