Multilayer ceramic capacitors are available in a variety of physical sizes and configurations, including leaded devices and surface mounted chips. Leaded styles include molded and conformally coated parts with axial and radial leads. However, the basic capacitor element is similar for all styles. It is called a chip and consists of formulated dielectric materials which have been cast into thin layers, interspersed with metal electrodes alternately exposed on opposite edges of the laminated structure. The entire structure is fired at high temperature to produce a monolithic block which provides high capacitance values in a small physical volume. After firing, conductive terminations are applied to opposite ends of the chip to make contact with the exposed electrodes. Termination materials and methods vary depending on the intended use.

TEMPERATURE CHARACTERISTICS

Ceramic dielectric materials can be formulated with a wide range of characteristics. The EIA standard for ceramic dielectric capacitors (RS-198) divides ceramic dielectrics into the following classes:

Class I: Temperature compensating capacitors, suitable for resonant circuit application or other applications where high Q and stability of capacitance characteristics are required. Class I capacitors have predictable temperature coefficients and are not effected by voltage, frequency or time. They are made from materials which are not ferro-electric, yielding superior stability but low volumetric efficiency. Class I capacitors are the most stable type available, but have the lowest volumetric efficiency.

Class II: Stable capacitors, suitable for bypass or coupling applications or frequency discriminating circuits where Q and stability of capacitance characteristics are not of major importance. Class II capacitors have temperature characteristics of ± 15% or less. They are made from materials which are ferro-electric, yielding higher volumetric efficiency but less stability. Class II capacitors are affected by temperature, voltage, frequency and time.

Class III: General purpose capacitors, suitable for by-pass coupling or other applications in which dielectric losses, high insulation resistance and stability of capacitance characteristics are of little or no importance. Class III capacitors are similar to Class II capacitors except for temperature characteristics, which are greater than ± 15%. Class III capacitors have the highest volumetric efficiency and poorest stability of any type.

KEMET leaded ceramic capacitors are offered in the three most popular temperature characteristics:

C0G: Class I, with a temperature coefficient of 0 ± 30 ppm per degree C over an operating temperature range of - 55°C to + 125°C (Also known as “NP0”).

X7R: Class II, with a maximum capacitance change of ± 15% over an operating temperature range of - 55°C to + 125°C.

Z5U: Class III, with a maximum capacitance change of + 22% - 56% over an operating temperature range of + 10°C to + 85°C.

Specified electrical limits for these three temperature characteristics are shown in Table 1.

SPECIFIED ELECTRICAL LIMITS

PARAMETER	TEMPERATURE CHARACTERISTICS		
	C0G	X7R	Z5U
Dissipation Factor: Measured at following conditions: C0G — 1 kHz and 1 vrms if capacitance > 1000 pF 1 MHz and 1 vrms if capacitance ≤ 1000 pF X7R — 1 kHz and 1 vrms* or if extended cap range 0.5 vrms Z5U — 1 kHz and 0.5 vrms	0.15%	2.5%	4.0%
Dielectric Strength: 2.5 times rated DC voltage.	Pass Subsequent IR Test		
Insulation Resistance (IR): At rated DC voltage, whichever of the two is smaller	1,000 MΩ-μF or 100 GΩ	1,000 MΩ-μF or 100 GΩ	1,000 MΩ-μF or 10 GΩ
Temperature Characteristics: Range, °C Capacitance Change without DC voltage	-55 to +125 0 ± 30 ppm/°C	-55 to +125 ±15%	+10 to +85 +22%, -56%

* 1 MHz and 1 vrms if capacitance ≤ 100 pF on military product.

Table I

GENERAL SPECIFICATIONS

Working Voltage:

	Axial (WVDC)	Radial (WVDC)
C0G	– 50 & 100	50, 100, 200, 500, 1k, 1.5k, 2k, 2.5k, 3k
X7R	– 50 & 100	50, 100, 200, 500, 1k, 1.5k, 2k, 2.5k, 3k
Z5U	– 50 & 100	50 & 100

Temperature Characteristics:
C0G – 0 ± 30 PPM / °C from - 55°C to + 125°C (1)
X7R – ± 15% from - 55°C to + 125°C
Z5U – + 22% / -56% from + 10°C to + 85°C

Capacitance Tolerance:
C0G – ±0.5pF, ±1%, ±2%, ±5%, ±10%
X7R – ±10%, ±20%, +80% / -20%, +100% / -0%
Z5U – ±20%, +80% / -20%

Construction:
Epoxy encapsulated - meets flame test requirements of UL Standard 94V-0.
High-temperature solder - meets EIA RS-198, Method 302, Condition B (260°C for 10 seconds)

Lead Material:
100% matte tin (Sn) with nickel (Ni) underplate and steel core.

Solderability:
EIA RS-198, Method 301, Solder Temperature: 230°C ±5°C.
Dwell time in solder = 7 ± ½ seconds.

Terminal Strength:
EIA RS-198, Method 303, Condition A (2.2kg)

ELECTRICAL

Capacitance @ 25°C:
Within specified tolerance and following test conditions.
C0G – > 1000pF with 1.0 vrms @ 1 kHz
≤ 1000pF with 1.0 vrms @ 1 MHz
X7R – with 1.0 vrms @ 1 kHz
Z5U – with 1.0 vrms @ 1 kHz

Dissipation Factor @ 25°C:
Same test conditions as capacitance.
C0G – 0.15% maximum
X7R – 2.5% maximum
Z5U – 4.0% maximum

Insulation Resistance @ 25°C:
EIA RS-198, Method 104, Condition A <1kV
C0G – 100k Megohm or 1000 Megohm x µF, whichever is less.
≤500V test @ rated voltage, ≥1kV test @ 500V
X7R – 100k Megohm or 1000 Megohm x µF, whichever is less.
≤500V test @ rated voltage, ≥1kV test @ 500V
Z5U – 10k Megohm or 1000 Megohm x µF, whichever is less.

Dielectric Withstanding Voltage:
EIA RS-198, Method 103
≤200V test @ 250% of rated voltage for 5 seconds with current limited to 50mA.
500V test @ 150% of rated voltage for 5 seconds with current limited to 50mA.
≥1000V test @ 120% of rated voltage for 5 seconds with current limited to 50mA.

ENVIRONMENTAL

Vibration:
EIA RS-198, Method 304, Condition D (10-2000Hz; 20g)
Shock:
EIA RS-198, Method 305, Condition I (100g)

Life Test:
EIA RS-198, Method 201, Condition D.
≤ 200V
C0G – 200% of rated voltage @ +125°C
X7R – 200% of rated voltage @ +125°C
Z5U – 200% of rated voltage @ +85°C
≥ 500V
C0G – rated voltage @ +125°C
X7R – rated voltage @ +125°C

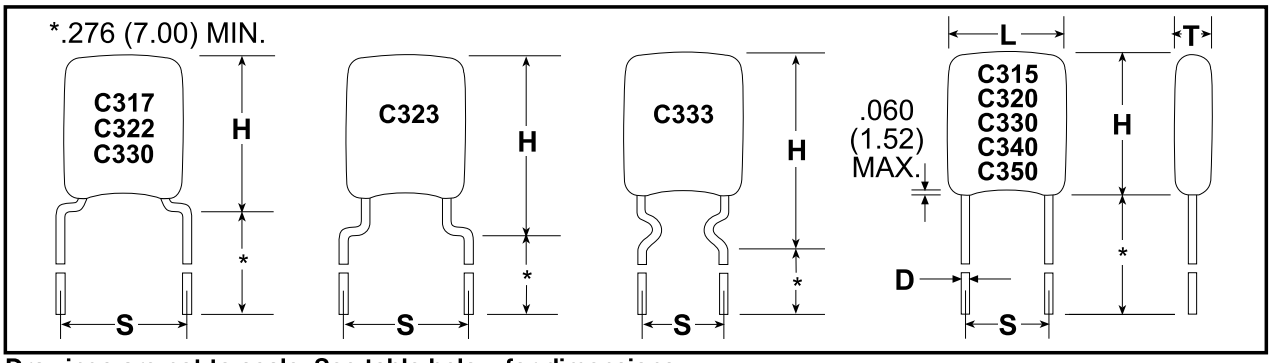
Post Test Limits @ 25°C are:
Capacitance Change:
C0G (≤ 200V) – +3% or 0.25pF, whichever is greater.
C0G (≥ 500V) – +3% or 0.50pF, whichever is greater.
X7R – + 20% of initial value (2)
Z5U – + 30% of initial value (2)
Dissipation Factor:
C0G – 0.15% maximum
X7R – 2.5% maximum
Z5U – 4.0% maximum
Insulation Resistance:
C0G – 10k Megohm or 100 Megohm x µF, whichever is less.
≥1kV tested @ 500V.
X7R – 10k Megohm or 100 Megohm x µF, whichever is less.
≥1kV tested @ 500V.
Z5U – 1k Megohm or 100 Megohm x µF, whichever is less.

Moisture Resistance:
EIA RS-198, Method 204, Condition A (10 cycles without applied voltage.)
Post Test Limits @ 25°C are:
Capacitance Change:
C0G (≤ 200V) – +3% or 0.25pF, whichever is greater.
C0G (≥ 500V) – +3% or 0.50pF, whichever is greater.
X7R – + 20% of initial value (2)
Z5U – + 30% of initial value (2)
Dissipation Factor:
C0G – 0.25% maximum
X7R – 3.0% maximum
Z5U – 4.0% maximum
Insulation Resistance:
C0G – 10k Megohm or 100 Megohm x µF, whichever is less.
≤500V test @ rated voltage, ≥1kV test @ 500V.
X7R – 10k Megohm or 100 Megohm x µF, whichever is less.
≥500V test @ rated voltage, >1kV test @ 500V.
Z5U – 1k Megohm or 100 Megohm x µF, whichever is less.

Thermal Shock:
EIA RS-198, Method 202, Condition B (C0G & X7R: -55°C to +125°C); Condition A (Z5U: -55°C to 85°C)

(1) +53 PPM -30 PPM/ °C from +25°C to -55°C, + 60 PPM below 10pF.
(2) X7R and Z5U dielectrics exhibit aging characteristics; therefore, it is highly recommended that capacitors be deaged for 2 hours at 150°C and stabilized at room temperature for 48 hours before capacitance measurements are made.

STANDARD LEAD CONFIGURATION — OUTLINE DRAWINGS



Drawings are not to scale. See table below for dimensions.
See page 10 for optional lead configurations.

DIMENSIONS — INCHES & MILLIMETERS

Case Size	L Max.	H. Max	Standard T Max.	High Voltage T Max.	S(1) ±.030 (.78)	D +.004(.10) -.001(.025)
C315	0.150 (3.81)	0.210 (5.33)	0.100	0.150	0.100 (2.54)	0.020 (.51)
C317	0.150 (3.81)	0.230 (5.84)	0.100	0.150	0.200 (5.08)	0.020 (.51)
C320	0.200 (5.08)	0.260 (6.60)	0.125	0.200	0.100 (2.54)	0.020 (.51)
C322	0.200 (5.08)	0.260 (6.60)	0.125	0.200	0.200 (5.08)	0.020 (.51)
C323	0.200 (5.08)	0.320 (8.13)	0.125	0.200	0.200 (5.08)	0.020 (.51)
C330	0.300 (7.62)	0.360 (9.14)	0.150	0.250	0.200 (5.08)	0.020 (.51)
C333	0.300 (7.62)	0.390 (9.91)	0.150	0.250	0.200 (5.08)	0.020 (.51)
C340	0.400 (10.16)	0.460 (11.68)	0.150	0.270	0.200 (5.08)	0.020 (.51)
C350	0.500 (12.70)	0.560 (14.22)	0.200	0.270	0.400 (10.16)	0.025 (.64)

NOTE: 1 inch = 25.4 mm.
NOTE: (1) Measured at seating plane.

ORDERING INFORMATION

C 320 C 102 M 1 R 5 T A*

CERAMIC

CASE SIZE
(See Table Above)

SPECIFICATION
C — Standard

CAPACITANCE, CODE
Expressed in Picofarads (pF)
First Two Digits — Significant Figures
Third Digit — Number of Zeros (Use 9 for 1.0 thru 9.9 pF. Example: 2.2pF — 229)

CAPACITANCE TOLERANCE
D — ±0.5 pF
F — ±1%
G — ±2%
J — ±5%
K — ±10%
M — ±20%
P — 0%, +100%
Z — -20, +80%

***Part Number Example: C320C102M1R5CA (14 digits – no spaces)**

RATED VOLTAGE
2 — 200
1 — 100
5 — 50
C — 500
D —1000
F — 1500
G — 2000
Z — 2500
H — 3000

DIELECTRIC
EIA Designation
G — C0G (NP0) — Ultra-Stable
R — X7R — Stable
U — Z5U — General Purpose

INTERNAL CONSTRUCTION
5 — Standard

TERMINATION MATERIAL
T — 100% Tin
H — SnPb
C — 100% Sn
(Not recommended for new design)

FAILURE RATE
A — Not Applicable

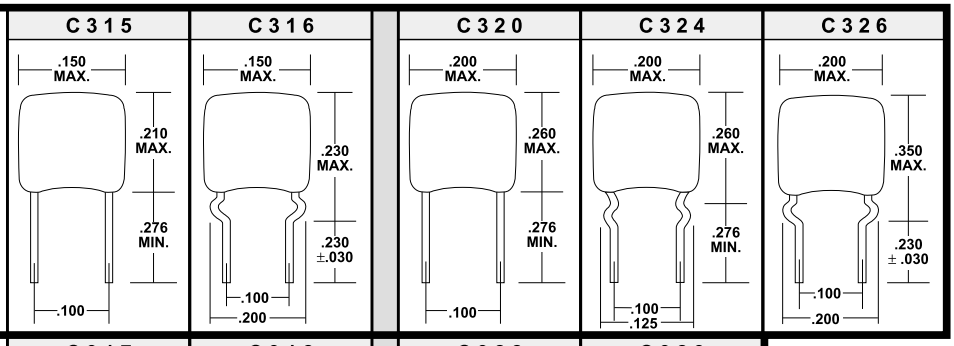
Golden Max

For packaging information, see pages 40, and 41.

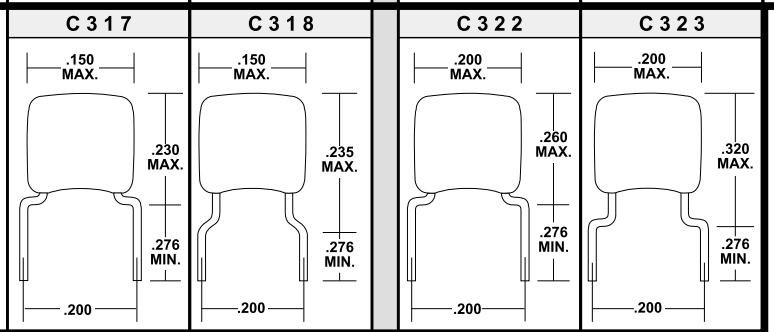
OPTIONAL CONFIGURATIONS BY LEAD SPACING

The preferred lead wire configurations are shown on page 9. However, additional configurations are available. All available options, including those on page 9, are shown below grouped by lead spacing.

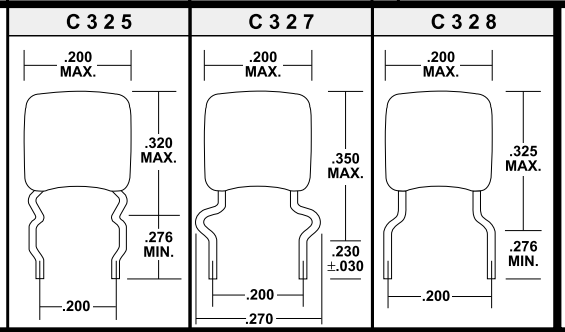
Lead Spacing .100" ± .030



Lead Spacing .200" ± .030

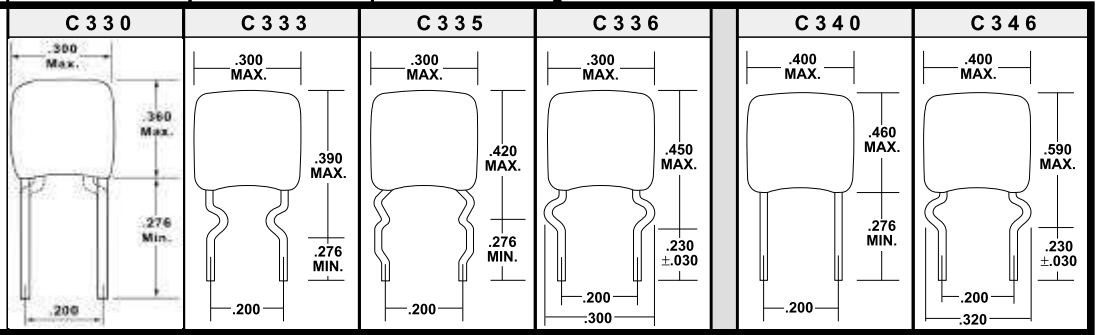


Lead Spacing .200" ± .030

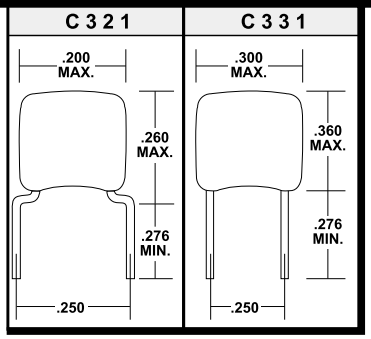


Lead Spacing .200" ± .030

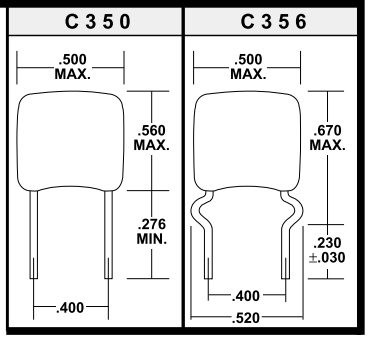
Note: C330 Shoulder bend leads:
X7R/50V 683-105
Z5U/100V 683-334



Lead Spacing .250" ± .030 (Available in bulk only)

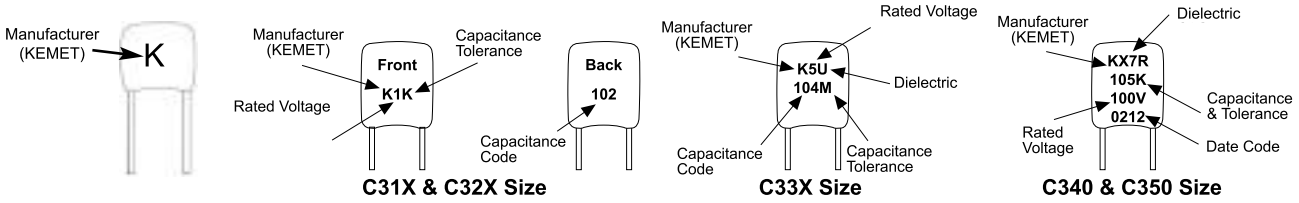


Lead Spacing .400" ± .030 (Available in bulk only)



Note: Non-standard lead lengths are available in bulk only.

CAPACITOR MARKINGS



RATINGS & PART NUMBER REFERENCE: ULTRA-STABLE TEMPERATURE CHARACTERISTICS – C0G/NPO

Style			C31X					C32X							C33X									C34X							C35X						
Cap	Cap Code	Cap Tol	WVDC					WVDC							WVDC									WVDC							WVDC						
			50	100	200	500	1k	50	100	200	500	1k	1.5k	2k	50	100	200	500	1k	1.5k	2k	2.5k	3k	50	100	200	500	1k	2k	3k	50	100	200	500	1k	2k	3k
1.0pF	109	D																																			
1.1	119	D																																			
1.2	129	D																																			
1.3	139	D																																			
1.5	159	D																																			
1.6	169	D																																			
1.8	189	D																																			
2.0	209	D																																			
2.2	229	D																																			
2.4	249	D																																			
2.7	279	D																																			
3.0	309	D																																			
3.3	339	D																																			
3.6	369	D																																			
3.9	399	D																																			
4.3	439	D																																			
4.7	479	D																																			
5.1	519	D																																			
5.6	569	D																																			
6.2	629	D																																			
6.8	689	D																																			
7.5	759	D																																			
8.2	829	D																																			
9.1	919	D																																			
10	100	J,K																																			
11	110	J,K																																			
12	120	J,K																																			
13	130	J,K																																			
15	150	J,K																																			
16	160	J,K																																			
18	180	J,K																																			
20	200	J,K																																			
22	220	J,K																																			
24	240	G,J,K																																			
27	270	G,J,K																																			
30	300	G,J,K																																			
33	330	G,J,K																																			
36	360	G,J,K																																			
39	390	G,J,K																																			
43	430	G,J,K																																			
47	470	G,J,K																																			
51	510	G,J,K																																			
56	560	F,G,J																																			
62	620	F,G,J																																			
68	680	F,G,J																																			
75	750	F,G,J																																			
82	820	F,G,J																																			
91	910	F,G,J																																			

For packaging information, see pages 40 and 41.

RATINGS & PART NUMBER REFERENCE: ULTRA-STABLE TEMPERATURE CHARACTERISTICS — C0G/NPO CONT.

Cap	Cap Code	Cap Tol	Style	C31X					C32X							C33X									C34X							C35X						
			WVDC	50	100	200	500	1k	50	100	200	500	1k	1.5k	2k	50	100	200	500	1k	1.5k	2k	2.5k	3k	50	100	200	500	1k	2k	3k	50	100	200	500	1k	2k	3k
100	101	F,G,J																																				
110	111	F,G,J																																				
120	121	F,G,J																																				
130	131	F,G,J																																				
150	151	F,G,J																																				
160	161	F,G,J																																				
180	181	F,G,J																																				
200	201	F,G,J																																				
220	221	F,G,J																																				
240	241	F,G,J																																				
270	271	F,G,J																																				
300	301	F,G,J																																				
330	331	F,G,J																																				
360	361	F,G,J																																				
390	391	F,G,J																																				
430	431	F,G,J																																				
470	471	F,G,J																																				
510	511	F,G,J																																				
560	561	F,G,J																																				
620	621	F,G,J																																				
680	681	F,G,J																																				
750	751	F,G,J																																				
820	821	F,G,J																																				
910	911	F,G,J																																				
1000	102	F,G,J																																				
1100	112	F,G,J																																				
1200	122	F,G,J																																				
1300	132	F,G,J																																				
1500	152	F,G,J																																				
1600	162	F,G,J																																				
1800	182	F,G,J																																				
2000	202	F,G,J																																				
2200	222	F,G,J																																				
2400	242	F,G,J																																				
2700	272	F,G,J																																				
3000	302	F,G,J																																				
3300	332	F,G,J																																				
3600	362	F,G,J																																				
3900	392	F,G,J																																				
4300	432	F,G,J																																				
4700	472	F,G,J																																				
5100	512	F,G,J																																				
5600	562	F,G,J																																				
6200	622	F,G,J																																				
6800	682	F,G,J																																				
7500	752	F,G,J																																				
8200	822	F,G,J																																				
9100	912	F,G,J																																				
.010uF	103	F,G,J																																				
.015	123	F,G,J																																				
.015	153	F,G,J																																				
.018	183	F,G,J																																				
.022	223	F,G,J																																				
.027	273	F,G,J																																				
.033	333	F,G,J																																				
.039	393	F,G,J																																				
.047	473	F,G,J																																				
.056	563	F,G,J																																				
.068	683	F,G,J																																				
.082	823	F,G,J																																				
.10	104	F,G,J																																				
.12	124	F,G,J																																				

For packaging information, see pages 40 and 41.

RATINGS & PART NUMBER REFERENCE: STABLE TEMPERATURE CHARACTERISTICS — X7R

Cap	Cap Code	Cap Tol	C31X WVDC					C32X WVDC							C33X WVDC								C34X WVDC							C35X WVDC						
			50	100	200	500	1k	50	100	200	500	1k	1.5k	2k	50	100	200	500	1k	1.5k	2k	2.5k	3k	50	100	200	500	1k	2k	3k	50	100	200	500	1k	2k	3k
10pF	100	K,M,P,Z																																		
12	120	K,M,P,Z																																		
15	150	K,M,P,Z																																		
18	180	K,M,P,Z																																		
22	220	K,M,P,Z																																		
27	270	K,M,P,Z																																		
33	330	K,M,P,Z																																		
39	390	K,M,P,Z																																		
47	470	K,M,P,Z																																		
56	560	K,M,P,Z																																		
68	680	K,M,P,Z																																		
82	820	K,M,P,Z																																		
100	101	K,M,P,Z																																		
120	121	K,M,P,Z																																		
150	151	K,M,P,Z																																		
180	181	K,M,P,Z																																		
220	221	K,M,P,Z																																		
270	271	K,M,P,Z																																		
330	331	K,M,P,Z																																		
390	391	K,M,P,Z																																		
470	471	K,M,P,Z																																		
560	561	K,M,P,Z																																		
680	681	K,M,P,Z																																		
820	821	K,M,P,Z																																		
1000	102	K,M,P,Z																																		
1200	122	K,M,P,Z																																		
1500	152	K,M,P,Z																																		
1800	182	K,M,P,Z																																		
2200	222	K,M,P,Z																																		
2700	272	K,M,P,Z																																		
3300	332	K,M,P,Z																																		
3900	392	K,M,P,Z																																		
4700	472	K,M,P,Z																																		
5600	562	K,M,P,Z																																		
6800	682	K,M,P,Z																																		
8200	822	K,M,P,Z																																		
.010uF	103	K,M,P,Z																																		
.012	123	K,M,P,Z																																		
.015	153	K,M,P,Z																																		
.018	183	K,M,P,Z																																		
.022	223	K,M,P,Z																																		
.027	273	K,M,P,Z																																		
.033	333	K,M,P,Z																																		
.039	393	K,M,P,Z																																		
.047	473	K,M,P,Z																																		
.056	563	K,M,P,Z																																		
.068	683	K,M,P,Z																																		
.082	823	K,M,P,Z																																		
.10	104	K,M,P,Z	#					#																												
.12	124	K,M,P,Z																																		
.15	154	K,M,P,Z																																		
.18	184	K,M,P,Z																																		
.22	224	K,M,P,Z																																		
.27	274	K,M,P,Z																																		
.33	334	K,M,P,Z																																		
.39	394	K,M,P,Z																																		
.47	474	K,M,P,Z																																		
.56	564	K,M,P,Z																																		
.68	684	K,M,P,Z																																		
.82	824	K,M,P,Z																																		
1.0	105	K,M,P,Z																																		
1.2	125	K,M,P,Z																																		
1.5	155	K,M,P,Z																																		
1.8	185	K,M,P,Z																																		
2.2	225	K,M,P,Z																																		
2.7	275	K,M,P,Z																																		
3.3	335	K,M,P,Z																																		
3.9	395	K,M,P,Z																																		
4.7	475	K,M,P,Z																																		
5.6	565	K,M,P,Z																																		
6.8	685	K,M,P,Z																																		

	C330 shoulder bend lead configuration is standard for these cap codes.
#	X7R Dielectric--extended range value--Cap and DF measured @0.5Vrms.

For packaging information, see pages 40 and 41.

RATINGS & PART NUMBER REFERENCE
GENERAL PURPOSE TEMPERATURE CHARACTERISTIC – Z5U

Cap	Cap Code	Cap Tol	Style	C31X			C32X			C33X			C34X			C35X		
				WWDC			WWDC			WWDC			WWDC			WWDC		
				50	100	200	50	100	200	50	100	200	50	100	200	50	100	200
1000pF	102	M,P,Z																
1200	122	M,P,Z																
1500	152	M,P,Z																
1800	182	M,P,Z																
2200	222	M,P,Z																
2700	272	M,P,Z																
3300	332	M,P,Z																
3900	392	M,P,Z																
4700	472	M,P,Z																
5600	562	M,P,Z																
6800	682	M,P,Z																
8200	822	M,P,Z																
.010uF	103	M,P,Z																
.012	123	M,P,Z																
.015	153	M,P,Z																
.018	183	M,P,Z																
.022	223	M,P,Z																
.027	273	M,P,Z																
.033	333	M,P,Z																
.039	393	M,P,Z																
.047	473	M,P,Z																
.056	563	M,P,Z																
.068	683	M,P,Z																
.082	823	M,P,Z																
.10	104	M,P,Z																
.12	124	M,P,Z																
.15	154	M,P,Z																
.18	184	M,P,Z																
.22	224	M,P,Z																
.27	274	M,P,Z																
.33	334	M,P,Z																
.39	394	M,P,Z																
.47	474	M,P,Z																
.56	564	M,P,Z																
.68	684	M,P,Z																
.82	824	M,P,Z																
1.0	105	M,P,Z																
1.2	125	M,P,Z																
1.5	155	M,P,Z																
1.8	185	M,P,Z																
2.2	225	M,P,Z																
2.7	275	M,P,Z																
3.3	335	M,P,Z																
3.9	395	M,P,Z																
4.7	475	M,P,Z																
5.6	565	M,P,Z																
6.8	685	M,P,Z																

C330 shoulder bend lead configuration is standard for these cap codes.

For packaging information, see pages 40 and 41.